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Editors

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PREFACE

*We are delighted to publish our book entitled "**Advances in Engineering Science and Technology Volume I".** This book is the compilation of esteemed articles of acknowledged experts in the various fields of engineering science and technology providing a sufficient depth of the subject to satisfy the need of a level which will be comprehensive and interesting. It is an assemblage of variety of information about rapid advances and developments in various subjects. With its application oriented and interdisciplinary approach, we hope that the students, teachers, researchers, scientists and policy makers in India and abroad will find this book much more useful.*

The articles in the book have been contributed by eminent scientists, academicians. Our special thanks and appreciation goes to experts and research workers whose contributions have enriched this book. We thank our publisher Bhumi Publishing, India for taking pains in bringing out the book.

Finally, we will always remain a debtor to all our well-wishers for their blessings, without which this book would not have come into existence.

- Editors

CONTENT

EFFECT OF PH AND TEMPERATURE ON THE PARTIAL MOLAL VOLUME AND VISCOSITY COEFFICIENTS OF AQUEOUS SOLUTIONS OF SODIUM HEXAMETAPHOSPHATE

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Abstract:

Partial molal volumes and coefficients of viscosity of sodium hexametaphosphate (SHMP) solutions by varying the concentrations (0.016 to 0.1176 mol kg^{-1}) and temperatures (300 to 333 K) have been examined in acidic, natural and alkaline pH respectively. On increasing the concentration of sodium hexametaphosphate solution, partial molal volume increases while the viscosity decreases at different temperatures in acid, natural and alkaline pH respectively. The variations in the partial molal volume and coefficients of viscosity at different temperatures of SHMP solutions are higher at acidic pH compared to that of natural and alkaline pH respectively. These variations have been correlated to changes in the solute-solvent interactions.

Keywords: Sodium hexametaphosphate, partial molal volume, viscosity, density, solute-solvent interaction.

Introduction:

In the treatment of municipal and industrial water, sodium hexametaphosphate (SHMP) is employed to minimize the development of scale, corrosion, biofilm in pipes and other components (Abd-El-Khalek and Abc-El-Nabey, 2013). Sodium carbonate is added to SHMP to raise pH to 8.0–8.6 and to produce a number of SHMP products which are used for water softening (de Morais *et al*., 2020). Sodium polyphosphate polymers are based on repeating NaPO$_3$ units and water dissolvable polyphosphate glass comprises of circulation of polyphosphate chain lengths during the municipal water treatment (Haleh Al Ansari, 2021). SHMP is used as emulsifier in foods, maple syrup, milk based products and beverages (Food and Ingredients Colours, 2021).

The design and optimization of any chemical process should take into account important parameters such as density, viscosity and partial molal volume of a liquid (Christ et al., 2020). Understanding these features could provide insight into ion extraction, gas adsorption and mass /charge transfer processes. Changes in excess molar/molal volume and viscosity are sensitive to various types of associations and dissociations which occur between pure components and

solvents (Crini *et al*., 2018; Tu *et al*., 2018). The molecular packing, movements, intermolecular interactions and their strengths have been studied using these properties (Tu *et al*., 2021; Vekilov *et al*., 2022). The interaction of the component molecules can also be influenced by their size, shape and chemical nature. Furthermore, the study of thermodynamics of a homogeneous system also provides information towards understanding of molecular liquid structure and intermolecular interactions (Hachula *et al*., 2022; Reis, 1982; Lewis *et al*., 1961; Dincer *et al*., 2001). Volume, entropy and the free energy are determined by the state of the system and the amount of the substance. Partial molal volume is also an extensive property at constant temperature and pressure (Reis, 1982). The condition of the system and the amount of the material present determines the volume, entropy, or free energy (Dincer and Cengel, 2001; Timmermans, 1960). The simplest way of determining the partial molal volume of the solute would be to plot the changes in the volume of solution against the molality (Millero, 1970). Till date there are no reports on the measurement of partial molal volume of SHMP at different pH in spite of its wide variety of applications. In this article, variations in the partial molal volume and viscosity coefficients of sodium hexametaphosphate at different pH and temperatures have been reported.

Experimental:

Sodium hexametaphosphate [$(NaPO_3)_6$, MW: 611.78] was purchased from Thomas baker, India (assay 68%) and used as received.

Preparation of sodium hexametaphosphate solutions

Solutions of sodium hexametaphosphate (1, 2.5, 5 and 7.5 wt%) were prepared in distilled water separately and used as such (considered as natural; pH 5-6.5). Also sodium hexametaphosphate solutions (1, 2, 5 and 7.5 wt%) in the pH range of 2-3 were prepared by dissolving it in distilled water followed by the addition of concentrated hydrochloric acid separately.

Sodium hexametaphosphate solutions (1, 2.5, 5, 7.5 wt%) are prepared in the pH range of 10-12 in distilled water and the solution pH was maintained by the addition of 10% of sodium hydroxide solution.

Density of the above solutions were measured using density bottle having bulb volume of 25 mL. For each measurement, the density bottle was filled with required quantity of the solution and kept in water bath to attain thermal equilibrium. The density of each solution was determined in the temperature range of 300K to 333K and the partial molal volume is calculated.

The coefficients of viscosity of solutions have been measured using Ostwald's viscometer maintained at constant temperature (300K to 333K).

Results and Discussion:

By comparing the volume (v) of a binary solution containing n_1 number of moles of solvent and n_2 number of moles of solute, one can experimentally estimate the partial molal property. We examined the density of sodium hexametaphosphate solutions maintained at varied temperatures at acidic, natural, and alkaline pH. The partial molal volume of the solute in various solutions was determined using density data as a function of temperature and pH (Figure 1). In the temperature range of 303 to 333 K, the coefficients of viscosity of sodium hexametaphosphate solutions (1 to 7.5 wt%) were measured. The coefficients of viscosity (η) of sodium hexametaphosphate solutions determined at various pH values and temperatures are shown in Figure 2.
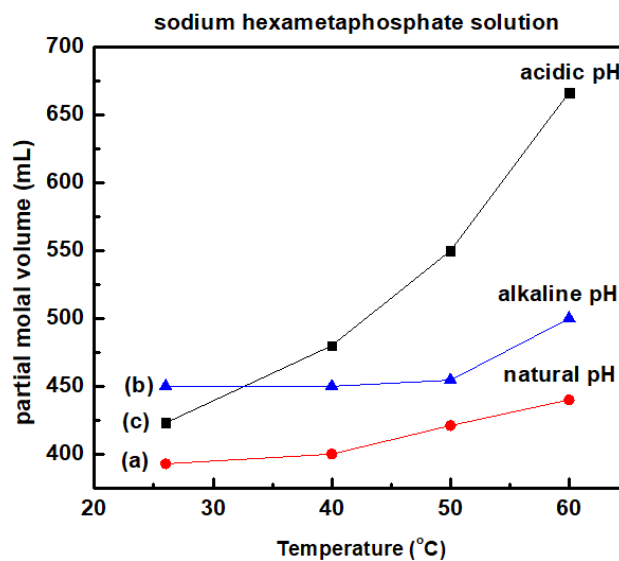

Figure 1: Partial molal volumes of sodium hexametaphosphate at different pH and temperatures
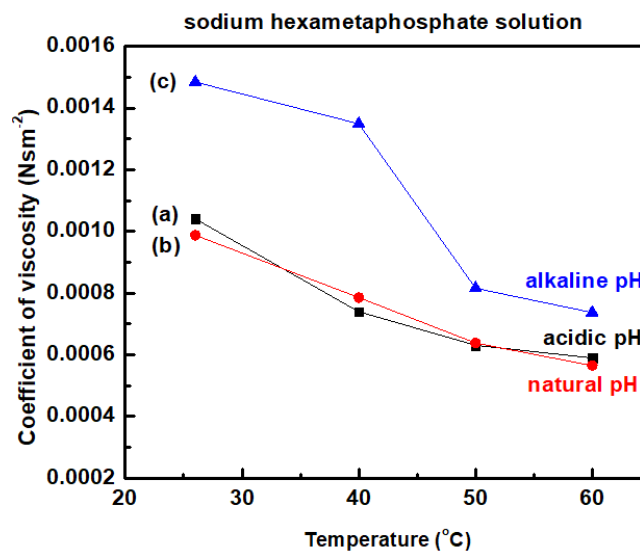
Figure 2: Coefficients of viscosity of sodium hexametaphosphate at different pH and temperatures

Sodium hexametaphosphate (SHMP) behave as polyanions and has been reported to get incorporated into polyelectrolyte aggregates having oppositely charged polycations. SHMP hydrolyzes in acidic conditions to sodium trimetaphosphate and sodium orthophosphate. While in alkaline pH, sodium hexametaphosphate solution converts into orthophosphate or pyrophosphate.

According to reports, sodium hexametaphosphate (SHMP), which exhibits polyanionic behaviour, can combine with polyelectrolyte aggregates that contain polycations with opposite charges. In acidic environments, SHMP hydrolyzes to sodium trimetaphosphate and sodium orthophosphate. Sodium hexametaphosphate solution changes into orthophosphate or pyrophosphate when the pH is alkaline. The transformation of sodium hexametaphosphate involves absorption of water by the metaphosphate and the reactions are

$$Na_6P_6O_{18} + 6H_2O \rightarrow 6NaH_2PO_4$$

or $Na_6P_6O_{18} + 3H_2O \rightarrow 3Na_2H_2P_2O_7$
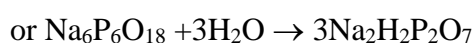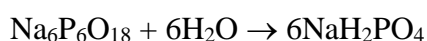
At various temperatures (300K to 333K), the partial molal volumes of sodium hexametaphosphate solutions increase from 423 to 666 mL in acidic pH. The amount changes from 392.85 to 440 mL in natural pH (300K to 333K). The partial molal volume of sodium hexametaphosphate solutions varies from 450 to 500 mL in alkaline pH (300K to 333K).

The coefficient of viscosity decreases with temperature (300K to 333K) from 1.0405×10^{-3} to 0.5896×10^{-3} Nsm^{-2} in acidic pH; 0.9874×10^{-3} to 0.5648×10^{-3} Nsm^{-2} in natural pH and 1.4842×10^{-3} to 0.7368×10^{-3} Nsm^{-2} in alkaline pH respectively. This clearly indicates that the viscosity and volume of SHMP changes significantly with variation in pH/temperature. This data provides significant information regarding the changes in their viscosity/partial molal volume during its use as an emulsifier/water softener in municipal water treatment.

Conclusion:

The outcome of this work shows that, while the coefficient of viscosity reduces in acidic pH, the partial molal volume increases significantly. This demonstrates unequivocally that sodium hexametaphosphate solutions prepared at various pH values show variation in their partial molal volumes and the coefficient of viscosity also changes significantly due to the conversion of sodium hexametaphosphate into various products due to their interactions with the solvent molecules with change in pH.

Acknowledgement:

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BIOSYNTHESIS OF SILVER NANOPARTICLES FROM *Ganoderma lucidum*

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Abstract

Reishi (*Ganoderma lucidum*) is one of the primary herbs of choice for any immune deficiency disease. It possesses a broad spectrum of immune-stimulating activities and anti-inflammatory and antiallergenic properties. It contains more than 100 oxygenated triterpenes, many of which exhibit a marked effect on the activity of NK cells. It has been reported to increase CD4 cells in vivo. It is also used as an effective antidepressant.In this investigation, our attention was focused on the preparation and evaluation of Bio-silver nanoparticles characterized using UV-VIS spec, and XRD. Finally, a UV-VIS confirms the reduction of Ag ionsAgNO3 solution to Ag nanoparticles XRD confirms the presence of silver and a crystalline substance. The study deals with the survey of the wild mushroom from the location of Tuticorin district in the local area and the study of characteristics, mycochemical analysis, and its applications of *Ganoderma lucidum.*

Keywords: Mushroom, *Ganoderma lucidum*, Silver Nanoparticles, XRD, UV-VIS.

Introduction:

Mushrooms are plant-like microorganisms, which grow like plants but are without chlorophyll. They depend on other organisms or plants for their nutrition. They are consumed worldwide for their high nutrition content. There are more than 200 species and only 22 are cultivable. Its nutrition is comparable to meat, milk, and egg. Mushrooms are rich in natural antioxidants, but they also accumulate a variety of secondary metabolites including phenoliccompounds polyketides, terpenes, and steroids, some of these compounds have tremendous importance to humankind andare useful as antibacterial, antiviral, and pharmaceutical activities as well as less toxic effects. Studies show that they show hepatoprotective, anticancer, leishmanicidal, anti-microbial, anti-diabetic, and immunomodulatory activities.The growth of mushrooms in fields and woodlands is very noticeable in a damp environment.

Reishi (*Ganoderma lucidum*) is one of the primary herbs of choice for any immune deficiency disease. It possesses a broad spectrum of immune-stimulatingactivities and anti-inflammatory and antiallergenic properties. It contains more than 100 oxygenated triterpenes, many of which exhibit a marked effect on the activity of NK cells. It has been reported to increase CD4 cells in vivo. It is also used as an effective antidepressant.

The present study deals with the survey of the wild mushroom firm the location of the Tuticorin district from the local area and the study of characteristics, mycochemical analysis, and its applications of Ganoderma lucidum.

Materials and Methods:

Collection of wild mushrooms

The 18 different types of specimens were collected from different locations in the rainy season from ourTuticorin District. The specimen was carefully uprooted by gently lifting them and holding the stipe gently but firmly close to the rhizomorph, thus carrying some soil along with it. This is to avoid damaging the tissue of the mushroom. Each specimen was carefully labeled before transporting to the laboratory. The specimens were air-dried and stored in transparent polythene bags that were loosely kept to allow for proper operation of the specimens.

Identification of sample

During collection, several types of mushrooms were collected and identified based on theircolor and morphology. At present, a totalof 3different types of mushrooms were collected for further studies.

Morphological characteristics

In this morphological identification method, the collected mushroom's morphology such as color, shape, size, cap's nature, and habitat was seen.

Macroscopic examination

Macroscopic characteristics of fresh mushrooms were noted after the collection place as well as in the laboratory.

Cultural characteristics

The fungal tissues were inoculated in media

Growth on potato dextrose agar

The potato dextrose agar plates were prepared and inoculated with the fungal culture and were incubated at room temperature for 2-3 days. After incubation, the plates were observed for the various colony characteristics on the media.

Spawn preparation

Sorghum or wheat grains were found to be the best substrates for Ganoderma spawn production (purkayastha *et al.,* 1976; Krishnamoorthy *et al*., 1997). During the preparation of thespawn culture, these substrates are half-cooked in water for about 30 min, and the excess water is usually drained before the grains are slightly air-dried and mixed thoroughly with 2% calcium carbonate (Theradimani *et al.,* 2001).This wet substrate is then transferred to an autoclavable glass bottle (usually 30 x 12 cm), which should be filled up to 75% volume and sterilized at 1.42 kg/cm² pressure for 2 hr. After cooling to ambient temperature, the bags should be aseptically inoculated with the Fungus mycelia, closed, and incubated at 30°C. After 15 to 20

days of incubation, complete colonization of the substrate by the Fungus mycelia should be observed, meaning that they can be used for the culture bed. Inoculation (phutela, *et al*. 2012; Pandey *et al*., 2000).

Cultivation of parameters:

1. Mushroom bed preparation

Cylindrical beds are prepared following the layer method of spawning. A layer of decomposing plant material is laid and sprinkles one tablespoon full of spawn the filled around the peripheral region. The second layer of processed the same plant material is filled and spawned as above. Repeat the process until the decomposing plant materials are finished. Every time before spawning, press with hand for making it compact. Finally, the bag is closedtightly with twine and the beds are incubated for spawn running under the semi-dark condition in a clean room. Spawn run will be completed in 12-15 days at 30-35°C.

2. Mycochemical analysis

The mushroom fungi Ganoderma lucidum extracts were subjected to qualitativechemical investigation to test for the presence of various phytochemicals in extracts.

2.1. Preparation of the mushroom extract

Whole mushrooms were shade dried and finely powdered. One gram of powder was extracted with 10ml solvents like Di Methyl Sulfoxide, N-butanol, and Ethyl Acetate. Incubate in a rotary shaker for 72 hours. The residue was filtered and the filtrate was used as a mushroom extract.

2.2. Test for Tannins

Ferric chloride Test: To 3ml of extract, 3ml of 10% ferric chloride solution was added. The blue-black color indicates the presence of tannins.

2.3. Test for Saponins

Foam Test: ml of extract was shaken vigorously with 5ml of water and observed for consistent foam, which indicates the presence of saponins

2.4. Test for Flavonoids

1 ml of extracted added with 5 drops of ferric chloride. The appearance of green color indicates thepresence of flavonoids

2.5. Test for Alkaloids

Mayer's Test: To 3ml of the filtrates, Iml o Mayer's reagent (potassium mercuric iodide) as added. The appearance of a white precipitate indicates the presence of alkaloids.

2.6. Test for Anthraquinones

To 1 ml of the extract, 2ml of distilled water, 3 drops of 10% aqueous ferric chloride and 3 drops of potassium ferrocyanide were added. The formation of the blue or green colorshowed the presence of anthraquinones.

2.7. Test for Terpenoid

5ml of the extract, 2ml of the chloroform, and followed by a drop of sulfuric acid. The formation ofthe brown color showed the presence of Terpenoids.

3. Paper chromatography

To take the WhatmanNol filter paper sheet with a 10 cm length and 5cm width Draw the line one or two cm above the base of the filter paper. Placed small circular marks along the baseline in such a way that the distance from the edge of the paper and the first spot and the distance between the adjacent spots are not less than 2.5cm.Calculate the Rf value of standard amino acids as well as those in the given mixture or sample as follows. Rf=distance traveled by amino acid/distance traveled by the solvent system. Identify the amino acids in the mixture of samples by comparing Rf values with those of applied standard amino acids.

4. Thin layer chromatography

A TLC plate (60F254 plates Merck, Darmstadt, Germany) is a sheet of metal that is coated with a thin layer of a solid absorbent-silica, A small amount of the extracts to be analyzed is spotted near the bottom of this plate, and run by the solvent system of Chloroform: Methanol: Distilled water. Toluene. After running the plate were dried at room temperature and the Re value was calculated based on the spot which is formed in the TLC plate

5. Moisture analysis

Three hundred grams of fresh mushroom was weighed into a moisture box and dried in an oven at 100-150c and cooled in a desiccator. The process of heating and cooling was peated till a constant weight was achieved.

The moisture content was calculated following the equation.

Moisture (%) -Initial Weight-Final Weight X 100 (Raghuramulu *et al.,* 2003)

6. Estimation of protein

The lowry solution should be prepared fresh, on the day of measurement. Though the individual solution for the lowry solution can be prepared in advance and then mixed on the day of measurement.

3.7. Synthesis of silver nanoparticle

1. Extracts Preparation

The dried mushroom sample was grounded into powder form using a mortar and pestle. 5g of powdered sample was extracted using water (200ml) via Soxhlet extracts at 80°C for 8 hours. Thus obtained extract was filtered through Whatman No:1 filter paper and then concentrated to 100ml under 60°C using a rotary evaporator. The extract was stored at 4°C in the refrigerator until further use (Milan Poudel, 2017).

2. Synthesis of silver nanoparticle

For the synthesis of silver nanoparticles, 10 ml of mushroom extract was added into250ml of a conical flask containing 90ml of 1mm (0.01) silver nitrate solution and incubatedat 60°C in dark also the stirring of the reaction solution was done with a different time intervals.The consequent reduction of silver ions (AG) was monitored periodically for 24 hours.After 4 hours of incubation, the color of the reaction mixture changed from light yellow to pale yellow color, further the color was changed into dark brown indicating the formation of AgNps (Gurunathan et al., 2013).

3. Purification of silver nanoparticles

The Ag-Nps formed were collected by centrifugation at 10,000 rpm for 30 minutes at4°C. The clear supernatant was discarded and the pellet of colloidal silver was washed three úmes with double distilled water to remove impurities and the unbound extract compound. Finally, Ag-Np was dried at 60°C in the hot air oven and was used for further characterization.

8. FTIR spectral interpretation

We have shown that FTIR spectroscopy is a very powerful tool with many applications, however, data interpretation is not straightforward. By nature, the total spectrum generated is a series function of absorbed energy response (hence the Fourier Transform portion of the name)

The absorbed bands presented in the spectrum are only somewhat discrete and degenerative. The particular "peak" of energy at a certain wavenumber can move around based on other chemical and matrix factors (as well as by the way the incident energy is introduced) Therefore we do not simply have a "look up" table to say what a particular band of energy will belong to. The spectrum must be interpreted as a whole system and therefore probably demands the most experienced analysts in all of the spectrographic techniques to correctly characterize the functionality presented some libraries can yield lookup information but these libraries are limited in scope and depth compared to the millions of industrial chemicals used, and also will not account for mixtures of chemicals which can yield erroneous search information.

9. XRD analysis procedure

Nanocrystalline materials have become a subject of both scientific and industrial importance in the past decade. The present work deals with the preparation of a-Fe and Ni powders by high-energy ball mill method and chemically prepared a-FeOs powders of nanocrystalline type respectively. There is a need to characterize the trace elements to check the purity of these samples. The results of trace element analysis of these nanocrystals by using PIXE characterization and size determination by XRD using the Debye-Scherrer formula with full-width at half-maximum (FWHM) have been discussed. Nano crystallinity is examined already by (TEM, FTIR, and MICRO-RAMAN) experiments done previously.

10. Antibacterial activity

The antibacterial activity of the mushroom extract was examined against various pathogenic bacteria such as salmonella sp, shigella sp, and streptococcus sp. Vibrio sp. Enterobacter sp. pseudomonas sp., by agar disc diffusion method. The Muller Hinton Agar plates were prepared. After the inoculation of test organisms, the discs were placed on the agar surface.

Result and Discussion:

1. Collection of specimen

Common Name:Lingzhi Mushroom

Scientific Name:*Ganoderma lucidum*

Taxonomy

Kingdom: Fungi

Division:Basidiomycota

Class :Agaricomycetes

Order : Polyporales

Family: Ganodermatacease

Genus: *Ganoderma*

Species: *lucidum*

2. Specimen collection

The specimens were collected inthe early morning from our Lakshmi Amurial polytechnic college. Totally 18 species were collected and the specimen was carefully uprooted by gently lifting them and holding the stipe but firmly close to the rhizomorph, thus carrying some soil along with it. This is to avoid damaging the tissue of the mushroom. Each specimen was carefully labeled before transporting to the laboratory. The specimens were air-dried and stored in transparent polythene bags that were loosely kept to allow for proper aeration of the specimens. Specimen selection among them specimen, I selected the Ganoderma because it is a predominant one and it is present all the time.

3. Moisture analysis

The moisture content was calculated following the equation,

Moisture (%)= Initial Weight-Final WeightX100

Weight of sample

$$=\frac{350-100}{100} \times 100$$

$$=250$$

The selected mushroom moisture content value is 250%

4. Preparation of the mushroom extract

Whole mushrooms were shade dried and finely powdered.One gram of powder was ted with 10ml solvents like Di Methyl Sulfoxide, N-butanol, and Ethyl Acetate. Incubate in y shaker for 72 hours. The residue was filtered and the filtrate was used as a mushroom extract

5. Mycochemical analysis

The present study indicates the presence of tannins, saponins, flavonoids, and alkaloids, in the extracts of selected fungi. The dimethyl sulfoxide extract of Ganoderma sp, the presence of saponins, flavonoids, and anthraquinone.

5.1. Test for Tannins

The result is positive because 3ml of extract and 3ml of 10% ferric chloride solution wasadded and the presence of a blue-black color indicates the presence of tannins in the sample.

5.2. Test for Saponins

Foam Tested positive because I'm of the extract was shaken vigorously with 5ml of water and observed for persistent foam indicating the presence of saponins in this sample.

5.3. Test for Flavonoids

The flavonoid test is positive because 1 ml of extracted added 5 drops of ferric chloride and appearance of green color was seen indicating the presence of flavonoids.

5.4. Test for Anthraquinones

The result is positive because of 1ml of extract, 2 ml of distilled water, 3 drops of 10%aqueous ferric chloride ($FeCl_3$), and 3 drops of potassium ferrocyanide were added and the formation of blue or green color was seen they indicate the presence of anthraquinones.

TEST	*Ganoderma sp.*
Tannins	+
Saponins	+
Flavonoids	+
Anthraquinones	+

6. Paper chromatography and this layer chromatography

Ganodermasp. In paper chromatography analysis the RS value of wee dimethyl sulfoxide and The Hf value are presented in a table based on the R-value following amino acids present in Ganoderma sp., valine, arginine, and threonine.

Ganoderma sp, In TLC analysis the Rf value was Dimethyl sulfoxide. The Rf value is presented in the table

Paper chromatography

Solvent	Distance Traveled By The Compound (Cm)	Distance Traveled By The Solvent Front (Cm)	Rf Value
Dimethyl sulfoxide	3	7.5	2.5

Thin layer chromatography

SOLVENT	Distance traveled by the compound (cm)	Distance traveled by the solvent front (cm)	Rf Value
Dimethyl sulfoxide	4.6	5.4	0.85

7. Fungi slide culture technique

This technique allows the intact morphology of the fungus to be seen under the microscope. The slide culture technique is the best for the microscopic examination of mold cultures. However it takes time, some fungi take months to sporulate, and even after months, only sterile hyphae can be seen. Time and the nature of the block of agar aredeterminant factors

8. Antimicrobial activity

In the present study, the extract of dimethyl sulfoxide in the mushroom extract showed activity against the organisms of *Salmonella,Shigella,Streptococcus,Staphylococci, Vibrio, E.coli*documented below antimicrobial activity in natural extracts depends not only on the presence of phenolic compounds but also on the presence of various secondary metabolites.

Type of extract	Test bacteria one of inhibition in (mm)					
	Salmonella	*Shigella*	*Pseudomonas*	*Streptococcus*	*Vibrio*	*E. coli*
Dimethyl sulfoxide	-	10mm	-	-	10mm	10mm

9. Synthesis of silver nanoparticle

9.1. Extracts Preparation

The dried mushroom sample was grounded into powder form using a mortar and pestle. 5g of powdered sample was extracted using water (200ml) via Soxhlet extracts at 80°C for 8 hours. Thus obtained extract was filtered through the Whatman No.1 filter paper and then

concentrated to 100ml under 60°C using a rotary evaporator. The extract was stored at 4°C in therefrigerator until further use.

9.2. Synthesis of Silver Nanoparticle

For the synthesis of silver nanoparticles, 10 ml of mushroom extract was added into 250ml of a conical flask containing 90ml of 1mm (0.01) silver nitrate solution and incubated at 60°C in dark also the stirring of the reaction solution was done in a different time interval.

The consequent reduction of silver ions (AC) was monitored periodically for 24 hours. After 4 hours of incubation, the color of the reaction mixture changed from light yellow to pale yellow color, further the color changed into dark brown indicating the formation of Ag Nps

9.3. Purification of Silver Nanoparticle

The Ships formed were collected by conjugation at 10000 RPMs for 30 minutes at PC. The clear supernatant was discarded and the pellet of colloidal silver was washed de tines with double distilled water to remove impurities and the unbood extract compound Finally Agipwas dried FC in the hot air oven and was used for further characterization

9.4. FTIR analysis

A strain of *Ganoderma lucidum* was obtained from the Mushroom, Cultures were grown for 20 days at 25°C on an orbital shaker in a Malom complete media Broth MCMB) containing glucose, 20 g peptone, 2 g ya extract, 2 g. 21P04, 1g. MgSO4. 7H20, 0.5g,KH2PO4, 0.46 g for 1 litter, and the broth were sterilized in an autoclave at 121°C for 20 min. Afterward,*Ganoderma lucidum*was inoculated on dis MCM froth and kept in an orbital chucker Incubator at 25°C. After 20 days the cultures were filtered through What man No 4 filter paper and centrifuged at 7000 rpm at 4°C for 10 min to separate cell mass from the mushroom complete medium bath. The supernatant was taken to the flanks and an equal volume of ethyl wetatewas added and kept in the cooker for 24 hours

After that, events were separated through a separating funnel. Separated solvents were concentrated in Vanes flash evaporator 4FC. Then the solvents were evaporated overnightThe metabolites were wrapped using 11PLC grade methanol and filtered using a 02pin syringe filter and stained 3 mi of metabolite for FT-IR analysis.

9.5. XRD analysis

Nanocrystalline materials have become a subject of both scientific and industrial importance in the past decade. The present work deals with the preparation of alpha-Fe and Ni powders by high-energy ball mill method and chemically prepared alpha-Fe2O3 powders of nanocrystalline type respectively. There is a need to characterize the trace elements to check the purity of these samples. The results of trace element analysis of these nanocrystals by using PIXE, characterization, and size determination by XRD using the Debye-Scherrer formula with

full-width at half-maximum (FWHM) have been discussed. Nanocrystalline is examined already by (TEM. FTIR and MICRO-RAMAN) experiments done previously.

Discussion:

Wild mushrooms and other fungi are a common sight on dead and decaying trees. Some kinds of fungus also grow on the trunks of live trees, decks, houses, and other wooden structures. All fungi are decomposers, which help break down plant material into fertile soil.The wild mushroom growing on a tree or log may be unattractive to look at, but they are performing an important job. Without mushrooms and other decomposers, dead wood mushrooms grow best in warm, damp conditions, and may not do as well in the weather is cool or dry. These fungi also prefer food containing plenty of nitrogen since this element helps them grow faster and larger.

Some wood fungi take the traditional mushroom or toadstool from when they fruit. These include such species as a sulfur tuft, a small yellow to green mushroom that prefers fallen logs, and honey mushroom a light brown edible species native to the northwestern United States. Golden pholiota, a slimy yellow genus of mushrooms and jelly fungi, transient yellow funnel or toadstool-shaped fungi that prefer dead branches. *Shitake mushrooms* popular in Asian cuisine, also grow on logs. Bird's nest fungi cup mushrooms and morels grow near dead wood, but don't look like a conventional mushroom

Mushroom belongs to a group of organisms known as fungi Mushroom is the fleshy, spore-bearing fruiting body of a fungus, typically produced above the ground on soil or its food source, mostly in forests. Mushrooms are an interesting group of fungi. Based on the morphological character and habitant. The *Ganoderma sp.* were collected.

The internal tissue is cut in aseptically and placed in potato dextrose agar is used to isolate the mycelium for controlled temperature. In the PDA agar is used to isolate the mycelium and it is by streaking method

Cereal grains are generally used as a spawning substrate. In our present study sorghum grains were used as a substrate for spawn preparation.

In the present study following my-chemical can present Tannins, Saponins Flavonoids, Alkaloid, and carbohydrates present in the selected mushroom

In the present study synthesized silver nanoparticles inhibit bacterial growth. The energetic study is also carryout following antibiotics can use streptomycin, amphibian, and erythromycin.

Conclusion:

G.lucidum is a well-known Asian herbal remedy with a long and impressive range of applications. Global consumption of *G, lucidum* is high, and a large, increasing series of patented and commercially available products that incorporate *G.lucidum* as an active ingredient are available as food supplements. These include extracts and isolated constituents in various

formulations, which are marketed all over the world in the form of capsules, creams, hair tonics, and syrups. With its growing popularity, many studies on *G.lucidum* composition. cultivation and reputed effects are being carried out, and some data support its positive health benefits, including anticancer effects; blood glucose regulation; antioxidant, antibacterial, and antiviral effects, and protection against liver and gastric injury. However, most studies have been performed on animals or in cell-culture models. Human experimental studies have often been small, and the results are not always supportive of the in vitro findings. Now, the great wealth of chemical data and anecdotal evidence on the effects of *G. lucidum* needs to be complemented by reliable experimental and clinical data from well-designed human trials to establish if the reported health-related effects are valid and significant. Many challenges are encountered due to a range of factors from dosage to production quality. Strategies for enhancing quality control procedures to define and standardize *G. lucidum* preparations are needed to determine mechanisms of action and to help characterize the active component(s) of this putative medicinal mushroom.

The *Ganoderma lucidum* mushroom is present in all dead plant matter and decomposing matter they containa high amount of antimicrobial activity and it's used all over the country for the use of medicinal purposes so the mushroom is continued for further study analysis in the future.

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R/W MODEL WITH CHARGE AND VARYING DECELERATION PARAMETER OF THE SECOND DEGREE IN B-D THEORY

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Abstract:

This chapter is devoted to studying the Viscous Robertson-Walker (R/W) model with a Polytropic equation of state with varying deceleration parameter of the second degree. In Brans-Dicke Theory of Gravitation, the stability of the cosmological model is found in case I and case II with the help of energy-momentum tensor for matter and the electromagnetic field. The exact solution of the R/W cosmological models are obtain with the help of a polytropic equation of state and variable cosmological constant. The kinematical and geometrical parameters are derived and analyzed in detail.

Keywords: Polytropic equation of state, varying deceleration parameter of the second degree, Brans-Dicke Theory, Robertson-Walker Model, Electromagnetic field, Bulk viscosity

Introduction:

One of the well-known scalar-tensor theories that have been able to define cosmological models with diverse contexts that support observational data is the Brans-Dicke (B-D) theory (1961). In their 2017 study, Singh and Bishi (2017) looked at the Brans-Dicke Theory's Bulk Viscous Cosmological Model with a New Time-Varying Deceleration Parameter. In Brans-theory Dicke's of gravity, Shaikh (2020) considered viscous dark energy cosmological models. Nimkar and Wath examined the Brans-Dicke Theory of Gravitation's Bianchi Type-IX Cosmological Model's Stability in 2022 (Nimkar and Wath, 2022). Some Viscous Holographic Dark Energy Cosmological Models of the Bianchi Type were derived (Santhi *et al.*, 2022) using the Brans-Dicke Theory. For more information, see Kumar and Beesham's (Kumar and Beesham, 2022) discussion of the Brans-Dicke theory's holographic dark energy. In this chapter, we looked into cosmological models with electromagnetic and B-D fields.

Metric and field equations

The spherically symmetric Robertson-Walker (R/W) metric is

$$ds^2 = dt^2 - R^2(t)\left[\frac{dr^2}{1-kr^2} + r^2(d\theta^2 + sin^2\theta \ d\varphi^2)\right] \tag{1}$$

where k is the curvature index which can take values $-1, 0, 1$.

The B-D theory of gravity is described by the action (in units $h = c = 8\pi G = 1$)

$$S = \int d^4x\sqrt{|g|}\left[\frac{1}{16\pi}\left(\phi R - \frac{\omega}{\phi}g^{sl}\phi_{,l}\phi_{,s}\right) + L_m\right] \tag{2}$$

where R represents the curvature scalar; g is the determinant of g_{ij}; ϕ is a scalar field; ω is a dimensionless coupling constant; L_m is the Lagrangian of the ordinary matter component.

The Einstein field equations in B-D theory of gravity [Weinberg (1972)] are given by

$$R_{ij} - \frac{1}{2}Rg_{ij} + \Lambda\, g_{ij} = -\frac{\kappa}{\phi}T_{ij} - \frac{\omega}{\phi^2}[\phi_{,i}\phi_{,j} - \frac{1}{2}g_{ij}\phi^{,s}\phi_{,s}] - \frac{1}{\phi}(\phi_{ij} - g_{ij}\phi_{;s}{}^{,s}) \qquad (3)$$

where

$$(3 + 2\omega)\phi_{;s}{}^{,s} = \kappa\, T, \qquad (4)$$

where $\kappa = 8\pi$, T is the trace of T_{ij}, Λ is the cosmological constant, R_{ij} is Ricci-tensor, g_{ij} is metric tensor and $\phi_{,i}$ is the partial differentiation with respect to x^i coordinate. The energy-momentum tensor with electromagnetic field [Bohra and Mehra (1978), Bykov et al. (2012)] is considered as

$$T_{ij} = M_{ij} + E_{ij} \qquad (5)$$

where

$$M_{ij} = (p + \rho)u_i u_j - \bar{p}g_{ij}, \qquad (6)$$

$$\bar{p} = p - \eta u^i{}_{;i} \qquad (7)$$

$$E_{ij} = -F_{il}F_j{}^l + \frac{1}{4}g_{ij}F_{lm}F^{lm} \qquad (8)$$

with $u_i(0,0,0,1)$, u_i is a four-velocity vector satisfying $u^j u_j = 1$, p is the pressure, ρ is the energy density and F_{il} is the electromagnetic field component.

Here a comma $(,)$ or semicolon $(;)$ followed by a subscript denotes partial differentiation or a covariant differentiation, respectively. Also, the velocity of light is assumed as unity.

The non-vanishing electromagnetic energy-momentum tensor $E_j{}^i$ are

$$E_1{}^1 = -E_2{}^2 = -E_3{}^3 = E_4{}^4 = -\frac{1}{2}g^{11}g^{44}F^2{}_{14} = \frac{1}{2}\frac{1-kr^2}{R^2}F^2{}_{14} \qquad (9)$$

The gravitational variable [Weinberg (1972)] is defined as

$$G = \frac{1}{\phi}\left(\frac{4+2\omega}{3+2\omega}\right) \qquad (10)$$

The deceleration parameter is defined as

$$q = -\frac{R\ddot{R}}{\dot{R}^2} \qquad (11)$$

Solutions of field equations

Assuming Brans-Dicke scalar field ϕ to be a function of time t only, the metric (1) along with field equations (3)-(5) gives

$$\frac{k}{R^2} + \frac{\dot{R}^2}{R^2} + 2\frac{\ddot{R}}{R} - \Lambda = -\frac{8\pi\bar{p}}{\phi} - \frac{4\pi}{\phi}\frac{1-kr^2}{R^2}F^2{}_{14} - \frac{\omega}{2}\frac{\dot{\phi}^2}{\phi^2} - 2\frac{\dot{R}}{R}\frac{\dot{\phi}}{\phi} - \frac{\ddot{\phi}}{\phi} \qquad (12)$$

$$3\left(\frac{k}{R^2} + \frac{\dot{R}^2}{R^2}\right) - \Lambda = \frac{8\pi\rho}{\phi} + \frac{4\pi}{\phi}\frac{1-kr^2}{R^2}F^2{}_{14} + \frac{\omega}{2}\frac{\dot{\phi}^2}{\phi^2} - 3\frac{\dot{R}}{R}\frac{\dot{\phi}}{\phi} \qquad (13)$$

$$(3 + 2\omega)\left[3\frac{\dot{R}\dot{\phi}}{R} + \ddot{\phi}\right] = 8\pi(\rho - 3\bar{p}), \tag{14}$$

From Eqs. (12), (13), and (14), we get

$$6\left(\frac{k}{R^2} + \frac{\dot{R}^2}{R^2} + \frac{\ddot{R}}{R}\right) - 4\Lambda = -\frac{8\pi}{\phi}\frac{1-kr^2}{R^2}F^2_{14} + \omega\left[6\frac{\dot{R}}{R}\frac{\dot{\phi}}{\phi} + 2\frac{\ddot{\phi}}{\phi} - \frac{\dot{\phi}^2}{\phi^2}\right] \tag{15}$$

Here, we consider

$$\phi = \phi_0 R^{\frac{1}{\omega}} \tag{16}$$

ϕ_0 is a constant.

Using eq. (16), (15) becomes

$$F^2_{14} = \frac{\phi_0}{8\pi}\frac{R^{\frac{1+2\omega}{\omega}}}{1-kr^2}\left[\left(\frac{1-2\omega}{\omega}\right)\frac{\dot{R}^2}{R^2} - 4\frac{\ddot{R}}{R} - \frac{6k}{R^2} + 4\Lambda\right] \tag{17}$$

The scale factor [Bakry and Shafeek (2019)] is assumed as

$$R(t) = \frac{[t(4n-t)]^{\frac{1}{8n^2}}}{(2n-t)^{\frac{1}{4n^2}}} \tag{18}$$

where n is a constant greater than zero.

From eq. (18) and (11), we get

$$q = (8n^2 - 1) - 12nt + 3t^2 \tag{19}$$

Brans-Dicke scalar field and Gravitational variable are

$$\phi = \phi_0\frac{[t(4n-t)]^{\frac{1}{8\omega n^2}}}{(2n-t)^{\frac{1}{4\omega n^2}}} \quad , \quad G = \left(\frac{4+2\omega}{3+2\omega}\right)\phi_0^{-1}\frac{[t(4n-t)]^{-\frac{1}{8\omega n^2}}}{(2n-t)^{-\frac{1}{4\omega n^2}}} \tag{20}$$

Spatial volume, Hubble's parameter, and Scalar expansion are given by

$$V = \frac{[t(4n-t)]^{\frac{3}{8n^2}}}{(2n-t)^{\frac{3}{4n^2}}}, \quad H = \frac{1}{t(2n-t)(4n-t)} \quad , \quad \Theta = \frac{3}{t(2n-t)(4n-t)} \tag{21}$$

In this chapter, the Cosmological Term [Al-Rawaft (1998] is considered as

$$\Lambda = a\left(\frac{\dot{R}}{R}\right)^2 + b\frac{\ddot{R}}{R}$$

and, Polytropic equation of state [Sarkar (2016), Kleidis and Spyrou (2015), Rahman and Ansari (2014), Malekjani (2013)] as

$$p = \alpha\rho^l \tag{22}$$

where α and l are polytropic constant and index, respectively.

Case I: Flat model $k = 0$

Using eq. (18), eq. (17), (12) & (13) becomes

$$F^2_{14} = \frac{\phi_0\frac{[t(4n-t)]^{\frac{(1+2\omega)}{8\omega^2 n^2}}}{(2n-t)^{\frac{(1+2\omega)}{4\omega^2 n^2}}}}{8\pi}\left[B_1\left\{\frac{1}{t(2n-t)(4n-t)}\right\}^2 + B_2\frac{8n^2-12nt+3t^2}{t(2n-t)(4n-t)}\right] \tag{23}$$

$$\bar{p} = -\frac{\phi_0 \frac{[t(4n-t)]^{\frac{1}{8\omega n^2}}}{(2n-t)^{\frac{1}{4\omega n^2}}}}{8\pi}\left[L_1\left\{\frac{1}{t(2n-t)(4n-t)}\right\}^2 + L_2\frac{8n^2-12nt+3t^2}{t(2n-t)(4n-t)}\right] \tag{24}$$

$$\rho = \frac{\phi_0 \frac{[t(4n-t)]^{\frac{1}{8\omega n^2}}}{(2n-t)^{\frac{1}{4\omega n^2}}}}{8\pi}\left[M_1\left\{\frac{1}{t(2n-t)(4n-t)}\right\}^2 + M_2\frac{8n^2-12nt+3t^2}{t(2n-t)(4n-t)}\right] \tag{25}$$

Now, restricting the distribution by considering equation (22) and using eq. (7), the explicit form of physical quantities p and η are obtained as

$$p = \alpha\left[\frac{\phi_0 \frac{[t(4n-t)]^{\frac{1}{8\omega n^2}}}{(2n-t)^{\frac{1}{4\omega n^2}}}}{8\pi}\left\{M_1\left\{\frac{1}{t(2n-t)(4n-t)}\right\}^2 + M_2\frac{8n^2-12nt+3t^2}{t(2n-t)(4n-t)}\right\}\right]^l \tag{26}$$

$$\eta = \frac{\alpha t(2n-t)(4n-t)}{3}\left[\frac{\phi_0 \frac{[t(4n-t)]^{\frac{1}{8\omega n^2}}}{(2n-t)^{\frac{1}{4\omega n^2}}}}{8\pi}\left\{M_1\left\{\frac{1}{t(2n-t)(4n-t)}\right\}^2 + M_2\frac{8n^2-12nt+3t^2}{t(2n-t)(4n-t)}\right\}\right]^l +$$

$$\frac{t(2n-t)(4n-t)\phi_0 \frac{[t(4n-t)]^{\frac{1}{8\omega n^2}}}{(2n-t)^{\frac{1}{4\omega n^2}}}}{24\pi}\left[L_1\left\{\frac{1}{t(2n-t)(4n-t)}\right\}^2 + L_2\frac{8n^2-12nt+3t^2}{t(2n-t)(4n-t)}\right] \tag{27}$$

Case II: Open model $k = -1$

Using eq. (18), eq. (17), (12) & (13) becomes

$$F^2{}_{14} = \frac{\phi_0 \frac{[t(4n-t)]^{\frac{(1+2\omega)}{8\omega^2 n^2}}}{(2n-t)^{\frac{(1+2\omega)}{4\omega^2 n^2}}}}{8\pi(1+r^2)}\left[B_1\left\{\frac{1}{t(2n-t)(4n-t)}\right\}^2 + B_2\frac{8n^2-12nt+3t^2}{t(2n-t)(4n-t)} + 6\frac{\{t(4n-t)\}^{\frac{-1}{8n^2}}}{(2n-t)^{\frac{-1}{4n^2}}}\right] \tag{28}$$

$$\bar{p} = -\frac{\phi_0 \frac{[t(4n-t)]^{\frac{1}{8\omega n^2}}}{(2n-t)^{\frac{1}{4\omega n^2}}}}{8\pi}\left[L_1\left\{\frac{1}{t(2n-t)(4n-t)}\right\}^2 + L_2\frac{8n^2-12nt+3t^2}{t(2n-t)(4n-t)} + 2\frac{\{t(4n-t)\}^{\frac{-1}{8n^2}}}{(2n-t)^{\frac{-1}{4n^2}}}\right] \tag{29}$$

$$\rho = \frac{\phi_0 \frac{[t(4n-t)]^{\frac{1}{8\omega n^2}}}{(2n-t)^{\frac{1}{4\omega n^2}}}}{8\pi}\left[M_1\left\{\frac{1}{t(2n-t)(4n-t)}\right\}^2 + M_2\frac{8n^2-12nt+3t^2}{t(2n-t)(4n-t)} - 3\frac{\{t(4n-t)\}^{\frac{-1}{8n^2}}}{(2n-t)^{\frac{-1}{4n^2}}}\right] \tag{30}$$

Again, restricting the distribution by considering equation (22) and using eq. (7), we obtain the explicit form of physical quantities p and η as

$$p = \alpha \left[\frac{\phi_0 \frac{[t(4n-t)]^{\frac{1}{8\omega n^2}}}{(2n-t)^{\frac{1}{4\omega n^2}}}}{8\pi} \left\{M_1 \left\{\frac{1}{t(2n-t)(4n-t)}\right\}^2 + M_2 \frac{8n^2 - 12nt + 3t^2}{t(2n-t)(4n-t)} - 3 \frac{\{t(4n-t)\}^{\frac{-1}{8n^2}}}{(2n-t)^{\frac{-1}{4n^2}}}\right\}\right]^l \tag{31}$$

$$\eta = \frac{\alpha t(2n-t)(4n-t)}{3} \left[\frac{\phi_0 \frac{\{t(4n-t)\}^{\frac{1}{8\omega n^2}}}{(2n-t)^{\frac{1}{4\omega n^2}}}}{8\pi} \left\{M_1 \left\{\frac{1}{t(2n-t)(4n-t)}\right\}^2 + M_2 \frac{8n^2 - 12nt + 3t^2}{t(2n-t)(4n-t)} - 3 \frac{\{t(4n-t)\}^{\frac{-1}{8n^2}}}{(2n-t)^{\frac{-1}{4n^2}}}\right\}\right]^l +$$

$$\frac{t(2n-t)(4n-t)\phi_0 \frac{\{t(4n-t)\}^{\frac{1}{8\omega n^2}}}{(2n-t)^{\frac{1}{4\omega n^2}}}}{24\pi} \left[L_1 \left\{\frac{1}{t(2n-t)(4n-t)}\right\}^2 + L_2 \frac{8n^2 - 12nt + 3t^2}{t(2n-t)(4n-t)} + 2 \frac{\{t(4n-t)\}^{\frac{-1}{8n^2}}}{(2n-t)^{\frac{-1}{4n^2}}}\right] \tag{32}$$

where $B_1 = \frac{\{4(a+b)-6\}\omega+1}{\omega}$, $B_2 = 4(1-b)$, $L_1 = \frac{6\{(a+b)-1\}\omega^2 + 5\omega + 2}{2\omega^2}$, $L_2 = \frac{(2-3b)\omega-1}{\omega}$,

$M_1 = \frac{18\omega - 10(a+b)\omega + 3}{2\omega}$, $M_2 = (5b-4)$.

Cosmological constant takes the form

$$\Lambda = (a+b) \left\{\frac{1}{t(2n-t)(4n-t)}\right\}^2 - b \frac{8n^2 + 12nt + 3t^2}{t(2n-t)(4n-t)} \tag{33}$$
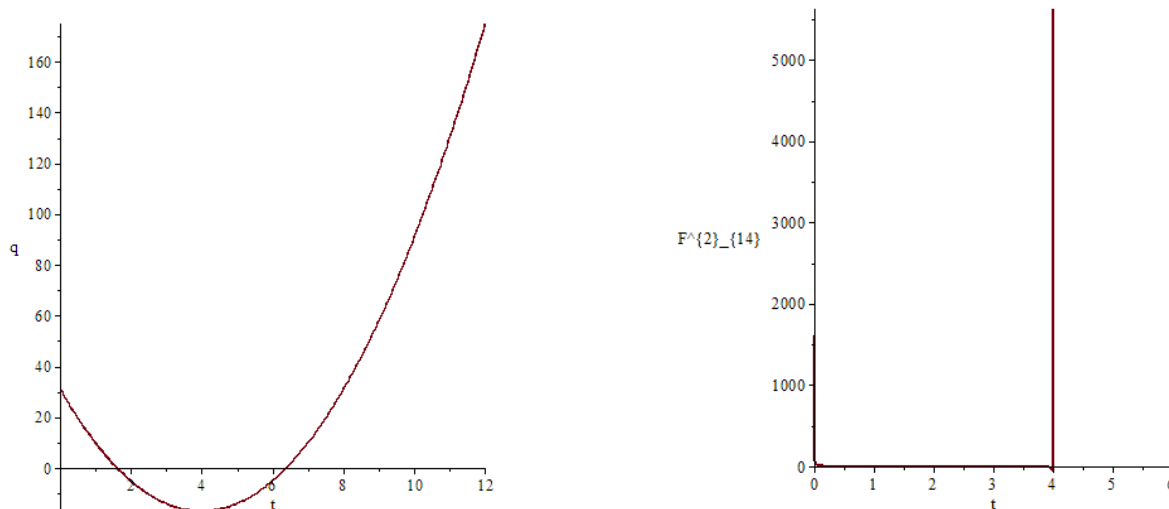
Figure 1: Graph of q & $F^2{}_{14}$ $vs.\,t$
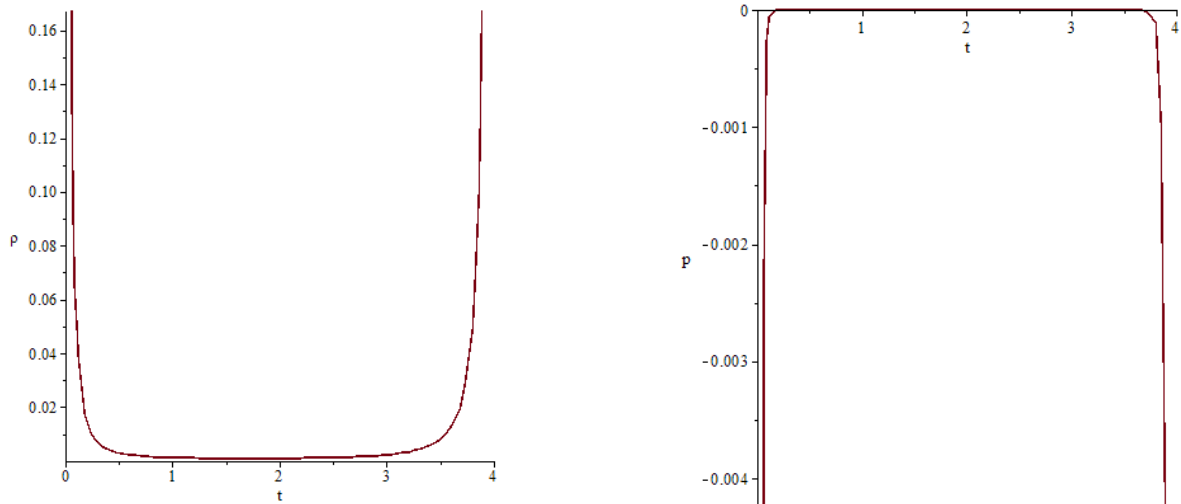
Figure 2: Graph of ρ & p $vs.$ t
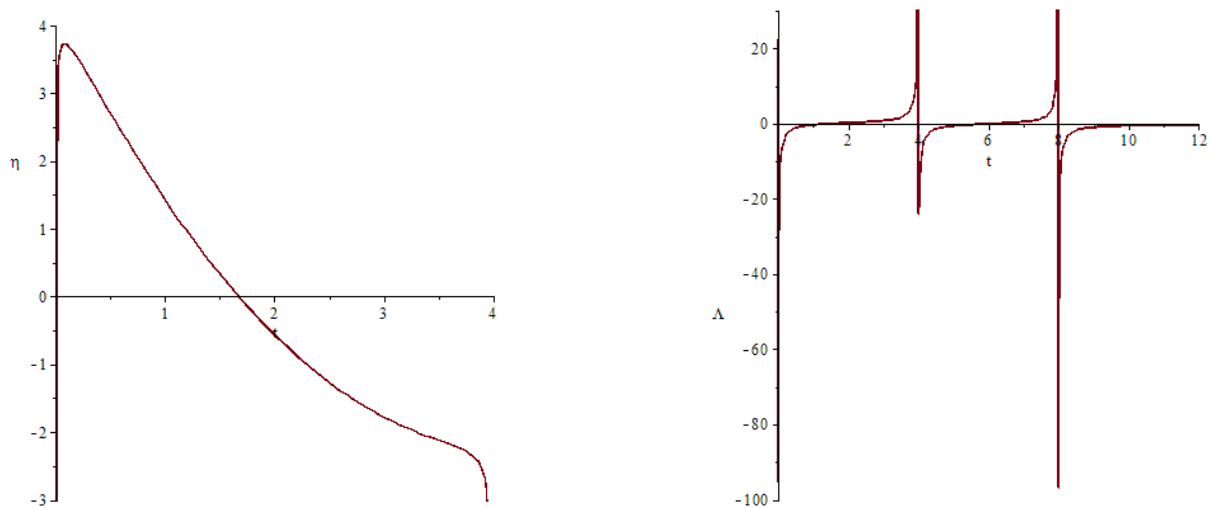
Figure 3: Graph of η & Λ $vs.$ t

Conclusions:

In this chapter, a particular form of the scale factor is considered, which gives a varying deceleration parameter of the second. A new exact solution of B-D Einstein's field equations for R/W space-time in the presence of Bulk viscosity. The model expands for $0 \leq t \leq 2n$ and then starts to contract for $2n \leq t \leq 4n$, the Universe passes through a big rip (at $t = 2n$) and then retreats as it was in the moment of the big bang (at $t = 4n$). The deceleration parameter shows early deceleration, in the middle $\{t \in [1.9, 6.1]\}$ with acceleration, then a late deceleration phase [ref Figure 1]. For $\omega > 40000$ [Will (2006)], F_{14}^2 changes as time increases and reaches an infinitely large value at $t = 4$ Gyrs [ref Figure 1]. Moreover, the process repeats itself for the $t \in [0, 2n]$ and $t \in [2n, 4n]$. Here, the energy density is positive and remains, so as time increases, it decreases from a very high value at the beginning, then remains constant for some

time; finally, it increases to infinitely large [ref Figure 2]. The pressure of the models changes in such a manner that it beahaves exactly in inverse way as in case of density ie. in negative direction [ref Figure 2]. From equation (20), we observe that the scalar field $0 \leq \phi \leq \infty$ as $0 \leq t \leq 2n$ and ϕ changes from ∞ to 0 as $2n \leq t \leq 4n$. The behavior of the G at the cosmic time $t \in [2n, 4n]$ is inverse behavior for $t \in [0, 2n]$. This helps in expanding the model universe and contraction. It is observed that the cosmological term-Λ changes with time [ref Figure 3]. For non-dust cases, dark energy models such as phantom energy ($\alpha < -1$) or quintessence ($-1 < \alpha < 0$), or vacuum fluid ($\alpha = -1$) can be found. The Bulk viscosity starts with a positive value and after $t \approx 3.9$ it becomes negative. The presence of negative Bulk viscosity in this model would help to propel the flow with negative pressure. For the present models, $a = 0.9, b = 0.8, n = 2, \omega = 40001, \alpha = -1, l = 3$ are taken into consideration for drawing figures. For different values of n the models will behave similar nature but with different time duration. According to our model, the spatially open and flat universes are allowed, they meet the requirements of the positive energy density, and these models are acceptable.

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POTENTIAL USES OF NANOTECHNOLOGY IN AGRICULTURE SUSTAINABILITY: CONCERNS NOW RAISED

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Abstract:

Nanotechnology has enormous potential for improving the living conditions of individuals through applications in agricultural and food systems. Agricultural production, foods, and natural assets are all part of the concerns about sustainability, adaptability, human health, and a healthy existence. The goal of nanotechnology in agriculture is to limit pesticide dissemination, reduce nutrient losses in fertilizations, and boost production through pest and nutrient control. As a result, nanotechnology would give green and effective solutions for managing predatory insects in agriculture without affecting the environment. This chapter focuses on traditional insect pest control tactics, the constraints of chemical pesticide usage, and the promise of nanoparticles in control of insect pests as current approaches to nanotechnology.

Keywords: Agro-technology, sustainability, nanomaterial, crop nutrition

Introduction:

Agriculture has been an integral part of daily life for thousands of years. Prior to agriculture, mankind were able to exist by hunting and gathering. Humans did not begin to thrive until the change to organised agricultural sowing and harvesting occurred. Humans created technologies and methods to increase agricultural productivity and provide more efficient means of survival. Agriculture may have a huge impact on the economy. Agriculture provides a living for 58% of Indians. Over the previous 14 years, agriculture production in India has climbed by 11%, from 87 USD billion to 397 USD billion. Furthermore, agriculture's contribution to India's GDP rose from 17.8% in 2019-20 to 19.9% in 2020-21. With $133.1 billion in agricultural exports, China has overtook the United States to become the world's leading exporter. Agriculture accounts for 25% of Brazil's GDP. Agriculture is also worth $7 trillion to the US economy (TG ADMIN STATISTICS DATA 2022). Global food safety is heavily reliant on crops and their supply, which require significant increases to bridge the production-demand imbalance. Because of the population growth, which is predicted to reach 9.7 billion by 2050, the need for improved food production has been much more apparent in recent years (Kah *et al.,* 2019). The world's expanding population and restricted cultivable agricultural land zones have led in the

development of new agro-technologies for farming to preserve agricultural output while protecting the environment. Fertilizers and pesticides usage has expanded internationally in recent decades, resulting in soil nutrient loss as a result of its cumulative addition to improve agricultural output, at the expense of soil health and mounting environmental challenges (Verma *et al.,* 2022). As a fundamental concept of sustainable agriculture, minimal agrochemicals should be used in order to protect the ecosystem and save species diversity. Furthermore, agricultural productivity should be characterized by minimal inputs, lower production costs, and higher net returns (Singh *et al.,* 2021). As a result, research into nanotechnology applications for agriculture has made significant progress because to its capacity to give viable and speedy solutions crucial for sustainable agriculture (Zulfiqar and Ashraf, 2021). Nanomaterial (NMs) are any materials having at least one dimension smaller than 100 nm .This extreme microscopic size, along with its distinctive features, opened up new avenues for improving agricultural output under a variety of environmental stress (Diaa Abd El-Moneim *et al.,* 2021). Nanoparticles (NPs) of 1-100 nm diameter that can be natural or bioengineered have dramatically different physical and chemical characteristics (Rajput *et al.,* 2021; Verma *et al.,* 2022), and are accessible as commercialized nanofertilizers (NFs) all over the world. NPs help the nitrogen cycle by increasing enzyme activity and promoting soil environmental friendly microorganisms. Ag(silver) nanoparticles have also demonstrated to enhance the density and number of diazotrophic bacteria in ground-soil, however CuO nanoparticles induced plant growth promoting bacteria (PGPR) in the rhizosphere of *Salvia miltiorrhiza L.* (red sage) with positive use of NFs in crop production (Shah *et al.,* 2014; Wei *et al.,* 2021). Nanotechnology is a study of small particles that has been shown to be a low-cost, effective, and environmentally safe solution for environmental rehabilitation. (yadav. 2021) this chapter will go through several uses of nanotechnology in agriculture sector.

Agriculture using nanomaterials

Nanomaterials have several promising uses in agriculture, including increasing crop yield and improving health of soil, as discussed in this section. We show diverse breakthroughs in the fields of nanobiosensors, nano-enabled rehabilitate of soil, nanofertilizers, nanoherbicides, nanopesticides and so on.

1. Nano-Fertilizers: A reliable source of crop nutrition

The invention of fertilisers is considered to be the most standard approach to boosting plant inner and outer growth by enhancing nutrient availability and mineral delivery efficiency. Chemical fertilisers supply critical nutrients to plants for optimal crop harvesting yield growth and help to food security. However, due to diminishing nutrients in soil, worldwide shortages of water, and a loss in fertile areas, the overuse of artificial fertilisers has been common in recent years (Singh *et al.,* 2021). As reported by the Food and Agriculture Organization (FAO), total

mineral fertiliser usage in agriculture reached approximately 48.5 megatonnes phosphate (P_2O_5), 110 megatonnes nitrogen(N), and 38.70 megatonnes potash(K_2O) in 2016, representing an increase of 34%, 40%, and 45%, respectively, over 2002(FAO., 2018). Such widespread fertiliser usage poses a significant danger to environmental sustainability, since it is known to cause polluted ground-water, soil degradation, green gas emissions, heavy metal contamination, and human health risks (Sharma *et al.,* 2017; Savci and Serpil, 2012). Nanomaterials used as fertilizers may offer advantages such as crop enhancement and lower eco-toxicity (Alaa Y. Ghidan and Tawfiq M. Al Antary.,). Nanofertilizers are referred to as "smart" carriers for macro/micronutrients because they improve the availableness and capacity to reach of active substances to plant sections, which resulting in higher crop harvesting yields and healthier vegetation. For example, macronutrients (like calcium, potash, magnesium, phosphorus, and nitrogen) and micronutrients (like iron, zinc, manganese, and copper) can be encapsulated within NPs coated with nano-films or agents and supplied directly in the form of nano-emulsions (Ghormade *et al.,* 2011; Kah *et al.,* 2018). In addition to supplying various nutrients at the same time, minimising nutrient loss, the nanolayers on the particles can assist retain the nutrients strongly because of their higher surface tension (Lavicoli *et al.,* 2017; Dimkpa *et al.,* 2017). The secured nutrients are given to the plant's specified locations, preventing nutrient loss (Kah *et al.,* 2018; Liu *et al.,* 2015; Rico *et al.,* 2011). Chitosan, calcite, silica, metal oxide NPs (titanium oxide NPs, zinc oxide NPs, copper oxide NPs, silica oxide NPs), carbon nanotubes, hydroxyapatite, mesoporouse silica, nanoclays, magnetite and zeolites are the most often utilised engineered materials in nano-enabled fertilizer for controlled nutrient release and delivery (Guo *et al.,* 2018; Xiumei *et al.,* 2005).Nanofertilizers helps in increase agricultural sustainability by lowering conventional fertilizer manufacturing costs.

2. Nanopesticides: An effective pest controller

Nanoparticles can also be used to repel pests and isects. Nanoparticles can be employed to create novel formulations such as pesticides, insecticide, and insect repellent (Barik *et al.,* 2008; Gajbhiye *et al.,* 2009). A recent discovery nanoencapsulated pesticide formulation has better dissolution, selectivity, and penetration, as well as delayed release properties. (Prasad *et al.,* 2017). These benefits are mostly obtained by either preventing the encapsulated active components from enzymatic degradation or boosting their pest control performance for a longer length of time. The development of nanoencapsulated pesticides reduced pesticide dose and human exposure to them, making crop protection more ecologically benign (Nuruzzaman *et al.,* 2016).

Microencapsulation-like nanoencapsulation is help to improve the quality of intended distribution of chemicals to the desired biological process. Recently, a few chemical firms have publicly promoted nanosized insecticides for sale as "microencapsulated insecticides." Some

Syngenta (Switzerland) products, like Penncap-M, Subdue MAXX, Karate ZEON, Ospray´s Chyella, and BASF microencapsulated insecticides, may be nanoscale compatible (Gouin, 2004). Nano-insecticides (especially nanosilicate-alumina (SiO_2) and inorganic NPs) have the potential to pave the way for the advancement of long-term pest management techniques. Nanosized alumina (NSA), for example, shown remarkable insecticidal effects against pests from the Coleoptera (Oryzaephilus surinamensis, Sitophilus oryzae,), Diptera (Ceratitis capitate), and leaf-cutting ants (Stadler *et al.,* 2018 and López-García *et al.,* 2018). As a result Inorganic nanosized alumina may give a less costly and more trustworthy choice for insect pest control when comparing to currently existing insecticides, and such development may open up new paths for Nanomaterials pest management technologies. (Prasad *et al.,* 2014).

3. Nanoherbicide: A powerful weed killer

Weeds can be easily eliminated by destroying their seeds in the soil and preventing them from germinat when the sessional weather and soil state are beneficial for their development. Nanoherbicides, due to their tiny size, will be able to mix with the soil, remove weeds in an environmentally benign manner without leaving poisonous substances, and inhibit the emergence of weed species that have developed resistant to traditional weedicides. Weeds live and spread via subterranean structures like deep roots and tubers. Ploughing diseased fields while manually clearing weeds might propagate these undesired plants to uninfected regions. The use of nanotechnology application is the same whether it is owing to a nanosized active component or the formation of a nanosized formulation via the use of an adjuvant. If the active substance is paired with a sophisticated delivery mechanism, herbicide will be sprayed only when necessary based on the circumstances of the agricultural field. Soils polluted with weed growth and weed seeds provide lower agricultural production. Improvements in herbicide efficacy through the application of nanotechnology might result in increased crop output without inflicting any harm to farm workers who are meant to manually clear weeds if no herbicides are used (Prasad *et al.,* 2014).

4. Nano-biosensors

Many benefits of the physical-chemical characteristics of nanoscale materials can also be used in the construction of biosensors (Sagadevan and Periasamy, 2014). Sensors are advanced technologies that response to biological, chemical, and physical elements and turn the responses into a signal or output that humans can use. (NNCO. 2019). Nanobiosensors are analytical devices in which a biological material's immobilised layer comes into touch with a sensor, which analyses the biological signal and transforms it to an electrical signal (Dwivedi *et al.,* 2016). Biosensors provide a novel analytical instrument with significant applications in the environment, clinical diagnostics, and agriculture. In agriculture, nanobiosensors can detect a wide range of fertilisers, herbicides, pesticides, insecticides, diseases, moisture, and other

contaminants. Identify the Importance of Nanomaterials in Agriculture soil pH and their regulated application can help to improve sustainable agriculture by increasing crop production (Rai *et al.,* 2012).

Conclusion:

Nanotechnology is an exciting technology that has the potential to transform the food and agriculture industries. Nanoparticles provide a stunning platform for a wide variety of biological applications. It invites more researcher scholars to go for future discoveries in the domain of electrochemical sensors, biosensors, healthcare, medicine and agriculture since it gives a one-step approach for biosynthesis of nanoparticles. New research also seeks to improve the efficiency with which plants utilise water, pesticides, and fertilisers, as well as to minimise pollution and also make agriculture more environmentally friendly (Suman et al., 2010). Agrochemicals, such as fertilisers and pesticides, are now administered to soil or plants by spray or drenching. Nanoparticles are able to recognize and treating any illness or malnutrition before symptoms appear. Furthermore, novel agro-nanotech products are having difficulty reaching the market, making agriculture a marginal industry for nanotechnology. This might be owing to the comparatively high manufacturing costs of nanotech items, ambiguous technological benefits, and legal uncertainty. As a result, it is critical to raise knowledge about the potential benefits of Nanomaterials in agriculture in order to pique the general public's interest and acceptance.

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NANOTECHNOLOGY FOR REMEDIATION OF GROUNDWATER CONTAMINANTS

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Abstract:

Groundwater is an important component of terrestrial ecosystems and plays a role in geochemical cycling. Groundwater is widely used for irrigation in different crops and also for the domestic supply as drinking water in most nations. Over exploitation of groundwater and pollutant load from the land surface led to contamination of the precious natural resource. For example, pesticides, fertilizers and other pollutants from industrial sources can find their way into groundwater supplies over time. In addition, the leakage of untreated waste from septic tanks and toxic chemicals from underground storage tanks, landfills etc. may also contaminate underlying groundwater. Hence, groundwater contamination has led to many research efforts on groundwater remediation technologies and strategies. National scale assessments of global water scarcity predict that by 2050 as much as 66% of the world's future population will experience water stress and water requirement for food production will be a major issue. The remediation processes usually involves a set of actions with more or less impact on the surrounding areas, but especially in mobilizing equipment, which always introduce some functional entropy in these areas. The use of nanoparticles allows remediation to a significant reduction of equipment involved, and moreover allows obtaining results in reduced periods of time. There are number of techniques developed for purification of contaminated water but the significance of use of nanotechnology is becoming vital as technological option. The use of nanoscaled zero-valent iron particles (nZVI) to remediate contaminated soil and groundwater has received increasing amounts of attention within the last decade, primarily due to its potential for broader application, higher reactivity and cost-effectiveness compared to conventional zero-valent iron applications and other in situ methods. Here are, however, concerns regarding the potential risks associated with the use of nanomaterials to the environment and human health. An understanding of the relationship between the properties of nanoparticles and their in vivo effects would provide an effective strategy to tackle the deleterious effects. It may be concluded that the use of nanoparticles to solve potential issues such as treatment of contaminated water for drinking and reuse more effectively, than through conventional means. But there are concerns and potential risks associated with the use of nanomaterials to the environment and human health. An understanding of the relationship

between the properties of nanoparticles and their in vivo effects would provide an effective strategy to tackle the deleterious effects.

Keywords: Contamination, Groundwater, Nanotechnology, Nanoscaled zero-valent iron particles, Remediation

Introduction:

`Groundwater is an important component of terrestrial ecosystems and plays a role in geochemical cycling. Groundwater is also used for agricultural irrigation and for the domestic supply of drinking water in most nations. However, groundwater contamination has led to many research efforts on groundwater remediation technologies and strategies (Niu *et al.,* 2014). National scale assessments of global water scarcity predict that by 2050 as much as 66% of the world's future population will experience some water stress and that water requirements for food production will be a major issue (Barghouti *et al.,* 1999).

The use of nanoscaled zero-valent iron particles (nZVI) to remediate contaminated soil and groundwater has received increasing amounts of attention within the last decade, primarily due to its potential for broader application, higher reactivity, and cost-effectiveness compared to conventional zero-valent iron applications and other in situ methods (Aitken *et al.,* 2009). Recent research on nanoparticles in a number of crops has evidenced for enhanced germination and seedling growth, physiological activities including photosynthetic activity and nitrogen metabolism, mRNA expression and protein level, and also positive changes in gene expression indicating their potential use in crop Improvement (Lu *et al.,* 2002).

It has many applications in all stages of production, processing, storing, packaging and transport of agricultural products. The reduced use of herbicides, pesticides and fertilizers with increased efficiency, controlled release and targeted delivery will lead to precision farming (Ditta *et al.,* 2012). Modern agriculture is need of hour because conventional agricultural will not be able to feed an ever increasing population with changing climate, depleting resources and shrinking landscape. But at the same time application of nano-materials in agri-food sector has to be evaluated for public acceptance so it does not come across a scenario as faced by GMOs in past (Predicala *et al.,* 2009).

It may be concluded that there are concerns and potential risks associated with the use of nanomaterials to the environment and human health. An understanding of the relationship between the properties of nanoparticles and their i*n vivo* effects would provide an effective strategy to tackle the deleterious effects.

Nanotechnology in agriculture

Nanotechnology is defined by the US Environmental Protection Agency19 as the science of understanding and control of matter at dimensions of roughly 1–100 nm, where unique physical properties make novel applications possible. This definition is slightly rigid with regard

to size dimensions. Greater emphasis could have been placed on the problem-solving capability of the materials. Other attempts to define nanoparticles from the point of view of agriculture include "particulate between 10 and 1,000 nm in size dimensions that are simultaneously colloidal particulate".

Ultimately, nanotechnology could be described as the science of designing and building machines in which every atom and chemical bond is precisely specified. It is not a set of particular techniques, devices, or products, but the set of capabilities that we will have when our technology comes near the limits set by atomic physics. Nanotechnology aims at achieving for control of matter what computers did for our control of information. For Drexler, the ultimate goal of nanomachine technology is the production of the "assembler". The assembler is a nanomachine designed to manipulate matter at the atomic level. The burgeoning applications of nanotechnology in agriculture will continue to rely on the problem-solving ability of the material and are unlikely to adhere very rigidly to the upper limit of 100 nm. This is because nanotechnology for agricultural applications will have to address the large-scale inherent imperfections and complexities of farm production systems (eg, extremely low input use efficiency), that might require nanomaterials with flexible dimensions, which nevertheless perform tasks efficiently in agricultural production systems. This is in contrast with nanomaterials that might be working well in well-knit factory-based production systems.
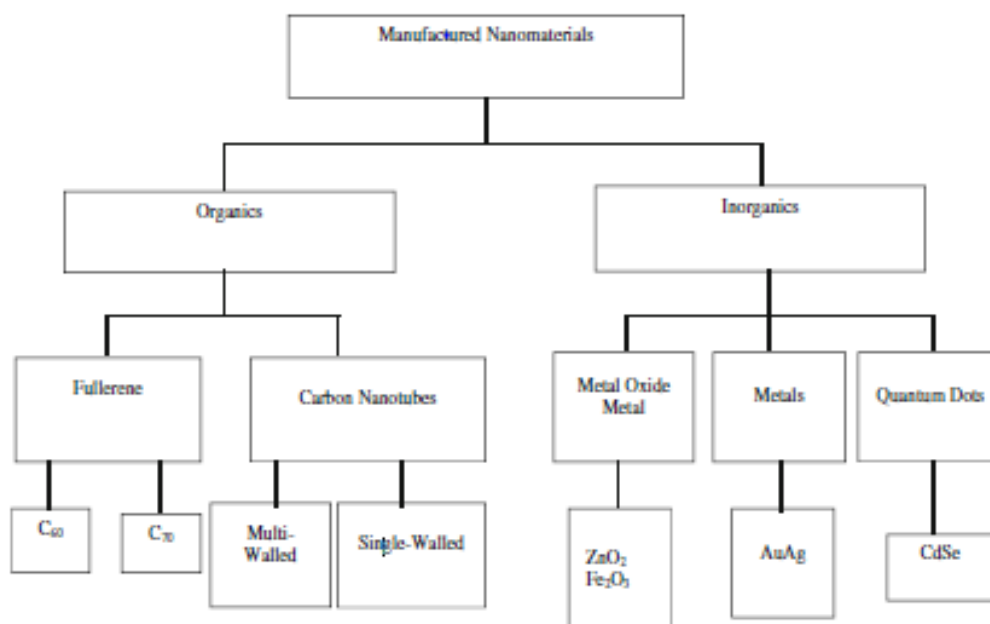
Nanomaterials

A nanometer (nm) is a billion part of meter, i.e., $10-9$ m. Nanomaterials are materials with a dimension of 100 nm or less in at least one dimension, and nanoparticles are those that have at least two dimensions between 1 and 100 nm. Due to the presence of a large proportion of atoms on the surfaces of NPs, they allow significantly higher numbers of adsorption/reactions with the surrounding contaminants. This characteristic makes NPs more reactive than those materials with the same composition in macro-scale. Either a sheet of paper that is 100,000 nm thick or a strand of human hair that has dimensions about 1,000 times higher than an NP (USEPA, 2007) can be used as examples in order to get a better physical sense of the size of these nanomaterials.

The NMs can be classified as occurring naturally, accidentally, or deliberately manufactured in the laboratory. Examples of naturally occurring NMs include clay, organic matter, and iron oxide; all of which are part of the soil composition. The accidental NMs are those generated through air emissions, solid or liquid wastes from production facilities for nanoscale materials, agricultural operations, fuel burning, and weathering (Klaine *et al.,* 2008). The nanomaterials manufactured at improving their application in a technological or industrial purpose. The NMs can be produced in a variety of ways, and they are grouped mainly into two technologies. The first technology is from top to bottom or from outside to inside (top down),

where part of something bigger (bulk material) is turning into something smaller. The second is a technology called bottom to top (bottom-up), where small things will build something bigger (Niemeyer, 2001). Most top-down technologies involve methods such as milling, friction, heating, and photolithography (Cao, 2004). Bottom-up technologies involve molecular components such as raw materials connected with chemical reactions, nucleation, and growth process to promote the formation of more complex clusters (Cao, 2004; Rotello, 2004).

The NMs manufactured are designed with specific properties and can enter the environment through industrial or environmental applications, such as their use for remediation of soils and groundwater for example (USDHHS, 2006; USEPA, 2007). Figure 1 presents the classification of the NMs on the basis of their physico-chemical properties (Peralta-Videa *et al.,* 2011). The NMs differ according to the physico-chemical composition, and they can be classified as organic or inorganic. Organic NMs are composedmostly of carbon atoms, and can present in the form of spheres, ellipsoids, or hollow tubes. The formation of hollow spheres and ellipsoids are called fullerenes, while the hollow tubes are called nanotubes that could have single or multiple walls. The inorganic NMs are classified as quantum dots, metal, and metal oxide. The quantum dots are mixtures of two chemical elements with a size up to 10 nm and are considered semi conductors (e.g., CdS, CdSe, and CdTe). The metals can be present in the form of oxides of metals (zinc oxide, iron oxide, etc.), in their pure form (nanogold, nanosilver, nanoirono), or bimetallic. The bimetallic metals consist of a corrosive metal, such as iron (Fe) and zinc (Zn), along with noble metal, such as palladium (Pd), platinum (Pt), nickel (Ni), silver (Ag), and copper (Cu) (Ju-Nam and Lead, 2008; Brar *et al.,* 2010; Fahlman, 2011; O'Carroll *et al.,* 2013).

Figure 1: Classification of nanomaterials according to physical–chemical properties

Nanoparticles for soil and groundwater remediation

The use of NPs for decontamination of waters began in the 1990s; therefore, it is considered a new technology and its development is still in progress. Gillham (1996) was the first researcher to present the idea of using zero valence iron in permeable reactive barriers (PRB), based on his experience with the use of zero valence iron on decontamination of waters containing contaminants of the halogenated group (Gillham and O'Hannesin, 1994). However, Wang and Zang (1997) and Zang *et al.,* (1998) were the first to present research using NPs for decontamination of groundwater contaminated with organochlorines. In their research, synthesized bimetallic NPs (Pd/Fe, Pd, Pt/Fe/Zn, Ni/Fe) were tested in the laboratory bench-scale tests for remediation of several aromatic chlorinated and some organ chlorine pollutants inwater. They observed a rapid and complete degradation of the pollutants with the use of NPs. For the first time, it was proven that the elements Fe and Zn served primarily as electron donors, while the Pd, Ni, and Pt as metal catalysts. Also, it was first observed that the reactivity of zero-valent nanoscale iron particles (zNIP) was 100 times higher than zero valent iron in the macro-scale form. Another important conclusion that was found was that no by-products were formed when zNIP degraded organochlorine, similar to that reported where iron in macroscale form was used. Finally, they concluded that NPs offered great opportunity for research and technological application. Ponder *et al.,* (2000) were the first to report the use of only the zNIP for decontamination of groundwater containing metal chromium (Cr VI) and lead (Pb II). The researchers found that the use of zNIP quickly converted the Cr (VI) to Cr (III) and Pb (II) to Pb (0). They concluded that this NP was suitable for use in situ remediation applications. Since 1997, many nanoscale materials have been researched for remediation, such as zeolites, nanometal oxides, nanotubes and carbon fiber, enzymes, and bimetallic nanoparticles (Elliott and Zhang 2001; Schrick *et al.,* 2002; He and Zhao 2005; Yoo *et al.,* 2007; Barnes *et al.,* 2010; Sakulchaicharoen *et al.,* 2010). However, the application of zNIP received greater attention for the remediation of contaminated soils and groundwater. Over 90 % of the studies dealing with NPs for site remediation used zNIP (Yan *et al.,* 2013), mainly due to their low toxicity and low cost of production in relation to other NPs. Several review articles have been published on the use of nNIP in remediation of contaminated soils and groundwater during the last decade, and these review articles cite over400 studies that have been published over the past 16 years addressing various aspects of using NPs for remediation of soils and groundwater. There are large numbers of publications demonstrate that, despite being a recent technology, much effort has been devoted to understand the behavior and application of zNIP with different contaminants in different soils and groundwater conditions.

Nanoparticles synthesis

Several methods have been developed for the production of NPs, including chemical vapor deposition, inert gas condensation, laser ablation, ignition load generation, gas-aggregation spraying, thermal decomposition, thermal reduction of oxide compounds, metal complex hydrogenation, and reduction of aqueous iron salts (Crane and Scott 2012). Wang and Zang (1997) were the first to synthesize zNIP by the aqueous-phase reduction technique of $Fe2+$ using hydrated sodium boron. However, this form of production is only feasible for use on a laboratory scale, considering the high cost (over \$200/kg of nFeZ) and the large amount of effluent with the presence of boron produced. Using this method on an industrial scale33 is unlikely. Obtaining the zNIP by reducing the penta carbonyl iron $(Fe(CO)5)$ in argon, in $NH3$, and organic solvents was also proposed (Choi *et al.,* 2001; Kim *et al.,* 2003; Karlsson *et al.,* 2005), but due to the high toxicity of $Fe(CH)5$ this method is also not a viable technique (Yan *et al.,* 2013).

Nanoparticles characterization

The main characteristics of NPs thatmust be determined are: morphology, particle size distribution, specific surface area, surface charge, and crystallographic characterization. For determination of themorphology, imaging equipment is used, and the most common equipment used in studies of zNIP are the scanning electron microscopy (SEM) and transmission electron microscopy (TEM). Several studies showed the morphological characteristics of zNIP in the shape of spheres with a smooth surface (Nurmi *et al.,* 2005; Sun *et al.,* 2007; Tiraferri *et al.,* 2008; Darko-Kagya *et al.,* 2010a, b; Tosco *et al.,* 2012; Eglal and Ramamurthy 2014). Yan *et al.,* (2013) reported that this type of particle is more common in zNIP produced by bottom-up technology (e.g., chemical reduction using boron hydrate). When the particles are obtained from the reduction of goethite and hematite for $H2$, they are more angular (Nurmi *et al.,* 2005). Crane and Scott (2012) presented the morphology of several zNIPs synthesized in different ways and from different commercial suppliers, showing the predominance of spherical particles. As the zNIP is quite reactive with oxygen, a crust of iron oxide $(Fe2O4)$ is formed around the particle (Fig. 2a). A scanning electron microscope image of NIP synthesized by TODA Company Inc. is presented in Fig. 2b (Reddy 2010).

Contaminants treated with nanoparticles

Although there are many types of NPs that can be used for the decontamination of soils and groundwater, almost all researchers consider using only zNIP for field applications practical. It is also interesting to note that most studies primarily deal with decontamination of saturated soils and/or groundwater. Only a few studies have addressed the remediation of contaminated soils in the vadose zone (Shen *et al.,* 2011). Since the work published by Wang and Zang (1997) using bimetallic nanoparticles to decontaminate water with chlorinated solvents, many studies were performed using a wide variety of organic and inorganic contaminants. An assessment

study performed by Yan *et al.,* (2013) (based on 445 publications) showed that the main types of contaminants that were treated with Znip were: halogenated aliphatics (26.9 %), halogenated aromatic hydrocarbons (17.8 %), other organic components (17.8 %), metals (25.8 %), and non-metals, inorganic (11.7 %). Therefore, the treatment of organic contaminants predominated, accounting for 62.5 % of the total studies. Inorganic contaminants correspond to 37.5 %, with emphasis on metallic contaminants that have been most studied in this category.
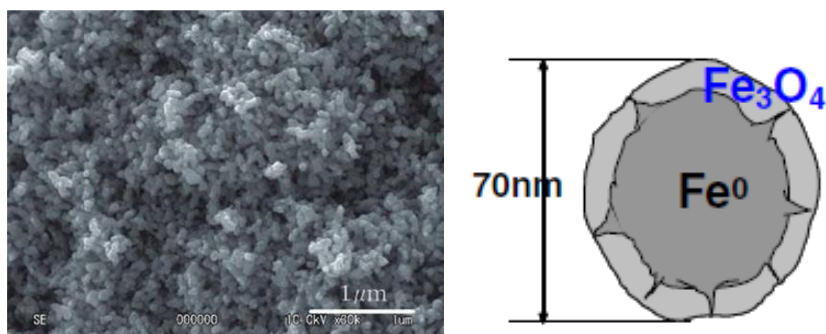
Figure 2: NIP synthesized by TODA Company Inc.: a schematic structure (b) and photomicrograph from MEV (source: Reddy)

Nanoremediation process

Nanoremediation methods involve application of reactive materials for the detoxification and transformation of pollutants. These materials initiate both chemical reduction and catalysis of the pollutants of concern. With respect to remediation of environmental contaminants, the range of nanotechnology applications mirrors the spectrum of non-nano‟ strategies for contaminant remediation. Two of the major distinctions that define types of conventional remediation technologies also apply to nanotechnologies for remediation: adsorptive versus reactive and in situ versus ex situ. Absorptive remediation technologies remove contaminants (especially metals) by sequestration, whereas reactive technologies affect degradation of contaminants. In situ technologies involve treatment of contaminants in place, whereas ex situ refers to treatment after removing the contaminated material to a more convenient location (e.g. pumping contaminated groundwater to the surface and treatment in aboveground reactors).

A. *Ex-Situ* **Nanotechnology**

A prominent example of a nanotechnology for contaminant remediation by adsorption is known as self-assembled monolayers on mesoporous supports (SAMMS). SAMMS are created by self-assembly of a monolayer of functionalized surfactants onto mesoporous ceramic supports, resulting in very high surface areas (~1000 m2/g) with adsorptive properties that can be tuned to target contaminants such as mercury, chromate, arsenate, and selenite. Dendritic polymers are another type of nanostructured material that has the potential for use in

remediation. Recent examples of this approach include dendrimer-enhanced ultrafiltration to remove Cu (II) from water and soil washing to remove Pb (II) contamination.
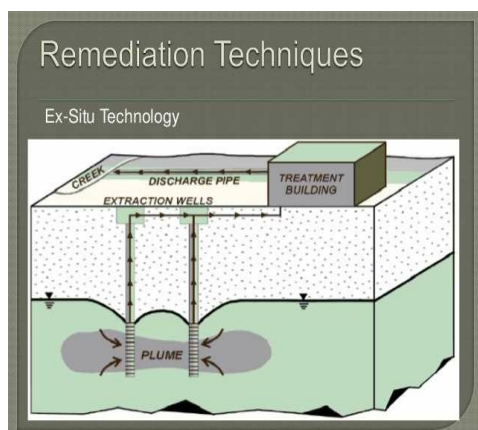

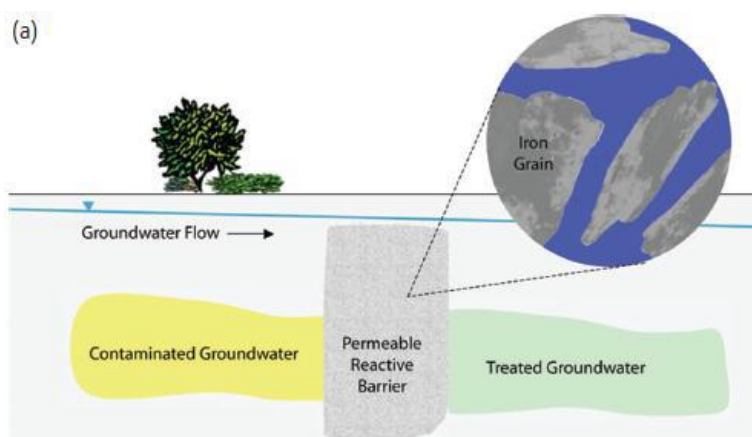**Figure 3: Remediation technique**

Figure 4a
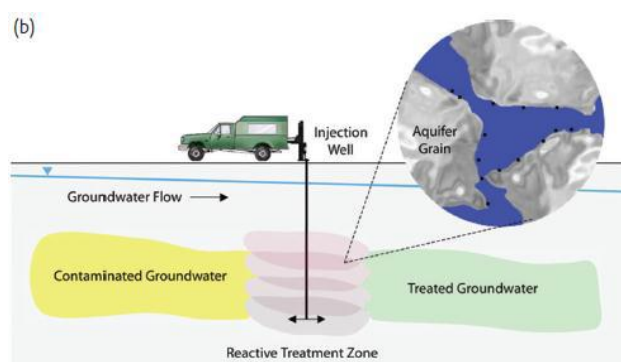
Figure 4b
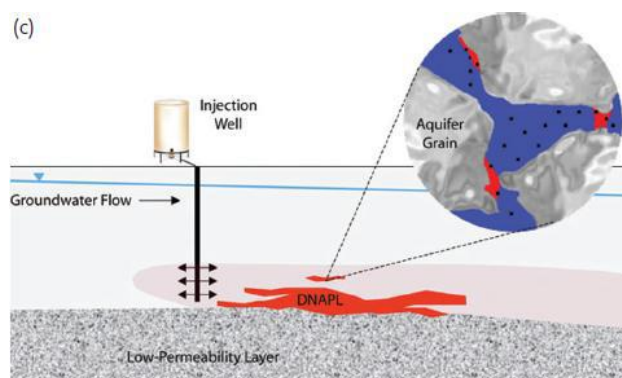
Figure 4c

Figure 4: Three approaches to application of Fe particles for groundwater remediation: (a) a conventional „permeable reactive barrier" made with millimeter-sized construction-grade granular Fe; (b) a „reactive treatment zone" formed by sequential injection of nanosized Fe to form overlapping zones of particles adsorbed to the grains of native aquifer material; and (c) treatment of nonaqueous phase liquid contamination by injection of mobile nanoparticles. In (b) and (c), nanoparticles are represented by black dots and zones that are affected by nanoparticles are represented as pink plumes

Nanotechnologies that affect remediation by contaminant degradation – rather than adsorption – are particularly attractive for organic contaminants. A well-established approach for remediation of organic contaminants is photo-oxidation catalyzed by metal oxide nanoparticle such as TiO2, and the potential benefits of quantum-sized (< ~10 nm) photocatalysts have long been recognized for contaminant degradation applications. Another method is based on injection of Fe0 nanoparticles into the groundwater through application wells. This technology is

environmentally friendly and cost-effective compared to methods like pump & treat or gas extraction (venting).

B. *In Situ* nanotechnology

In situ degradation of contaminants, when feasible, is often preferred over other approaches because it has the potential to be more cost effective. However, in situ remediation requires delivery of the treatment to the contamination at on site position and this has proven to be a major obstacle to expanded development of in situ remediation technologies. With respect to this issue, nanotechnology has special relevance because of the potential for injecting nanosized (reactive or absorptive) particles into contaminated porous media such as soils, sediments, and aquifers. Although a variety of types of nanoparticle might be applicable to in situ remediation (e.g. nonionic amphiphilic polyurethane or alumina-supported noble metals by far the greatest interest is currently in nanoparticles that contain nZVI.
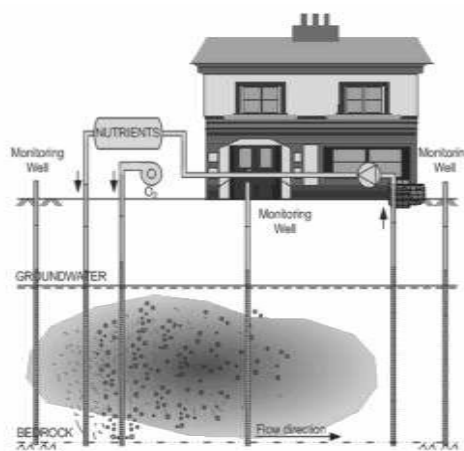
A common type of in situ or below-ground remediation method used for cleaning up contaminated groundwater is the permeable reactive barrier (PRB). PRBs are treatment zones composed of materials that degrade or immobilize contaminants as the groundwater passes through the barrier. They can be installed as permanent, semi- permanent or replaceable barriers within the flow path of a contaminant plume.

Nanomaterials as remediation agent

A. Titanium Dioxide (TiO_2) Based Nanoparticles

Titanium dioxide (TiO_2) is one of the popular materials used in various applications because of its semiconducting, photocatalytic, energy converting, electronic and gas sensing properties. Many researchers are focused on TiO_2 nanoparticle and its application as a photocatalyst in water treatment. Nanoparticles that are activated by light, such as the large band-gap semiconductors titanium dioxide (TiO_2) and zinc oxide (ZnO), are frequently studied for their ability to remove organic contaminants from various media. These nanoparticles have the advantages of readily available, inexpensive, and low toxicity. The semiconducting property of TiO_2 is necessary for the removal of different organic pollutants through excitation of TiO_2 semiconductor with a light energy greater than its band gap, which could generate electron hole pairs. These may be exploited in different reduction processes at the semiconductor/solution interface. It is known that, the semiconducting properties of TiO_2 materials is responsible for the removal of various organic pollutants, but the rapid recombination of photo-generated electron

hole pairs and the non-selectivity of the system are the main problems that limit the application of photocatalysis processes.

B. Nanoscale Iron Nanoparticle (nZVI)

Nanoparticles could provide very high flexibility for both in situ and ex situ remediations. For example, nanoparticles are easily deployed in ex situ slurry reactors for the treatment of contaminated soils, sediments, and solid wastes. Alternatively, they can be anchored onto a solid matrix such as carbon, zeolite, or membrane for enhanced treatment of water, wastewater, or gaseous process streams. Direct subsurface injection of nanoscale iron particles, whether under gravity-feed or pressurized conditions, has already been shown to effectively degrade chlorinated organics. Iron nanoparticles are an attractive component for nanoremediation.

Iron at the nanoscale was synthesized from Fe (II) and Fe (III), using borohydride as the reductant. Nanoscale zero-valent iron particles range from 10 to 100 nm in diameter. They exhibit a typical core shell structure.

The core consists primarily of zero-valent or metallic iron whereas the mixed valent [i.e., Fe (II) and Fe (III)] oxide shell is formed as a result of oxidation of the metallic iron. nZVI are generally preferred for nanoremediation because of large surface area of nanoparticles and more number of reactive sites than microsized particles and it possess dual properties of adsorption and reduction. Zero-valent iron removes aqueous contaminants by reductive dechlorination, in the case of chlorinated solvents, or by reducing to an insoluble from, in the case of aqueous metal ions. Iron also undergoes "Redox" reactions with dissolved oxygen and water.
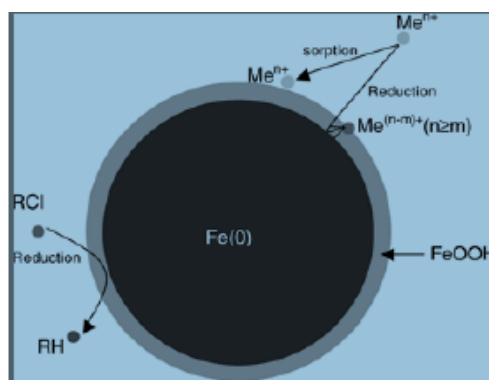
Figure 6: Schematic diagram of Zero valent Iron

C. Nanoclay

Nanoclays are natural nanomaterials that occur in the clay fraction of soil, among which montmorillonite and allophane are the most important species. Montmorillonite is a crystalline hydrous phyllosilicate (layer silicate). Recently Organically modified montmorillonites or organoclays are develop in the form of polymer-clay nanocomposite

Clays are layered minerals with space in between the layers where they can adsorb positive and negative ions and water molecules. Clays undergo exchange interactions of

adsorbed ions with the outside too. Although clays are very useful for many applications, they have one main disadvantage i.e. lack of permanent porosity. To overcome this problem, researchers have been looking for a way to prop and support the clay layers with molecular pillars. Most of the clays can swell and thus increase the space in between their layers to accommodate the adsorbed water and ionic species. The composite structures, known as pillared clay, could stabilize TiO2 particles and give access of different molecules to the surface of TiO2 crystals. Ooka *et al.,* prepared four kinds of TiO2 pillared clays from Montmorillonite, saponite, fluorine hectorite and fluorine mica serves as nanoclay for water remediation.

D. Nanotubes

In recent years, nanotechnology has introduced different types of nanomaterials to the water industry and has produced some promising outcomes. Since its discovery, carbon nanotubes have attracted great attention due to its unique properties. CNTs are nanomaterials that are rolled into a tube and are classified as single-walled carbon nanotubes (SWNT) and multi-walled carbon nanotubes (MWNTs).

Carbon nanotubes act like as nanosorbent, and hold tremendous potential for applications because of their unique properties, such as strong antimicrobial activity, higher water flux than other porous materials of comparable size, tunable pore size and surface chemistry, high electrical & thermal conductivity, special adsorption properties and their ability to be attached to a functional group to increase the affinity towards the target molecule makes CNTs as a promising material for water remediation.. To increase the absorption capacity of MWCNTs, it is oxidized with nitric acid, this creates reactive sites in either on tip of nanotube or either by creating defects site on the side wall of the tube, resulting to which a higher level of adsorption was achieved due to high reactivity.
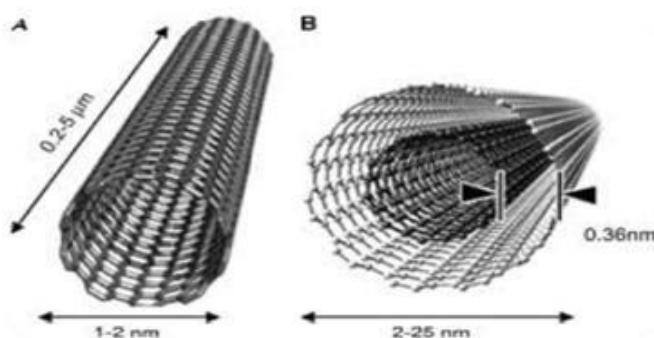
Figure 7: A schematic Representation of Carbon Nanotube and Multi walled Carbon Nanotube

E. Magnetic nanoparticles

One of the major applications of magnetic particles is in the area of magnetic separation. In this case, it is possible to separate a specific substance from a mixture of different other substances. The separation time is one of the important parameters in the magnetic separation

method. Separations using magnetic gradients, such as "High Magnetic Gradient Separation" (HGMS), are now widely used in the fields of medicine, diagnostics and catalysis. In HGMS, a liquid phase containing magnetic particles is passed through a matrix of wires that are magnetized by applying a magnetic field. The particles are held onto the wires and at the conditions that the field is cut off, they can be released. If these particles are used in order to be fixed to specific molecules, the latter can be isolated from waste water or slurries. It is well known that Cr (VI) is toxic to animals and plants, while Cr (III) is considered to be less harmful. Hu *et al.,* developed an innovative process combining nanoparticle adsorption and magnetic separation for the removal and recovery of Cr (VI) from wastewater. They produced ten nanometer modified $MnFe_2O_4$ nanoparticles as a new adsorbent using a co-precipitation way followed by a surface redox reaction.

F. Nanomembrane

A membrane is a semi-permeable and selective barrier between two phases (retentive and permeate) through which only selected chemical species may diffuse. Membrane filtration is frequently employed for the separation of dissolved solutes in a fluid or the separation of a gas mixture. Historically, membrane technology has had wide application in wastewater treatment and desalination via reverse osmosis. In this method, a pressure difference across a membrane is employed to overcome the osmotic pressure gradient. The smaller water molecules are literally pushed through the membrane while the large solute species are retained behind. Among different classes of membranes, reverse osmosis (RO) filtration is a well-known process in the desalination of seawater and ultrafiltration (UF) is a well-established process in the fractionation of Natural Organic Matter (NOM).

Nanofiltration (NF) is a process with membrane permeability between RO and UF. Another membrane design is emulsion liquid membrane (ELM). An ELM is formed by first encapsulating an aqueous "receiving" or strip phase within a hydrophobic membrane liquid. This emulsion is then further dispersed within the continuous aqueous feed phase. This technology was used for the extraction of phenols, removal of heavy metal cations such as zinc, cadmium, chromium, copper, lead, palladium and mercury from wastewater and also removal of alkali metal cations such as Na+, K+, Li+ and Cs+, radioactive fission products, such as Cs-137, Sr-90, Ce-139 and Eu-152 and anions, such as chlorides, sulfate, phosphate and chromate.

Ultrafiltration has been applied in most membrane separation processes. The hydrophilicity of the membrane and its porous structure play important roles in these processes. An appropriate porous membrane must have high permeability, good hydrophilicity and excellent chemical resistance to the feed streams. In order to obtain high permeability, membranes should have high surface porosity, and good pore structure. Polyvinylidene fluoride (PVDF) is a material that can form such asymmetric membranes, since it is thermally stable and

resistant to corrosion by most chemicals and organic compounds. PVDF-based membranes exhibit outstanding anti-oxidation activities, strong thermal and hydrolytic stabilities and good mechanical properties.

The soil and groundwater remediation with zero valent iron nanoparticles

Nanoremediation use aqueous suspensions of very small particles (called nanoparticles) to treat and degrade contaminants in soil or groundwater. There are several definitions of the term "nanoparticle". In general it describes a particle having one or more dimensions of 100 nanometers or less. A nanometer is one thousand millionth of a meter, which can be written as 10-9 m. A single human hair has a diameter of 50.000 to 100.000 nanometers. This would mean that perhaps as many as 1.000 nanoparticles made of iron could fit across a single hair. Nanoparticles of Fe(0) have recently become a strategic material with great application potential in the broad range of modern nanotechnologies. Due to their extraordinary reduction capabilities (figure 1), small size in the range of several tens of nanometers and high reactivity with a broad spectrum of toxic substances, these ultrafine particles are highly applicable in the reduction technologies of groundwater remediation and waste water treatment.
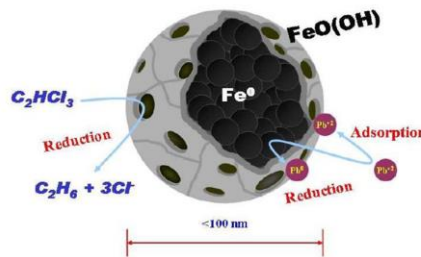
Figure 7: Schematic three dimensional presentation of the nZVI regarding the double effect of reduction process and adsorption of the heavy metal on its surface

Site injection method and monitoring

Three different zones have been prepared for the nZVI application. Using a mechanical drilling rig adapted for the injection process the nZVI have been injected at different depths, in the saturated horizon using different slurry concentrations for the different zones: 1, 3 and 7g nZVI/L of water. Considering the direction of the groundwater flow it was decided to inject in a middle point which would be at the same distance between the upstream and downstream monitoring points. Therefore the distribution of the monitoring points to evaluate the injection method effect, was three meters distance between monitoring wells

Piezometers were installed in the test areas, with a specific distribution in order to assess:

a) The nanoparticles mobilization capacity in saturated environments;

b) The local hydrodynamic flow influence in the dispersion of nanoparticles;

c) The relationship between *nZVI* concentrations in the injected solution and the decreasing of contaminants concentrations;
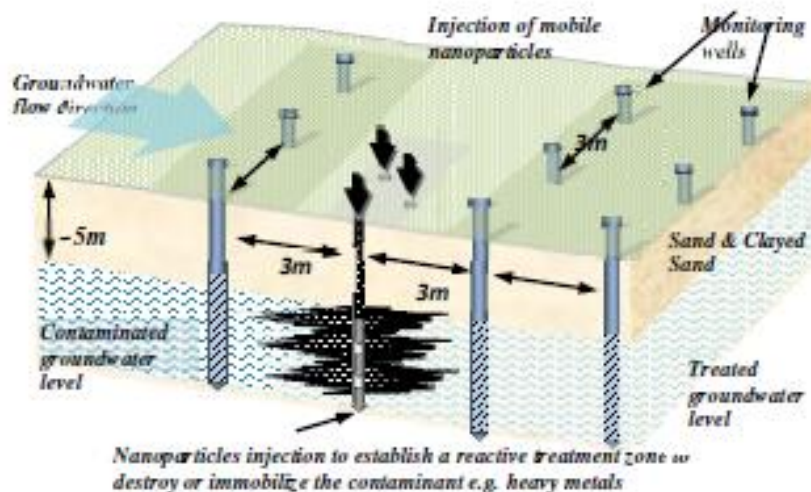
Figure 8: Scheme of nZVI application procedure (Gonçalves, 2014)

The adsorption of metals is clearly more favorable in alkaline pH and, in this aspect, the recorded values revealed that the pH increase, although very tenuous, will have influenced the degrading action of nanopatículas of some of the present metals. Moreover the pH increase is due in particular to the reductive action of nZVI acting not as the metals reducing agent but as facilitating the hydrogen production for the environ and so been consumed in a function for which they were not intended. It occurs and thus for these more aggressive environs, a corrosion effect of the nanoparticles which degrade more easily, not fulfilling as effectively should the function for which they were applied.

Figure 9: Time evolution of some of the contaminants concentration

Adsorption of heavy metal ions from aqueous solution by polyrhodanine-encapsulated magnetic nanoparticles
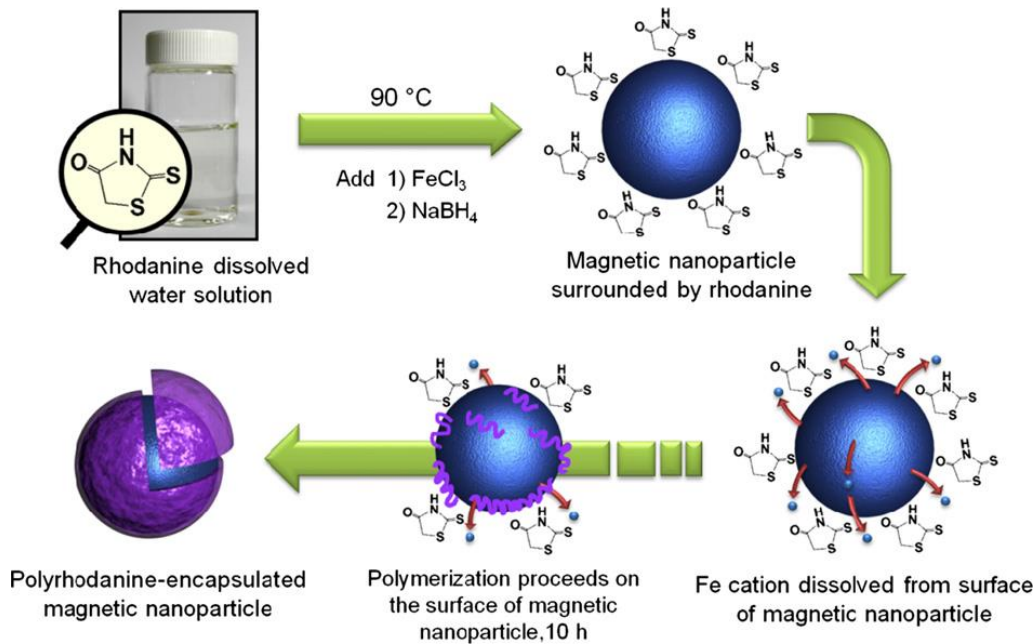
Figure 10: Schematic illustration of the fabrication process of polyrhodanine-encapsulated magnetic nanoparticles
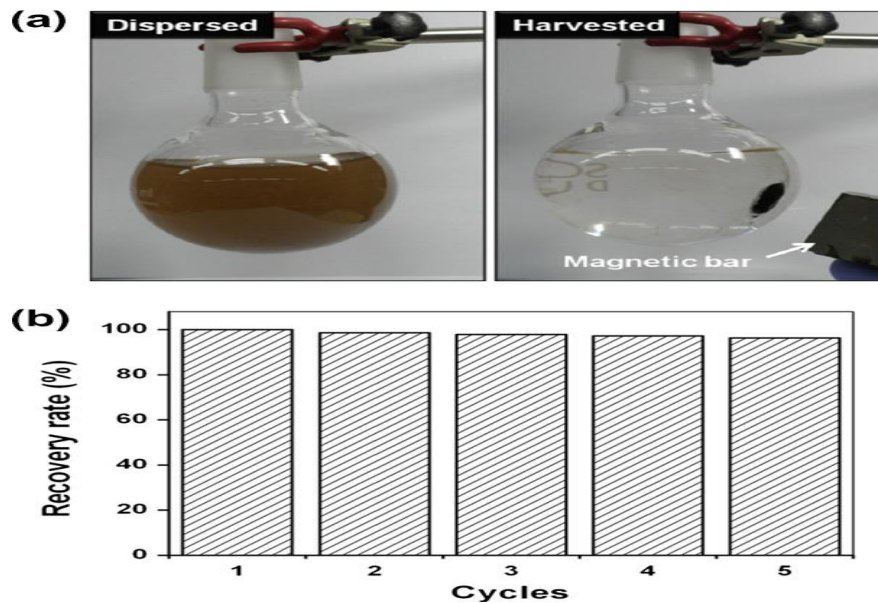
Figure 11: (a) Photographs of the dispersed and harvested PR-MNPs and (b) the adsorption efficiency of Hg(II) in adsorption–desorption cycles by the PR-MNPs. The initial Hg(II) ion concentration was 80 mg/L and pH value was 6.0. Five milligrams of the PR-MNPs was contacted with Hg(II) ions for 4 h at 25 _C.

Polyrhodanine-coated c-Fe_2O_3 nanoparticles, synthesized by one-step chemical oxidation polymerization, were applied to the process of removal of heavy metal ions from aqueous solution. Factors influencing the uptake of heavy metal ions such as solution pH, initial metal ion concentration, contact time, and species of metal ions were investigated systematically by batch

experiments. The adsorption equilibrium study exhibited that the Hg(II) ion adsorption of polyrhodanine-coated magnetic nanoparticles followed a Freundlich isotherm model than a Langmuir model. The kinetic data of adsorption of Hg(II) ion on the synthesized adsorbents were best described by a pseudo-second-order equation, indicating their chemical adsorption. In addition, the synthesized nano-adsorbents can be repeatedly used with help of an external magnetic field due to their magnetic properties. This work demonstrates that the magnetic polyrhodanine nanoparticles can be considered as a potential recyclable adsorbent for hazardous metal ions from wastewater.

Photocatalytic activity of N, S co-doped and N-doped commercial anatase TiO₂ powders towards phenol oxidation and E. coli inactivation under simulated solar light irradiation

Nitrogen and sulfur co-doped and N-doped TiO2 anatase TKP 102 (Tayca) were prepared by manual grinding with thiourea and urea, respectively, and annealing at 400 _C. Both materials showed visible-light absorption as measured by Diffuse Reflectance Spectroscopy (DRS). Interstitial N-doping, anionic and cationic S-doping was found when the TiO2 was doped with thiourea while TiO2 doped with urea showed only the presence of interstitial N-doping as measured by X-ray Photo-electron Spectroscopy (XPS). The N content on the surface of N-doped TKP 102 photocatalyst was 2.85 at.% and higher than the N content in the N, S co-doped TiO2 photocatalyst (0.6 at.%). The photocatalytic activity of the doped catalysts was tested using phenol and Escherichia coli as chemical and biological targets, respectively, using N, S co-doped, N-doped TiO2, undoped Degussa P-25 and undoped TKP 102 powders under simulated solar light.

It was found that undoped Degussa P-25 was the photocatalyst with the highest photocatalytic activity towards phenol oxidation and E. coli inactivation. N, S co-doped powders showed almost the same photocatalytic activity as undoped TKP 102 while N-doped TKP 102 was the less active photocatalyst probably due the N impurities on the TiO2 acting as recombination centers.
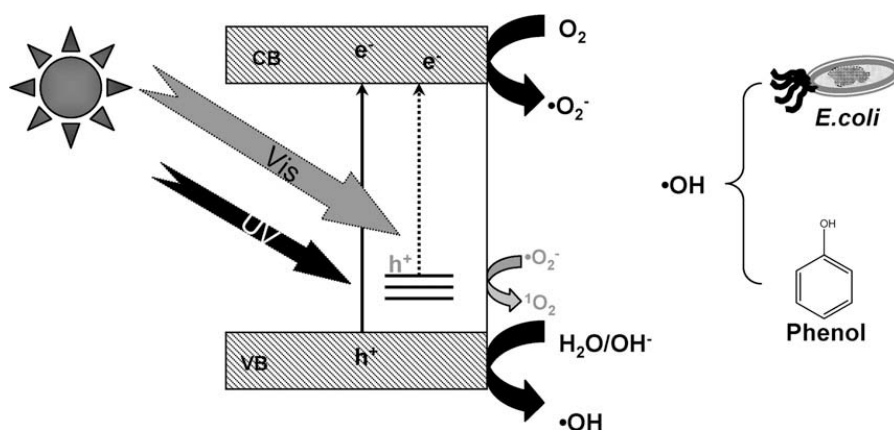
Figure 12: Photocatalytic phenol oxidation and E. coli inactivation mechanism suggested under simulated solar exposition on N, S co-doped and N-doped TKP 102 powders
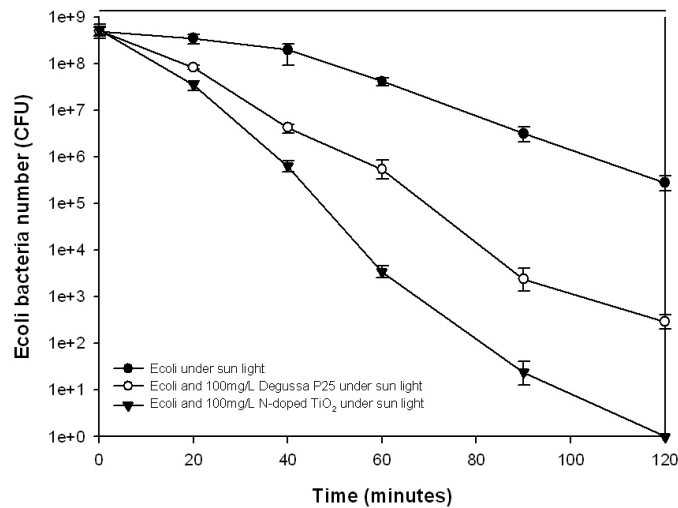
Figure 13:*E.coli* **bacteria disinfection by Degussa P25 and N-doped TiO₂ nanoparticles**

under solar light with average light intensity 10mW/cm2

Growth in nanotechnology

Map of remediation sites listed in Supplemental Material (Project on Emerging

Nanotechnologies 2009)
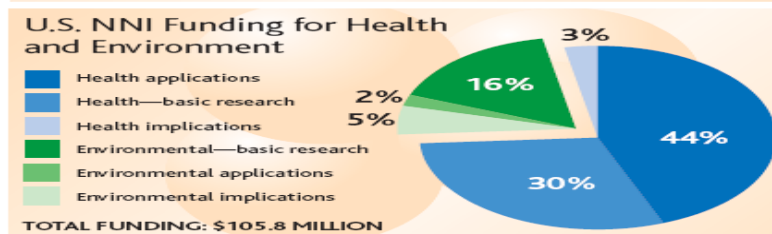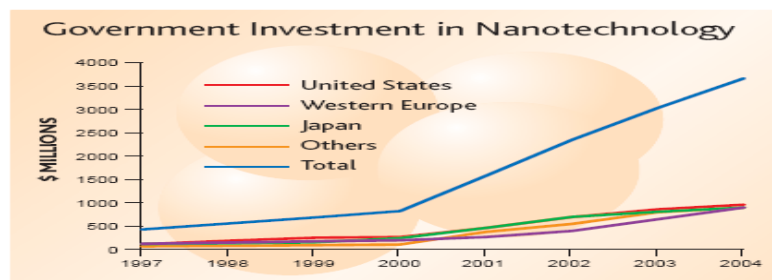
Present area of activities in the field of Nanotechnology in India
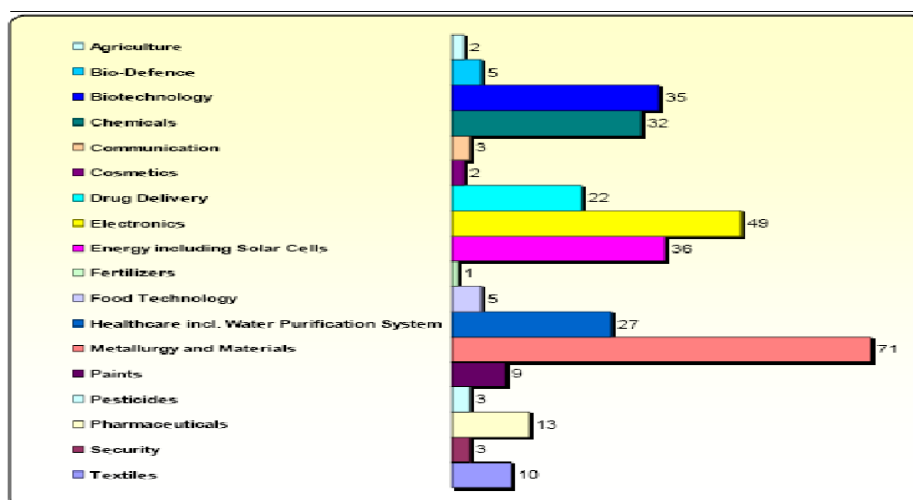
Constraints in Nanotechnology

- Nano particles effect on biological systems and the environment such as toxicity generated by free radicals

- High concentration of nanosilica silver produced some chemical injuries on the tested plants (cucumber leaves and pansy flowers)

- Problems can actually arise from the inhalation of these minute particles, much like the problems a person gets from inhaling minute asbestos particles

- Presently, nanotechnology is very expensive and developing it can cost you a lot of money. It is also pretty difficult to manufacture

- Extremely high doses of these materials are associated with fibrotic lung responses and result in inflammation and an increased risk of carcinogenesis

Future Prospectives

- Nanotechnology requires a detailed understanding of science and material technology

- We could say that the prospects of nanotechnology are very bright

- More studies are needed to explore the mode of action of NP's

- More research should be done on the potential adverse effects of nanomaterials on human health, crops and the environmental safety

- Nanotechnology will be an undeniable force in near future

Conclusion

- Current water treatment & distribution system have a lot of drawbacks

- Nanotechnology have the potential to replace them and increase the efficiency

- However most of techniques for the treatment of wastewater involving nanotechnology so far have been done in laboratory scale only

- Development of cost effective nanomaterials   with proven non toxicity effects on environment could revolutionize water treatment domain

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A TECHNICAL APPROACH TO SOLVING THE NONLINEAR VAKHNENKO EQUATION FOR TRAVELING WAVES

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Abstract:

We examine the well-known Vakhnenko Equation, which describes the propagation of high-frequency waves in a relaxing medium, as an application of this novel methodology. General types of Soliton solutions and periodic Vakhnenko Equation solutions are achieved with two additional expansions.

Even if this new approach only unifies a number of expansion techniques, we think it might help in the search for a strategy that can resolve the majority of nonlinear equations and produce. To identify travelling wave solutions to the nonlinear evolution problem, a new function expansion method—which is essentially a generalisation $(G'/G)-$ of expansion—is developed recently (Wang *et al.,* 2008). It is known as the $(\theta/g)-$ expansion approach.

Introduction:

The fundamental types of waves include matter waves, electromagnetic waves, and mechanical waves. The study of nonlinear partial differential equations has increased recently.

It seems that several of the variables in this study have some fundamental relationships. Basic and solvable nonlinear ordinary differential equations and more complex nonlinear equations and differential equations (NODEs), including the sine-Gordon and Ricatti equations. Weierstrass elliptic equation, sinh-Gordon equation, etc. Numerous effective strategies have been proposed in this endeavour to utilise NODEs' solutions. An important aspect of the study of soliton theory is the examination of the precise solutions to nonlinear evolution equations. Numerous effective techniques have been proposed during the past ten years, including the tanh function expansion approach [1, 2], the Jacobi elliptic function method [3, 4], the Exp-function method [5,] and others. The F-expansion [9–11] and the hyperbolic tangent function expansion approach [6–8]. The methods mentioned above can be used to analytically solve a large number of nonlinear equations. Although several efforts have been made to identify various approaches to solve nonlinear equations, There is no single approach. Recently $(G'/G)-$, the expansion approach [20] which may be used to solve a wide variety of nonlinear equations—was presented. The method was then expanded upon by Zhang *et al.* [21] to solve nonlinear equations with

variable coefficients. We introduce $(\theta/g)-$ the expansion, which is actually a family of expansion methods, as a result of this method. Some well-known expansion techniques can be obtained when θ and g are given special consideration.

Such as expansion $(G'/G)-$ and tanh-expansion. On the basis of these intriguing findings, we provide two additional innovative expansion methods. Our approach is used to the Vakhnenko Equation, a crucial equation that describes the propagation of high-frequency waves in a relaxing medium, in order to clearly demonstrate the efficiency of our approach. It will be demonstrated that our method can be used to derive a number of novel types of solutions.

1. An explanation $(\theta/g)-$ of the growth strategy

Generally speaking, a nonlinear wave equation has the following form:

$$P(u, u_t, u_x, u_{tt}, u_{xt}, u_{xx}, ...) = 0. \quad \text{..............} \quad (1)$$

We seek its traveling wave solution $u(\xi)$ by letting

In order to find a travelling wave solution $u(\xi)$, we have taken

$$\xi = x - Vt, \quad \text{...................} \quad (2)$$

Where V is a future-determined parameter. We'll now give a quick example of the $(\theta/g)-$ expansion method.

Modeling physical phenomena using (NLPDEs) has grown in importance.

The relaxing medium's nonlinear evolution equation is discovered, and its solutions are examined

Step 1: As always, combine the independent variables into a single variable. ξ ,then eqn. (1) becomes

$$P(u, -Vu', u', V^2 u'', -Vu'', u'', ...) = 0. \quad \text{.................} \quad (3)$$

Step 2: Suppose the solution of equation (3) can be expressed by a polynomial in (θ/g), and θ, g satisfy the following relation:

$$\left(\frac{\theta}{g}\right)' = a + b\left(\frac{\theta}{g}\right) + c\left(\frac{\theta}{g}\right)^2,$$

We can write, $\theta' g - \theta g' = ag^2 + b\theta g + c\theta^2,$ \quad \text{.................} \quad (4)

Where a, b, c are arbitrary constants? Let us examine eqn. (4) Carefully. If we take following choice, $\theta = g', a = -\mu, b = -\lambda, c = -1$, then $u(\xi)$ can be expressed as

$$u(\xi) = \sum_{m=0} a_m \left(\frac{g'}{g}\right)^m, \quad \text{.................} \quad (5)$$

Where g satisfies relation $g'' + \lambda g' + \mu g = 0$. It is just the $(G'/G)-$ expansion method that M.

Wang et al [20] have proposed recently. Furthermore, if we put

$\theta = \tanh\xi$, $g = 1, a = 1, b = 0, c = -1$, and $u(\xi)$ now becomes

$$u(\xi) = \sum_{m=0} a_m \left(\tanh\xi\right)^m, \quad \text{................................} \quad (6)$$

This is the way of function expansion.

In the current study, we provide two further new expansion types from which it is possible to

derive brand-new solutions to the nonlinear wave equation. For the initial, let $\theta = g'/g$, $b = 0$,

thus

$$u(\xi) = \sum_{m=0} a_m \left(\frac{g'}{g^2}\right)^m, \quad \text{..............................} (7)$$

Where g satisfies

$$g''g^2 - 2gg'^2 = ag^4 + cg'^2. \quad \text{...........................} \quad (8)$$

For another, let $\theta = gg'$, then

$$u(\xi) = \sum_{m=0} a_m \left(g'\right)^m. \quad \text{...........................} \quad (9)$$

Now the differential equation about g becomes

$$g'' = a + bg' + cg'^2. \quad \text{...........................} \quad (10)$$

Step 3: We can create a system of algebraic equations from which V and a_m can be obtained

directly by substituting eqn.(7) or eqn.(9) into eqn.(3) using eqn.(8) or eqn.(10), and setting the

coefficients of all powers of $(\theta/g)^m$ to zeros.

Step4: By entering the value a_m from Step 3 back into eqn. (7)or eqn.(9), we can retrieve all of

its potential solutions.

2. New solutions of Vakhnenko Equation

High-frequency wave propagation in a relaxing medium is described by the nonlinear

equation Vakhnenko Equation [22–24] with loop soliton solutions. $u_{tx} + u_x^2 + uu_{xx} + u = 0$.

$$\text{.......................} \quad (11)$$

We incorporate new independent variables X,T in the style of Vakhnenko et al. [22], defined by

$$x = T + W\left(X,T\right) + x_0, \ t = X, \quad \text{..............................} \quad (12)$$

Where $u\left(x,t\right) = W_X\left(X,T\right)$, x_0 is a arbitrary constant.

From eqn. (12) it follows that

$$\frac{\partial}{\partial X} = \frac{\partial}{\partial t} + u\frac{\partial}{\partial x}, \ \frac{\partial}{\partial T} = \left(1 + W_T\right)\frac{\partial}{\partial x}. \quad \text{...........................}(13)$$

Thus eqn. (11) can be rewritten as

$$W_{XXT} + W_X W_T + W_X = 0. \qquad \text{……………………} \quad (14)$$

Now we look for the traveling solution of W by putting

$$W = \phi(\xi), \ \xi = X - VT. \qquad \text{……………………………} \quad (15)$$

Substituting eqn. (15) into eqn. (14), we have

$$-V\phi''' - V(\phi')^2 + \phi' = 0. \qquad \text{……………………………} \quad (16)$$

We need that the highest order of the polynomial in (θ/g) be 1 because of the homogeneous

balancing ϕ''' and $(\phi')^2$ in eqn.(16) and noting eqn.(4)

We investigate the well-known Vakhnenko equation, which defines how high-frequency waves move through a resonant material. General types of soliton solutions and periodic solutions to the Vakhnenko equation are obtained with the help of two new expansions.

2.1 $\left(g'/g^2\right)$ – Expansions

Suppose

$$\phi(\xi) = a_0 + a_1 \left(\frac{g'}{g^2} \right). \qquad \text{……………………} \quad (17)$$

By noting $\left(\dfrac{g'}{g^2} \right)' = a + c\left(\dfrac{g'}{g^2} \right)^2$, we have the concrete form of ϕ', ϕ'', ϕ''' and $(\phi')^2$, then

substitute them into Eq. (16), collect all terms with same order of $\left(\dfrac{g'}{g^2} \right)$, and set the coefficients

of all powers of $\left(\dfrac{\theta}{g} \right)^m$ to zeros. We will get a system of algebraic equations for a_0, a_1 and V as

following,

$$= \begin{cases} -2Va_1 a^2 c - Va_1^2 a^2 + a_1 a = 0 \\ -8Va_1 ac^2 - 2Va_1^2 ac + a_1 c = 0. \qquad \text{…………………} \quad (18) \\ -6Va_1 c^3 - Va_1^2 c^2 = 0 \end{cases}$$

After some algebraic calculation, and yields

$$a_1 = -6c, \ V = -\frac{1}{4ac}. \qquad \text{……………………} \quad (19)$$

Substituting eqn. (19) and the general solution of eqn. into eqn. (17), we therefore have two types of solutions as following:

We get two different types of answers when we substitute eqn.(19) and the general solution of eqn.(17).

For $ac > 0$,

$$\phi_1(\xi) = a_0 - 6\sqrt{ac}\,\frac{C_1\cos\left(\sqrt{ac}\,\xi\right) + C_2\sin\left(\sqrt{ac}\,\xi\right)}{C_1\sin\left(\sqrt{ac}\,\xi\right) - C_2\cos\left(\sqrt{ac}\,\xi\right)}, \quad \dots\dots\dots\dots\dots\dots \quad (20)$$

Where $\xi = X + \dfrac{1}{4ac}T$ and C_1, C_2 are arbitrary constants.

Thus the solution of Vakhnenko Equation is

$$u_1(x,t) = \frac{6ac\left(C_1^2 + C_2^2\right)}{\left(C_1\sin\left(\sqrt{ac}\,\xi\right) - C_2\cos\left(\sqrt{ac}\,\xi\right)\right)^2},$$

$$x + 4act = 4ac\xi + x_0 + a_0 - 6\sqrt{ac}\,\frac{C_1\cos\left(\sqrt{ac}\,\xi\right) + C_2\sin\left(\sqrt{ac}\,\xi\right)}{C_1\sin\left(\sqrt{ac}\,\xi\right) - C_2\cos\left(\sqrt{ac}\,\xi\right)}. \quad \dots \quad (21)$$

u_1 Here had not been given in Ref.[22-24]. It is a general form of periodic solution.

For $ac < 0$,

$$\phi_2(\xi) = a_0 + 6\sqrt{|ac|}\left(\frac{C_1 e^{2\xi\sqrt{|ac|}} + C_2}{C_1 e^{2\xi\sqrt{|ac|}} - C_2}\right), \quad \dots\dots\dots\dots\dots\dots \quad (22)$$

Where $\xi = X + \dfrac{1}{4ac}T$ and C_1, C_2 are arbitrary constants. In particular, if C_1 and C_2 take the special value, for example, $C_2/C_1 = -e^{2\xi_0}$, then

$\phi_2(\xi) = a_0 + 6\sqrt{|ac|}\tanh\left(\sqrt{|ac|}\,\xi + \xi_0\right) = a_0 + \dfrac{3}{\sqrt{V}}\tanh\left(\dfrac{\xi}{2\sqrt{V}} + \xi_0\right)$, which has same form as

Ref.[22].

In general, the soliton solution is

$$u_2(x,t) = -6ac + 6ac\left(\frac{C_1 e^{2\xi\sqrt{|ac|}} + C_2}{C_1 e^{2\xi\sqrt{|ac|}} - C_2}\right)^2,$$

$$x + 4act = 4ac\xi + x_0 + a_0 + 6\sqrt{|ac|}\left(\frac{C_1 e^{2\xi\sqrt{|ac|}} + C_2}{C_1 e^{2\xi\sqrt{|ac|}} - C_2}\right). \quad \dots\dots\dots\dots \quad (23)$$

2.2 g' – Expansion

Let

$$\phi(\xi) = b_0 + b_1 g'. \quad \dots\dots\dots\dots\dots\dots\dots\dots\dots \quad (24)$$

Similarly, noting $\left(g'\right)' = a + bg' + cg'^2$, one substitutes the new form of ϕ', ϕ'', ϕ''' and $\left(\phi'\right)^2$ into eqn. (16), and gets

$$
= \begin{cases}
-V\left(ab^2 b_1 + 2a^2 b_1 c\right) - V b_1^2 a^2 + b_1 a = 0 \\
-V\left(b_1 b^3 + 8b_1 abc\right) - 2V b_1^2 ab + b_1 b = 0 \\
-V\left(7b_1 b^2 c + 8b_1 ac^2\right) - V\left(b_1^2 b^2 + 2b_1^2 ac\right) + b_1 c = 0 \\
-12V b_1 bc^2 - 2V b_1^2 bc = 0 \\
-6V b_1 c^3 - V b_1^2 c^2 = 0
\end{cases} \quad \cdots\cdots\cdots\cdots \quad (25)
$$

Then we have $\qquad b_1 = -6c, \quad V = -\dfrac{1}{4ac - b^2}.$ $\qquad\qquad$ (26)

Substituting eqn. (26) and the general solution of eqn. into eqn. (24), we have three types of traveling wave solutions of the Vakhnenko Equation as follows:

Case 1: When $\Delta \equiv 4ac - b^2 < 0$,

$$
\phi_3(\xi) = b_0 - 3\left[\sqrt{-\Delta}\,\tanh\left(-\frac{\sqrt{-\Delta}}{2}\xi\right) - b\right]
$$

$$
= \left(b_0 + 3b\right) + \frac{3}{\sqrt{V}}\tanh\left(\frac{\xi}{2\sqrt{V}}\right), \qquad\qquad (27)
$$

Therefore, we have

$$
u_3(x,t) = -\frac{3\Delta}{2}\operatorname{sech}^2\left(-\frac{\sqrt{-\Delta}}{2}\xi\right),
$$

$$
x + \Delta t = \Delta\xi + b_0 - 3\left[\sqrt{-\Delta}\,\tanh\left(-\frac{\sqrt{-\Delta}}{2}\xi\right) - b\right] + x_0. \qquad\cdots\cdots\cdots\cdots \quad (28)
$$

Which is the one-loop soliton solution [22-26].

Case 2: When $\Delta > 0$,

$$
\phi_4(\xi) = b_0 - 3\left(\sqrt{\Delta}\,\tan\left(\frac{\sqrt{\Delta}}{2}\xi\right) - b\right), \qquad\cdots\cdots\cdots\cdots (29)
$$

$$
u_4(x,t) = -\frac{3\Delta}{2}\sec^2\left(\frac{\sqrt{\Delta}}{2}\xi\right),
$$

$$
x + \Delta t = \Delta\xi + b_0 - 3\left(\sqrt{\Delta}\,\tan\left(\frac{\sqrt{\Delta}}{2}\xi\right) - b\right) + x_0. \qquad\cdots\cdots\cdots\cdots \quad (30)
$$

u_4 here had not been given in Ref.[22-26]. Obviously, u_3 and u_4 are the special case of u_1 and u_4.

Compared with the $\left(g'/g^2\right)$-expansion and g'-expansion, is a more powerful tool to explore the solutions for nonlinear evolution equations.

Summary and Conclusion:

The expansion method, which is the generalisation $(G'/G)-$ of the $(\theta/g)-$ expansion method, has been proposed in this study. Numerous travelling solutions to the Vakhnenko Equation, including periodic. We are aware that various solutions are initially discovered. Additionally, it is shown that $(g'/g^2)-$ expansion is more efficient than expansion $g'-$ since the former can provide periodic solutions and Soliton solutions in general forms whereas the latter cannot. Even if this new method merely represents the amalgamation of a number of expansion techniques, we think it may help in the search for a technique that can resolve the majority of nonlinear equations and produce a wide range of novel solutions.

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STUDY OF ISOTHERMAL BULK MODULUS AND ITS FIRST PRESSURE DERIVATIVE USING BY MURNAGHAN AND TAIT'S EQUATION FOR THE STATE OF SOLIDS

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Abstract:

One of two EOSs taken into consideration is the one put forth by Birch-Murnaghan and Tait. The applicability has been assessed based on the degree to which the data deviation curves depart from the fit parameters and the agreement of the fit parameters with the compression and pressure ranges. Numerous astonishing results are drawn from the current investigation. Surprisingly, both the old EOSs—the so-called universal equation of state, which is currently used as a standard EOS alongside that of the Birch—are extremely subpar, and more importantly, its two-parameter counterpart is superior to all the isothermal unrealistic two-parameter EOSs thus far proposed in the literature. A structured technique for scaling the relative appropriateness of the EOSs in proportion to the test parameters is also devised. The work contributes, which is an extension of a previous one, aims to get precise values for the isothermal bulk modulus and its pressure derivative.

Introduction:

When pressure is applied, a substance's volume decreases; yet, when pressure is released, the substance's volume increases. A measure of a substance's resistance to volume changes when subjected to all-around compression is the bulk modulus, often known as the incompressibility. By dividing the applied pressure by the relative deformation, this amount is calculated. Solid state equation formulation is gaining in popularity. The results of the Murnaghan expression are generally consistent with the input parameters, such as the values of the materials' bulk modulus and its first-order pressure [1-4]. The maximum stress or strain a solid material can sustain per unit area before starting to irreversibly deform is known as the elastic limit. When subjected to forces above its elastic limit, a material yields or flows. The crossover from elastic to plastic function is marked by the elastic limit for such materials. When exposed to forces that exceed their elastic properties, brittle materials typically collapse with little to no plastic deformation.

In this instance, the relative deformation, also known as strain, is calculated by dividing the original volume by the changed volume. The strain can therefore be stated as the change in volume, $V_o - V_n$, divided by the original volume, or $(V_o - V_n)/V_o$, if the original volume V_o of a

material is decreased by an applied pressure p to a new volume Vn. The bulk modulus, which is the pressure divided by the strain by definition, can be mathematically stated as

$$\text{Bulk modulus} = \frac{\text{Pressure}}{\text{Strain}} = \frac{P}{(V_0 - V_n)/V_0}$$

This is a particular application of Hooke's law of elasticity, which applies when the bulk modulus is constant (regardless of pressure).

Method of analysis:

The proportion of confining pressure to fractional volume reduction in response to applied hydrostatic pressure is known as the bulk modulus (k). The sample's volume strain is calculated by dividing the pattern's volume change by its initial volume. The term "bulk modulus" also refers to the "incompressibility modulus." Mathematically valid answers to the equation of bulk modulus can be found in the expression known as Murnaghan's equation of state in the high-pressure research community, although it is limited by a small number of factors[5-6].

Murnaghan's equation of state:

Murnaghan's equation is broadly applied in the literature and is the most important empirical equation. The bulk modulus on pressure P is given in this equation.

$$K = a + b\,P \qquad\qquad \text{------ (1)}$$

Where a and b are constants which are depends only temperature and independent pressure. At given temperature and pressure at, P=0 then

$$K = K_0 \quad \text{and} \quad \frac{dK}{dP} = K_0'$$

Applying the condition in the equation (1) we then get

$$a = K \quad \text{and} \quad b = K_0'$$

Murnaghan simplest relationship for incompressibility

$$K = K_0 + K_0'P \qquad\qquad \text{------ (2)}$$

The isothermal bulk modulus K which is the inverse of the isothermal compressibility is defined as

$$K = -V\left(\frac{dP}{dV}\right)_T \qquad\qquad \text{--- ----- (3)}$$

Comparing the equation (2) and (3) then we get

$$-V\left(\frac{dP}{dV}\right) = K_0 + K_0'P$$

$$\frac{dP}{K_0 + K_0'P} = -\frac{1}{V}dV \qquad\qquad \text{------ (4)}$$

Now at pressure P=0, Volume = V_0

And at pressure P=0, Volume = V

Now integrating according to proper limits

$$\int_0^P \frac{dP}{[K_0 + K'_0 P]} = -\int_{V_0}^V \frac{dV}{V} \qquad \text{------ (5)}$$

$$-[\ln V]_{V_0}^V = \left[\frac{\ln[K_0 + K'_0 P]}{K'_0}\right]_0^P$$

$$\ln\left(\frac{V}{V_0}\right) = -\frac{1}{K'_0}\ln\left\{\frac{[K_0 + K'_0 P]}{K_0}\right\}$$

$$\left(\frac{V}{V_0}\right) = \left[1 + \frac{K'_0 P}{K_0}\right]^{-1/K_0} \qquad \text{-- ------ (6)}$$

This equation can be used to study to the compressibility of solid under the effect of pressure. Equation (6) is called Murnaghan's first order equation of state [1].

$$\frac{K'_0 P}{K_0} = \left[\left(\frac{V}{V_0}\right)^{-K_0} - 1\right]$$

$$P = \frac{K_0}{K'_0}\left[\left(\frac{V}{V_0}\right)^{-K_0} - 1\right] \qquad \text{------- (7)}$$

Where V_0 is the volume at pressure zero pressure and K'_0 is the first order pressure derivative of bulk modulus at zero pressure. It should be emphasized that Murnaghan's equation (7) is based on the assumption that K depends linearly on the pressure. It is assumed that $K' = K'_0$ =constants

II . Tait' s equation of state

Modification of Murnaghan's equation[7-8] according to Tait equation of state

$$K = [K_0 + (K'_0 + 1)P]\frac{V}{V_0} \qquad \text{------ (8)}$$

The isothermal bulk modulus K which is the inverse of the isothermal compressibility is defined as

$$K = -V\left(\frac{dP}{dV}\right)_T \qquad \text{------ (9)}$$

Comparing the equation (8) and (9) then we get

$$-V\left(\frac{dP}{dV}\right) = [K_0 + (K'_0 + 1)P]\frac{V}{V_0} \qquad \text{------ (10)}$$

$$\frac{dP}{[K_0 + (K'_0 + 1)P]} = -\frac{1}{V_0}dV \qquad \text{------ (11)}$$

Now at pressure P=0, Volume =V_0

And at pressure P=0, Volume =V

Now integrating according to proper limits

$$\int_0^P \frac{dP}{[K_0 + (K'_0 + 1)P]} = -\frac{1}{V_0}\int_{V_0}^V dV \qquad \text{------ (12)}$$

$$\left[\frac{1}{(K'_0 + 1)}\ln[K_0 + (K'_0 + 1)P] - \ln K_0\right] = -\frac{1}{V_0}[V - V_0]$$

$$\frac{1}{(K'_0 + 1)}\ln\left\{\frac{[K_0 + (K'_0 + 1)P]}{K_0}\right\} = \frac{1}{V_0}\left[1 - \frac{V}{V_0}\right]$$

$$\text{In}\left\{\frac{[K_0+(K'_0+1)P]}{K_0}\right\} = (K'_0+1)\left[1-\frac{V}{V_0}\right]$$

$$[K_0+(K'_0+1)P]] = K_0\exp(K'_0+1)\left[1-\frac{V}{V_0}\right]$$

$$(K'_0+1)P = K_0\exp\left[(K'_0+1)\left(1-\frac{V}{V_0}\right)\right]-K_0$$

$$(K'_0+1)P = K_0\left[\exp\left[(K'_0+1)\left(1-\frac{V}{V_0}\right)\right]-1\right]$$

$$P = \frac{K_0}{(K'_0+1)}\left[\exp\left\{(K'_0+1)\left(1-\frac{V}{V_0}\right)\right\}-1\right] \qquad \text{------ (13)}$$

The isothermal bulk modulus K is defined by Murnaghan's modification equation. Murnaghan's modification equation (8) can be written as

$$K = [K_0+(K'_0+1)P]\frac{V}{V_0} \qquad \text{------ (14)}$$

Substituting the value of P from equation (13) in (14) then we get the relation for the isothermal bulk modulus K

$$K = \left[K_0+(K'_0+1)\times\frac{K_0}{(K'_0+1)}\left[\exp\left\{(K'_0+1)\left(1-\frac{V}{V_0}\right)\right\}-1\right]\right]\frac{V}{V_0}$$

$$K = \left[K_0+K_0\left[\exp\left\{(K'_0+1)\left(1-\frac{V}{V_0}\right)\right\}-1\right]\right]\frac{V}{V_0}$$

$$K = K_0\left(\frac{V}{V_0}\right)\left[1+\left[\exp\left\{(K'_0+1)\left(1-\frac{V}{V_0}\right)\right\}-1\right]\right]$$

$$K = K_0\left(\frac{V}{V_0}\right)\exp\left[(K'_0+1)\left(1-\frac{V}{V_0}\right)\right] \qquad \text{------ (15)}$$

The isothermal bulk modulus K' is the first pressure derivative

$$K' = \left(\frac{dK}{dP}\right)$$

$$= \left(\frac{dK}{dV}\right)/\left(\frac{dP}{dV}\right) \qquad \text{------ (16)}$$

Now differentiating of equation (9) with the respect to V then we get

$$\frac{dK}{dV} = K_0\left[\begin{array}{c}\left(\frac{V}{V_0}\right)\frac{d}{dV}\exp\left[(K'_0+1)\left(1-\frac{V}{V_0}\right)\right]\\+\exp\left[(K'_0+1)\left(1-\frac{V}{V_0}\right)\right]\frac{d}{dV}\left(\frac{V}{V_0}\right)\end{array}\right]$$

$$\frac{dK}{dV} = K_0\left[\begin{array}{c}\left(\frac{V}{V_0}\right)\times\exp\left[(K'_0+1)\left(1-\frac{V}{V_0}\right)\times(K'_0+1)\left(-\frac{1}{V_0}\right)\right]\\+\exp\left[(K'_0+1)\left(1-\frac{V}{V_0}\right)\right]\times\left(\frac{1}{V_0}\right)\end{array}\right]$$

$$\frac{dK}{dV} = \frac{K_0}{V_0}\exp\left\{(K'_0+1)\left(1-\frac{V}{V_0}\right)\right\}\left[(K'_0+1)\left(-\frac{V}{V_0}\right)+1\right]$$

$$\frac{dK}{dV} = -\frac{K_0}{V_0}\exp\left\{(K'_0+1)\left(1-\frac{V}{V_0}\right)\right\}\left[(K'_0+1)\left(\frac{V}{V_0}\right)-1\right] \text{----- (17)}$$

Now differentiating of equation (13) with the respect to V then we get

$$\frac{dP}{dV} = \frac{K_0}{(K'_0+1)}\left[\exp\left\{(K'_0+1)\left(1-\frac{V}{V_0}\right)\right\}\times(K'_0+1)\left(-\frac{1}{V_0}\right)\right]$$

$$\frac{dP}{dV} = -\frac{K_0}{(K'_0+1)} \left[\exp\left\{ (K'_0+1)\left(1-\frac{V}{V_0}\right) \right\} \times (K'_0+1)\left(\frac{1}{V_0}\right) \right]$$

$$\frac{dP}{dV} = -\frac{K_0}{V_0} \exp\left\{ (K'_0+1)\left(1-\frac{V}{V_0}\right) \right\} \qquad \text{------ (18)}$$

Putting the values of $\frac{dK}{dV}$ and $\frac{dP}{dV}$ from equation (17) and (18) in equation (16) then we get the first pressure derivative of isothermal bulk modulus K'

$$K' = \left(\frac{dK}{dV}\right) / \left(\frac{dP}{dV}\right)$$

$$K' = \left[\frac{-\frac{K_0}{V_0}\exp\left\{(K'_0+1)\left(1-\frac{V}{V_0}\right)\right\}\left[(K'_0+1)\left(\frac{V}{V_0}\right)-1\right]}{-\frac{K_0}{V_0}\exp\left\{(K'_0+1)\left(1-\frac{V}{V_0}\right)\right\}} \right]$$

$$K' = \left[(K'_0+1)\left(\frac{V}{V_0}\right) - 1 \right] \qquad \text{------ (19)}$$

From equation (16) can be become negatively at sufficiently high compression. It is only at a density well beyond the range of interest [9].

Table 1: Calculated by (a) Birch-Murnaghan's EOS (b) Tait's EOS

Values of isothermal bulk modulus K for MgO at different Compression			Values of isothermal bulk modulus K for CaO at different Compression			Values of isothermal bulk modulus K for MgSiO₃ at different Compression		
V/V_0	(a)	(b)	V/V_0	(a)	(b)	V/V_0	(a)	(b)
1.00	162	162	1.00	114	114	1.00	264	264
0.95	199	199	0.95	140	139	0.95	323	322
0.90	245	244	0.90	171	170	0.90	395	392
0.85	303	297	0.85	211	207	0.85	485	475
0.80	377	362	0.80	261	250	0.80	598	574
0.75	471	438	0.75	325	302	0.75	742	691
0.70	594	528	0.70	407	363	0.70	928	828
0.65	757	634	0.65	516	434	0.65	1172	987
0.60	976	757	0.60	662	516	0.60	1497	1170
0.55	1279	896	0.55	862	608	0.55	1941	1378

Values of First pressure derivative of isothermal bulk modulus K' for MgO at different Compression			Values of First pressure derivative of isothermal bulk modulus K'for CaO at different Compression			Values of First pressure derivative of isothermal bulk modulus K'for MgSiO₃ at different Compression		
V/V_0	(a)	(b)	V/V_0	(a)	(b)	V/V_0	(a)	(b)
1.00	4.13	4.13	1.00	4.05	4.05	1.00	4	4
0.95	3.94	3.97	0.95	3.87	3.90	0.95	3.82	3.85
0.90	3.78	3.82	0.90	3.71	3.75	0.90	3.66	3.72
0.85	3.64	3.66	0.85	3.57	3.59	0.85	3.52	3.55
0.80	3.52	3.50	0.80	3.45	3.44	0.80	3.40	3.41
0.75	3.41	3.35	0.75	3.34	3.29	0.75	3.29	3.25
0.70	3.31	3.19	0.70	3.24	3.14	0.70	3.19	3.12
0.65	3.22	3.03	0.65	3.15	2.98	0.65	3.10	2.95
0.60	3.14	2.88	0.60	3.07	2.83	0.60	3.02	2.83
0.55	3.07	2.72	0.55	3.00	2.68	0.55	2.95	2.65
0.50	3.01	2.57	0.50	2.93	2.53	0.50	2.86	2.53

Results and Discussions:

Because of the linear dependency of the bulk modulus on pressure and the constant bulk modulus pressure derivative, the Murnaghan's equation of state generally fails for compression ratios more than 0.7–0.8 times the original volume. The Birch-Murnaghan's equation of state is one of many well-liked versions that have been suggested to deal with this problem.
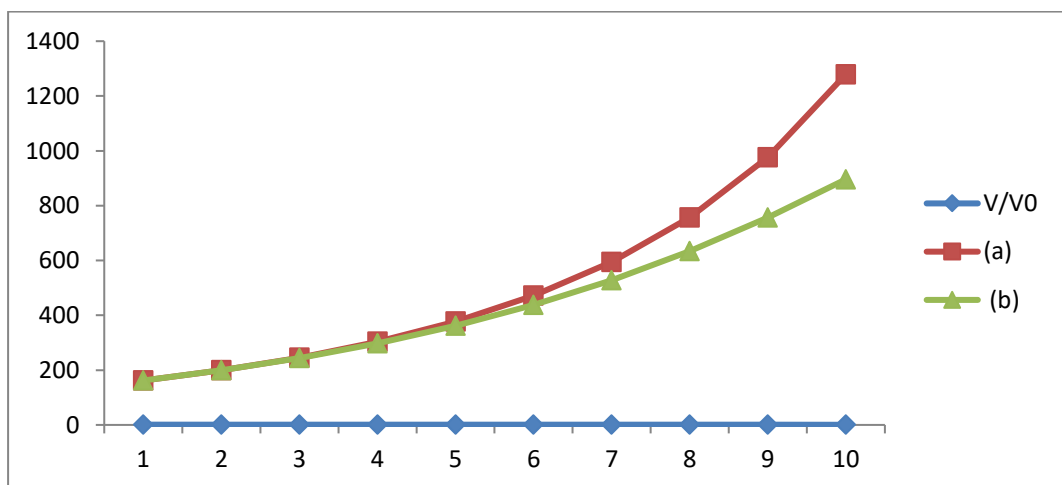
Figure 1: Values of isothermal bulk modulus K for MgO at different Compression
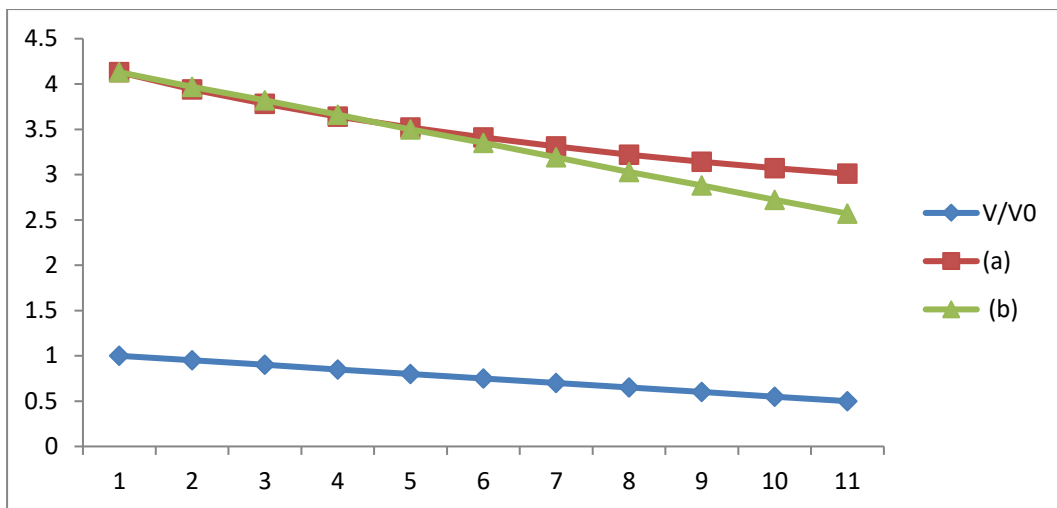
Figure 2: Values of First pressure derivative of isothermal bulk modulus K' for MgO at different Compression
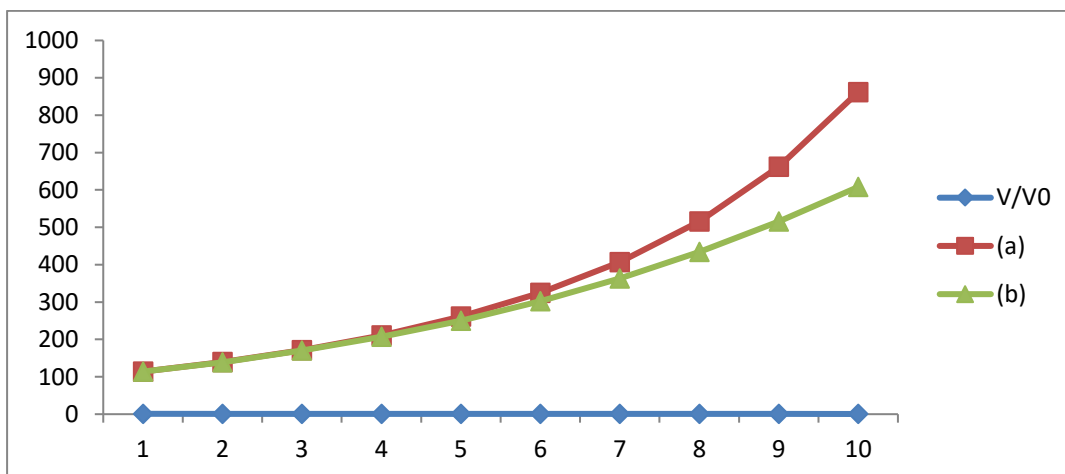
Figure 3: Values of isothermal bulk modulus K for CaO at different Compression
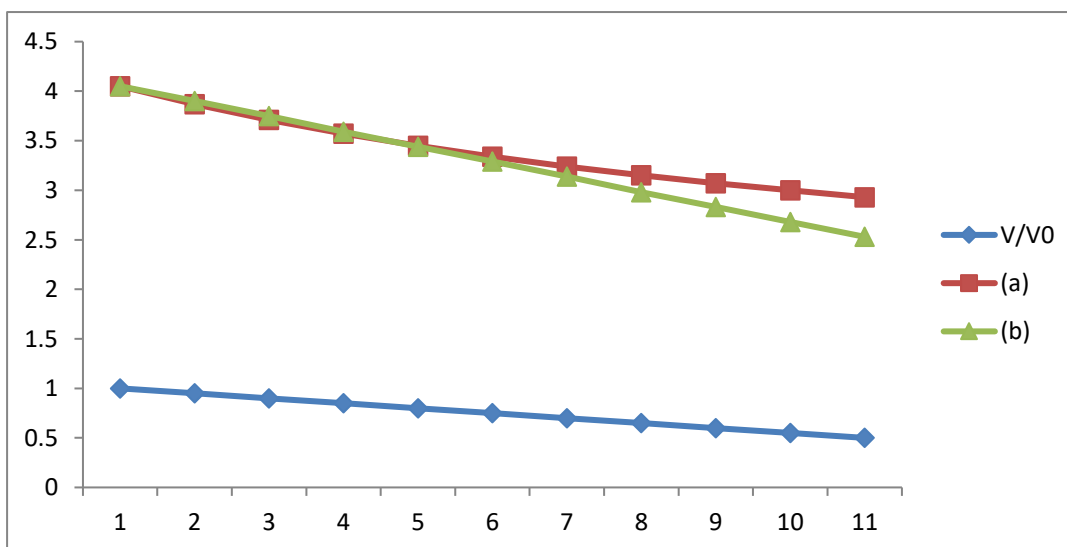
Figure 4: Values of First pressure derivative of isothermal bulk modulus K'for CaO at different Compression
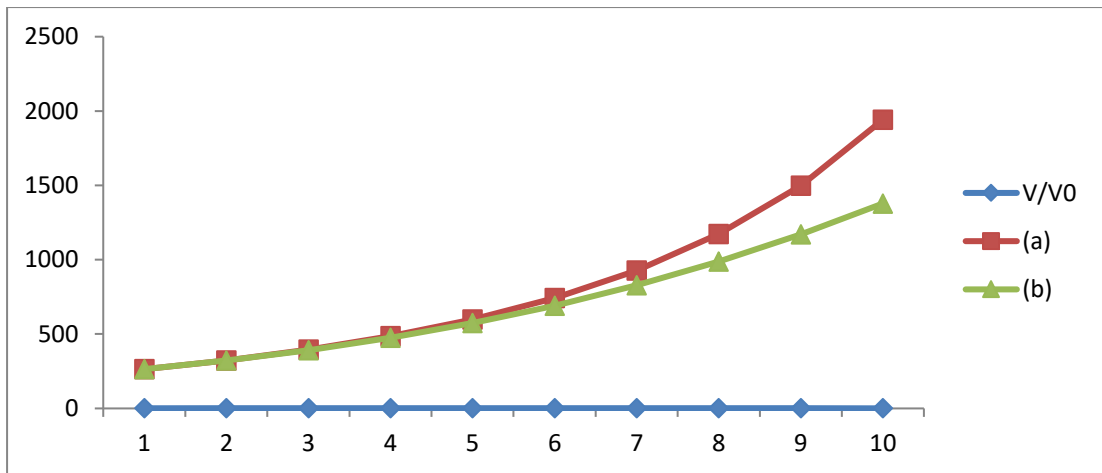
Figure 5: Values of isothermal bulk modulus K for MgSiO₃ at different Compression
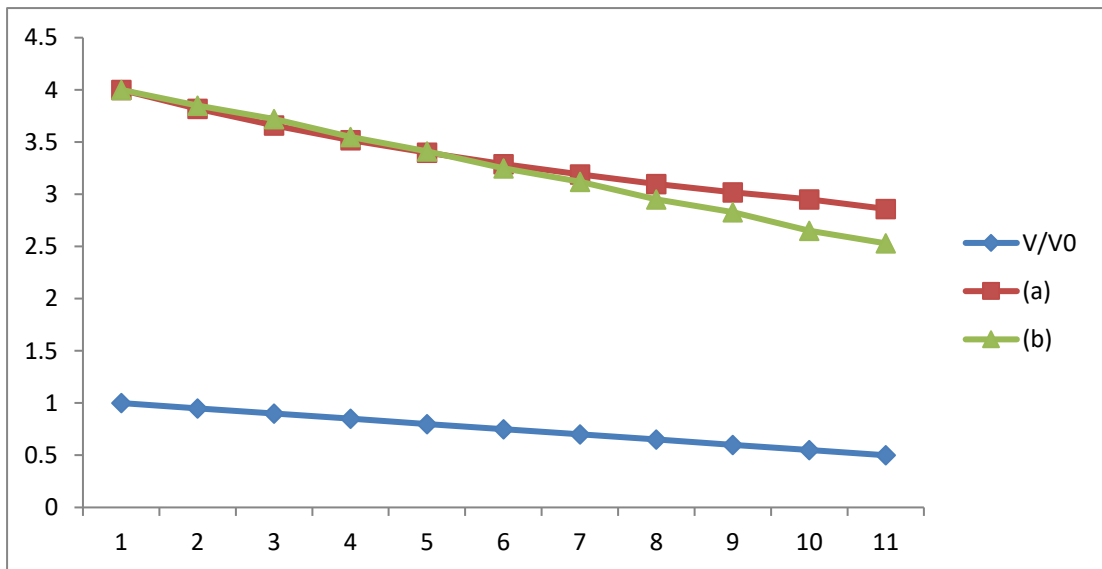
Figure 6: Values of First pressure derivative of isothermal bulk modulus K'for MgSiO₃ at different Compression

Moreover, the equation of state in question exhibits a peculiar behavior at high pressures when fitted to compression data. An alternative expression with a much wider range of validity is given. No peculiarity appears in the resultant compression curve. The latter expression thus provides a new tool as an infinitesimal-strain equation of state for quick estimate of compression characteristics of substances.

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AI TECHNOLOGIES IN EDUCATION ERA

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Abstract:

Since the education sector is allied with highly vibrant business environments which are proscribed and maintained by information systems, recent technological advancements and the mounting pace of adopting artificial intelligence (AI) technologies represent a require to identify and analyze the issues regarding their accomplishment in education sector. However, a study of the contemporary literature reveled that relatively little research has been undertaken in this area. To fill this void, we have recognized the benefits and challenge of implement artificial intelligence in the learning segment proceed by an under sized argument on the concepts of AI and its advancement over time. Before I finish, i have developed an approach accomplishment model our analysis showed that AI offers teachers several instance for improved planning (e.g., by essential students' needs and familiarizing teachers with such needs), realization (e.g., through instantaneous feedback and teacher intrusion), and assessment of their teaching. We also found that teachers have a variety of roles in the development of AI expertise.

Keywords: Artificial Intelligence, AIED, emerging, pedagogical, Transform Education

Introduction:

AI has been stabbing our day by day life in various traditions such as from end to end mobile apps, web search engines, & healthcare related systems [1].The rapid advancement of AI technology also has significant implications for culture and training. In fact, AI-supported instruction is projected to make over education [2].

As a result, significant investments have been completed to integrate AI into training and learning [3].A noteworthy challenge in the efficient incorporation of AI into teaching and learning, however, is the profit direction of most current AI requests in education. AI developers are familiar with little about knowledge sciences and lack educational knowledge for the operative execution of AI in teaching [4]. Moreover, AI developers often are unsuccessful to consider the potentials of AI end-users in learning. Educators are reflected among the most critical participants in AI-based education[5], so their observations, involvements, and potentials need to be measured for the successful adoption of AI in schools [6] particularly, to make AI pedagogically appropriate, the rewards that it suggestions teachers and the challenges that educators face in AI-based teaching necessity to be implicit superior. Moreover, teachers' skills in the pedagogical use of AI and the roles of teachers in the expansion of AI have been somehow

discounted in nonfiction[5,7]Since the field of AI-based instruction is still developing, this study can contribute to the development of inclusive AI-based training systems that allow teachers to contribute in the strategy procedure.

The Global AI in Education society (AIED) is an interdisciplinary society at the limits of the fields of Computer Science, Psychology & Education. The International AIED society was propelled on 1st January 1997. In general, there are four areas of AIED in academic sustenance services, and institutional and organizational services such as Profiling and Prediction, appraisal and Evaluation, Adaptive systems, Personalization and intellectual tutoring systems. Working of AIED is shown in following Figure.
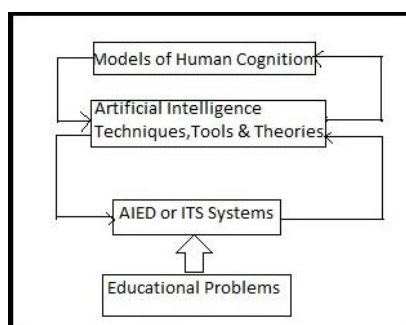
Figure 1: Working of AIED

Education is an arena where the existence of teachers is must which is the best educational practice the advent of Artificial Intelligence changes.

Educational use of AI

There have been numerous influences of developing instructive technologies over the earlier few years and now, there is Artificial Intelligence [8].The term AI was first revealed in 1956 by John McCarthy [9]. These approaches can be categorized as Machine Learning, Neural Networks, & Deep Learning [10]. Machine learning is distinct as the capability of a computer procedure learning from the data to kind conclusion without being spontaneous [11] Although various machine learning models exist, the two most used models are supervised and unsupervised learning models [12] Supervised machine learning algorithms build a sculpt based on the model data, while unsupervised machine learning procedures are formed from untagged data [13].

AI is used in education in altered traditions. For illustration, AI is integrated into numerous instructional technologies such as chatbots [14], intelligent tutoring, and automated grading systems [15]. These AI-based systems offer several occasions to all participants during the education and instructional process [16].Previous research conducted on the educational use of AI presented AI's support for student collaboration and personalization of learning experiences scheduling of learning activities and adaptive feedback on learning processes reducing teachers'

assignment in cooperative knowledge creation predicting the probability of beginners reducing out of school or being acknowledged into school profiling students' backgrounds, monitoring student progress [17].

As the solutions in AI continue to get to higher level it helps to identify the gaps in teaching and learning and increases the expertise of education. AI can drive efficiency, personalization and make more efficient admin tasks to allow teachers the time and freedom to provide understanding and adaptability uniquely human capabilities where machines would struggle. With the combination of machinery and teachers it is possible to pull out the best results from students.

Educator's roles of in AI based education

The progression of learning towards digital training does not indicate that people will require less teachers in the upcoming time [18] Instead of venturing if AI will switch teachers, accepting the rewards that AI proposals teachers and how these benefits can change teachers' roles in the classroom is more sensible [19] Established this during the early phases of growth of educational technology by pointing out the need to think how knowledge occurs through and with computers. For AI to be capable to truly assist teachers in this way, however, it must first learn effective orchestration of learning and teaching from teachers' data. This is because effective teaching depends on teachers' capability to tool suitable pedagogical methods in their instruction [20], and their pedagogically expressive and productive teaching incidents can serve as model for AI-based instructive systems [21].That is, the data collected from the knowledge setting orchestrated by teachers form the foundation of AI-based instruction. For instance, the data may help investigators to recognize when and how teaching is efficiently succeeding. To show that the part of teachers in provided that the data on structures of effective learning is crucial for the development of AI algorithms, we examined the kind of data composed from teachers and teachers' characters in the establishment of AI algorithms.

To effectively assimilate AI-based education in schools, educators must be authorized to implement such combination by endowing them with the requisite knowledge, assistances, and insolences. This training discovered the viewpoint and roles of teachers in AI-based research through a systematic appraisal of the newest investigation on the topic.

AI based solutions in education

There are lot of tech driven solutions in the industry of education There are several educational platforms based on AI technology such as.

- **Third Space Learning:** It was created with the help of scholars from London University College. It helps to recommend the ways to make the teaching techniques better, like giving a warning when the explanation of teacher is either slow or very fast.

- **Little Dragon:** The Little Dragon creates smart applications that analyze the user's facial expressions or gestures and adapt the user interface accordingly. Little Dragon also creates educational games for kids.

- **CTI:** The online service called Cram101 by the company CTI use AI to revise the manuals and theoretic credentials and locate the highlights of the substantial online. It also generates practice tests and flashcards as student exercises.

- **Carnegie learning:** Several companies such as Carnegie Learning and Content Technology started the accomplishment of AI for trying, learning and for attractive feedback in educational system from Pre-KG to college level by developing high level instruction design and digital platforms.

List of Artificial Intelligence in Education:

Various tools of AI are using in education system, such as:

Grading software

AI-powered grading software combine Machine Learning to generate calculating systems after it collects significant data on metrics for grade assignments from identification that have been graded by instructor. The tools are intended to understand and repeat the teachers' human grading process previously. They are versatile when the number of papers is noteworthy so that the teachers can be occupied by more value-based work instead of wasting hours in grading.

Management jobs

To get rid of manual management work in n Schools, Colleges and Universities such as development, rescheduling program, mark attendance, grade papers, finance and accounting &documentation preservation. AI tools can accomplish range of functions like

- Ending truancy alerts & Plan and schedule meetings
- Computerize schedule, Students form, Enrollments, & other official procedure to the precise department.

It can facilitate teachers and professors to focus primarily on civilizing educational excellence in its place of physical paperwork and dropping work pressure.

Voice assistants

Voice assistants are an attractive and suitable way to bring learning at home, pay attention to coaching directions while on the go, and give instantaneous answers to students' basic questions in class. The benefits of voice assistant in education contain:

- well-organized saving of time for students and teachers
- as long as adapted learning within seconds

These AI-powered influence supporter can be worn in apps on the Smartphone even if they don't have elegant speaker.

Personalized learning

AI tools can aid learning from beginning to end tailor-made study schedule and modify knowledge based on the explicit requirements of unit learners. AI-powered software, games and tools can set come up to for students to learn at their speed, time and necessities for repeated practice.

Smart tutoring

Tutoring programs or Intelligent Tutoring Systems (ITS) based on AI are operational to handle personalized feedback and instructions for one-on-one teaching. However, they cannot replacement teachers since they are not superior enough to teach how a human can. It can be an effectual tool in e-learning platforms to teach languages, Geography, Circuits, Medical opinion, Math, Physics, Computer program, Heredity, Chemistry, etc.

Smart content

Stylish content can choice from digital textbooks, guides, instructional snippets, videos to AI utensils that create customized environments for the educational association based on strategy and goal. For illustration, schools can generate AR/VR based learning environment as well as web-based education to accompany.

Universal admittance to education

It's always a task to certify that standardized quality of education is spread from corner to corner geography and ethnicities. Still, AI technologies can considerably association the restrictions between students, teachers, nobles and educational administrator. Smart data meeting, can be made probable with AI tools. They can also create descriptions and language translation and unlike plug and play software that can be disseminated across counties to improvement global and worldwide knowledge.

Simulated knowledge environment

Using this technology, students can honestly attach to their mobile device or laptop and admittance contented interactively. It can assist students with ADD/ADHD by obstructive out disruptions and growing attention spans. In addition, learners can also aid learner in soft skill coaching, life skills, and self-development with interactive virtual imitation.

Advantages of AI in education:

The prospect of education is extremely linked with the development of new artificial intelligence technologies and computing.

AI tools can make universal classrooms likely as well as people who are visually or consideration impair. This can also help students who cannot attend classes due to illness.

AI provides with quite a few resources to people who speak different languages or have hearing or visual difficulties. Presentation Translator provides subtitles in real-time mode, which is an AI based system application. For example, with the help of Google translator students can

read and hear in their countrywide language. For more interactive sessions modern technologies like VR is helpful.

Admissions and enrollment processes can also be done with AI in the future and its full potential is yet to be out. AI can produce group in students who are suited for particular tasks. This is known as Adaptive Group Formation. The crucial parts of AIED system is Domain Knowledge prototypical that provide the ability of the system to wide-ranging the tasks that makes the students to justice to supply towards the voice assistants assistances students to reverse right with the educational material that are the Intellectual Tutoring Structure is used to stimulate one-to-one particular tutoring. Contingent on the neural networks, algorithms they can make a decision against an individual student.

Development

The benefits of AI associated to development involved getting information on students' circumstances and assisting teachers in decide on the learning content during example planning.

Implementation

AI systems can reduce the teaching burden on teachers by as long as them criticism and support them with development intervention and with student monitoring.

Assessment

AI helps teachers in exam mechanization and composition scoring and in resolution making on student routine. Numerous existing AI-based systems consent teachers to check the legitimacy of compositions submitted by students in alumnus courses [22] this can be painstaking a significant effectiveness of AI in student valuation.

Following Figure demonstrates the part of teachers in AI research and the compensation of AI for teachers.
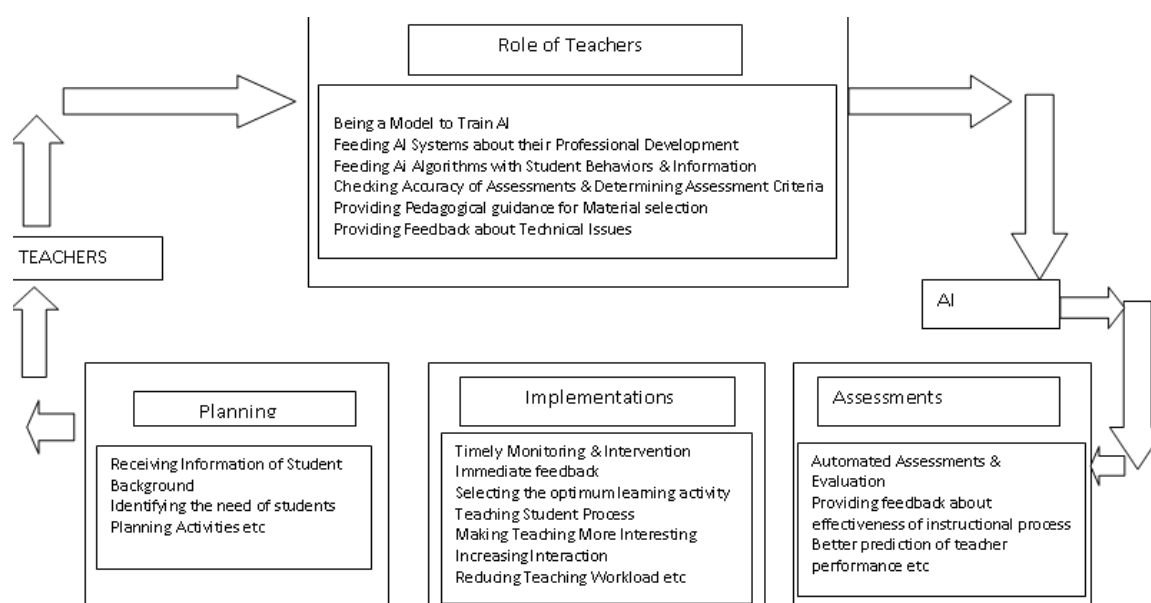
Figure 2: Role of Teachers according to AI

Supervise and scrutinize student progress in real-time

Teachers can observe and analyze students' progress in real-time using AI apparatus. It means that the educators do not essential to stay until they compile once a year report sheets. Also, AI gives teachers' references as to the areas that involve repeat or auxiliary clarification.

Saves time and improves effectiveness

Because AI demonstrates human-like skill like learning, significant idea, and problem-solving, there's an anxiety about AI. It helps save up more occurrence so educators can emphasis on education the students and other critical responsibilities.

More adapted Knowledge Skill

AI in education permits schools to carve out modified learning involvements for their apprentices. After student statistics, AI can examine the student's learning momentum and needs. With the consequences, schools can initial course summaries that enhance education based on students' assets and failing.

Suitable and Improved Student-Teacher connections

AI helps us appreciate the mood or ease of student throughout the addresses by using Sign acknowledgment Technology. Since AI becomes more sophisticated the mechanism reads the facial terminologies or motions of the student and uses them to know if the student is struggling to understand the address and modify the lesson so that the apprentice can track up easily.

Simplifying administrative tasks

Every educational foundation has lots of school management tasks they need to contract with on a daily basis. Including AI to their schemes can help to mechanize such everyday jobs. It means that administrators can have additional time to track and establish the school additional easily. Such services can help ensure that managerial documents are well printed and error-free.

AI encounters in education:

In spite of of the huge occasions AI offers there might also be some possible risks with it.

- AI could sustenance education and knowledge but new principled suggestions& risks Emerges with the development of AI applications in higher education. One such instance is, due to the constant corona virus epidemic and the reasonable cuts, the administrators might think of substituting teaching with money making mechanized AI solutions. If the usage of AI in education increases there might be accidental those personal interactions get reduced and students get Technology addicted and sometimes this may hurt the learners instead of helping them.

- The faculty members, student counselors, teaching subordinates and managerial staff might get feared that the Intellectual Instructor System which is request of AI might substitute them.

- AI system requires a huge amount of data including information of students and staff which is confidential and it heads to thoughtful secrecy issues.
- When associated to the cost of connection, maintenance and repair AI is highly expensive. Only the heavily funded educational organizations can allow themselves to enjoy such high technology.
- The imperfect dependability of the AI procedure was found to be additional substantial task. Incompetence of AI systems in valuation and assessment is connected more to validity than to reliability.

Conclusion:

AI in education is a revolutionary change. According to a report distributed by Centre for Integrative Research in Computer and Knowledge Sciences conditions that the next level uses of AI in Education is not yet designed. Although there are numerous convicts of using AI in educational sector, our future is AI so the educational system should start exposing their students to this sort of technology which ongoing using a bit of AI. The main purpose of AI is to make the effort of an educator easier but not to replace them.

From classroom communications, coursework learning, and admin process, AI makes it all better & the compensation keep refining and growing as new AI machineries come into view.

On the reverse AI, education is not without its challenge. Educators are in fear of institute robotic and systemic changes that are susceptible to attacks. Yet, teachers and schools cannot have enough money to ignore AI's consequence in enhancing learning and process competence.

In concluding assumption, AI has prejudiced numerous sectors and teaching is one of them. An application and acceptance is obvious in the education segment. AI technologies are not imperfect to shrewd learning, training arrangements, and social robots; there are lots of other intellectual skills, such as virtual organizer, online learning situations, learning organization systems, and education analytics, which also supply drastically to the sector.

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PATTERN LEARNING OF NEWS EXTRACTION IN ONLINE NEWS REPOSITORIES USING CONTENT MINING AND MACHINE LEARNING ALGORITHMS APPROACHES

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Abstract:

Motivation of this paper for the researcher to identify online news extraction of essential data from standard language text via online text mining is an automatic procedure used in web mining which facilitates natural language processing to derive valuable insights from unstructured text. By changing data into information that devices can learn, text mining automates the phase of classifying texts by sentiment, subjects, and intent. Web Content extraction task is not easiest job. Specific content extraction should be digging out and identified via Web mining algorithms. For the effective identification of text content in online news extraction machine learning algorithms and tools could be more helpful.

Introduction:

The newspaper agencies have their online editions available on the web. Day by day, increasing number of users prefer the online newspapers as they have offered the opportunity for in-depth content, multimedia and interactivity that is not available in traditional newspapers [1].The online users and readers are demanding the high quality online delivery and services; searchable archives, personalized news services, intermediary services etc. The users and domain experts frequently require domain related information, news, articles, literature etc from the online newspapers. Such information may be triggered to useful action and decision making for them. However most online newspapers still offer all the users the same news/article or the irrelevant news that does not satisfy the individual needs, its not given effective results.

Recently several web content mining techniques/tools have been developed to retrieve the relevant information from the structured or unstructured data. For example, several information extraction systems have been developed to retrieve relevant information out of text. Further, some text mining tools for information retrieval and knowledge generation have been developed that creates one-to-one relationship between content provider and the user. The Pew Research Center for people and press in its survey report published on July 30 2006, shows that the use of online newspapers is increased from 2% in the 1996 to 31% in the year 2006 [2].

Also in their article published on February 26, 2009 shows the overall newspaper readership declined in spite of an increase in the number of people reading online newspapers. The survey report also highlights the fact that the readers who logged on for news spent 32 minutes, on average, getting the online news. That is significantly less than the average number of minutes that newspaper readers, radio news listeners, and TV news viewers spend with those sources [3]. In addition, web news users emphasize speed and convenience over detail. Of the 23% who got news on the internet yesterday, only a minority visited newspaper websites. Instead, websites that include quick updates of major headlines, such as MSNBC, Yahoo, CNN, and Rediff, [4] dominate the web-news landscape. Hence there is a need to develop a system that provides a platform to the web news users to extract relevant news of their interest from several online newspapers speedily and accurately.

However, the existing search engines search the online documents using keywords and check the frequency of occurrences of the keywords in the text. And most of the text that is extracted is irrelevant of the keywords.

Aim:

Considering above problem in news extraction the main aim of the research is to develop a system for news extraction in online news repositories using web content mining approaches that can extract the specific news of the online user interest from the several online English newspapers available on the web.

Objectives:

Following are the objectives of the proposed research work.

- Study of different text mining algorithms specially applied to web content mining with respect to news.
- Use of text mining algorithms for web content to the web pages, content, specific text in online newspapers.
- Determining support and confidence for news text mining in web contents.
- Study of text mining applications with reference to news mining.
- The analytic study of news mining using different tools.
- Study of tools supporting browsing and navigation for the news extraction.
- Study of descriptive phrase extraction from news repository.
- Study of classification and clustering of news text from news repositories.
- Study of news categorization and summarization of news
- Study of strategies for news retrieval.
- Study of online services provided to the online reader and improving performance and effectiveness of them for readers.

- Study of incremental text mining and intelligent system for news.
- Study of implementing web content mining using machine learning algorithms.

Relevant work

Fotudimu *et al.* [5] has developed a text mining system based on the modified Generating Association Rule based on Weighing Scheme (GARW) algorithm that will generate inferences from the political data set of online news repositories. This system uses Term Frequency Inverse Document Frequency (TF-IDF) scheme to assign higher weights to distinguished terms in a document, and then GARW algorithm to capture dependency among items in the database. More work was carried out on text classification using Distance based algorithm, Learning Algorithm, Bayesian classification, and N-gram frequency method [6, 7] in developing automated text classification system. A news article Recommender System developed by Sung Ho Ha and *et al.*[8] using Bayesian classification for classifying the news and Self Organizing Map (SOM) algorithm for news clustering, which provides personal online content based on a users preference. Rainer Malik *et al.* [9, 10, 11] created a system CONAN by combining a three different tagging name algorithms and filtered the output by a boosting technique for extracting information out of biomedical text. Fatudimu I.T, and *et al.* [12] implements a text mining algorithm on some unstructured data format in some newspapers. The main contributions of the technique is to integrates information retrieval scheme (Term Frequency Inverse Document Frequency) (for keyword/feature selection that automatically selects the most discriminative keywords for use in association rules generation) with Data Mining technique for association rules discovery. A comparative study done by Laila Khreisat [13] test the behavior of the N-Gram Frequency Statistics technique for classifying Arabic text documents employing a dissimilarity measure called the "Manhattan Distance", and Dice's Measure of similarity. Sung Ho Ha, *et al.* [14] developed a news article recommender system, which provides personalized online content based on a users preference. This system helps raise the user's satisfaction, increase customer loyalty toward the content provider. Ioan Dzitac [15] in his paper first briefly discusses the different web mining tasks and the then focusing on advanced artificial intelligence (AI) methods for information retrieval and web search, link analysis, opinion mining and web usage mining. The discovery of relevant document relationships, motivated by the need for enhanced relevance based navigation of Web-accessible resources using suitability of fuzzy clustering methods was analyzed by M. E. S. Mendes and L. Sacks [16, 17]. The objective of the study of Yoshimitsu Takahashi and *et al.* [18] is to characterized public health problem related to use of asbestos in Japan. In this paper Text Mining with Network analysis method of newspaper headlines including the word 'asbestos' published in 1987 and 2005 was conducted [19]. The CONAN system (2006) developed by Rainer Malik and *et al.* [20] show that combining different text-mining algorithms significantly improves the results. In particular, the sought granularity level defines the number of clusters.

Furthermore, the algorithm exploits the concept of asymmetric similarity to link clusters hierarchically and to form a topic hierarchy. Raymond J. Mooney and Un Yong Nahm [21] presents a framework for text mining, called DISCOTEX (Discovery from Text Extraction), using a learned information extraction system to transform text into more structured data, which is then mined for interesting relationships. The process described by G. Desjardins and *et al.* [22] uses a genetic algorithm to cope with the combinatorial explosion of the term sets. The genetic algorithm identifies combinations of terms that optimize an objective function, which is the cornerstone of the process. M.E.S. Mendes Rodrigues and L. Sacks [23] proposed e novel scalable hierarchical fuzzy clustering algorithm for document clustering that was motivated by the e-learning context, but that has wider applicability as a genetic text mining tool. T. P. Martin and M. Azmi-Murad [24] give details of an incremental algorithm to compute similarities and outline some tests, which show the method effectiveness. A novel feature extraction algorithm presented by Song Liangtu and *et al.* [25], which is based on the improved particle swarm optimization with reverse thinking particles (PSORTP). This algorithm will greatly improve the efficiency of web texts processing. Richard S. Segall and *et al.* [26] reviews current literature of text mining, and discusses features of two text mining software packages SAS Text Miner and Megaputer Polyanalyst in analyzing unstructured qualitative data. The paper presented by C. M. Velu and *et al.* [27] deals with Pattern Matching (PM) using two-dimensional (2D) sub-array and PM by sliding window technique. Raymond J. Mooney and *et al.* [28] discuss methods and implemented systems for natural-language information extraction and IE systems and summarize results on mining real text corpora of biomedical abstracts, job announcements, and product descriptions. Nicholas Holden and *et al.* [29] utilizes Ant-Miner – the first Ant Colony algorithm for discovering classification rules in the field of web content mining, and shows that it is more effective than C5.0 in two sets of BBC and Yahoo web pages used in our experiments. It also investigates the benefits and dangers of several linguistics-based text preprocessing techniques to reduce the large numbers of attributes associated with web content mining [30].

All The above review algorithms has been discussed, apart from this some machine learning algorithms and techniques are more effective for the online web content analysis and data extraction. Following machine learning algorithms techniques has been reviewed for online web content extractions.

Time series analysis

From a statistical perspective, the detected values frequently represent the observations of a random sample of independent random variables. The type of dependence between the sequence's components forms the basis for the time series analysis. With this method, many events are no longer treated as being haphazardly distributed throughout time around a rather steady average. The concept of memory, persistence, or hysteresis must be at the core of the study of time series.

[11, 12].The stochastic process is the method we employ to model the observed time series. A stochastic process is conceptualized intuitively as an endlessly long chain of random variables or an infinitely large random vector [13, 14]. The degree of link between the random variables that make up a stochastic process, which determines its memory, determines how a sample of t consecutive observations throughout time should be viewed of rather than as realizations of t separate random variables [15, 16].The deterministic and random disturbance components of the process are assumed to exist in the classical approach to time series [17, 18].

Time series data sets

To apply machine learning algorithm, perhaps it has already been done away with. The stochastic component, which is thought to be a process with regulated components, is the main focus[19]. Due to the limited number of accessible observations, the stochastic process can never be precisely recognised; nonetheless, we can try to recreate it using a model [20].However, a model that simulates the datagenerating process must have a few features in order to be identifiable with reasonable accuracy. It must be possible to invert the process, it must be Gaussian, and it must be possible to invert the process from the time series [21].

Time series data analysis using machine learning algorithms

AI based machine learning calculations independently foster their insight thanks to the information designs got, without the need to have explicit beginning contributions from the engineer [22]. In these models, the machine can lay out without help from anyone else the examples to follow to get the ideal outcome, consequently, the genuine element that recognizes man-made brainpower is independence. In the growing experience that recognizes these calculations, the framework gets a bunch of information essential for preparing, assessing the connections between the information and yield information: these connections address the boundaries of the model assessed by the framework [23].

Research methodology:

In the proposed research work, the text mining algorithm will be used for web page content mining. The e-newspapers using its Uniform Resource Locator (URL) will be used for the study. In the training phase of the system, the web pages from the different URL of the online English newspapers will be used to generate the vocabulary of related words. The association rule with minimum support and confidence will be used to find the associated words related to specific subject. In the Data Mining phase, the specific subject/topic related news or article from the specified e-newspapers using its URL will be searched and extracted. For this purpose the vocabulary generated in training phase shall be used.

Proposed methodology

The proposed method focuses on web pages with unstructured text as the primary source of information.The entire webpage is subject to the information extraction technique, and only th

e key content blocks of the web pages are really searched for information. Information on the user species is necessary for the system.Starting from one or more seed URLs, web crawlers download all associated pages, extract the hyperlink URLs from those sites. Following steps has been suggested by researcher for successful implementation of web content information extraction mechanism in online mode.

i.   Selection of URL Webpages

ii.   Choosing webcrawler for identification and analyzing of text

iii. Clustering of text using webcrawler

iv.   Analysis of clustered content information as relevant data and irrelevant data

v.   Apply algorithmic approach for classification of relevant data content and irrelevant data content

vi.   Finalization and interpretation of summarized text from resource website.

Implication

The system will help the users and the domain experts to extract the domain related information, news, articles, literature etc from the online newspapers. Such information may be triggered to useful action and decision making for them. The system will also be applicable in retrieving the information from many other form of text, such as, journals, magazines, articles, e-books, and many other products and services.

Working model stages

The proposed working model for the system has a main website where users enter the URL of the webpage whose data has to be crawled and it operates by using following stages to gain accurate content from the web is as follows:

i.   Enter the site's URL

ii.   A crawler will investigate the site and accumulate text information.

iii. Use bunching to isolate the recovered information into groups like text, joins, and so on.

iv.   Assigning a 1 to information that is associated with that page and a 0 to information that is irrelevant.

v.   Use SVM or any Machine Learning algorithm to separate information into content and non-content classes.

vi.   This method will kill copy information, increases, and clamor.

vii. The site's text outline will be the last result.

Web contents system flow

System flow for web content of information extraction is as follows:

```
┌─────────────────────────────────────────────────────────┐
│                   URL Resource Webpages                   │
└─────────────────────────────────────────────────────────┘
                            ▼
┌─────────────────────────────────────────────────────────┐
│  Webcrawler for identification and analyzing the text via online mode │
└─────────────────────────────────────────────────────────┘
                            ▼
┌─────────────────────────────────────────────────────────┐
│   Clustering of  text using web crawler information extraction         │
│                         techniques                        │
└─────────────────────────────────────────────────────────┘
                            ▼
┌─────────────────────────────────────────────────────────┐
│   Analysis of clustered content information as relevant data and      │
│                       irrelevant data                     │
└─────────────────────────────────────────────────────────┘
                            ▼
┌─────────────────────────────────────────────────────────┐
│   Apply algorithmic approach for classification of relevant data content │
│                   and irrelevant data content             │
└─────────────────────────────────────────────────────────┘
                            ▼
┌─────────────────────────────────────────────────────────┐
│   Finalization and interpretation of summarized text from resource    │
│                          website.                         │
└─────────────────────────────────────────────────────────┘
                            ▼
┌─────────────────────────────────────────────────────────┐
│             Resultive  extracted information content      │
└─────────────────────────────────────────────────────────┘
```

Figure 1: System Flow of Web Content Extraction

Conclusion:

The above system flows collects information, identifies web content models using algorithmic approach using machine learning and classify it according to clustering mechanism, trains support vector classifier, and assesses learned model in a android manner. The learning and trained algorithm could accomplish wonderful marking of online content based information when prepared on a solitary site. The researcher incorporated these modification for achieving better results as: The rundown is acted in even configuration. Rather than showing connections of pictures, the portrayal of the pictures shown in linkages.

The links to the online web content information can be made dynamic for the reference of human clients.

The framework can be scaled to deal with a site all in all, and, surprisingly, further for numerous sites. Nonetheless, the memory required and the expense related for a similar will be exceptionally high. For business execution, this choice merits attempting.

Future implications:

As per above algorithmic approach researchers may choose other machine learning algorithms for gaining good results. These algorithms are Artificial Neural Network-Based Methods, Time Series Clustering Methods, Convolution Neural Network for Time Series Data, Recurrent Neural Network, Auto encoders Algorithms in Time Series Data Processing, Automated Features Extraction from Time Series Data.

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SETS AND FUNCTION

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Functions:

Definition: If A ,B are sets ,then the cartesion product of A and B (denoted by A X B) is the set of all ordered pairs $<a ,b>$ where $a \epsilon A$, $b \epsilon B$.

 i.e. A X B = {$< a, b >$/ $a \epsilon A$ and $b \epsilon B$}

Definition: Let A and B be any two sets. A function f from A into B is a subset of A X B with the property that each $a \epsilon A$ belongs to only one pair $< a ,b >$ as a first component.

 Instead of $< a, b > \epsilon$ f we usually write $y = f(x)$. Then y is called the image of x under f. The set A is called the domain of f. The rang of f is the set

 {$b \epsilon B$/ b = f(a) for some a } $f(x) = x^3 - 3x + 1$

For example: the set f = {$<x, x^2 >$ / $-\infty < x < \infty$} is the function usually described by the equation

$$f(x) = x^2 \quad (-\infty < x < \infty)$$

The domain of f is the whole real line. The range of f is $[0, \infty)$

Definition: If f is a function from A into B, we write f : A →B . If the range of f is all of B, we say that f is a function from A onto B. In this case we some time write f : A ⇒ B

Theorem: If f : A →B and $X \epsilon A$, $Y \epsilon B$ then prove that f (X∪Y) = f(X) ∪ F(Y). In wards, the image of the union of two sets is the union of the image.

Proof: Suppose b ϵ f (X∪Y) ⇒ ∃ a ϵ X∪Y such that b= f(a)

 ⇒ either a ϵ X or a ϵ Y

 ⇒ either f(a)ϵ f(X) or f(a) ϵ f(Y)

 ⇒ either bϵ f(X) or b ϵf(Y)

 ⇒ b ϵ f(X) ∪f(Y)

Thus, f (X∪Y) ⊂ f(X) ∪f(Y) ------ (1)

Conversely, if bϵ f(X) or b ϵf(Y) ⇒ either bϵ f(X) or bϵ f(Y)

 ⇒ either f(a) ϵ f(X) or f(a) ϵ f(Y)

 ⇒ either a ϵ X or a ϵ Y

 ⇒ a ϵ X∪Y

$$\Rightarrow\ f(a) \in f(X \cup Y)$$

$$\Rightarrow\ b \in f(X \cup Y)$$

Thus, $f(X) \cup f(Y) \subset f(X \cup Y)$ ------ (2)

From (1) and (2) we get

$$f(X \cup Y)\ =\ f(X) \cup f(Y)$$

Theorem: If f : A →B and if X∈ B , Y ∈ B , then prove that

$$f^{-1}(X \cap Y) = f^{-1}(X)\ \cap\ f^{-1}(Y)$$

In words, the inverse image of the intersection of two sets is the intersection of the inverse image.

Proof: Suppose $a \in f^{-1}(X \cap Y) \Rightarrow f(a) \in X \cap Y$

$$\Rightarrow\ f(a) \in f(X)\ \text{and}\ f(a) \in f(Y)$$

$$\Rightarrow\ a \in f^{-1}(X)\ \text{and}\ a \in f^{-1}(Y)$$

$$\Rightarrow\ a \in f^{-1}(X) \cap f^{-1}(Y)$$

Thus, $f^{-1}(X \cap Y) \subset f^{-1}(X) \cap f^{-1}(Y)$ -------- (1)

Conversely, if $b \in f^{-1}(X) \cap f^{-1}(Y) \Rightarrow b \in f^{-1}(X)$ and $b \in f^{-1}(Y)$

$$\Rightarrow\ f(b) \in X\ \text{and}\ f(b) \in Y$$

$$\Rightarrow\ f(b) \in X \cap Y$$

$$\Rightarrow\ b \in f^{-1}(X \cap Y)$$

Thus, $f^{-1}(X) \cap f^{-1}(Y)\ \subset\ f^{-1}(X \cap Y)$ -------- (2)

From (1) and (2) we get

$$f^{-1}(X \cap Y)\ =\ f^{-1}(X) \cap f^{-1}(Y)$$

Definition: The composition of function:

If f : A →B and g : B →C , then we define a function gof by

$$gof = g[f(x)]\ ,\ \ x \in A$$

That is, the image of x under gof is defined as the image of $f(x)$ under g. The function gof is called composition of f with g . We also write g(f). Thus   gof : A →c .

For example:

If $f(x) = 1 + \sin x$; $g(x) = x^2$ defined then

$$gof(x) =\ g[f(x)]$$

$$=\ g[1 + \sin x]$$

$$=\ [1 + \sin x]^2$$

$$=\ 1 + 2 \sin x +\ \sin x^2$$

Example: Let $f(x) = \log x$ $(0 < x < \infty)$

a)   What is the range of f ?

b) If A=[0,1] and B=[1,2] find $f^{-1}(A)$, $f^{-1}(B)$, $f^{-1}(A \cup B)$, $f^{-1}(A \cap B)$,

$f^{-1}(A) \cup f^{-1}(B)$, $f^{-1}(A) \cap f^{-1}(B)$.

Solution: a) The range of f is $(-\infty, \infty)$

b) A=[0,1] and B=[1,2] and $f(x) = \log x$

$\because$ $f(1) = \log 1 = 0 \Rightarrow 1 = f^{-1}(0)$

$f(10) = \log 10 = 1 \Rightarrow 10 = f^{-1}(1)$

$f(100) = \log 100 = 2 \Rightarrow 100 = f^{-1}(2)$

$\because$ $\therefore$ $f^{-1}(A) = f^{-1}([0,1]) = [1,10]$

$\because$ $\therefore$ $f^{-1}(B) = f^{-1}([1,2]) = [10,100]$ $\therefore$

$\because$ $f^{-1}(A \cup B) = f^{-1}([0,1] \cup [1,2]) = [1,100]$

$\because$ $f^{-1}(A \cap B) = f^{-1}([0,1] \cap [1,2]) = \{10\}$

$\because$ $f^{-1}(A) \cup f^{-1}(B) = f^{-1}([0,1]) \cup f^{-1}([1,2]) = [1,10] \cup [10,100] = [1,100]$

$\because$ $f^{-1}(A) \cap f^{-1}(B) = f^{-1}([0,1]) \cap f^{-1}([1,2]) = [1,10] \cap [10,100] = \{10\}$

Example: Consider the function defined by $f(x) = \sin x$ $(0 < x < \infty)$

a) What is the image of $\frac{\pi}{2}$ under f ?

b) Find $f^{-1}(1)$

c) Find $F([0, \frac{\pi}{6}])$, $F([\frac{\pi}{2}, \frac{\pi}{6}])$, $F([0, \frac{\pi}{2}])$

Solution : a) $F(\frac{\pi}{2}) = \sin \frac{\pi}{2}$

b) $f^{-1}(1) = \{ \frac{\pi}{2}, \frac{-3\pi}{2}, \frac{-5\pi}{2} \}$

c) $F([0, \frac{\pi}{6}]) = [0, \frac{1}{2}]$; $F([\frac{\pi}{2}, \frac{\pi}{6}]) = [\frac{1}{2}, 1]$; $F([0, \frac{\pi}{2}]) = [0,1]$

Example: Consider the function f defined by $f(x) = \tan x$ $(-\frac{\pi}{2} < x < \frac{\pi}{2})$

a) What is the domain of f ?

b) What is the image of f ?

c) Let $A = (-\frac{\pi}{2}, -\frac{\pi}{4})$, $B = (\frac{\pi}{4}, \frac{\pi}{2})$. Does $f(A \cap B) = f(A) \cap f(B)$

Solution : a) The domain of f is $(-\frac{\pi}{2}, -\frac{\pi}{2})$

b) The image of f is $(-\infty, \infty)$

c) If $A = (-\frac{\pi}{2}, -\frac{\pi}{4})$ then $f(A) = (-\infty, 1)$, if $B = (\frac{\pi}{4}, \frac{\pi}{2})$ then $f(B) = (1, \infty)$

$\because$ $f(A \cap B) = (-\infty, 1) \cap (1, \infty) = \varphi$

and

$f(A \cap B) = f([-\frac{\pi}{2}, -\frac{\pi}{4}] \cap [\frac{\pi}{4}, \frac{\pi}{2}]) = \varphi$

Thus,   f (A∩B) = f (A)   ∩ f (B).

Example: Let I denote the set of positive integer, I = {1,2,3,----}.

If   f(n) = n+7 (n ε I),   g(n) = 2n (n ε I) . What is the range of gof ? What is range of fog ?

Solution: We know

$$\text{fog (n)} = f [g (n)]$$
$$= f [2n]$$
$$= 2n + 7$$

Therefore the range of fog is {9,11,13,-----}

Similarly, we know

$$\text{gof} = g [f(n)]$$
$$= g [n + 7]$$
$$= 2n + 14$$

Therefore the range of gof is {16,18,20,-----}

Example: If f : A →B , g : B →C and h : C →D. Prove that h o (gof) = (hog) o f.

Solution: Let x ε A, now

$$\text{h o (gof)}(x) = \text{h o } [g(f(x)]$$
$$= h [g (f(x)]$$
$$= h \text{ o g } [(f(x)]$$
$$= [(hog) \text{ o f}] (x)$$

Therefore , h o (gof) = (hog) o f.

Real – Valued Functions :

Definition: If f : A →R we call f a real-valued function. If x ε A   then f(x) is called the value

at x .

Definition: If f : A →R and g : A →R, we define f + g as the function whose value at x ε A

is equal to f(x) + g(x) . That is

$$(f + g) (x) = f(x) + g(x), \ x \text{ ε A}$$

In set notation

$$f + g = \{< x, f(x) + g(x)>/ x \text{ ε A} \}$$

It is clear that   f + g = A →R

Similarly, we define   f – g and   f.g

$$(f - g) (x) = f(x) - g(x), \ x \text{ ε A}$$
$$(f . g) (x) = f(x) . g(x), \ x \text{ ε A}$$

Finally, if g(x) ≠ 0 for all x ε A, we can define f/g by

$$(\tfrac{f}{g})(x) = (\tfrac{f(x)}{g(x)}), \ x \text{ ε A}$$

Definition: If f : A →R and C is a real number (C ε R) the function Cf is define by

$$(Cf)\ (x) =\ C\ [f(x)],\ (x \in R)$$

Thus the value of 3f at x is 3 times the value of f at x .

Definition: For a,b are real numbers, let max(a,b) and min(a,b) denoted the smaller of a and b. [If a=b, then max(a,b) = min(a,b) = a = b] Then we can define max(a,b) and min(a,b), then max(a,b) for real-valued functions f, g .

Definition: If f : A →R and g : A →R then max(f, g) is the function define by

$$max\ (f, g)\ (x) =\ max\ [f(x), g(x)]\ ,\ (x \in R)$$

and

$$min\ (f, g)\ (x) =\ min\ [f(x), g(x)]\ ,\ (x \in R)$$

For Example:

If $f(x) = \sin x\ (0 \le x \le \frac{\pi}{2})$ and $g(x) = \cos x\ (0 \le x \le \frac{\pi}{2})$ and h = max (f, g) then

$$h(x) = max\ (f, g)\ (x) = max\ [f(x), g(x)](x)$$

Therefore , $h(x) = \cos x\ ,\ \ 0 \le x \le \frac{\pi}{4}$

$$= \sin x\ ,\ \ \frac{\pi}{4} \le x \le \frac{\pi}{2}$$

Definition: If f : A →R, then $|f|$ is the function define by

$$|f|(x) =\ |f(x)|\ ,\ (x \in A)$$

If a, b are real numbers, the formula

$$max\ (a,b)\ =\ \frac{|a-b|+a+b}{2}$$

$$min\ (a,b)\ =\ \frac{-|a-b|+a+b}{2}$$

From this it follows that

$$max\ (f,g)\ =\ \frac{|f-g|+f+g}{2}$$

$$min\ (f,g)\ =\ \frac{-|f-g|+f+g}{2}$$

for real-valued function f, g.

Definition: Let S be a set and A⊂ S. Then the complement $A' = $ S-A. The characteristic function χ_A of A is define by

$$\chi_A\ (x) = 1\ ,\ \ (x \in A)$$

$$\chi_A\ (x) = 0\ ,\ \ (x \in A')$$

Theorem: Verify the following equations for characteristic function where A, B are subsets of S.

i) $\chi_{A\cup B} = max\ (\chi_A, \chi_B)$ ii) $\chi_{A\cap B} = min\ (\chi_A, \chi_B)$ iii) $\chi_{A-B} = \chi_A - \chi_B$

Proof: i) Suppose $x \in A\cup B$ then $\chi_{A\cup B}\ (x) = 1$

Since $x \in A\cup B \Rightarrow$ either $x \in A$ or $x \in B$

$\Rightarrow$ either $\chi_A\ (x) = 1$ or $\chi_B\ (x) = 1$

$$\Rightarrow \max (\chi_A, \chi_B)(x) = 1$$

Hence $\quad 1 = \chi_{A \cup B}(x) = \max (\chi_A, \chi_B)(x)$ ------ (1)

Next**,** if $\quad x \notin A \cup B$ then $\chi_{A \cup B}(x) = 0$

Since $\quad x \notin A \cup B \Rightarrow x \in (A \cup B)'$

$$\Rightarrow x \in A' \cap B'$$

$$\Rightarrow x \in A' \text{ and } B'$$

$$\Rightarrow \chi_A(x) = 0 \text{ and } \chi_B(x) = 0$$

$$\Rightarrow \max (\chi_A, \chi_B)(x) = 0$$

Hence $\quad 0 = \chi_{A \cup B}(x) = \max (\chi_A, \chi_B)(x)$ ------ (2)

From (1) and (2) we get

$$\chi_{A \cup B}(x) = \max (\chi_A, \chi_B)(x)$$

ii) Suppose $\quad x \in A \cap B$ then $\chi_{A \cap B}(x) = 1$

Since $\quad x \in A \cap B \Rightarrow$ either $x \in A$ and $x \in B$

$$\Rightarrow \text{either } \chi_A(x) = 1 \text{ and } \chi_B(x) = 1$$

$$\Rightarrow \min (\chi_A, \chi_B)(x) = 1$$

Hence $\quad 1 = \chi_{A \cap B}(x) = \max (\chi_A, \chi_B)(x)$ ------ (1)

Next**,** if $\quad x \notin A \cap B$ then $\chi_{A \cap B}(x) = 0$

Since $\quad x \notin A \cap B \Rightarrow x \in (A \cap B)'$

$$\Rightarrow x \in A' \cup B'$$

$$\Rightarrow \text{either } x \in A' \text{ or } B'$$

$$\Rightarrow \text{either } \chi_A(x) = 0 \text{ or } \chi_B(x) = 0$$

$$\Rightarrow \min (\chi_A, \chi_B)(x) = 0$$

Hence $\quad 0 = \chi_{A \cap B}(x) = \min (\chi_A, \chi_B)(x)$ ------ (2)

From (1) and (2) we get

$$\chi_{A \cap B}(x) = \min (\chi_A, \chi_B)(x)$$

iii) Suppose $\quad x \in A\text{-}B$ then $\chi_{A-B}(x) = 1$

Since $\quad x \in A\text{-}B \Rightarrow x \in A$ and $x \notin B$

$$\Rightarrow \chi_A(x) = 1 \text{ and } \chi_B(x) = 0$$

$$\Rightarrow \chi_A(x) - \chi_B(x) = 1$$

Hence $\quad 1 = \chi_{A-B}(x) = \chi_A(x) - \chi_B(x)$ ------ (1)

If $x \notin A \cup B$ then there are two cases i) $x \in A$ and $x \in B$ ii) $x \notin A$ and $x \notin B$

Now, i) If $x \in A$ and $x \in B \Rightarrow \chi_A(x) = 1$ and $\chi_B(x) = 1$

$$\Rightarrow \chi_A(x) - \chi_B(x) = 0$$

Hence, $0 = \chi_{A-B}(x) = \chi_A(x) - \chi_B(x)$ ------ (2)

$\quad$ ii) $\quad$ If $x \notin A$ and $x \notin B \Rightarrow x \in A' \text{ and } x \notin B'$

$$\Rightarrow \quad \chi_A(x) - \chi_B(x) = 0$$

Hence, $0 = \chi_{A-B}(x) = \chi_A(x) - \chi_B(x)$ ------ (3)

From (2) and (3) we get

$$0 = \chi_{A-B}(x) = \chi_A(x) - \chi_B(x) \quad ------ (4)$$

From (1) and (4) we get

$$\chi_{A-B} = \chi_A - \chi_B$$

Equivalence**,** Countability :

Definition: If $f : A \rightarrow B$**,** then f is called one to one (denote 1-1) if

$$f(a_1) = f(a_2) \Rightarrow a_1 = a_2 \quad\quad (a_1, a_2 \in A)$$

Definition: If $f : A \rightarrow B$ and f is 1-1**,** then the function f^{-1} is define as follows

If $f(a) = b$ then $f(x) = \log x$ $(b) = a$

Definition: If $f : A \Rightarrow B$ (f is a function from A into B) and f is 1-1 then f is called a 1-1 correspondence (between A and B). If there exists a 1-1 correspondence between sets A and B then A and B are called equivalent .

Definition: The set having n elements is called finite set .

Or

The set containing finite number of elements is called finite set .

For Example: A = {1,2,- - -**,** 10} ; B = {1,2, - - -**,** 100} etc are finite sets .

Definition: The set wich is not having finite is called infinite set .

Or

The set having infinitely many elements is called infinite set .

For Example: N = {1,2,3, - - - }

    I = { - - -**,** -2,-1,0,1,2, - - -}

Definition: The set A is said to be countable if a is equivalent to the set I of positive integers.

$$I = \{ 1,2,3, - - -\}$$

Thus A is countable if there exists 1-1 function f from I into A. The elements of A are then the image f(1)**,** f(2)**,** - - - of the positive integers.

$$A = \{ f(1), f(2), - - -\}$$

For Example: The set of all integers is countable i.e. A = { - - -**,** -2,-1,0,1,2, - - -} as 0, -1, 1, -2, 2, - - - There is 1-1 correspondence between set I of all positive integer and the set of all integers define by

$$f(x) = \frac{n-1}{2} \quad (n= 1,2,3, - - -)$$
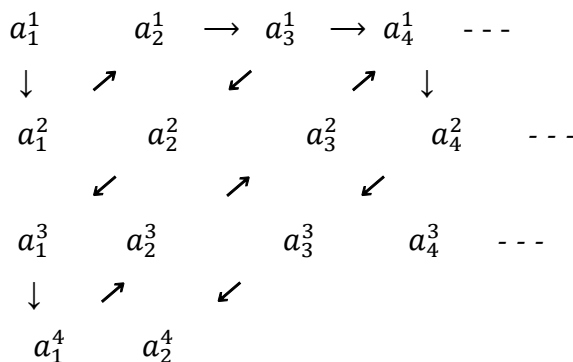
$$= -\frac{n}{2} \quad (n= 2, 4,6, - - -)$$

Theorem: If $A_1, A_2,$ - - - are countable sets**,** then prove that $\bigcup_{n=1}^{\square} A_n$ is countable. In wards**,** the countable union of countable sets is countable.

Proof: i) We may write $A_1 = \{ a_1^1, a_2^1, a_3^1, -, -, - \}, A_2 = \{ a_1^2, a_2^2, a_3^2, - - - \}, ---,$

$A_n = \{ a_1^n, a_2^n, a_3^n, - - - \}, ----$. So that a_k^j is the kth element of the set A_j. Define the

height of a_k^j to be j+k. Then a_1^1 is the only element of height 2; like wise a_2^1 and a_1^2

Are the only elements of height 3; and so on. Since for any positive integer m ≥ 2 there are only

m-1 element of height m. We may arrange the elements of $\bigcup_{n=1}^{\square} A_n$ ∞ according to their

height as

$$a_1^1, \ a_1^2, a_2^1, \ a_3^1, a_2^2, a_1^3 \ a_1^4, ---$$

We least the elements of $\bigcup_{n=1}^{\square} A_n$ ∞ as follows

$$
\begin{array}{cccc}
a_1^1 & a_2^1 \rightarrow & a_3^1 \rightarrow & a_4^1 \quad --- \\
\downarrow \quad \nearrow & \swarrow & \nearrow \ \downarrow & \\
a_1^2 & a_2^2 & a_3^2 & a_4^2 \quad --- \\
\swarrow & \nearrow & \swarrow & \\
a_1^3 & a_2^3 & a_3^3 & a_4^3 \quad --- \\
\downarrow \quad \nearrow & \swarrow & & \\
a_1^4 & a_2^4 & &
\end{array}
$$

This scheme of counting counts every a_k^j proves that $\bigcup_{n=1}^{\square} A_n$ is countable.

Corollary: Prove that the of all rational numbers is countable.

Proof: The set of all rational numbers in the union $\bigcup_{n=1}^{\square} E_n$ where E_n is the set of rational

which can be written with denominator n. That is

$$E_n = \{ \frac{0}{n}, -\frac{1}{n}, \frac{1}{n}, -\frac{2}{n}, \frac{2}{n}, --- \}$$

Now each E_n is clearly equivalent to the set of all positive integer and is the countable. Hence

the set of all rational is the countable union of countable sets and so that the set of all rational

numbers is countable.

Theorem: If B is an infinite subset of the countable set A then prove that B is countable.

Proof: Let A = $\{ a_1, a_1, --- \}$. Then each element of B is an a_i. Let n_1 be the smallest

subscript for which $a_{n_1} \in$ B, let n_2 be the next smallest subscript, and so on. Then

$$B = \{ a_{n_1}, a_{n_2}, --- \}$$

The elements of B are thus labelled with 1, 2, --- and so B is countable.

Theorem: Prove that the of all rational numbers in [0, 1] is countable.

Proof: The set of all rational in [0, 1] is an infinite and subset of the all rationals which is

countable. Hence, the of all rational numbers in [0,1] is countable.

Example: Which of the following define a 1-1 function?

a) $f(x) = e^x$ $(-\infty < x < \infty)$ b) $f(x) = e^{x^2}$ $(-\infty < x < \infty)$

c) $f(x) = \cos x$ $(0 \leq x \leq \pi)$ d) $f(x) = ax + b$ $(-\infty < x < \infty)$ a,b $\in$ R

Solution: a) Let $x_1, x_2 \in (-\infty, \infty)$

$$\therefore \qquad f(x_1) \quad = \quad e^{x_1} \qquad \text{and} \qquad f(x_2) \quad = \quad e^{x_2}$$

Since $x_1 \neq x_2$ then $e^{x_1} \neq e^{x_2}$. That is $x_1 \neq x_2 \Rightarrow f(x_1) \neq f(x_2)$.

Therefore $f(x) = e^x$ is 1-1.

b) Let $x_1 = 1$, $x_2 = -1$

$$\therefore f(x_1) = f(1) = e \quad \text{and} \quad f(x_2) = f(x_2) = e. \text{ That is} \quad f(x_1) = f(x_2) \not\Rightarrow x_1 = x_2$$

Therefore $f(x) = e^x$ is not 1-1.

c) Let $x_1, x_2 \in (0,)$

$$\therefore f(x_1) = \cos x_1 \text{ and } f(x_2) = \cos x_2$$

Since $x_1 \neq x_2$ then $\cos x_1 \neq \cos x_2$. That is $x_1 \neq x_2 \Rightarrow f(x_1) \neq f(x_2)$.

Therefore $f(x) = e^x$ is 1-1.

d) Let $x_1, x_2 \in (-\infty, \infty)$

$$\therefore \qquad f(x_1) \quad = \quad ax_1 + \quad b \qquad \text{and} \qquad f(x_2) \quad = \quad ax_2 + \quad b$$

Since $x_1 \neq x_2$ then $e^{x_1} \neq e^{x_2}$. That is $x_1 \neq x_2 \Rightarrow ax_1 + b \neq ax_2 + b$.

Therefore $f(x) = ax + b$ is 1-1.

Example: If $f : A \rightarrow B$, $g : B \rightarrow C$ and both f and g are 1-1 is $g \circ f$ also ?

Solution: Let $f : A \rightarrow B$, $g : B \rightarrow C$ then $gof : A \rightarrow C$

Let $x_1 \neq x_2$

$$(g \circ f)(x_1) = g[\, f(x_1)\,]$$
$$\neq g[\, f(x_2)\,] \qquad (\because f \text{ is 1-1})$$
$$= (g \circ f)(x_2)$$

That is $x_1 \neq x_2 \Rightarrow (g \circ f)(x_1) \neq (g \circ f)(x_2)$.

Therefore $f(x) = ax + b$ is 1-1.

Example: If f is 1-1 function from A into B. Show that

$$(f^{-1} \circ f)(x) \quad (x \in A) \qquad \text{and} \qquad (f \circ f^{-1})(y) \quad (y \in B)$$

Solution: Given f is 1-1 and $f: A \Longrightarrow B$

$$(f^{-1} \circ f)(x) = f^{-1}[f(x)]$$
$$= x$$

And

$$(f \circ f^{-1})(y) = f[f^{-1}(y)]$$
$$= y$$

Example: If $g : C \rightarrow A$ and $h = f \circ g$, show that $g = f^{-1} \circ h$

Solution: Let $g : C \rightarrow A$ and $h = f \circ g$

$$f^{-1} \circ h = f^{-1} \circ (f \circ g)$$
$$= (f^{-1} \circ f) \circ g$$

$$= \text{I o g}$$
$$= \text{g}$$

Real numbers:

We assume that every real number x can be written in decimal expansion

$$x = b. \, a_1 a_2 a_3 \text{ - - -}$$

For Example: $\frac{1}{4} = 0.25432$ - - -

where the a_i are integers , $0 \leq a_i \leq 9$.

Every number $x \in [0, 1]$ can be expand $x = 0. \, a_1 a_2 a_3$ - - - . Conversely, we assume that every decimal of the form

$$b. \, a_1 a_2 a_3 \text{ - - -}$$

in the decimal expansion for some real number.

Theorem: Prove that the set $[0, 1] = \{ \, x / \; 0 \leq x \leq 1 \, \}$ is uncountable.

Proof: Suppose $[0, 1]$ were countable. The $[0, 1] = \{ \, x / \; 0 \leq x \leq 1 \, \}$ where every number in $[0, 1]$ occurs among the x_i. Expanding each x_i in decimal we have

$$x_1 = 0. \, a_1^1, \, a_2^1, a_3^1, -, -, -$$
$$x_2 = 0. \, a_1^2, \, a_2^2, a_3^2, - \, - \, -$$
$$\text{- - - - - - - - - -}$$
$$x_n = 0. \, a_1^n, \, a_2^n, a_3^n, - \, - \, -$$
$$\text{- - - - - - - - - - - -}$$

Let b_1 be any integer form 0 to 8 such that $b_1 \neq a_1^1$. Then let b_1 be any integer form 0 to 8 such that $b_2 \neq a_2^2$. In general, for each n= 1 ,2,3, - - - let b_n be any integer form 0 to 8 such that $b_n \neq a_n^n$.

Let $y = 0. \, b_1 b_2 b_3$ - - - b_n - - -. Then, for any n the decimal expansion for y is different form the decimal expansion for x_n. Since $b_n \neq a_n^n$. Moreover, the decimal expansion for y is unique since no b_n is equal to 9. Hence $y \neq x_n$ for every n and $0 \leq y < 1$, which contradicts the assumption that every number in $[0, 1]$ occurs among the x_i. This contradiction proves the theorem.

Example: If f : A →B and the range of f is uncountable. Prove that the domain of f is uncountable.

Solution: Given f(A) is uncountable and we have to prove that A is uncountable.

Let f : A →B and f(A) is uncountable. By definition of function

$$A = \{ f^{-1} \, (y) = y \in f(A) \, \}$$

Is clearly uncountable.

Example: Prove that if B is a countable subset of the uncountable set A then A - B is uncountable.

Solution: Suppose A – B were countable. Then

$$(A – B) \cup B = A$$

Being union of two countable sets is countable which is contradiction to the hypothesis. Therefore, A – B must be uncountable.

Example: Prove that the set of all irrational number is uncountable.

Solution : Let us denote the set of real number, the set of rational numbers and the set of all irrational numbers by R, Q and Q^* respectively. We know that

$$R = Q \cup Q^* \quad and \quad Q \cup Q^* = \phi$$

If ϕ^* were countable set then $R = Q \cup Q^*$ must be countable. Since Q is countable. Thus R is countable, which is contradiction to the fact that the set R is countable.

Therefore Q^* the set of all irrational must be uncountable.

Least upper bounds:

Definition: The subset $A \subset R$ is said to be bounded above if there exit a number $N \in R$ such that $x \leq N$ for all $x \in A$.

The number N is called upper bound.

For Example:

1) The set $A = \{1, 2, 3, 4, 5\}$ is bounded above and 5,6, 7, - - - are the upper bounds. Because for every elements of the set A is less than or equal 5,6, 7, - - -

2) The set $A = \{1, 2, 3, - - - \}$ is not bounded above.

Definition: The subset $A \subset R$ is said to be bounded below if there exit a number $M \in R$ such that $M \leq x$ for all $x \in A$.

The number M is called lower bound.

For Example:

1) The set $A = \{1, 2, 3, 4, 5\}$ is bounded below and 1, 0, -1, - - - are the lower bounds. Because no elements of the set A is smaller than or equal 1, 0, -1, - - -

2) The set $A = \{- - -, -2, -1, 0, 1, 2 \}$ is not bounded below.

Definition: The subset $A \subset R$ is said to be bounded if it is bounded above and bounded below.

For Example:

1) The set $A = \{1, 2, 3, 4, 5\}$ is bounded

2) The set $A = \{- - -, -2, -1, 0, 1, 2, - - - \}$ is not bounded below.

Definition: The A be a subset of the set of real numbers. A real number L is called the least upper bound (l.u.b.) of A if

    i)   L is an upper bound of A and

    ii)   No number smaller than L is an upper bound for A.

        e. g. The set $A= \{1, 2, 3, 5, 11\}$ the number 11 is the l.u.b. because

i) 11 is an upper bound of A and

ii) no number smaller than 11 is an upper bound for A.

Definition: The A be a subset of the set of real numbers. A real number l is called the greatest lower bound (g.l.b.) of A if

i)   l is a lower bound of A and

ii)   No number greater than l is an lower bound for A.

e. g. The set A= {1, 2, 3, 5, 11} the number 1 is the g.l.b. because

i) 1 is an lower bound of A and

ii) no number greater than 1 is an lower bound for A.

Example: Find   the   greatest   lower   bound   for   the   following   sets

a) (7, 8)   b) { $\pi + 1, \pi + 2, \pi + 3$, - - - }   c) { $\pi + 1, \pi + \frac{1}{2}, , \pi + \frac{1}{3}, ,$ - - - }

Solution: a) Greatest lower bound is 7

b) Greatest lower bound is $\pi + 1$

c) Greatest lower bound is π

Example: Find the least upper bound for the following sets

a) (7, 8)   b) { $\pi + 1, \pi + \frac{1}{2}, , \pi + \frac{1}{3}, ,$ - - - }   c) The complement in [0,1] of the canter set.

Solution: a) Least upper bound is 8

b) Least upper bound is $\pi + 1$

c) Least upper bound is 1

Example: Give an example of a countable bounded subset A of R whose greatest lower bound are both in R - A .

Solution: The set A of all rational numbers is an open interval (0,1) and its greatest lower bound is 0 and least upper bound is 1. Both 0 and 1 are not in the set A. That is both 0 and 1 in R – A.

Definition: Least upper bound Axiom:

The   A is any nonempty subset of R that is bounded above then A has least upper bound in R.

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A REVIEW OF DIGITAL MARKETING AND ITS SIGNIFICANCE

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Abstract:

Recent estimates regarding the number of people using the internet are 5 billion in April 2022, which is about 63.1 % of the world's total population. Many individuals all across the globe rely heavily on their use of social media. In this digital scenario to be competitive and relevant in business, one needs to invest in digital marketing. Lacking any kind of online or digital presence, a company loses out on many chances to connect with its intended clientele. The greatest results may be achieved by using a wide variety of digital marketing means or channels. This paper presents overview of types of digital marketing. Further advantages and disadvantaged are presented. It is concluded that digital marketing reaps greater benefits in long run.

Keywords: Digital Marketing, Internet, Online, Social Media

Introduction:

Most of people across the globe now use the internet, smart phone applications, social media and other forms of digital communications as part of their daily routine. Recent estimates regarding the number of people using the internet are 5 billion in April 2022, which is about 63.1 % of the world's total population. Many individuals all across the globe rely heavily on their use of social media. In April 2022, there were 4.7 billion global social media users which are around 59 per cent of the world's total population. (Statistica, 2022).

Online activities such as research on goods and services, customer-to-customer feedback, and company engagement are all growing in popularity. In light of the shift in customer preferences, businesses have incorporated digital and social media marketing strategies.

By "digital marketing," we mean any advertising effort that makes use of digital technologies, such as computers, smartphones, and tablets. Digital marketing include even traditional forms of advertising like radio and television advertisements; nevertheless, the industry has already advanced to the point where new approaches may be more successful.

In this digital scenario to be competitive and relevant in business, one needs to invest in digital marketing. Lacking any kind of online or digital presence, a company loses out on many chances to connect with its intended clientele.

Review of Literature:

According to research by Gaber *et al.* (2019), consumers' perceptions of an advertisement utility, entertainment value, legitimacy, and ability to prevent discomfort all have a role in how

they feel about it. Growing customer apprehension over their privacy has been linked to the rise of personalized marketing campaigns.

According to research by Gironda *et al.* (2018), consumers' intentions to take action in response to privacy concerns are significantly affected by the perceived level of intrusiveness, the ability to exercise control over one's own data, the perceived value of the service, and the level of consumer innovation.

Chen and Lee (2018) looked at how businesses might utilise Snapchat to reach a younger demographic. According to the results of the survey, Snapchat is favoured by its users because of its status as the most personal, relaxed, and adaptable medium for sharing news, connecting with friends and family, and enjoying media. According to the findings, the majority of young customers have a favourable impression of Snapchat, which translates into favourable sentiments toward the companies promoted there.

Objectives of the study:

1. To known about digital marketing.
2. To study different types of digital marketing and its significance.
3. To know benefits and limitations of digital marketing.

Research Methodology:

This paper on digital marketing is based on secondary data, such as published online reports, websites and journals associated with digital marketing

Types of digital marketing and its significance

It is possible to expand customer base by using one of the various forms of digital marketing. The greatest results may be achieved by using a wide variety of digital marketing means or channels. Following are the six most successful forms of digital marketing:

1. Content marketing

The term "content marketing" is used to describe the promotion of informative and useful matter such as articles, videos, and other types of online content. Marketing in this mode allows interacting with your target audience and providing them with the information they want. Likewise, it may aid in the production of leads and the finalisation of sales.

Consistent content aimed at a certain demographic should be released on a regular basis. Assuming that business consistently put out credible articles; business brand will gain credibility and become a go-to resource in your field.

The price tag is zero. Having access to content is a very adaptable choice. By informing, amusing, and motivating your target demographic, you may strengthen your brand. It's the lifeblood of all the other forms of online advertising. Since there is so much competition, optimizing a website to get a high organic search ranking for a certain set of keywords is a time-consuming process. Maintaining a constant standard of excellence is critical to success. To

successfully promote your company and achieve your business goals, your content must also satisfy the needs of your clients.

A successful launch depends on a well-thought-out content strategy that is both easy to implement and highly effective. Pick four or five central ideas that best represent what your brand stands for and what its target audience cares about. Determine the mediums, which might include articles, audios, videos, audio, articles so on. Finally determine definitively where each individual piece of material will be published.

2. Search engine optimization

To score well on search engine results pages (SERPs) on websites like Google so that your content page is on high rank, you need to use a method called search engine optimization (SEO).Google's algorithm determines how closely your website relates to the user's search terms. SEO techniques need to be updated often to keep up with the continual updates to search engine algorithms. If you want your page to rank higher and get more organic traffic; you need to use SEO strategies.

It's a great way to get your brands name out there and the savings are substantial.

SEO relies on both content and technology. The ever-evolving nature of Google's algorithms might potentially hinder your efforts.SEO is a process that yields results over time.

Search engine optimization (SEO) starts with high-quality content. Develop a content plan and do keyword analysis to learn what consumers are looking for.Follow Google's content suggestions for the latest and greatest.

3. Search engine marketing/ Pay-per-Click (PPC)

Search engine marketing is done through sponsored advertisements that are viewed at the top of the web page. Pay-per-click refers to the model in which the advertiser only pays when a user clicks on one of their advertisements. When you pay for these prominent positions on search engine results pages, your URL will be labeled as an "Ad." Although consumers are usually aware that these are advertisements, many nevertheless choose to click on them.

It helps obtain a high position rapidly. Spending one's time in this channel can prove to be productive. Targeting common search terms might be costly. Most individuals are distrustful of advertisements that appear on search page and choose to belief the usual search results.

You may go for PPC to create additional leads. Find out what keywords to use, and then try out various targeting strategies to determine what works best.

4. Social media marketing

In digital marketing, social media networks are employed as a promotional tool. You may buy ads to expose your business to a wider audience, or you can set up a social media presence for your company and start posting about your latest deals and content creation. The social media site you choose to utilize should be determined by the target demographic.

Its rates of conversion are quite high.As more people engage with your work through comments, shares and likes the results will come swiftly. Ads on Facebook and Instagram reach certain subsets of users that you want to target and convey with your message.Troubleshooting in the realm of social media are difficult. The algorithm is periodically updated. There is also a constant influx of novel content forms. The pursuit of new information and revisions will be an ongoing mission critical for you. Posting on social media may seem easy at first, but it really takes some preparation, as well as a substantial time commitment, to do it well and on a regular basis.

Integrate your social media sites into your content promotion plan. Get clear on what you want to say, how you want to say it, and where you want to say it. To implement this promotional strategy, you will need to make a calendar in which you may denote the days on which content should be shared through one channel vs. another. As social media is a two-way street, posting exceptional material isn't enough; you also need to communicate with your audience. Honest dialogues are a powerful tool for building trust and bolstering customer loyalty.

5. Affiliate and influencer marketing

If you partner with an affiliate or influencer, you can tap into their already-established fan base to spread your message to a wider audience. If you want your affiliate/influencer connection to succeed, you should seek for someone who is already well-known and respected in your field. They may write up material about your company or its products and distribute it online, complete with a link to your site. The affiliate or influencer will earn a commission each time one of their links is clicked or a transaction is made.

When an influencer endorses your product or service, you have access to their already-built-in fan base without having your own right now. If you're trying to attract new fans and buyers, aligning yourself with a well-known figure may help.

However, there is more to successful influencer marketing than simply a hefty price tag. Finding the perfect influencer for your audience and company, and then figuring out a genuine method to collaborate with them, is crucial.Since more and more people are beginning to doubt influencers, you need tread carefully and be completely upfront when compensating them for endorsements.

Close out your goals for the influencer marketing effort. Get a list of people who appear to be a good fit for your business and might perhaps inspire others to buy your product. Make contact and try to work out some kind of negotiation, taking their position into account.

6. Email marketing

A visitor to your website or store should be encouraged to sign up for your email newsletter. Those that opt up to your email list will get information about upcoming deals, events, and new offerings. Despite its low profile generated revenue is considerable.

Value endowment is the most crucial component of this digital marketing channel. You can create a strong connection with them and promote brand loyalty by giving them access to exclusive content they can't get at other places. This methods of digital marketing, is not affected by any altering algorithms. Staying regularly in touch with email directory helps to develop connections, and audience generally consider you in their thoughts when they intend to purchase. Generally emails are not viewed. It is challenging to develop methods to give value so that the subscription is continued. One can choose software for email such as ConvertKit etc and gather targeted audience emails.Offer them something of value in exchange for their email address, such as downloadable step-by-step guidelines in PDF format or free design patterns.

Keep in touch with your list on a consistent basis by sending out a weekly email. Create material that is useful beyond only the promotional messaging.

7. Mobile marketing

Searches using voice input through mobile devices is increasing at a faster pace. There has been a meteoric growth in the number of purchases made on smart phones. Smart phones are one of the most accessible, quick problem-solving associates everywhere, at any time, which is essential for successful digital marketing.

If a company really wants to connect with its clients, they need to embrace mobile marketing. In order to be successful, the marketer must modify all of his desktop-only strategies for use on mobile devices. A proficiency in mobile-specific activities including in-app advertising to social messaging applications is also required. Brands aiming to appeal to a younger demographic should pay special attention to this. Today's consumers rely on their mobile devices more than they do their desktop computers or laptops. Therefore, mobile marketing assists in getting to the places where people spend the most time.

Geo-fencing and other forms of audience segmentation make it possible to deliver messages to the most relevant people. When compared to PCs, the area is somewhat cramped.The click through rate for mobile advertisements are poor. Many individuals find it annoying when commercials interrupt their conversations at inappropriate times.

It's crucial that you mobile-proof your website and all of its content. It has to be fully functional and aesthetically pleasing across all platforms. Making use of geo-location tools, instant messenger advertising, and app development are all viable options.

You should keep your messages brief and easy to understand. Incorporate large fonts and button sizes. If you want your movies to reach folks who have the volume turned down, you should include subtitles.

8. Promotional videos

Short and sweet movies are more effective than words in today's rapidly changing environment. Promoting your business online using either live or prerecorded videos, whether they're meant to inform or amuse, is a solid strategy. Each month, more than 2 billion individuals

use YouTube to do some kind of search. Reaching out to the new audiences using video marketing methods seems promising, as it boosts conversions at every stage of the sales process.

About 80% of consumers use online video and search engines to learn more about a product before buying it. Over half of all shoppers use it as a pre-purchase research tool. Videos are a powerful tool for reaching a large audience and leaving a lasting impression. They outshine written or visual media in terms of retention. Video content is being promoted on social media platforms such as Facebook, Instagram, and LinkedIn in an effort to increase views, likes, comments, and shares. Trying to captivate an audience in a matter of seconds becomes more difficult. In a flash, readers have moved on to the next item in their feed. High-quality video production requires investment of time, resources, and expertise.

Include videos in your content marketing plan. Be precise about whether you want to contribute motivation, insight, or fun. Keeping in mind the returns that are to be achieved, speeds up the process of achieving the marketing goals. Perfectionism or high production values are unnecessary at first. Make sure the video's lighting and audio are good so viewers can easily understand what's happening.

9. Audio marketing

Since the dawn of commercial radio, listeners have consistently favored this medium. From the 1920s all the way up to the present day, there has always been a core audience for radio that has migrated from analogue to digital platforms. Audio advertising has been given a boost by platforms like Spotify. Podcasts and voice-enabled digital assistants like Google Home or Amazon Alexa expand the scope of audio marketing significantly.

With the rise in popularity of podcasts, listeners are shifting their attention away from traditional radio. A lot of people choose them for use in the gym or while performing any kind of physical labour. When it comes to audio marketing, success hinges on knowing your audience and how they like to consume content. Consider what they could be doing besides listening to your audios. In this manner, audio advertising may become a significant channel for expanding your company's customer base.

Audio marketing, whether via radio or podcasts, is a useful channel for reaching a busy audience on-demand and while they're on-the-go. Audio content production is less expensive and uncomplicated than video. Individuals who are listening while doing other things may become too preoccupied to take action. However, there is a high learning curve associated with marketing using smart home assistants, since this method is still in its infancy.ROI is less likely to materialize right away.

Start by settling on an end objective and preferred method of reaching that goal, such as a radio commercial or a podcast etc. Consider your intended audience and the kinds of things they would be interested in doing. Choose the most effective medium and devote your attention there. Your current material may be used in creative ways.

Benefits of digital marketing:

The use of digital marketing has several benefits, including the promotion of brand loyalty and the acceleration of online sales.

1. Using digital media, which is less expensive than traditional forms of advertising like radio and television, you may easily create an efficient online marketing campaign without breaking the bank. A well-thought-out digital media campaign may reach more people for less money than more traditional forms of advertising.

2. Better visibility achieved by switching to cost-effective digital marketing methods to reach many target audiences. Using digital advertising is a great way to get results in the long run. Digital marketing helps you save time and money since it yields instant results. Data on site traffic, user interaction, peak sales times, new subscribers gained daily, and other useful metrics may all be tracked with digital marketing.

3. To earn social prevalence, consider the promotional possibilities offered by digital marketing, where you may use a number of different channels to spread your message. These campaigns will become viral on social media, spreading from person to person and gaining traction as a result.

4. Developing a recognizable brand identity is a goal for each successful business. Increasing the brand's visibility and popularity among users and search engines is accomplished through cross-platform promotion.

Limitations of digital marketing:

Among the many drawbacks and difficulties of digital marketing are:

1. One must provide its team with the skills and experience necessary to execute digital marketing effectively. It is crucial that you stay up-to-date on the latest tools, platforms, and trends.

2. Online advertising campaign optimization and content creation are two examples of time-consuming jobs. If you want to get your money's worth, you need to keep track of your progress.

3. Digital marketing's worldwide reach comes with the challenge of competing with brands from all over the world. Standing out from the crowd of competing messages striving for customers' attention online may be difficult.

4. The public may see any criticism or unfavorable comments made about your brand on review and social media platforms. Providing top-notch support to customers in an online environment is no easy task. Brand reputation may be harmed by unfavorable remarks and ineffective responses.

5. Concerns about customers' personal information being misused or stolen are only two of the many legal factors to take into account while utilizing consumer data for digital

marketing. One has to be cautious and follow all regulations pertaining to the security and confidentiality of personal information.

Conclusions:

With the advent of new technologies, digital marketing has altered consumer preferences and preferences. Digital marketing technology provides to consumers more up-to-date information about goods and services Consumers these days have a lot of options.

Consumers are more involved because of the interactive nature of digital marketing and the products and services offered by the firm. Since more and more businesses are embracing digital marketing to sell their goods and services, consumers now have a significant benefit in being able to quickly and easily compare the offerings of several vendors. Digital advertising, consumers have the option to make an instantaneous purchase. Thus, we can say that India is undergoing a dramatic transformation as a result of the rise of digitization. Digital marketing reaps greater benefits in long run.

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INTERNATIONAL AGRICULTURAL RESEARCH CENTRES FOR PLANT IMPROVEMENT RESEARCH REVIEW

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Abstract:

Research on plant improvement at international research institutions of the Consultative Group of International Agricultural Research has made a significant contribution to the goal of enhancing productivity of major food crops globally but particularly in developing countries. Plant breeding in countries collaborating with international centres has benefited from three types of outputs of the centers (1) Fixed lines from Centre's breeding programme which on testing were found suitable and superior to the locally gramme which on testing were found suitable and superior to the locally bred material. These could be released for commercial cultivation for the relevant ecologies. (2) Segregating material, sent out as breeding nurseries. National Agricultural Research System (NARSs) of the collaborating countries have been able to make selections from these segregating populations under local conditions and process the selections to release them as commercial varieties. (3) Enhanced germplasm which has been used as donor for relevant traits in the breeding programme of collaborating institutions.

Keywords: Agricultural, Research, International, Plant improvement, productivity

Plant improvement research review

The impact of the contribution of the international centres has been very high and visible. To give an illustrative example, over 80% of wheat varieties now being released by NARSs are based on the CIMMYT programme's germplasm research. In the last four years alone, more than 160 bread and durum wheats, triticale and barley varieties derived from CIMMYT germplasm have been released by more than 0 countries. The area in developing countries sown to CIMMYT based bread wheat is nearly 50 million hectares and accounts for about 70% of total production. The story of contribution of IRRI to rice scenario is equally dramatic. This chapter summarizes the events leading to the establishment of the Consultative Group of International Agricultural Research (CGIAR), its mission, mandate, structure and other relevant details of the centres that operate under its ambit.

The Consultative Group on International Agricultural Research (CGIAR)

The CHIAR formally came into being in 1971 but the story of its origin goes to 1944 when the Rockefeller Foundation sent four scientists (Norman Borlaug, William Colwell,

George Harrar and Edward Welthausen) to Mexico to help farmers grow more wheat and maize. At a time when most people were preoccupied with World War II, the Rockefeller Foundation foresaw that large parts of the low-income world would need to increase food production not only for economic development but also, in many cases for survival. It was recognized that for achieving increased production, two elements were crucial: (1) science based agricultural technology suited to the agro ecological circumstances of the developing countries, and (2) extension services that will effectively and efficiently disseminate knowledge on how to grow more food and achieve greater crop stability. The nucleus that the Rockefeller team established together with Mexican colleagues developed into the Centro Intermaceonal de Mejormiento de Maize Trigo (CIMMYT) in 1983. CIMMYT is well known as the creator of advanced varieties of wheat and maize as also production technologies that had a dramatic effect first on Mexican agriculture and subsequently all over the world. A parallel event was the development of high-yielding varieties of rice at the International Rice Research Institute (IRRI) which formally began operating in Los Banos near Manila in the Phillippines in 1962. By late 1960s high yielding Wheat of CIMMYT and rices of IRRI broke all previous production records in many developing countries and ushered in the so called green revolution.

During the 1970s it was observed that the benefits of modern varieties where sometimes accompanied by adverse side effects. This attracted criticism from some quarters but it was relised that high yielding varieties and the accompanying scientific developments were indispensable because food needs were mounting due to the rapidly growing human population, particularly in the developing countries. What was needed was a more comprehensive research agenda so that the power of science could be more effectively applied to achieve sustained and sustainable gains in agricultural production. A series of meetings took place between 1969 and 1971 which culminated in the establishment in 1971, of the CGIAR. The CHIAR is a unique organization as that it has:

1. No legal identity;
2. No written charter;
3. No formal requirement for membership; and
4. It operates a forum for discussion and coordination.

The CHIR is remarkably successful in meetings its objectives. It is an association of fifty-three public and private sector members that supports a network of 16 international agricultural research centres. The World Bank, the Food and Agricultural Organization of the United Nations, the United Nation Development Programme, and the United Nations Environment Programme are co-sponsors of the CGIAR. The Chairman f the Group is a senior official of the World Bank. The World Bank also provides the CHIAR system with a Secretariat in Washington, D.C. The CHIAR budget is to the tune of around US$300 million per year.

The objective approved for the CGIAR at its inaugural meeting in 1971 were:

1. To examine the needs of developing countr4ies for special efforts in agricultural research at the international level.

2. To encourage complimentary of international and regional research through exchange of information.

3. To consider the financial requirements of high-priority international research.

4. To assess the feasibility of specific proposals, and

5. To review priorities for agricultural research in the developing countries.

Today, the CHIAR works to help ensure food security for the twenty –first century through its network of 16 international and autonomous research centres. Together, the centre conduct research on crops, live stock, fisheries, and forests; develop policy initiatives; strengthen national agricultural organizations and promote sustainable resource management practices that help provide people worldwide with better livelihoods.

The CGIAR Centres are not only recognized for scientific excellence, they develop real products and practical methods for use on the ground. Their work focuses on all aspects of food production, from producing higher yielding crop varieties to understanding the wor4ld's diverse growing conditions to developing improved farming practices.

Individual CGIAR Centres devote their efforts to improving cereals, legumes, root and tuber crops, as well as livestock and fish varieties. They focus on increasing food production practices in dry, semi-arid, desert, tropical and high altitude regions, where farmers have to struggle against the harshest of conditions with few resources. The CGIAR experts continually develop practices and policies that improve agroforestry, forestry, and irrigation management.

The system employees over 1,000 internationally recruited and about 8,000 nationally recruited staff. They work in collaboration with advanced research institutions, national agricultural research systems, non-governmental organizations', community groups and the private sector.

The CGIAR is assisted by an advisory board, the Technical Advisory Committee (TAC) which advises the Group on scientific matters and recommends support of budgets for each of the centre that the Group has agreed to include within its responsibility. The Secretariat of TAC is at FAO in Rome. At the twenty-fifth anniversary of the CGIAR in 1996, the organization stated that "The mission of CHIAR is to contribute, through its research, to promoting sustainable agriculture for food security in the developing countries. The CGIAR conducts strategic and applied research, and its products are international public goods. It focuses its research agenda on problem solving through interdisciplinary programmes implemented by one or more of its international centre in collaboration with a full range of partners in an emerging global agricultural research system. Such programmes concentrate on increasing productivity,

protecting the environment, saving biodiversity, improving policies, and contribution to strengthening agricultural research in developing countries."

The international centres:

All sixteen centre have the same general goal; to increase agricultural productivity in developing countries in an ecologically balanced, environmentally safe and socially acceptable fashion. The goal also is to raise farm incomes, reduce food costs and improve human nutrition. A brief description of the centres involved in plant germplasm enhancement is given in the following pages.

International Center for Tropical Agriculture (CIAT):

- Head quarters: Cali, Colombia.
- Founded: 1967
- Joined CGIAR in 1971
- Regional Offices: Cruz das Almas, Brazil; Quito, Ecuador; Guatemala City, Guatemala; Tegucigalpa, Honduras; Lilongwe, Malawi, Managua, Nicaragua; Manila, Phillippines; Arusha, Tanazania; Bangkok, Thailand; Kampala, Uganda.
- Focus: To alleviate thunder and poverty in tropical countries by applying in science to the generation of technology that will lead to lasting increase in agricultural output while preserving the natural resources base. Research focuses on the development of germplasm for beans, cassava, tropical forages, and rice for Latin America and on improving resource management in humid agro ecosystem areas in tropical America, such as hill sides, forest margins, and savannas.

Center for International Forestry Research (CIFOR)

- Headquarters: Jakarta, Indonesia.
- Founded: 1992
- Joined CHIAR in 1992.
- Focus: To contribute to the sustained well-being of people in developing countries particularly in the tropics, through collaborative strategic and applied research in forest systems and forestry, and by promoting the transfer of appropriate new technologies and the adoption of new methods of social organization for national development.

International Center for the Improvement of Maize and Wheat (CIMMYT)

- Headquarters: Mexico City, Mexico
- Founded: 1963
- Joined CGIAR in 1971
- Regional Offices: Dhaka, Bangladesh; Santa Cruz, Bolivia; Cali, Colombia; San Jose, Costa Rica; Addis Ababa, Ethiopia; Guatemala City, Guatemala; Tegucigalpa, Honduras;

Nairobi, Kenya; Kathmandu, Nepal, Aleppo, Syrian Arab Republic; Bangkok, Thailand; Ankara, Turkey; Montevideo, Uruguay; Harare, Zimbabwe.

- Focus: To help the poor through agricultural research and in concert with national research system by increasing the productivity of resources committed to maize and wheat in developing countries, while protecting the environment.

International Potato Center (CIP)

- Headquarters: Lima, Peru
- Founded : 1971
- Joined CGIAR in 1973
- Regional Offices: Cochabamba, Bolivia: Quitto, Ecuador; Nairobi, Kenya; Bamenda, Cameroon; Kampala; Uganda; Ibadan, Nigeria; Kafr ElZayat, Egypt: New Delhi, India, Bogor and Bandung; Indonesia; Manila, Philippines; Beijing, China.
- Focus: To contribute to increased food production, the generation of sustainable and environmentally sensitive agricultural systems and improved human welfare by conducting coordinated, multidisciplinary research programmes on potato and sweet potato. In pursuit of this research programmes on potato and sweet potato. In pursuit of this goal, CIP conducts worldwide collaborative research and training to catalyze collaboration among countries in solving common problems and help scientists worldwide successfully address changing demands in agriculture.

International Center for Agricultural Research in the Dry Areas (ICARDA):

- Headquarter: Aleppo, Syrian Arab Republic
- Founded: 1977
- Joined CGIAR: 1978
- Regional Offices: Damascus, Syrian Arab Republic; Beirut, Lebanon; Cairo, Egypt; Tunis, Tunisia; Rabat, Morocco; Amman, Jordan; Ankara; Turkey; Tehran, Iran; Dubai, United Arab Emirates; Dharar, Republic of Yemen; Mexico City, Mexico.
- Focus: To meet the challenges posted by harsh and variable environments by increasing the productivity of winter rain fed agricultural systems to higher sustainable levels, by arresting and reversing soil degradation, by improving water use efficiency, and ensuring the quality of the fragile environmental resources. ICARDA has a worldwide responsibility for the improvement of barley, lentils, and Faba bean, and a regional responsibility in West Asia and North Africa for the improvement f wheat, chickpea, forages, and pasture. ICARDA emphasizes ranges land improvement, small ruminant management and nutrition, and rain fed farming systems associated with these crops.

International Center for Research in Agro-forestry (ICRAF)

- Headquar4ters: Nairobi, Kenya
- Founded: 1977
- Joined CGIAR: 1991
- Regional Offices: Machakos, Kenya; Yaounder, Cameroon; bagor, Indonesia; Embu, Kenya; Zomba, Malawi; Bamako, Mali; quintans Rao, Mexico; Niamey, Niger; Pucallpa, Peru; Laguna, Phillippines; Shiyanga, Tanzania; Chiang mai, Thailland; Kampala, Uganda; Chipta, Zambia; Harare, Zimbabwe.
- Focus: to mitigate tropical deforestation, land depletion, and rural poverty through improved agro forestry systems. Trees in farming systems can increase and diversity farmer income, make farming systems more robust, reverse land degradation and reduce the pressure on natural forests. Working together with national agricultural and forestry research systems, non-governmental organizations, and other research partners, ICRAF carries out research and focuses on finding alternatives to slash-and-burn agriculture in the humid tropics and overcoming land depletion in sub-humid and semi-arid Africa.

International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)

- Headquarters: Patancheru, Telangana, India
- Founded: 1972
- Joined CGIAR: 1972
- Regional Offices: Niamey, Niger; Bamako, Mali; Kano, Nigeria; Bulawayo, Zimbabwe; Nairobi, Kenya; Lilongwe, Malwi, New Delhi, India.
- Focus: to conduct research leading to enhanced sustainable food production in the harsh condi8tions of the semi-arid tropics. ICRISATs main crops are sorghum, finger millet, pearl miller, chickpea, pigeonpea, and groundnut. These are vital to life for the one-sixth of the world's population that lives in the semi-arid tropics. ICRISAT conducts research n partnership with the national agricultural systems that encompasses the management of the region's limited natural resources to increase the productivity, stability, and sustainability of these and other crops.

International Institute of Tropical Agriculture (IITA)

- Headquarters: Ibadan, Nigeria.
- Founded: 1967
- Joined CGIAR in 1971
- Regional Offices: Kano and Port Harcourt, Nigeria; Cotonou, Repubiquedu Benin; Yaounde, Cameroon; Kumasi, Ghana; Bouake, Cote d'ivoire; Kampala, Uganda;

Lilongwe, Malawi; Maputo, Mozambique; Manza, Zambia; Dar-Es-Salam, Tanzania; Marondera, Zimbabwe.

- Focus: To help those countries increase food production on an ecologically sustainable basis by conducting research and outreach activities with partner programme in the countries of sub-Saharan Africa. IITA seeks to improve the food quality, plant health, and post-harvest processing of cassava, maize, cowpea, soybean, yam and banana and plantain and strengthen national research capabilities.

International Plant Genetic Resources Institute (IPGRI)

- Headquarters: Rome, Italy
- Founded: 1974
- Joined the CGIAR: 1974
- Regional Offices: Nairobi, Kenya; Serdang, Malaysia; Beijing, China; Newdelhi, India; Aleppo, Syria; Cali, Colombia; Cotonou, Republique du benin.
- IPGRI/INIBAP Offices: Montpellier, France Heverlee, Belgium; Douala, Cameroon; Kampala, Uganda; Los banos, Philippines; Turrialba, Costa Rica; San Pedro Sula, Honduras.
- Focus: To encourage support and engage in activities to strengthen the conservation and use of plant genetic resources worldwide, with special emphasis on developing countries, by providing scientific and technical information, research and training.

International Rice Research Institute (IRRI)

- Hedquarters: manila, The Phillippines.
- Foudned: 1960
- Joined the CHIAR IN 1971
- Regional Offices: Dhaka, Bangladesh; Yangon, Myanmar; New Delhi, India; Bogor, Indonesia; Bangkok, Thailand; Ibaraki, Japan, Antananarivo, Madagascar; Vietiane, Lao PDR; Phnom Pench, Cambodia; Hanoi, Vietnam.
- Focus: To improve the well-being of present and future generations of rice farmers and consumers, particularly those with low incomes, by generating and disseminating rice-related knowledge and technology of short and long term environmental, social and economic benefit and by helping to enhance national rice research.

West Africa Rice Development Association (WARDA)

- Headquarters: Bouake, Cote d'lvoire.
- Founded: 1971
- Joined the CGIAR IN 1975
- Regional Offices: Abidjan, Cote d'ivoire; St.Louis, Senetal; Ibadan, Nigeria.

- Focus: To strengthen the capability of agricultural scientist in West Africa to generate technology for the sustainable productivity of intensified rice-based cropping systems to improve the well-being of poor farm families and conserve and enhance the national resource base. Research focuses on the grown in mangrove swamps, inland valleys, upland conditions, irrigated conditions.

There are another five International Centres of the CHIAR, which are not directly involved in primary plant breeding activity but are critically relevant to the goal of enhancing food production and sustainability of agriculture. The activity profile of these centre is given below.

International Center for Living Aquatic Resources management (ICLARM)

- Headquarters: Makati City; The Philippines.
- Founded : 1977
- Joined the CGIAR in 19921
- Regional Offices; Honiara, Solomon Islands; Dhaka, Bangladesh; Zomba Malwai; Tortola, British Virgin Islands; Giga, Egypt.
- Focus: To improve the production and management of aquatic resources, for sustainable benefits to present and future generations of low-income producers and consumers in developing countries through international multidisciplinary research in partnership with national agricultural research systems. The declining state and threatened sustainability of fisheries, resulting from overfishing, poverty, pollution, and the potential for increases in aquaculture production; call for research that explores the dynamics of coastal and coral reef resources systems and integrated agriculture-aquaculture systems, investigating alternative management schemes in these systems and improving the productivity of key species.

International Food Policy Research Institute (IFPRI)

- Headquarters: Washington, DC, United States of America.
- Founded: 1975
- Joined the CGIAR in 1980
- Focus: To identify and analyze alternative national and international strategies and policies for meeting the food needs of the developing world on sustainable basis, with particular emphasis on low-income countries and on the poorer groups in those countries. While IFPRTs research is specifically geared to contributing to the reduction of hunger and malnutrition, the factors involved are many and wide-ranging, requiring analysis of underlying processes and extending beyond a narrowly defined food sector. IFPRI collaborates with governments and private and public institutions worldwide and

disseminates its research to policymakers, administrators, policy analysts, researchers and other concerned with national and international food and agricultural policy.

International Irrigation Management Institute (IIMI):

- Headquarters: Colombo, Sri Lanka
- Founded:1984
- Joined the CGIAR in 1991
- Regional Offices: Battarmulla, Sri Lanka; Quagadougou, Bur4kina Faso; Mexico City, Mexico; Niamey, Niger, Lahore, Pakistan; Izmir, Turkey
- Focus: To foster improvement in the management of water resource systems and irrigated agriculture. IIMI conducts a worldwide program to generate knowledge to improve water resource systems and irrigation management, strengthen national research capacity, and support the introduction of improved technologies, policies, and management approaches.

International Livestock Research Institute (ILRI)

- Headquarters: Nairobi, Kenya
- Founded : 1995
- Joined the CGIAR in 1995
- Regional Offices: Addis Ababa, Ethiopia; Ibadan, Nigeria; Lima, Peru; Cali,Colombia; Nizmey, Niger; Andhrapradesh, India; Babo-Dioulasso, Burkina Faso.
- Focus: To increase animal health, nutrition, and productivity and protect environments supporting animal production by tailoring production systems and developing technologies that are sustainable over the long term. ILRI works to characterize and conserve the genetic diversity of indigenous tropical forage species and livestock breeds and promote quotable and sustainable national policies for animal agriculture and related national resources management.

International Service of National Agricultural Research (ISNAR)

- Headquarters: The Hague, The Netherlands
- Founded: 1979
- Joined the CGIAR in 1980

Conclusion:

To help developing countries bring about sustained improvements in the performance of their national agricultural research systems and organizations by supporting institutional development, promoting appropriate policies and funding for agricultural research, developing or adapting improved research management techniques, and generalizing and disseminating relevant knowledge and information.

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STUDIES OF COPPER SULPHIDE THIN FILMS DEPOSITED BY CBD TECHNIQUE

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Abstract:

Copper Sulphide (CuS) thin films deposited on glass substrates by the Chemical Bath Deposition technique. Copper Sulphide for copper and Thiourea for sulfur were used as sources for Copper and Sulphur ions respectively. Effect of bath temperature concerning the assets of copper sulphide films was studied. Optical characterization was done by using a UV- VIS spectrophotometer in the wavelength range of 200 nm to 1100 nm. Transmittance, absorbance and band gap were calculated. Band gap energy range was found in between 2.25 eV to 2.34 eV and these consequences that the films can appropriately be castoff in the formation of solar cells. XRD studies long-established that the thin films had hexagonal structure and confirmed the excellence of crystallinity of the films by acquisitive the bath temperature. Surface roughness, thickness of the films and grain size were also improved with increasing of bath temperature from 50 and 55 °C. However, the samples deposited at 55 °C showed comparable and uniform structure giving to SEM and EDAX pictures. Electrical transport readings exhibited that the films are semiconducting in nature. Highest room temperature electrical conductivity of 6.37×10^{-3} to 8.34×10^{-3} $(\Omega\text{-cm})^{-1}$ was observed for the films. Thermo power extents indicated similar manner of variations corresponding to the electrical conductivity and that the samples show n-type conduction. The bath temperature was one of the key deposition parameters that control the possessions of semiconductor thin films.

Keywords: CBD technique, XRD studies, SEM and EDAX, semiconductor thin films.

Introduction:

Thin films of copper chalcogenides have usual much consideration due to their extensive range of application in semiconducting devices such as in photovoltaic, optoelectronic devices, radiation detectors, and solar cell convertors. Copper Sulfide chalcogenides have been of much attention to scientists because they achieve a number of the requirements for numerous modern

electronic and optoelectronic devices such as LED's, photodiodes, etc. Copper Sulfide is one of the direct band gap semiconductors with a varied gap which make them interesting for photovoltaic performance [1]. The Copper sulphide is a base material for the construction of innovative quaternary compounds and have also been of excessive interest in research because after doping they offer good window material assets. CuS thin films are widely used as an absorber considerable in opto-electronics, solar cells, photothermal conversion, electroconductive electrodes, microwave shielding coatings and solar control coatings etc. [2-6]. Chemical vapour deposition, chemical bath deposition, spray pyrolysis, sputtering, electrodeposition and vacuum evaporation are broadly used methods for deposition of thin films. Chemical bath deposition technique is comfortable, low-cost and suitable method for large area preparation of thin films. Other beautiful feature of the CBD method is that, ternary and quaternary compounds can be easily formed without the use of any sophisticated instrumentation and process control [7]. Numerous studies have been designated on the CuS binary system in powder, bulk, and as thin films with different compositions and properties. Differences in the properties originated mainly by factors associated to phases equilibria, because of a strong tendency of Cu and S to form several metastable and nonstoichiometric phases. Detecting physical properties we found that our material has excellent photocatalytic properties. In this paper, the deposition was carried out under changed bath temperatures in order to inspect the structural, morphological and optical characteristics of the films. The possible applications of the film were showing from their properties.

Experimental detail

For the deposition of samples all the chemicals of AR grade were used and the solutions were prepared in double distilled water. The copper sulphide thin films were prepared by chemical bath deposition method using aqueous solutions of copper sulfate ($CuSO_4$) and Thiourea (H_2NCSNH_2) acted as a source of Cu^{2+} and S^{2-} ions, respectively. The experiment was carried out for temperature 50 ^{0}C and 55 ^{0}C. Before deposition the glass substrates were washed with soap and a soft stuff and then washed with distilled water; after that placed in a chromic acid solution for 24 h. Then, the substrates were cleaned with deionized water several times and chemically attacked in a water-nitric acid solution for 3 hours at slowly boiling. The glass slides were immersed vertically in an aqueous solution containing copper sulfate(0.5M, 10mL), thiourea (0.5 M,10mL), triethanolamine (3.0 mL), sodium hydroxide (5.0mL) and ammonia 10 M). Distilled water was used for the preparation of solution. The pH of resultant solution was adjusted to 10. The cleaned glass substrate was immersed vertically into beaker which placed inside a temperature bath. Film deposition time was kept 45 min. After the completion of deposition, the as deposited samples splashed with double distilled water and kept for characterization and analysis [8].

Characterization of the samples

Weight difference method was used to measure the thickness of the as deposited film. Optical absorption measurements were carried out using UV-Vis spectrophotometer in the wavelengths range from 200 - 1100 nm. Structure of the film was studied by an X-ray diffraction technique using Regaku Miniflex XRD machine. Range of 2θ values was from 20° to 80° and radiations used were CuKα with wavelength1.5406 Å. Chemical composition of the films was carried out using an energy dispersive spectrometer (EDAX), Quanta 200ESEM. Scanning electron microscopy (SEM) indexation was intended for the as deposited films. Electrical conductivities of the films were tested by a two point probe method in the temperature range from 300 - 500 K. Thermovoltages were also noted on these films in the temperature range of 300 to 500 K. Ag-paste was used as the contact material for TEP characterization.

Results and Discussion:

The as-deposited thin films were smooth, transparent, absolutely adherent to the substrate, free of pinholes and reproducible. Typical XRD images of the CuS thin films prepared at 50°C and 55°C by the chemical bath deposition technique are illustrated in Figure 1.The chemical bath deposited CuS thin films are found to be polycrystalline in nature. The XRD shapes of the samples indicate presence of six peaks with different widths and intensities. These peaks are correspond to orientation along (004), (101), (102), (103), (111) and (108) planes of hexagonal phase of CuS [9, 10]. These peaks are well match with the standard JCPDS (79-2321) data. As per the bath temperature increases from 50 ^{0}C to 55 °C all the diffraction peaks become narrower and intensities of peaks increase signifying an enhancement of crystallinity. It means that the grain size increases with increase in the bath temperature. This plane seems dominant at this stage of experiment. It can be seen that the film crystallinity, grain size is mainly affected by bath temperature. From the XRD patterns, the peak (101) is considered as major peak with higher intensity. In our observed patterns of XRD the (102), (111), (107) and (105) planes are weak peaks and have lower intensity values. The crystallite sizes were calculated using Scherres relation. It is seen that crystallite size were in the nano range of 20.8 nm & 24.5 nm.

Figure 2 shows the chemical composition of the films was resolute by an energy dispersive spectroscopy (EDAX). The contents of Cu and S as taken in the deposition solution and that observed in the samples. It has been seen that CuS sample is Cu rich. It appears that S content is less than that of the expected (50 %), although the solution was taken to be in stoichiometric proportion.

The absorbent nature of capacity of films can be detected from the SEM image of Figure 3 which indicates that nanodisks are arbitrarily concerned with in the space [10]. The influence of the temperature on the electrical properties of the CuS samples was estimated by two probe technique with Ag-dot contacts in a square sample of the 1 cm^2 with Van der Pauw configuration.

The samples exhibited n-type conductivity. The resistivity, the holes concentration, the mobility is calculated. The result of conductivity is correlated with measured thickness of samples (285nM and 335nM).
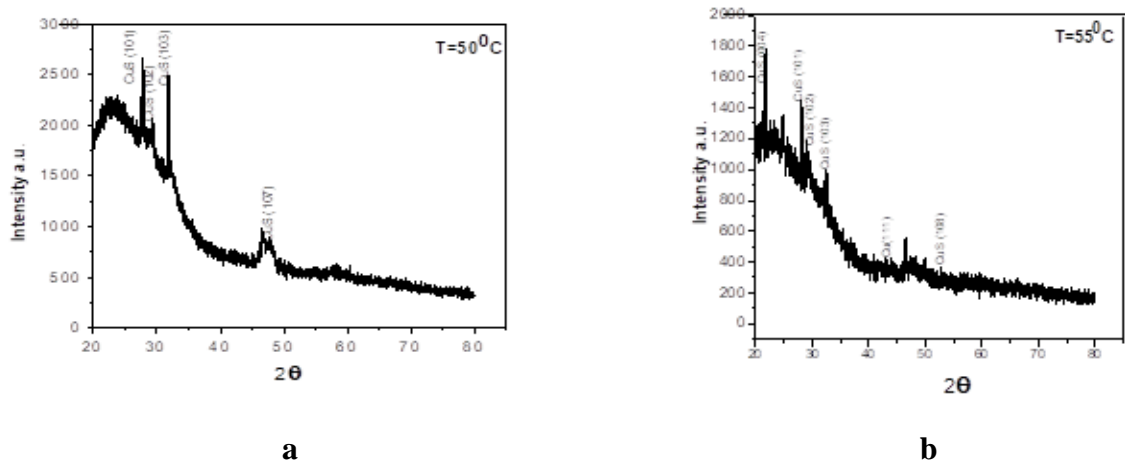

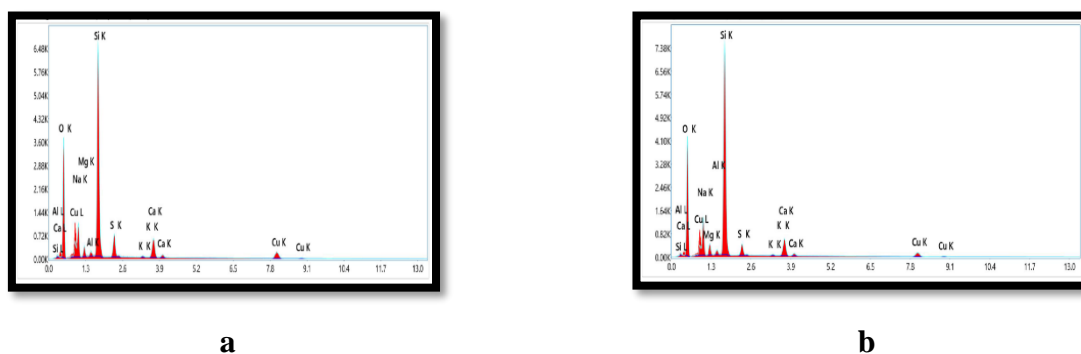**Figure 1: X-ray diffraction patterns of CuS deposited at (a) temp. = 50 ^{0}C and (b) temp. = 55 ^{0}C**

Figure 2: EDAX of CuS thin film at (a) 50 ^{0}C and (b) 55 ^{0}C
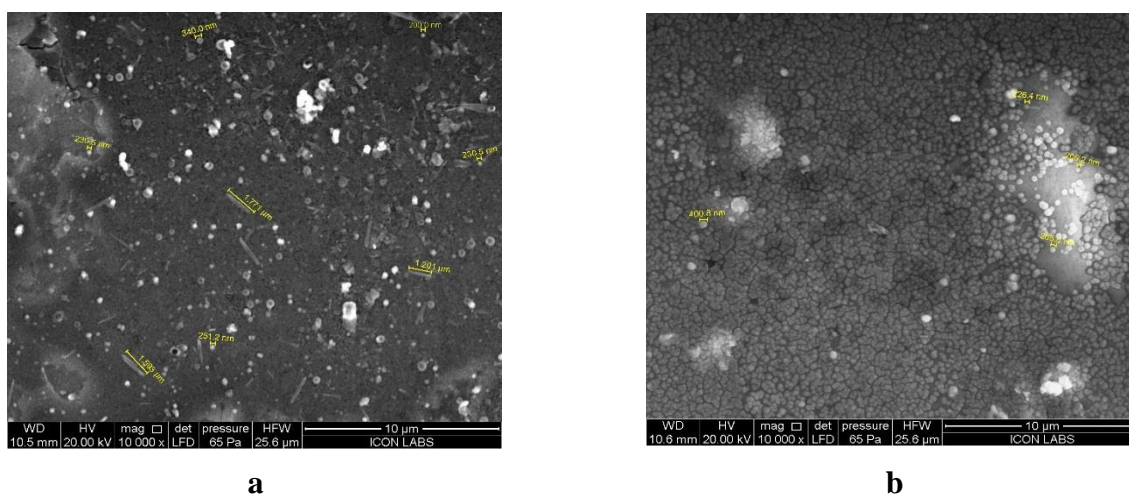

Figure 3: SEM images of a CuS thin films at (a) 50 ^{0}C and (b) 55 ^{0}C

CuS thin films deposited on glass substrate were characterized by the spectrophotometric technique for optical absorption in the 200 - 1100 nm wavelength range. The absorption data were examined for near edge optical absorption of semiconductor. For allowed direct transitions, n=1/2.The optical gaps were then determined frome the $(\alpha h v)^2$ vs hv variation and an energy bandgap with temperature as shown in figure4. It is seen that E_g increased with increase in temperature [10]. The optical gap of pure CuS is found to be 2.25 eV and 2.34 eV.
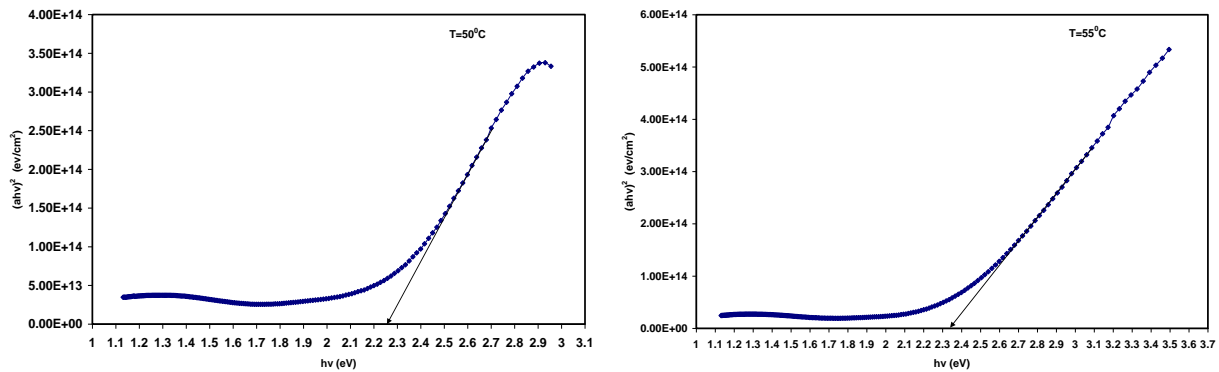

Figure 4: Bandgap of CuS samples

The electrical conductivities of the as deposited CuS thin films were measured using two-probe method in the range of temperature from 300 – 500 K. Fig.5 shows variation of the electrical resistivity with film temperature. The films are semiconducting and nonlinear nature and show presence of many defects in the films.The increase in electrical conductivity can be attributed to increase in the particle size. The type of conductivity revealed by the chemically deposited CuS thin film is determined from TEP measurements. It is found that CuS exhibits n-type conduction.
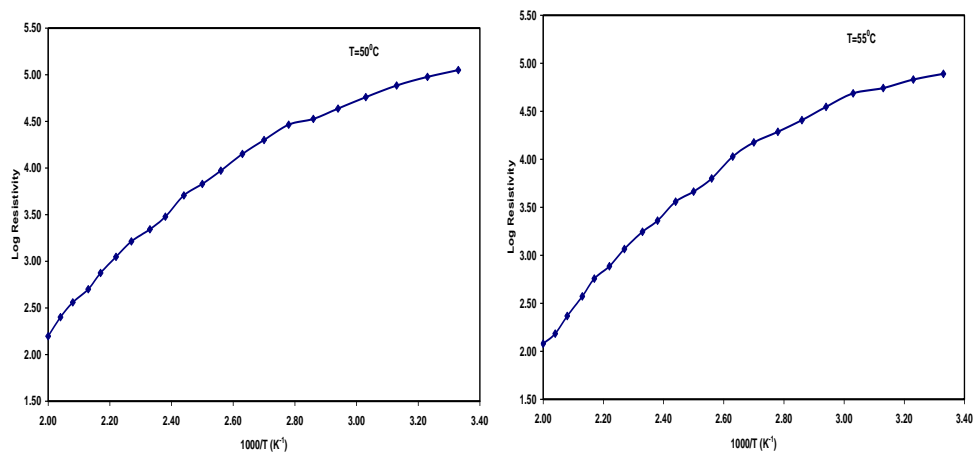

Figure 5: Variation of the electrical resistivity with film temperature

Conclusions:

Thin films of Copper Sulphide have been grown on glass substrate using chemical bath method at changing temperature and characterized to study the structural property using EDAX, SEM, XRD and Spectrophotometer to determine its optical properties. It is observed that the film absorbance is high in UV region and low in VIS NIR region while the transmittance is low in UV region and high in VIS – NIR regions. The energy band gap of the film obtained is between 2.25eV and 2.34eV. These results propose that the films can appropriately be used in the construction of solar cells.

Acknowledgment:

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LASER: CHARACTERISTICS AND APPLICATIONS

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Abstract:

In the rich tapestry of scientific innovation, few discoveries have left as indelible a mark on our technological landscape as the Laser. An acronym for Light Amplification by Stimulated Emission of Radiation, the Laser represents a transformative leap beyond conventional light sources. Birthed in the fertile realms of 20th century ingenuity, the Laser's journey from scientific breakthrough to ubiquitous application has been nothing short of extraordinary. This marvel of physics has woven itself seamlessly into the fabric of our daily lives, finding applications in an astonishing array of fields. From the sleek hum of CD players and the mesmerizing glow of laser printers to the precision of eye surgery equipment and the intricate choreography of optical communication systems, the Laser stands as a testament to the boundless possibilities of human invention.

Keywords: Laser, Absorption, Stimulated Emission, Pumping.

Introduction:

Laser is more than just an artificial light source; it is a device that harnesses the captivating phenomenon of stimulated emission. This intricate dance of physics manifests in a highly directional, coherent, monochromatic, polarized, and intense beam of light. As we embark on an exploration of the Laser's intricacies, we delve into the science that underpins its brilliance and the myriad ways it has reshaped the landscape of technology and daily life. Join us on this illuminating journey into the heart of the Laser, where science meets innovation and light takes on a whole new dimension.

Understanding how a LASER operates requires exploring the intricate interplay between light radiation and matter through three key quantum processes. These processes unfold within a material when exposed to radiation, revealing the energy states of its constituent atoms. At the atomic level, identical atoms have discrete energy levels-namely, E_1 (ground state) and E_2 (excited state). While atoms may have numerous energy levels, focusing on these two provides clarity. E_1 and E_2 are universal across all atoms in the material.

Incident radiation, visualized as photons with energy hv, interacts with atoms, leading to three quantum transitions: absorption, spontaneous emission, and stimulated emission. These transitions, or quantum jumps, describe how atoms move between energy states.

Interaction of light radiation with matter: Three quantum processes:

Absorption / Induced absorption / Stimulated absorption:

Within the realm of quantum mechanics, the phenomenon of absorption, induced absorption, or stimulated absorption unveils a captivating dance of energy transitions within an atom. Imagine an atom nestled in the lower energy level (E_1) that encounters an incident photon with an energy of $E_2 - E_1 = hv$, propelling it to the excited state E_2. This orchestrated transition, known as stimulated absorption, not only characterizes the absorption of the photon but also contributes to the dynamic interplay between light and matter. Each absorption event results in the disappearance of a photon from the incident beam, exemplifying the intricate relationship between photons and atoms. Mathematically, the number of absorption transitions (Nab) occurring in the material at any given instant is proportional to both the number of atoms at energy level E_1 and the photon density in the incident beam.

In essence, stimulated absorption not only marks a quantum jump in an atom's energy state but also serves as a pivotal player in the dynamic equilibrium between photons and atoms. This interplay lays the groundwork for comprehending the underlying processes that make lasers a fascinating intersection of quantum physics and technological marvels.

Spontaneous emission:

In the realm of quantum dynamics, an atom dwelling in the higher energy state (E_2) finds itself in an inherently unstable condition. Driven by the relentless pursuit of minimum potential energy, atoms possess an innate tendency to gravitate towards the lower energy level (E_1), an excited atom residing in the state E_2, compelled by the imperative of achieving a state of minimum potential energy, spontaneously returns to the lower state E_1. In this fascinating ballet of energy, the excess energy is liberally released in the form of a photon. This unscripted and natural process, where photon emission occurs without any external impetus, is aptly termed spontaneous emission.

In the symphony of spontaneous emission, atoms relinquish their elevated energy states willingly, contributing to the ever-present, flow of light and matter. This unscripted release of photons adds a spontaneous and unpredictable element to the intricate quantum choreography within the material.

Spontaneous emission highlights:

1. Autonomous process driven by the natural tendency of excited atoms to return to a lower energy state.
2. Photons exhibit varied phases, polarizations, and directions, lacking synchronization.

3. Light scatters in all directions around the source, in contrast to focused laser beams.

4. Light intensity diminishes swiftly with distance due to photon scattering.

Stimulated emission:

In the intricate dance between light and matter, a photon carrying energy hv can induce an excited atom to undergo a downward transition. This transition results in the release of excess energy in the form of another photon. This process, where an external influence compels an excited atom to emit a photon, is aptly termed stimulated emission, also recognized as induced emission.

In essence, stimulated emission represents the forced emission of a photon by an excited atom, triggered by the action of an external agency. This phenomenon plays a pivotal role in the operation of lasers, where the controlled release of photons contributes to the creation of a highly focused, coherent, and intense beam of light.

Characteristics of stimulated emission:

Directional propagation:

The photon induced in stimulated emission propagates in the same direction as the incident photon, maintaining a precise trajectory.

Identical photon features:

The induced photon mirrors the characteristics of the incident photon. It shares the same frequency, phase and plane of polarization, ensuring coherence in the emitted light.

Photon multiplication:

A hallmark of stimulated emission is the exponential multiplication of photons. A single interaction between a photon and an excited atom results in the emergence of two photons. These two photons, in turn, stimulate two more excited atoms, leading to a cascade effect. This multiplication is a key mechanism in laser technology, generating the intense and focused beams of light essential for various applications. The number of photons builds up in an avalanche like manner, as shown in figure below:
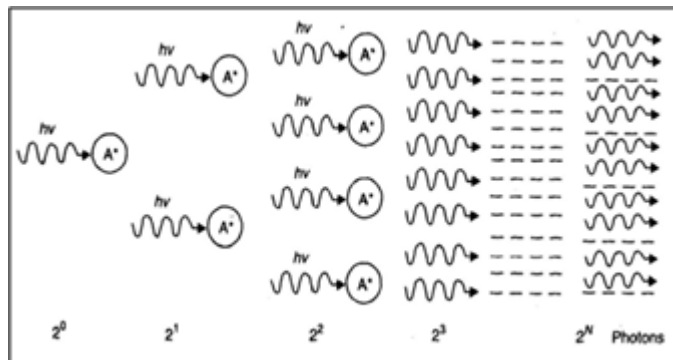
In the practical realm, absorption and spontaneous emission invariably coexist with stimulated emission. The crux of laser operation lies in achieving a delicate equilibrium where stimulated emission surpasses absorption and spontaneous emission. This process, when

maximized, not only produces coherent photons but also initiates a multiplication effect. Consequently, to facilitate light amplification within the material, stimulated emission must take precedence. Achieving this balance is essential for unleashing the full potential of lasers in various technological applications.

Principal pumping schemes in laser technology

In the realm of laser technology, two pivotal pumping schemes take centre stage: the three-level and four-level pumping schemes. Despite atoms having numerous energy levels, only three or four prove suitable for the pumping process.

The laser operation lies in the transition between two specific levels, known as lasing transitions, that generate stimulated emission. Within this framework, the lower lasing level initiates the process and the upper lasing level represents the culmination of the stimulated emission. At the topmost tier sits the pumping level, serving as the catalyst for the entire system. In the schematic representation:

- An upward arrow signifies the pumping transition, symbolizing the energy influx.
- Conversely, a downward arrow indicates the lasing transition, symbolizing the release of stimulated emission.

Understanding and optimizing these pumping schemes are fundamental to the efficiency and functionality of lasers in diverse technological applications.

Three-level pumping scheme overview:

Consider an atomic system featuring three energy levels: E_1 (Ground State), E_2 (Metastable State), and E_3 (Excited Pumping State). When incident light photons with energy $hv = (E_3 - E_1)$ interact with the medium, atoms in the ground state are easily excited to the pumping level E_3. However, E_3 is not a stable state, prompting atoms to undergo a downward transition to either E_1 or E_2 through non-radiative or spontaneous transitions. The likelihood of spontaneous transition from E_3 to E_1 is lower than E_3 to E_2. As E_2 represents a metastable state, atoms tend to be trapped in this state due to its longer lifetime, resulting in a significant accumulation of atoms at the E_2 level.
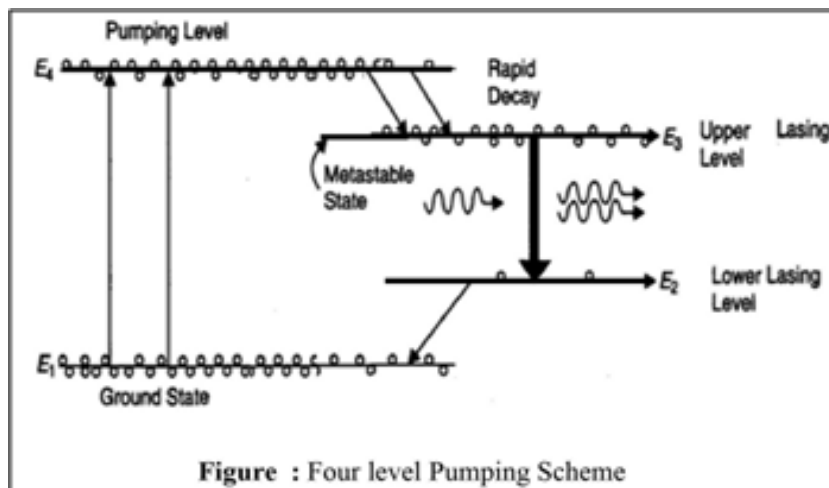

Figure : Three level Pumping Scheme
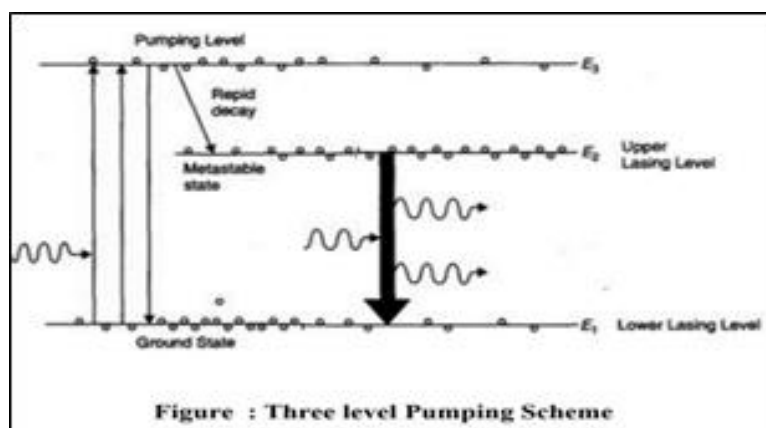
Once more than half of the ground state atoms accumulate at E_2, a population inversion condition is achieved between E_2 and E_1. This sets the stage for stimulated emission, where a spontaneously emitted photon of energy $hv = (E_2 - E_1)$ triggers the emission of more photons by atoms at E_2. Consequently, laser light is generated between the metastable state (E_2) and the ground state (E_1). This three-level pumping scheme forms the basis for laser operation, with the accumulation of atoms at the metastable state facilitating the production of coherent and amplified light.

Four-level pumping scheme overview:

In the context of a four-level pumping scheme within an atomic system, let's explore the energy levels: E_1 (Ground State), E_3 (Metastable State), and E_2/E_4 (Excited States). Initiating with a pumping frequency, the active centre (active atoms) is elevated from the ground state E_1 to the uppermost level E_4. From E_4, atoms swiftly descend to the metastable state E_3. The population at E_3 increases rapidly, while E_2 remains virtually empty. This asymmetry results in a population inversion between the states E_2 and E_3.

A photon of energy $hv = E_3 - E_2$ becomes the catalyst, initiating a chain of stimulated emission that brings the atom into state E_2. Subsequently, atoms from E_2 undergo non-radiative transition to the ground state E_1, making them available once again to participate in the overall process. This four-level pumping scheme provides a strategic framework for achieving population inversion and stimulating the emission of coherent and amplified light. The transitions between these energy levels form the foundation for the efficient operation of lasers in various technological applications.

Figure : Four level Pumping Scheme

Role of optical resonator in laser operation:

Enhancing photon density:

To ensure that stimulated emission prevails over spontaneous emission, a high photon density is crucial in the active medium. The optical resonator achieves this by repeatedly reflecting photons, building up their density within the medium.

Directional amplification:

The optical resonator determines the direction in which light is amplified, aligning with the optical axis of the mirror pair. This selective amplification makes the laser beam highly directional, contributing to its precision.

Monochromatic laser output:

By selecting and amplifying specific frequencies, the optical cavity ensures that the laser output is highly monochromatic. This feature results in a laser beam with a singular and well-defined wavelength, contributing to its coherence and application precision.

Lasers, or Light Amplification by Stimulated Emission of Radiation, come in various types, each designed for specific applications based on their unique properties and characteristics. Here is a detailed discussion of some common types of lasers:

Gas lasers:

Gas lasers use a gas mixture, often including helium, neon, argon, krypton, or carbon dioxide, as the active medium. They operate through electron collisions within the gas, producing a range of wavelengths.

Applications: Gas lasers are utilized in medical procedures, industrial cutting and welding and scientific research.

Solid-state lasers:

Solid-state lasers employ a solid crystal or glass as the active medium. Common materials include ruby, neodymium-doped yttrium aluminium garnet and semiconductor materials. They are known for their compact size and high-power output.

Applications of LASER:

1) In materials processing, medical surgery and scientific research.

Semiconductor lasers (Diode lasers):

Semiconductor lasers use a semiconductor as the active medium. They are compact, energy-efficient, and widely used in various consumer electronics, fiber optics communication, and laser pointers.

2) In telecommunications, optical data storage, and laser printing.

Fibre lasers:

Fiber lasers utilize an optical fiber doped with rare-earth elements such as erbium, ytterbium, or neodymium as the active medium. They offer high efficiency, excellent beam quality, and are suitable for various applications.

Applications: Metal cutting, welding, telecommunications, and medical devices.

Dye lasers:

Dye lasers use an organic dye as the gain medium. They can be tuned to emit light over a wide range of wavelengths, making them versatile for different applications.

Applications: Medical applications (skin treatments, eye surgery), spectroscopy and research.

Free electron lasers:

Free Electron Lasers use relativistic electrons as the lasing medium. They can generate coherent radiation across a broad range of wavelengths from infrared to X-rays.

Applications: Scientific research, materials science and medical imaging.

Excimer lasers:

Excimer lasers use rare gas-halide combinations as the active medium. They emit short pulses of ultraviolet light, often used in precise material removal processes.

Applications: Laser eye surgery, semiconductor manufacturing, and micromachining.

Chemical lasers:

Chemical lasers utilize a chemical reaction as the energy source. Common types include hydrogen fluoride (HF) and deuterium fluoride (DF) lasers.

Applications: Military applications, such as missile defence and scientific research.

Quantum cascade lasers:

Quantum cascade lasers use semiconductor layers to create quantum wells for electron transitions. They are known for their tunability in the mid-infrared range.

Applications: Gas sensing, environmental monitoring, and medical diagnostics.

Coherent beam combining lasers:

These lasers combine multiple individual laser beams into a single, powerful beam with high brightness. This approach enhances the overall output power.

Applications: Defence systems, industrial cutting, and scientific research.

These types of lasers cater to a diverse range of applications, showcasing the versatility and impact of laser technology across various industries. The continuous advancements in laser technology contribute to new and innovative applications in fields ranging from healthcare to manufacturing and beyond.

Conclusions:

In conclusion, the world of lasers epitomizes technological ingenuity, offering a diverse array of tools that have revolutionized numerous industries. From the precision of solid-state lasers to the versatility of semiconductor lasers, influencing applications ranging from medical procedures and communications to materials processing and scientific research. The evolution of laser technology has not only facilitated breakthroughs in cutting-edge fields like quantum cascade lasers for gas sensing but has also permeated everyday life through semiconductor lasers powering our devices.

The significance of lasers extends beyond their ability to produce coherent light; they serve as catalysts for progress, enabling advancements in fields as varied as telecommunications, healthcare, and manufacturing. The future promises even more remarkable applications, driven

by the collaborative efforts of researchers, engineers and visionaries, and hope that this would increase the interest of the reader to keep up to the many more laser applications that keep coming up with time.

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