"3.4.6 Number of books and chapters in edited volumes published per teacher during the last five years (15)"

Book

Introduction to Cognitive Radio Networks and Applications

Edited By ***Geetam Tomar, Ashish Bagwari, Jyotshana Kanti***

Edition	1st Edition
First Published	2016
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Chapter

Basics of Cognitive Radio Networks: An Appraisal

By ***Rajib Biswas***

Book [Introduction to Cognitive Radio Networks and Applications]

Edition	1st Edition
First Published	2016
Imprint	Chapman and Hall/CRC
Pages	6
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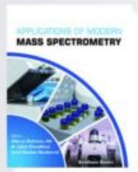

Applications of Modern Mass Spectrometry

DOI: 10.2174/97898114338251200101
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ISSN: 2717-6029 **(Print)**
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Recent Developments of Allied Techniques of Qualitative Analysis of Heavy Metal Ions in Aqueous Solutions with Special Reference to Modern Mass Spectrometry

Pp. 98-127 (30)

DOI: 10.2174/9789811433825120010006
Author(s): Bijoy Sankar Boruah, Rajib Biswas

Abstract

Heavy metal ions are basic elements of earth crust. These metal ions are non-biodegradable in nature and tend to accumulate in our ecosystem in due course of time. Some of the most toxic heavy metal ions include arsenic, mercury, cadmium, lead, nickel etc. The toxicity level depends on density for any biological system. Due to increasing applications of heavy metal ion compounds in industrial, agricultural and medical fields, water pollution induced by excess levels of heavy metal ion becomes a big crisis for us. As such, detection of heavy metal ions in water is an important issue for us. Mass spectroscopy methods are the most conventionally applied methods for the detection of heavy metal ions in water. Some of the mass spectroscopic methods are atomic absorption spectroscopy, inductively coupled plasma mass spectroscopy, graphite furnace atomic absorption spectroscopy etc. These methods have well detection capability of heavy metal ions in water with good selectivity and sensitivity. Along with mass spectroscopic methods, the use of optical fiber technology for heavy metal ions detection is remarkable. Optical fiber based sensors system for the detection of heavy metal ions basically works by changing the effective refractive index of its surroundings. For selective binding of heavy metal ions, sensitive layers are coated on optical fiber probe. Laser or light emitting diode is used as a light source in an optical fiber sensor for signal purpose. Accordingly, output response for various heavy metal ions is recorded on an optical spectrometer. From their output response, we can determine the concentration of metal ions present in water. It is noticed that optical fiber sensor can also have good sensitivity and selectivity towards the detection of heavy metal ions as mass spectroscopy methods.

Keywords:

Arsenic, Cadmium, Colorimetric, Detection, Electrochemical, Heavy metal ion, Lead, Mass spectrometry, Mercury, Optical fiber sensor, Sources of heavy metal ions.

Book

Advances in Photonic Crystals and Devices

Edited By Narendra Kumar, Bhuvneshwer Suthar

Edition	1st Edition
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eBook ISBN	9781351029421
Subjects	Engineering & Technology

ABSTRACT

In recent decades, *t*here has been a phenomenal growth in the field of photonic crystal research and has emerged as an interdisciplinary area. Photonic crystals are usually nanostructured electromagnetic media consisting of periodic variation of dielectric constant, which prohibit certain electromagnetic wave frequency ranges called photonic bandgaps to propagate through them. Photonic crystals elicited numerous interesting features by unprecedented control of light and their exploitation is a promising tool in nanophotonics and designing optical components. The book 'Advances in Photonic Crystals and Devices' is designed with 15 chapters with introductory as well as research and application based contents. It covers the following highlighted features:

- Basics of photonic crystals and photonic crystal fibers
- Different theoretical as well as experimental approaches
- Current research advances from around the globe
- Nonlinear optics and super-continuum generation in photonic crystal fibers
- Magnetized cold plasma photonic crystals
- Liquid crystal defect embedded with graphene layers
- Biophysics and biomedical applications as optical sensors
- Two-dimensional photonic crystal demultiplexer
- Optical logic gates using photonic crystals
- *A large number of references*

The goal of this book is to draw the background in understanding, fabrication and characterization of photonic crystals using a variety of materials and their applications in design of several optical devices. Though the book is useful as a reference for the researchers working in the area of photonics, optical computing and fabrication of nanophotonic devices, it is intended for the beginners like students pursuing their masters' degree in photonics.

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Book

Internet of Things

Integration and Security Challenges

By S. Velliangiri, Sathish A. P. Kumar, P. Karthikeyan

Edition	1st Edition
First Published	2020
eBook Published	30 December 2020
Pub. Location	Boca Raton
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Subjects	Computer Science, Engineering & Technology

ABSTRACT

IoT is empowered by various technologies used to detect, gather, store, act, process, transmit, oversee, and examine information. The combination of emergent technologies for information processing and distributed security, such as Cloud computing, Artificial intelligence, and Blockchain, brings new challenges in addressing distributed security methods that form the foundation of improved and eventually entirely new products and services. As systems interact with each other, it is essential to have an agreed interoperability standard, which is safe and valid.

This book aims at providing an introduction by illustrating state-of-the-art security challenges and threats in IoT and the latest developments in IoT with Cloud, AI, and Blockchain security challenges. Various application case studies from domains such as science, engineering, and healthcare are introduced, along with their architecture and how they leverage various technologies Cloud, AI, and Blockchain.

This book provides a comprehensive guide to researchers and students to design IoT integrated AI, Cloud, and Blockchain projects and to have an overview of the next generation challenges that may arise in the coming years.

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Reference Hub

Spectrum Sensing Techniques: An Overview

Rajib Biswas (Tezpur University, India)

Source Title: Sensing Techniques for Next Generation Cognitive Radio Networks
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ISBN13: 9781522553540 | ISBN10: 1522553541 | ISBN13 Softcover: 9781522587927 | EISBN13: 9781522553557
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Abstract

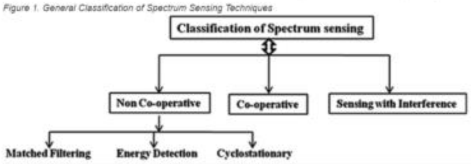
Cognitive radio has come a long way in the recent years with the advent of improved algorithms and instrumentation. However, for ease and efficient working of cognitive radio, there is a need to have effective detection of spectrum sensing. The objective of spectrum sensing techniques is to find spectrum holes which can be accessible by the users of cognitive radio. The deployment of suitable sensing techniques reduces undesirable congestion in traffic and enhancement of spectrum usage. All these require sensing techniques whose main goal is oriented towards efficient identification and subsequent deployment of spectrum. This chapter is aimed to give a brief overview of some spectrum sensing techniques. An attempt is made to give the characteristics of the highly deployable sensing schemes. Accordingly, the merits and demerits are comprehensively highlighted. Further, emphasis has been given to relevant future challenges.

Full Text Preview

Spectrum Sensing Methods

There are several ways of sensing spectrum. Chiefly, it is categorized into two-namely co-operative and non-co-operative. However, there arises another classification known as interference based sensing. It is depicted in Figure 1. Again, the co-operative sensing is split into three ways, viz., matched filtering, energy detection and cyclostationary detection. In the following section, the sensing techniques are elaborated.

Figure 1. General Classification of Spectrum Sensing Techniques



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Frontiers in Basic Physics and Applications

Frontiers in Basic Physics and Applications

Kamal Jyoti Nath
Debika Kangsha Banik
Nayan Mani Nath
Sebika Kangsha Banik

This Edited Book is a collection of research papers/articles on the theme of **"Frontiers in Basic Physics and Applications"**. The book is intended for students, research scholars, academicians and planners who are interested and engaged in the field of Physics and its various applications.

Editors: **Kamal Jyoti Nath**
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Scotogenic Model and its Implication in Neutrino Physics and Related Cosmology: A Brief Overview

Lavina Sarma *, Bichitra Bijay Boruah and Mrinal Kumar Das
Tezpur University, Tezpur-784028, Assam, India
*Email: sarmalavina@gmail.com

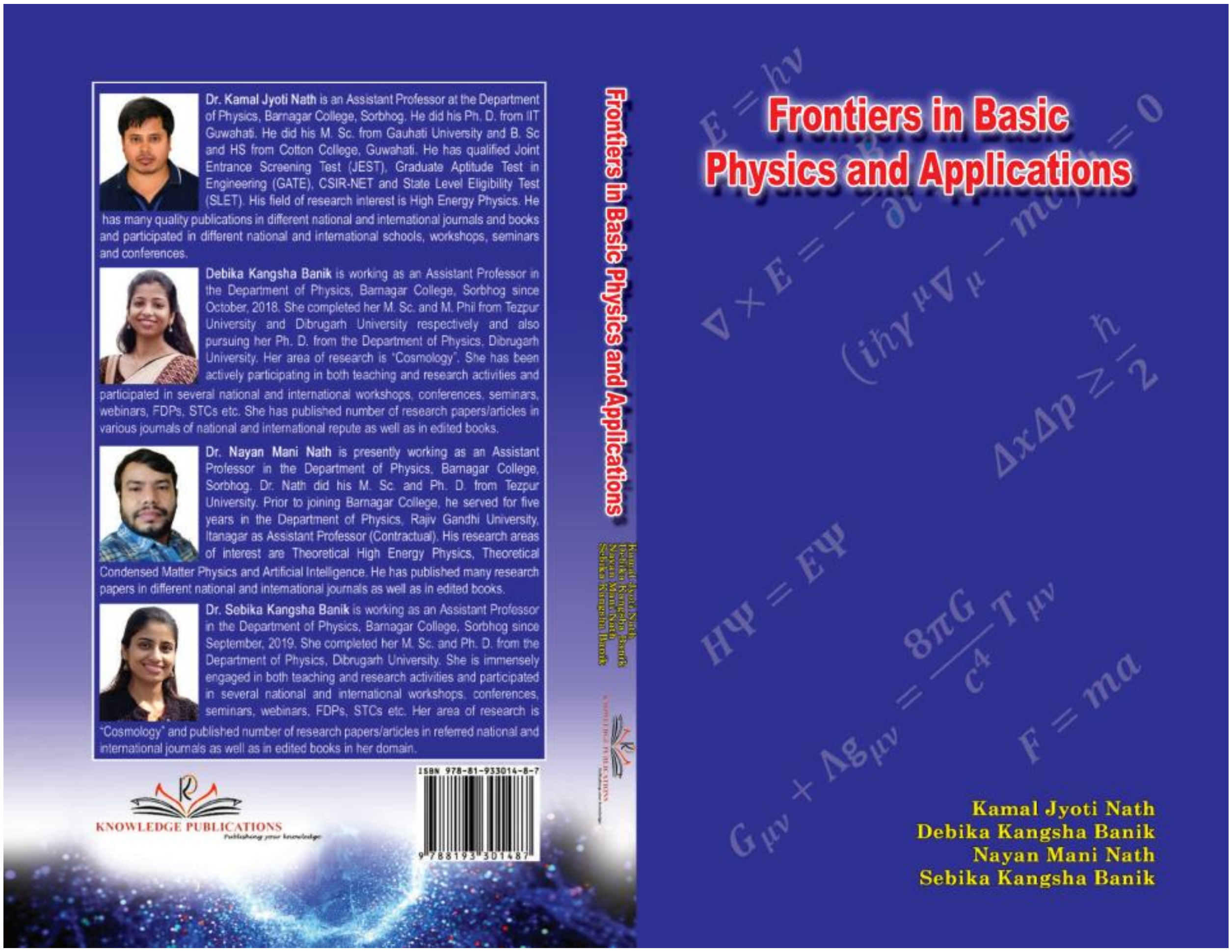
Abstract

In this chapter we have discussed about the radiative generation of neutrino mass through scotogenic model. The scotogenic model proposed by Ernest Ma represents a minimal extension of Standard model(SM), in which small neutrino mass can be generated via radiative correction in the dark matter sector. This model is an attractive framework within which we can study a lot of unexplained phenomena related to neutrino mass as well as dark matter mass along with baryon asymmetry of universe (BAU) in Standard model of particle physics. One important insight we can draw from this model is that it provides a common framework where we can relate neutrino mass and dark matter. In this article we discussed different implications of scotogenic model.

Keywords: Scotogenic model, dark matter, baryon asymmetry, inert doublet.

1. Introduction

It is well known fact that, in the field of high energy physics (HEP), the standard model (SM) of particle physics has been a tremendous success and popular one. It is a compact theory for fundamental particles and their interaction. Discovery of Higgs boson in the year 2012 at the large hadron Collider (LHC) has added credence to the SM along with its ability of classifying the other known elementary particles of all the ideas upon which SM is built, the Gauge principle is the most important insight gained in Quantum Field Theory (QFT). The gauge group therefore representing the SM is $SU(3)_C$ (x) $SU(2)_L$ U(1) Again contradicting to the fact that the SM is theoretically self consistent. It has to face many anamolies as it fails in exploring the


Frontiers in Basic Physics and Applications
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Sterile Neutrino: A Fourth Flavor of Neutrino

Nayana Gautam* and Mrinal Kumar Das
Department of Physics, Tezpur University, Napaam,
Tezpur 784028, India
*Email: nayanagtm72@gmail.com

Abstract
We present a brief review of sterile neutrino with mass in eV and keV ranges. We first introduce the idea behind the existence of the fourth flavor of neutrinos. We study the phenomenological consequences of eV scale sterile neutrino in a model known as inverse seesaw (2,3). After reviewing the eV scale, we focus on the role of keV scale sterile neutrino in cosmology as well as particle physics. We discuss the keV scale sterile neutrino dark matter considering the constraints from cosmology and astrophysics. In support of the sterile neutrino dark matter concept, we present some crucial properties like relic abundance, decay rate, and active-sterile mixing in this study.
Keywords: Sterile neutrino, inverse seesaw, relic abundance, decay rate, active-sterile mixing.

1. Introduction

The Standard Model of particle physics has been highly successful, both theoretically and in confronting a wide range of experimental data. Regardless of its incredible success, it fails to address the neutrino oscillation phenomenon which is the origin of the idea behind the massive nature of neutrinos [1]. Moreover, the standard model has no explanation for the CP violation in the lepton sector, baryon asymmetry of the universe, and dark matter. These shortcomings provide reasons to expect physics Beyond Standard Model (BSM). There are several models proposed as an extension of the standard model which can explain the unsolved issues of the standard model. Most of the models have been devoted to explain the three neutrinos flavor oscillation established in many solar, reactor, and accelerator experiments. Later LSND [2] and MiniBooNE [3] experiments https://link.springer.com/chapter/10.1007%2F978-981-33-4408-2_140

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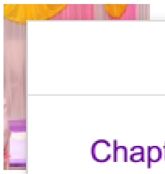

Dhruba Jyoti gogoi

Chapter-5 Evaluation of Microwave Absorber and Current Scenario on Water/Liquid-Based Microwave Absorber: A Review and Prospective

Authors	Dhruba Jyoti Gogoi, Nidhi Saxena Bhattacharyya
Description	This chapter specifies a summarizing discussion on evaluation of resonant type microwave absorber and recent research on liquid/water based electromagnetic absorbers. The fundamentals of electromagnetic absorber (ie the loss mechanism) and the basic principles for designing a perfect absorber are deliberated. An attempt has been made to justify the need of lossy liquid material to develop flexible, robust and thin microwave absorber with wide band absorption characteristics. This chapter give a brief scenario on the challenges encountered while designing a broadband microwave absorber with a small design thickness. Discussion of several techniques to achieve broadband absorption with metamaterial absorber are also carried out.
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Chapter-5 Evaluation of Microwave Absorber and Current Scenario on Water/Liquid-Based Microwave Absorber: A Review and Prospective
DJ Gogoi, NS Bhattacharyya

POLARIZATION INSENSITIVE, NON-METALLIC AND FLEXIBLE METAMATERIAL ABSORBER FOR X-BAND APPLICATIONS: DESIGN
D Borah, DJ Gogoi, NS Bhattacharyya

THIN FLEXIBLE MICROWAVE ABSORBER USING WASTE OF LI-ION BATTERY-RUBBER COMPOSITE FOR X-BAND APPLICATIONS
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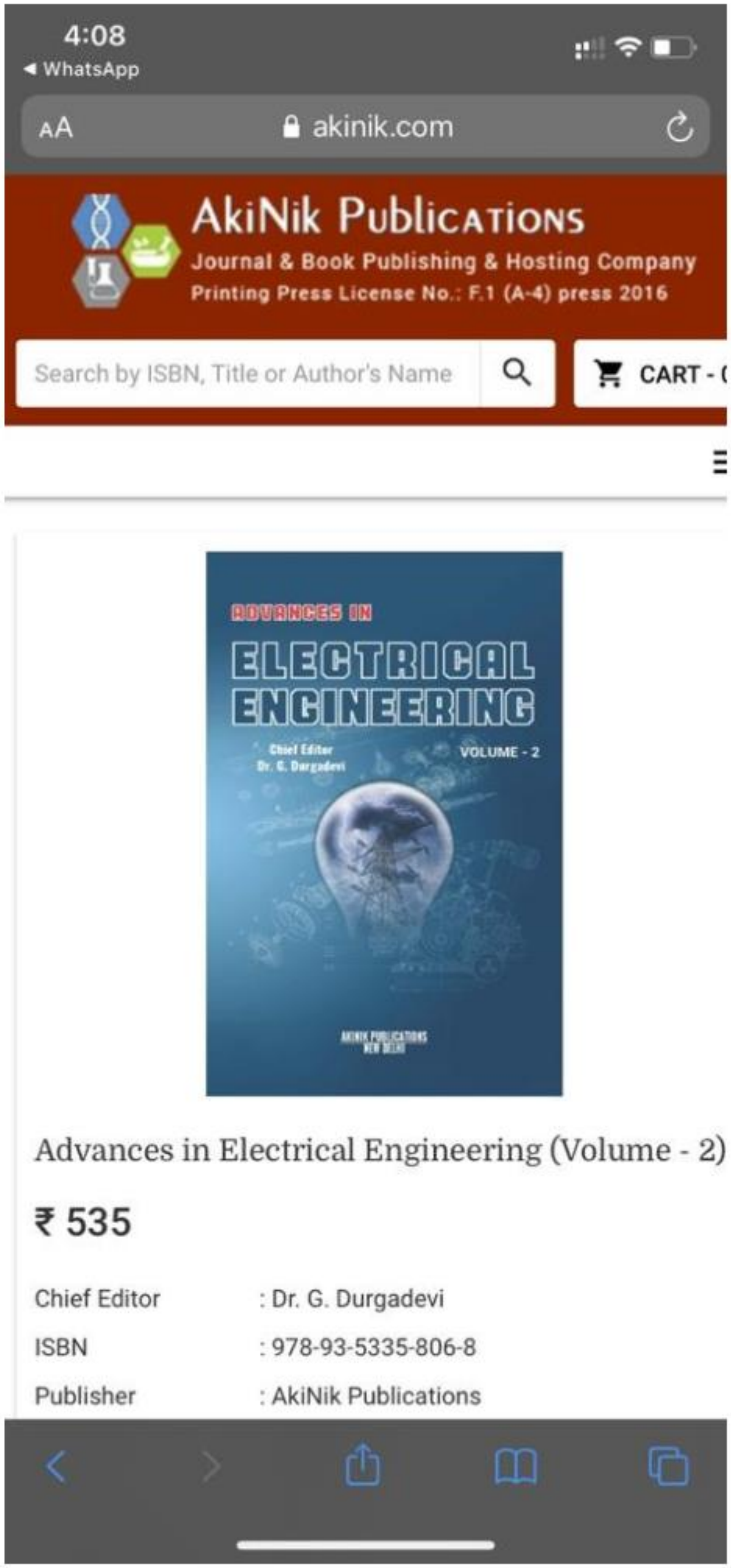
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Quantum Streaming Instabilities in Multi-component Plasma with Dust Particles

U. Deka, K. Choudhury and P.K. Karmakar

Abstract Streaming instabilities in quantum dusty plasmas composed of multi-ionic species are investigated by applying quantum hydrodynamic model. The growth characteristics in two separate cases of ion streaming and dust streaming are discussed. Implications and applications are highlighted.

Keywords Streaming instability · Quantum hydrodynamics · Multi-ion dusty plasma · Quantum plasma

1 Introduction

Quantum plasma has aroused a lot of interest among the scientists and engineers from various fields of science and engineering from the beginning of this century [1–3]. The driving force for the growth of research in this area is because of the advancement in the technology for building micro- and nano-electronic devices and its role in other disciplines of physics, e.g., dense astrophysical systems and laser-produced plasmas [2–4]. The electron gas in an ordinary metal is actually quantum plasma. The impetus in the degree of miniaturization and robustness of today's electronic components vastly depends upon the theoretical development in the field of quantum plasma. The rationale of application of the principle of quantum mechanics is validated by the fact that the de Broglie wavelength of the charge carriers is on an average equivalent to the size of the system [5–9], which is confirmed by numerical methods [10] too. Hence, application of quantum mechanics (e.g., tunneling) is justified and is going to be fundamental in the manufacturing of the futuristic electronic components in the coming years [11, 12].

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Dr. Lakshmi K. Singh
Advances in Nuclear Physics and Condensed Matter

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Preface

The terms Nuclear physics and Condensed matter are very fascinating and fast growing research fields. It has attracted scientists' worldwide working in multidisciplinary fields including chemistry, physics, electronics, biotechnology and bio engineering. Research in these fields starting from nuclear medicine, energy harvesting and green energy has enormous impact on the modern society.

The book "***Advances in Nuclear Physics and Condensed Matter***" comprises of the two main domains of Physics, Nuclear and Condensed Matter.

Nuclear physics is the study of protons and neutrons and their interaction that holds them some nanometers apart. Nuclear reactions include radioactive decay, fission, fusion, merging of nuclei etc. The branches under this subject include experimental nuclear physics, theoretical nuclear physics, nuclear astrophysics, superheavy element etc. Latest research in the field of nuclear physics is on nuclear spin dependent parity violation, cold fusion, optically polarized vapor, supernova, evolution of fusion, experimental and theoretical beta decay rates, laser plasma ion accelerator, nuclear shell evolution etc. which were reported recently in nature publications.

Condensed matter physics also termed as Solid state physics is the study of materials in solid state. It studies both crystalline and amorphous materials. Latest research in condensed matter is in block copolymer epitaxy, organic semiconductor films, zinc oxide nanowires, superconductivity, itinerant magnetism, hyperbolic lattice etc.

There are two sections in this book: Section I having 06 chapters on nuclear physics which reports Radiotherapy, Double beta decay, fusion sub-barrier cross-section, QCD potential model, S-shells, hypernuclei and variationally improved perturbation theory. Section II having 24 chapters on condensed matter which reports on investigation starting from natural rubber, modified chitosan to dendrimers.

The contributors of this book are from international scientific research community and the book is intended for researchers, scientists, engineers, graduate and undergraduate students who are interested in emerging fields of nuclear physics and condensed matter.

Dr. Lakshmi K. Singh

12

Gyrokinetic Influence on Star-forming Bimodal Cloud Stability

Archana Haloi
Pralay Kumar Karmakar

Abstract

The conjugational bimodal stability of non-thermal nonextensive complex gyrogravitating astrofluid is theoretically investigated. It consists of inertialess electrons and ions governed by the non-extensive thermo-statistical distribution laws. The constituent collisional identical partially ionized charge-fluctuating massive dust grains are treated in the fluidic fabric. The Coriolis rotations on the inertial component fluids are integrated. We take the ratio, dust charge/mass $-\sqrt{G}$, G: universal gravitational constant, for bounded structures to form. A local perturbative analysis marks a linear generalized quintic dispersion relation with multi-parametric holomorphic coefficients. We numerically analyze the key stabilizing factors of the model against the long-range mutualistic gravito-electrostatic interplay. It is seen that both the dust mass and the Coriolis rotation act as a stabilizer to the cloud against collapse featuring a special effect of the gyrokinetics, and so forth. A synoptic highlight on the main implications and non-trivial applications of our results in various astrocosmic environs of practical significance is summarily emphasized.

Keywords: *Astroclouds, Coriolis force, Gravito-electrostatic instability*

Introduction

The large-scale astrophysical clouds are indeed non-extensive non-thermal in nature due to the presence of diversified non-zero equilibrium gradient forces

stemming from nonuniformities and inhomogeneities [1-2]. The clouds are gravito-gyratory [2] in realistic dynamics because of the Coriolis rotational effects [3-4], which in fact, act on the bulk constitutive massive dust grains arising from the explosive dust-gas kinetic interactions.

It is notable that the astrophysical objects are the fundamental outcomes of the gravitational instability triggered by the dynamics of massive dust grains [5-6]. Examples in this context are stars, circumstellar rings, planets, planetary rings, Eagle Nebula, etc. Such astrophysical constituent grains compositionally consists of Silicates and composite derivatives, Graphites, Amorphous Carbons and Carbonaceous compounds, Polycyclic Aromatic Hydrocarbon (PAH) molecules, Silicon Carbides, Magnesium Sulfides, and so on [5]. The presence of such grains plays vital roles in collective wave excitations, oscillations and instabilities in diversified astro-environs. As in the above, stars and other bounded structures are formed in astrophysical partially ionized dense dusty fluid media [7]. It is seen that the dust mass acts as a dispersive stabilizer to such clouds [7]. Several researchers have studied the effects of polarization and nonthermal parameters on the dynamic bimodal cloud stability with both static [2] and non-static [8] dust-charge models. The bimodal instability dynamics in such media in the presence of dust-charge fluctuations, inter-species collisional effects and Coriolis rotational effects has still been lying clearly unaddressed and unexplored.

The present study, purely motivated from the above astrophysical factual survey, proposes a theoretic instability model analysis of conjugational gravito-electrostatic source in complex non-extensive non-thermal gyro-gravitating clouds. The stabilizing agencies are explored, illustrated and discussed alongside futuristic applicability in real astro-environs.

Model and Formalism

We consider an unbounded infinitely extended non-thermal gravitating complex astrofluid system. It consists of lighter non-thermal electrons and ions, governed by the q-nonextensive thermo-statistical distribution laws [1-2]. The constitutional massive adiabatic dust grain (adiabatic index $\gamma_{de} \approx \gamma_{dr} = \gamma = 3$, where $\gamma = (2+D)D^{-1}$ with D: Number of degrees of freedom [9]) micro-spheres with partial ionization are treated in the fluid limit approximation [6]. A sheet-like geometry of the gyrogravitating astrofluid [3-4] is adopted for holomorphic reduction of the analysis. It is described by the basic governing equations in a standard normalized form with all the usual notations [1-2] in a planar coordinate space (X, T) respectively given as

$$N_e = [1+(1-q_e)\Phi] \quad (1)$$

13

Evolution of Conjugational Hybrid Mode in Partially Ionized Astroplasmas

Pranamika Dutta
Pralay Kumar Karmakar

Abstract

The excitation of hybrid ion-gas acoustic instability modes (inter-mixed) in self-gravitating partially ionized magnetized collisional astrofluids is analyzed. A new sextic linear dispersion relation and a multiparametrically modified instability criterion are obtained. A rapid growth (decay) of the instability, destabilized (stabilized) by the interspecies collisions, is speculated in the unmagnetized (magnetized) configurations. Applications of our results in varied naturalistic wave propagation dynamics featuring real astrospace environs are lastly briefed.

Keywords: *self-gravity, kinematic viscosity, astroplasma*

Introduction

The physics of partially ionized space plasmas has received remarkably growing interest in recent years. This is due to the fact that such plasmas possess a plethora of diversified waves and associated instabilities, formation of large-scale galactic structures, stellar evolution, and so on [1, 2]. The plasma-neutral collisions here are very much significant rather than the plasma-plasma interactions. This type of plasmas is naturalistically found in a diversified area of terrestrial atmosphere, solar photosphere, interstellar clouds, and so forth [3-6].

The plasma-neutral interactions significantly modify the stability dynamics of magnetized astroplasmas via exchange processes involving energy and

momentum transfer among the plasma constituent particles with partial ionization. The collisional coupling of the particles with the lines of the magnetic field produces a relative drift among the constituent species [3, 4]. Many authors have studied instability phenomena in such plasmas in different real astrospace environs. Researchers have investigated the key wave propagation dynamics in nonuniform partially ionized gravitomagnetized molecular clouds in different conditions. Their main conclusion is that the density inhomogeneity, magnetic field, drag force and ionization-recombination drastically affect the normal mode behaviors of the clouds [1, 5].

The idea of coupled gas-acoustic and ion-acoustic waves has for the first time been developed in the case of solar atmospheric plasmas [3]. It has been found therein that an angle-dependent instability threshold due to the presence of ion-neutral collisions results in neutral sound modes. It may be noted that the modal dynamics of the coupled waves in the presence of self-gravity and polytropicity has been lying as an open problem yet to be addressed. We propose a continued study on the stability dynamics of the normal electromagnetic modes in self-gravitating collisional magnetoactive astroplasmas. A curious hybrid mode (pulsational-type) due to interplay of the usual gravitational mode, ion-acoustic mode, and neutral sound mode is revealed via a sextic dispersion relation of a unique type.

Model and Formalism

We consider a self-gravitating partially ionized plasma fluid on the Jeans spatiotemporal scales. It consists of tiny electrons and heavy ions, alongside neutral gas atoms, thereby initially forming a quasi-neutral hydrostatic homogenous equilibrium configuration. The model plasma is embedded in magnetic field $\vec{B} = B_0\hat{z}$ in configuration space (x, y, z). In such a situation, the plasma electrons get magnetized (total electron collision frequency << electron gyro-frequency); whereas, the ions do not (total ion collision frequency >> ion gyro-frequency). Such circumstances are practically realizable in real astronomical environments, such as the terrestrial atmosphere, solar photosphere, interstellar clouds, and so on [3-6].

The basic governing equations depicting such a macroscopic plasma fluid medium comprise of the equation of continuity, momentum equation, and closing electrostatic and self-gravitational Poisson equation in a closed form [3-5]. These equations for the constituent fluids of the macroscopic system in customary notations can respectively be given as

$$\frac{\partial n_j}{\partial t} + \vec{\nabla}.(n_j\vec{v}_j) = 0 \ , \qquad (1)$$

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Nonlinear Nucleus-acoustic Waves and Possible Equivalent Conservation Laws

Papari Das
Pralay Kumar Karmakar

Abstract

The evolutionary dynamics of nonlinear nucleus-acoustic waves (NAWs) excitable in strongly coupled self-gravitating quantum degenerate plasmas (QDPs) is reported. The model compositions are strongly coupled non-degenerate heavy nuclei, weakly coupled degenerate light nuclei; and non-relativistic and ultra-relativistic degenerate lighter electrons. A weakly nonlinear perturbation analysis yields a conjugate pair of extended Korteweg-de Vries (e-KdV) equations dictating the NAWs. Our numerical tapestry portrays their microphysical collective excitations and associated equivalent conservation laws of varied successive ranks.

Keywords: *Quantum degenerate plasmas, Nucleus-acoustic waves, Soliton-antisoliton pair*

Introduction

The existence of quantum plasmas in diversified naturalistic environments is widely well known. Such plasmas are exceptionally dense ($\sim 10^{29}$-10^{34} m^{-3}) and cold (T << Fermi temperature). In such highly compact environs, electron degeneracy arises due to the Heisenberg uncertainty principle and the Pauli principle for overlapping electronic wave functions [1, 2]. On laboratory scales, such plasmas exist in many metallic and semiconductor nanostructures, such as metallic nanoparticles, metal clusters, thin metal films, spintronics, nanotubes,

quantum wells and quantum dots, nanoplasmonic devices, quantum *X*-ray free-electron lasers, etc. Besides, quantum plasmas naturalistically exist *in* compact stellar objects of the dwarf- and pulsar-families [1-3]. The white dwarfs are the primary sources of QDPs, having inner cores relatively denser than elsewhere, fulfilling the extreme existential conditions of very high density and ultra-low temperature simultaneously. The basic constituents of the dwarfs are the degenerate electronic species, lighter nuclear species (e.g., $^{1}H_{1}$, or $^{1}H_{2}$) and heavy nuclear species (e.g., $^{6}C_{12}$, or $^{8}O_{16}$), as depicted in the literature [2-3].

The most naturalistic eigenmode in the dwarfs is known to be nucleus-acoustic waves well known to be propagatory longitudinal oscillations driven by thermal electrons and inertial nuclear species. In this direction, their excitation in diversified dwarf-centric QDPs has recently gathered enormous interest [4]. A standard reductive perturbation technique has been extensively applied to identify the basic features of small but finite amplitude nonlinear nucleus-acoustic shock structures in the fabric of the Korteweg-de Vries (KdV) equation [5]. We, herein, report a continuation of the above, but now in the concurrent presence of realistic factors, such as viscoelasticity, quantum Bohm and statistical pressure effects afresh.

Physical Model and Governing Equations

A generalized hydrodynamic model of QDPs in a planar geometry on the astrophysical scales of space and time is considered. It is constituted of strongly correlated non-degenerate heavy nuclei, weakly correlated degenerate non-relativistic light nuclei and non-relativistically or ultra-relativistically degenerate electrons. The basic set of governing equations consists of the continuity equation, momentum equation, polytropic equation of state alongside the closing electro-gravitational Poisson equations [4]. A standard astronomical normalization scheme [4], where the normalizing multiparametric variables are typical for the dwarfs, is adopted. The normalized set of equations in a standardized coordination space (ξ, τ) are put as

$$\frac{\partial N_e}{\partial \tau} + \frac{\partial}{\partial \xi}(N_e M_e) = 0, \tag{1}$$

$$N_e \frac{\partial \Phi}{\partial \xi} - K_e' N_e^{\gamma_e - 1} \frac{\partial N_e}{\partial \xi} - \left(\frac{v_{Fe}}{c}\right)^2 N_e^2 \frac{\partial N_e}{\partial \xi} - \frac{1}{4} H' \left(\frac{v_{Fe}^2}{C_1^2 c^2}\right) \frac{\partial^3 N_e}{\partial \xi^3} = 0, \tag{2}$$

$$\frac{\partial N_l}{\partial \tau} + \frac{\partial}{\partial \xi}(N_l M_l) = 0, \tag{3}$$

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To Dr. P.K. Karmakar
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Preface

The Plasma Research Scholars Colloquium was mooted by Plasma Science Society of India in 2012 to have an annual event for providing a platform to the research scholars across the country to disseminate high quality research work and to build a channel for cross institutional interaction. The 6th PSSI Plasma Scholars Colloquium (PSC 2018) is jointly organized by the department of Physics, SMIT and PSSI.

We are pleased to receive a very strong response from the research scholars working in diverse field of plasma science and technology. The sessions conducted for the three days were addressed by few senior Keynote Speakers. This time the Colloquium was limited to only fifty participants only. However, looking at the overwhelming response from more than 80 scholars we have tried our best to accommodate all the scholars. We are also fortunate to receive a quite a large number of participants from our neighbouring country Nepal.

This proceedings presents the collection of the articles presented as review papers, keynote lectures, oral and posters presentations in the form of full length paper and abstracts varying from researches in basic plasma, industrial plasma, computational plasma, laser plasma, plasma diagnostics, fusion, space & astrophysical plasma during the colloquium. It is being observed that researches in basic plasma encompass most of the research in plasma physics. The number of full manuscript receive is 24 and rest are in the form of abstract submission.

Overall, articles from this intellectual convergence reflecting author's own work as claimed by them and peered reviewed by reviewers. The editor and publisher do not claim responsibility of misrepresentation of any facts or data. However, we apologize for any typographical error in printing that might have occurred inspite of utmost care taken in printing the matter as it is. We are fortunate to organize such a confluence that brought a spectrum of current aging research and highlight its prospects and future directions. We hope that they will attract the attention of a broad scientific readership toward building the framework for sustainable development.

This proceeding will be incomplete without acknowledging the support and guidance received from the Honorable Vice Chancellor, SMU, Director, SMIT, and Associate Directors of the institute and other Heads of Departments in organizing the event. The help and timely suggestions received from President, PSSI and other members are unfathomable. It is needless to mention the effort faculty members and staff of the department has put in for the smooth conduction of the colloquium. As the editor of this proceedings and convener of this colloquium, I highly appreciate the reviewers who have helped in improving the technical quality of this proceeding. This is our humble gratitude toward all people who have supported directly or indirectly in the successful conduction of this colloquium.

Utpal Deka
Convener

Part III

Abstracts

Nonlinear Excitation of Gravitational Instability in Complex Viscoelastic Astrofluids

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A semi-analytical investigation of the nonlinear gravitational instability excited in a self-gravitating unbounded complex viscoelastic polytropic astrofluid is proposed. It concurrently takes into account the key effects of fluid buoyancy, thermal fluctuations, volumetric expansions, and so forth. Applied nonlinear normal mode (local) analysis over the fluid system yields a Korteweg-de Vries (KdV) equation on the lowest-order perturbed density. It numerically demonstrates the excitation of a spectral class of compressive solitary chain patterns as the evolutionary eigenmodes having atypical dynamics. Their diversified features are explained elaborately alongside phase-plane, scale-length, and conservation analyses. It is seen that the fluid temperature plays as a destabilizing agency to the fluid. In contrast, the polytropic index acts as a stabilizing agent against the fluid collapse. Finally, applicability of our explored results is indicated in the context of diverse compact astrophysical objects and their ambient correlated fluidic atmospheres.

1. Introduction

The dynamical mechanism responsible for the formation of astrophysical bounded structures in diversified astro-cosmic cloud environments is understood via the so-called gravitational (Jeans) instability [1]. Such instabilities occur when the gravitational pressure force (organizing, inward) overpowers the internal pressure force (randomizing, outward) leading to dynamic fragmentation or collapse of the self-gravitating structure-forming clouds [2,3].

Several investigations have been done on the gravitational instabilities in different astrofluidic configurations in the past [4-10]. It may be worth mentioning that most of the investigations are focused on exploring various stabilizing and destabilizing factors to the instability leading to the initiation processes of bounded astro-proto-structures amid some assumed simplifications. In this direction, Chandrasekhar has studied the role of uniform rotation and uniform magnetic field in arresting the gravitational collapse in an infinite homogenous fluidic medium [4]. He showed that the nonlocal self-gravitational collapse dynamics is independent of the action by both the rotation-field factors, either separately or conjointly. Besides, Cadez has boldly investigated the condition for applicability of the Jeans instability excitation on stationary self-gravitating clouds. He found that, for the instability to set in, the inhomogeneity scale-length of the perturbation must be larger the associated Jeans scale lengths [5].

In the cosmological hydrodynamic perspectives, Tsiklauri has investigated such instabilities in interstellar neutral gaseous clouds in the presence of weakly interacting massive particles (WIMPs), thereby concluding that the presence of WIMPs always reduces both the Jeans length and the Jeans mass of the composite cloud [6]. Likewise, various instability features on the gravitationally coupled complex bi-fluidic admixture of neutral fluid and dark matter fluid in the viscoelastic fluid framework

have also been reported in both the linear [7,8] and nonlinear [9] regimes. In addition, several authors have found that the linear instability in a self-gravitating viscoelastic medium occurs at a lower wavenumber against the purely neutral gas scenarios. The thermo-elastic pressure effects have been reported to introduce stabilizing influences to the instability [10], and so forth. It can be eventually noted that the nonlinear gravitational instability dynamics excitable in a self-gravitating complex viscoelastic medium in the presence of all the possible hydrodynamic complications is still lying as an open problem to be addressed. Such investigations are indeed needed to understand the viscoelastic fluid dynamics realizable in diversified compact astro-objects, formation and their surrounding atmospheres.

We, herein, thus motivated by the above, report a generalized hydrodynamic model description to investigate the nonlinear evolutionary dynamics of the gravitational instability in a self-gravitating complex viscoelastic fluid. It is in the presence of various fluidic effects, such as polytropicity, buoyancy, thermal fluctuations, and volumetric expansion. A nonlinear normal mode (local) analysis yields a normal Korteweg-de Vries (KdV) equation with a unique set of unusual multi-parametric coefficients. We construct a numerical illustrative standpoint to demonstrate how the obtained KdV dynamics excites a spectral class of compressive solitary chain patterns as the supported evolutionary eigenmodes. The new KdV properties and conserved quantities (rank-1) are explained elaborately alongside applicability in the domain of real compact astro-structures.

2. Physical model

A generalized hydrodynamic model for a self-gravitating structure-forming cloud fluid is considered. It includes all the realistic fluid effects concurrently, such as polytropicity, fluid buoyancy, thermal fluctuations, and volumetric expansions [11]. The viscoelasticity arises here due to the mutualistic collective correlative interactions among the microscopic fluid constituent particles [12]. As a result, it exhibits the properties of both viscosity (damping or dissipation effects) and elasticity (memory or restoration effects). The viscoelasticity is responsible for the development of a plethora of collective excited waves, fluctuations and oscillations. As a consequence, astrophysical and cosmic fluids are to be categorically treated in a more profound justified fabric of viscoelasticity [13]. Such physical circumstances are realistically encountered in a large number of astro-cosmo-plasmic environs, such as different super-dense compact astro-objects and their surrounding gaseous atmospheres copiously well-known to be viscoelastic in nature [10,14].

3. Mathematical Formalism

The dynamics of the considered fluid system is governed by the continuity equation (net flux-density conservation), momentum equation (net force-density conservation), polytropic equation of state (perfect heating-cooling balance) and self-gravitational Poisson equation (closure tool) in normalized form [7-10,15] as follows

$$\frac{\partial \rho'}{\partial \tau}+\frac{\partial}{\partial \xi}\left(\rho' M\right)=0, \qquad (1)$$

Excitation Dynamics of Gravitational Instability in Complex Viscoelastic Polytropic Fluids

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We herein report on a generalized hydrodynamic fluid model constructed to investigate the evolutionary dynamics of gravitational instability in a complex polytropic viscoelastic fluid. It concurrently includes the effects of buoyancy, thermal fluctuations, volumetric expansions, and so forth. Application of normal mode analysis yields a quadratic linear dispersion relation. A numerical illustrative analysis shows that the equilibrium polytropic index, effective generalized viscosity and viscoelastic relaxation time act as stabilizing factors against the self-gravitational collapse dynamics. In contrast, the equilibrium temperature behaves as a destabilizing agency. Besides, it is only the effective generalized viscosity that boosts up the instability growth in a wave-packet.

1. Introduction

The dynamics of astro-structure formation processes is well-known as initiated by the so-called gravitational (Jeans) instability triggered in large-scale self-gravitating fluids [1]. Such instabilities have widely been investigated in different astro-fluidic configurations to explore the diversified underlying stabilizing and destabilizing agencies influencing the initiation processes of astro-proto-structures in the past [2-7]. The effect of uniform rotation and uniform magnetic field on the instability in an infinite homogeneous medium has been studied along with the main conclusion that this instability is independent of these two factors [2]. The non-local stability of interstellar gas cloud gravitationally coupled with weakly interacting massive particles (WIMPs) has also been investigated [3], but with the WIMP-reduced Jeans length, and, hence, the Jeans mass. Next, the instability of a gravitationally coupled viscoelastic composite system of neutral fluid and dark matter fluid has been addressed both in the linear [4,5] as well as non-linear [6] regimes. A theoretical framework of self-gravitational generalized fluid model has also been reported later [7]. It has been shown semi-analytically that the instability is significantly affected by the conjoint action of both viscosity and relaxation effects. The threshold condition for the instability onset occurs at lower wavenumbers in a viscoelastic (non-ideal) fluid medium against that in the conventional pure inviscid (ideal) nebular fluid [7].

It is now clearly evident from the above that the gravitational instability dynamics in such correlated fluid media in the presence of all the possible realistic hydrodynamic complication agencies has still been remaining as an open problem to be explored for years. It may be clearly seen that a comprehensive and rigorous study of the non-local instability needs a proper model inclusion of polytropicity, buoyancy, thermal fluctuations, volumetric expansion, etc.

A new generalized viscoelastic fluid model to investigate the gravitational instability in the presence of all the above key realistic unavoidable factors is herein proposed. The main motivation of

this investigation is driven from the unavoidable fact that the gravitational instability dynamics in the presence of all the realistic fluid properties taken concurrently into account, despite modelling complication, has never been addressed in the past. A normal mode analysis relative to the hydrostatic homogeneous local equilibrium reduces the perturbed fluid model into a generalized quadratic dispersion relation affected by a unique set of multi-parametric coefficients. A numerical illustrative analysis is put to see the various underlying stabilizing and destabilizing factors towards the instability. It summarily ends up with a reliable validation and applicability in the context of super-dense compact astro-objects and their ambient atmospheres [8,9].

2. Physical Model

As a first step, we consider a self-gravitating polytropic viscoelastic fluid model in the fabric of generalized hydrodynamic model configuration on the astrophysical scales of space and time. It concurrently includes the effects of fluid buoyancy, thermal fluctuations, volumetric expansion, and so forth. The lowest-order viscoelasticity here comes from the collective correlative transport processes among the fluid constituent particles [10,11]. As a result, the fluid is characterized with two kinds of uniform viscosity. The first one is the shear viscosity (offering resistance to flow), and the second, the bulk viscosity (offering resistance to volumetric expansion). The main motivation behind the viscoelasticity is that the cosmic fluids are viscoelastic (non-Newtonian) in nature [8]. Such fluids are rich in collective wave excitation processes due to the combined action of both viscosity (energy dissipation, sink) and the elasticity (energy restoration, source). The interplay between the two negative-positive sources results in a new variety of waves, oscillations and fluctuations. The role of plasma effects is ignored herein on the grounds that astro-cosmic fluids on a large scale are neutral in nature because of the negligible value of the ratio of the plasma Debye length (screening scale) and the gravitational instability scale length (Jeans length) [12]. Such physical situations indeed exist in super-dense compact astrophysical objects and their surrounding atmospheres well-known to behave as viscoelastic fluids [8,9].

3. Analytic Formalism

The basic set of the normalized generalized hydrodynamic equations governing the correlative fluid system comprises of the equation of continuity for the fluid flux-density conservation, momentum equation for the net force-density conservation, polytropic equation of state for the bulk macroscopic specific entropy conservation due to perfect heating-cooling balance, closing long-range self-gravitational Poison equation on the Jeansian scales of space and time, and so forth [5-7,13]. These equations in the classical non-relativistic regime in a closure form are respectively given in usual notations as follows

$$\frac{\partial \rho'}{\partial \tau}+\frac{\partial}{\partial \xi}\left(\rho' M\right)=0, \qquad (1)$$

[illegible]