

CHAPTER 45

PHYSICS AND ASTROPHYSICS

Doctoral Theses

491. AGRAWAL (Manish)
Phase Synchronization in Forced Nonlinear Oscillators.
Supervisor : Dr. Awadhesh Prasad
Th 18242

Abstract

Studied the behaviour of interacting and forced nonlinear dynamical systems. Discusses the dynamics of coupled nonlinear oscillators when one of them is subject to external quasiperiodic driving. To understand the manner in which the effect of external driving is transmitted via the coupling. Also studied the manner in which the effect of an external drive is transmitted through mutually coupled response systems by examining the phase synchrony between the drive and response sub-systems. Further it deals with the effect of external forcing on systems with invariant symmetry e.g. Lorenz attractor. The drive-response coupling scenario of interacting systems has been realized by diffusive scalar coupling.

Contents

1. Introduction. 2. Quasiperiodically forced coupled chaotic systems. 3. Relaying phase synchrony in chaotic oscillator chains. 4. Driving induced bistability in coupled chaotic attractors. 5. Summary and bibliography.

492. ANJU
Study on the Effect of Swift Heavy Ion Irradiation on Mechanism of Charge Transport in Conducting Polymers.
Supervisors : Dr. Amarjeet Kaur and Dr D K Avasthi
Th 18125

Abstract

Studies the charge transport mechanism in fully undoped polymers irradiated with SHI beam (100MeV Ag^{8+} , 100MeV Ni^{10+})

and 80MeV C⁶⁺). The fully undoped samples have been chosen to investigate the effect of irradiation on the conduction properties of pure polymer without any influence from the dopant. Further, the mechanism of ac conduction in these SHI irradiated polymers have been thoroughly investigated for the first time. It has been observed that there is huge increase in dielectric constant of PPY irradiated with 100MeV silver ions.

Contents

1. Introduction to conducting polymers and swift heavy ion beam irradiation. 2. Preparation of the specimen, characterization and experimental techniques. 3. Effect of swift heavy ion beam irradiation on optical, structural, morphological and chemical properties of polypyrrole and poly(3-hexylthiophene). 4. DC conduction in swift heavy ion beam irradiated polypyrrole and poly(3-hexylthiophene). 5. Low frequency ac conduction and dielectric relaxation in swift heavy ion beam irradiated polypyrrole and poly(3-hexylthiophene). 6. Summary and outlook.

493. BHATTACHARYA (Sudeshna)
Processing and Characterization of Conducting Composites for EMI Shielding.
 Supervisor : Prof. R P Tandon and Prof. Ratnamala Chatterjee
 Th 18127

Abstract

Conducting polymer and cement composites are prepared for electromagnetic (EM) shielding using novel technique. The conductivity, dielectric properties, D shore and EM shielding properties of the composites are investigated systematically. The change in dc conductivity as a function of filler concentration revealed that all composites exhibit percolation behavior with very well agreement to the power law model. The measurement of EMI shielding efficiency (SE) of polymer and cement composites are made in the frequency range of 8.0-12.0 GHz.

Contents

1. Introduction. 2. Electromagnetic interference shielding. 3. Composite fabrication and characterization. Electrical properties of conducting polymer composites. 5. Electrical properties of conductive cement composites. EMI shielding properties of conducting cement and polymer composites. 6. Conclusion.

494. DEB (Sukanta)
Study of Light Curves of Some Variable Stars.
 Supervisor : Prof. H P Singh and Prof. T R Seshadri
 Th 18117

Abstract

The photometric solution for the eclipsing binary EK Com is presented obtained from new high-precision time series CCD photometric observations with complete phase coverage in the V band. The observations indicate that the star may be of A-type with a flat secondary minimum. By using the WD code, it has been found that the system is a total-eclipsing binary star with an orbital inclination of $i[^\circ] = 89.800 \pm 0.075$ and high degree of over-contact configuration 33.0%. The difference in the mean temperatures between the two components was found to be 141 ± 10 K. The observed light curve is quite asymmetric, especially at quadrature levels, because of surface activity on either of the two components. The photometric mass ratio determined from the WD light curve modelling approach is reliable for a totally eclipsing over-contact binary. Keeping in view of this fact, the absolute physical parameters of the two components were determined based on the results of the light curve solution and by the MV96 method.

Contents

1. Introduction. 2. Light curve analysis of variable stars using fourier decomposition and principal component analysis. 3. Physical Parameters of the small magellanic cloud RR lyrae stars and the distance scale. 4. Physical parameters of eclipsing binary stars using the all sky automated survey-3 data. 5. CCD photometric study of late type contact binaries ek commae berenices and asas 134738+0410.1. 6. Photoelectric photometry of the δ scuti star HD 40372. Bibliography.

495. DEEPAK KUMAR
Sodium Ion Conducting Polymeric Gel Electrolytes for Rechargeable Batteries.
 Supervisor : Dr. S A Hashmi
 Th 18126

Abstract

The present thesis covers the works performed on the development of sodium ion conducting gel polymer electrolyte composites

dispersed with silica nanoparticles and the ionic liquid based gel polymer electrolytes for their applications in sodium-sulfur batteries. The sodium ion conducting gel polymer electrolyte composites based on sodium salt solution in organic solvents immobilized in host polymers like PMMA and PVdF-HFP, and dispersed with SiO₂ nano-particles have been prepared. The investigations involve various experimental techniques used for the morphological/structural, thermal, spectroscopic, electrical and electrochemical characterization of the gel polymer electrolytes and gel nonocomposites. the optimized electrolytes have been utilized for their applications in sodium-sulfur (Na/S) batteries.

Contents

1. Introduction. 2. Experimental Techniques. 3. Studies on poly (methyl methacrylate) based sodium ion conducting gel polymer electrolyte composites dispersed with silica nanoparticles. 4. Studies on poly (vinylidene fluoride-co-hexa fluoro propylene) based sodium ion conducting gel polymer electrolyte nanocomposites. 5. Studies on ionic liquid based sodium ion conducting gel polymer electrolytes. 6. Gel polymer electrolytes based sodiumsulfur batteries. 7. Summary and conclusions.

496. GUPTA (Manoj Kumar)
Growth of Doped & Undoped ZnO Nanostructure & their Morphological, Structural, Optical, Dielectric and Piezoelectric Characterization.
 Supervisor : Dr. Binay Kumar
 Th 18121

Abstract

Various methods have been developed to synthesize ZnO nanostructure in various morphologies like nanobelts, nanotubes, dendritic, nanosaws, nanorings, tetrapods-like, cage-like, tower-like structures and flower-like nanorods. In this work flower-like pure ZnO nanorods, potassium (K) doped ZnO NR with p-type conductivity, high quality and uniform lithium (Li)-doped ZnO NR, vanadium (V)-doped ZnO NR and chromium (Cr)-doped ZnO NR are prepared by low cost, low temperature wet chemical solution route.

Contents

1. Introduction. 2. Experimental techniques. 3. Growth and

characterization of flower-like pure ZnO nanostructure. 4. Growth and characterization of p-type K-doped ZnO nanorods (NR). 5. Growth & characterization of li-doped ZnO NR. 6. Growth & characterization of V-doped ZnO NR. 7. Growth & characterization of Cr-doped ZnO NR. 8. Conclusions and scope of future work.

497. KRISHAN KUMAR
Synthesis and Characterization of pure and (Sb, Nb & Ta)-Doped Lead-Free Piezoelectric $[\text{Bi}_{0.5}(\text{Na}_{1-x}\text{K}_x)_{0.5}\text{TiO}_3$ Ceramics
 Supervisor : Dr. Binay kumar
 Th 18128

Abstract

This work presents an investigation on structural, dielectric, electrical and ferroelectric properties of pure and (Sb, Nb & Ta)-doped $\text{Bi}_{0.5}(\text{Na}_{0.5}\text{K}_{0.5})_{0.5}\text{TiO}_3$ ceramics. The most widely used, but toxic, PZT ceramics for various high performance piezoelectric applications in sophisticated research, medical and defence devices, lead free environmental friendly alkali based system have been investigated.

Contents

1. Introduction. 2. Literature survey. 3. Synthesis of ceamics and experimental techniques. 4. Result and discussion on pure BNKT ceramic. 5. Result and discussion on Sb-doped BNKT ceramics. 6. Result and discussion on Nb-doped BNKT ceramics. 7. Result and discussion on Nb-doped BNKT ceramics. 8. Conclusions and scope for future work.

498. MALHOTRA (Yashi)
Plasma Processing of Nanomaterials Using Dense Plasma Focus Device.
 Supervisor : Prof. M P Srivastava
 Th 18240

Abstract

This thesis presents the plasma route for the fabrication of nanostructures using 3.3 KJ modified Dense Plasma Focus (DPF) device at Plasma Research Laboratory and their characterization. The work includes (a) Extremely non-equilibrium synthesis of luminescent zinc oxide nanoparticles through energetic ion condensation in a dense plasma focus device, (b) Fabrication, nucleation and characterization of carbon nanostructures

using dense argon plasma on Si <111> substrates and (c) Fabrication of silver nanoparticles using ions generated by hot, dense and strongly non-equilibrium argon plasma and their characterization.

Contents

1. Introduction. 2. Dense plasma focus device, its modifications for nanofabrication and characterization techniques. 3. Luminescent zinc oxide nanoparticles fabrication and characterizations. 4. Graphitic carbon nanostructures. 5. Fabrication and characterization of silver nanoparticles.

499. MATHARU (Zimple)
Preparation and characterization of Monolayers Immobilized with Proteins for Application to Biosensors.
 Supervisor : Prof. Vinay Gupta and Dr. B D Malhotra
 Th 18124

Abstract

Efforts have been made to utilize two most important monolayer based techniques [LB and SAM] for the fabrication of cholesterol and LDL biosensors. These biosensors have been developed by covalent immobilization of bio-recognition protein molecules such as enzymes [cholesterol oxidase (ChOx), cholesterol esterase (ChEt)] and antibodies (antiapolipoprotein B; AAB) etc. Extensive efforts on optimization of these monolayer based bioelectrodes have been systematically made. The biosensing studies include investigations on stability of immobilized biomolecules as a function of temperature and pH. The response of the biosensors has also been investigated in the presence of different interferents. The efforts have been made for online monitoring and quatitative measurements of aainity based detection of LDL using surface plasmon resonance (SPR) and quart crystal microbalance (QCM)

Contents

1. Introduction and literature survey. 2. Materials and experimental techniques. 3. Application of monolayers for detection of cholesterol. 4. Application of monolayers for low density lipoprotein detection. 5. Surface plasmon resonace based low density lipoprotein detection. 6. Summary and future prospects.

500. MENON (Rashmi)
Growth and Characterization of ZnO Films for Ultraviolet Photodetector Applications.
 Supervisor : Prof. K Sreenivas
 Th 18241

Abstract

The thesis is focussed on the preparation of ZnO films by physical and chemical methods. It was of interest to investigate the impact of residual stress in ZnO films, and identify the optimised growth conditions for producing films of high quality with minimal stress. The influence of stress on the structural, optical, vibrational and electrical properties has been analysed to gain a better understanding on the UV photoconduction mechanisms in ZnO films.

Contents

1. Ultra violet photodetector. 2. Statement of the problem and thesis objectives. 3. Experimental techniques. 4. Growth of ZnO films and residual stress analysis. 5. Role of defects on Ultra-Violet photo response. 6. Studies on furnace and laser annealing. 7. Ion implanted ZnO UV photo detector. 8. Chemical derived ZnO films and nano-structures.

501. PANWAR (Vivek)
A Study on the Characteristics of the Tropical Tropopause over Asian Monsoon Region: Influence of Convection and Wave Activity.
 Supervisor : Dr. S K Dhaka
 Th 18119

Abstract

Examines the process of tropospheric air enters the stratosphere, particularly in association with tropical meso-scale convective systems (TMCS) which are considered one of the causative mechanisms for the observation of extremely LTT over the tropics. The phenomena of convection and its association with extreme low LTT event is, therefore, examined over the Asian monsoon region using data from multiple platforms. Satellite observation show that the area of low OLR, which is a proxy for the enhanced convection, is embedded with high altitude clouds top temperatures (~ 193 K).

1. Introduction. 2. Experimental techniques and data base. 3. Observations of extreme low tropopause temperature over bay of Bengal during bobmex campaign. 4. Armex campaign and champ/cosmic satellite observations. 5. Characteristics of the large scale wave activity during observations. 6. Aura MLs observations of water vapor in troposphere and lower stratosphere. 7. Summary and Concluding remark.

502. PRASAD (Ravikant)
Study of Thickness Modified Magnetotransport in Doped Manganite Thin Films.

Supervisor : Dr. Amarjeet Kaur and Dr. H K Singh
 Th 18122

Abstract

The present work studies the impact of substrate induced strain and film thickness on magnetic and transport properties of doped manganite thin films. The thicknesses of these film are generally in the range of 5-120 nm. the compounds and composition are chosen judiciously to make the impact of strain and film thickness the dominant factor in determining the physical properties. The chosen manganites are $\text{La}_{0.88}\text{Sr}_{0.12}\text{MnO}_3$, $\text{Nd}_{0.51}\text{Sr}_{0.49}\text{MnO}_3$ and $\text{Nd}_{0.37}\text{Sr}_{0.63}\text{MnO}_3$. The growth and characterization technique used: are thin film preparation by DC magnetron sputtering technique, thickness analysis by surface profile and atomic force microscopy. Structure/microstructure and morphology analysis by x-ray diffraction and atomic force microscopy (AFM), respectively.

Contents

1. Introduction to doped rare earth manganites and their thin films. 2. Thin film preparation and characterization techniques. 3. Effect of thickness on magnetic and magnetotransport properties in compressively strained and polycrystalline $\text{La}_{0.88}\text{Sr}_{0.12}\text{MnO}_3$ thin films. 4. Nature of electrical transport in ferromagnetic and paramagnetic regime of strained and polycrystalline $\text{La}_{0.88}\text{Sr}_{0.12}\text{MnO}_3$ thin films. 5. Effect of thickness on magnetic phase coexistence and electrical transport in $\text{Nd}_{0.51}\text{Sr}_{0.49}\text{MnO}_3$ films. 6. Thickness induced insulator-metal transition and weak ferromagnetism in $\text{Nd}_{0.37}\text{Sr}_{0.63}\text{MnO}_3$ thin films.

503. SAPRA (Rupali)
Influence of Solar Cycle and Tropospheric Energetics on Temperature in the Tropopause Region.
 Supervisor : Dr. S K Dhaka
 Th 18118

Abstract

This describes on the energetics of the Earth's atmosphere in the tropopause region using radiosonds data at difference stations covering mainly the tropical/equatorial belt over India. The analysis is based on investigating the influence of Eath's dynamics and atmospheric long period oscillations in the temperature of the tropopause region. The relationship between convective available potential energy (CAPE) variability and response on the temperature field in the upper troposphere is examined

Contents

1. Introduction. 2. Convection system, large scale oscillations and experimental techniques. 3. Relationship between convective available potential energy (CAPE) and 100-hPa temperature on seasonal, annual, and large over Indian region. 4. Association of solar cycle and temperature in the tropopause region. 5 Association of out going long wave radiation (OLR) with convective available potential energy (CAPE) and temperature at 100-hPa level. 6. Summary and conclusions.

504. SINGH (Neelam)
Structural, Optical and Dielectric Characterization of Solution Grown Organic/Semiorganic Single Crystals.
 Supervisor : Dr. Binay Kumar
 Th 18120

Abstract

This thesis presents the growth of single crystals of α -and γ -glycine and their characterization in respect of structural, optical, thermal and dielectric properties. Further, glycine with various organic and inorganic additives has been synthesized and the effect of these additives on aforementioned properties is investigated.

Contents

1. Theoretical background and literature survey. 2. Experimental

techniques. 3. Growth and characterization of α - and γ -glycine single crystals. 4. Structural, optical and dielectric studies of glycinium maleate single crystals. 5. Structural, optical and dielectric studies of glycinium trifluoroacetate single crystals. 6. Growth, structural, optical and dielectric properties of glycine complex with metal halogen. 7. Growth structural optical and dielectric properties of tris glycine cerium tri chloride trihydrate single crystals. 8. Conclusions and scope of future work.

505. SINGH (Nongmaithem Kamal)
Plasmonic Behavior of Noble Metals and Metal-Metal Oxide Hybrid Nanostructures.
 Supervisor : Prof. S Annapoorni
 Th 18243

Abstract

This work has investigated the plasmonic behavior of metal nanostructures both in the LSPR and ATR-SPR mode. Further investigates the plasmon induced energy electron transfer in the metal/metal oxide nanostructures and the enhancement in the biosensing capability. Polyol process which is one of the most widely used chemical processes is employed for making silver (Ag) nanoparticles. Modified from of polyol process namely "Heating the precursor" and "Precursor injection" process are employed for making the nanoparticles.

Contents

1. Introduction. 2. Experimental techniques. 3. LSPR of metal and alloy nanoparticles. 4. Structural, morphological and optical properties of ZnO. 5. Gas/Chemical sensing applications of ZnO films. 6. Plasmon induced energy and electron transfer in Au-ZnO nanostructures. 7. Propagating SPR and it's bio-molecular sensing. 8. Summary and future scope.

506. SUBHASH KUMAR
Waves and Instabilities in Relativistic and Nonrelativistic Plasma.
 Supervisor : Prof. H P Singh
 Th 18129

Abstract

This thesis has been the study of propagation of low frequency waves and instabilities in a plasma medium considered to be a

concatenation of two qualitatively different anisotropic MHD fluids linked together by the ambient large scale magnetic field. This modeling of the plasma medium has been used to simulate galactic cosmic rays in the interstellar medium and in the magnetosheath. The interstellar medium and the average magnetosheath plasma is considered to be a nonrelativistic homogeneous anisotropic plasma, while the galactic cosmic rays are modeled by a relativistic anisotropic plasma. This two-population HMD has been utilized to study the effect of cosmic rays on the propagation of hydromagnetic waves.

Contents

1. Introduction. 2. Waves in two population MHD. 3. Waves in two population MHD with polytropic energy equations. 4. Two population MHD in nonrelativistic relative motion. 5. Two population MHD in relativistic relative motion.

507. SUNIL Devi

Investigation of Multinucleon Transfer Reactions and their Effects on Fusion Reaction Mechanism Around the Coulomb Barrier for $^{28}\text{Si}+^{90,94}\text{Zr}$ Systems.

Supervisor : Dr. Samit Kr Mandal and Prof. Raghuvir Singh
Th 18116

Abstract

This study investigates the mechanisms of fusion and the multinucleon transfer reactions around the coulomb barrier for $^{28}\text{Si}+^{90,94}\text{Zr}$ systems. The coupling of the internal degrees of the freedom of the colliding nuclei to the relative motion between them gives rise to a distribution of the barriers and hence, leading to the subbarrier fusion cross section enhancement. The fusion excitation functions have been measured for $^{28}\text{Si}+^{90,94}\text{Zr}$ systems around the coulomb barrier to investigate the role of multinucleon transfer in the subbarrier fusion enhancement. The multinucleon transfer reactions are measured for both the systems. It is observed that the pairing correlation is an important phenomenon in nuclear physics which enhances the transfer probability of even number of pairs especially of two nucleon transfer.

Contents

1. Introduction. 2. Theroretical background. 3. Experimental details. 4. Analysis of transfer data for $^{28}\text{Si}+^{90,94}\text{Zr}$ systems. 5. Analysis of fusion data for $^{28}\text{Si}+^{90,94}\text{Zr}$ systems. 6. Summary and conclusion.

508. TANWAR (Amit)
Dielectric and Piezoelectric Properties of Stoichiometric and Doped $\text{CaBi}_4\text{Ti}_4\text{O}_{15}$ Ferroelectric Ceramics and Thin Films.
 Supervisor : Prof. K Sreenivas
 Th 18123

Abstract

This work focuses on stoichiometric $\text{CaBi}_4\text{Ti}_4\text{O}_{15}$ (CBT) piezoelectric ceramics, and examines the changes in the properties by substituting appropriately at the A and B sites with effective dopants (Sr and Mn). $\text{Ca}_{1-x-y}(\text{Sr}_x\text{Mn}_y)\text{Bi}_4\text{Ti}_4\text{O}_{15}$ ceramic compositions with $x = 0.0, 0.25, 0.50, 0.75, 1.0$ and $y = 0.0, 0.1, 0.2, 0.3$ have been developed by a solid state reaction method. Thermal processing has been optimized to arrive at the right calcination and sintering conditions to develop the single phase material using DTA/TGA, FTIR, X-ray diffraction (XRD) and TEM techniques. Changes in the dielectric and piezoelectric properties of stoichiometric CBT ceramics are correlated to the changes in the microstructure under different sintering conditions.

Contents

1. High temperature piezoelectric transducers. 2. Statement of the problem and thesis objectives. 3. Experimental techniques. 4. $\text{CaBi}_4\text{Ti}_4\text{O}_{15}$ ceramic processing and characterization. 5. Strontium substituted $\text{CaBi}_4\text{Ti}_4\text{O}_{15}$ (CSBT). 6. Manganese substituted $\text{CaBi}_4\text{Ti}_4\text{O}_{15}$ (CMBT). 7. Stoichiometric and Mn doped $\text{CaBi}_4\text{Ti}_4\text{O}_{15}$ films.

509. VERMA (Maya)
Dielectric and Ferroelectric Studies on Strontium Bismuth Niobate Ceramics and Films.
 Supervisor : Prof. K Sreenivas
 Th 18245

Abstract

This work is focused on the preparation and characterization of doped and undoped SBN ceramics. Progress in the area of bismuth layered structured ferroelectrics (BLSF's) and in particular the current literature on Strontium bismuth Niobate (SBN) ceramics and thin films is reviewed. The present state of art and research on SBN is discussed, and scientific issues in understanding this material composition, and technological issues are highlighted. Also attempt has been made to prepare

SBN thin films by metal-organic decomposition technique and the effect of annealing temperature and film thickness on the optical, structural and electrical properties.

Contents

1. Introduction. 2. Strontium bismuth niobate - A literature review. 3. Experimental techniques and characterization tools. 4. Phase evolution of SBN ceramics by conventional solid state reaction method. 5. Substitution of antimony at Bi-site in $\text{SrBi}_{2-x}\text{Sb}_x\text{Nb}_2\text{O}_9$. 6. Lanthanum substitution at Bi-site in $\text{SrBi}_{2-x}\text{La}_x\text{Nb}_2\text{O}_9$. 7. Preparation of strontium bismuth niobate thin films by MOD technique.

510. YOGESH KUMAR
Studies on Polymeric Gel Electrolytes Based Electrochemical Supercapacitors.
 Supervisor : Dr. S A Hashmi
 Th 18244

Abstract

The present thesis covers the works performed on the development of electrical double layer supercapacitors based on Mg^{2+} and Li^+ ion conducting ionic liquid (1-ethyl,3-methyl-imidazolium trifluoromethanesulfonate, EMITF) incorporated polymer based electrolytes, and activated charcoal and MWCNT electrodes. Different types of ionic liquid incorporated electrolytes based on PEO and poly (vinylidene fluoride-hexafluoropropylene) (PVdF-HFP) have been prepared using solution-cast method. The morphological/structural, thermal, spectroscopic, and electrochemical characterization of the polymer/gel electrolytes have been carried out using various physical techniques.

Contents

1. Introduction. 2. Experimental techniques. 3. Studies on ionic liquid based lithium and magnesium ion conducting polymer/gel electrolytes. 4. Studies on electrical double layer capacitors using polyethylene oxide based polymer electrolyte and multiwalled carbon nanotubes as electrodes. 5. Studies on electrical double layer capacitors using PVdF-HFP based gel polymer electrolytes and multiwalled carbon nanotubes (MWCNTs) as electrode. 6. Studies on electrical double layer capacitors using PVdF-HFP based gel polymer electrolytes and activated charcoal as electrode. 7. Summary and conclusions.