CHAPTER 42

PHYSICS AND ASTROPHYSICS

Doctoral Theses

377. ABDULLAH Q.HUSSEIN ALQUDAMI
Optical and Magnetic Properties of Nanometals Prepared by Electro-Exploding Wire Technique
Supervisor : Prof. S. Annapoorni
Th 15396

Abstract

The physical technique namely the electro-exploding wire (EEW) technique has been used to prepare nanoparticles of pure iron, silver and silver-gold alloy without the use of any chemicals that tend to contaminate the product. The exploding wire process involves the generation of high current density through a thin wire - plate system. Nanopatterns of silver and gold were also generated using RF sputtering and thermal evaporation. The electro-exploding wire technique, which is a simple physical technique, can be used for preparing (i) high purity metal nanoparticles (ii) metallic alloy nanoparticles (iii) nanoparticles with capping molecules.

Contents

378. AVNINDRA KUMAR SINGH
Relativistic Atomic Structure Calculations for Highly Charged Ions
Supervisor : Dr. Man Mohan
Th 15392

Abstract

Discusses the various methods, necessary to consider the theory of atomic properties to which they have most frequently been applied and also consider the older methods used for one and two electron atoms since these form the basis for work on many electron atoms or systems and hence, making a formalism for the configuration interaction technique used for doing the atomic structure calculations, relevant to the present study. Also discusses the configuration interaction method in detail and also done an extensive calculation to evaluate energy levels, transition probabilities and lifetimes for transitions. Presents level energies, oscillator strengths and transition probabilities for the transitions from ground state.

Contents

379. DWIJENDRA PRATAP SINGH
Synthesis, Transport and Conduction Noise Studies of Doped Rare Earth Manganites and Superconductors
Supervisors : Prof. G. L. Bhalla and Dr. Neeraj Khare
Th 15380

Abstract

The grain boundaries of polycrystalline MgB_2 superconductors have been investigated by employing rf-SQUID and harmonic generation studies, whereas to explore the vortex dynamics conduction noise and magnetic noise studies have been employed. Similarly, the grain boundaries of ternary rare earth intermetallics have been investigated by employing rf-SQUID and scanning tunneling microscopy/spectroscopy (STM/STS) studies. X-ray diffraction and scanning electron microscopy studies have been carried out to confirming the phase purity and detecting surface morphology of the materials. Proposes a phenomenological model for transport across grain boundary in doped rare earth manganites. The experimental data has enabled to understand the nature of grain boundary in MgB_2 as well as ternary rare earth intermetallic superconductors along with the vortex dynamics of MgB_2 superconductors.

Contents

1. Introduction 2. Experimental techniques. 3. Doped rare earth manganites : Synthesis, transport and conduction noise. 4. Grain boundary and conduction noise of MgB2 superconductor. 5. Grain boundaries of intermetallic superconductor. 6. Summary and future scope.

380. GULIA (Vikash)
Quantum Confinement and Strain Effect on the Optical Properties of Some Metal (Pb, Ba, Sr) Iodides Thin Films
Supervisor : Dr. A. G. Vedeshwar
Th 15382

Abstract

Investigates some metal iodides, namely, Lead iodide (PbI_2) Barium iodide (BaI_2) and Strontium iodide (SrI_2) in thin film form, using the optical properties as the main technique along with other characterizing techniques. Among these iodides, PbI_2 is studied considerably both experimentally and theoretically. However, BaI_2 and SrI_2 are not at all studied so far as evident from the literature. Except little structural information, surprisingly no other details are available in the literature. Therefore, the results of the present study included in this thesis serve as a sort of 'first information report (FIR)' on BaI_2 and SrI_2. All the films in the present study are grown by thermal evaporation in a high vacuum.

Contents

1. Introduction 2. Experimental techniques and theoretical background. 3. Optical properties of IbI_2 thin films : Quantum confinement and residual stress effect. 4. Optical properties of BaI_2 films : Anisotropy and residual stress effect. 5. Optical properties of SrI_2 films : Anisotropy and residual stress effect. 6. Summary and Conclusions.

381. GUPTA (Ajai Kumar)
Investigations on Structural and Magnetotransport Properties of Layered Manganites
Supervisors : Prof. G. L. Bhalla and Dr. Neeraj Khare
Th 15388

Abstract

The double layered $La_{2-2x}Ca_{1+2x}Mn_2O_7$ manganites with dopant

concentrations x =0.0 - 0.5 have been synthesized. The X-ray diffraction study has been carried out to find the lattice parameters and the phase purity. The scanning electron microscopy has been employed to study the morphology of the samples. The magnetotransport properties of these doped double layered manganites with different dopant concentrations have been investigated systematically. A study of conduction noise has also been carried out. The experimental data, viz. resistivity as a function of temperature, temperature and magnetic field dependence of magnetoresistance, temperature dependence of ac susceptibility have been taken for polycrystalline samples of double layered $La_{2-2x}Ca_{1+2x}Mn_2O_7$ manganite for the value of x = 0.0 - 0.5. The temperature dependent resistivity and conduction noise in the absence and in the presence of magnetic field, temperature dependent magnetization and ac susceptibility, temperature and magnetic field dependent magnetoresistance have been studied for bulk sample of $La_{1.4}Ca_{1.6}Mn_2O_7$. For comparison, the experimental magnetotransport and conduction noise data for infinite layered $La_{0.7}Ca_{0.3}MnO_3$ manganite has also been obtained. These data were analyzed systematically.

Contents

1. Introduction 2. Experimental techniques. 3. Synthesis and structural characterization of infinite and double layered manganite. 4. Magnetotransport in infinite and double layered manganite. 5. Transport mechanisms in double layered manganite. 6. Summary and future scope.

382. GUPTA (Lokesh Kumar)
Ground State Properties of Correlated Bose-Einstein Condensate of Massive Gaseout Bosons in a Magnetic Trap
Supervisors : Prof. S. P. Tewari and Dr. Poonam Silotia
Th 15395

Abstract

The BE condensate of different elements : ^{87}RB, ^{23}Na, ^{85}Rb have been considered taking into account the presence of hard-core interaction and higher order interaction in addition to the two-body interactions. The modified GPG equation of the BE condensate in the presence of localized impurity potential has been numerically solved to obtain the various ground state properties as the position of localized impurity is changed in the condensate from core to a peripheral position. While the total, harmonic oscillator potential and impurity energies decrease as the position of localized impurity is displaced from core of

the condensate to its periphery, the value of two-body inter-particle interaction energy increases. Further, the values of chemical potential and total energy per particle shows decrease by ` 9% and ` 17% respectively, leading to the inference that the stability of the condensate increases as the localized impurity is moved away from the core of the condensate. This study provides meaningful insight into the stability of the condensate in the presence of an impurity potential.

Contents

383. GUPTA (Monika)
Electron collisions with molecules of point group C_{2v} using R-matrix method
Supervisor : Prof. K. L. Baluja
Th 15379

Abstract

Presents an ab initio method to obtain cross sections and other important parameters related to various types of resonances. This has been demonstrated for many molecules of point group C_{2v}. For bigger molecules like biomolecules, this method can be extended to its functional groups and then make use of interference to obtain cross sections for the biomolecules. In semiconductor applications, a key goal is development of electron cross section sets for plasma chemistry modeling, while biological studies are largely focused on understanding the role of localized resonances in inducing DNA strand breaks. Accurate calculations of low-energy electron collisions with polyatomic molecules are required which may be achieved with R-matrix method conveniently in lesser time.

Contents

1. Introduction 2. Theoretical background. 3. Electron collisions with an ozone molecule. 4. Low energy elastic and inelastic scattering of electrons from SO_2. 5. Electron-F_2O collision study. 6. Electron-H_2S collisions in the low energy range. 7. Differential cross sections for electron impact on some diatomic and triatomic molecules - OClO, ClOCl, ClO, CH, SH, SF and SF_2.

384. JAIN (Rajni)
Strontium Bismuth Tantalate (SBT) Cermics for Piezoelectric Applications.
Supervisors : Prof. K. Shreeniwas
Th 15490

Abstract

Focuses on non-stoichiometric strontium bismuth tantalate (SBT) ceramic compositions prepared by sol gel technique which is known to yield well reacted powders that are homogenous and crystallize at relatively low processing tempratures. Limitations of existing materials used for piezoelectric transducer applications, and the recent trends in research on load free piezoelectric compositions are reviewed. The progress on bismuth layered perovskites e.g., strontium bismuth tantalate (SBT), and successive developments in the evaluation of its structural, dielectric, piezoelectric and electric properties has been reviewed.

Contents

1. Introduction. 2. Sol-gelsynthesis of SBT poeders, Ceramic sintering and electroding. 3. Properties of non-stochiometric $Sr_{1-x}Bi_{2+2x/3}Ta_2O_9$ ceramics and limit of solubility. 4. Electrical poling studies on SBT ceramics. 5. Piezoelectric properties of SBT ceramics.

385. JHA (Agam Kumar)
Some Aspects of Quark Hadron Phase Transition
Supervisor : Dr. R. Ramanathan
Th 15383

Abstract

Studies in developing a simple statistical model of quark gluon plasma (QGP) under the influenceof a “meanfield potential” in the form of a hybrid potential (Peshier Potential and Richardson-

Cornell Potential) which enables to extract a chunk of the physics of QGP-hadron phase transition which can be used in the phenomenological analysis of fireball data as and when they are available from the Ultra Relativistic Heavy Ion Colisions (URHIC) experiments going on at various laboratories at present. Thus, by using this model can compute thermal and interfacial properties of the QGP to ascertain the order of the phase transition and other thermodynamic characteristics of the system.

Contents

386. JHA (Alok Kumar Singh)
Relativistic Calculations of Photoionization Cross Sections in Multielectron Atomic System
Supervisor : Dr. Man Mohan
Th 15378

Abstract

Updates the database of energy levels and photoionization cross section of these ions to the accuracy required to exploit the high quality of observations from the current space and ground based telescopes. Atomic chlorine is an astrophysically important free radical, present in diffuse interstellar clouds. Accurate transition data in neutral chlorine are important not only in astronomy and astrophysics but also in other scientific areas such as plasma physics. Describes the application of the relativistic R-matrix method to calculate the photoionization cross sections of atoms and ions.

Contents

387. JHA (Manoj Kumar)
Tests of QCD in pp Interactions at 14 TeV
Supervisors : Prof. R. K. Shivpuri and Prof. D. P. Goyal
Th 15386

Abstract

Deals with the ultimate constituents of matter and the interactions between them. The aim is to understand the working of our Universe at the most fundamental level. In trying to reveal its unknown microstructure, physicists have formulated a theoretical framework which describes the interactions between elementary constituents of Nature : the Standard Model. Address the requirements on CMS software and its framework that has been used in the present work. The CMS Object Oriented (CMSOO) framework is used to build real data processing applications, ranging from high level trigger to analysis, by incorporation of physics software modules. Presents the work on optimization of shape of lead absorbers in the Preshower of the CMS detector. Deals with the study of direct photon production at the LHC energy. Analyzes the CDF and Dϕ measurements of direct photon cross section at /s = 1.8 TeV and /s = 630 GeV.

Contents

388. KHORSANDI (Jamshid)
Modeling Semiconductor Laser Devices
Supervisor : Dr. Shahnawaz
Th 15384

Abstract

It studies to make a self consistent tool for modeling and simulation of semiconductor laser diodes. The tool is capable of modeling and simulation of heterostructure devices, especially heterostructure laser diode. Electrical as well as optical characteristics of laser diode including two dimensional electron and hole carrier densities, two dimensional electron and hole current densities, I-V curve, L-I curve, energy band diagram and one and two dimensional distribution of optical field can be calculated by the package in different working condition i.e. before and beyond lasting. Since accurate and fast solution of wave equation is necessary a great effort has been done to develop a novel non-uniform semivectorial model for the solution of the wave equation which is the main part of the optical model.

Contents

1. Introduction 2. Laser theory. 3. Theory of semiconductor lasers. 4. Electrical modeling. 5. Optical modeling. 6. Results and discussion.

389. LUMB (Sonia)
Lattice Equilibrium Theory and Size Effect for Trapped Bose-Einstein Condensates.
Supervisors : Prof. S.K. Muthu
Th 15491

Abstract

It is an analitical study of the phenomenon of BEC in a system of finite number of bosons trapped in a bounded 3D harmonic oscillator potential. Adopts an analytical approach to the problem of studying the various thermodynamical properties of an assembly of trapped bosons.

Contents

1. Introduction. 2. Bose-Einstein Gases trapped in a Bounded Harmonic Potential : basic Formulation in terms of Lattice equilibrium Theory. 3. Bose-Einstein condensation and calculation of thermodynamic functions. 4. Analytical results for a1 large and small and size effects. 5. Density and pressure profiles for a weakly repulsive Bose gas in a harmonic potential. 6. Summary of the result and conclusions. References.

390. MAHESH KUMAR
Epitaxial adsorption of Metals on Single Crystal Silicon Surfaces and Interfacial Superstructure Formation
Supervisors : Dr. S. M. Shivaprasad and Dr. A. G. Vedeshwar
Th 15385

Abstract

Attempts to provide a sophisticated archival experimental data that can be employed in forming interfaces of desired properties and performances for high quality device fabrication. The studies involve the atomically clean low indexd and high index silicon surfaces used as templates for the submonolayer adsorption of metals in ultrahigh vacuum environment. The reactive properties of Mg with silicon and the electron rich interface provided by Sb adsorption have been carefully maneuvered to form different types of interfaces. Studied the adsorption of

Mg and Sb on three different reconstructions of the silicon namely Si (001)-2x1, Si (111)-7x7 and Si (5 5 12)-2x1 surfaces. The various interfaces formed at room temperature provide various stable surface phases in the submonolayer coverage regime. The interface stability is also studied by annealing the system to various high temperatures and also by keeping the substrate at different temperatures. Various kinetic parameters like flux rate, substrate temperature and lower steps in desorption dynamics provide the various surface phases with desired interface properties. These kinetically steered interfaces reveal the differences in the pathways adopted in forming the novel surface phases.

Contents

1. Motivation. 2. Overview. 3. Experimental techniques. 4. Results and discussions-I. 5. Results and discussions-II. 6. Summary and conclusions.

391. MALIK (Sanjay)
Study of Gravity Waves due to Convection using MST Radar
Supervisors : Dr. Anjan Dutta and Dr. S. K. Dhaka
Th 15387

Abstract

Studies the dynamic of the earth's lower atmosphere covering troposphere and lower stratosphere (1 - 20 km height from ground) using the Indian MST radar at Gadanki (13.5^0 N, 79.2^0 E) near Tirupati. The mesoscale convective systems (horizontal scale <_ 100 Km) induced gravity waves and turbulence has been investigated. The cardinal objective of the thesis work is to study the gravity wave signatures in the convective environment by monitoring the development, maximizing, and weakening of convective phenomena and to discuss the source mechanism of the generation of gravity waves due to convection.

Contents

1. Introduction 2. Theoretical aspects of atmospheric oscillations. 3. Experimental techniques and method of analysis. 4. Observable signature of a convectively generated gravity waves over the tropics using Indian MST radar at Gadanki (13.5^0N, 79.2^0E). 5. Observations of deep convective updraft in tropical convection and their role in the generation of gravity waves. 6. Summary of results and conclusions.

392. MOHD. NAIMUDDIN
Some Aspects of Hadron Hadron Collisions in High Energy Interactions
Supervisor : Prof. D. S. Kulshreshtha
Th 15390

Abstract

Reports the study on one such particle called the B^0_8 meson made up of a bottom and a strange quark. B^0_8 mesons are currently produced in a great numbers only at the Tevatron and we report a study done to measure the mixing parameter Δm8 between B^0_8 meson and its anti-particleB^0_8. Mixing is the ability of a very few neutral mesons to change from their particle to their antiparticle and vice versa. Until recently there existed only a lower limit on this measurement, here we report an upper bound and a most probable value for the mixing parameter. Discusses the theoretical motivation. The measurement technique and the different factors that effect the measurement are also given. Presents a new initial state flavor tagging algorithm using electrons and measurement of the B^0_d mixing parameter Δmd with the new technique. Details of the combined initial state tagging used in the B^0_8 mixing study are also given.

Contents

393. RASHMI
Conduction mechanisms in Poly(3-Hexylthiophene)(P3HT) - A Polymeric Semiconductor
Supervisors : Prof. S. Annapoorni and Prof. Vikram Kumar
Th 15377

Abstract

Presents a detailed study of the polymer- poly(3-hexyl thiophene). Its properties reveal its suitability for its use in organic thin film devices as a semiconductor. Critical analysis of conduction mechanisms taking place in P3HT plays an important role to realize a stable, useful functional device.

Contents

Hexylthiophene) as a polymeric semiconductor : Its properties. 4. Conduction mechanisms in P3HT. 5. Influence of contacts on P3HT thin film sandwich devices. 6. Organic thin film transistors : Fabrication and modelling. 7. Summary and scope of future work.

394. SARABJOT KAUR

Memory Effect in Deformed Helix Ferroelectric and Electroclinic Liquid Crystal Materials

Supervisors : Prof. S. Annapoorni and Dr. A. M. Biradar
Th 15394

Abstract

Deals with the memory effect in deformed helix ferroelectric and electroclinic liquid crystal materials. Dielectric and electro-optical studies have been done on both types of materials. The main objective of the present thesis is to understand the basic mechanism behind the memory behaviour of Deformed Helix ferroelectric and electroclinic liquid crystal material. The memory exhibited by both the materials is entirely different from the memory found in conventional Ferroelectric liquid crystal materials. Therefore an attempt has been made to explain the mechanism of memory in these materials. Dielectric, textural and electro-optical data have been the various tools to establish the behaviour of these materials.

Contents

1. Introduction to liquid crystals. 2. Experimental techniques. 3. Memory effect in deformed Helix ferroelectric liquid crystals. 4. Dynamics of memory in deformed Helix Ferroelectric liquid crystals. 5. Dielectric and electro-optical studies of electroclinic liquid crystals. 6. Memory effect in electroclinic liquid crystals.

395. SISODIYA (Avnish Kumar)

Quark and Diquark Interaction Energies in Quark-Gluon Plasma and Their Role in the Stability of Stars

Supervisor : Dr. R. S. Kaushal
Th 15389

Abstract

Study the two-diquark interaction energies in various possible color-spin states of the diquarks, such as (3^-, 0), (3^-, 1), (6, 0) and (6, 1), carries out within the framework of constituent quark model. To this effect, the role of an intermediate phase between the hadronic and quark-gluon plasma (QGP) is highlighted. Stud-

ies two different two-diquark composite systems consisting of (i) quark-diquark-gluons with only nonstrange flavor of quarks, i.e., u and d quarks and (ii) quark-diquark-gluons with three flavors of quarks, i.e., u, d and s quarks. Our model suggests several acceptable values of the coupling parameter λ' repreenting the diquark-diquark interaction in the effective Lagrangian. Derived equations state the Tolmann-Oppenheimer-Volkoff equations for the mass-radius configuration of the diquark (nonstrange as well as strange) stars are solved. Studies other multiquark states and their role in QGP formation, we have investigated the charge distribution and form factors of some recently discovered particles, denoted by θ^+ (01540 MeV) in the literature and identified as ($uudds^-$) and another state ($uuddc^-$), designated as ξ^0 (3099 MeV) in our studies. We also discussed the occurrence of such exotic multiquark systems in the process of hadronization of QGP by way of using an analogous Saha's ionization formula for the colored ions.

Contents

396. SRIVASTAVA (Ajay Kumar)
Characteristics of the Si Detectors and Study of Some Process in 14 TeV p-p Interactions.
Supervisor : Prof. R. K. Shivpuri
Th 15381

Abstract

Provides an overview of the CMS experiment at LHC, CERN, Geneva and highlights the detailed 2-D T-CAD analysis of the breakdown performance of Si microstrip detectors to be used in Preshower at CMS, hence a more detailed discussion on the Preshower Detector (PSD) is presented. The role of the pn junction as Si detector and basic physics of p-n junction are discussed. Describes the various aspects of the process and device simulation program including mesh generation, boundary condition, physical models description and numerical solution of the equations are briefly discussed and the validation of the simulator with experimental result is also presented. Presents the comparison of the p^+-n junction formed by BF_2^+ and B^+ implantation at equivalent energy in Si microstrip detector with low and high thermal budget : Impact of fluorine on electrical

characteristics. A two-dimensional computer based analysis is presented.

Contents

1. CMS experiment at the LHC. 2. Physics and operation principle of p^+-n Si microstrip detector. 3. 2-D computer based T-CAD simulation. 4. Electrical characteristics of BF_2^+ and Boron implanted devices. 5. Effect of dielectric passivation on the breakdown voltage of Si microstrip detector. 6. Characterization of Si microstrip detector and development of radiation hard Si detector for S-LHC cern. 7. Rapidity gaps in dijets events at LHC.

397. VERMA (Nupur)
Theoretical Relativistic Calculations for Astrophysically Abundant Ions
Supervisor : Dr. Man Mohan
Th 15391

Abstract

Theoretical calculations of electron impact excitation processes in atomic ions have important applications in high temperature plasma research. Of particular importance are studies of transition metal ions, such as Ni, which are directly applicable to plasma cooling, transport, and confinement in experimental fusion devices. Knowledge of nickel spectrum is also required for the study of impurities injected into tokamak plasmas which originate from the nickel alloy liner currently chosen for these devices. Presents elaborate calculations of collision strengths and effective collision strengths for transitions between the ground state and levels of $3s^23p^53d$ and $3s3p^63d$ configurations using the relativistic Breit-Pauli R-matrix method. Includes the important electron correlations and the relativistic effects into account. The effective collision strengths are presented over a wide temperature range suitable for use in modeling a variety of astrophysical plasmas. A point worth mentioning here is that ours is the first detailed calculation on electron impact excitation of Ni XI. This investigation for Ni XI is very important, as it is needed urgently to explain the astrophysical models.

Contents

1. Introduction. 2. Fine structure energy levels, oscillator strengths and lifetimes of chlorine-like Cobalt. 3. Level energies, oscillator strengths, transition probabilities and lifetimes for transitions in Fe IX. 4. Collisional excitation of Argon-like Ni XI using the

Breit-Pauli R-matrix method and Conclusion.

398. VERMA (Shashi)
Study of Nuclear Reactions Induced by Radioactive Ion Beams
Supervisor : Prof. Raghuvir Singh
Th 15393

Abstract

Aims to gain insight into the nuclear reactions involving radioactive nuclei. Studies reactions involving two of the radioactive nuclei namely ^{7}Be and ^{14}C. The effect of the breakup of weakly bound structure of projectile on process like fusion is addressed here through the study of reactions involving two of the weakly bound projectiles ^{7}Be and ^{7}Li. Elastic scattering angular distributions have been measured for ^{7}Be + ^{9}Be system at E_{lab}=17, 19 and 21 MeV. Also one proton transfer channel which has a positive Q-value of 0.98 MeV was also measured at E_{lab} = 19 and 21 Mev. However, due to low intensity of the radioactive ion beam it is currently not possible to perform direct fusion measurements. In view of the similarities of weakly bound stable systems with their associate radioactive ones, the study of the reactions involving weakly bound stable nuclei may shed more light on the effect of the breakup on fusion process.

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