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.

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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

1. Introduction 2. Level energies and oscillator strengths in Ni XII. 3. Fine structure energy levels, oscillator strengths and lifetimes of chlorine like chromium. 4. Level energies, oscillator strengths and lifetimes for transitions in Ti VI and Summary and Conclusion.

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.

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 (PbI2), Barium iodide (BaI2) and Strontium iodide (SrI2) in thin film form, using the optical properties as the main technique along with other characterizing techniques. Among these iodides, PbI2 is studied considerably both experimentally and theoretically. However, BaI2 and SrI2 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 BaI2 and SrI2. All the films in the present study are grown by thermal evaporation in a high vacuum.

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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 La2-xCa1+xMn2O5 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 \(\text{La}_{2-2x}\text{Ca}_{1+2x}\text{Mn}_2\text{O}_7\) 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 \(\text{La}_{1.6}\text{Ca}_{1.4}\text{Mn}_2\text{O}_7\). For comparison, the experimental magnetotransport and conduction noise data for infinite layered \(\text{La}_{0.7}\text{Ca}_{0.3}\text{MnO}_3\) manganite has also been obtained. These data were analyzed systematically.

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382. GUPTA (Lokesh Kumar)

**Ground State Properties of Correlated Bose-Einstein Condensate of Massive Gaseous Bosons in a Magnetic Trap**

Supervisors : Prof. S. P. Tewari and Dr. Poonam Silotia
Th 15395

**Abstract**

The BE condensate of different elements : \(^{87}\text{Rb}, ^{23}\text{Na}, ^{85}\text{Rb}\) 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 pro-
vides meaningful insight into the stability of the condensate in
the presence of an impurity potential.

Contents

1. Introduction 2. Effect of higher order energy corrections includ-
ing three-body interaction on the Bose-Einstein condensate with
the variation of repulsive self interaction energy. 3. Effect of three-
body interaction in strongly interacting Bose-Einstein condensate
in isotropic and highly anisotropic magnetic trap. 4. Effect of incor-
porating three-body interaction in the low density energy ex-
pansion of Bose-Einstein condensate trapped in a harmonic poten-
tial. 5. Vortices in Bose-Einstein condensate in the presence
of higher order energy corrections including three-body interac-
tions for large values of gas parameter. 6. Variation of the ground
state properties of trapped Bose-Einstein condensate due to local-
ized impurity and Conclusion.

383. GUPTA (Monika)

Electron collisions with molecules of point group C\textsubscript{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\textsubscript{2v}. For bigger molecules like biomolecules, this method can be
extended to its functional groups and then make use of inter-
ference to obtain cross sections for the biomolecules. In semi-
conductor applications, a key goal is development of electron
cross section sets for plasma chemistry modeling, while bio-
logical 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.

384. JAIN (Rajni)

**Strontium Bismuth Tantalate (SBT) Ceramics 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 temperatures. 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-stoichiometric Sr$_{1-x}$Bi$_{2+2x/3}$Ta$_2$O$_9$ 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 influence of 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 Collisions (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

1. Introduction 2. CMS detector. 3. CMS software. 4. Optimization of transverse shape of lead absorbers in the CMS preshower. 5. Direct photon production at LHC. 6. Parton kT smearing effects in direct photon production and Bibliography.

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.
1. Introduction
2. Bose-Einstein Gases trapped in a Bounded Harmonic Potential: basic Formulation in terms of Lattice equilibrium Theory.
4. Analytical results for a weakly repulsive Bose gas in a harmonic potential.
5. Density and pressure profiles for a weakly repulsive Bose gas in a harmonic potential.
6. Summary of the results and conclusions.

Abstract

It is an analytical 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.
4. Analytical results for a weakly repulsive Bose gas in a harmonic potential.
5. Density and pressure profiles for a weakly repulsive Bose gas in a harmonic potential.
6. Summary of the results and conclusions.

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°N, 79.2°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

Abstract

Reports the study on one such particle called the $B_{s}^{0}$ meson made up of a bottom and a strange quark. $B_{s}^{0}$ mesons are currently produced in great numbers only at the Tevatron and we report a study done to measure the mixing parameter $\Delta m_{s}$ between $B_{s}^{0}$ meson and its anti-particle $\bar{B}_{s}^{0}$. 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 $B_{s}^{0}$ mixing parameter $\Delta m_{d}$ with the new technique. Details of the combined initial state tagging used in the $B_{s}^{0}$ mixing study are also given.

Contents

1. Introduction 2. Theoretical overview. 3. Experimental apparatus. 4. Initial state tagging. 5. $B_{s}^{0}$ mixing analysis. 6. Combination and results.

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

1. General introduction. 2. Experimental techniques. 3. Poly(3-

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 $\lambda'$ representing 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 $\Theta^+$ (01540 MeV) in the literature and identified as (uudds) and another state (uuddc), designated as $\xi^0$ (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

1. Introduction. 2. Diquark interaction energies. 3. Diquark matter within the framework $\phi^4$ - theory. 4. Diquark stars and their stability. 5. Diquark model for pentaquark baryons and tetraquark mesons. 6. Discussion and Conclusions.

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.

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^3p^3d and 3s3p^6d 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
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 \(E_{\text{lab}} = 17\), \(19\) and \(21\) MeV. Also one proton transfer channel which has a positive \(Q\)-value of \(0.98\) MeV was also measured at \(E_{\text{lab}} = 19\) 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.

Contents

1. Introduction
2. Experimental details.
3. Experiment, analysis and results: \(^7\)Be + \(^9\)Be system.
4. Experiment, analysis and results: \(^7\)Li + \(^9\)Be system.
5. Elastic scattering analysis for \(^{14}\)C + \(^{14}\)C and \(^{14}\)C + \(^{12}\)C systems.
6. Conclusions.