CHAPTER 46

PHYSICS AND ASTROPHYSICS

Doctoral Theses

514. CHAUHAN (Sushil Singh)
Search For Quark Compositeness At $\sqrt{s}$ = 14 TeV at the Large Hadron Collider.
Supervisors : Prof. Brajesh Chandra Choudhary and
Prof. Raghuvir Singh
Th 16765

Abstract

Within the Standard Model (SM) of particle physics, quarks and leptones are under-stood to be the fundamental particles. Their existence and various properties have been verified experimentally. It studied one model in detail where the magnetic transition of the excited quarks is considered with ordinary quarks. Also evaluated the search potential of these states in γ + jet and $\gamma\gamma$ final states at the LHC center of mass energy of $\sqrt{s}$ = 14 TeV. The simulation is done at the generator level using Compact Muon Solenoid (CMS) experimental setup for photon and jet candidate reconstruction. The track and calorimetric activities are used for isolation purpose to reduce SM back-grounds. The analysis shows that for a choice of $\Lambda = M_{q^*} = 2$ TeV, an excited state q* in γ + jet mode can be discovered with 200 pb^{-1} of data, while a 5 TeV state can be confirmed with ~ 140 fb^{-1} of integrated luminosity.

Contents

1. Introduction & motivation. 2. Physics of compositeness. 3. The LHC machine and the CMS experiment. 4. Event generation. 5. Analysis. 6. Significance. 7. Results and Systematics. 8. Summary and conclusions. Bibliography.

515. CHOUDHARY (Amit)
Dynamics of Memory Effect in Ferroelectric Liquid Crystals.
Supervisors : Prof. K. Sreenivas and Dr. A. M. Biradar
Th 16769

Abstract

Deals with the dynamics of memory effect in FLCs which is independent of cell thickness, unlike the bistabiligy effects in surface stabilized FLC (SSFLC) which is thickness dependent. It is focused on the memory effects in a special class of FLC material, called de Vries electroclinic liquid crystals (ELCs). These materials are known for their large induced tilt amngle in SmA phase. This is called electroclinic effect and characterized by electroclinic coefficient $e_c = d\theta/dE$, where e_c is electroclinic coefficient, θ is the applied electric field, q is the induced tilt. It has been predicted that such ELC materials have a specific molecular arrangement within a layer, unlike the conventional FLCs and is predominantly seen near the phase transition of SmC*-SmA, and is named as random mode.

Contents

1. Introduction to liquid crystal. 2. Experimental techniques. 3. Memory efect in SmC* phase of electroclinic liquid crystal. 4. Dependency of soft mode on SmA phase width in ferroelectric liquid crystal. 5. Effect of gold nanoparticles on electro-optical properties of ferroelectric liquid crystals. 6. Behaviour of ferro-electric liquid crystal doped with isotropic medium. Bibliography.

516. GAMBHIR (Monica)
Laser Field Effects on Intersubband Transitions in Quantum Nanostructures.
Supervisors : Prof. Man Mohan and Dr. Vinod Prasad
Th 16767

Abstract

It explores the intersubband transitions in quantum well nanostructures under the influence of applied laser field. The theoretical description of intersubband transitions due to interaction with strong fields, originatedby an applied ac voltage or a high-intensity infrared laser, in semoconductor nanostructures is of crucial importance. At frequencies of the order of few Terahetz (THz), typical of free-electron lasers, photon energies are comparable to the energy separation of the electronic levels and nanostructures couple strongly to the electromagnetic field. When a semiconductor nanostrucutre couples strongly to a laser field whose frequency is in the same order of magnitude of the characteristic energies of system, electronic properties depend on amplitude and frequency of the laser field nonlinearly.

Contents

1. Introduction. 2. Intersubband transitions in a quantum wire driven by a strong terabertz field. 3. Optical intersubband transitions in coupled quantum wells. 4. Coherent population transfer in coupled semiconductor quantum wells. 5. Conclusion. Bibliography.

517. GUPTA (Kopal)
Complexity Measures of Chaotic Time Series and their Application.
Supervisors : Prof. H. P. Singh and Dr. B. Biswal
Th 16889

Abstract

In the thesis, time series obtained from three different complex systems have been analyzed using nonlinear data analysis techniques and relevant complexity measures have been calculated for each system. Based on them the dynamics is interpreted and some applications based on these complexity measures are also presented.

Contents

1. Introduction. 2. Adaptive anticontrol of ahaos in neural system. 3. ASA of strange nonchaotic dynamics. 4. Analysis of solar wind flows in an activity cycle. 5. Summary. Bibliography.

518. KSHETRIMAYUM (Roshan)
Design and Applications of Surface Acoustic Wave (SAW) Devices.
Supervisors : Prof. R. P. Tandon and Prof. R. D. S. Yadava
Th 16764

Abstract

It explores novel SAW deivce deisgn methods for optimizing and improving performance characteristics of SAW chemical sensors. A new degisn method for surface acoustic wave interdigital transducers (SAW IDTs) to realize multifrequency SAW comb filters is developed. This takes advantage of the Remez exchange algorithm for designing rung IDTs of a ladder transducer to help achieving both the wide band width as well as a large number of comb modes with nearly constant insertion losses. Simulated characteristics of the new design are

compared with those for the standard comb filter designs to illustrate its advantages. This new SAW comb filter design proposed offers possibility for multifrequency SAW oscillator operation over a decade of frequency variation. The feasibility for experimental realization of wide bandwidth multifrequency SAW platforms is also illustrated. The role of phase transfer characteristics in SAW oscillator sensors based on two-port resonator devices are examined and analyzed by taking into account the nonlinearity in phase response.

Contents

1. Introduction. 2. Theoretical basis for SAW device designs. 3. A novel SAW comb filter design for multifrequency oscillators. 4. SAW resonator designs based on COM theory and mass sensitivity analysis for chemical sensor applications. 5. Theory of multifrequency SAW characterization of viscoelastic polymer and vapor sensing. 6. Equivalent circuit modeling of polymer-coated SAW resonators based on COM theory. 7. Conclusions and future work. Bibliography and Appendix.

519. MALIK (Rakesh)
Magnetic Interactions in Nanomagnetic Nickel Ferrite Clusters.
Supervisor : Prof. S. Annapoorni
Th 16888

Abstract

Describes the various structural and megnetic properties of the nano sized nickel ferrite particles, commercially obtained from Aldrich Co. with a purity of ~98% and those prepared by sol-gel process. From the result in both the systems it can be concluded that the macroscopic properties invariably tend to be the same in both the systems. Deals with the study of $NiFe_2O_4$ embedded in a polyaniline matrix.

Contents

1. Introduction. 2. Experimental Techniques. 3. Megnetic interactions in nickel ferrite clusters : Annealing effect. 4. Effect of annealing on nickel ferrite nanoparticles prepared by sol-gel technique. 5. $NiFe_2O_4$ thin films prepared by pulsed laser deposition : Effect of annealing and hydrogen ion irradiation. 6. Properties of $NiFe_2O_4$/Polyaniline nanomagnetic composites : EMI shielding and memory effect. 7. Summary and conclusions. Bibliography.

520. PAL (Partha Sarathy)
On Behaviour of Convection in Sun-Like Stars.
Supervisors : Prof. H. P. Singh and Prof. M. P. Srivastava
Th 16763

Abstract

Examines the behaviour of penetrative turbulent compressible convection under the influence of rotation by means of three-dimensional numerical simulations. Estimates the extent of penetration below a stellar-type rotating convection zone in an f-plane configuration. Several models have been computed with a stable-unstable-stable (three layer) configuration by varying the rotation rate Ω, the inclination θ of the rotation vector with vertical axis and the stability of the lower stable layer S. The spatial and temporal average of kinetic energy flux F_k is computed for several turnover times after the fluid has theremally relaxed and is used to estimate the amount of penetration below the convectively unstable layer. Experiments show that with the increase in rotational velocity, the downward penetration decreases. A similar behaviour is observed when the stability of the lower stable layer is increased in a rotating configuration. Furthermore, the relative stability parameter S shows S-1/4 dependence on the penetration distance implying the existence of a thermal adjustment region in the lower stable layer rather than a nearly adiabatic penetration region.

Contents

1. Introduction. 2. Turbulent compressible convection with rotation - Penetration below a convection zone. 3. Turbulent compressible convection with rotation - Penetration above a convection zone. 4. Study of internal gravity waves above a stellar-type convection zone using numerical simulations. Bibliography.

521. PANDEY (Binod Kumar)
Nonlinear Interaction of High Power Electromagnetic Waves with Solids and Plasmas.
Supervisors : Prof. M. P. Srivastava and Prof. V. K. Tripathi
Th 16766

Abstract

It has developed analytical formalisms of laser tunnelling through overdense plasmas. The tunnelling is facilitated by the

increase in the electron mass with the intensity of the laser. This relativistic effect is important at laser intensity $I_l \geq 3x10^{18}$ W/cm^2 when laser wavelength is 1 μm. The higher laser frequency the requisite laser intensity is larger. For a thin foil 5 times the critical density and width of one tenth of a micron above 90% transmission occurs at $I_l \geq 3x10^{19}$ W/cm^2 when only relativistic mass nonlinearity is considered. The inclusion of ponderomotive force nonlinearity lowers this intensity very significantly to 5 x 10^{18} W/cm^2. two very interesting features of anomalous tunnelling are that the transmitted wavefont has smaller spot size than the incident beam and that it acquires a converging wavefront. This features can be useful diagnostics.

Contents

1. Introduction. 2. Tunneling of a relativistic laser pulse through on overdense plasma slab. 3. Anomalous transmission of an intense short pulse laser through magnetized overdense plasms. 4. Resonant second harmonic generation of a mullimeter wave in a plasms filled waveguide. 5. Upper hybrid wave driven electron acceleration in a plasms. 6. Summary and future directions. Bibliography.

522. PANKAJ KUMAR
Studies of Optical and Electrical Properties of Some Organic Semiconductors.
Supervisor : Prof. R. P. Tandon
Th 16768

Abstract

It investigate the optical and electrical properties of two very important conjugated polymers viz MEH-PPV and P3HT. MEH-PPV and P2HT are very important active materials for respectively the LEDs and solar cells applications. The optical properties have been studied in terms of UV-visible and PL spectroscopy in solutions and thin films using different organic solvents. The use of different solvents has been observed to have effect on both the absorption of PL of these materials. This solvent effect on obsorption and PL has been corrrelated to the polarity of the solvents. Absorption and PL in thin films have been observed to be red shifted compared to that in solutions and this effect the absorption, PL and morphology of the polymer in thin films, which are important parameters that determine the performance of LEDs and solar cells.

Contents

1. Organic semiconductors and applications. 2. Experiemntal techniques and procedures. 3. Optical properties of MEH-PPV and P3HT. 4. Effect of temperature on charge transport. 5. Effect of doping of CoFe nono-particles on hole transport in MEH-PPV. 6. Effect of non-zero schottky barrier on charge transport. 7. Trap filled limit. 8. Current through organic bulk heterojuction solar cells. 9. Summary. Bibliography.

523. PATTANAIK (Amitanshu)
Luminescence Properties of Some Organic Laser Dye Solutions for Their Applications as Optical Sensors.
Supervisor : Prof. P. D. Sahare
Th 16771

Abstract

The fluorescence intensity and its excitation and emission spectra, however depends on the surroundings of the dye molecule and hence on the types of the solvents, adsorbed gases, surfactants (if added), and also the dye concentration, temperature, viscosity etc. The dye molecule in its excited state on absorption of light may form complexes with the sourrounding molecules or at least could have collisions with them and could result in the quenching or sensitization. the property of some of the the dyes with some adsorbed toxic gases and other toxic polluting species have been studied for the application of optical sensors.

Contents

1. Introduction. 2. Experimental. 3. Theoretical considerations. 4. Photo-physical studies of some organic laser dyes. 5. Applications of organic dyes as optical sensors. 6. Summary and furute projections. Bibliography.

524. RAJESH KUMAR
Studies on ZnO Thin Films, Its Nanocrystals in Polyvinyl Alcohol and Hybrid Structure With P-Type Organic Material.
Supervisors : Dr. Neeraj Khare and Prof. G. L. Bhalla
Th 16890

Abstract

Describes the experimental techniques employed for the preparation of samples, structural characterization, optical characterization adn charge transport studeis. The synthesis of the samples by

rf magnetron sputtering, vacuum thermal evaporation, solution casting and self-assembled growth techniques have been described. Studies transport mechanism for the vacuum annealed ZnO thin film. Describes the synthesis of ZnO nanocrystals on polyvinyl Alcohal (PVA) film surface.

Contents

1. Introduction. 2. Experimental techniques. 3. Synthesis of ZnO thin films by rf magnetron sputtering : Structural and optical properties. 4. Electrical transport properties of ZnO thin film. 5. ZnO/α –NPD based inorganic-organic hybrid junctions. 6. Preparation of ZnO nanocrystals and ZnO/PVA nanocomposite. 7. Summary, conclusions and future scope. Bibliography.

525. SANJAI KUMAR

Study of Carrier Lifetime and Related Parameters in Silicon Wafers and Solar Cells by Impedance Spectroscopy.

Supervisors : Dr. P. K. Singh and Dr. G. S. Chilana

Th 16885

Abstract

Deals with the measurement and interpretation of carrier lifetime in silicon wafers, a thorough understanding of which is imporatant from both material as well as device point of view. The minority carrier lifetime insilicon wafers has been measured by applying impedance spetroscopy (IS) technique on induced p^+-p and p-n junctions were formed on both sides of p-type silicon wafer. The resultant device structure is p^+p-n which acts as solar cell. As such, no thermal treatment was given to the device, and therefore deleterious effects related with high temprature processing on carrier lifetime have completely been avoided. It has been shown that both generation and cecombination lifetimes of semiconductor devices can be deducted from the impedance data under reverse and forward bias conditions respectively.

Contents

1. Introduction. 2. Carrier lifetimes in silicon and their measurement. 2. Theory, device development and characterization. 3. Carrier lifetime measurement using impedance spectroscopy. 4. Determination of bulk carrier lifetime using impedance spectroscopy. 5. Study of silicon solar cells and multi-crystalline silicon wafers using impedance spectroscopy. 6. Impedance spectroscopy measurement on induced structure

devices and solar cells under illumination. 7. Development of photo current generation method for carrier lifetime measurement and validation using photo conductive decay technique. 8. Conclusions. Bibliography.

526. SINGH (Budhendra Kumar)
Structural, Piezoelectric, Dielectric, Optical and Electrical Characterization of Flux Grown $Pb(Zn_{1/3}Nb_{2/3})_{0.91}Ti_{0.09}O_3$ Single Crystal.
Supervisor : Dr. Binay Kumar
Th 16770

Abstract

Presents an investigation of Strucutral, Piezoelectric, Dielectric, Optical and Electrical properties of flux grown lead based $Pb(Zn_{1/3}Nb_{2/3})_{0.91}Ti_{0.09}O_3$ single crystals. The growth is carried out using conventional solid-state reaction route after optimizing the growth condition. To minimize the Zn^{2+} dificiency in the grown crystals, excess ZnO has been added during growth to obtain a proper stoichiometric. Structural characterization is carried out using X-ray diffraction. The obtained crystals are further characterized using various techniques viz. Raman, UV-Vis, Microhardness etc. A shift in T_{max}, the temperature corresponding to ε'_{max} with frequency is observed, confirming the relaxor behaviour of the system. The relaxor behaviour of the compounds is studied using various model. Low temperature dielectric and ac conduction behaviour is investigated. The crystals are investigated for Curie Weiss law, Vogel Fulcher relation, Jonscher equation (for frequency dependence of imaginary part of dielectric constant), phenomena of diffused phase transition, dc conductivity, ac condictivity, relaxor behaviour (including relaxation time). Also the activation energy for various phenomena (like conduction, relaxation) has been calculated by non-linear curve fitting.

Contents

1. Introduction. 2. Experimental techniques. 3. Enhancement of perovskite phase and the effect of Ti^{4+} variation. 4. Structural, optical dielectric and piezoelectric analysis. 5. Impedance analyais and NTC thermistor behaviour. 6. Evidence of additonal phases at lower temperature region and calculation of thermo-dynamical parameters. 7. Effect of electric field on dielectric, ac conduction and ferroelectric behaviour. 8. Conclusion and scope for future work. Bibliography.