CHAPTER 43

PHYSICS AND ASTROPHYSICS

Doctoral Theses

01. BANDYOPADHYAY (Bidisha)
Possible Observational Signatures and the Effect of Some Exotic Sources on Cosmic Reionization.
Supervisors: Prof. T.R. Seshadri and Prof. Shiv K. Sethi
Th 23135

Contents

1. Introduction. 2. 21 cm cosmology. 3. Fractal dimension study of neutral hydrogen regions. 4. Helium Reionization by quasars and annihilating dark matter. 5. Helium Reionization by sommerfeld enhances DM annihilation. 6. Summary. Appendix

02. GEETANJALI
Structural Electrical and Defect Studies of Germanium Chalcogenide Glasses and Crystals.
Supervisor: Dr. S. Murugavel
Th 23096

Abstract
(Not Verified)

Chalcogenide glasses are the special class of amorphous solids containing “chalcogen” element sulphur (S), selenium (Se), or tellurium (Te). A range of stable non-crystalline materials can be synthesized in bulk, fiber, and thin film by alloying of chalcogen element with other elements generally from group V (Sb, As) or group IV (Ge, Si). Together with other group (IV, V) elements, they form an interesting class of materials which finds an application in advanced communication and computation technology. The present work deals with investigations on the local structure, electrical transport and nature of defects in germanium based chalcogenide glasses and crystals, understanding their variation with composition and temperature and correlation of the associated defects with transport properties. In the first part of the work, we have carried out the structural, electrical transport and defects studies on the Pb modified Ge-Se glasses which exhibit technically interesting phenomenon i.e carrier type reversal (CTR). The estimated quantities from all the measurements have been discussed in the light of CTR. In the subsequent part, an extensive study on binary Ge-Te glass system with different compositions by using Raman scattering and broad band impedance spectroscopic studies have been carried out. The results have been found to show marked difference at x=20 from the other glass compositions. In the last part, structural studies on single crystal of nano/micro sized α-GeTe have been carried out. Here we present the synthesis of GeTe single crystal with various sizes by using vapor transport method via vapour-liquid-solid (VLS) mechanism. The results obtained in the present thesis work have provided a deeper understanding about the structure and defects variation in the Chalcogenides glasses and crystals.

Contents

1. Introduction to chalcogenide glasses. 2. Experimental and characterization techniques. 3. Structural, electrical transport and defect studies in pb modifies ge-se glasses. 4. Structural and electrical conductivity studies on ge-te glassy systems. 5. Structural studies on nano /micro crystals of α-GeTe. 6. Summary and future scope of work.

03. JYOTI

Growth of Piezoelectric Non-Linear Optical Organic / Semi Organic Single Crystals and their Structural, Optical, Thermal and Dielectric Characterizations.

Supervisor: Dr. Binay Kumar

Th 22879

Contents

04. DEEPAK KUMAR

Development of Single Walled Carbon Nanotube Based Resistive Sensor for Detection of Hazardous Chemicals.

Supervisors: Prof. R.P. Tandon and Dr. P.K. Chaudhury

Th 22878

Abstract

(Not Verified)

The objective of this thesis is to work on the enabling technique and the development of procedure for the fabrication of highly sensitive, selective and reproducible SWNT based sensor for NO_2 and Dimethyl methylphosphonate (DMMP) detection. To fabricate the SWNT based gas sensor following two techniques are used: SWNT thin film resistive sensor over flexible membrane by vacuum filtration and the micro gas sensors by aligning SWNT between pre-patterned electrodes by using dielectrophoresis method. The sensing study of these sensors are carried out at assembled gas sensing setup capable of generating 0.5 ppm to 100 ppm concentration of NO_2, NO, SO_2, CO and NH_3. The fabricated sensors are highly sensitive to NO_2 and give selective response for NO_2 amongst different pollutant gases. These sensors give 1.3 % response 50 ppb of $NO_2$and theoretical detection limit is 125 ppt. The CNT-TFR gas sensor is introduced to different concentration of NO_2 ranging from 0.5-25 ppm and it gives the response of 11.7% to 109.2% with varying concentration of NO_2. The adsorption model is developed for the study of the adsorption of the analyte on the SWNT gas sensor surface. This adsorption model incorporates simultaneously, reversible and irreversible adsorption on the SWNT surface. The adsorption model fit the response reasonably well for all exposed concentration. The response and selectivity of the sensor can be improved by functionalizing it with a functional group which is selective for a particular target chemical. SWNTs based sensor is functionalized with 4-(Hexafluoro-2-hydroxy isopropyl)aniline (HFiP-1) group to enhance the response and selectivity for DMMP a simulant of nerve agent Sarin (warfare agent). The response of the sensor increases from 16.0% to 47.0% for 5 minutes exposure duration.Functionalized sensor gives 0.48% response to 480 ppb of DMMP.

Contents

05. NAVEEN KUMAR

Nuclear Structure of Transitional Strontium (Sr) Nuclei near Shell Closure N=50.

Supervisor: Dr. Suresh Kumar

Th 23136

Abstract

(Verified)

The nuclei in mass A=90 region fall in the category of transitional nuclei and have structure in which single particle excitations compete with collective excitations. This doctoral thesis presents investigation of spectroscopic properties viz energy levels, transition probabilities, spin and parities for ^{85,86}Sr nuclei. The experimental data was obtained following a ^{76}Ge + ^{13}C (45 MeV) fusion-evaporation reaction using Indian National Gamma Array (INGA) with 15 Compton suppressed HPGe clover detectors at Tata Institute of Fundamental Research (TIFR), Mumbai. The double and triple coincidence data has been analyses to establish and confirm the high spin states. The spin and parity of the levels were confirmed using the RDCO value and polarization measurements.In ^{85}Sr nucleus, 50 new gamma-ray transitions and 25 new levels has been identified and previously known gamma-ray transitions have been confirmed. Lifetime measurements were done using Doppler Shift Attenuation Method (DSAM) for two dipole bands. In previous study, a positive parity dipole band was predicted to have Magnetic Rotational (MR) character. In the present work, MR nature of this dipole band has been confirmed. The electromagnetic transition probabilities B(M1) were found to decrease with increase in spin, which is one of the experimental evidence of shears mechanism. In ^{86}Sr nucleus, the level scheme has been extended up to spin and parity I=19 and excitation energy of 10.9 MeV. In present study, the positive parity dipole (ΔI = 1) band with band head at 6878.3 keV level has shown the characteristics of band crossing at I=16. The B(M1) transition rates support the MR phenomenon in this band.The theoretical calculations were also performed for both 85,86Sr nuclei using shell model (having two recent interaction JUN45 and jj44b) and hybrid tilted axis cranking (TAC) model to interpret the experimental nuclear structure and assigned their configurations.

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06. MAMTA

Nonlinear Interactions of a Laser with Plasmas in Relativistic Regime

Supervisor: Dr. Devki Nandan Gupta

Th 22880

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07. PANDEY (Parth Pratim)

Mathematical Models of Cells: Bacterial Growth Laws, Size Control and Balanced Growth.

Supervisor: Prof. Sanjay Jain

Th 22881

Abstract
(Verified)

This thesis presents a new set of mathematical models to describe certain system level properties of growing and dividing cells. Genetically identical bacterial cells exhibit many regularities like the exponential growth of cell-size and intracellular molecular populations between the birth and division of a cell, the dependence of cell-size and molecular composition on the growth-rate of the cells known as the 'bacterial growth laws', and cell-size fluctuations being characterized by the 'adder property' of size-control wherein cells add a fixed volume between birth and division. These are questions related to cellular dynamics at the system level. In our mathematical models of these cellular processes, cell growth is described by well-stirred catalyzed chemical dynamics. Cell division is controlled by an internal 'division-variable', a function of the molecular populations, reaching a threshold. These models exhibit time dependent attractors corresponding to a cell-cycle in steady-state cultures. We identify necessary conditions for chemicals and cell-size to grow exponentially with time within a generation at the steady-state. For a simple coarse-grained model of a cell we obtain explicit formulae for the steady-state growth-rate and ratios of molecular populations in the cell as functions of cellular and medium parameters. By maximizing the growth-rate with respect to one of the parameters, the fraction of ribosomes making ribosomes, we are able to analytically derive the bacterial growth laws. We show that the adder property of size fluctuations can arise as an emergent property of the dynamics of the cell with a suitable molecular mechanism of division control. Our models also shed light on the origin of balanced growth of cells, wherein thousands of chemicals apparently coordinate their doubling between birth and division in the same inter-division time. The models described in this thesis are a step towards a unified mathematical description of several different phenomena exhibited by cells.

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08. RADHESHYAM
Compositional Microstructural and Electrical Characterization of Surface and Interface in HgCdTe Based Heterostructure.
Supervisor: Prof. S.A. Hashmi, Dr. R.K. Sharma
Th 23137

Abstract
(Not Verified)

HgCdTe based IRFPAs are used for high end military and civilian applications from last three decades and are expected to continue in future. This thesis covers the issues related to the surface preparation, dislocations and non-uniformity in HgCdTe material. The surface of the HgCdTe epilayers grown by vertical dipping liquid phase epitaxy has indicated the presence of < 2 μm low-x HgCdTe over layer in the HRXRD and FTIR characterization results. The surface preparation of HgCdTe epilayers was carried out on pellon pad and nylon cloth pad and their results were compared using X-ray topography, defect etching, and atomic force microscopy. Iodine-potassium iodide based non-aqueous solution is proposed for surface preparation of HgCdTe epilayers. A comparative study of the oxide content and elemental tellurium residue on the polished surface is made using X-ray photoelectron spectrometry measurements. Possibility of the diffusion of Potassium during I-KI polishing has been ruled out at the HgCdTe surface as well as at CdZnTe/HgCdTe interface using secondary ion mass spectrometry investigation. A new etchant, based on the modification of standard Chen etchant has been developed for revealing etch pits in HgCdTe epilayers at (111)B and (110) planes. The oxidizing and dissolving agents in the solution have been optimized by systematic experimentation to obtain the new etchant. The dislocations were investigated by the study of etch pits at (111)B surface and at the cleaved plane, i.e., (110) face. A statistical method has been proposed for analyzing the performance non-uniformity of HgCdTe photodiode arrays. The dynamic resistance verses voltage signatures have been parameterized in such a way that the obtained signature

parameters have some relevance with different physical parameters. The proposed method is useful for initial technology development and for quick analysis of the process variations and optimization.

Contents

1. Introduction. 2. Characterization tools and their theory. 3. HgCdTe surface and its preparation. 4. Surface studies on HgCdTe using non-aqueous iodine based polishing solution. 5 Study of dislocations in HgCdTe. 6. Numerical analysis of non-uniformity over the focal plane array. 7. Conclusion and future work.

09. ROHILLA (Aman)
Lifetime Measurements Probing Nuclear Structure Issues at High Spins In ^{167}Lu and ^{188}Pt.
Supervisor: Prof. A. A. Sen
Th 22883

Abstract
(Not Verified)

In the present thesis work, we report the nuclear shape properties at high spins in ^{167}Lu and ^{188}Pt using lifetime measurement technique. The level lifetimes were measured by Recoil Distance Doppler shift Method (RDM). All the experimental work was done using RDM plunger setup available at IUAC, New Delhi. To populate high spin states in ^{167}Lu and ^{188}Pt nuclei, the ^{159}Tb(^{12}C, 4n) @ E_{lab} = 68 MeV and ^{174}Yb(^{18}O, 4n) @ E_{lab} = 84 MeV respectively were used. From the measured level lifetimes, the reduced transition probabilities (B(E2)) and the transitional quadrupole moments (Q_t) were extracted. The Lu - nuclei (A = 160-167) belonging to the rare earth region where strongly deformed prolate shapes are found in the ground state but strongly deformed triaxial nuclear shapes (TSD) have been observed at high spins (I > 30 ħ). In our measurements we extracted the level lifetimes of ^{167}Lu up to 29/2$^-$ħ state. The extracted B(E2) values show stable behavior with increasing spin with high average Q_t(= 6.98 eb) value, which indicate stability of highly deformed structure for ^{167}Lu. The Pt-nuclei with A ~ 190 belong to the region of shape coexistence and shape transition. For Pt isotopes, shape transition rather than the shape coexistence is predicated with transition of shape from prolate to oblate happening at A = 188. In our measurements we extracted the level lifetimes in ^{188}Pt nucleus upto 12$^+$ state. The extracted B(E2) values show a sharp increase upto 4$^+$ state and a near constant nature thereafter with increasing spin. Comparing the experimental values with the results of the triaxial projected shell model (TPSM) and the total routhian surfaces (TRS) calculations gives contrasting picture, suggesting further theoretical investigations in this nucleus.

Contents

1. Introduction to nuclear structure 2. Scientific motivation 3.Theoretical consideration 4. Experimental techniques and data analysis. 5. RDM lifetime measurement in ^{167} lu 6. RDM lifetime measurements in ^{188} pt. 7. Summary, Conclusion and future outlook, Appendix, Bibliography.

10. SAMPURNANAND
Cosmology and Particle Physics from Higher Dimensional Theories.
Supervisor: Prof. A. A. Sen
Th 22883

Abstract
(Not Verified)

In this thesis, we have provided a mechanisms to stabilize the modulus and simultaneously address the above mentioned hierarchy problem by considering the correction, liable in any quantum theory of gravity, to the Einstein-Hilbert action itself in the form of f(R). Since, scalar field (in the Einstein frame) would

couple to the metric as well. It is expected that the the field would backreact on the metric. Hence, we tried to present a more realistic situation by considering the backreaction of the field on the metric. This thesis also reports that the late time acceleration of the universe can be ascribed to the extra spatial dimensions. We consider a particular kind of model which assumes that only gravity is allowed to diffuse into extra dimensions. Based on this idea, Dvali, Gabadaze and Porrati proposed a model which assumes a 1+3 dimensional brane embedded in flat five dimensional spacetime. In a particular limit, the specific form of the 1+3 dimensional action for the scalar field, which is the manifestation of extra dimension and usually represented by π, inherits a symmetry from a combination of five dimensional Poincare invariance and the brane reparametrization invariance. However, in the small field limit, these symmetries reduce to Galilean symmetry. The scalar field π which appears in the effective theory is associated with the Galilean symmetry as well and hence, known as the galileon field and the terms in the action are referred as Galileon terms. Later on, it was shown that the Galileon terms, in certain limit, arise from an action for a brane living in flat five dimensional space which share the symmetries of Dirac-Born-Infeld (DBI) action. We have studied the cosmological implications of such a general scenario.

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11. SANTHUST

Structure of Intracellular Regulatory Networks in Bacteria: Hierarchy and Feedback.

Supervisors: Prof. Sanjay Jain and Prof. Shobit Mahajan

Th 22884

Abstract

(Not Verified)

We study the global architecture and design principles of gene regulatory networks (GRNs), focusing on the GRNs of two bacteria Escherichia coli and Bacillus subtilis. The networks are taken from databases that exist in the literature. The GRN of E. coli consists of approximately 3300 genes and 9000 interactions, and that of B. subtilis of approximately 1600 genes and 3200 interactions. The network is treated as a directed graph whose nodes are genes and a directed link between two nodes means that the product coded for by the gene at the source node of the link regulates the expression of the gene at the target node of the link. We study a number of structural (graph theoretic) and functional properties of these networks, e.g., bottlenecks, two component systems, conserved genes, feed forward loops, etc. We find that the complicated looking GRNs can be organized into a causal, largely acyclic (hierarchical) architecture, with a few islands of feedbacks. We augment the GRN by introducing nodes and links corresponding to metabolites belonging to the metabolic network (MN) that bind to transcription factors and change their regulatory activity, thus adding new feedbacks into the network. Further, we determine active feedbacks from MN into GRN in several environmental conditions using flux balance analysis (FBA). We analyse the resulting network by identifying its strongly connected components (SCCs) and constructing the hierarchical graph that connects these components. We identify these SCCs as modules, each representing a sub-system of the whole network having a dynamics which is relatively independent of the rest of the network. Our method not only sheds light on the causal architecture of the network but also provides an algorithmic way of identifying certain dynamical modules of the metabolic-regulatory system.

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augmented with metabolic feedbacks can be associated with functional modules. 5. Conclusion and Appendixes.

12. SHARMA (Jyoti)
Magnesium Ion Conducting Polymer Electrolytes for Solid-State Magnesium Batteries.
Supervisor: Dr. S. A. Hashmi
Th 22885

Abstract
(Not Verified)

The thesis contains seven chapters focused on the preparation and characterization of some novel magnesium ion conducting polymer-based electrolytes suitable of magnesium batteries. Polymer electrolytes are the materials of growing importance in view of their applications in solid state ionic devices, the most important of which is high energy density rechargeable batteries. By employing thin films of solid polymer electrolytes to substitute liquid electrolytes, several advantages such as improved electrochemical stability, thermal stability, absence of leakage, miniaturization and better transportability are anticipated. In thesis, magnesium ion conducting polymer electrolytes incorporated with plastic crystal succinonitrile and nanocomposites gel polymer electrolytes dispersed with Al_2O_3/$MgAl_2O_4$ were prepared by using solution cast method. Prepared electrolytes were characterized by various structural/morphological, thermal and electrochemical techniques like optical microscopy, FESEM, XRD, FTIR, Raman spectroscopy, DSC, TGA, ionic conductivity, ESW, CV, LSV and transport number measurement. The performance characteristic of polymer electrolytes indicates their potential applicability as electrolytes in magnesium batteries. The magnesium batteries using magnesium, magnesium composite, tin, tin composites as anode and manganese dioxide (MnO_2) as cathode with optimized GPEs have been fabricated. The charge-discharge behaviour of the prepared cells is presented and discharge capacity has been calculated for the first discharge curve of each cell. Nanocomposite gel polymer electrolyte appears to be the most appropriate electrolyte material, which suggests its usefulness in the development of magnesium batteries. Finally, my deepest gratitude and warmth regards to Dr. S. A. Hashmi and advisors Dr. Shyama Rath and Dr. Binay Kumar for their valuable suggestions, guidance and motivation for the completion of the research work.

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13. SHARMA (Varun)
Search for Excited Quarks at √s + 8Te V with the CMS Experiment at the Large Hadron Collider
Supervisor: Prof. Brajesh Chandra Choudhary
Th 22886

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14. SOLANKI (Raman)
Study Of Aerosol Distribution And Associated Meteorology Over The Central Himalayas
Supervisor: Dr. Narendra Singh and Dr. S.K. Dhaka
Th 23097

Abstract
(Not Verified)

Air pollution is intrinsically linked with meteorological parameters and this linkage further strengthens over complex mountainous terrain, an attempt to understand this association over a mountain ridge in the central Himalayas through measurements of aerosol vertical distribution, surface layer characteristics and local boundary layer (LBL) evolution is being made. This study presents ground based measurements taken at ARIES, Nainital (Manora Peak, 79.5oE, 29.4oN and 1958 m AMSL). Intermittent LiDAR observations were made during March 2012 to May 2013, which revealed highest aerosol loading (3.40 (Mm sr)-1 at 3.3 km) in the vertical column during MAMJ-2012, and the lowest (0.48 (Mm sr)-1 at 2.5 km) during DJF 2012-13. A comparison of ground based LiDAR observations with the CALIPSO satellite derived aerosol backscatter profiles has also been made. The mean percent bias are found to be +18±42%, +22±28%, +32±36% and +18±51% for MAMJ-2012, SON-2012, DJF-2012-13 and MAM-2013 respectively. Surface layer characteristics have been studied during spring (2013) and winter (2013-14) season, utilizing the three-dimensional wind components and virtual temperature observed with a pair of sonic anemometers. Sensible heat flux (H) exhibits prominent diurnal variations attaining peak values at noontime; the seasonal mean H decreases from spring (50 W m-2) to winter (17 W m-2) season. The time-evolution of the LBL has also been studied using a Radar Wind Profiler (RWP) (November 2011 to March 2012). A criterion of SNR > 6 dB for the LBL characterization has been implemented. The daytime average observed LBL height ranges from 440±197 m in November to 766±317 m in March. The RWP measurements of LBL are further utilized to evaluate biases in model simulated boundary layer and the implications of these biases in context with trace species model simulations.

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15. THOMAS (Mathew Arun)
Formalism And Phenomenology of Six Dimensional Warped Space.
Supervisor: Prof. Debajyoti Choudhury
Th 22887

Abstract
(Verified)

The warped geometry model of Randall and Sundrum (RS) while very successful in addressing several problems of the Standard Model(SM), cannot survive the negative search results at the LHC, unless a large hierarchy is reintroduced. We circumvent this by introducing a 6-dimensional generalization with nested warping. Calculating the graviton masses and their couplings to SM particles, we find regions in parameter space where the graviton naturally evades the LHC bounds while respecting the hierarchy and quantum gravity constraints. Continuing on this, we show that the model can accommodate the reported 750 GeV resonance. As our next task, we decouple the SM from the brane and allow the fields to propagate in the bulk. After setting up the entire formalism, we confront (and satisfy) the constraints from electroweak precision tests and other low-energy observables. These four papers show that nested warping is much richer than RS. One regime of the theory has a geometry conformal to an ADD like extension of the 5-dimensional RS scenario. The second regime, with the induced cosmological constant nearly vanishing, possesses 5-dimensional hypersurfaces with flat metric, resembling a Universal Extra Dimensional (UED)

scenario.In the last chapter, we show that both the large coupling and small coupling limits could be dynamically stabilized. An interesting consequence is that we can dynamically stabilize the 5-dimensional UED scale along with finding a solution for the mass hierarchy problem. The resultant theory has a protected Higgs scale, a UED scale and, with the SM localized on this 5-dimensional hypersurface, a viable Dark Matter candidate.

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16. TYAGI (Punit)
Development of SO_2 Sensor Using SnO_2 Thin Film Based Heterostructures and Nanocomposites
Supervisor: Prof. Vinay Gupta
Th 22888

Abstract
(Verified)

Sulphur dioxide (SO_2) gas is a toxic gas having a pungent and irritating smell and contributes to acid rain. Hence, SO_2 gas sensing is of utmost importance. Among a variety of semiconducting metal oxides, tin oxide (SnO_2) is the most preferred material for gas sensing application because of its enhanced ability to adsorb/desorb oxygen molecules from the atmosphere on its surface. The present work aims towards the development of efficient low temperature operated sensor structures based on SnO_2 sensing element with high sensing response for detecting low concentration of SO_2 gas. Deposition conditions (Pressure = 10 mT) of rf sputtered SnO_2 thin films have been optimized and an enhanced sensing response (1.23) is obtained at a low operating temperature (220 °C) towards 500 ppm SO_2 gas for 90 nm thickness. NiO nanoclusters (thickness =10 nm) were dispersed on the surface of optimized SnO_2 thin film and a maximum sensing response (~56) at low operating temperature (180 °C) with fast response time (80 sec) and recovery time (70 sec) was obtained. The modification in structural and surface morphology of NiO/SnO_2 heterojunction sensors using swift heavy ion (SHI) irradiation of Ni^{7+} is investigated. The sensor exhibits high sensing response of 84 at a low operating temperature of 40 °C with high response time and recovery time of 19.5 min and 37.5 min respectively. To detect SO_2 at lower temperature, hybrid nanocomposite of SnO_2 nanoparticles with MWCNTs and rGO were prepared separately using chemical route. rGO-SnO_2 nanocomposite sensor showed enhanced sensing response (~84) in comparison to MWCNTs-SnO_2 (~8) at an operating temperature of 60 °C. Simultaneous efforts in packaging and reliability testing of the already developed sensor after integrating the heater with the sensing element are also presented. The obtained results are encouraging towards the mass production and commercialization of reliable gas sensors.

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17. YADAV (Harsh)
Morphological, Optical and Dielectric Studies of Piezoelectric Crystals Grown By Solution And Modified Czochralski Technique For Patch Antenna Fabrication
Supervisor: Dr. Binay Kumar
Th 22889

Abstract
(Verified)

High quality well characterized single crystals are needed to understand the basic science and also to fulfill modern technological needs of various devices. In the present thesis, growth of organic and semiorganic single crystals of benzil, pure and dye (crystal violet and xylenol orange) doped benzophenone, lithium sulfate monohydrate oxalate and benzyl by slow evaporation solution and Czochralski techniques are reported. A modification in the Czochralski system was performed which facilitated the growth of single crystals of low melting point organic crystals. A novel method to predict the crystal morphology was proposed which is based on the geometrical considerations and HNB propagation vector which has given better result to match the experimentally observed morphology of grown crystals. Intermolecular interactions are investigated using Hirshfeld surface analysis. The structural, optical, dielectric, piezoelectric, thermal and mechanical properties of grown crystals have been studied and the results are discussed. Effect of doping and growth conditions on various properties of crystals were studied. These crystals were found to belong to the category of the nonlinear optical and piezoelectric materials, which make them suitable for laser tuning and dielectric substrate for device (patch antenna) applications. Microstrip patch antenna is a type of radio antenna which needs a significant attention in the wireless communications due to its light weight, small size, low cost, ease of fabrication, narrowband, wide-beam etc. Rectangular and circular patch antennas, using the grown organic single crystal substrates, are simulated and fabricated for single and dual band communication applications in GHz range. The experimental value of working frequency of the fabricated patch antennas was achieved to be close to the simulated and predicted value. In summary, the thesis presents growth of important organic crystals by modified Czochralski technique, their characterization and use in fabricating communication devices.

Contents

18. YADAV (Pinki)
Study Of Parametric Instabilities In Plasmas Relevant To Fusion.
Supervisor: Dr. Devki Nandan Gupta, Prof. Avinash Khare
Th 23138

Abstract
(Not Verified)

This thesis presents the study of parametric instabilities in plasmas relevant to fusion. Main objective of this thesis is to understand the theory and simulation of parametric instabilities in plasmas, especially as it pertains to inertial confinement nuclear fusion. Controlled thermonuclear fusion of hydrogen isotopes (deuterium and tritium) into helium offers the possibility of a virtually unlimited source of energy. Parametric instability conventionally implies the modulation of the parameters such that plasma density, particle drift, subsequent excitation and Eigen modes of the system i.e. growth of waves in the plasma at the expense of a large amplitude wave, via modification of plasma parameters etc is called as parametric instability. In a parametric instability, a pump wave excites sidebands and low frequency fluctuations. Some studies on parametric instabilities have been studied in the interaction of laser with plasmas, such as the stimulated Raman scattering, stimulated Brillion scattering, two-stream instability etc. In this thesis, we have worked on these phenomena and our findings may be a major step towards the application of laser based fusion mechanism. The instabilities in laser-produced plasma can be seen but the threshold laser intensity would be significant for development of instability. These results are relevant to laser driven fusion where high intense laser required initiating fusion process. The objective of this thesis is to understand the basic phenomena resulting from the interaction of laser pulses with plasmas. In a broad prospective, the work here can be described as a detailed theoretical study of laser-plasma interaction via parametric instabilities. To explore the possibility of laser-fusion, laser-plasma interaction has been a subject of world-

wide research, revealing many novel nonlinear phenomena. Theoretical studies of laser-plasma instabilities have become particularly important in recent years as a result of the vigorous research effort in laser-driven inertial confinement fusion (ICF).

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