

Studies on microwave lamellar reflection gratings

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Abstract : We derive the expression for the intensity of the diffracted waves from a lamellar reflection grating. We attempt the problem by examining the effects of the elevations and that of the depressions separately and finally derive the resultant intensity.

If suitably designed, the applicability of such a grating may be extended to the microwave regions apart from the normal optical and near infra-red region in which it is mostly used. Such a microwave reflection lamellar grating can have significant applications in astronomy and astrophysics. By proper choice of geometrical parameters and modifying its construction with suitable materials, a lamellar grating may be used as a microwave antenna in space communications as well.

Keywords : Microwave diffraction, lamellar gratings, microwave antenna.

PACS No. : 84.40.Az, 84.40.Ba, 42.79.Dj, 84.40.Ua

A laboratory study on the effect of sulfuric acid on charge transfer during ice-graupel collision

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Abstract : Charge transfer experiments were carried out inside a walk-in cold room to investigate the sign and magnitude of charge that is transferred to the graupel (soft-hail) during collision between ice crystal and graupel. Different concentrations (0%, 25%, and 50%) of aqueous solution of sulfuric acid were used to produce cloud during the experiments. A cloud of supercooled droplets is formed inside the cloud chamber by heating the aqueous solution of sulfuric acid, and the ice crystal formation in the cloud is initiated by momentarily introducing a metal rod dipped in liquid nitrogen into the cloud. It is observed that the magnitude of charge transfer increases with concentration of sulfuric acid in the aqueous solution. If the aqueous solution contains 25% and 50% of sulfuric acid by weight, a coat of dark film is seen on the crystal surface. Due to this film, the crystals boundaries are no longer sharp and well defined like that observed in the crystals produced in pure water cloud. It is suggested that during collision between ice crystal and graupel, this film could be transferred to the graupel resulting in higher values of charge transfer.

Keywords : Thunderstorm electrification, sulfuric acid, graupel, charge transfer.

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On the phenomenology of enzyme-substrate recognition

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Abstract : A model for enzyme-substrate recognition is presented in which both the substrate and the enzyme are represented by Hilbert space operators A and W of trace class; and the recognition proceeds by the evaluation of the trace functional $Tr(AW)$. The eigen values of A (and analogously of W) are interpreted as response values that the substrate can give to an enzyme. The non-commutativity or otherwise of A and W permits to incorporate both the induced-fit hypothesis as well as the lock-and-key ansatz in the model. Key features of recognition like finite power of resolution, the specificity of the recognition states as well as the duality during recognition between the enzyme and the substrate are derived. Several refined aspects of recognition like invariance under change of state in induced-fit situation, a quantitative measure of recognition as well as the existence of a complete set of simultaneous recognition states in the lock-and-key situation are deduced. The present model substantially refines earlier models proposed by Edelman and Rosen and by Louie, Richardson and Swaminathan.

Keywords : Enzyme-substrate recognition, Hilbert space operator, eigen values and eigen space, induced-fit theory, lock and key hypothesis.

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Three-dimensional viscous fingering patterns in a lifting Hele-Shaw cell : a simulation study

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Abstract : A hierarchical pattern is formed by viscous fingers in a lifting Hele-Shaw cell. If the defending fluid is visco-plastic, a permanent three-dimensional pattern is formed which is usually approximated as quasi-two-dimensional. The viscous fingers show a hierarchical pattern due to competition between growing fingers in a converging geometry. Using a simple algorithm, a Monte-Carlo simulation is presented which attempts to reproduce the real three-dimensional pattern in rectangular geometry. The finger-length distribution, rate of increase of coverage of the invading fluid, the height profile of the final pattern is calculated and their variation studied with changes in the characteristics of the fluid.

Keywords : Viscous fingering, pattern formation, computer simulation, Hele-Shaw cell.

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Study of bound states in Schrödinger equation of a particle using the Hopfield model of artificial neural network

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Abstract : In the solution of Schrödinger equation for a particle, confined within one-dimensional infinitely hard boundaries, there are discrete energy states in which the particle can exist. The particle has finite probability of finding itself inside the boundaries for ground, first, second... n -th excited states (*i.e.* for quantum numbers $n = 1, 2, 3, \dots, n$). To explore the optimized possibility of finding a particle inside the boundaries for any quantum number, we use the Stochastic Hopfield Neural Network Model with Mean field Approximation of Simulated Annealing. In this process, the network activation dynamics at a given temperature, reaches the thermal equilibrium position. This equilibrium position is the steady state position of the network that is achieved only if the probability of visiting the global minimum energy states becomes maximum and it refers to the optimized probability of finding the particle inside the boundaries.

Keywords : Bound states, Schrödinger equation, Hopfield model, mean field approximation, simulated annealing.

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Theoretical study of waves diffracted from asymmetrical profile lamellar gratings

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Abstract : Diffraction from a microwave asymmetrical lamellar grating (ALG) has been thoroughly investigated. Expressions for intensity, dispersive and resolving power for such a grating have been derived. It is anticipated that such gratings with asymmetrical structure may be used with significant advantage for taking observations in both optical and quasi-optical region. By a suitable choice of geometrical parameters, its applicability may as well be extended to the millimeter and microwave bands which will have significant applications in instruments for astronomical observations and microwave space-communication.

Keywords : Microwave diffraction, millimeter waves, lamellar gratings.

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Photon tunneling and light transmission in transparent media

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Abstract : We show that the light transmission in transparent media can be described using photon tunneling phenomenon. Photon tunneling time for the index of refraction barrier can be investigated using Helmholtz wave equation. We report an analytical expression for the tunneling time of a photon from the index of refraction barrier as well as the transmission coefficient. It is predicted that the tunneling time depends on the refractive index, the thickness of barrier, and also on the incident wave frequency. We will exploit this idea to describe the light transmission in transparent media. A comparison with the experimental data and the theoretical result is also reported.

Keywords : Photon tunneling, transit time, light transmission in transparent media, index of refraction barrier.

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Spectroscopic investigation and vibrational analysis of paraldehyde by FTIR and laser Raman techniques

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Abstract : Paraldehyde is a trimer of acetaldehyde formed from this under acid catalysis. It falls under the broad classification of the sedative hypnotics used as anti-convulsant in epilepticus and tetanus. The work presents vibrational band analysis on the molecular structure of the compound paraldehyde through infrared and Raman spectral measurements. Normal coordinate analysis has been carried out with a new set of symmetry coordinates to obtain the molecular force field of the system based on C_{3v} point group symmetry. Potential energy distribution evaluated for all the normal modes of vibration, confirm that the chosen set of vibrational frequencies contribute maximum to the potential energy associated with the normal coordinates of the molecule.

Keywords : Vibrational spectroscopy, paraldehyde, normal coordinate analysis, potential energy distribution.

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FTIR and laser Raman spectra of 2-amino-5-bromobenzoic acid

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Abstract : The method of normal coordinate analysis is used to evaluate the force constant and the vibrational frequencies of 2-amino-5-bromobenzoic acid. FTIR and laser Raman spectra have been recorded and the assignments of vibrational frequencies have been made. The calculated values of the frequencies fairly agree with the experimental values.

Keywords : FTIR and laser Raman spectra, 2-amino-5-bromobenzoic acid, vibrational assignment.

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Particle aspect analysis of the electrostatic ion-cyclotron instability : effects of ion and electron beam and general distribution function

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Abstract : Dispersion relation, resonant energy transferred, growth rate and marginal stability of the electrostatic ion cyclotron wave (with general loss-cone distribution function in low β homogeneous plasma) in the presence of upgoing ion beam and downcoming electron beam are discussed by investigating the trajectories of the charged particles. The wave is assumed to propagate obliquely to the static magnetic field. The whole plasma is considered to consist of resonant and non-resonant particles. It is assumed that resonant particles participate in energy exchange with the wave whereas non-resonant particles support the oscillatory motion of the wave. Effects of the steepness of the loss-cone distribution and ion and electron beam velocities on resonant energy transferred and growth rate of the instability are discussed. It is found that the effect of upgoing ion beam is to stabilize the wave and enhance the transverse acceleration of ions whereas the downcoming electron beam acts as a source of free energy for the electrostatic ion-cyclotron wave and enhances the growth rate. Effect of steepness of loss cone is also to enhance the growth rate and decrease the transverse acceleration of ions. The results are interpreted for the space plasma parameters appropriate to the auroral acceleration region.

Keywords : Electrostatic ion cyclotron wave, auroral acceleration region, loss-cone, ion and electron beam.

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Large amplitude ion-acoustic solitary waves in a relativistic multi-component plasma

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Abstract : Exact Sagdeev potential for a multidimensional relativistic multi-component plasma consisting of both positive and negative ions is derived without neglecting electron inertia. It is shown how the negative ion concentration, solitary $\frac{L.v\alpha_0}{c}$ all play significant role in determining the nature of solitary waves.

Keywords : Ion-acoustic solitary waves, large amplitude, relativistic multi-component plasma.

PACS Nos. : 52.35.Qz, 52.35.Fb

Studies of some elements in urinary stones by proton induced X-ray emission (PIXE) technique

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Abstract : The levels of trace elements in urinary stones were investigated by PIXE technique at CCCM, Hyderabad using protons of 2.5 MeV energy. Some of the common elements detected were Ca, Fe, Cu, Zn and Sr and the distribution of the said elements were observed at various region of the stone.

Keywords : PIXE, urolithiasis, trace element.

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