

Planetary orbits around a spinning gravitating star

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Abstract : It is an empirical fact based on solar physics of sunspots, that our sun and generally stars are spinning gravitational sources for bodies in orbit in any such solar system. Thus, a planetary theory for the gravitational field of a star or a satellite dynamics around a (spinning) planet – including the problem of artificial satellites – should in principle, take into account the possible effect of axial symmetry. But to the best of our knowledge, existing formalisms of gravitation physics do not address the problem of spin referred to above. This paper proposes the following strategy to handle this kind of computational physics. Our calculations suggest that this kind of spin should give rise to a slight residual perturbation on constant areal velocity, computed by the standard model of orbital theory. In particular, the second law of planetary motion might require revision. Also, it turns out that the classical result of Kepler is recoverable from our result as a special case.

Keywords : Spin of a star, planetary orbits, Kepler's laws, areal velocity

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Determination of the expected solar diurnal vectors of cosmic rays on the earth

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Abstract : Using the best-fitting technique, we determined the parameters of the solar diurnal vector in free space by considering one space anisotropy of the flat spectrum and by using the observed cosmic-ray data of the Deep River neutron monitor as well as the Socorro underground muon telescope over two solar cycles. Positive results have been obtained for these parameters. Further, we used the above parameters of the solar diurnal vector in free space to calculate the expected solar diurnal vectors of cosmic rays on the Earth for other 10 neutron monitor stations. Comparison between the observed and the expected solar diurnal vectors of the above stations shows that both the expected as well as the observed amplitude and phase are very close to each other for stations of low cut-off rigidity. However, as the cut-off rigidity increases, the expected and the observed amplitude and phase differ from each other.

Keywords : Cosmic rays, solar modulation

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The universe of operations of thermodynamics vis-à-vis Boltzmann integro-differential equation[†]

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Abstract : In a previous paper [*Indian J. Phys.* **76B** 715 (2002)], we have elaborated Bridgman's assertion about the "universe of operations" of thermodynamics which revealed that the time scale shorter than τ_{therm} (the minimum time required for sensing of thermal interaction) falls in the domain of natural fluctuations. Using the Boltzmann integro-differential equation, we have traced in this paper, the origin of the natural fluctuations which in essence, is the case of breakdown of the *equal a priori probability* for binary collisions and their reverse ones. Thus the natural fluctuations about equilibrium states (both under adiabatic and non-adiabatic conditions), nonequilibrium stationary states and the general nonequilibrium states have been discussed. Using the deductions thereof, the mathematical expressions for probability of achieving nonequilibrium state on account of natural fluctuations about equilibrium and nonequilibrium states have been rationalized. These deductions also help in understanding the origin of replicas of a given system in a Gibbsian ensemble. These findings are crucial for developing an irreversible thermodynamic framework and also for evolving corresponding statistical mechanical description. The minimum time scale of τ_{therm} when imposed on the statistical mechanical description, generates the corresponding thermodynamic description and hence the application of this condition is indeed, an act of imposing the dictates of the laws of thermodynamics on the microscopic level of mathematical expressions.

Keywords : Statistical mechanics, irreversibility, fluctuations, nonequilibrium thermodynamics, Gibbsian ensemble.

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Theoretical and experimental investigations on the frequency selective property of an array of slotted dipoles

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Abstract : A frequency selective surface (FSS) comprising of a two dimensional array of slotted dipoles resonant at a single frequency is proposed. A computationally efficient method for analyzing this FSS is presented. The formulation is carried out in the spectral domain where the convolution form of the integral equation for the induced current reduces to an algebraic one and the Spectral-Galerkin technique is used to solve the resulting equation. Entire- domain basis function that satisfies the edge condition is introduced to expand the unknown induced current on the complimentary structure *i.e.* an array of metal printed dipoles. Using Babinet's principle for complementary screen, the transmitted electric field for the structure of slotted dipoles have been calculated. This theoretical result has been compared with the experimental data also. The theoretical and experimental data indicate that this structure can be used as a band pass filter.

Keywords : Frequency selective surface, slotted dipoles, spectral-Galerkin technique, band pass filter

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Fourier transform emission spectroscopy of the $A^1\Pi - X^1\Sigma^+$ transition in $^{74}\text{Ge}^{80}\text{Se}$

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Abstract : For the first time, the electronic spectrum of the specific isotopomer $^{74}\text{Ge}^{80}\text{Se}$ of germanium monoselenide was produced in a microwave discharge through an electrodeless quartz tube containing the single isotopes of ^{74}Ge and ^{80}Se and neon as carrier gas. The bands in the 35000-25000 cm^{-1} region belonging to the main transition $A^1\Pi - X^1\Sigma^+$ were recorded on BOMEM DA8 Fourier transform spectrometer under medium (10 cm^{-1}) and high (0.05 cm^{-1}) resolutions. In all, an overwhelming 344 bands, including several new bands in the 28000-25000 cm^{-1} region have been assigned to the $A-X$ system. The observation of isotopically pure spectrum has enabled a comprehensive vibrational analysis of the $A-X$ bands. The Franck-Condon factors (FCF) and r-centroids were computed and the observed intensities were compared with the FCFs. To facilitate the FCF calculations the rotational analysis of the (0-5) band has also been carried out.

Keywords : Germanium monoselenide, Fourier transform spectrum, vibrational analysis, rotational analysis.

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Electronic spectral studies of 2-chloro-6-methoxypyridine in various solvents

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Abstract : The present work reports the electronic transition bands of 2-chloro-6-methoxy pyridine molecule in liquid state and the effect of α -halogen atom on the absorption intensity of the *B*-band (characteristic band of aromatic ring). The $\pi - \pi^*$ transition (*E*₂-band) has shown the usual behaviour towards the substitution and the polarity of the solvents. But the $n - \pi^*$ transition (*R*-band) has evidenced a usual behaviour towards the solvent polarity and unusual behaviour towards the substitution (*i.e.* the $n - \pi^*$ transition has shown red shift with respect to the $n - \pi^*$ system of pyridine). The halogen atom and/or ortho para directing group (having high potential for a large inductive effect) have shown a marked influence on the sp^2 electrons of the *N*-atom of the ring. As a result, the *B*-band has evidenced an unusual behaviour *i.e.* it has not shown a hyperchromic effect with increase in the polarity of the solvent.

Keywords : Ultraviolet absorption spectra, electronic absorption bands, effect of substitution and solvent polarity.

PACS Nos. : 33.20.Lg, 31.70.Dk

Vibrational studies of trifluoromethyl benzene derivatives : II 5-amino-2-fluoro and 5-amino-2-chloro benzotrifluorides

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Abstract : Raman spectra of 5-amino-2-fluoro and 5-amino-2-chloro benzotrifluorides have been recorded in the liquid phase on a Jobin Yvon Ramanor HG.2S and a Spex 1403 spectrometers in the spectral range $100\text{-}4000\text{ cm}^{-1}$. Polarisation measurement for the observed Raman lines has also been carried out. Infrared spectra of these two compounds have been recorded in the spectral range $200\text{-}4000\text{ cm}^{-1}$ on a Perkin Elmer 783 and on an FTIR model Cygnus-100 (Mattson Co.) spectrometers. Assuming C_s point group symmetry for these molecules, vibrational assignments for the observed frequencies have been proposed. Out of the 45 expected normal modes, 43 could be assigned on the basis of the observed frequencies directly and 2 are estimated from the assignments of overtone/combination bands.

Keywords : Raman and IR spectra, vibrational frequencies, normal modes, 5-amino-2-fluoro-and 5-amino-2-chloro benzotrifluorides

PACS Nos. : 33.20.Ea, 33.20.Fb, 33.20.Tp

Electronic spectra of oxadiazoles

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Abstract : MRINDO/S calculation augmented by singly excited configuration interaction was performed on oxadiazoles. Net charge distributions, ionization potentials and electronic spectra of oxadiazoles are reported. The Rydberg transitions are also discussed.

Keywords : Oxadiazoles, ionization potentials, electronic spectra

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Double pass *L*-band erbium-doped fiber amplifier with enhanced gain characteristics

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Abstract : A double pass long wavelength band (*L*-band) erbium-doped fiber amplifier (EDFA), which can effectively suppress and completely exploit the backward conventional band (*C*-band) amplified spontaneous emission (ASE) with a reflector, is presented in this paper. Circulator or broadband fiber Bragg grating (FBG) is used as the reflector to doubly passing the forward ASE and signal in the erbium-doped fiber (EDF). The gain of the double pass EDFA can be improved by about 10dB with an extra noise figure penalty of about 3dB, compared to the conventional single pass EDFA.

Keywords : Erbium doped fibre; optical amplifier; *L*-band; double pass technique; backward ASE

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Studies of the emission characteristics of erbium / ytterbium-doped optical fibers

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Abstract : Modified Chemical Vapor Deposition (MCVD) process along with solution-doping technique is used for the fabrication of Er/Yb-doped optical fibers. The spectral variation of amplification of spontaneous emission (ASE) has been measured by pumping Er/Yb-doped fiber with the wavelength of 800 nm at 100 mW power. Peak emission-wavelengths have been obtained at 971 nm and 1050 nm for Yb³⁺ and 1537 nm for Er³⁺. The emission cross-sections for Yb³⁺ and Er³⁺ are found using the fluorescence characteristics of the fiber and the absorption cross sections are calculated using Mc-Cumber relationship. This work will be useful for designing Er-doped, Yb-doped and Er/Yb co-doped amplifiers and lasers.

Keywords : Fiber amplifier, solution doping, amplification of spontaneous emission, fiber lasers

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FTIR–characterisation and thermal analysis of natural calcite and aragonite

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Abstract : The data given in the literature for the infrared identification of carbonate minerals is summarised, and a technique is described which may be used to identify calcite, aragonite, kaolinite, nacrite, feldspar, quartz, montmorillonite, illite, tourmaline, gibbsite and saponite by the analysis of their infrared absorption bands. The fundamental vibrations of aragonite and calcites are identified. The changes in these modes are analysed through thermal treatment. Structural changes occur in aragonite of coral reef to calcite beyond 350 °C. The quality of calcite is assessed by detecting the presence of quartz and dolomite.

Keywords : Limestone, coral reef, calcite, aragonite and FTIR

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Daytime very low frequency (VLF) emissions observed at Maitri station, Antarctica

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Abstract : The present paper deals with the study of naturally occurring Very Low Frequency (VLF) radio waves at Indian Antarctic Station, Maitri (70° 46'S, 11° 44'E) on the basis of routine continuous observation made during day time. From the detail analysis of daytime data on the basis of continuous observation made at the ground station, we have presented a few of VLF phenomena such as rising types of emissions - discrete and periodic emissions. These recent observations at Maitri, Antarctica may reveal propagational characteristic for the various VLF emissions generated during daytime.

Keywords : VLF emission, whistler, electromagnetic field, propagational characteristics

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Thermodynamics of polar fluid mixtures of hard non-spherical molecules

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Abstract : The problem of calculating the thermodynamic properties of polar fluid mixtures of hard non-spherical molecules is studied. Explicit analytic expressions for the virial coefficients and Helmholtz free energy are given. Numerical results are estimated for the third virial coefficient, equation of state and excess internal energy of quadrupolar hard gaussian overlap fluid mixtures. They are found to depend on the conditions and shape parameters.

Keywords : Polar fluid mixture, virial coefficients, equations of state

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An optimal angle of launching a point mass in a medium with quadratic drag force

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Abstract : The problem of finding an optimal angle of launching a point mass in a medium with quadratic drag force is considered. An equation for determining an approximate value of this angle is obtained. After finding the optimal angle of launching, eight main parameters of the particle motion are analytically determined. These parameters are used to analytically construct six main functional relationships of the problem. An example is given.

Keywords : Analytical formulae, functional relationships, kinematical parameters

PACS Nos. : 04.25.-g, 45.50.Dd

On oscillatory Bénard-Marangoni convection in a fluid layer with strong surface deformation

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Abstract : Linear stability theory is applied to the problem of the onset of oscillatory Bénard-Marangoni convection in a horizontal layer of fluid bounded from below by a rigid boundary and above by a strongly deformable free surface and heated from below. We obtain critical values of the Prandtl number below which convection sets in as oscillatory motions and give an example of a situation in which two different modes of instabilities coexist.

Keywords : Bénard-Marangoni convection, linear stability theory

PACS Nos. : 47.20.Bp, 47.20.Dr, 47.27.Te
