



The M-G Hamiltonian - a pedagogic review

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Abstract : In this review, we discuss Majumdar-Ghosh Hamiltonian which is a one dimensional system of spin $1/2$ particles with isotropic interactions between nearest and next-nearest neighbours. The model is exactly solvable when the next-nearest neighbour strength is half that between the nearest neighbours. The ground state is doubly degenerate and consists of dimers of nearest neighbour singlet pairs.

Keywords : Majumdar-Ghosh chain, Heisenberg model, Haldane conjecture, Haldane-Shastry model.

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Resonating valence bond states in 2 and 3D – brief history and recent examples

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Abstract : Resonating valence bond states are quantum spin liquids, having low energy spin- $\frac{1}{2}$ (spinon) or spin-1 excitations. Although spins are ‘disordered’, they possess subtle topological orders and some times chiral orders. RVB states are easily appreciated and seem natural in the quantum fluctuation dominated 1D world. In 2 and 3D, competing orders such as antiferromagnetism, charge order or even superconductivity often hide an underlying robust quantum spin liquid state. Introduction of additional spin interactions or doping of delocalized charges, or finite temperatures, could frustrate the long range magnetic order and reveal a robust RVB state. To this extent they are natural in 2D and above. We present a brief history of insulating RVB states. Then we summarise our own recent theory of RVB states for 2 and 3D systems, including some newly synthesised ones: (i) boron doped diamond, (ii) $\text{Na}_x\text{CoO}_2 \cdot y\text{H}_2\text{O}$, (iii) quasi 2D organic conductors and (iv) a 2D graphene sheet.

Keywords : Resonating valence bond theory, quantum spin systems, Mott insulators, high temperature superconductors

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Majumdar-Ghosh-like spin models in low dimensions

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Abstract : The Majumdar-Ghosh model occupies a special position amongst the models of interacting spin systems. The model has motivated the search for other low-dimensional spin systems with quantum paramagnetic ground states and a gap, the so-called spin gap, in the excitation spectrum. In this brief review, some generic features of MG-like spin models will be described in terms of theoretical results and experimentally observed phenomena.

Keywords : Majumdar-Ghosh model, spin gap antiferromagnets, frustration, spin ladder, quantum spin liquid

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Nonlinear sigma model approach to quantum spin chains

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Abstract : We introduce and motivate the study of quantum spin chains on a one-dimensional lattice. We classify the varieties of methods that have been used to study these models into three categories, (a) exact methods to study specific models (b) field theories to describe fluctuations about the classical ordered phases and (c) numerical methods. We then discuss the J_1 - J_2 - δ model in some detail and end with a few comments on open problems.

Keywords : Quantum spin chains, nonlinear sigma model

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A solvable quantum antiferromagnet model

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Abstract : We introduce a quantum antiferromagnet model, having exactly soluble thermodynamic properties. It is an infinite range antiferromagnetic Ising model put in a transverse field. The free energy gives the ground state energy in the zero temperature limit and it also gives the low temperature behaviour of the specific heat, the exponential variation of which gives the precise gap magnitude in the excitation spectrum of the system. The detailed behaviour of the (random sublattice) staggered magnetisation and susceptibilities are obtained and studied near the Néel temperature and the zero temperature quantum critical point.

Keywords : Quantum antiferromagnets, Ising models in transverse fields, quantum critical point

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The effect of high magnetic field on the scattering of electron with atomic hydrogen

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Abstract : Investigation has been carried out to show the effect of high magnetic field over the scattering parameters for electron-hydrogen scattering. The magnitudes of the magnetic field vary from 0.2 to 5 a.u. Three first-order models have been employed to study the system. These models reveal the relative effect of high magnetic field on the projectile and the target both separately and simultaneously. The scattering cross sections are compared amongst themselves and also with the corresponding field-free results. It has been found that the effect of field distortion of the target is negligible on the scattering parameters. But the dressing of the incoming electron for the magnetic field bring significant qualitative change.

Keywords : Electron, hydrogen, high magnetic field, scattering cross section

PACS Nos. : 34.50.-s, 34.80.-i, 34.90.+q



Effect of neutron irradiation on the 1615-cm⁻¹ Raman band of polyester fibre

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Abstract : Amorphous polyethylene terephthalate (PET) fibres of denier per filament value 2.17 were irradiated by fast neutron of energy 4.44 MeV at different fluences. The radiation-induced physical, macromolecular changes have been investigated applying micro-Raman scattering. It is observed that the 1615-cm⁻¹ band of amorphous PET fibre get vanished at the fluence of 1×10^{11} n/cm² indicating the formation of pure *gauche* phase due to radiation heating. This *gauche* phase was also confirmed from the entropy value of irradiated PET material obtained using DSC technique. A *phase-diagram* of amorphous PET was plotted using Raman band intensity and neutron fluence.

Keywords : Polyethylene terephthalate, neutron fluence, Raman scattering

PACS Nos. : 81.05.Lg, 36.20.Ng, 61.82.Pv



Unsteady MHD convection and mass transfer flow of micropolar fluids past a vertical permeable moving plate with heat absorption

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Abstract : By the use of the theory of micropolar fluids due to Eringen, perturbation method is presented to study an unsteady MHD convection and mass transfer flow of micropolar fluids past a vertical permeable moving plate with heat absorption. The plate moves with a constant velocity in the direction of fluid flow, while the free stream velocity follows an exponentially increasing or decreasing small perturbation law. Approximate solutions of the coupled nonlinear governing equations are obtained for different values of microrotation and magnetic parameters. Numerical calculations are carried out for the various parameters entering into the problem. The results of velocity, angular velocity, temperature and concentration profiles have been presented graphically for various values of the material parameters. The results indicate that the micropolar fluids display a reduction in drag as well as heat transfer rate when compared with Newtonian fluids.

Keywords : Magnetohydrodynamic, heat and mass transfer, micropolar fluids.

PACS Nos. : 44.25.+f, 44.05.+e, 47.27.Te



An exact solution of the time-dependent Ginzburg-Landau equations for propagating fronts in superconductor

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Abstract : We have found an exact solution of the time-dependent Ginzburg-Landau (TDGL) equations in connection with the problem of front (interface) propagation in superconductor. Here, we find a distinct solution of the mentioned problem found earlier by Di Bartolo and Dorsey [*Phys. Rev. Lett.* **77** 4442 (1996)] with a front speed $c = 2.828$ and display some of its properties.

Keywords : Ginzburg-Landau equation, exact solution, front propagation in superconductor

PACS Nos. : 74.40.+k, 47.20.Ky



An investigation of the $^{16}\text{O}+^{16}\text{O}$ elastic scattering by phenomenological and double-folding potentials in optical model formalism at the energies between $E_{\text{lab}}=75$ and 145 Mev

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Abstract : In this study, the experimental data on elastic scattering of $^{16}\text{O}+^{16}\text{O}$ reaction for ten incident energies between $E_{\text{lab}}=75.0$ and 145.0 MeV have been analyzed theoretically within the framework of the Optical model formalism. In the construction of the real part of the optical potential, the phenomenological Woods-Saxon squared and calculated double-folding model potential forms have been used with new parameters. The analyses using those potential forms have been compared with the experimental data. The most suitable fits have been obtained when phenomenological Woods-Saxon squared potential forms are used in both real and imaginary parts of the nuclear potential. Our cross section analyses have exhibited a very good agreement with the experimental measurements, and agreement with the experimental data is better than the previous theoretical works. Thus, the $^{16}\text{O}+^{16}\text{O}$ system has been described by optical potentials having a deep real potential part and a weak absorptive imaginary potential part.

Keywords : $^{16}\text{O}+^{16}\text{O}$ elastic scattering cross section, optical model, double-folding potential, phenomenological potential.

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Third harmonic generation by an obliquely incident laser on a vacuum – plasma interface

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Abstract : A high power laser obliquely incident on a plasma produces a third harmonic component in the reflected component. The process is sensitive to the plasma frequency and the angle of incidence. At higher plasma densities, the efficiency peaks at smaller angles of incidence and as the plasma becomes rarer, the efficiency peaks at higher angles of incidence. The efficiency also drops with plasma frequency. In gaseous plasma, the efficiency is higher by more than an order as compared with solid-state plasmas.

Keywords : Third harmonic generation, laser plasma interaction

PACS Nos. : 42.65.Ky, 52.38.-r



On the acoustic deformation potentials of some II-IV-V₂ ternary chalcopyrites and their mixed versions

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Abstract : The valence band and conduction band acoustic deformation potentials of some II-IV-V₂ chalcopyrites and their mixed versions have been evaluated for the first time from the knowledge of the temperature dependence of the band gap dE_g/dT and the pressure dependence of the band gap dE_g/dp . It is interesting to note that the analysis gives an idea of electron-phonon contribution term to the temperature dependence of the band gap in these compounds which is very useful for understanding some physical processes taking place in these type of compounds.

Keywords : Chalcopyrite, deformation potentials, mixed versions.

PACS Nos. : 63.20.Kr, 42.70.Mp



Analysis of thermal expansivity of NaCl and KCl crystals at high temperatures

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Abstract : In the present study, various relationships for temperature dependence of thermal expansivity in high temperature domain at 1 bar pressure are deduced for NaCl and KCl crystals. These relationships are derived on the basis of temperature dependence of volume expansion ratio studied recently. It is found that among the various relationships, the thermal expansivity derived from the Srivastava equation of volume expansion ratio shows close agreement with the experimental data available in literature. The present relationship for thermal expansivity may be used to understand the high temperature behaviour of solids.

Keywords : Volume expansion ratio, thermal expansivity

PACS Nos. : 65.40.De, 62.20.Dc

Some comments on fractality of proton at small x

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Abstract : Using the concept of self-similarity in the structure of the proton at small x , we comment on possibility of a single positive fractal dimension of proton in analogy with classical monofractals. Plausible dynamics and physical interpretation of fractal dimension are also discussed.

Keywords : Self-similarity, fractal dimension, deep inelastic scattering, structure function, low x .

PACS Nos. : 05.45.Df, 47.53.+n, 12.38.t, 13.60.Hb



Orbital ice and its melting phenomenon*

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Abstract : We coin a phrase “orbital ice” to describe the orbitally ordered phase of LaMnO_3 , which is formed by the cooperative Jahn-Teller transition below $T_{JT} \approx 750$ K. We interpret the transition at T_{JT} to be a “melting” of the “orbital ice” by analogy with the phenomenon of ice melting. We will demonstrate some similarities between the two melting phenomena of which the first phenomenon is of electronic origin and the other of course is a well known lattice melting known to humanity for hundreds of centuries.

Keywords : Orbital ordering, Jahn-Teller transition, X-ray diffraction, neutron diffraction

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