There is Room for Room Temperature Superconductivity

Prof. G. Baskaran (IMSc Chennai)

Realizing superconductivity, a fascinating quantum phenomena, at room temperatures is at present a dream. There have been however certain claims of observation of UFS (unidentified fleeting superconductors) at room temperatures ! I will offer theoretical hopes for realizing this dream in real materials, within known quantum chemical and solid state constraints. This prospect arises in a natural fashion in the resonating valence bond mechanism of superconductivity. I will describe few recent experimental discoveries and signals of potential high Tc superconductivity in silicene, pressurized solid H2S and K3(pTerphenyl), in the above light.

Superconductivity near an antiferromagnetic Mott insulator

Prof. Pinaki Majumdar (HRI Allahabad)

The cuprates are the most famous example of superconductivity emerging on doping a Mott state. I will discuss a simpler problem, related more to the organics, where pressure induced bandwidth variation can convert a magnetic Mott state into a d-wave superconductor, with an intermediate regime of coexistence. I will present our preliminary results on a model motivated by the experiments, and discuss the features that arise due to the interplay of magnetic and superconducting fluctuations at finite temperature.

Jastrow-Form of the Ground-State Wave Functions for All Fractional Quantum Hall States

Prof. Sudhansu S. Mandal (IIT KGP)

It was an insight of Laughlin that he could ascertain the ground state wave function for 1/n fractional quantum Hall effect (FQHE) states in a Jastrow form. Thereafter, based on general principles such as antisymmetry against interchanging of any two electron coordinates and being eigenstate of total angular momentum, he could explicitly express simple looking manybody wave function of such FQHE states. Halperin generalized Laughlin wave function for polarized bilayered FQHE states and unpolarized single-layered FQHE states. This principle is however could not be so far gneneralized for other observed FQHE states.

We of course have very accurate wave functions for most of the FQHE states in the lowest Landau levels in terms of composite fermions posessing integer quantum Hall effect. However, the form of these wave functions are very complex and cannot be expressed in a single line. Further, some of the FQHE states in the lowest Landau level such as $\nu=4/11$, 5/13 and most of the states in the second Landau level, e.g., $\nu=2+1/2$, 2+1/3, 2+3/8 remain enigmatic as we lack of having minimal groundstate wave function for describing these states.

In this talk, I will describe an approach for determing the groundstate wave functions of any given state in Jastrow form. This has been achieved by relaxing the stringent requirement of same exponent to all the pairs of electrons. I will exemplify with certain states and show that these wave functions are extremely accurate, sometime even better than any known wave function, and predict accurate wave functions for certain FQHE states.

Atomic clusters as functional materials: Density functional theoretic study

Prof. Sourav Pal (IISER Kolkata)

Statistical Mechanics and Fully Developed Turbulence

Prof. J. K. Bhattacharjee (IACS Kolkata)

Assembling colloidal crystals using laser templates

Prof. Surajit Sengupta (TIFR Hyderabad)

Colloids are nano to micrometer sized particles suspended within a liquid and stabilised against precipitation by electrostatic, magnetic or steric interactions. These system, which show many different crystalline, glassy, liquid, and liquid crystalline phases, have many industrial uses. They also form convenient model systems to study properties of condensed matter at easily accessible length and time scales. Being dielectrics, colloidal particles may also be conveniently manipulated using light. In this talk, I shall first review work done in our group over many decades on the problem of assembling these colloidal particles into periodic crystals using static optical patterns. I will then show that dynamic, feed-back controlled optical traps, whose positions depend on the instantaneous local configuration of particles in a pre-determined way, can stabilise colloidal particles in finite lattices of any given symmetry. Unlike in a static template, the crystal so formed is invariant under uniform translations and retains all possible zero energy modes.

Revisiting metamagnetism in correlated electrons

Prof. Arghya Taraphder (IIT KGP)

Metamagnetism, in a correlated electronic system is revisited with new insights. Inspired by an earlier experiment [1] on liquid He3 and an analysis by Vollhardt, the feasibility of metamagnetism and critical response in a correlated metal are addressed using a model Hamiltonian approach. Although there are several reports of metamagnetism in real systems, the underlying cause is shrouded in competing effects, viz. structural, spin exchange and Coulomb correlation. To focus on correlation-driven metamagnetism, we work on correlated models like Hubbard ($t-U$), $t-U-J$ and $t-t^{'}-U-J$ model in the presence of external Zeeman field, using dynamical mean-field theory [3] and slave-rotor and its cluster incarnations [4]. We show that the proximity to a Mott transition allows realization of metamegntism in a range of parameters and a magnetic field well within the experimental limits. It is also shown that the problem of exciton formation in a typical repulsive model is formally analogous to metamagnetism [5].

[1] S. Weigers, P. E. Wolf, and L. Puech, Phys. Rev. Lett. **66**, 2895 (1991)
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[3] D. Parihari, N. S. Vidhyadhiraja and A. Taraphder, J. Phys. Condens. Matter **23**, 055602 (2011)
[4] Swagata Acharya, Amal Medhi, N S Vidhyadhiraja and A Taraphder, J. Phys. Condens. Matter **28**, 116001 (2016)
[5] Subhasree Pradhan and A. Taraphder, arxiv: 1707.04701

Strange Metallicity from Selective-Mottness: A High-D Perspective

Prof. M. S. Laad (IMSc Chennai)

Strange Metallicity, a buzzword for a specific kind of non-Landau Fermi liquid, is characterized by absence of conventional quasiparticles, i.e, by a branch-cut infra-red structure of one- and two-particle propagators in the infra-red. Whilst well-known in D=1, how such nehavior arises in D>1 quantum matter (as in cuprates, f-electron systems, Fe-arsenides, etc) remains largely engmatic. I will talk about this "strange" metalicity, and describe how such an unusual state can arise as a consequence of an orbital- or momentum-selective Mott transitions (wherein Mott-localized and itinerant aspects of the spectral function co-exist in the infra-red). The breakdown of Landau quasiparticles arising from a many-body orthogonality catastrophe leads to branch-cut propagators and an anomalous continuum in responses that bears uncanny resemblance to experimental observations in the "strange metal".