School of Physics Half-day Colloquia

Date: 15th October 2019 Venue: PSB seminar hall

Program Schedule

1. **Magnetism in a Mott-insulating Ruthenate Ca_2RuO_4**
   Dr. Anil Jain
   BARC, Mumbai
   12:20 – 13:05

LUNCH BREAK
13:05 – 14:15 @ CDH

2. **An introduction to critical points in nonlinear dynamical systems and its applications**
   Dr. Awadhesh Prasad
   University of Delhi, Delhi
   14:15 – 15:00

3. **Organic Semiconductor Devices: How different is the physics from conventional ones?**
   Dr. Y. N. Mohapatra
   IIT Kanpur, Kanpur
   15:00 – 15:45

TEA BREAK
15:45 – 16:00

4. **Critical slowing down in a first-order phase transition with hysteresis**
   Dr. Bhavtosh Bansal
   IISER Kolkata, Kolkata
   16:00 – 16:45

5. **Black Holes In String Theory**
   Dr. Amitabh Virmani
   CMI, Chennai
   16:45 – 17:30

School of Physics
Half-day Colloquia
Abstract book

Talk 1

Title: Magnetism a Mott-insulating Ruthenate Ca_2RuO_4

Speaker: Anil Jain

Affiliation: Solid State Physics Division, Bhabha Atomic Research Centre, Mumbai 400 085

e-mail: ajain@barc.gov.in

Abstract: Low-dimensional transition metal oxides show many interesting phenomena ranging from classical magnetic ordering to high-temperature superconductivity. The magnetic properties of these oxides are generally described within the framework of conventional spin only Heisenberg model with rigid spins. However, in Mott insulators containing d^4 ions with strong spin-orbit coupling, one may encounter a curious situation where the ionic ground sate has no magnetic moment (J = 0), yet may order magnetically by virtue of low-lying magnetic J = 1 levels, if the magnetic exchange interactions are strong enough to overcome the gap between the J = 0 and J = 1 levels. Since the magnetic order is due to the condensation of the J =1 levels and hence "soft," the amplitude (Higgs) mode is expected.

In this talk, I will discuss novel magnetism in the intermediate strength regime of spin-orbit coupling in Mott insulating two-dimensional antiferromagnet Ca_2RuO_4. At the end, I will discuss recently electric-current stabilized metallic state exhibiting an exceptionally strong diamagnetism in Ca_2RuO_4.

References:

1. A. Jain, M. Krautloher, J. Porras, G. H. Ryu, D. P. Chen, D. L. Abernathy, J. T. Park, A. Ivanov, J. Chaloupka, G. Khaliullin, B. Keimer, and B. J. Kim, Nature Physics **13**, 633 (2017).
2. S. M. Souliou, J. Chaloupka, G. Khaliullin, G. Ryu, A. Jain, B. J. Kim, M. Le Tacon, and B. Keimer Phys. Rev. Lett. **119,** 067201 (2017).
3. J. Bertinshaw, N. Gurung, P. Jorba, H. Liu, M. Schmid, D. T. Mantadakis, M. Daghofer, M. Krautloher, A. Jain, G. H. Ryu, O. Fabelo, P. Hansmann, G. Khaliullin, C. Pfleiderer, B. Keimer, and B. J. Kim (Accepted, Phys. Rev. Lett. 2019).

Talk 2

Title: An introduction to critical points in nonlinear dynamical systems and its applications

Speaker: Awadhesh Prasad
Affiliation: Department of Physics and Astrophysics, University of Delhi, Delhi 110007.
e-mail: awadhesh@physics.du.ac.in

Abstract: In this talk, a new class of critical points in dynamical systems, termed as "perpetual points", where acceleration becomes zero but the velocity remains non-zero, will be discussed. The velocity at these points is either maximum or minimum or of inflection behavior. Bifurcation behavior as a function of parameters will be presented. The applications of these perpetual points, particularly for locating the multistable attractors, will be highlighted.

Talk 3

Title: Organic Semiconductor Devices: How different is the physics from conventional ones?

Speaker: Y. N. Mohapatra
Affiliation: Dept. of Physics, IITKanpur, Kanpur 208 016
e-mail: ynm@iitk.ac.in

Abstract: Organic and Flexible Electronics have emerged as a potential revolution in technology for large area and wearbale applications. The development of applications in this area is based on components similar to the conventional electronics, but the method of realising them and the physics of operation are very different from conventional electronic components. Most of these components need be printed through solution processing on flexible substrates such as plastic, paper or textile, and hence the area is also referred to as printable electronics. I will illustrate, through a couple of examples form our work, how different is the physics and process design for organic and flexible

electronic components such as diodes, solar cells and thin film transistors. I will focus on some of the essential properties of organic semiconductors, and characteristics of their devices to bring out the significant physics of transport and kinetics of charge processes in them. I will also have the opportunity in the process to briefly describe our efforts at the National Centre for Flexible Electronics at IIT Kanpur.

Talk 4

Title: Critical slowing down in a first-order phase transition with hysteresis

Speaker: Bhavtosh Bansal

Affiliation: Department of Physics Science, IISER Kolkata, Nadia, Kolkata 741 246

e-mail: bhavtosh@iiserkol.ac.in

Abstract: I will discuss an elementary aspect of first order phase transitions. Let me state it in the somewhat more familiar language of the van der Waals equation of state. Below the critical temperature, a part of the PV-isotherm in the van der Waals' original equation becomes multivalued and corresponds to the metastable and unstable regions of the phase diagram. This undesirable feature was corrected by Maxwell through his famous construction. While the unstable region is clearly unphysical, I will argue that a subset of materials undergoing an abrupt phase transition do seem to partly follow van der waals' prediction. The phase transition shows hysteresis and persists in the metastable phase almost right up to the limit of stability, the spinodal. A consequence of reaching this spinodal singularity is that the system shows critical slowing down and critical opalescence, which are generally thought to be attributes of the second-order transition.

Talk 5

Title: Black Holes In String Theory

Speaker: Amitabh Virmani
Affiliation: Chennai Mathematical Institute (CMI), Kelambakkam, Chennai 603 103
e-mail: amitabh.virmani@gmail.com

Abstract: Black holes are our best guide towards understanding properties of a quantum theory of gravity. On the one hand, the study of black holes has added to our understanding of string theory as a whole, and on the other hand string theory has come a long way in addressing puzzles associated with black holes. In this talk I will provide an introduction of these developments and the context in which my works fit.