CCT Colloquium Series

Explorations in the Physics of Materials and Connections between the Arts and Science, Engineering and Technology

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Johnston Hall 338
October 30, 2009 - 01:00 pm

Abstract:
Given the broad range of interests at the CCT, I will divide my talk into two parts. In the first part I will discuss selected results from our recent research which is aimed at understanding the physics of novel materials. This will be followed by a brief discussion of some of our educational/outreach activities aimed at exploiting connections between the arts and science, engineering and technology for purposes of formal and informal educational programs. Computational approaches are playing a rapidly growing role in ushering in a new 'golden age' of spectroscopic studies of materials for deciphering how charge, spin, orbital and lattice degrees of freedom interact to produce emergent phenomena and exotic states of matter with vast potential for applications. The need for realistic modeling of various highly resolved spectroscopies (e.g. photoemission, inelastic and elastic light scattering, scanning tunneling microscopy/spectroscopy, positron annihilation), increasingly relying on large facilities and synchrotron sources around the world, is becoming of critical importance in providing discriminating tests of competing theoretical models and as a rational basis for future experimentation. I will discuss how as we move to model spectroscopic data from a qualitative to a quantitative level, surprising new insights into the nature of electronic states and correlation effects are obtained in high-temperature cuprate superconductors and other complex material properties. As an illustrative example I will focus on photoemission spectroscopy, i.e. Einstein's photoelectric effect, which in its modern incarnations has become a powerful tool for 'seeing' individual electronic states in materials. Turning to the arts, I will discuss our education/outreach efforts under the rubrics of the PASTEL (for Partnership for Arts, Science & Technology Learning) and ELMO (for Embedded Learning Modules) projects, with focus on the PASTEL project, which involves collaboration with Boston's Museum of Science, Museum of Fine Arts, the Boston Symphony Orchestra and the CiTi (formerly Wang) Center for the Performing Arts. PASTEL is based on the notion that opportunities abound in every city for learning about science and technology, not only in its science-focused venues but also in its arts venues, including concert halls, performance spaces and art galleries, where scientific analysis and principles play a key role. The goal of PASTEL is to develop a new generation of programming connecting the arts with science and technology so that thousands of Boston's families can explore the arts through the prism of science to create a new model of informal science learning. I will comment on how computers and computational tools can play a large role in the PASTEL project.

Speaker's Bio:
Professor Bansil received his bachelor's degree from the University of Delhi, India, master's degree from the State University of New York at Stonybrook and Ph.D. from Harvard University. He joined the faculty of the Department of Physics at Northeastern University in 1976 following a two-year research appointment at Brandeis University. In 2002, Bansil was also jointly appointed as a professor in the School of Education at Northeastern University in recognition of his educational and outreach contributions. Since January 2008, he has been serving as an IPA at the US Department of Energy (DOE) managing the Theoretical Condensed Matter Physics program. In 1994 he was selected to serve as the east coast academic editor of the International Journal of Physics and Chemistry of Solids. He is the founding director of the ELMO (for Embedded Learning Modules) program for developing novel curricula for teaching science to diverse audiences as well as Northeastern University's Advanced Scientific Computation Center (ASCC). He is an honorary professor in Solid State Theory at Tampere University of Technology in Finland, a guest senior scientist at Lawrence Berkeley National Laboratory (Berkeley, California), a scientific consultant to the Netherlands Energy Research Foundation, a resident associate at Argonne National Laboratory (Argonne, Illinois), and a member of various international editorial boards and commissions. He has been appointed as the Series Editor of a new 'Materials Physics' book series started by Elsevier Science (Oxford) in 2005. He founded the highly successful international conference series on "Spectroscopies in Novel Superconductors (SNS)" in 1991 and on "Inelastic X-ray Scattering (IXS)" in 1993. Bansil was awarded the 2002 Robert D. Klein University Lectureship at Northeastern University for his many scholarly accomplishments. He has authored/co-authored over 200 technical articles, 14 volumes of conference proceedings, and a major book, X-Ray Compton Scattering (Oxford University Press, Oxford, 2004) covering a wide range of topics in theoretical condensed matter physics. Professor Bansil's recent research interests have focused on questions concerning the electronic structure and spectroscopy of high-Tc superconductors and other complex materials. His research effort involves extensive collaborations with groups within and outside United States. Professor Bansil has developed and implemented the theoretical methodology for carrying out realistic modeling of spectral intensities relevant for angle-resolved photoemission, scanning tunneling spectroscopy, inelastic light scattering and positron-annihilation angular correlation spectra in systems of the complexity of the high-Tc's. Approaches for treating effects of substitutions, non-stoichiometry and correlation effects in materials have also been developed. These investigations have yielded new insights into the existence of Fermi surface, the nature of electronic states near the Fermi energy, as well as the mechanism of superconductivity in the high-Tc's.

Refreshments will be served.
This lecture has a reception.

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