Frontiers of Condensed Matter Physics
FCMP Columbia 2018 Fall
Lectures by leading CMP researchers

Sep. 6 (Thursday) 2:40 – 3:55 PM at Columbia U Pupin 329
Anbhay Pasupthy (Columbia) [live]
Tunable strain solitons in transition metal dichalcogenides

Sep. 7 (Friday) 9:30 – 10:45 AM at Columbia U Pupin 329
Taka Shibauchi (Tokyo U) [video recorded on Sep 4 for FCMP]
Unusual superconductivity in FeSe

Grad students, post-docs, senior researchers all welcome

For access info of uploaded videos: contact YJ Uemura <yu2@columbia.edu>
Tunable strain solitons in transition metal dichalcogenides

Abhay Pasupathy (Columbia U)

Abstract: In a bilayer van der Waals material, the application of differential strain between the layers can lead to the formation of strain "solitons". Such solitons are one-dimensional lines where there is a phase slip of one lattice constant between the two layers that comprise the bilayer [1,2]. I will describe scanning tunneling microscopy experiments of such strain solitons in transition-metal dichalcogenides. Using a piezo-driven apparatus, we describe a technique by which uniform as well as differential strain can be applied to single crystal materials with arbitrarily large achievable strains. We apply this to a single crystal of semiconducting MoSe2 which has a single freely-standing monolayer on the surface. We describe the controllable application of strain and the production of strain solitons in this system. We find that strain solitons form along the principal axes of the crystal, and in the case of an arbitrary direction of applied strain the solitons form elongated, quasi-periodic, hexagonal patterns for strain relief. At the vertices of each hexagon, a Y junction is formed, and the vertex of the junction is under triaxial strain. STM spectroscopy measurements show the presence of Landau levels in the Y-junction vertex, with an effective magnetic field of about 300 Tesla.


Abhay Pasupathy Narayan: Profile

1998 BSc and MSc in Physics, Indian Institute of Technology, Kanpur, India.
2004 PhD in Physics, Cornell University.
2005-2008 Postdoctoral Associate, Physics Department, Princeton University.
2009- 2013 Assistant Professor, Physics Department, Columbia University.
2013- Associate Professor, Physics Department, Columbia University.
Unusual superconductivity in FeSe

Taka Shibauchi
University of Tokyo

Among iron-based superconductors, FeSe has the simplest crystal structure, but it has several unique features that may be important in understanding the pairing mechanisms [1]. In this lecture I will review the key features of the superconductivity in FeSe including very recent experimental advances. The superconducting order parameter (or the superconducting gap) has a strong momentum dependence indicating the unconventional pairing nature, but surprisingly the detailed structure changes when approaching a twin boundary of nematic domains [2]. The analysis suggests that the time reversal symmetry breaking state is induced near the boundaries, and I will show some experimental evidence for this unusual superconducting state [2,3]. Moreover, the gap magnitude is very close to the scale of Fermi energy, placing the system deep inside the BCS-BEC crossover regime [1,4]. The signatures of the BCS-BEC crossover in this system will also be discussed.


http://qpm.k.u-tokyo.ac.jp/index_en.html

Profile

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1990 B.Eng., Department of Applied Physics, University of Tokyo
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1999 Postdoctoral Fellow, Los Alamos National Laboratory
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2001 J. Robert Oppenheimer Fellow, Los Alamos National Laboratory
2001 Associate Professor, Dept. Electronic Sci. & Eng., Kyoto University
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