DEPARTMENT OF PHYSICS UNIVERSITY OF MARYLAND **CNAM** Condensed Matter Colloquium

2pm, **October 23rd**, Room 1201

Towards the Lifshitz Transition in Elemental Bismuth: Light Electrons Gone Heavy at the Metal-Insulator Transition?

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Since the seminal work of Wigner in 1930's, it has been believed that the diverging electron-electron interactions found in low density electron gases can manifest in a variety of novel phases like electronic crystals or correlated heavy electron fluids. In principle elemental semi-metal Bismuth presents a model system to investigate such physics as the application of modest pressure is believed to drive electron and hole bands apart resulting in a semi-metal/semiconductor transition. Around 25 kbar the already small Fermi surfaces collapse to points resulting in a vanishing charge density. Within a non-interacting purely band point of view this is an electronic topological transition of the Lifshitz variety, which is of order 2.5 in the Eherenfest classification. It is unclear however the role which electronic correlations play on the approach to the transition. Do interaction effects dominate result in a strongly correlated liquid state? Perhaps the topological transition is actually superseded by an exotic phase like an electron crystal or excitonic insulator?

I present the results of our detailed optical study investigating these issues and trying to answer these questions. In the ambient pressure spectra correlations manifest themselves in a novel fashion by the observation of a strong coupling of conduction electrons to a plasmon collective mode. The observation of a “plasmaron” as such is made possible by the exceptional properties of semi-metal bismuth, but it is also likely relevant to the low energy transport and thermodynamic properties of other semi-metals, like graphite and graphene. As a function of pressure, we observe massive changes in bismuth's optical and infrared conductivity as the material approaches the Lifshitz-like metal/insulator transition. In the transition region we find evidence for a correlated fluid regime, which is likely driven by a pairwise electron-hole interaction. This study shows the anomalous effects of interactions in a low carrier density system and particularly one such as this one in which Galilean invariance is broken.

Host: Min Ouyang