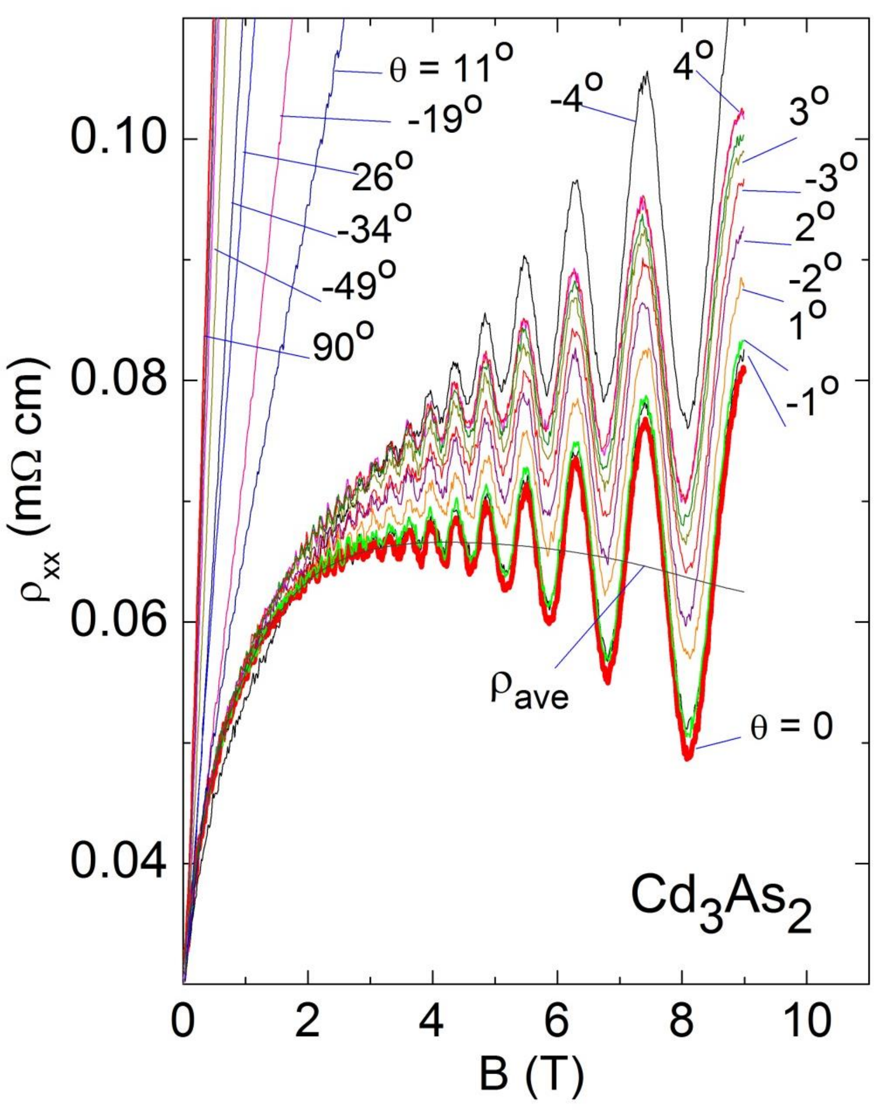
ZERNIKE INSTITUTE COLLOQUIUM
Thursday, January 8th, 2015

16:00h, Lecture Hall: 5111.0080 **Coffee and cakes from 15:30h**

Transport experiments on Dirac semimetals

Nai Phuan Ong
Department of Physics
Princeton University
Princeton, NJ, USA

In monolayer graphene, the nodes of the 2D Dirac states are especially robust. They are protected against gap formation by time-reversal and inversion symmetry. Are there 3D analogs of graphene? Recently, Cd_3As_2 and Na_3Bi were predicted to be Dirac semimetals, and confirmed to be so by ARPES and STM experiments. In these semimetals, gap inversion of the *s* and *p* orbitals leads to two small 3D Dirac pockets straddling the Gamma point. Now, point-group symmetry, in concert with time-reversal and inversion symmetry, protect the 3D nodes against gap formation. Intense interest has been stimulated by predictions that each Dirac pocket will split into two Weyl nodes when time-reversal symmetry is broken (Weyl nodes may be likened to monopoles of Chern flux in **k**-space). I will describe transport experiments on both semimetals[1,2]. The experiments have uncovered some interesting features unanticipated by theory. In Cd_3As_2, we found that single crystals can display unexpectedly small residual resistivities, corresponding to mobilities as high as 9 million cm^2/Vs (in the league of the cleanest 2D gas in GaAs/GaAlAs quantum wells). The ultrahigh mobilities occur despite substantial lattice disorder. Application of a magnetic field *B* immediately degrades the mobility causing a giant positive magnetoresistance that is strictly linear in *B* in some samples. This suggests to us that, in zero *B*, the carriers are protected against back-scattering by a mechanism that is destroyed by a finite *B*. In Na_3Bi, the unusual *B*-linear MR is observed in all crystals studied to date. We show that it leads to an unusual Hall-angle field profile in the shape of a step-function, again suggestive of a strong B suppression of the transport lifetime. I will discuss the challenges and prospects for observing transport consequences of Weyl physics in strong magnetic fields.



1. Tian Liang, Quinn Gibson, et al., Nature Materials, DOI: 10.1038/NMAT4143
2. Jun Xiong, Satya Kushwaha, et al., submitted.

* Research supported by US Army Research Office, MURI project on Topological Insulators, and a MRSEC grant from the US National Science Foundation, and the Gordon and Betty Moore Foundation.

In collaboration with Tian Liang, Quinn Gibson, Minhao Liu, Mazhar Ali, Jun Xiong, Satysh Kushwaha, Jason Krizan, and Robert Cava.

university of groningen

zernike institute for advanced materials