Abstract Submitted
for the MAR17 Meeting of
The American Physical Society

Spatial Charge Inhomogeneity and Defect States in Topological Dirac Semimetal Thin Films MARK EDMONDS, JAMES COLLINS, JACK HELLERSTEDT, Monash University, INDRA YUDHISTIRA, JOAO NUNO BARBOSA RODRIGUES, LIDIA CARVALHO GOMES, SHAFFIQUE ADAM, National University of Singapore, MICHAEL FUHRER, Monash University — Dirac materials are characterized by a charge neutrality point, where the system breaks into electron/hole puddles. In graphene, substrate disorder drives fluctuations in E_F, necessitating ultra-clean substrates to observe Dirac point physics. Three-dimensional topological Dirac semimetals (TDS) obviate the substrate, and should show reduced E_F fluctuations due to better metallic screening and higher dielectric constants. Yet, the local response of the charge carriers in a TDS to various perturbations has yet to be explored. Here we map the potential fluctuations in TDS 20nm Na_3Bi films grown via MBE using scanning tunneling microscopy/spectroscopy. The potential fluctuations are significantly smaller than room temperature ($\Delta E_F \approx 5$ meV $= 60$ K) and comparable to the highest quality graphene on h-BN; far smaller than graphene on SiO_2, or the Dirac surface state of a topological insulator. This observation bodes well for exploration of Dirac point physics in TDS materials. Furthermore, surface Na vacancies show a bound resonance state close to the Dirac point with large spatial extent, a possible analogue to resonant impurities in graphene.

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Date submitted: 13 Nov 2016 Electronic form version 1.4