Abstract Submitted
for the MAR17 Meeting of
The American Physical Society

Resonant electronic Raman excitations with A_{2g} symmetry in the topological insulator Bi_2Se_3[1] HSIANG-HSI KUNG, XUEYUN WANG, SANG-WOOK CHEONG, GIRSH BLUMBERG, Rutgers University — Inelastic light scattering from Dirac fermions can lead to electronic excitations odd in time reversal symmetry [2,3]. Here, we report the observation of a sharp collective mode with energy of 150 meV, below the edge of a gapped continuum, in bulk Bi_2Se_3. Both the gapped continuum and the collective mode have pseudovector-like symmetry of the A_{2g} representation of the D_{3d} group, and are only present when excitation energy is in resonance with interband transitions between the occupied and unoccupied Dirac surface states. The gapped continuum can be understood as the electron-hole excitations between the lower and upper Dirac cones near the Fermi surface, whereas the slightly below gap edge collective mode is the excitonic bound states of the electron-hole pairs. Such inter-Dirac-cone excitation flips the in-plane electron spin, but preserves the out-of-plane angular momentum, resulting in singlet excitonic states. Such exciton is dark in photoluminescence spectra, as opposed to the doublet states which can be populated with circularly polarized light. This is a demonstration of novel collective excitation from the surface states of 3D topological insulators.

[1]GB and HHK acknowledge support by the U.S. DOE BES DE-SC0005463. XYW and SWC acknowledge support from NSF Award DMREF-1233349.
[2]E. Riccardi et al., PRL 116, 066805
[3]O. Kashuba and V.I. Fal'ko, PRB 80, 241404(R)

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Date submitted: 11 Nov 2016 Electronic form version 1.4