Abstract Submitted
for the MAR12 Meeting of
The American Physical Society

Field-induced polarization of Dirac valleys in bismuth KAMRAN BEHNIA, ZENGWEI ZHU, AURELIE CALLAUDIN, BENOIT FAUQUE, ESPCI, WOUN KANG, Ewha Womans University — The principal challenge in the field of "valleytronics" is to lift the valley degeneracy of electrons in a controlled way. In graphene, a number of methods to generate a valley-polarized flow of electrons have been proposed, which are yet to be experimentally realized. In bulk semi-metallic bismuth, the Fermi surface includes three cigar-shaped electron valleys lying almost perpendicular to the high-symmetry axis known as the trigonal axis. The in-plane mass anisotropy of each valley exceeds 200 as a consequence of Dirac dispersion, which drastically reduces the effective mass along two out of the three orientations. We present a study of angle-dependent magnetoresistance in bismuth which shows that a flow of Dirac electrons along the trigonal axis is extremely sensitive to the orientation of in-plane magnetic field. The effect is visible even at room temperature. Thus, a rotatable magnetic field can be used as a valley valve to tune the contribution of each valley to the total conductivity. At high temperature and low magnetic field, the three valleys are interchangeable and the three-fold symmetry of the underlying lattice is respected. As the temperature is decreased or the magnetic field increased, this symmetry is spontaneously lost. This loss may be an experimental manifestation of the recently proposed valley-nematic Fermi liquid state.

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Date submitted: 03 Nov 2011 Electronic form version 1.4