Abstract Submitted
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Large Intrinsic Spin Hall Conductivity in Bismuth, Antimony and $\mathbf{Bi_{1-x}Sb_x}$ Alloys[1] CUNEYT SAHIN, MICHAEL E. FLATTÉ, Optical Science and Technology Center and Department of Physics and Astronomy, University of Iowa, Iowa City, Iowa 52242, USA — Bismuth and antimony, which are building blocks of 3 dimensional topological insulators, are expected to exhibit a large spin Hall conductivity due to their large spin-orbit couplings. Furthermore the semimetal characteristics of these materials that originate from slightly overlapping conduction and valence bands can be altered by opening a gap through alloying them up to certain concentration. This so called semi-metal semiconductor transition also allows $Bi_{1-x}Sb_x$ alloy to exhibit topologically protected states [1]. In this work we use a low-energy effective spin-orbit Hamiltonian within a tight-binding approach for Bi and Sb as well as $Bi_{1-x}Sb_x$ alloys. Beginning with this low-energy Hamiltonian and band structure we calculate the intrinsic spin Hall conductivity using a Berry's curvature technique in the clean static limit. We have also investigated the behavior of the Berry's curvature in a full zone picture and observed that several symmetry points contribute largely to the SHC due to extreme curvature. Robust spin-orbit couplings and Berry curvatures in bulk Bi, Sb and $Bi_{1-x}Sb_x$ alloys result in SHC which is comparable to platinum and considerably larger than conventional semiconductors and metals.

[1] Zhang et al., Nature Physics 5, 438, (2009)

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