Ultrahigh mobility and giant magnetoresistance in the Dirac Semimetals Cd$_3$As$_2$ and Na$_3$Bi

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Dirac semimetals and Weyl semimetals are 3D analogs of graphene in which crystalline symmetry protects the nodes against gap formation. Na$_3$Bi and Cd$_3$As$_2$ were predicted to be Dirac semimetals, and recently confirmed to be so by photoemission. Several novel transport properties in a magnetic field $H$ have been proposed for Dirac semimetals. Here we report an interesting property in Cd$_3$As$_2$ that was unpredicted, namely a remarkable protection mechanism that strongly suppresses back-scattering in zero $H$. In single crystals, the protection results in a very high mobility, $10^7$ cm$^2$/Vs at 5 K. Suppression of backscattering results in a transport lifetime $10^4$ longer than the quantum lifetime. The lifting of this protection by $H$ leads to very large magnetoresistance with a striking $H$-linear profile. I will also report transport results on Na$_3$Bi and compare them with results in Cd$_3$As$_2$. I discuss how this may relate to changes to the Fermi surface induced by $H$.

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