Orientation and temperature dependence of the anomalous Hall effect in hcp cobalt IVO SOUZA, University of California, Berkeley, ERIC ROMAN, YURIY MOKROUSOV, University of California, Berkeley and University of Hamburg — We calculate from first-principles the evolution of the intrinsic anomalous Hall conductivity vector $\vec{\sigma}_a$ of hcp Co as the spin magnetization direction $\hat{M}$ is tilted away from the c-axis. We find that $\vec{\sigma}_a$ varies smoothly with the tilt angle $\theta$, and that its magnitude is strongly reduced, by a factor of about four, between $\theta=0$ and $\theta=\pi/2$, in good agreement with the measured anisotropy ratio of about three.\(^1\)

In addition to the anisotropic linear magnetization dependence ($\sigma_a^z/M_z \neq \sigma_a^x/M_x$) expected for any uniaxial crystal, there is a considerable nonlinearity in the dependence of $\sigma_a^z$ on $M_x = M \sin \theta$, while the relation between $\sigma_a^x$ and $M_z = M \cos \theta$ is essentially linear, as in Mn$_5$Ge$_3$.\(^2\) The overall angular dependence of $\vec{\sigma}_a$ is well-described by an expansion in terms of $l=1$ and $l=3$ spherical harmonics. From Zener’s model for the influence of thermal fluctuations of $\hat{M}(\mathbf{r})$ on the temperature dependence of magnetic anisotropies,\(^3\) we predict that the $l=3$ terms give rise to an appreciable increase with temperature of the anisotropy ratio.