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Nonlinear Hall effect as a potential response for polarity detection in polar metals[1] SOBHIT SINGH, Rutgers University, NJ, JINWOONG KIM, KARIN M. RABE, DAVID VANDERBILT, Department of Physics and Astronomy, Rutgers University, Piscataway, NJ 08854, USA — An experimental determination of electric polarization has remained challenging in metals and semimetals, although current experimental techniques allow us to easily detect and switch the ferroelectric polarization in insulators. In this work, we theoretically propose that nonlinear Hall current can serve as a potential response to detect the electric polarization in polar nonmagnetic metals/semimetals. We particularly focus on the polar metal $LiOsO_3$ and type-II Weyl semimetals T_d-$MoTe_2$ and T_d-WTe_2, and calculate the Berry curvature dipole moment (BCDM) tensor, a quantity first proposed by Sodemann and Fu [1], in the aforementioned systems. Our calculations indicate that the studied systems exhibit a non-vanishing BCDM indicating possible realization of nonlinear Hall current generated as the second order Hall response by an external electric field oscillating at low-frequencies $\mathcal{O}$(10-100 Hz) [2]. We further show that the polarity reversal is always accompanied by the reversal of BCDM and consequently, the reversal of the nonlinear Hall current, which can be experimentally detected [3]. Refs. [1] I. Sodemann and L. Fu, Phys. Rev. Lett. 115, 216806 (2015). [2] Ma et al., Nature 565, 337-342 (2019). [3] Singh et al., Phys. Rev. Lett. 125, 046402 (2020).

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