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Theory of Intrinsic Anomalous Hall Effect and Spin Hall Effect in Transition Metals TAKURO TANAKA, HIROSHI KONTANI, JUN-ICHIRO INOUE, Nagoya University, Japan, KOSAKU YAMADA, Ritsumeikan University — To elucidate the origin of anomalous Hall effect (AHE) in ferromagnetic transition metals, we study the intrinsic AHE based on a multi-orbital tight-binding model. A large anomalous velocity comes from the atomic d-orbital degrees of freedom. We derive a general expression for the intrinsic anomalous Hall conductivity (AHC) which is valid for any damping rate $\hbar/2\tau$. This expression enables us to calculate the AHC in metals with a wide range of resistivity ρ. The obtained AHC is almost constant with a value of $10^2 \sim 10^3 \Omega^{-1}\mathrm{cm}^{-1}$ when ρ is small, as found by Karplus and Luttinger. However, this relation does not hold any more in bad metals; we show that AHC is proportional to ρ^{-2} when $\hbar/2\tau$ is larger than the minimum band-splitting measured from the Fermi level, Δ. This crossover behavior of the intrinsic AHE, which was first derived by H. Kontani and K. Yamada [J. Phys. Soc. Jpn. **63** (1994) 2627], is recently observed in various ferromagnetic metals universally by A. Asamitsu et al. We also present the mechanism of spin hall effect in transition metal oxides.

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