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Electrical spin manipulation in spin-orbit coupling systems AKIHITO TAKEUCHI, Department of Applied Physics, University of Tokyo, NAOTO NAGAOSA, Department of Applied Physics, University of Tokyo and RIKEN Center for Emergent Matter Science — Generation of spin by applying as electric current in a spin-orbit coupling system has been investigated with much theoretical and experimental attention in spintronics. Although the electronic spin is the well-defined quantity, the spin is not conserved in the presence of spin-orbit interaction and therefore the theoretical definition of spin current is not uniquely given. To resolve this ambiguity in the definition, the non-Abelian gauge theory is one of the possible solutions. By associating the spin-orbit interaction with the non-Abelian vector potential, a proper definition of spin current is given on the basis of the SU(2) gauge invariance and the electronic spin is covariantly conserved. In this context, we present theoretically a general form of spin polarization in terms of an effective Yang-Mills field corresponding to the spin-orbit interaction and usual U(1) Maxwell electromagnetic field. In particular, we focus on a purely electrical spin manipulation, and we find that both of the spin Hall effect and the inverse of the spin galvanic effect arise from the same origin, i.e., the SU(2)×U(1) Hall effect.

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