Microscopic Theory of the Inverse Edelstein Effect

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The spin Hall effect and the inverse spin Hall effect are well known phenomena in current spintronics research. A third effect, deeply connected to the above two, is the the so-called Edelstein effect (EE), where a steady current J_x, driven by an electric field E_x produces a steady non-equilibrium spin polarization S^y. On the other hand, relatively little attention has been paid to the "inverse Edelstein effect" (IEE), the Onsager reciprocal of the EE, recently observed by Rojas Sánchez et al. (Nature Commun. 4, 2944 (2013)). In this presentation, we provide a precise microscopic definition of IEE, in which a non-equilibrium spin accumulation in the plane of a two-dimensional (interfacial) electron gas drives an electric current perpendicular to its own direction. The drift-diffusion equations that govern the effect, based on a $SU(2)$ gauge-theory formulation of the Rashba spin-orbit coupling in a two-dimensional disordered electron gas, are presented and applied to the interpretation of the experiments. The results here presented have partly appeared in PRL 112, 096601 (2014).