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Interplay of disorder and spin-orbit coupling in diluted magnetic semiconductors XAVIER CARTOIXÀ, Departament Enginyeria Electrònica, Universitat Autònoma de Barcelona, 08193 Bellaterra, Spain, BYOUNGHAK LEE, Computational Research Division, Lawrence Berkeley National Laboratory, Berkeley, California 94720, NANDINI TRIVEDI, Department of Physics, Ohio State University, Columbus, Ohio 43210, RICHARD M. MARTIN, Loomis Laboratory of Physics, University of Illinois at Urbana-Champaign, Urbana, Illinois 61801 — We address two open questions: (i) upon doping GaAs with Mn, where do the holes go? (ii) how does the disorder arising from the random Mn locations affect the carrier polarization? Using a realistic multi-band tight-binding model with disorder effects included exactly, we find upon examining the nature of the eigenstates that the system is composed of two components: for a given doping of Mn atoms, a fraction of holes are localized in the midgap region, whereas the rest hybridizes with the host valence band generating extended states. These fractions change in a systematic way with doping. We further find that while spin-orbit coupling reduces the spin polarization by mixing different spin states in the valence bands, disorder from the random locations of the Mn ions enhances the spin polarization. This is primarily because the additional field from the ferromagnetically aligned impurities polarizes the itinerant carriers. We also show that the ferromagnetic coupling between localized Mn moments exhibits a strong real space anisotropy.

Xavier Cartoixa
Universitat Autonoma de Barcelona

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