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Spin relaxation via exchange with donor impurity-bound electrons¹

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At low temperatures, electrons in semiconductors are bound to shallow donor impurity ions, neutralizing their charge in equilibrium. Inelastic scattering of other externally injected conduction electrons accelerated by electric fields can excite transitions within the manifold of these localized states. Promotion of the bound electron into highly spin-orbit-mixed excited states drives a strong spin relaxation of the conduction electrons via exchange interactions, reminiscent of the Bir-Aronov-Pikus process where exchange occurs with valence band hole states. Through low-temperature experiments with silicon spin transport devices and complementary theory, we reveal the consequences of this spin depolarization mechanism both below and above the impact ionization threshold.

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