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g-Factor Anisotropy Driven Spin Relaxation in Germanium[1]

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In semiconductors possessing more than a single conduction band valley, g-factor anisotropy opens a new channel of electron spin relaxation. This unusual mechanism arises in a magnetic field because the effective Zeeman field is tilted along the valley axis, and is randomized when electrons undergo intervalley scattering. This fluctuation depolarizes electron spins [1], similar to the Dyakonov-Perel mechanism in noncentrosymmetric semiconductors where spin relaxation is driven by a wavevector dependent magnetic field. We study the unique nature of g-factor anisotropy spin relaxation by spin transport measurements from long-distance germanium devices in a magnetic field aligned to the initial spin orientation [2]. The confluence of electron-phonon scattering (leading to Elliott-Yafet spin flips) and this previously unobserved physics enables the extraction of spin lifetime solely from spin-valve measurements. We find spin lifetimes in Ge up to several hundreds of ns at low temperature, far beyond any other available experimental results. Electric field and magnetic field are used to manipulate the spin signal by accelerating the spin polarized electrons and generating carrier heating, or by inducing Hanle spin precession.

[1] J.-N. Chazalviel, J. Phys. Chem. Solids 36, 387 (1975)
[2] Pengke Li, Jing Li, Lan Qing, Hanan Dery, and Ian Appelbaum, Phys. Rev. Lett. (2013)

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