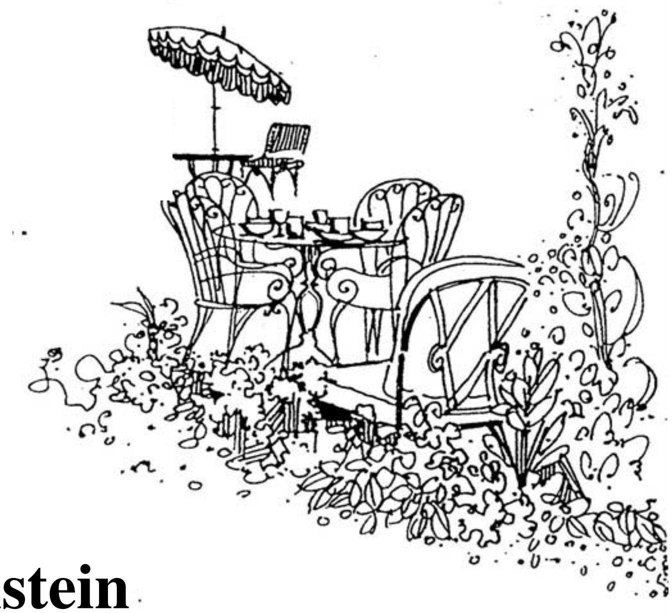
Chez Pierre

Presents …



Monday, December 8, 2008

12:00pm

MIT Room 4-331

Joe Orenstein

UC Berkeley and LBNL

"Emergence of the persistent spin helix in semiconductor quantum wells"

According to Noether's theorem,[i] for every symmetry in nature there is a corresponding conservation law. For example, invariance with respect to rotation of the electron's spin, or SU(2) symmetry, leads to conservation of spin polarization. For electrons in a solid, SU(2) symmetry is ordinarily broken by spin-orbit (SO) coupling, allowing spin angular momentum to flow to orbital angular momentum. However, it has recently been predicted that SU(2) and spin conservation can be recovered in a two-dimensional electron gas, despite the presence of SO coupling[ii]. This can occur when the strength of two dominant SO interactions, the Rashba (α) and linear Dresselhaus ($\beta1$), are tuned to be equal, resulting in the conservation of a helical spin density wave known as the persistent spin helix (PSH) . As a consequence of this new conserved quantity, the distance over which spin information can propagate is predicted to diverge as $\alpha \rightarrow \beta1$. As α can be modulated by external electric fields, the PSH effect provides a mechanism for rapid gate control of spin dynamics. In this talk I describe the observation of a PSH in GaAs quantum wells with independently tuned α and $\beta1$, using transient spin-grating spectroscopy. We find a spin-helix lifetime that is enhanced by two orders of magnitude relative to the spin-diffusion limited lifetime. Excellent quantitative agreement with theory across a wide range of sample parameters allows us to obtain an absolute measure of all relevant SO terms, identifying the cubic Dresselhaus interaction as the main factor limiting the stability of the PSH in our samples. The tunable suppression of spin-relaxation demonstrated in this work is well-suited for application to spintronics.

[i] *Noether, E.* Invariante Variationsprobleme. *Nachr. d. König. Gesellsch. d. Wiss. zu Göttingen, Math-phys. Klasse: 235–257 (1918)*

[ii] Bernevig, B. A., Orenstein, J.O. & Zhang, S.-C., *Phys. Rev. Lett.* **97**, 236601 (2006).