Theory of single spin detection using ESR-STM techniques

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Recently, Durkan and Welland [1], have detected the spin of an unpaired electron on a free-radical BDPA molecule using a stationary scanning tunnelling microscopy technique.
The experiment was performed in a constant magnetic field and the tunnelling current spectrum showed a modulation at a frequency equal to the Larmor precession frequency of the molecule in this field.

As the modulation is only present when the STM tip is held over a molecule, we expect a spin-orbit interaction to be responsible. To allow for this, we work in a relativistic framework.
We present a delta shell model for the experiment which treats the STM tip and the molecule as separate potentials acting at a thin sphere around the actual site of the tip and molecule.
The spin on the molecule is positioned on the molecular potential shell and the vacuum barrier will be treated as an integrable boundary between the two potentials.

Here we show the bound states and scattering behaviour of the conduction electrons from the potentials, and investigate what effect the spin on the molecule has on the scattering. Combining the scattering results with the model vacuum barrier will allow us to calculate the modulation of the tunnel current due to precession of the spin of the unpaired electron in the BDPA molecule.

[1] C. Durkan, M. Welland, App. Phys. Lett. 80, 3, (2002)