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Electron Spin Resonance of Individual Atomic and Molecular Spins on a Surface

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Abstract:

Scanning Tunneling Microscopy (STM) can be combined with electron spin resonance [1]. The major advantage of spin resonance is the fact that the energy resolution is independent of the temperature and thus can be much higher than a Fermi-function limited spectroscopy technique such as STM tunneling. In ESR-STM we apply a microwave-frequency electric field to the STM tunnel junction and convert this AC electric field into a driving field for the ESR. We find an energy resolution, which is about 10,000 times better than low-temperature STM. Two advantages of ESR-STM over ensemble-averaging techniques are first, the obvious fact that individual spin systems are measured and second, that this can be combined with precise atom manipulation to build engineered nanostructures.

We will begin by introducing the basic concepts of STM, which might be new to some members of this community. Then we will focus on one example of ESR-STM. We will utilize the atomic spin of Ti-H molecules which are adsorbed on thin MgO films supported on Ag metal substrates. Ti-H is a beautiful example since it has a spin of S=1/2 in this configuration together with a rich isotope distribution including nuclear spins [2].

In the second example we will investigate molecules with ESR-STM. We found that Fe-Pc has an S=1/2 spin state due to charge transfer from the substrate. In contrast to Fe atoms on the same surface, this spin is isotropic and shows no signs of magnetic anisotropy [3].

ESR-STM is just in its infancy with many groups joining this research effort. I believe that this technique will occupy a bright corner of quantum-coherent nanoscience.

References:

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