Probing Ultrafast Electron Spin Dynamics by Optical Pump-probe Scanning Tunneling Microscopy

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The understanding and direct measurement of ultrafast electron spin dynamics on nanostructures had always been an everlasting research topic both theoretically and experimentally during past decades. Several scanning tunneling microscopy (STM) based spatially resolved techniques, as well as the temporally resolved ultrafast spectroscopy methods had been successfully demonstrated to be powerful tools for characterizing localized electron spin dynamics on nanoscale. Originally and complementarily, here, we present our newly developed optical pump-probe STM (OPP-STM) technique, which enables us to probe ultrafast spin dynamics on nanoscale with both high temporal and spatial resolution at the same time.

In OPP-STM, femtosecond laser pulse trains are divided into two different optical paths, to be pump and probe, respectively. Then, the pulses are tightly focused on the sample under STM. By carefully designing the optical system and choosing a novel optical polarity modulation method on both of the pump and probe pulses, electron spin dynamics on GaAs were probed with ultimate temporal and spatial resolution.

The experimental setup and some of the results are shown in figure 1 below, more details and other results will be given and discussed in the presentation.

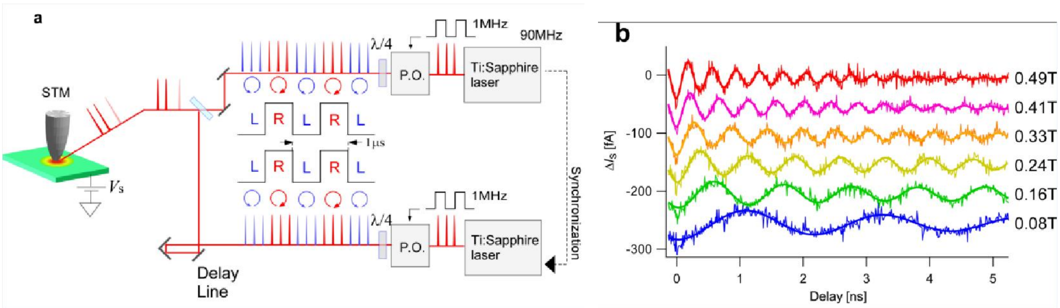

Fig.1. (a) The schematic of the OPP-STM. (b) The magnetic field dependence of spin precessions on GaAs(110) under the OPP-STM setup, the spin precession occurs at the Larmor frequency $\omega = g\mu_B B/$, where g is the Landé's g factor, B is the magnetic field, μ_B is Bohr magneton and is Dirac constant.

References:

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