Abstract:
Stabilizing the magnetization of a single surface-adsorbed atom is the key to store and process information in the smallest unit of matter. To achieve this goal, a strong magnetic anisotropy is required to stabilize the spin of the magnetic atom against thermal fluctuations. In addition, the magnetic quantum levels have to be protected against quantum tunneling of the magnetization and scattering with the electrons of the supporting substrate. For a decade, the research in the field focused on 3d magnetic atoms such as Co and Fe. Several atom/surface combinations were found to exhibit large magnetic anisotropy [1, 2]. However, they all show a paramagnetic behavior down to 0.3 K, with the longest achieved magnetic lifetime being 230 µs at 0.6 K [3]. Recently, the focus of the research shifted on rare earth atoms, whose magnetic 4f orbitals provide large magnetic moments and anisotropies, as well as an efficient decoupling from the environment [4].
In this talk, I will show that single rare earth atoms exhibit magnetic stability on the timescale of hours when adsorbed on ultra-thin decoupling layers grown on a metal substrate. First, we used X-ray magnetic circular dichroism (XMCD) to prove that Ho atoms adsorbed on MgO/Ag(100) exhibit magnetic stability, with a spin lifetime of 1500 s at 10 K and open hysteresis loops up to 40 K [5]. These features qualify them as the first single atom magnets. Second, combining XMCD with scanning tunneling microscopy, we realized a model bit patterned media made of single Dy atoms. When deposited on graphene/Ir(111), these atoms exhibit magnetic stability at 2.5 K. In addition, the moiré pattern originating from the graphene/Ir lattice mismatch drives a self-assembly mechanism, which allows organizing the Dy atoms into ordered arrays. Our results pave the road to magnetic information storage at the single atom level.

References

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