Magnetic anisotropy goes spintronic

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Magnetic anisotropy of quantum spins as found in magnetic atoms and single-molecule magnets has traditionally been considered an intrinsic effect, generated locally by the combination of spin-orbit coupling and ligand field effects. In this talk I will show that magnetic anisotropy can, however, appear in a new way as a transport quantity, even in a very simple a spin-isotropic quantum dot supporting a spin-1 which is exposed to the influence of magnetic electrodes. Much like spin-polarization transport, spin-anisotropy transport has two main aspects:
First, magnetic anisotropy is shown to appear as a dissipative transport quantity which is able to "get stuck" in a system, quite similar to how spin accumulates in a spin-valve. This idea is made precise by continuity equations that relate an accumulation of the spin-quadrupole moment tensor to corresponding currents [1]. The latter new tensor-valued currents describe the flow of magnetic anisotropy, very similar to how spin-currents describe the flow of the vectorial quantity of spin-polarization. I will show how measurable charge transport in a quantum-dot spin-1 valve depends on this flow and accumulation of spin-anisotropy [2].
Second, magnetic anisotropy can also be generated by coherent transport processes, resulting in a proximity effect, much like that responsible for the well-known (dipolar) exchange field, an effective magnetic field which allows for control over spin-1/2 quantum dot spin-valves, even in the time-domain [3]. The most dramatic illustration of this kind of "quadrupolar proximity effect" is the generation "from scratch" of a magnetic anisotropy term in the effective Hamiltonian of a spin-1 quantum dot. This turns an isotropic spin-1 system into a full-blown single-molecule magnet with electrically controllable magnetic bistability [4]. The magnitude of the proximity-induced spin-reversal barrier can match that of state-of-the art single-molecule magnets.

References:

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