Abstract for an Invited Paper
for the MAR10 Meeting of
The American Physical Society

Molecular Spintronics[1]

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In organic molecules and molecular solids the weak spin-orbit and hyperfine interactions result in extremely long spin-lifetimes reaching up to the second mark. However the same are characterized by a generally poor mobility, so that the spin-diffusion lengths are rather short. These peculiar characteristics position organic molecules in a unique space within Spintronics and one should envision applications where the spins are manipulated close to where they are injected [1]. In this contribution I will review the current state of the art of the theory of spin-transport and manipulation in organic molecules. I will start the discussion by presenting a new mechanism, the electrostatic spin crossover effect, for manipulating electrically the magnetic state of a molecules without calling for current-driven spin-transfer torques [2]. This is based on the fact that the different spin states of a molecule Stark-shift differently and it is mostly effective when inversion symmetry is broken. Then I will move to discuss the consequences of such an effect on the transport properties of a molecule presenting two magnetic centers and demonstrate that there exist a critical voltage at which the current becomes temperature-independent [3]. Finally I will present results for spin-transport in Mn_{12} and demonstrate that the magnetic state of the molecule can be read electrically with a single I-V read-out obtained by using non-magnetic electrodes [4].

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[1]This work is supported by Science Foundation of Ireland and by the EU.