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Electrical detection of proton-spin motion in a polymer device at room temperature[1]

CHRISTOPH BOEHME, Department of Physics and Astronomy, University of Utah

With the emergence of spintronics concepts based on organic semiconductors there has been renewed interest in the role of both, electron as well as nuclear spin states for the magneto-optoelectronic properties of these materials. In spite of decades of research on these molecular systems, there is still much need for an understanding of some of the fundamental properties of spin-controlled charge carrier transport and recombination processes [1]. This presentation focuses on mechanisms that allow proton spin states to influence electronic transition rates in organic semiconductors. Remarkably, even at low-magnetic field conditions and room temperature, nuclear spin states with energy splittings orders of magnitude below thermal energies are able to influence observables like magnetoresistance and fluorescence [2]. While proton spins couple to charge carrier spins via hyperfine interaction, there has been considerable debate about the nature of the electronic processes that are highly susceptible to these weak hyperfine fields. Here, experiments are presented which show how the magnetic resonant manipulation of electron and nuclear spin states in a π-conjugated polymer device causes changes of the device current [3]. The experiments confirm the extraordinary sensitivity of electronic transitions to very weak magnetic field changes and underscore the potential significance of spin-selection rules for highly sensitive absolute magnetic fields sensor concepts [4]. However, the relevance of these magnetic-field sensitive spin-dependent electron transitions is not just limited to semiconductor materials but also radical pair chemistry [5] and even avian magnetoreceptors [6]. [1] C. Boehme, J. M. Lupton, *Nat. Nanotechn.* **8**, 9 (2013); [2] S.-Y. Lee et al., *JACS* **133**, 072019 (2011); [3] H. Malissa et al., *Science* **345**, 1487 (2014); [4] W. J. Baker et al., *Nature Commun.* **3**, 898 (2012); [5] U.E. Steiner and T. Ulrich, *Chem. Rev.* **89**, 51-147 (1989).; [6] T. Ritz, et al., *Nature* **429**, 17780 (2004).

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