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Probing carrier-pair spin-spin interactions in a conjugated polymer by detuning of electrically detected beating of Rabi oscillations

KIPP VAN SCHOOTEN[1], DOUGLAS BAIRD, MARK LIMES, JOHN LUPTON, CHRISTOPH BOEHME, Dept. of Physics and Astronomy, University of Utah, Utah — Radical pair reactions can explain phenomena ranging from avian magnetoreception to spin-dependent charge-carrier recombination and transport rates in semiconductor materials. Central to the radical pair model are weakly-coupled electron spin pairs in a matrix with weak spin–orbit interactions. However, while it has been known that the magnetic-dipolar and spin-exchange interaction strengths within these pairs are weak, specific values within their native operating environment (e.g. within organic light emitting diodes) have been experimentally difficult to obtain. To probe intra-pair coupling strengths *in situ* for an organic semiconductor diode under operating conditions, we use electrically detected magnetic resonance to measure the detuning behavior of Rabi nutation frequencies. In the limit of negligible exchange and dipolar coupling, a fundamental Rabi frequency is analytically predicted to be accompanied by a first harmonic frequency. Deviations from this analytical prediction are due to finite values of exchange and dipolar interactions. By comparing these measured deviations with those obtained from an accurate numerical simulation of various combinations of finite coupling, constraints on both the exchange ($|J|<30$ neV) and dipolar ($|D|=23.5$ neV) coupling energies are formulated. Further, by considering the dipolar portion alone, a mean intercharge separation of 2.1 nm is implied.

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