DEPARTMENT OF PHYSICS & ASTRONOMY

CONDENSED MATTER SEMINAR

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Probing Triplet Excitons with Spin in Organic Semiconductors

Spin plays a key role in organic semiconductors, with examples ranging from spin-dependent losses in organic photovoltaics and light-emitting diodes to magnetic field-dependent charge mobility in transistors. One such spin-dependent process, singlet fission, involves the production of two triplet excitons (each with spin *S=1)* following excitation of one singlet exciton (spin *S=0*). This pair production process has the potential to boost the theoretical efficiency of photovoltaics beyond the Shockley-Queisser limit, while the reverse process, triplet-triplet annihilation, underpins applications of organic semiconductors in photocatalysis, bio-imaging, and light-emitting diodes [1-3]. Recently we have used singlet fission as a means of optically generating spin-1 excitations to study their fundamental spin interactions [4,5]. We have deployed broadband optically detected magnetic resonance, electron spin resonance, and magneto-optics to extract dipolar and exchange interactions between triplet excitons in an organic semiconductor. Mapping the experimentally extracted spin parameters onto the molecular crystal structure provides a window into exciton localization, dissociation, and diffusion in the molecular lattice. This mapping of spin properties to excited-state electronic structure is made possible by sustained excited-state spin polarization and coherence over microsecond timescales, and so these spin properties not only provide us with a probe of electronic processes in organic materials, but also present an opportunity for future development of molecular spin-based technologies.

[1] Congreve, D. N., et al. *Science* 340.6130 (2013)
[2] Ravetz, B. D., et al. *Nature* 565.7739 (2019)
[3] Singh-Rachford, T N., *Coordination Chemistry Reviews* 254 (2010)
[4] Weiss, L. R., et al. *Nature Physics* 13.2 (2017)
[5] Bayliss, S. L., et al. *PNAS* 115.20 (2018)

Tuesday, November 19, 2019
4:00 pm, JFB 334
Refreshments will be served in JFB 334 at 3:45 pm