Abstract Submitted
for the MAR15 Meeting of
The American Physical Society

Hyperfine-induced spin relaxation of a hopping carrier: implications for spin transport in 1-D vs 3-D organic semiconductors[1] VAGHARSH MKHITARYAN, VIATCHESLAV DOBROVITSKI, Ames Laboratory, Iowa State University, Ames, Iowa 50011, 0 TEAM — The hyperfine coupling of a carrier spin to a nuclear spin bath is a predominant channel for the carrier spin relaxation in organic semiconductors. We investigate the hyperfine-induced spin relaxation of a carrier performing a random walk on a d-dimensional regular lattice theoretically, in a transport regime typical for organic semiconductors. We show that in $d = 1$ and $d = 2$ the time dependence of spin polarization, $P(t)$, is dominated by a superexponential decay, crossing over to an exponential tail at long times. The faster decay is attributed to multiple self-intersections (returns) of the random walk trajectories, which occur more often in lower dimensions. We also show, analytically and numerically, that the returns lead to sensitivity of $P(t)$ to external electric and magnetic fields, and this sensitivity strongly depends on dimensionality of the system ($d = 1$ vs. $d = 3$). Furthermore, we consider the coordinate dependence of spin polarization, $\sigma(r)$, in a hypothetic lateral or vertical organic spin-valve device. We demonstrate that, while $\sigma(r)$ is essentially exponential, the effect of multiple self-intersections can be identified in transport measurements from the specific field-dependence of spin relaxation length.

[1]This work was supported by the Department of Energy-Basic Energy Sciences under Contract No. DE-AC02-07CH11358

Vagharsh Mkhitaryan
Ames Laboratory, Iowa State University, Ames, Iowa 50011

Date submitted: 13 Nov 2014 Electronic form version 1.4