Quantum and semiclassical methods for radical pair spin dynamics

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Peter Hore introduced us to the spin dynamics of radical pairs almost a decade ago. Since then, we have developed new semiclassical [1,2] and quantum mechanical [3-5] methods for simulating this spin dynamics, and applied them to a variety of interesting problems. For example, we have recently calculated the exact quantum mechanical spin dynamics of a photo-excited carotenoid-porphyrin-fullerene (CPF) radical pair containing 45 hyperfine-coupled nuclear spins [6]. This was quite an achievement because the $2^{47}$ coupled states in the Hilbert space would have made a standard quantum mechanical calculation quite impractical. We have also shown that an appropriate semiclassical approximation reproduces our quantum mechanical results for the CPF radical pair at a small fraction of the computational cost [6]. This talk will review these developments and use them to argue that the problem of simulating the spin dynamics of even rather complicated radical pairs has now been solved.