Contribution ID: **278** Type: **Poster Presentation**

An open quantum systems approach to the radical pair mechanism

Tuesday, 26 June 2018 15:00 (2 hours)

The development of the radical pair mechanism has allowed for theoretical explanation of the fact that magnetic fields are observed to have an effect on chemical reactions. The mechanism describes how an external magnetic field can alter chemical yields by interacting with the spin state of a pair of radicals. Since the inception of quantum biology, there has been interest in the application of this mechanism to biological systems, in particular the avian compass. However, one of the pitfalls of attempting to apply the tools of quantum theory to the messy and complex systems that typify living organisms is the risk of oversimplification. To this end, the aim of the research outlined here is twofold. First to develop an open quantum systems approach to a model of the radical pair mechanism that allows for an investigation into the effects of different hyperfine configurations on radical pair dynamics while maintaining the necessary complexity and flexibility of the biological context. This model would allow for the simulation of, for instance, the case in which the electrons interact with a number of nuclei each at different distances from the radical and the distinction between weak or strong coupling with the nuclear environment. And second, this research aims to investigate whether the radical pair model might be applied to other emerging topics of interest within the field of quantum biology.

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Session Classification: Poster Session 1

Track Classification: Track G - Theoretical and Computational Physics