MAR15-2014-020281

Abstract for an Invited Paper
for the MAR15 Meeting of
the American Physical Society

A molecular compass for bird navigation[1]

PETER HORE, University of Oxford

Migratory birds travel spectacular distances, navigating and orienting by a variety of means, most of which are poorly understood. Among them is a remarkable ability to perceive the intensity and direction of the Earth's magnetic field. Biologically credible mechanisms for the sensing of such weak fields (25-65 microtesla) are scarce and in recent years just two proposals have emerged as frontrunners. One involves biogenic iron-containing nanoparticles; the other relies on the magnetic sensitivity of short-lived photochemical intermediates known as radical pairs. The latter began to attract attention following the proposal 15 years ago that the necessary physics and chemistry could take place in the bird's retina in specialised photoactive proteins called cryptochromes. The coherent dynamics of the electron-nuclear spin systems of pairs of photo-induced radicals is conjectured to form the basis of the sensing mechanism even though the interaction of an electron spin with the geomagnetic field is six orders of magnitude smaller than the thermal energy. The possibility that slowing decohering, entangled electron spins could form the basis of an important sensory mechanism has qualified radical pair magnetoreception for a place under the umbrella of "Quantum Biology." In this talk, I will introduce the radical pair mechanism, comment on the roles of entanglement and quantum coherence, outline some of the experimental evidence for the cryptochrome hypothesis, and summarize what still needs to be done to determine whether birds (and maybe other animals) really do use a chemical compass to find their way around.

[1]This work was supported by grants from DARPA, AFOSR, ERC and the EMF Biological Research Trust.