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Finding Myelin: Quantum mechanics in cow brains?

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Myelin is the fatty insulating material that covers nerve axons in white matter brain tissue and spinal cord. A number of neurodegenerative diseases, the most prominent of which is multiple sclerosis, are associated with damage to myelin with consequent degradation of neuronal signal transmission and functional impairment. A number of magnetic resonance imaging techniques have been developed to characterize myelin in order to assess disease progression and the effectiveness of treatment and treatment candidates. Several of these imaging techniques will be discussed,with a focus on a new technique, misleadingly named inhomogeneous magnetization transfer (ihMT), which relies upon the quantum mechanics of the dipolar interactions between 1H nuclei in the hydrocarbon chains of myelin lipids. Working with in vitro bovine brain tissue and a variety of phantom samples, we have demonstrated that the original explanation for the technique, offered by its inventors, that the observed effect is associated with "hole burning" in inhomogeneously broadened NMR spectra, is not correct. We have shown that instead, ihMT is due to connections to the dipolar-coupled nuclear spin bath in the myelin lipid molecules. The equivalence between two coupled spin-1/2 particles and a single spin-1 allows a simple explanation of how the dipolar couplings in lipids give rise to the observed contrast in ihMT MRI images.

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