Scattering of keV Neutrons and the problem of Quantum Entanglement

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Abstract

During the last eight years, several experiments were reported concerning the observation of a strong anomalous drop, ~ 40%, of the n-p scattering cross section compared to the accepted values. This anomaly, was reported for 10 eV - 200 eV neutrons, scattered from H-containing samples at room temperature [1]. More than 10 different samples (such as water (H_2O), polystyrene (C_8H_8), benzene (C_6H_6), liquid H_2, hydrides of Nb, Pd, and Li) were studied, all of which seemed to reveal more or less the same effect. An explanation involving short lived (10^{-15} to 10^{-16}s) quantum entanglement of protons, was proposed to explain the anomalous drop off in the scattering cross section. It was suggested that during the very short times of the scattering process, no quantum decoherence is expected to take place. To test the above findings, we scattered keV neutrons [2], generated by the RPI Electron Linac, from pure liquid H_2O and compared the scattering intensity to that of pure D_2O and also relative to H_2O-D_2O mixtures at room temperature. The final energy of 24.3 keV was selected using a pure iron filter. At such higher energies and the shorter scattering times (10^{-17} to 10^{-18}s), decoherence is less likely to occur, and the effect of quantum entanglement of the protons was expected to show up more clearly. However in the actual experiment, we observed no anomaly and the scattering intensity ratios were found to agree with expected values deduced from the tabulated (n,total) cross sections on H, D and O to within an accuracy of 3%.

[1] C.A. Chatzidimitriou-Dreismann, et al., Phys. Rev. Lett. **79**, 2839 (1997)

[2] R. Moreh, R. C. Block, Y. Danon, and M. Neuman, Phys. Rev. Lett. **94**, 185301 (2005)