# Using quantum theory to predict dark matter fractions of galactic halos

A.D. Ernest[a]

[a] *Faculty of Science, Charles Sturt University, Wagga Wagga, NSW, Australia.*

The accepted paradigm for understanding the nature of dark matter is based on the existence of an "as yet unknown" particle beyond the standard model. The hypothesis is that this particle was formed at the beginning of the universe and is weakly interacting with photons and, possibly to a lesser extent other baryonic particles and electrons. Calculations from quantum theory applied to gravitational potentials show however that it is possible for individual baryons and electrons in gravity halos to have environmentally dependent cross sections, cross sections often much lower than accepted ones based on traditional measurements in the deep gravity wells of galaxy halos [1,2]. Individual baryons and electrons can function as dark matter particles, given a "suitable" environment. Halos could be simply gaseous agglomerations with varying eigenspectral compositions. This can only happen for particles that remain bound before and after an interaction in a very large gravitational well. In a large gravitational halo, there are plethora of bound states available for transfer so it might be expected that a quantum approach would yield that same result for bound particles as for free particles (as say, predicted by the Klein-Nashina formula) but this is not the case. In large gravity wells there are an overwhelming number of extremely "dark" gravitational eigenstates many states. A localized Gaussian wavepacket representing an individual baryon in a halo can have various degrees of darkness depending on its gravitational eigenstate composition and the weighted sum of the individual eigenstate-to-eigenstate cross sections of its eigenspectral components.

The same concept of environmental quantum-induced darkness is not applicable to internal atomic transitions In a hot, ionized halo individual protons and electron and helium nuclei potentially have cross sections that enable them to behave like dark matter, so hot halos can exhibit substantial dark matter fractions. There is a narrow range of temperatures over which a halo's mass can have almost all hydrogen atoms. In this case the gas is easily detected via the 21 cm line. The so-called dark matter appears as hydrogen atoms as in the recent galaxies that are observed to have no dark matter. This HI excess also happens in the EDGES result [3]. In cooler halos, the halo gas is almost all hydrogen molecules. The temperature is too low to enable detection of helium transitions and detecting vibrational or rotational transitions is difficult. This presentation will elaborate further on understanding how the dark matter fractions relate to the quantum temperature of galaxy halos.

[1] A. D. Ernest, *J. Phys. A: Math. Theor.* **42**, 115207 (2009).

[2] A. D. Ernest, *J. Phys. A: Math. Theor.* **42**, 115208 (2009).

[3] N. Mahesh et al., arXiv:2103.00423 (2021).