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What Dark Matter Halos and the Proton Radius Puzzle May Have in Common

The existence of the HI regions in dark matter halos of a number of galaxies is the observational fact. Each of the eight galaxies analyzed by observers had approximately the same maximum surface brightness temperature throughout its disc, what was explained by the self-absorption in the hydrogen line 21 cm. The opacity or absorption coefficient $\tau\nu$ is controlled by the column density NH of hydrogen atoms and their spin temperature Tspin. The brightness temperature TB is the known function of Tspin, $\tau\nu$, and NH. This allows determining the column density NH from the observed TB and the assumed or estimated Tspin. Coming from cosmic scales to nuclear scales: to the proton radius puzzle. Precise knowledge of such fundamental quantity as the proton charge radius rp is extremely important both for the quantum chromodynamics (for quark-gluon structure) and for atomic physics (for atomic hydrogen spectroscopy). Yet the ambiguity in measuring rp persists for over a dozen of years by now –from the time when in 2010 the muonic hydrogen spectroscopy experiment yielded rp ≈ 0.84 fm in contrast to the form factor experiment by the Mainz group that produced rp ≈ 0.88 fm. Important was that this difference corresponded to about seven standard deviations and therefore was inexplicable. In the intervening dozen of years, more experiments of various kinds were performed in this regard. Nevertheless, the controversy remains, which is why several different types of new experiments are being prepared for measuring rp. In one of our papers, we pointed out the factor that was never taken into account by the corresponding research community. We showed that the allowance for this factor can reconcile the above two values of the proton charge radius. The same factor, being taken into account for dark matter halos, leads to the conclusion that the column density of hydrogen atoms NH could have been overestimated by about 30%.

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