

Recent Developments in the Proton Radius Puzzle

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The CODATA-recommended value of the proton rms charge radius r_p is based on hydrogen/deuterium spectroscopy and electron-proton/deuteron scattering experiments. Since 2010, a discrepancy between the r_p value determined from muonic hydrogen spectroscopy and the CODATA-recommended value has led to intense research activity both in theory and experiment. The situation has recently become even more puzzling as a contradiction appeared between two new hydrogen spectroscopy results: the 2S-4P transition frequency [Beyer *et al.*, Science 358, 2017] agrees with the muonic r_p value, while the 1S-3S transition frequency presented here supports the CODATA value.

In our experiment at Laboratoire Kastler Brossel (Paris, France), the two-photon 1S-3S hydrogen transition is excited in an atomic beam, with a continuous-wave 205-nm laser obtained by sum frequency generation in a non-linear crystal. The transition frequency is measured with respect to the LNE-SYRTE Cs clock by means of a frequency comb. The second-order Doppler shift and other systematic effects have been included in the analysis to determine the 1S-3S transition frequency with a relative uncertainty of 9×10^{-13} [Fleurbaey *et al.*, PRL accepted for publication, 2018]. The value of the proton radius which can be inferred is in very good agreement with the CODATA-recommended value.

In this talk, I will present the current situation of the proton radius puzzle and our latest results.

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