Determination of the Moments of the Proton Charge Density: Is There a Proton Radius Puzzle?

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The charge radius of the proton can be determined using two different kinds of experiments: the spectroscopy technique, where it is determined from the hyperfine structure of muonic atoms, and the scattering technique, where it is deduced from the cross section of elastic lepton scattering off a proton target. These two methods lead to quite different results, yielding 0.84087(39) fm and 0.879(8) fm, respectively. This discrepancy is known as the "proton radius puzzle" (see [1] for a recent review). To shed light on this problem, we have proposed a novel method for the determination of spatial moments from densities expressed in the momentum space. This method provides a direct access not only to the second moment, directly related to the proton radius, but to even, odd, and more generally any real, negative and positive moment with order larger than -3 [2]. The method has recently been applied to the global analysis of proton electric form factor experimental data from Rosenbluth separation and low squared four-momentum transfer experiments, paying specific attention to the evaluation of the systematic errors of the method. Within this comprehensive analysis of proton electric form factor data, the moments of the proton charge density have been determined for integer order moments, the second one leading to a proton charge radius of 0.8261(12)Sta.(76)Sys. [3].

References

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