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Overview and status of the proton radius measurements

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The discrepancy between the proton charge radius extracted from the muonic hydrogen Lamb shift measurement and the best present value obtained from the elastic scattering experiments, remains unexplained and represents a burning problem of today's nuclear physics. After more than 50 years of research the radius of a basic constituent of matter is still not understood.

This discrepancy created a great excitement in the physics community, because it rigorously tests the theory of quantum electrodynamics and our understanding of nuclear physics. Since the observation of the discrepancy in 2010, various explanations for the problem have been offered, ranging from trivial experimental mistakes to those that suggest the need for physics beyond the Standard model. Some of the explanations have already been rejected, while the intriguing ideas, like the introduction of a new mediator particle, still need to be tested. Therefore, several new experiments have been proposed that will provide new constraints to the existing interpretations.

High-precision electron scattering experiments are scheduled at the Thomas Jefferson National Accelerator Facility and the Mainz Microtron accelerator at the Johannes Gutenberg University Mainz. As a complement to these measurements, a muon-proton scattering experiment is envisioned at the Paul Scherrer Institute. This will be the first experiment of its kind and will provide information on proton radius from a perspective yet unexplored. Together with the nuclear scattering experiments, new atomic experiments are also foreseen. Very precise measurements of Lamb shift in both hydrogen and deuterium will be performed in order to provide further insight into the proton radius puzzle.

Summary

In the presentation results of existing proton radius measurements will be discussed together with an overview of ongoing and upcoming experiments, dedicated to remeasuring the proton radius with improved statistical and systematic precision.

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