

Kolloquium Physik / TransRegio211

Strong-Interaction Matter under Extreme Conditions

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The mystery of the proton mass, and what J/ψ can tell us about it

The way in which the proton – a state made of massless gluons and almost massless quarks – acquires its large mass is still mysterious. The radius of the proton's mass distribution can shed light on this mystery – yet, so far it has not been determined from experiment. I will first discuss how the mass radius of the proton can be rigorously defined through the formfactor of the trace of the energy-momentum tensor (EMT) of QCD in the weak gravitational field approximation. I will then demonstrate that the scale anomaly of QCD enables the extraction of the formfactor of the trace of the EMT from the data on threshold photoproduction of J/ψ and Υ quarkonia, and use the recent data of GlueX Collaboration to extract the r.m.s. mass radius of the proton $R_m = 0.55 \pm 0.03$ fm. The extracted mass radius is significantly smaller than the r.m.s. charge radius of the proton $R_C = 0.8409 \pm 0.0004$ fm. I will discuss the possible origin of this striking difference.

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via zoom