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Matching Contact Interactions in QED-NRQED Effective Field Theory STEVEN DYE, MATTHEW GONDERINGER, GIL PAZ, Wayne State University — In 2010 the proton charge radius was first extracted from muonic hydrogen and was found to have a value five standard deviations away from the regular hydrogen value. An effective field theory analysis using Non-Relativistic Quantum Electrodynamics (NRQED) indicates that the muonic hydrogen result can be interpreted as a large, compared to some model estimates, muon-proton spin-independent contact interaction. One of the most promising avenues to resolve this puzzle is by muon-proton scattering. Such an experiment, called MUSE, is planned at the Paul Scherrer Institute in Switzerland. The typical momenta of the muons in this experiment are of the order of the muon mass. In this energy regime the muons are relativistic but the protons are still non-relativistic. The interaction between them can be described by a QED-NRQED effective field theory. Here we present elements of this effective field theory. In particular, we look at $\mathcal{O}(\mathcal{Z}\alpha)$ scattering up to power m^2/M^2, where m (M) is the muon (proton) mass, and $\mathcal{O}(\mathcal{Z}^{\in}\alpha^{\in})$ scattering at leading power. We also take a brief look at $\mathcal{O}(\mathcal{Z}^{\in}\alpha^{\in})$ at subleading power.

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