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Progress in the calculation of order α^7 radiative-recoil corrections to the energy levels of muonium and positronium

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Muonium and positronium, the $e^-\mu^+$ and e^-e^+ bound systems, are described almost completely within quantum electrodynamics. Their energy levels can be calculated to high precision, and these systems are also subject to high precision measurements. Recent developments include intense experimental work on muonium by the MuSEUM collaboration at J-PARC, the MuMASS collaboration at PSI, and a new measurement of the positronium fine structure by the Cassidy group at UCL. In order to match the uncertainties of projected experimental results the calculation of additional higher order corrections will need to done.

In this talk I will describe progress on a calculation of a set of radiative-recoil corrections to the energy levels of muonium and positronium at order α^7. These are terms involving two-loop radiative corrections to the exchange of two photons betweeen the bound fermions. There are 38 distinct Feynman graphs of this type, leading to a large number of three-loop Feynman integrals. Integration by parts identities were used to reduce the number of independent integrals that need to be done, and their evaluation is being accomplished by solving first order differential equations satisfied by groups of the needed integrals. The variable being used is the ratio x of the two fermion masses. Since results for all values of x are anticipated, the results will be applicable to both muonium and positronium.

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