Abstract

The gyromagnetic ratio of bound particles is an active field of experimental and theoretical research. Early measurements of corrections to the bound g-factor came from experiments involving hydrogen-like ions. As the sensitivity of such experiments has increased, it has become possible to instead use them to measure the electron-ion mass ratio — but only if the theoretical bound g-factor is known with sufficient precision for these systems. By constructing an effective nonrelativistic Lagrangian, we derive leading order binding and recoil corrections for systems comprised of particles with arbitrary spin.

Lagrangians for spin one-half and spin one-theories are developed, before moving on to the more general case of arbitrary spin. In each case, an effective nonrelativistic Lagrangian taking into account all relevant terms is constructed. The coefficients of this Lagrangian are then fixed by calculating scattering processes in both the relativistic and nonrelativistic theories.

A relativistic framework for dealing with particles of arbitrary spin is considered. In this framework the relevant terms in the scattering process are heavily constrained by the symmetries required of the electromagnetic current. This allows the determination of an effective Lagrangian valid for arbitrary spin. It is found that the only coefficients which depend upon the spin of the particle in question involve derivatives of the magnetic field. This general form is consistent with the previously derived Lagrangians for spin one-half and spin one particles.

With this effective nonrelativistic Lagrangian, the leading order binding and recoil corrections to the bound gyromagnetic ratio are calculated. These corrections found to be universal, independent of the spin of the particles involved.

Bibliography