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Finite Range Effects in Atomic and Nuclear Three-Body Physics[1]

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I examine effects of the finite range of the 2-body interaction on 3-body physics in the low energy limit where there has been much recent effort in understanding these phenomena using Effective Theories (ET's). I assume separable (SP) 2-body interactions – widely used in nuclear 3-body calculations shortly after the crucial work of Faddeev fifty years ago – which permit analytic solutions for the exact t-matrix which, eg, respect unitarity exactly. I compare these results with "standard" ET calculations in which incorporation of finite range effects is based on the Effective Range Expansion (ERE) of the 2-body on-shell scattering amplitude. We find that ET-ERE calculations for the quartet (spin=3/2) s-wave channel of neutron-deuteron elastic scattering disagree significantly from the the SP results in some cases. I discuss the origin and the significance of these discrepancies. I also discuss similar sets of calculations for cold, dilute atomic Bose gases. These provide a relatively simple means of reliably computing, eg, 3-body recombination coefficients while appropriately accounting for Efimov physics. I also discuss how these calculations can be adapted to treat certain many-body effects in Bose gases which might help in understanding, eg, the single quasi-particle dispersion relation as revealed by Bragg scattering experiments.

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