A renormalisation group approach to two-body scattering in the presence of long-range forces

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We apply the renormalisation group (RG) to two-body scattering by a combination of long- and short-range forces. This is similar to an earlier application of the RG to scattering by short-range forces only [1]. A central feature of our approach is that the cut-off is applied within the basis of distorted waves of the long-range potential. This allows us to construct an effective field theory [2] in which the terms in the expansion of the short-range potential are in one-to-one correspondence with the terms of a distorted-wave (or modified) effective-range expansion [3]. We use this to determine the power-counting for scattering by Coulomb plus short-range potentials, building on the work of Kong and Ravndal [4]. We also apply it to scattering in the presence of a $1/r^2$ potential, which has features in common with three-body systems [5]. We choose a particular self-adjoint extension of the $1/r^2$ potential, which can be thought of as an additional short-range potential whose role is just to make the distorted waves well-defined. By applying the cut-off in this basis, we find a well-defined power-counting for the rest of the short-range potential, avoiding the oscillatory "limit cycle" behaviour found in other treatments [6].

References

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