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A New Holizon of Few-Body Problems Exact Coulomb treatment and the energy-momentum translation of the three-body Faddeev equations

Our two recent developments will be presented.
1) We confirm the reliability of the well-known Alt's Coulomb renormalization method (CRM). It is found that the CRM is only available for a very- long-range screened Coulomb potential (SCP), where asymptotic property can be satisfied. However, such an SCP calculation in momentum space is considerably difficult because of the cancelation of significant digits. In con- trast to the CRM, we propose a new method by using an on-shell equivalent SCP and the rest term. We introduce the two-potential theory with r-space, which defines fully off-shell Coulomb amplitude. We obtain the Coulomb
phase shift with nine~ten digit accuracy. Our method can reproduce any
charged particle systems from electron-electron to heavy ion-heavy ion sys- tems such as ²⁰⁸Pb-²⁰⁸Pb.
2) An energy-momentum translation in the three-body Faddeev equation, with a proposed extension of the integral domain of the conventional Fad- deev equations, is carried out. We found that the quasi-two-body threshold
at the energy $E = -\epsilon B$ for the reaction process (a, b, c,) $\longrightarrow$ a + (b, c) di-
verges, and so does the three-body break up threshold at the three-body energy $E = 0$ for the process a + (b, c) $\longrightarrow$ a + b + c. Furthermore, an
analytic continuation from the three-body Faddeev equations to the multi- channel quasi-two-body Lippmann-Schwinger equations is performed. The divergence at the quasi-two-body threshold plays an essential role for solv- ing the scattering length in a three-body system. In our new procedure, the three-body binding energy can be redefined.

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