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Coulomb interaction in the HORSE formalism

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The J-matrix formalism in the oscillator basis, known also as the HORSE (Harmonic oscillator representation for scattering equations) [1] formlism, is used for calculations of elastic scattering, nuclear resonant states and reactions. Within the HORSE, the tridiagonal infinite kinetic energy matrix is fully taken into account, ensuring the correct asymptotic behavior of the wave function, while the potential energy matrix of the nuclear interaction is truncated at a certain radial quantum number. In the case of the Coulomb interaction, such a truncation leads to inaccurate results. Based on the ideas of the Kiev group [2], we suggested a method [3] to allow for the long-range part of the Coulomb interaction by a diagonal addition to the Hamiltonian matrix elements in the asymptotic region. However, unlike Ref. [2], we use a soft cutoff of the nuclear potential matrix as proposed in Ref. [4]. This allows us to obtain accurate results using fewer resources, since our approach does not require the calculation of a large number of Coulomb matrix elements.

For applications to *ab initio* calculations in many-body systems it is promising to combine our version of the HORSE formalism for charged particles with the modification of the Hulthén–Kohn variational method proposed by V. D. Efros [5] as suggested in Ref. [6]. We investigate the applicability of this approach and study its convergence using a model problem.

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Primary authors: KULIKOV, V. A. (Skobeltsyn Institute of Nuclear Physics, Lomonosov Moscow State University, Moscow 119991, Russia); SHIROKOV, A. M. (Skobeltsyn Institute of Nuclear Physics, Lomonosov Moscow State University, Moscow 119991, Russia); YANIKOV, U. M. (Department of Physics, Lomonosov Moscow State University, Moscow 119991, Russia)

Presenter: KULIKOV, V. A. (Skobeltsyn Institute of Nuclear Physics, Lomonosov Moscow State University, Moscow 119991, Russia)

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