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Three-body systems with contact interactions in one dimension

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Considered are different one-dimensional three-body systems in the universal low-energy limit of zero-range two-body interactions. Included are the two-component system with usual contact interactions and three-component system with impenetrable particles. Main attention is paid to the possibility to find analytical results and main patterns of the dependencies of bound-state energies and scattering characteristics on the parameters of systems (interaction strengths, masses of particles, parity).

For a system with usual zero-range interaction, there are few known analytical results, for example, for systems with infinite or zero strength of interaction between identical particles and with equal mass particles or for one heavy and two light particles [1]. In contrast, for a system with impenetrable particles due to correspondence to the symmetrical case of usual zero-range model, it was possible to find the bound-state solution in the diffraction-free (Bethe ansatz) form [2]. Moreover, this model for impenetrable particles is mathematically identical to the problem of reflection and diffraction of the plane or surface waves by an impedance wedge described in [3]. One more interesting problem to discuss is the scattering of dimer on a hard wall [4] that corresponds to the three-body system in which one particle has infinite mass.

[1] O.I. Kartavtsev, A.V.Malykh, S.A. Sofianos, ZhETF **135**, 419 (2009).

[2] O.I. Kartavtsev, A.V.Malykh, to be published.

[3] G. D. Maluzhinetz, Dokl. Akad. Nauk SSSR **121**, 436–439 (1958).

[4] X. Zhang, Sh. Tan, Phys. Rev. A **113**, 043312 (2026).

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