UNISA college of science, engineering and technology

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Scaling behavior of scattering observables for three-body systems near the unitary limit

Low-energy scaling properties of three-body systems are investigated, by considering the elastic $s-$wave collision of a particle in a bound-state formed by the remaining two-body system. In the first part of my presentation I will concentrate in the case of the halo nucleus ^{20}C, where we have examined the neutron$-^{19}$C scattering properties near the critical condition for the occurrence of an excited bound state in ^{20}C (within a neutron$-$neutron$-^{18}$C configuration), by considering zero-range and finite-range interactions [1] for the two-body subsystems. The results for the $s-$wave scattering amplitude present universal scaling features, with the variation of the ^{19}C binding energy for fixed ^{20}C binding and neutron-neutron singlet virtual state energies. The scaling of the effective-range parameters and the pole position of the scattering observable $k \cot \delta_0^R$ (where k is the momentum corresponding to the colliding energy and δ_0^R is the real part of the $s-$wave phase shift) are in general consistent with the scaling obtained with a zero-range potential. Next, by considering the actual possibilities for verification of low-energy scaling properties in cold-atom laboratories, I am going to consider strongly-mass-imbalanced three-body atomic systems, with the collision of a heavy particle in the light-heavy weakly-bound system. Our preliminary results [2] for scattering observables, obtained with zero-range interactions for the two-body bound system and no
interaction between the two-heavy particles, are evidencing the universal scaling features.

References:
[1] M.A. Shalchi, M.T. Yamashita, M.R. Hadizadeh, T. Frederico, L. Tomio,
Neutron$-^{19}$C scattering: Emergence of universal properties in a finite-range potential,
Phys. Lett. B {\bf 764} (2017) 196-202.

[2] M.A. Shalchi, M.T. Yamashita, M.R. Hadizadeh, L. Tomio, T. Frederico,
Probing the Efimov scaling for atom-molecule scattering, in preparation.

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