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Finite range effects in two-body and three-body interactions

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Efimov physics in ultracold gases is described very well by the universal scaling laws, based on the scattering length and van der Waals length. The first can be tuned magnetically via a Feshbach resonance, the second is constant and connected to the radial range of the potential. However, experimental hints at non-universal behavior, when going away from resonance, are quite badly understood. The next leading coefficient in the scattering phase shift, the effective range parameter, gives an indication of this non-universality, but at the same time it can also be strongly dependent on the magnetic field. Moreover, higher-order terms take over quickly when increasing the collision energy. We show how the finite range corrections can be understood by making the connection to more fundamental parameters of the two-body physics, and use this description to derive a better criterion for entering the non-universal regime.

Auteur principal: Dr KOKKELMANS, Servaas (Eindhoven University of Technology)

Orateur: Dr KOKKELMANS, Servaas (Eindhoven University of Technology)

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