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Universality in Nuclear Physics and Leading Corrections

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Effective field theories (EFT) are the ideal tool to calculate observables of systems with a separation of two scales. The ratio of these scales can be used as a small expansion parameter and observables can therefore be calculated in a controlled expansion which allows reliable error estimates. One such separation of scales familiar in nuclear physics is the sizable difference between the nucleon-nucleon scattering length and the associated interaction range $r \sim 1/m_\pi$. In the last decade an EFT has been developed which allows for a precise calculation of observables of low-energy nuclear systems. This EFT is built up from contact interactions only and is the appropriate framework for systems with relative momenta $k \ll 1/|r|$. Systems with a large scattering length have recently also gained a lot of interest in atomic physics. The possibility to change the two-body scattering length if a Feshbach resonance can be exploited gives the oppurtunity to analyze many- and few-body systems with a tunable interaction strength. In my talk I will present recent results obtained with this EFT. In particular, I will discuss universal relations for spin-1/2 fermions which can be derived using the well-known operator product expansion and which apply to neutron matter at very low densities. I will then consider the three-nucleon case and discuss how observables can be calculated to higher order in the EFT expansion and how these finite range effects impact the universal limit of this EFT. If time allows I will present results for electromagnetic observables calculated within this framework.