One- and two-neutron halos in effective field theory

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In this talk I will discuss recent work our group has undertaken to treat one- and two-neutron halos in effective field theory (EFT).

In Refs. [1,2] we demonstrated that an EFT containing core and neutron degrees of freedom, which is built on the scale hierarchy $R_{\rm core} \ll R_{\rm halo}$, can be used to analyze the Coulomb dissociation of one-neutron halos (specifically: ^{11}Be and ^{19}C). I will first describe our analysis of ^{19}C Coulomb dissociation data [2]. There is a good separation of scales in this system because of the ≈ 500 keV one-neutron separation energy of ^{19}C, c.f. $S_{1n}(^{18}{\rm C}) = 4.2$ MeV. We obtained accurate values for this neutron-separation energy and the effective-range parameters of the n^{18}C system by fitting the results of this EFT to the experimental data [3] on the Coulomb dissociation cross-section. The extracted values were used to predict the longitudinal momentum distribution, which was compared to data from Ref. [4].

I will then turn my attention to two-neutron halos. Here we analyzed the recent measurement of the rms matter radius of ^{22}C: $\langle r_m^2 \rangle^{1/2} = 5.4 \pm 0.9$ fm [5]. By applying universal relations derived from EFT to ^{22}C, and including estimates of higher-order EFT corrections in a treatment where ^{20}C is an inert core (its matter radius is markedly smaller than that of ^{22}C), we were able to put constraints on the poorly-known values of the ^{22}C two-neutron separation energy and n^{20}C virtual energy using this experimental datum. We found that the ^{22}C two-neutron separation energy must be less than 100 keV, even after the quoted errors on the experimental datum and the theoretical uncertainty are accounted for. We also studied the implications of this result for the existence of bound excited Efimov states in the ^{22}C system and found that the n^{20}C system needs to have a virtual state within a keV of threshold for such states to occur [6]. We are presently analyzing ^{6}He in a similar EFT framework. If time permits I will discuss those results also.

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