

Alpha-Cluster Structures above Double Shell Closures from Chiral Effective Field Theory

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α -cluster states above double shell closures are important examples of nuclear α clustering. They include ${}^8\text{Be} = \alpha + \alpha$, ${}^{20}\text{Ne} = {}^{16}\text{O} + \alpha$, ${}^{44,52}\text{Ti} = {}^{40,48}\text{Ca} + \alpha$, ${}^{104}\text{Te} = {}^{100}\text{Sn} + \alpha$, ${}^{212}\text{Po} = {}^{208}\text{Pb} + \alpha$, etc. Many theoretical and experimental efforts have been made to understand their physical properties.

We develop new cluster models with local potentials to study these α -cluster states in the light of chiral effective field theory (χ EFT) [1]. Compared with phenomenological models for nuclear interactions, χ EFT is characterized by its intimate connections to quantum chromodynamics through chiral symmetry breaking [2,3]. Also, its EFT framework provides a systematic way to make improvements and estimate theoretical errors. We obtain the local potentials between α clusters and doubly magic core nuclei by doubly folding their realistic density distributions with soft local chiral nucleon-nucleon potentials at next-to-next-to-leading order proposed in Ref. [4]. To simulate the Pauli blocking between alpha clusters and core nuclei, we adopt a modified version of the Wildermuth condition.

Various physical properties of α -cluster states in ${}^8\text{Be}$, ${}^{20}\text{Ne}$, ${}^{44,52}\text{Ti}$, and ${}^{212}\text{Po}$ are studied by our new model. The theoretical results agree well with experimental data and theoretical expectations. We also study ${}^{104}\text{Te}$, which has become a hot topic recently [5,6]. We analyze the available experimental data systematically within our model. The results could be helpful references for future experiments.

- [1] D. Bai and Z. Ren, α -Cluster Structures above Double Shell Closures from Chiral Effective Field Theory, under review (2020).
- [2] E. Epelbaum, H.-W. Hammer, and U. G. Meissner, *Rev. Mod. Phys.* **81**, 1773 (2009).
- [3] R. Machleidt and D. R. Entem, *Phys. Rept.* **503**, 1 (2011).
- [4] V. Durant, P. Capel, L. Huth, A. B. Balantekin, and A. Schwenk, *Phys. Lett. B* **782**, 668 (2018).
- [5] K. Auranen *et al.*, *Phys. Rev. Lett.* **121**, 182501 (2018).
- [6] Y. Xiao *et al.*, *Phys. Rev. C* **100**, 034315 (2019).

Field of your work

Theoretical nuclear physics

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