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The Puzzle of Super Heavy Helium Isotope - ^{9}He

Structure of neutron rich ^{9}He isotope studied via the T=5/2 isobaric analog states in ^{9}Li

THE SCIENCE

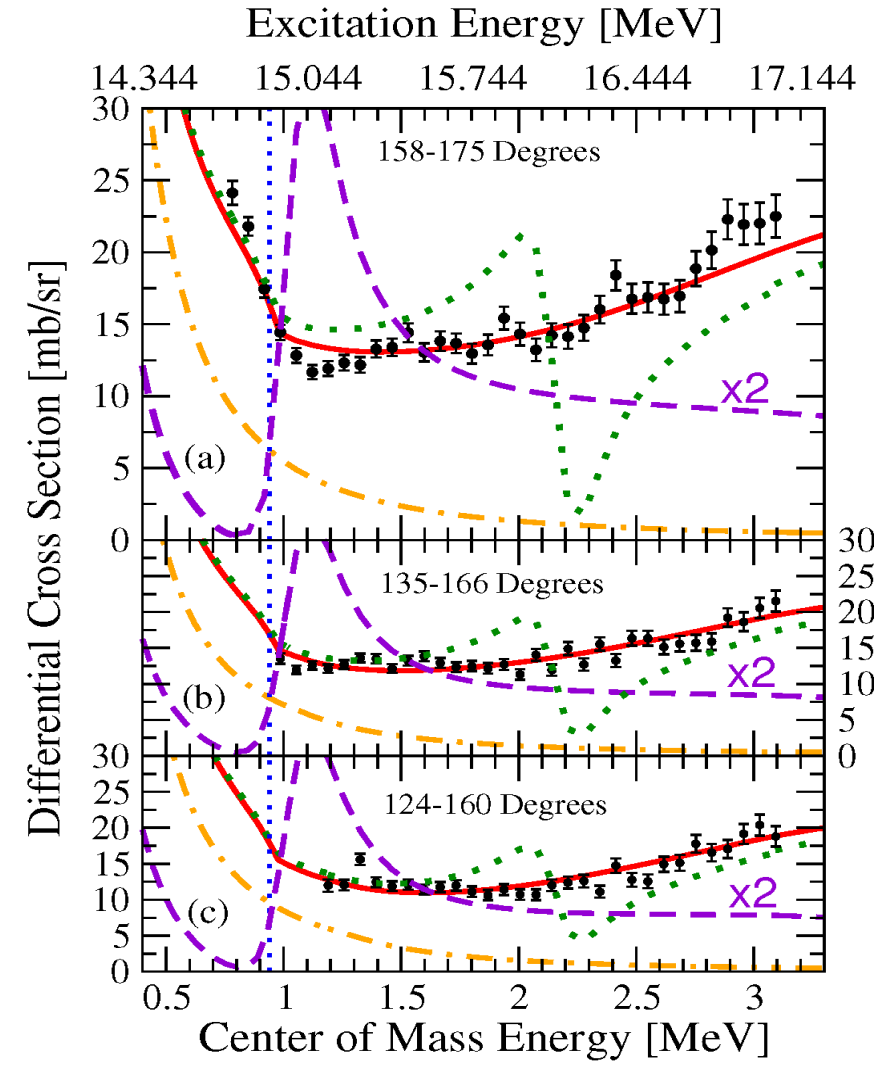
The longstanding view that the ground state of ^{9}He — a very exotic helium isotope that has five more neutrons than the regular helium — is a narrow resonance located at energy just above the neutron decay threshold is challenged by the new experimental data. Based on the new, high statistics and high energy resolution measurements, we conclude that ^{9}He does not have any narrow resonances within 2 MeV above the neutron decay threshold.

THE IMPACT

The longstanding discrepancy between experimental data that previously indicated the existence of narrow resonance structures near the neutron decay threshold in ^{9}He and predictions of the most advanced nuclear structure models has now been resolved. We show that no narrow low lying states exist in ^{9}He, as would be expected based on the current knowledge of nuclear interaction and state-of-the-art theoretical analysis.

SUMMARY

Structure of very exotic helium isotope - ^{9}He was studied using resonance elastic scattering of radioactive beam of ^{8}He on protons. It is difficult to populate states in ^{9}He directly, and many previous experiments produced inconclusive results. We applied a different approach in which states in ^{9}He are studied through their nuclear analogs (Isobaric Analog States - IAS) in less exotic nucleus - ^{9}Li. Due to isospin symmetry, if narrow resonance states exist in ^{9}He, then their isospin analogs should also be present in the spectrum of ^{9}Li at excitation energy that is easy to predict. These states would be preferentially populated in ^{8}He+p resonance elastic scattering. We obtained a high statistics and high energy resolution (~50 keV) spectrum of protons from ^{8}He+p resonance scattering and observed no indication of any narrow structures in ^{9}Li at excitation energies where ^{9}He IAS would be expected. This provides strong evidence that ^{9}He structure does not pose a dramatic challenge to modern nuclear theory after all.



^{8}He+p elastic scattering excitation function measured at three different lab. angles. No narrow structures are observed in the proton spectrum. The sensitivity of these data to the hypothetical narrow T=5/2 isobaric analog resonances in ^{9}Li is demonstrated by purple dashed and green dotted lines.

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PUBLICATIONS

E. Uberseder, G.V. Rogachev, V.Z. Goldberg, E. Koshchiy, B.T. Roeder, M. Alcorta, G. Chubarian, B. Davids, C. Fu, J. Hooker, H. Jayatissa, D. Melconian, R.E. Tribble, "Nuclear Structure beyond the neutron drip line: The lowest energy states in ^{9}He via their T=5/2 isobaric analogs in ^{9}Li". Physics Letters B 754 323 (2016).

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ABOUT THE CYCLOTRON INSTITUTE: *Dedicated in 1967, the Cyclotron Institute serves as the core of Texas A&M University's accelerator-based nuclear science and technology program. Affiliated faculty members from the Department of Chemistry and Department of Physics and Astronomy conduct nuclear physics- and chemistry-based research and radiation testing within a broad-based, globally recognized interdisciplinary platform supported by the United States Department of Energy (DOE) in conjunction with the State of Texas and the Welch Foundation. The facility is one of five DOE-designated Centers of Excellence and is home to one of only five K500 or larger superconducting cyclotrons worldwide.*