Consistency between the monopole strength of the Hoyle state determined by structural calculation and that extracted from reaction observables

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The 0_2^+ state of ^{12}C, the so-called Hoyle state, has intensively been studied theoretically and experimentally. Despite a rather clear understanding of its three-α structure, the description of the Hoyle state appeared in reaction observables, the (α,α') inelastic scattering cross section in particular, has not been achieved. It was reported in many studies that the (α,α') cross section theoretically obtained with using the transition density of ^{12}C from the ground state to the 0_2^+ state significantly overshot the observed cross section. This puzzle is called the missing monopole strength of the Hoyle state [1].

We analyze the *alpha*-^{12}C inelastic scattering to the 0_2^+ state of ^{12}C, in a fully microscopic framework using the transition density of ^{12}C obtained by the resonating group method [2] and the nucleon-nucleon g-matrix interaction developed by the Melbourne group [3]. For the calculation of coupling potentials, the target density approximation [4] for light-ion scattering is used.

In Fig. 1, we show the differential cross sections of α-^{12}C inelastic scattering to the 0_2^+ state at 172.5, 240, and 386 MeV, as a function of the scattering angle in the center-of-mass system. With no free adjustable parameter, the inelastic cross sections at forward angles are well reproduced, although the calculation slightly overshoots the experimental data at larger angles . There seems to be no room for the missing monopole strength; if it could exist, the inelastic cross section would decrease at all angles and the good agreement at forward angles would be lost. It is thus shown that the monopole transition strength obtained by the structural calculation is consistent with that extracted from the reaction observable.

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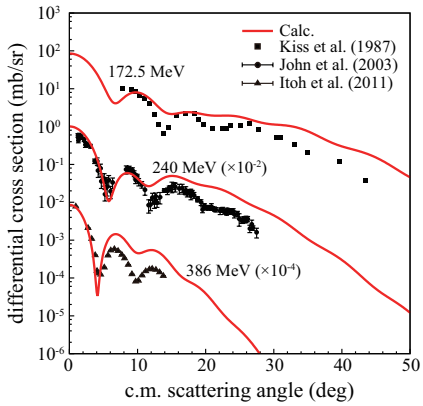

Figure 1: Differential cross sections of α-^{12}C inelastic scattering to the 0_2^+ state at 172.5, 240, and 386 MeV, as a function of the scattering angle in the center-of-mass system. This figure is taken from Ref. [5].

References

[1] D. T. Khoa and D. C. Cuong, Phys. Lett. B **660**, 331 (2008).
[2] M. Kamimura, Nucl. Phys. A **351**, 456 (1981).
[3] K. Amos, P. J. Dortmans, H. V. von Geramb, S. Karataglidis, and J. Raynal, Adv. Nucl. Phys. **25**, 275 (2000).
[4] K. Egashira, K. Minomo, Phys. Rev. C , (2014).
[5] K. Minomo and K. Ogata, Phys. Rev. C **93**, 051601 (2016).