Search for α-cluster states in ^{13}C using α inelastic scattering

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The 0_2^+ state in ^{12}C, which is called the Hoyle state, is suggested to have spatially well-developed 3α cluster structure. On the other hand, 3α+n cluster structure where an excess neutron is coupled with the Hoyle state is expected to emerge in ^{13}C. The spin and parity of this state are expected to be $1/2^-$ or $1/2^+$. In this work, we searched for 3α+n cluster states by measuring the strengths distributions of the $\Delta L = 0$ and 1 transitions for the $1/2^-$ and $1/2^+$ states in the ^{13}C(α, α') reaction at forward angles.

In the analysis, the transition potentials were obtained by folding the macroscopic transition strengths with the effective α-N interaction. We carried out the distorted-wave born-approximation (DWBA) calculation using the transition potentials and obtained the strength distributions for the $\Delta L = 0$–3 transitions by multipole decomposition analysis (MDA). The MDA reasonably reproduces the known transition strengths for the discrete states in ^{13}C. We found the 11.08 and 12.5-MeV states are strongly excited by the monopole transitions and observed a bump structure at $E_x = 14.5$ MeV in the $\Delta L = 1$ strength distribution. Since these states locate near the ^{9}Be+α and 3α+n decay thresholds, it is suggested these states are candidates for developed 3α+n cluster states on the basis of the threshold-rule presented by the Ikeda diagram.

In the present talk, we will report the detail of the analysis and the results.