Contribution ID: **8** Type: **Contributed Oral/Poster**

The second 0^+ state of unbound 12O via the (p, t) reaction

Wednesday, 13 July 2016 11:25 (15 minutes)

We will present the recent finding of the second 0^+ state in ^{12}O, the lightest oxygen nucleus ever found, in our measurement of the ^{14}O(p, t) reaction at GANIL. ^{12}O with Z = 8 is a proton-rich mirror nucleus of ^{12}Be with N = 8. The level scheme of ^{12}Be, including its intruder 0^+_2 state at a very low excitation energy of 2.25 MeV, has been crucial in establishing the breakdown of the shell closure at N = 8. The present search for the mirror 0^+_2 state was thus aimed at investigating if the disappearance phenomenon of the shell closure also occurs at Z = 8 and if so, how the $2s_{1/2}$ orbital intruding near the Fermi surface impacts the mirror symmetry between ^{12}O and ^{12}Be. Despite its importance, the spectroscopy of ^{12}O has been challenging for decades as this nucleus is unbound for two-proton emission. In the present study, we measured the two-neutron transfer (p, t) reaction using a radioactive ^{14}O beam at 51 MeV/u produced by the LISE spectrometer via the projectile fragmentation reaction. Missing-mass spectroscopy in inverse kinematics was realized by using MUST2 telescopes, each consisting of a double-sided silicon strip detector and a CsI calorimeter, to obtain resonance energies and differential cross sections of unbound states. The shell closure at Z = 8 and the mirror symmetry with respect to ^{12}Be will be discussed from the final result of the experiment.

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Track Classification: Exotic structures through direct reactions