INTERACTION CROSS SECTIONS AND RADII OF LIGHT NUCLEI

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The use of beams of radioactive nuclei provides a unique method for determining matter radii of unstable nuclei and enable us to make a direct comparison of radii between isobars. Some of the isospin dependence of matter radii were measured for A=6-12, 17 [1,2]. In the present experiment, we have measured the interaction cross sections and radii of light nuclei; ^{9}C, ^{10}C, ^{14}C, ^{15}C, ^{13}N, ^{16}N, ^{13}O, ^{14}O, and ^{15}O on target nuclei Be, C, and Al around 750A MeV. The present experiment allows us to make a direct comparison of radii between isobars in the p-shell region.

The secondary beams were produced through projectile fragmentation of the 800A MeV ^{12}C, ^{18}O, ^{20}Ne, and ^{22}Ne primary beams, that were accelerated by the Bevalac at the Lawrence Berkeley Laboratory. The secondary beams were produced in a production target of Be and were separated by their rigidity using the beam-line as described in a previous paper [3]. The interaction cross section was measured by a transmission method as also described in a previous paper [3]. The effective root-mean-square (rms) radii are derived from the same manner as a previous paper [3].

Including the results of this experiment we have complete 6 mirror sets of radii in the p-shell region. (For some stable nuclei, we didn't measure interaction cross sections.) By using effective rms charge radii, we can deduce Coulomb energy difference (ΔE_c(rms)) for the sets. Since mass differences for the sets are also known precisely, we can deduce Coulomb energy difference from the mass differences (ΔE_c(mass)). Thus, mass dependence of the ratio; ΔE_c(rms)/ΔE_c(mass) can be derived, as shown in Fig.1. The ratios of the sets are consistent with each other, and show no mass and isospin dependencies. Since masses for light unbound nuclei are known and the charge symmetry is believed to be valid in the mirror nuclei, above comparisons can extend to unbound region, as shown in Fig. 2. In the figure, the neutron skin is assumed to ^{6}He and ^{8}He [4]. The obtained ratios of ^{6}Be-^{6}He and ^{8}C-^{8}He pairs are consistent with the mean value obtained in Fig. 1. That suggests ^{6}Be and ^{8}C have the proton skin. On the other hand, ones of ^{11}N-^{11}Be, ^{15}F-^{15}C, and ^{17}Ne-^{17}N pairs are largely deviated from the mean value. For the above nuclei, some kind of the charge-symmetry breaking are suggested. The nuclei are said to have an anomalous structure; ^{11}Be is the neutron-halo nucleus [5], ^{15}C has an anomalous spin-parity in the ground state [6], and the large asymmetry of the radii has been observed in the ^{17}Ne-^{17}N pair [2].

References

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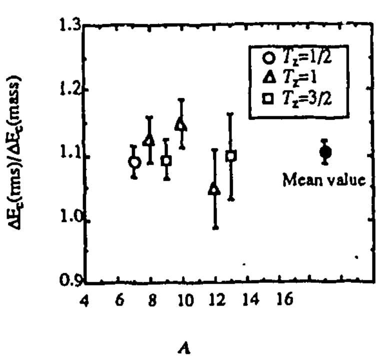

Fig. 1

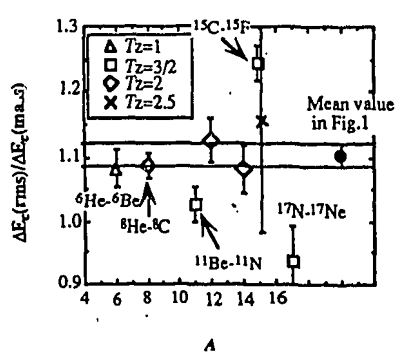

Fig. 2