^{6}He SCATTERING WITH POLARIZED PROTON TARGET

M. Hatano[a,b], H. Sakai[a,b,c], T. Wakui[c], T. Uesaka[c] and PSPT collaboration
[a] *Department of Physics, University of Tokyo, Hongo 7-3-1, Tokyo 113-0033, Japan*
[b] *RIKEN, Hirosawa 2-1, Wako, Saitama 351-0198, Japan*
[c] *Center for Nuclear Study, University of Tokyo, Hirosawa 2-1, Saitama 351-0198, Japan*

Measurements of polarized proton scattering on stable nuclei have continuously yielded basic key information on nuclear structure as well as nuclear reaction mechanism. It is particularly interesting and important to extend such polarization measurements to unstable nuclei.

We have developed a new spin polarized solid proton target (PSPT) which can be operated under a low magnetic field of 0.08 T and a high temperature of 100 K. The basic principle to polarize a proton is a pulsed dynamic nuclear polarization method [1]. An aromatic material (host), naphthalene, doped with pentacene is optically pumped to attain an alignment of electron population in triplet state of pentacene which is subsequently transferred to the proton polarization by using the integrated solid effect. We have achieved the proton polarization of about 36% with a relaxation time of about 22 hours in the off-line test experiment [2].

The first polarization asymmetry measurement [3] was performed by the unstable beam of ^{6}He with 71 MeV/u produced by RIPS at RIKEN. For this reaction, the cross sections were measured for $\theta_{\rm cm} = 20^\circ - 50^\circ$ [4]. The cross section and the polarization asymmetry (=target polarization$\times$analyzing power) were measured for $\theta_{\rm cm} = 40^\circ - 80^\circ$ which covers the second diffraction peak of cross sections. The polarized target with estimated polarization of about 20% with a size of 1 mm thick with 14 mm diameter was bombarded by the ^{6}He beam of 10^5 particles/sec.

The magnitude and its angular dependence of cross sections are almost identical with those of $\vec{p}$+^{6}Li scattering at 72 MeV by R. Henneck et al. [5], indicating similar interaction potentials for both nuclei. However, it is very surprising to find that the observed polarization asymmetry shows a remarkable difference between the $\vec{p}$+^{6}He and $\vec{p}$+^{6}Li scatterings. The polarization asymmetry changes the sign from a positive value at $\theta_{\rm cm} = 40^\circ - 50^\circ$ to the negative value at $\theta_{\rm cm} = 60^\circ$ degrees for $\vec{p}$+^{6}He, while it increases rapidly from the small positive value to the large positive value for the same angular range in case of $\vec{p}$+^{6}Li. This peculiar behavior of $\vec{p}$+^{6}He can be roughly understood by the difference of the spin-orbit potentials. The optical potential analysis shows that the spin-orbit potential for ^{6}He locates outside further by about 0.8 fm compared to that for ^{6}Li, which could be due to the neutron skin characteristic to the ^{6}He nucleus.

[1] T. Wakui, M. Hatano, H. Sakai, A. Tamii, and T. uesaka Proc. of the Ninth International Workshop on Polarized Sources and Targets, (World Scientific, Singapore, 2002), p. 133.
[2] T. Wakui, M. Hatano, H. Sakai, A. Tamii, and T. Uesaka AIP Conf. Proc. 675, 911 (2003).
[3] M. Hatano, PhD Thesis, University of Tokyo, unpublished, 2004.
[4] A.A. Korsheninnikov, *et al.*, Nucl. Phys. A**616**, 45 (1997).
[5] R. Henneck, *et al.*, Nucl. Phys. A**571**, 541 (1994).