Contribution ID: **9** Type: **Invited Presentation**

Quasi-free Proton Knockout Reactions on the Oxygen Isotopic Chain

Thursday, 1 June 2017 17:50 (15 minutes)

According to the Independent Particle Model (IPM) single-particle (SP) states are fully occupied up to the Fermi energy with spectroscopic factors (SF) of one. However, it is well known from electron-induced proton knockout that the SP strength is reduced to about 60-70% for stable nuclei, which has been attributed to the presence of short- and long-range correlations[1]. This finding has been confirmed by nuclear knockout reactions using stable and exotic beams, however, with a strong dependency on the proton-neutron asymmetry [2]. The observed strong reduction of SP cross sections for the deeply bound valence nucleons in asymmetric nuclei is theoretically not understood. To understand this dependency quantitatively a complementary approach, quasi-free (QF) knockout reactions, is introduced. QF knockout reactions in inverse kinematics at relativistic energies provide a direct way to investigate the SP structure of stable and exotic nuclei [3].
We have performed a systematic study of spectroscopic strength of oxygen isotopes using QF (p,2p) knockout reactions in complete kinematics at the R3B/LAND setup at GSI with secondary beams containing 13–24O. The oxygen isotopic chain covers a large variation of separation energies, which allow a systematic study of SF with respect to neutron-proton asymmetry.
We will present results on the (p,2p) cross sections for the entire oxygen isotopic chain obtained from a single experiment. By comparison with the Eikonal reaction theory [4] the SF and reduction factors as a function of separation energy have been extracted and will be compared to existing data in literature. The results include total and partial cross sections extracted by means of gamma-coincidence measurements as well as momentum distributions. The latter are sensitive to the angular momentum of the knocked-out nucleon in the projectile.
Finally, a brief report will be given on a pioneer experiment performed at RIKEN where the QF (p,2p)-fission reaction was employed for the first time on 238U as a benchmark test for future applications to determine fission barriers of neutron-rich exotic nuclei near 208Pb and 214Bi.
This work is supported by the GSI-TU Darmstadt cooperation agreement and the BMBF Verbundforschung under contract 05P15RDFN1.
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Session Classification: Breakout 2