Contribution ID: **11** Type: **Submitted**

Probing the semi-magicity of 68Ni via the 3H(66Ni,68Ni)p and 2H(66Ni,67Ni)p transfer reactions in inverse kinematics

Monday 17 December 2012 17:15 (10 minutes)

The region around the nucleus 68Ni, with a shell closure at Z = 28 and a sub-shell closure at N = 40, has drawn considerable interest over the past decades. 68Ni has properties that are typical of a doubly-magic nucleus, such as a high excitation energy and low B(E2:2+-0+) transition probability for the first excited 2+ level [1-3] and a 0+ level as the first excited state [4]. However, it has been suggested that the magic properties of 68Ni arise due to the fact that the N = 40 separates the negative parity pf shell from the positive parity 1g9/2 orbital [5,6], and indeed, recent mass measurements [7,8] have not revealed a clear N = 40 shell gap. Despite all additional information that was acquired over the last decade the specific role of the N = 40 is not yet understood.

Transfer reactions are a powerful tool to constrain spin and parities of excited states and to determine (relative) spectroscopic factors. In a first experimental campaign in 2009, the excitation spectrum of 67Ni was studied by performing a (d,p)-reaction on 66Ni in inverse kinematics using the MINIBALL setup in combination with the T-REX particle detection array. The excitation spectrum of odd mass nuclei, e.g. 67Ni, in the direct neighborhood of closed shells, such as 68Ni, is usually governed by single particle excitations. By measuring effective single-particle energies the shell gaps can then be fixed in order to further update the existing nuclear models.
In a second experimental campaign in 2011, 68Ni was studied through a (t,p)-reaction on 66Ni, using the same set-up. In this experiment a radioactive beam in combination with a radioactive target was used. The aim of this campaign was to measure the cross section for the population of the 0+ ground state and characterize the 0+ and 2+ excited states in 68Ni.

The excitation spectrum and the angular distribution of the emitted protons can be used to determine the spin and parity of the states populated in 67,68Ni. Further, excited states can be identified by using proton-gamma correlations. Preliminary results of such coincidence analysis, revealing the most populated states in the reactions, will be presented.

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Session Classification: Medium nuclei I