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Probing the semi-magicity of ^{68}Ni via the ^{3}H(^{66}Ni,^{68}Ni)^{1}H and ^{2}H(^{66}Ni,^{67}Ni)^{1}H transfer reactions in inverse kinematics

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The region around the nucleus ^{68}Ni, with a shell closure at Z = 28 and a sub-shell closure at N = 40, has drawn considerable interest over the past decades. ^{68}Ni 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 ^{68}Ni arise due to the fact that the N = 40 separates the negative parity pf shell from the positive parity $1g_{9/2}$ 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. Therefore two experiments were performed at ISOLDE, CERN, using one- and two-nucleon transfer reactions. In a first experimental campaign in 2009, the excitation spectrum of ^{67}Ni was studied by performing a (d,p)-reaction on ^{66}Ni in inverse kinematics. A ^{66}Ni beam of 2.85MeV/u was projected onto a 100μg/cm² CD_2 target and the resulting particles and gamma rays were detected using the MINIBALL setup [9] in combination with the T-REX particle detection array [10]. The excitation spectrum of odd mass nuclei, e.g. ^{67}Ni, in the direct neighborhood of closed shells, such as ^{68}Ni, 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, ^{68}Ni was studied through a (t,p)-reaction on ^{66}Ni, using the same set-up as in the 2009 campaign. In this case a 2.6MeV/u ^{66}Ni beam was projected onto a tritium-loaded titanium target of 500μg/cm². Thus, 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 ^{68}Ni.

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 ^{67,68}Ni. 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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