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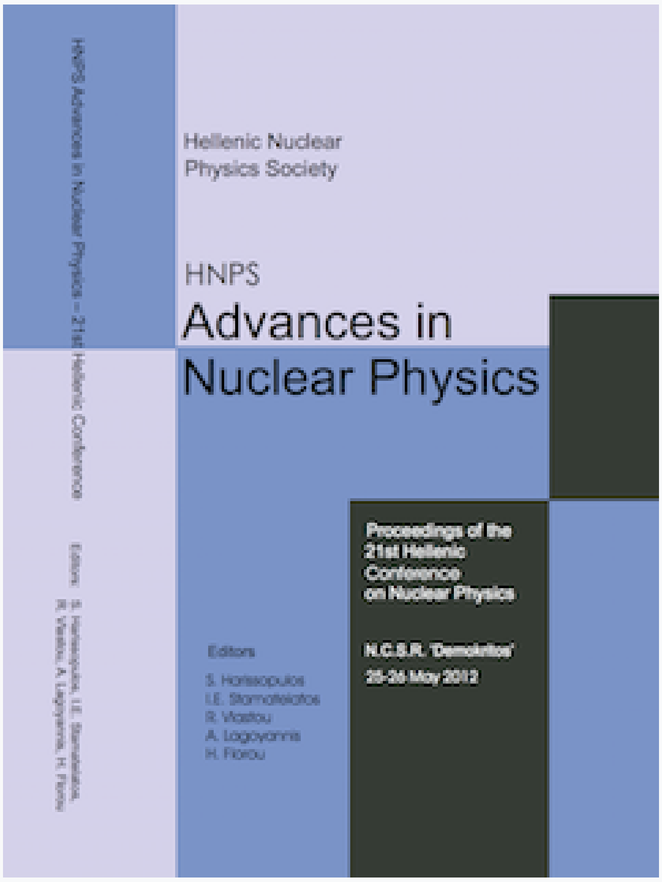

One neutron transfer reactions around 68Ni: First results from the 66Ni(d,p)67Ni experiment

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One neutron transfer reactions around ^{68}Ni: First results from the ^{66}Ni(d,p)^{67}Ni experiment

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Abstract

First results from the ^{66}Ni(d,p)^{67}Ni experiment performed at REX-ISOLDE - CERN are presented. In this experiment, the newly built T-REX particle detection system was successfully coupled to the γ-ray MINIBALL detector array towards to a better understanding and studying of the single particle character of the neutron rich Ni isotopes.

Key words: Radioactive ion beams, nuclear structure, nuclear ractions, transfer reactions

1 Introduction

Theoretical studies indicate that the size of shell gaps can alter when changing the N/Z ratio leading to changes in magic numbers when going away from the valley of stability. One of the most interesting regions of the chart of nuclides is situated around ^{68}Ni. The observation of the high excitation energy of the first 2^+ state of this nucleus [1], in combination with the minimum in the systematics of B(E2;2$\rightarrow$0) values [2,3], has led to interpretations in terms of a harmonic oscillator subshell closure. On the other hand, the two-neutron separation energies in the N=40 region do not present any irregularity - characteristic of a shell closure [4,5]. In view of this controversial experimental evidence, the single particle character of ^{67}Ni has been decided to be investigated [6].

In the last four decades the one-nucleon transfer reactions have been proved to be the workhorse for the deduction of spectroscopic information for nuclei at -or near the valley of stability. Nowadays, the development of radioactive ion beams allows access to nuclei that were previously unapproachable. Accordingly, the excitation spectrum of ^{67}Ni was studied by performing the ^{66}Ni(d,p)^{67}Ni reaction study in inverse kinematics with an energy of 3 MeV/u.

2 Experimental Setup

The experiment was performed at REX-ISOLDE (CERN). The ^{66}Ni beam was produced by using the 1.4 GeV proton beam from the CERN PS Booster. The proton beam was impinging on an UCx target. The produced Ni atoms were selectively ionized by using the RILIS laser ion source and accordingly were mass separated in the ISOLDE general purpose separator. The post-acceleration to 2.95 MeV/u was utilized by the REX-ISOLDE linear accelerator after bunching and charge breeding.

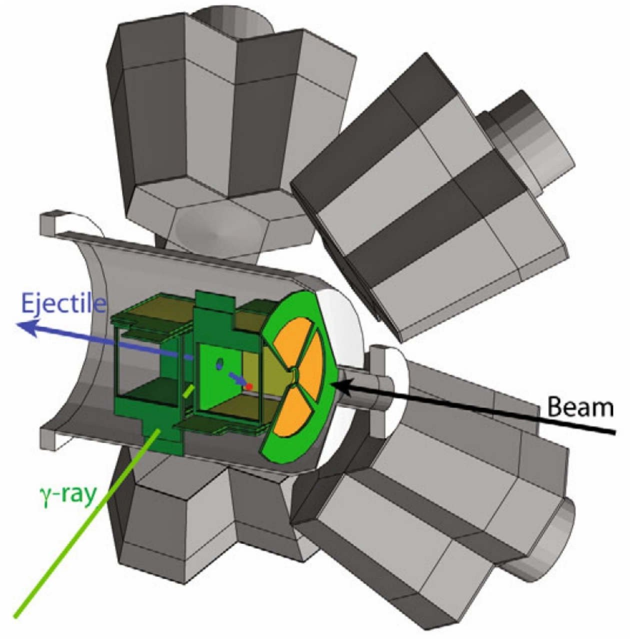

Fig. 1. A simplified drawing of the experimental setup. The left side of the MINIBALL array, vacuum chamber, and particle detection is cut away for visualisation purposes

Afterwards, the ^{66}Ni beam with intensity 10^6 pps was sent to the T-REX particle detection setup [7] surrounded by the MINIBALL γ-ray detector array [8]. A simplified drawing of the experimental setup can be seen in Fig. 2.

The MINIBALL array consists of eight clusters and each cluster from three HPGe crystals 6-fold segmented. The overall detection efficiency of the 24 MINIBALL crystals was $\sim$8% at the energy of 1 MeV.

T-REX consists of position sensitive ΔE-E telescopes facilitating the detection and identification of the light target-like reaction products. The solid angle coverage of T-REX amounts to 58.5% of 4π solid angle. Despite the minimal thickness of the CD_2 secondary target (100 μgr/cm^2) the overall energy resolution of the particle detection setup (T-REX) was not enough to resolve the excitation energies of the quite dense level scheme of ^{67}Ni. The needed resolution for the determination of the excitation energies was finally achieved through the MINIBALL γ-ray spectrum prompt coincident with protons detected by T-REX.

3 Results

In spite of the special interest in the mass region around ^{68}Ni the previously available spectroscopic information was limited. Only a few levels and a few

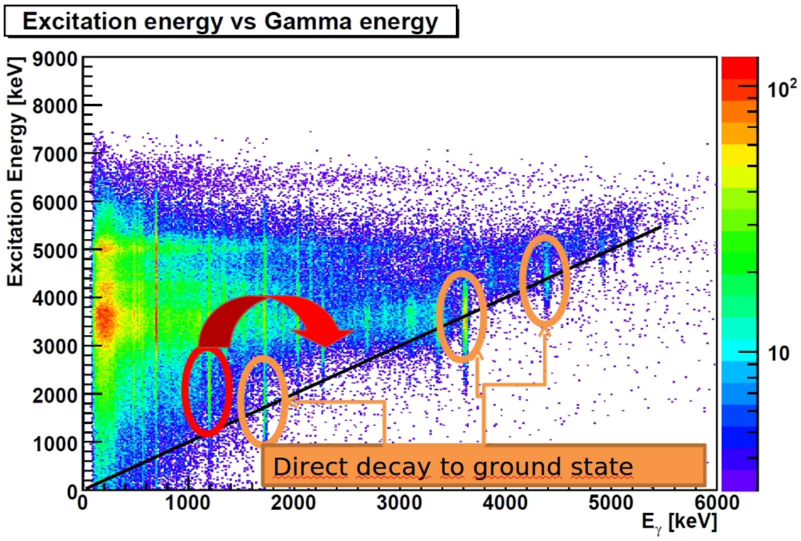

Fig. 2. The excitation energy of the residual nucleus (^{67}Ni) as deduced from the kinetic energy of the protons plotted together with the γ-ray energy detected in coincidence with the the protons. The transitions that de-excite directly to the ground state are lying across the diagonal (black line). Other populated levels that deexcite through an intermediate level are lying above the diagonal (e.g. the 2.2 MeV state indicated with the red circle).

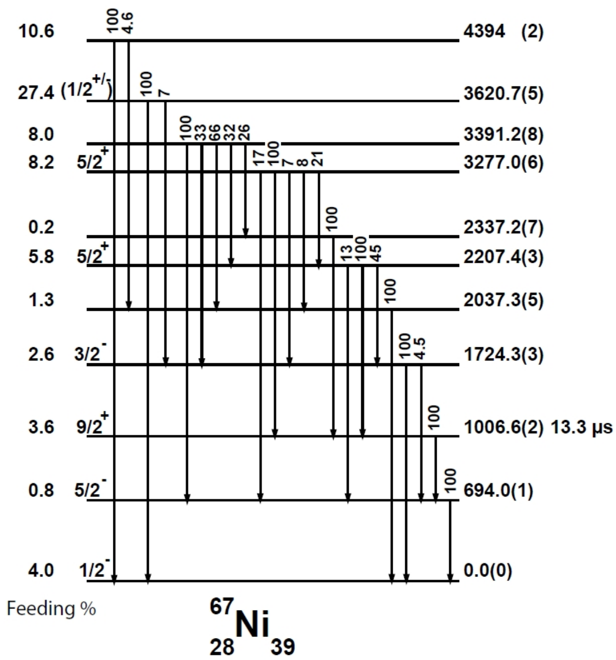

Fig. 3. Partial level scheme of ^{67}Ni

γ-ray transitions were known. As can be seen in Fig. 2 by combining the particle dection with γ-ray spectroscopy levels up to the excitation energy of 6 MeV were identidied. The first results of the present work are summarised in the level scheme of ^{67}Ni seen in Fig. 3. In this figure all the observed levels below 2 MeV are shown. Above 2 MeV the partial level scheme focuses on the most populated levels with feeding probability greater than 5%. The remaining (d,p) strength is distributed among other states up to 6.0 MeV in excitation energy and will be discussed in Ref. [9]. In total 17 levels of which 7 are shown between 2.0 and 5.8 MeV were identified and characterised by their γ decay.

Additionally, by recording the angular distribution of the detected protons the spin and parity of the populated levels will be identified by means of DWBA calculations. In the same way the relative spectroscopic factors (SF) will be also deduced. As a final step in terms of the physics interpretation of the experimental results large-scale shell model calculations will be performed [9].

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