Experimental report

11/02/2019

Proposal: 3-17-12 **Council:** 4/2017

Title: Searching for shape coexistence in65Ni

Research area: Nuclear and Particle Physics

This proposal is a new proposal

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Samples: 64Ni

Instrument	Requested days	Allocated days	From	To
FIPPS	7	7	15/03/2018	22/03/2018

Abstract:

Search for shape coexistence in the 65Ni nucleus, which is predicted by Monte Carlo Shell Model calculations, will be performed by investigating the low-spin excitations populated in the gamma decay of the neutron-capture state at 6098 keV. Gamma rays will be detected by using the multidetector germanium array FIPPS, complemented with the LaBr3 scintillator detectors which will provide information on states lifetimes in the range from tens of ps to ~1 ns.

Searching for shape coexistence in65Ni
Experiment 3-17-12

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We have performed a neutron capture experiment using a target of ^{64}Ni with the goal to investigate low-spin gamma ray transitions in ^{65}Ni. Our investigation concerns the possibility to study in detail the presence of shape isomers in ^{65}Ni, following our previous results on the ^{66}Ni published recently and the calculation for ^{65}Ni by the nuclear Tokyo group. Monte Carlo Shell Model calculation predicted shape coexistence - spherical, oblate and prolate shapes - for these nuclei. Our previous experiment on ^{66}Ni probed the presence of four 0+ states: there excited one - 0^+_2 at 2443, 0^+_3 at 2671 and 0^+_4 at 2974 keV – are associated to oblate, spherical and prolate shapes. We measured at the Bucharest tandem also the half-life of these states using the plunger and the DSAM techniques (1). To fully understand the effect of the evolution of the nucleon occupation energy levels with the shape coexistence in this region, we have devoted our attention on the even-odd nucleus ^{65}Ni. MSMC calculations by Otsuka and Tsunoda have predicted the presence of different low level spin states 1/2 and 3/2 of both oblate and prolate character. An example of the Potential Energy Surfaces for ^{65}Ni (left) and ^{66}Ni (right) is shown in the figure as a function of the quadrupole moment (2). The possible shapes are indicated in the figure.

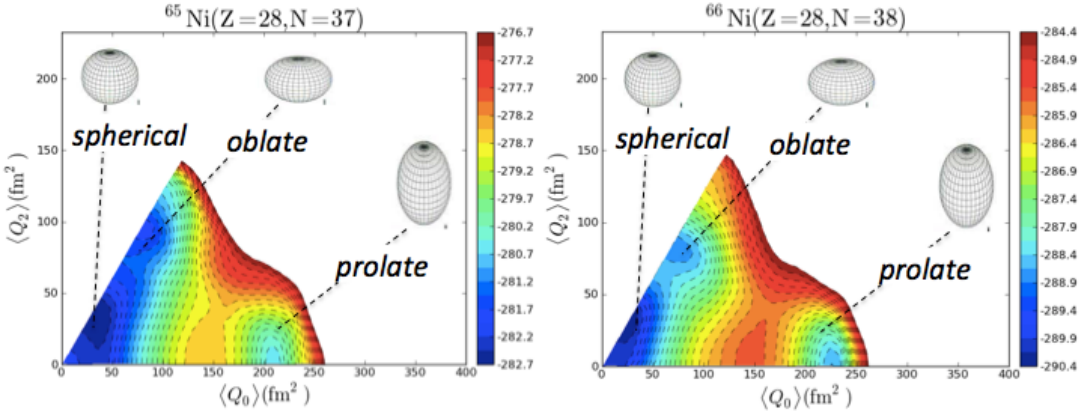

Figure 1 : The PSE for ^{65}Ni and ^{66}Ni (Otsuka and Tsunuda and (1))

With this goal, we have performed an experiment at ILL using a target of ^{64}Ni; the neutron capture state is 6098 keV. A further experiment was also performed at the Bucharest tandem using a transfer reaction. Gamma rays were detected using the HpGE array FIPPS. 8 $LaBr_3$ scintillator detectors were also employed for half- life measurements in the range of from 10-20 ps to a few ns. Figure 2 shows the gamma ray coincidence spectra with a gate on the 310 keV (transition $3/2^-$ to $5/2^-$) and 629 keV ($3/1^-$ to $1/2^-$) of ^{65}Ni. New lines are indicated in red.

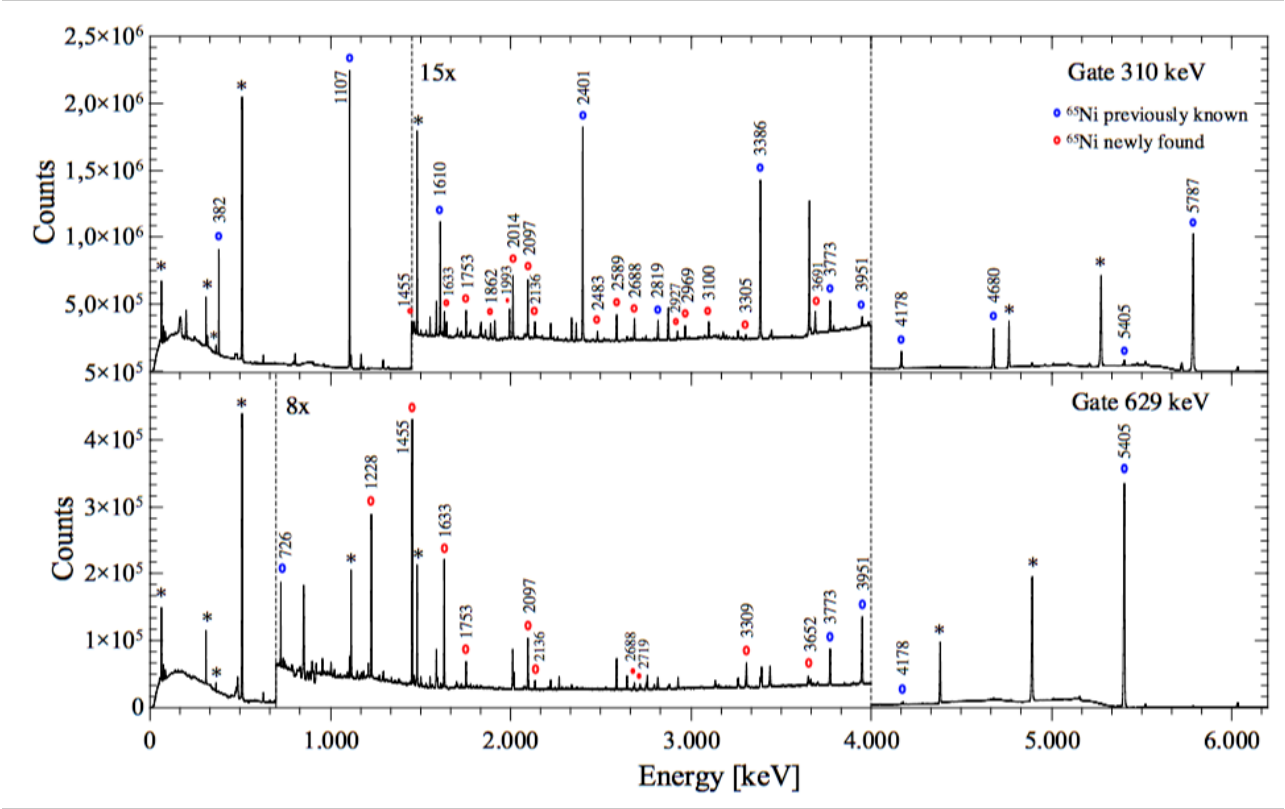

Figure 2: Coincidence spectra on 310 keV and 629 keV gate of ^{65}Ni (C. Porzio – Master thesis, Università di Milano).

Previous level scheme of ^{65}Ni was established using a deep inelastic reaction ^{208}Pb+^{64}Ni up to 4 MeV (3), neutron capture using polarized neutrons (4) and recently using the ^{64}Ni (d,pγ) ^{65}Ni reaction (5). **We have studied the level scheme assigning many new gamma ray transitions**; **the angular distribution is also analysed for the spin assignment. The half-life measurement analysis with the LaBR3 will be performed**.

(1) S. Leoni et al, PRL 118, 162502 (2017).
(2) Y. Tsunoda et al., Phys. Rev. C 89, 031301(R) (2014)
(3) T. Pawlat et al, Nuclear Physics A574 (1994), 623
(4) S.M. Polikanov, Sov. Phys. Uspekhi 15, 486 (1973)
(5) L. Crespo Campo et al. PRE 96, 014312 (2017).