Probing the structure of the doubly-odd nuclei ^{126,128}I through lifetime measurements

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Abstract:
The proposed experiment aims to measure the lifetimes of the 8^- and 10^+ states in ^{126}I and ^{128}I. The high spin structure of the iodine nuclei, when approaching the $N = 82$ shell closure, is insufficiently studied. The goal of the experiment is to shed some light on the structure of the nuclei in the $N = 82$ region. Excited states in the nuclei of interest will be populated in the ^{124}Sn(^{6}Li,4n) and ^{124}Sn(^{7}Li,3n) reactions. To do the proposed measurement we ask for **eight days** of beam time.

1 Motivation

The high spin structure of the iodine nuclei, when approaching the $N = 82$ shell closure, is insufficiently studied. In all doubly-odd Iodine nuclei, 10^+ states build on the $\pi h_{11/2} \otimes \nu h_{11/2}$ configurations are expected. Such positive parity states have been tentatively assigned in the $^{116-128}$I nuclei and rotational bands have been observed.

An experiment to identify the high-spin structure of ^{128}I was previously made at the Bucharest Tandem accelerator [1] and the level scheme was considerably extended.

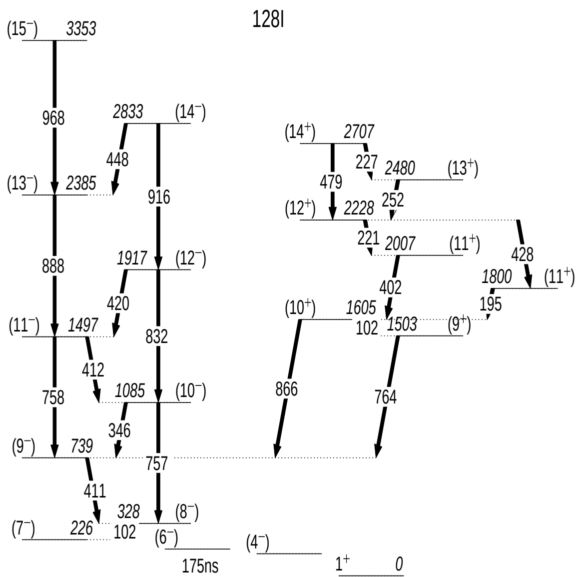

Figure 1: The level scheme of ^{128}I.

Fourteen levels were newly added and lifetimes of two states were estimated. These two states, 8^- 328 keV and 10^+ 1605 keV, decay by emmiting γ transitions of almost equal energy, 102 keV. Using the fast timing method, time spectra were obtained for both states which decays emmiting the 101 and 102 keV γ rays. The time spectra revealed two clear different structures which supported the existence of the 102 doublet. Because a pulsed beam was used in this experiment, the obtained statistics was not enough to allow an accurate measurement of these lifetimes.

In the negative parity band, from the time spectra of the 102 keV transition depopulating the 328 keV state the lifetime was estimated to be quite high, up to several tens of ns. The short coincidence window limited by the pulsed beam frequency hindered a precise measurement of this lifetime. The 101 keV transition from the positive parity band proved to be a prompt transition with a lifetime lower than 100 ps (less than the method resolution). This implies that 101 kev is a fast M1 transition. The results are also probed with the results of the RDCO method. We propose to precisely measure the lifetime of the 8^- 328 keV and 10^+ 1605 keV

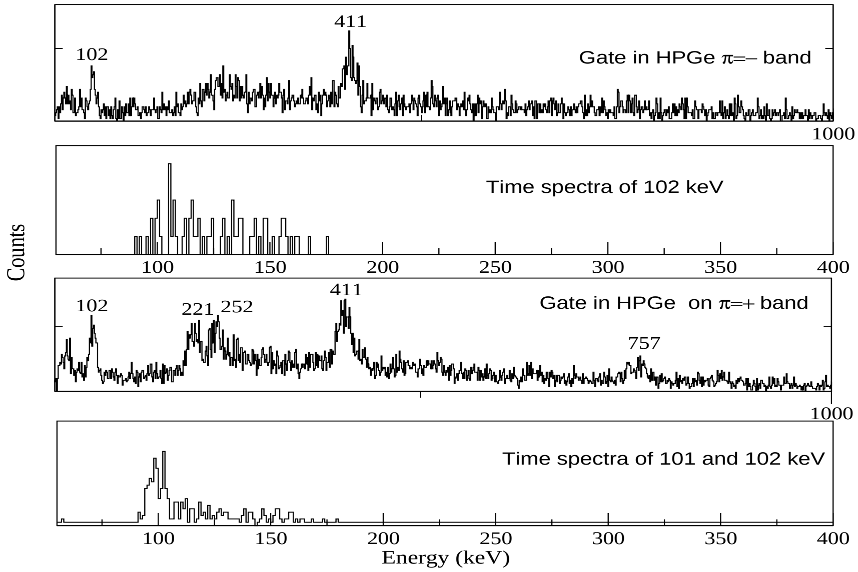

Figure 2: Time spectra of 101 and 102 keV.

states from ^{128}I by using the fast timing method.

Based on the clear similarities of the ^{128}I and ^{126}I level schemes we also propose to measure the lifetime of the 10^+ 1433 keV state from ^{126}I. In a previous work (see the 2002 ANU Annual Report [2]) this state was described to deexcite via an E1 transition of 80 keV. This parity change was not verified until now using precise lifetime measurement and it contradicts our previously mentioned estimation from ^{128}I, where the 10^+ state deexcites on 9^+ via a possible fast M1 transition.

Following the same pattern, it could be interesting to also investigate the lifetime of the 8^- 411 keV state in ^{126}I and include it in our systematics. Partial level schemes of ^{128}I obtained at Bucharest Tandem accelerator in the privious experiment and the level scheme of ^{126}I [2] are shown in Fig.2.

The experiment results regarding the lifetime measurements can clarify the level scheme of the ^{126}I nucleus and also to bring a precise value of the lifetime of the 8^- state from ^{128}I.

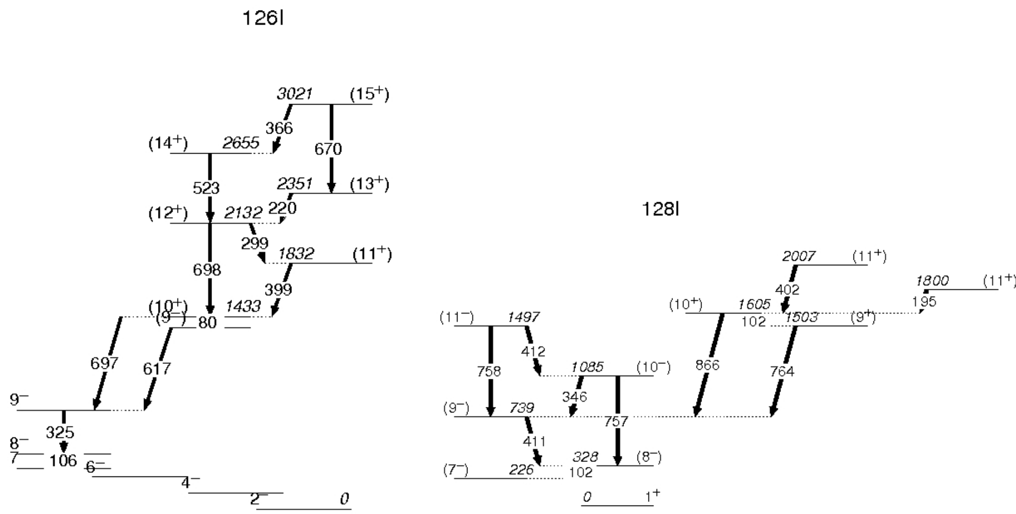

Figure 3: Partial level schemes of ^{128}I obtained at Bucharest Tandem accelerator in the privious experiment and the level scheme of ^{126}I [2].

2 The experiment

We suggest to use the ^{6}Li + ^{124}Sn fusion evaporation reaction at 30 MeV to populate excited states in ^{126}I and the ^{7}Li + ^{124}Sn reaction at 27 MeV to populate excited states in ^{128}I.

The Bucharest detectors array dedicated for nuclear spectroscopy measurements consisting of eight HPGe and seven $LaBr_3$ scintillator detectors will be used. Several measurements were done recently with this setup, which revealed its potential for lifetime measurements [4]. Since properties of nuclear states in doubly-odd nuclei are measured, it will be an important improvement the use of three planar HPGe detectors that will be added in the set up in this experimental campaign.

The trigger condition for the acquisition system should be: at least two $LaBr_3$ detectors fired in coincidence with any HPGe detector. Thus, in the analysis triple $\gamma\gamma\gamma$ coincidences.

The lifetime of the 10^+ states in ^{128}I and ^{126}I will be estimated using cetroid shift method.

3 Beam time request

Based on our previous measurements we ask for four days for lifetime measurement of 328 keV state from ^{128}I following the ^{124}Sn(^{7}Li,3n) reaction and another four days for lifetime measurements of (10+) 1433 keV state from ^{126}I following the ^{124}Sn(^{6}Li,4n) reactions. ^{6}Li ions should be accelerated to 30 MeV and ^{7}Li ions at 27 MeV. The measurements will be performed with the γ array already described, installed on the first beam line.

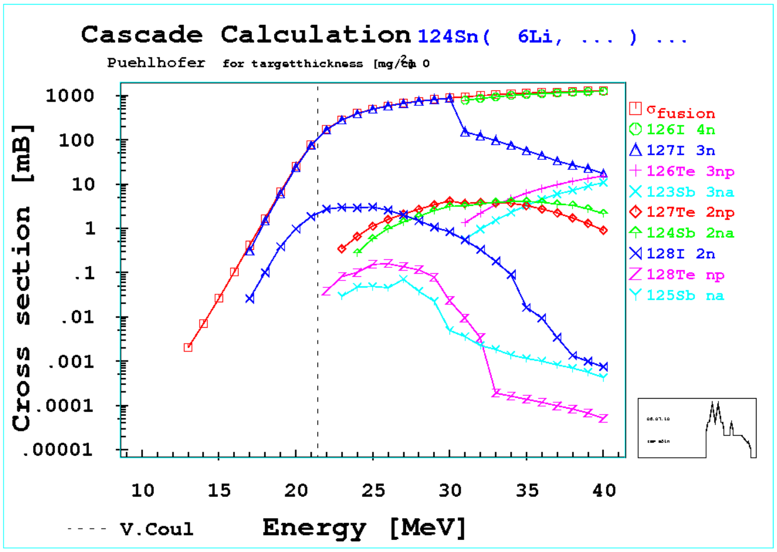

Figure 4: CASCADE calculation of the excitation functions for the ^{6}Li + ^{124}Sn fusion-evaporation reaction.

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