LABORATÓRIO ABERTO
DE FÍSICA NUCLEAR

N°

Proposta de Experimento

Período : 1 ano

Título: Assessing Collective Properties in Transitional Nuclei
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Número de dias solicitados: 5 + 5 dias
Datas preferidas:
Datas realmente impossíveis:
Canalização: 15^{o} A

Feixe	Est. Carga	$I_{mínima}$ (alvo)	V_{min}	V_{max}	Pulsado?
^{6}Li	3	100 nA	6,5 MV	7,5 MV	não

Alvos: ^{76}Ge, ^{64,66,68}Zn.
Pastilhas: fluoreto de Li.
Características de Feixe Pulsado:
Continuação da Experiência já Aprovada N°:
Outras informações:

Assessing collective properties in transitional nuclei

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In the recent past, the Nuclear Spectroscopy with Light Ions Group has made a great effort to master both theoretical as well as experimental aspects of the problem of extracting B(ISL) values, which provide information on how the whole mass (that is protons plus neutrons) contributes to transitions between nuclear states with collective character. Although commonly employed in that sense, it is our argument that the B(EL) values do not reflect the whole of the collectivity which characterizes the process, since, without taking core polarization effects into consideration, B(EL) values are related only to the contribution of the protons to those transitions.

This kind of reasoning is especially important in the so-called transitional nuclear mass regions. In fact, in these regions, the number of protons and/or neutrons, beyond the respective "core", is not sufficient to produce more easily predictable "collective" effects, neither are they so few as to be taken into account on a totally microscopic basis. So, one of the most difficult tasks in Nuclear Structure studies has been to understand those regions where the addition of just one or a few pairs of nucleons, in particular of neutrons, is frequently responsible for an appreciable change in nuclear structure.

Historically, the first excited state, which for even-even nuclei is predominantly a 2^+ one, has given the most consistent clues to the extend of collective behavior of the nucleons and to the most convenient description thereof.

The Nuclear – Coulomb Interference (NCI) method with isoscalarly interacting projectiles is especially advantageous for the purpose of extracting sound B(ISL) values, since it directly provides B(EL)/B(ISL) ratios, in a manner such as to cancel some of the unavoidable systematic uncertainties associated with the absolute cross section scale and the reaction model adopted[1-5]. For the reasons presented above the study of the quadrupole transitions to the first 2^+ states is especially interesting.

In particular if deuterons are employed as probes, the Pelletron-Enge-split-pole-spectrograph facility is extremely well suited for NCI studies, as it permits to achieve much better peak to background ratios, especially if nuclear emulsions are employed as detectors[2,3]. Furthermore, detection is possible at rather forward angles, in part due to good energy resolution obtained with the combined properties of this facility. The Group developed the NCI method with deuterons and applied it to the even-even Ru, Mo and Zr nuclei[2-5]. To our knowledge, no previous NCI results with this projectile have been reported in the literature. Investments have more recently been made to make a ^{6}Li beam also available. This is an interesting projectile, with isoscalar character, for those targets with a lower Z, which, therefore, present a lower Coulomb interaction. This projectile has been employed in the study of the Ge chain[1], where a survey of collective characteristics of the first 2^{+} state of the transitional ^{70,72,74}Ge nuclei disclosed several interesting features. The extension of our research line to a lower mass region, which has for long been[6,7] of spectroscopic interest, was totally performed at the Pelletron-Enge-Spectrograph facility by the group, as were our previous studies.

For the heaviest isotope under investigation in the referred paper[1], ^{74}Ge, it was shown that neutrons contribute considerably more than protons to the first quadrupole excitation, since the B(IS2; $0_1^+ \rightarrow 2_1^+$) value came out substantially higher than the corresponding B(E2; $0_1^+ \rightarrow 2_1^+$) value[1]. This result was interpreted[1] as evidence for a mixed symmetry character of the ^{74}Ge ground state, while the first 2^{+} was found to be rather pure[7,8]. The study of next heaviest stable isotope, ^{76}Ge, with the same experimental procedures is therefore of extreme interest, the more so as these aspects have so far eluded a comprehensive theoretical interpretation. Due to this interest, the Group has already purchased enriched material of this isotope and included its study with high priority into the NCI program. A suitable target, of quality similar to the previously employed for the study of the lighter Ge isotopes, has already been produced by the Group.

Pursuing the evolution of the nuclear structure characteristics in this same interesting A~70 transitional region, the next focus of interest will be the study of the NCI of the first quadrupole excitation in the stable zinc isotopes, with A = 64, 66, 68.

During one first year, a total of 10 efficient machine days, split into 5+5 days, at a terminal potential of 7 MV, is required for the NCI work, employing ^{6}Li projectiles on ^{76}Ge and making a preliminary survey on ^{64,66,68}Zn. Part of the detection will be performed with newly purchased PSD devices disposed on the focal plane of the spectrograph. Data acquisition will be made by transforming, already in the experimental area, the outcoming amplified E and EX/L analog pulses into digital ones. A PCI-6133 plate (National Instruments) and interaction with the LabView (Laboratory Virtual Instrument Electronic Workbench) program has been tested for the purpose. By thus substituting the formerly used (NIM norm) analog procedure, it was already verified that a substantial reduction of electronic noise can be achieved. Preliminary tests at acquisition frequencies of 2.0E+6(Hz) and 2.5E+6 (Hz) have provided positive results in the identification of the E and EX/L associated with a specified event.

The requested machine time was estimated taking a peak cross section of about 30 mb/sr, a beam intensity of at least 100 nA, and a downward variation of the cross section of about one decade into account. It is also to be remembered that, besides the inelastic angular distribution, an elastic one is usually taken, under the same conditions, to provide a good absolute scale reference for the cross sections.

References

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