Assessing collective properties in transitional nuclei

M. R. D. Rodrigues*, T. Borello-Lewin, X. X. Zhang, L. B. Horodynski-Matsushigue, J. L. M. Duarte, G. M. Ukita, C. L. Rodrigues and L. R. B. Benevides
Grupo de Espectroscopia Nuclear com Íons Leves - IFUSP

The Nuclear Spectroscopy with Light Ions Group has developed a research line to explore the coulomb-nuclear interference (CNI) in the inelastic scattering of isoscalarly interacting projectiles following the evolution of the collective behavior through isotope chains[1-5]. The adopted procedure applies the deformed optical potential model (DOMP) with global optical parameters as the nuclear transition potential in the analysis of the inelastic scattering. It is to be noted that for the first quadrupolar excitation the majority of the calculated microscopic form factors do not differ substantially from the macroscopic ones in the important tail region. Through this macroscopic CNI analysis in the DWBA approach, the square of mass deformation length,$(\delta_L^N)^2$, is extracted as a scale factor from the fit of the predicted cross sections to the experimental data of the inelastic scattering reaction and, analyzing the characteristic changes in the angular distribution shape, the value of the ratio between charge δ_L^C and mass δ_L^N deformation lengths, C, is also obtained. These quantities can be put in correspondence with the value of B(ISL) and of the ratio B(EL)/B(ISL), for which, therefore, a scale uncertainty cancellation occurs, favoring more accurate results. The previous CNI work, in the A ~ 70 transitional mass region, considering the germanium isotopic chain demonstrate an abrupt change in the B(E2)/B(IS2) ratio for ^{74}Ge: although for $^{70;72}$Ge, values of the order of 1.0 or slightly higher were obtained, this ratio is 0.66 (7) for ^{74}Ge. The heavier Ge isotope is thus one of the few nuclei that, so far, have been shown to present clear mixed symmetry components in their ground-state band. The main purpose of the present proposal is pursue the CNI study on the germanium isotopic chain with measurements of inelastic scattering of ^{6}Li on ^{76}Ge, in order to determine the relative contributions of protons and neutrons in the transition to the first quadrupole state in this isotope is comparable with those determined for ^{74}Ge.

The Pelletron-Enge-split-pole-spectrograph facility is extremely well suited for CNI studies, due to good energy resolution and detection at rather forward angles. The ^{6}Li beam, with isoscalar character, has been employed in the study of the Ge chain[(1)], where a

*Spokesperson e-mail: marciadr@if.usp.br

survey of collective characteristics of the first 2^+ state of the transitional ^{70,72,74}Ge nuclei. The beam energy of 28MeV was chosen, since the predicted DWBA-DOMP angular distribution is well structured and measurements near the interference minimum, at approximately $\theta_{CM} = 12.5°$, were accessible with the spectrograph.

Pursuing the evolution of the nuclear structure characteristics in this same interesting A~70 transitional region, the next focus 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, at a terminal potential of 7 MV, a total of ten days (5+5) is required for the CNI 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 position sensitive surface barrier detector on the focal plane of the spectrograph.

The requested machine time was estimated taking a peak cross section of about 30 mb/sr, a beam intensity of 100 nA, and a downward variation of the cross section of about one decade into account. Detailed experimental inelastic angular distributions, with at least thirty points each, are required for the analysis. 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. In order to do preliminary measurements on zinc isotopes besides the measurement on germanium, a total of ten days is necessary this year.

In the last year, the beam time of 6 days obtained in the previous PAC was not used, due to technical problems and low beam intensity.

References

(1) M. D. L. Barbosa, T. Borello Lewin, L. B. Horodynski-Matsushigue, J. L. M. Duarte, C. L. Rodrigues, M. R. D. Rodrigues, G. M. Ukita, "Coulomb-nuclear interference with Li: isospin character of the 2_1^+ excitation in ^{70,72,74}Ge", *Phys. Rev. C* **71**, 024303 :1-13 (2005).

(2) G. M. Ukita, T. Borello-Lewin, L. B. Horodynski-Matsushigue, J. L. M. Duarte, and L. C. Gomes, "Coulomb-nuclear interference with deuterons: Isospin character of the 2_1^+ and 3_1^- excitations in ^{94,98}Mo", *Phys. Rev. C* **64**, 014316:1-10 (2001).

(3) J. L. M. Duarte, G. M. Ukita, T. Borello-Lewin, L. B. Horodynski-Matsushigue, and L. C. Gomes, "Inelastic deuteron scattering in the Coulomb-nuclear interference region: Procedures for estimating the statistical uncertainty of the extracted B(E2) and B(IS2) values", *Phys. Rev. C* **56**, 1855-1865 (1997).

[4] M. R. D. Rodrigues, C. L. Rodrigues, T. Borello-Lewin, L. B. Horodynski-Matsushigue, J. L. M. Duarte and G. M. Ukita, "Coulomb Nuclear Interference with deuterons in even Palladium Isotopes", *Brazilian Journal of Physics* **34 n3A**, 777-780 (2004).
[5] C. L. Rodrigues, M. R. D. Rodrigues, T. Borello-Lewin, L. B. Horodynski-Matsushigue, J. L. M. Duarte, G. M. Ukita and G. N. Hanninger, "Coulomb-Nuclear Interference (CNI) Results of the Collective Quadrupolar Excitations in Odd and Even Ru isotopes", *Brazilian Journal of Physics* **34 n3A**, 760-762 (2004).