Proposition de stage/ thèse 2010-2011
The nature of the Pygmy Dipole Resonance on ^{68}Ni.

Spécialité : Spécialité NPAC (DEA CPM)

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Titre de la thèse (ou du stage) :
The nature of the Pygmy Dipole Resonance in ^{68}Ni

Durée du stage : entre 2 et 5 mois environ. Ce stage débouche sur une thèse.

Lieu(x) de travail : Orsay et GANIL (CAEN).

Déplacements éventuels : GANIL

Collaborations : ex GANIL (Caen, France), Legnaro National Laboratory (INFN-Italy), SPhN (Saclay, France), ATOMKI (Hungary), IFJ PAN (Krakow, Poland)

Sujet et nature du travail proposé :

Context:
The E1 strength distribution in atomic nuclei is dominated by the Isovector Giant Dipole Resonance (IVGDR). In a macroscopic picture this $1\hbar\omega$ resonance can be described as a small amplitude oscillation of protons against neutrons. Since its discovery in 1937 by Bothe and Gentner, systematic studies, both experimental and theoretical, showed that the IVGDR is a collective excitation observed in all nuclei at energies and with widths going from 25 MeV and 5 MeV for light nuclei to 12 MeV and 2.5 MeV for heavy spherical nuclei. Almost all of the E1 strength is concentrated in the IVGDR.
However, few percents of this strength were found at lower energy, closer to the particle emission threshold in heavy nuclei or in some light or medium mass exotic nuclei. This is the Pygmy Dipole Resonance and it was interpreted as being the oscillation of a neutron skin against an isospin saturated core. While different models agree with each other on the mean energy and width of the PDR, they don't agree on the collective or single particle or the isoscalar or isovector nature of this (soft) excitation mode.
Furthermore, the occurrence of the low-lying dipole strength close to the 1 neutron separation energy can play an important role in neutron-capture rates in the r-process.
Recently, it has also been pointed out, that experimental study of the PDR can be analyzed to constrain the isospin asymmetric part of the equation of state of nuclear matter. It has been showed in mean-field calculations that this mode is directly linked to the symmetry energy.

PhD research program:

Recently, the PDR in 68Ni has been observed in GSI in Coulomb excitation of a 600 MeV/u 68Ni beam. A small bump in the gamma spectrum has been observed at about 10 MeV excitation energy. Consequently, we have proposed an experiment in GANIL, using the spectrometer LISE, in order to investigate the isoscalar nature of the observed PDR. We intend to do this by measuring the cross section of the inelastic scattering of the 68Ni radioactive beam on a 208 Pb target and a proton target. With the 208Pb target, 68Ni will be excited only by electromagnetic interaction (and so, only the protons in 68Ni should participate), whilst with the proton target only by nuclear interaction (both protons and neutrons in 68Ni are excited). The gamma de-exciting the populated states will be detected using the Chateau de Cristal, composed of 74 BaF2 crystals.

Our experiment was accepted and should be scheduled in 2011. The student will participate during the training period to testing, calibration and simulations of the Chateau de Cristal. During the thesis, he/she will participate to the preparation of the experiment on LISE/GANIL and to the data analysis. Because there is an important need of theoretical input for this subject, the student will also have to familiarize with theoretical approaches suitable for the description of the PDR.