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PAIRING VIBRATIONS STUDY USING A TIME-DEPENDENT ENERGY-DENSITY-FUNCTIONAL APPROACH

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We discuss pairing vibrations in the context of Time-Dependent Energy-Density-Functional formalism. The focus is put on the pairing part of the energy functional. We found that the density-dependence of the pairing functional impacts 2-nucleons transfer strengths.

Keywords: pairing vibrations; time-dependent energy-density-functional formalism.

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1. Introduction

The Energy-Density-Functional formalism (EDF) is one of the most efficient model to describe bulk and spectroscopic properties of a wide range of nuclei[1]. In particular, it allows the incorporation of pairing correlations through the $\mathcal{U}(1)$ symmetry breaking. However, parameterizations of the pairing part of the functional are highly empirical like in existing Skyrme-based EDF methods. In order to better constrain pairing functionals, it has recently been suggested[2] that pairing vibrations could help to understand and constrain pairing in EDF models. In this contribution, we propose to study the influence of the density dependence of the pairing part of Skyrme-based functionals on pairing vibrations.

2. Numerical results and discussion

In first-order perturbation theory, one can study excitations modes through Fourier analysis in time. In order to study pairing vibrations, we thus use the tdhfbrad code which solves the time-dependent Skyrme-Hartree-Fock-Bogoliubov equations in spherical symmetry[3]. We take the SLy4[4] Skyrme parameterization of the EDF for the particle-hole channel and a delta density-dependent pairing functional. Its effective vertex reads in coordinate-space:

$$\overline{v}^{pp} = \tilde{V}_0 \left(1 - \alpha \frac{\rho(r)}{\rho_{sat}}\right) \delta(\mathbf{r}_{12}),$$

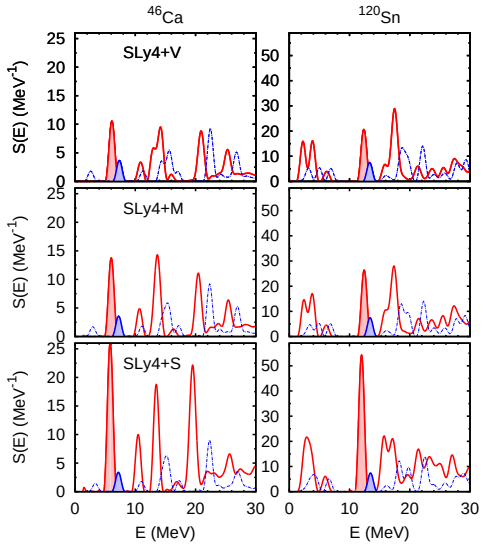

Fig. 1. (red) Self-consistent and (blue) unperturbed strength function of a 2-nucleon pair-transfer operator applied on ^{46}Ca and ^{120}Sn using volume (up), mixed (middle) and surface (bottom) pairing functionals.

where the parameter α, governing the density-denpendence of the pairing field, is tuned from 0 to 0.5 and 1 to simulate respectively a volume (V), mixed (M) and surface (S) pairing. The values of $\tilde{V}_0$ are finally adjusted to reproduce a theoretical spectral gap of 1.25 MeV in ^{120}Sn for an energy cut-off of 80 MeV acting in the quasi-particle spectrum.

The self-consistent (red) and unperturbed (blue) strength of a 2-nucleon pair-transfer operator[3] are shown on figure 1. The focus will be made on the first 2-neutron additional modes which are highlighted. The comparison of both response functions is shown to understand the effect of static and dynamical pairing correlations. As one can see for the considered isotopes, whereas different pairing functionals give approximatively the same strength at the static level, it is not the case when dynamical pairing correlations are at play. Indeed, whereas dynamical effects globally increase the strengths of every system we studied, their impact are more important when considering surface-peaked pairing, which could have an impact on 2-nucleon transfer cross-sections.

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