

## Microscopic Models for the Particle-Vibration Coupling in Exotic Nuclei

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We briefly discuss here calculations of the dipole response of neutron-rich oxygen isotopes, and we conclude that the spreading effects are even larger than in the standard cases.

The dipole states have been extensively studied since the early days of nuclear physics, and are efficiently probed at present by means of Coulomb excitation experiments at relativistic energies. Recent measurements of this type, performed at GSI,<sup>1)</sup> have shown that the low-lying dipole strength is increasing along the oxygen isotope chain as a function of the neutron number from  $^{18}\text{O}$  to  $^{22}\text{O}$ . The natural question arises, whether this strength has collective character (and can consequently be interpreted as a coherent vibration of the valence neutrons against the other particles) or not. In the present work, we aim to a description of these dipole states based on a mean field approach [quasi-particle RPA (QRPA)] plus the coupling with density vibrations of multipolarity  $2^+$ ,  $3^-$  and  $4^+$ . In stable nuclei, this kind of couplings is known to be very efficient to produce the spreading of, e.g., the giant resonance strength. We show that in the present case the effect of this coupling is even stronger than in standard cases.

The main input of our calculations is an effective nucleon-nucleon interaction of the Skyrme type. In particular, we have chosen the SIII parametrization.<sup>2)</sup> The pairing interaction has also been taken into account in a simple way, namely we have performed HF-BCS calculations with constant neutron pairing gaps  $\Delta_n$ . These gaps correspond to a constant pairing strength  $G$  along the chain of about 0.4 MeV. We have performed QRPA calculations on top of HF-BCS. The QRPA equations are written in matrix form, in the configuration space made up with two quasi-particles states. The continuum is discretized and the energy cutoff of the configuration space is large enough so that the appropriate energy-weighted sum rules (EWSR) are satisfied. The effect of the coupling with low-lying phonons is taken into account by extending the microscopic model of Ref. 3) to include the pairing correlations. This model, developed within a Milano-Orsay collaboration and aimed to a fully microscopic description of giant resonances excitation and decay mechanisms, has been applied successfully in the last decade to a number of cases (see the references quoted in Ref. 4)). We refer to Ref. 3) for details about the model and to Ref. 4) for its extension to the case of superfluid nuclei.

The dipole response of the oxygen isotopes is shown in Fig. 1. We can dis-

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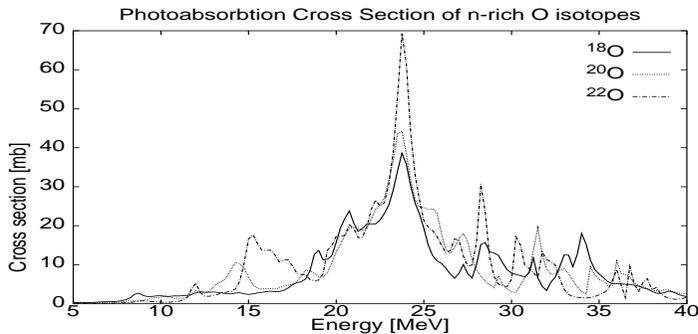


Fig. 1. Total photoabsorption cross section for the isotopes  $^{18,20,22}\text{O}$ .

tinguish roughly a “giant resonance” region (around 20–25 MeV) where the main peak essentially is mass-independent, from a low-energy region which shows progressive cumulation of strength with increasing  $A$ . Experimentally, the photoabsorption cross section has been measured in the whole range 0–42 MeV only for the stable isotope  $^{18}\text{O}$ .<sup>5)</sup> Our findings are in reasonable agreement with these measurements. As mentioned in the introduction, only very recently it has been possible to try to determine the dipole cross section in the unstable isotopes. The results

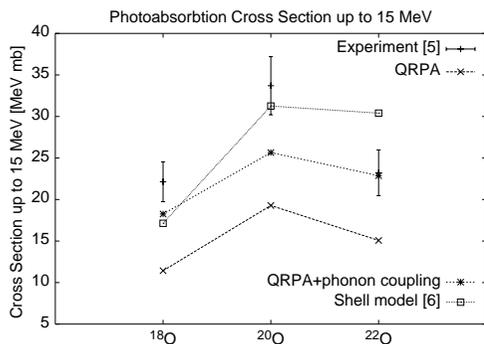


Fig. 2. Integrated photoabsorption cross section (up to 15 MeV) in  $^{18,20,22}\text{O}$ .

of the experiment performed at GSI by the LAND collaboration are reported in Fig. 2. The quantity which is plotted is the integral of the cross section until 15 MeV (approximate threshold for the emission of the protons, which are not detected in the experiment). In the same figure, we compare with the results of the present work (QRPA and complete calculation) and of Ref. 6). One can see that the coupling with the vibrations increases the low-energy cross section compared to the case of QRPA, bringing it in rather good agreement with the data.

## References

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