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Two recent extensions of the second random phase approximation and their applications to atomic nuclei

The Second Random Phase Approximation (SRPA) is a natural extension of Random Phase Approximation (RPA) obtained by introducing more general excitation operators where two particle-two hole configurations, in addition to the one particle-one hole ones, are considered. Only in the last years, large-scale SRPA calculations have been performed, showing merits and limits of this approach. Performing such calculations has allowed to identify some specific features of the SRPA model that could not be seen in previous strongly truncated and simplified calculations. Unexpectedly, the SRPA spectrum is systematically lowered by several MeV with respect to that obtained in the ordinary random-phase approximation. Some possible reasons of this behavior will be discussed and two different methods to cure it will be presented. The first one is based on a subtraction procedure [1] proposed to overcome double–counting in the SRPA. This procedure will be shortly introduced and then some applications will be shown [2]. In particular, we will show that this procedure leads to results that are weakly cutoff dependent and that the systematically found SRPA downwards shift is strongly reduced. After that, we will present an extension of the RPA where the RPA phonons are used as building blocks to construct more general excited states. In particular, in the present study we include up to two RPA phonons [3]. This is an approximate and simplified way, with respect to the full SRPA, to include two-particle–two-hole configurations allowing at the same time to reduce the anomalous shift observed in SRPA.

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[2] D. Gambacurta, M. Grasso and J.Engel, Phys. Rev. C 92 , 034303 (2015).
[3] D. Gambacurta, F. Catara, M. Grasso, M. Sambataro, M. V. Andrés, and E. G. Lanza Phys. Rev. C 93, 024309 (2016).

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