Collective excitation modes of unstable nuclei in the continuum quasiparticle random phase approximation

K. Mizuyama[1], M. Matsuo[2] , Y. Serizawa[2]
[1]*Graduate School of Science and Technology, Niigata University, Niigata 950-2181, Japan*
[2]*Department of Physics, Faculty of Science, Niigata University, Niigata 950-2181, Japan*

We expect that collective modes of excitation reflect exotic properties of neutron-rich nuclei such as neutron skin and presense of weakly bound neutrons. For this reason we explore collective modes theoretically, i.e., by means of the continuum quasiparticle random phase approximation (continuum QRPA) based on the selfconsistent Hartree-Fock-Bogoliubov mean-field theory[1, 2, 3]. We also have been developing the continuum QRPA models continuously to improve predictablity of the theory[4].

One of the recent achievements is a new formulation of the continuum QRPA which takes into account the most important parts of the effective interaction, the Skyrme interaction, so that the theory satisfies the energy weighted sum-rule (EWSR) for the strength function of the multipole density excitations[4]. The description satisfying the EWSR has been achieved for the first time for the Skyrme continuum QRPA approach. Figure 1(a) shows the isoscalar quadrupole strength $B(IS2)$ strength as a function of the excitation energy, in which both the giant resonace and the low-lying quadrupole modes are well described. Fig.1(b) demonstrate that the energy weighted sum reaches the sum-rule value (the holizontal line) with high accuracy. Consequently, using the developed model we are able to analyze the strength distribution in the whole excitation energy region convering from the low-lying states to the giant resonance region.

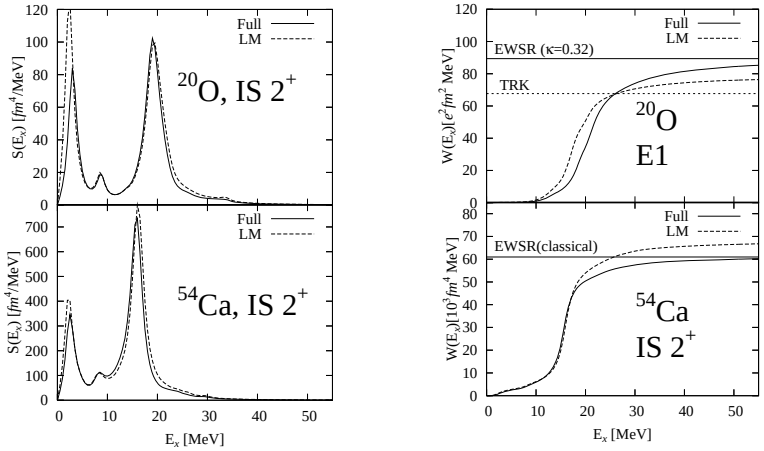

Figure 1: (a) Isoscalar strength function for the quadrupole excitation in neutron rich nuclei ^{20}O and ^{54}Ca calculated using the Skyrme parameter set SkM*. (b) The energy weighted sum of the isovector dipole and isoscalar quadrupole strength functions in ^{20}O and ^{54}Ca. The horizontal solid lines represent the EWSR value.

We plan to apply this improved Skyrme continuum QRPA model to investigate various types of collective excitation in neutron and proton rich nuclei.

References

[1] M. Matsuo, *Nucl. Phys.* **A696**, 371 (2001).
[2] M. Matsuo, K. Mizuyama, and Y. Serizawa, *Phys. Rev. C* **71**, 064326 (2005).
[3] M. Matsuo, Y. Serizawa, K. Mizuyama, *Nucl. Phys.* **A788**, 307c (2007).
[4] K. Mizuyama, M. Matsuo, Y. Serizawa, preprint arXiv:0706.1115 (nucl-th).