Usage Report for Fiscal Year 2016

Project Title:

Properties of finite systems including nuclei at high temperature and angular momentum (Properties of highly excited nuclei)

Name:

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1) Completing the study of the effective restoration of dipole sum rules within the renormalized random-phase. In this work, it is shown that the sum rule violation in the particle-hole renormalized random-phase approximation can be eliminated by taking into account the contribution of the particle-particle and hole-hole excitations together with the particle-hole ones in a simple and perturbative way.

2) Proposing an improved treatment of blocking effect at finite temperature, in which the blocking effect caused by the odd particle on the pairing properties of systems with an odd number of fermions at finite temperature interacting via the monopole pairing force is studied within several approximations. The results are compared with the predictions obtained by using the exact solutions of the pairing Hamiltonian. The comparison favors the approximation with the odd particle occupying the top level, which is the closest to the Fermi surface and whose occupation number decreases with increasing temperature.

3) Proposing a simultaneous microscopic description of nuclear level density and radiative strength function. The nuclear level density (NLD) and radiative strength function (RSF) are described simultaneously within a microscopic approach, which takes into account the thermal effects of the exact paring as well as the giant resonances within the phonon-damping model. The good agreement between the results of calculations and experimental data extracted by the Oslo group for $^{170\text{-}172}$Yb isotopes shows the importance of exact thermal pairing in the description of NLD at low and intermediate excitation energies and invalidates the assumption based on the Brink-Axel hypothesis in the description of the RSF.

4) Calculating the giant dipole resonance (GDR) observables within the thermal shape fluctuation model (TSFM) by considering the probability distributions of different angular momentum (I) and temperature (T) values estimated recently in the de-excitation process of the compound nucleus ^{88}Mo. These results are found to be very similar to the results obtained with the average T (T_{ave}) and average I (I_{ave}) corresponding to those distributions. The shape transitions in ^{88}Mo at different T and I are also studied through the free energy surfaces calculated within the microscopic-macroscopic approach. The deformation of ^{88}Mo is found to increase considerably with T and I leading to the Jacobi shape transition at I ~ $50\hbar$. The combined effect of increasing deformation, larger fluctuations at higher T, and larger Coriolis splitting of GDR components at higher I, leads to a rapid increase in the GDR width.

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Schedule and propose for the FY 2017:

We plan to continue the project in the next fiscal year starting from 1st April, 2017, including

1) In collaboration with Prof. N. Quang Hung of Duy Tan University and Mr. Le Tan Phuc (PhD student) of HoChiMinh University of Science, proposing the self-consistent Hartree-Fock plus exact pairing (SC HF+EP)using Skyrme interactions to incorporate exact pairing in the Hartree-Fock mean field.
2) Based on this SC HF + EP approach, we will construct the HF+EP+RPA as an alternative of the conventional quasiparticle RPA without particle-number violation.
3) We will also explore the possibility of obtaining pairing reentrance effect from the level density calculated using exact pairing and angular momentum.
4) In collaboration with Dr. A.K. Rhine Kumar and Prof. P. Arumugam, we will constructing state-of-the-art theoretical tools to study the several aspects of nuclei at extremes of temperature, angular momentum and iso-spin by performing the calculations of the experiment-comparable observables. We have already constructed one among the best models to study the GDR with proper treatment of pairing and its fluctuations along with the thermal shape fluctuations. In the proposed work, we will attempt a few improvements and development of better approaches to describing the giant dipole resonance in hot rotating nuclei.

All these studies require the use of RIKEN computer system at HOKUSAI, so we request the ACCC to kindly renew our accounts for this purpose.

Fiscal Year 2016 List of Publications Resulting from the Use of the supercomputer

[Publications:]

1) **N. Quang Hung, N. Dinh Dang, L.T. Quynh Huong,**
Simultaneous microscopic description of nuclear level density and radiative strength function
Phys. Rev. Lett. 118 (2017) 022502.

2) **N. Quang Hung, N. Dinh Dang, T. V. Nhan Hao, L. Tan Phuc,**
Effective restoration of dipole sum rules within the renormalized random-phase approximation
Phys. Rev. C 94 (2016) 064312.

3) **N. Quang Hung, N. Dinh Dang, L.T. Quynh Huong,**
Improved treatment of blocking effect at finite temperature
Phys. Rev. C 94 (2016) 024341.

4) **D. Chakrabarty, N. Dinh Dang, and V.M. Datar,**
Giant dipole resonance in hot nuclei,
(invited review) Eur. Phys. Jour. A 52 (2016) : 143.