Usage Report for Fiscal Year 2015

Project Title:

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

Names: Nguyen Dinh Dang, Nguyen Quang Hung, B. K. Agrawal, A.K. Rhine Kumar

Laboratory at RIKEN: Theoretical Nuclear Physics

1) I succeeded to show that the phonon damping model (PDM by Dang & Arima 1998), which I extended to finite angular momentum in 2012, describes very well the most recent data of the giant dipole resonance (GDR) built on hot rotating nuclei produced during evaporation of light particles from ^{88}Mo compound nucleus by the experimentalists in Krakow and Milano.

2) We applied the FTBCS1 theory (proposed and developed by Dang and Hung in 2008) at finite temperature and angular momentum to study the pairing phenomenon and level density in ^{104}Pd, of which an enhancement of level density at low excitation energy and high angular momentum has been experimentally observed by the experimentalists at BARC (Mumbai). The quantitative agreement between experiment and theory suggests that this enhancement is indeed the first experimental evidence of the reentrance of superfluid pairing in a finite nucleus.

3) We presented the complete formalism based on the microscopic - macroscopic approach for determining the deformation energies and a macroscopic approach which links the deformation to GDR observables. We discussed our results for the nuclei ^{97}Tc, ^{120}Sn, ^{179}Au, and ^{208}Pb, and corroborate with the experimental data available. We showed that the thermal-shape fluctuation model could explain the data successfully at low temperature only with a proper treatment of pairing and its fluctuations.

4) In collaboration with the experimentalists at the VECC (Kolkata), who studied the effect of temperature T and angular momentum J on the inverse level density parameter k by populating the compound nucleus ^{97}Tc in the reaction ^{4}He + ^{93}Nb at four incident beam energies of 28, 35, 42, and 50 MeV, we compared the T dependence of k for two angular momentum windows with different theoretical predictions as well as with the results of calculations within the FTBCS1. We found that the experimental data are in good agreement with the theoretical calculations at higher J but deviate from all the calculations at lower J.

Schedule and propose for the FY 2016:

We plan to continue the project in the next fiscal year starting from 1st April, 2016, including

1- Completing the study of the effect of ground state correlations beyond the RPA on the PDR and GDR (in collaboration with N. Quang Hung of Duy Tan University);

2- Studying if the pairing reentrance effect is expected in most of the nuclei or if it is enhanced in a certain region of nuclear landscape in order to set a guidance for a possible experimental measurement. (in collaboration with N. Quang Hung, B.K.

Agrawal, and R. Palit);

3- Using the nuclear level densities obtained within the FTBCS1 to generate the proton spectra for ^{104}Pd for a direct comparison with the experimental data (in collaboration with V. Datar, D. Chakrabarty and B.K. Agrawal, and A. Mitra).

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 2015 List of Publications Resulting from the Use of the supercomputer

[Publication]

1) M. Ciemala, M. Kmiecik, A. Maj, V.L. Kravchuk, S. Barlini, G. Casini, F. Gramegna, F. Camera, A. Corsi, L. Bardelli, M. Bini, P. Bednarczyk, B. Fornal, M. Krzysiek, M. Matejska-Minda, K. Mazurek, W. Meczynski, S. Myalski, J. Styczen, B. Szpak, B. Wasilewska, M. Zieblinski, M. Cinausero, T. Marchi, V. Rizzi, G. Prete, M. Degerlier, G. Benzoni, N. Blasi, A. Bracco, S. Brambilla, F. Crespi, S. Leoni, B. Million, O. Wieland, D. Montanari, R. Nicolini, A. Giaz, G. Baiocco, M. Bruno, M. D'Agostino, L. Morelli, M. Chiari, A. Nannini, G. Pasquali, S. Piantelli, S. Valdre, A. Chbihi, J.P. Wieleczko, I. Mazumdar, O. J. Roberts, J. Dudek, N. Dinh Dang*, Giant Dipole Resonance built on hot rotating nuclei produced during evaporation of light particles from Mo-88 compound nucleus*, Phys. Rev. C 91 (2015) 0454313.

2) B. Dey, D. Pandit, S. Bhattacharya, K. Banerjee, N. Quang Hung, N. Dinh Dang, D. Mondal, S. Mukhopadhyay, S. Pal, A. De, S. R. Banerjee,
Experimental investigation on the temperature dependence of the nuclear level density parameter, Phys. Rev. C 91 (2015) 044326.

3) A.K. Rhine Kumar, P. Arumugam, and N. Dinh Dang, *Effects of thermal shape fluctuations and pairing fluctuations on the giant dipole resonance in warm nuclei*, Phys. Rev. C 91 (2015) 044305.

[Proceedings]

1) N. Quang Hung, N. Dinh Dang, B.K. Agrawal, V.M. Datar, A. Mitra, and D. R. Chakrabarty, *Pairing reentrance in warm rotating 104-Pd nucleus*, Acta Physica Polonica B - Proceedings Supplement 8 (2015) 551

2) N. Quang Hung, N. Dinh Dang, B.K. Agrawal, V.M. Datar, A. Mitra, and D. R. Chakrabarty, *Reentrance phenomenon of superfluid pairing in hot rotating nuclei*, J. Phys.: Conference Series 627 (2015) 012006.

3) N. Dinh Dang, Thermal pairing and giant dipole resonance in highly excited nuclei, J. Phys.: Conf. Series 580 (2015) 012050.

[Oral presentation at an international symposium]

1) N. Dinh Dang, *Pairing reentrance in hot rotating nuclei*, invited lecture at the XXII Nuclear Physics Workshop "Marie & Pierre Curie", September 22 – 27, 2015, Kazimierz Dolny, Poland.

2) N. Dinh Dang, *Effect of thermal fluctuations in the pairing field on the width of giant dipole resonance*, invited lecture at the 5th International conference on "*Collective Motion in Nuclei Under Extreme Conditions*" (COMEX5), September 14 – 18, 2015, Krakow, Poland.

3) A.K. Rhine Kumar, P. Arumugam, and N. Dinh Dang, *Pairing fluctuations and giant dipole resonances,* oral contribution at the 5th International conference on "*Collective Motion in Nuclei Under Extreme Conditions*" (COMEX5), September 14 – 18, 2015, Krakow, Poland.