

---

# LARGE SCALE SHELL MODEL CALCULATIONS ON E1 SPECTRA IN MEDIUM-HEAVY NUCLEI

Noritaka Shimizu, Center for Nuclear Study, the University of Tokyo, Tokyo, Japan

---

S. Ebata<sup>1</sup>, M. Honma<sup>2</sup>, T. Otsuka<sup>3</sup>, T. Togashi<sup>4</sup>, Y. Utsuno<sup>5</sup>

<sup>1</sup> Faculty of Science, Hokkaido University, Sapporo, Japan

<sup>2</sup> Center for Mathematical Sciences, University of Aizu, Aizu-Wakamatsu, Japan

<sup>3</sup> Department of Physics, the University of Tokyo, Tokyo, Japan

<sup>4</sup> Center for Nuclear Study, the University of Tokyo, Tokyo, Japan

<sup>5</sup> Japan Atomic Energy Agency, Ibaraki, Tokai, Japan

Large-scale shell model calculations (LSSM) have been broadening their applicable region to collective excitations thanks to both the growth of supercomputer and methodological developments. In this talk, we discuss microscopic description of E1 excitations of Ca isotopes. We performed LSSM calculations of neutron-rich Ca isotopes with *sd-pf-sdg* model space and *3hw*-excitation truncation, and obtained their photoabsorption cross sections. The *M*-scheme dimension of the many-body Hamiltonian matrix of the LSSM reaches  $10^{10}$ , quite huge. It gives a good description of giant dipole and low-lying pygmy resonances rather independently of smoothing parameter. We also discuss its isospin dependence.

The straightforward application of the shell-model calculation to heavier-mass region is still hampered by the rapid increase of the *M*-scheme dimension of the LSSM. In order to overcome this difficulty and to investigate the E1 properties microscopically, we adopt the Monte Carlo shell model (MCSM) [2]. We extend the framework of the MCSM to describe E1 excitation up to 20-MeV excitation energy, and demonstrate numerical results of some nuclei including  $^{90}\text{Sr}$ , which is one nuclide of long-lived fission products in radioactive waste.

This work has been supported by the HPCI Strategic Program from MEXT, a Grant-in-Aid for Scientific Research (25870168) from JSPS, and the CNS-RIKEN joint project for large-scale nuclear structure calculations. The numerical calculation was performed partly on the FX10 supercomputer at the University of Tokyo, COMA supercomputer at the University of Tsukuba, and K computer at RIKEN AICS (hp130024, hp140210, hp150224).

## REFERENCES

- [1] Y. Utsuno, N. Shimizu, T. Otsuka, S. Ebata and M. Honma, Progress in Nuclear Energy, accepted, doi:10.1016/j.pnucene.2014.07.036.
- [2] N. Shimizu, T. Abe, Y. Tsunoda, Y. Utsuno, T. Yoshida, T. Mizusaki, M. Honma, and T. Otsuka, Prog. Theor. Exp. Phys. **2012**, 01A205 (2012)