Nuclear tetrahedral states and high-spin states studied by quantum number projection method

S. TAGAMI*, M. SHIMADA*, Y. FUJIOKA*, Y. R. SHIMIZU*, AND J. DUDEK**

* *Department of Physics, Faculty of Sciences, Kyushu University Fukuoka 812-8581, Japan,*

** *Institut Pluridisciplinaire Hubert Curien (IPHC), IN_2P_3-CNRS/Université de Strasbourg, F-67037 Strasbourg, France*

We have recently developed an efficient method [1] to perform quantum number projection calculations, i.e., the projections of parity and angular momentum as well as particle number at the same time, from most general symmetry-broken mean-field states. The crucial point of our method is the full use of the canonical basis of given mean-field state, which enables us to efficiently truncate the model space, and to accurately calculate various overlaps with the aid of the Thouless amplitudes with respect to the Slater determinant states. With this method, we are able to perform the projection calculations using the realistic Woods-Saxon potential with large oscillator shells ($N_{\rm osc} \approx 20$), although the employed hamiltonian is rather schematic and composed of the multi-separable-type interactions; see Ref. [1] for details.

As an interesting application, we have investigated collective excitations of the tetrahedrally deformed nuclei [2]. Although it is an exotic shape, the tetrahedral shape has a higher point-group symmetry than, e.g., the usual quadruple shape has, and many characteristic features are expected. We have found that the specific spin-parity combinations appear just as the group theory predicts, and the transition from the vibrational to the rotational spectra occurs when increasing the tetrahedral deformation. In Ref. [2] we have concentrated on the even-even closed shell configurations of the tetrahedra deformed shells. In this talk, we would like to report on the results for the one-particle (or one-hole) excitations and more complicated excitations in comparison with the prediction of the tetrahedrally symmetric rotor model.

A more standard application of the angular momentum projection may be the study of high-spin states. Recently many exotic rotational bands have been observed, for example, the nuclear wobbling bands and the chiral doublet bands, where the direction of the angular momentum vector deviates from the inertia axes of the deformed body. However, the predictions for such interesting nuclear rotations have been done either by the macroscopic models or by the mean-field approaches. We would like to report our studies of such kinds of interesting rotational motions by means of the fully microscopic quantum number projection method.

References

[1] S. Tagami and Y. R. Shimizu, Prog. Theor. Phys. **127**, 79 (2012).
[2] S. Tagami, Y. R. Shimizu, and J. Dudek, Phys. Rev. C **87** (2013), 054306.