Mixed Representation RPA Calculation for Negative-Parity Excitations built on Superdeformed Sates in the ^{40}Ca and Neutron-Rich Sulfur Regions

T. Inakura,[1] H. Imagawa,[2] Y. Hashimoto,[2], S. Mizutori,[3] M. Yamagami,[4] and K. Matsuyanagi[5]

[1]*Graduate School of Science and Technology, Niigata University, Niigata 950-2181, Japan*

[2]*Institute of Physics, University of Tsukuba, Ibaraki 305-8571, Japan*

[3]*Department of Human Science, Kansai Women's College, Osaka 582-0026, Japan*

[4]*Heavy Ion Nuclear Physics Laboratory, RIKEN, Saitama 351-0198, Japan*

[5]*Department of Physics, Graduate School of Science, Kyoto University, Kyoto 606-8502, Japan*

Quite Recently, the superdeformed (SD) bands in ^{36}, ^{40}Ca and ^{44}Ti were observed. One of the important new features of them is that they are built on excited 0^+ states and observed up to high spin. Drip-line Sulfur nuclei ^{48,50}S constitute a new "SD doubly closed" region[1]. They have the SD magic numbers Z=16 for proton and $N = 32-34$ for neutron, associated with SD magic numbers $N = 32-34$ in states nuclei. It is indicated that SD nuclei are very soft against both axial and non-axial octupole deformations, so we expect low-lying octupole vibrational modes to emerge on the superdeformed 0^+ states in the ^{40}Ca and neutron-rich Sulfur regions.

We have carried out fully self-consistent RPA calculation on these SD stats with the mixed representation RPA[2, 3] on the three-dimensional Cartesian mesh in a box. There are several merits in this approach: Firstly, it is relatively easy, in comparison with the Green's function method, to take into account all terms of the residual interaction. Secondly, the upper energy cut-off is very high. Thirdly, thanks to the use of the Cartesian coordinate representation, we can treat strongly deformed nuclei on the same footing as spherical nuclei.

Figure 1 shows the low-lying negative-parity excitations on those SD states, possessing mass octupole transition probabilities greater than 10 W.u. We predicted a number of vibrational modes in the ^{40}Ca region ; the $K^\pi = 2^-$ state (the major components of which are excitations $[211\frac{3}{2}]\to[321\frac{1}{2}]$ of proton and neutron) in ^{32}S, the $K^\pi = 2^-$ state ($[211\frac{3}{2}]\to[321\frac{1}{2}]$) and the $K^\pi = 1^-$ state ($[202\frac{5}{2}]\to[321\frac{1}{2}]$) in ^{36}Ar, the very low-lying $K^\pi = 1^-$ state ($[321\frac{3}{2}]\to[200\frac{1}{2}]$) and the $K^\pi = 0^-$ state ($[321\frac{3}{2}]\to[202\frac{3}{2}]$) in ^{40}Ca, the $K^\pi = 0^-$ state ($[321\frac{3}{2}]\to[202\frac{3}{2}]$) and the $K^\pi = 2^-$ doublet ($[202\frac{1}{2}]\to[312\frac{5}{2}]$) in ^{44}Ti. In neutron-rich Sulfur region, we obtained low-lying states possessing large strengths. However, these states are essentially built of neutron single particle-hole excitations. The unperturbed strengths themselves have large strengths. It is because loosely bound hole and particle states (and resonant state) can spread partially.

low-lying collective octupole vibrational modes will be mixed with soft dipole modes in deformed nuclei, search for new kinds of soft (dipole+octupole) vibrational modes of excitation in neutron-rich deformed nuclei is challenging, both theoretically and experimentally. In order to contain heavier nuclei and normal deformed systems for searching them, we are presently extending the SHF+RPA scheme to include the pairing correlations.

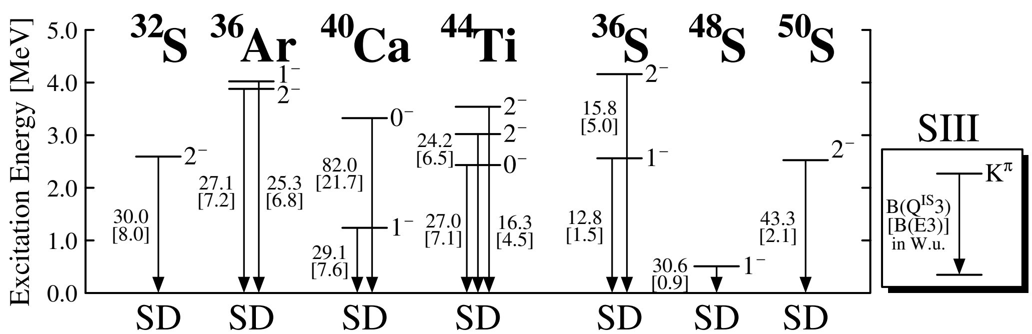

Figure 1: Few low-lying intrinsic negative-parity excitations built on the SD states in ^{32}S, ^{36}Ar, ^{40}Ca, ^{44}Ti, and ^{36,48,50}S obtained by the mixed representation RPA calculation. Numbers beside the arrows (in parentheses) indicate the squared intrinsic transition matrix elements for the mass (electric) octupole operators, $B(Q^{\rm IS}3)$ and $B(E3)$, in Weisskopf unit.

Acknowledgments

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References

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