Chapter 5

Application to spherical nuclei

In this chapter, we show numerical results with several Skyrme interactions for spherical nuclei. In this thesis, we do not consider the extended Skyrme force with the three-body momentum-dependent forces [20, 21, 22] or tensor force [74]. We calculate low-lying excitation energies of several spherical nuclei in terms of our self-consistent SHF plus RPA method with the standard Skyrme interactions.

^{16}O

In Fig. 5.1, we show the low-lying excitation energies of ^{16}O. The upper figure shows isoscalar excitation energies and the lower part shows isovector excitation energies. The isoscalar levels with SkM* seem to be close to the experimental levels. The order of calculated levels with SkM*, SGII, and SkO are the same as the order of experimental levels. The reduced transition probability $B(E3)$ with all of the displayed forces are more or less lower than experimental value. The isovector levels with all of the displayed forces are rather different from the experimental levels. Especially, calculated isovector levels of 3^- and 2^- state are much lower than those of experimental values. Therefore, we can not expect that the isovector levels calculated with Skyrme force displayed here reproduce the experimental levels for the other nuclei.

^{40}Ca

In Fig. 5.2, we show the isoscalar low-lying excitation energies of ^{40}Ca. The levels with SkM* and SGII seem to be close to the experimental levels. The order of calculated levels with SIII, SkM*, anad SGII are the same as the order of experimental levels. The excitation energy and reduced transition probability $B(E3)$ with SGII and SkI4 are very close to those of the experimental values.

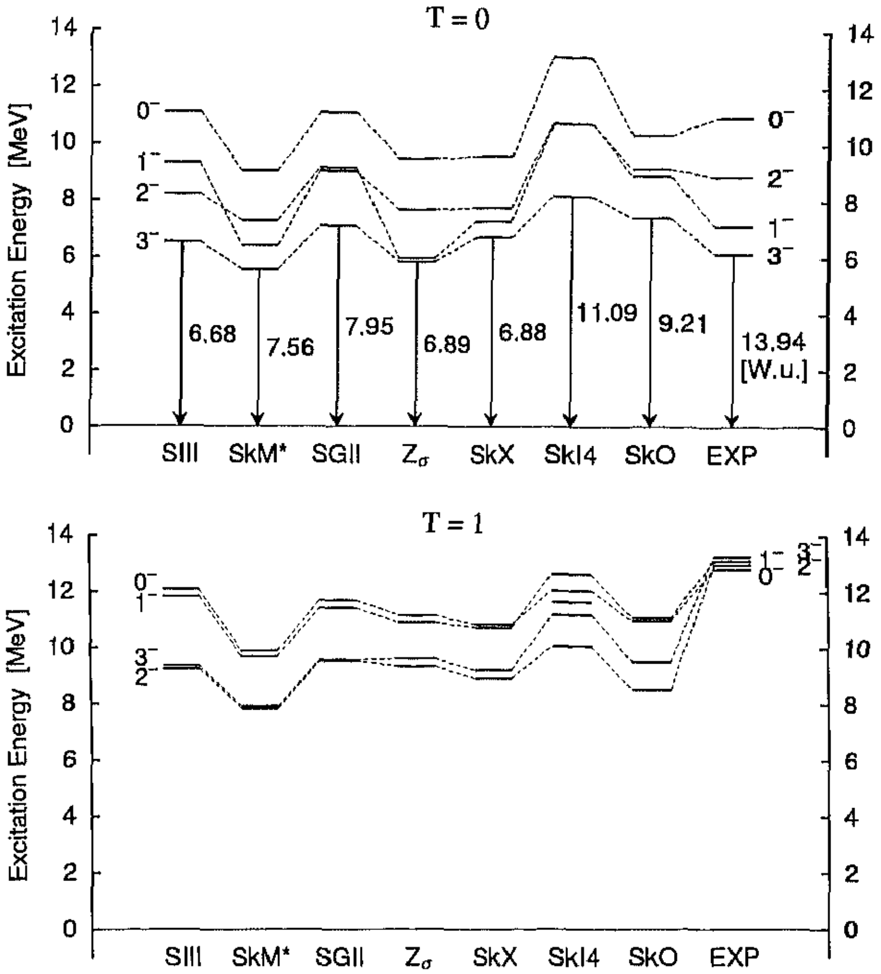

Figure 5.1: Low-lying excitation energies for ^{16}O. The upper figure shows isoscalar excitation energies and the lower part shows isovector excitation energies. The arrows in the upper figure represent reduced transition probability $B(E3)$ in Weisskopf units for 3_1^- state. Each of the levels are labeled by J^π. The experimental values (EXP) refer to Ref. [75] for excitation energy and Ref. [66] for reduced transition probability.

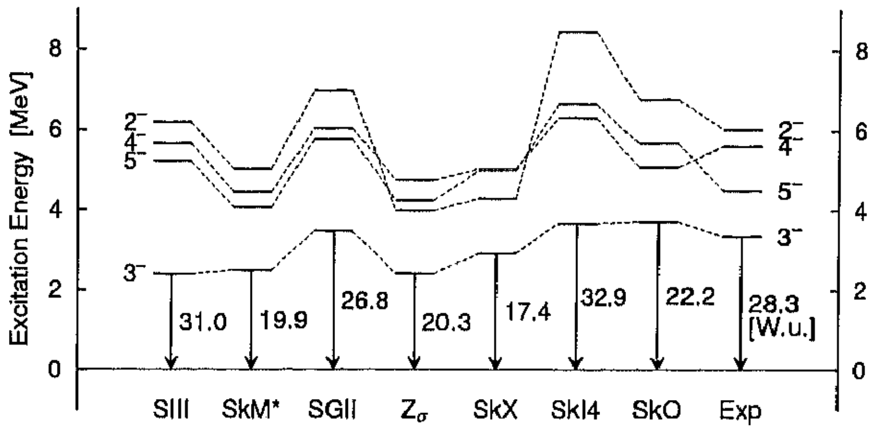

Figure 5.2: Isoscalar low-lying excitation energies for ^{40}Ca. Notation is same as Fig. 5.1. The experimental values (EXP) refer to Ref. [70] for excitation energy and Ref. [66] for reduced transition probability.

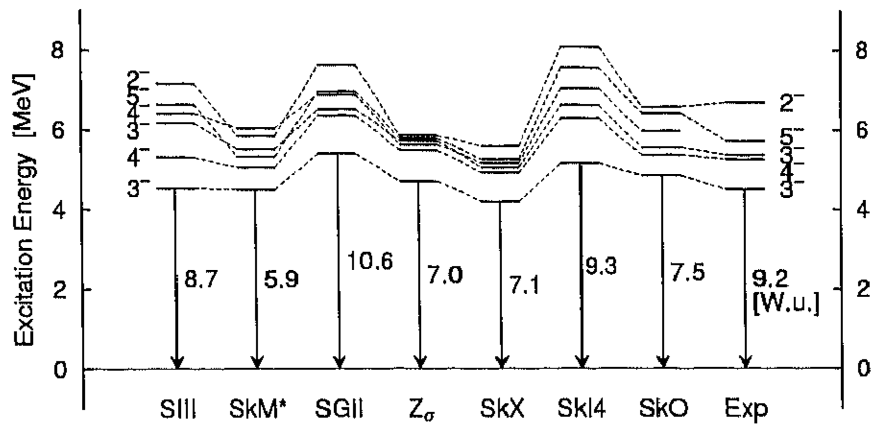

Figure 5.3: Low-lying excitation energies for ^{48}Ca. Notation is same as Fig. 5.1. The experimental values (EXP) refer to Ref. [76] for excitation energy and Ref. [66] for reduced transition probability.

^{48}Ca

In Fig. 5.3, we show the low-lying excitation energies of ^{48}Ca. The levels with SGII and SkX seem to be close to the experimental levels. The order of calculated levels except for SkM* are the same as the order of experimental levels. The excitation energy and reduced transition probability $B(E3)$ with SIII and SkI4 are well close to those of the experimental value.

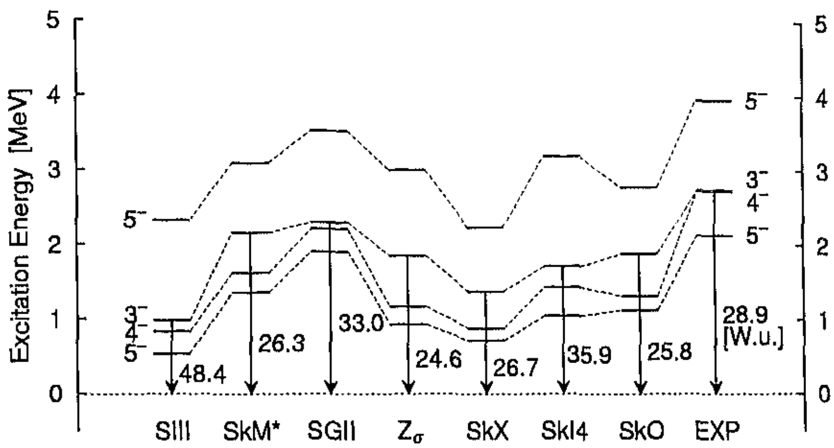

Figure 5.4: Low-lying excitation energies for ^{90}Zr. Notation is same as Fig. 5.1. The experimental values (EXP) refer to Ref. [77] for excitation energy and Ref. [66] for reduced transition probability.

^{90}Zr

In Fig. 5.4, we show the low-lying excitation energies of ^{90}Zr. The levels with SGII seem to be close to the experimental levels. The order of calculated levels with all of the displayed interaction are the same as the order of experimental levels. The excitation energy and reduced transition probability $B(E3)$ with SkM* and SGII are somewhat close to those of the experimental value.

^{208}Pb

In Fig. 5.5, we show the low-lying excitation energies of ^{208}Pb. The reduced transition probability $B(E3)$ with SkX are very close to those of the exper-

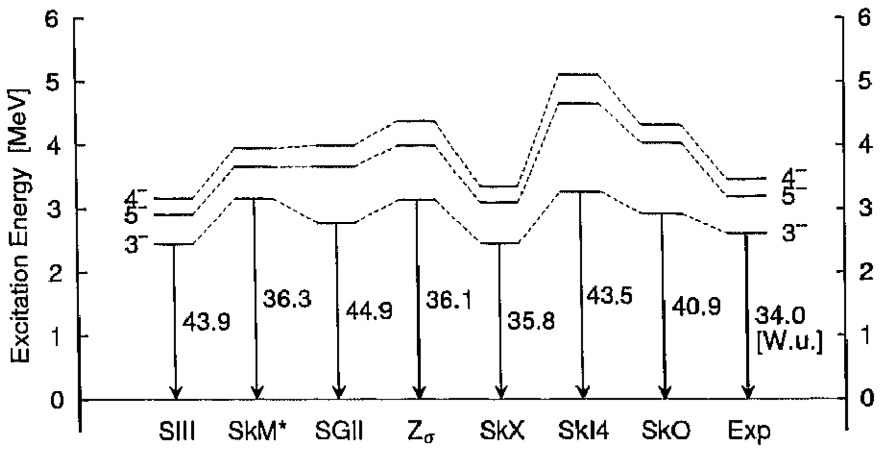

Figure 5.5: Low-lying excitation energies for ^{208}Pb. Notation is same as Fig. 5.1. The experimental values (EXP) refer to Ref. [78] for excitation energy and Ref. [66] for reduced transition probability.

imental values. The order of the calculated levels for each of the displayed interactions is the same as the order of experimental levels.

From the above calculations, we can expect that the calculation with the Skyrme force give the qualitative information of the isoscalar excited states.