formed through statistical fluctuation in nuclear collision, the external magnetic field prevents protons to form cluster with other nucleons due to the Lorentz force added. From Fig. 2, we can see that the neutron to proton ratio of free nucleons with magnetic field is evidently larger than that without magnetic field. Free nucleons of the spallation reaction are mainly from the initial de-excitation of hot matter (executed by BUU through nuclear evolution). Because the magnetic field holds protons to shoot out, the initial de-excitation of hot matter is partly prevented. We thus see small number of free neutrons and protons in the spallation reaction and large n/p of emitted free nucleons with external magnetic field.

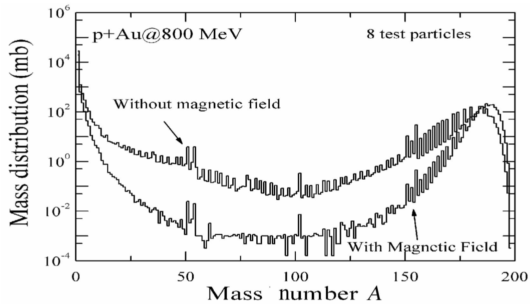

Fig. 1 Mass distribution of fragments in the p+^{197}Au reaction at the incident energy of 800 MeV/u with and without magnetic field, the strength of magnetic field added is 10^{15} Tesla, taken from Ref. [1].

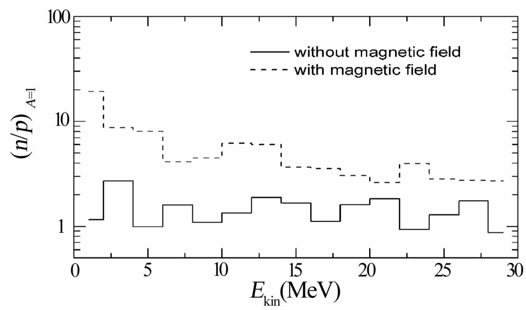

Fig. 2 Neutron to proton ratio of free nucleons in the p+^{197}Au reaction at the incident energy of 800 MeV/u with and without strong magnetic field, taken from Ref. [1].

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1 - 10 Nuclear Incompressibility and Isoscalar Giant Dipole Resonance in Relativistic Continuum Random Phase Approximation

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Nuclear incompressibility is an important parameter to depict the nuclear equation of state and plays an important role in understanding diverse phenomena ranging from giant resonances in finite nuclei to supernova explosions. However, this quantity can not be measured directly. In general, the value of nuclear incompressibility is deduced from the experimental data of compressional-mode in finite nuclear. The two important compressional modes are the isoscalar giant monopole resonance (ISGMR) and the isoscalar giant dipole resonance (ISGDR). The ISGMR is the better known compressional mode and a large amount of work has carried out to the ISGMR, since the measurement of the centroid energy of the ISGMR can provide a very sensitive method to determine the value of nuclear incompressibility K_{nm}. On the other side, the other compressional mode, ISGDR is also very important since it can provide another independent source of information on the nuclear incompressibility. Though the ISGDR was theoretically studied already more than 30 years and various experimental efforts have been made, it remains somewhat elusive and the distribution of ISGDR strength obtained from the experimental data is still under disputing. More than 10 years ago, available theoretical calculations have a tendency to give about 5 MeV higher centroid energy of ISGDR than that identified in experiments. At present, the discrepancy is reduced to about 2 MeV due to the more precise measurement.

The self-consistent relativistic random phase approximation (RRPA) has been built 10 years ago. Recently we have extended our fully consistent RRPA calculation to treat the continuum exactly by employing the Green's function technique. The fully consistent relativistic continuum random phase approximation (RCRPA)[1] built on the RMF ground state has been constructed in the momentum representation. Here

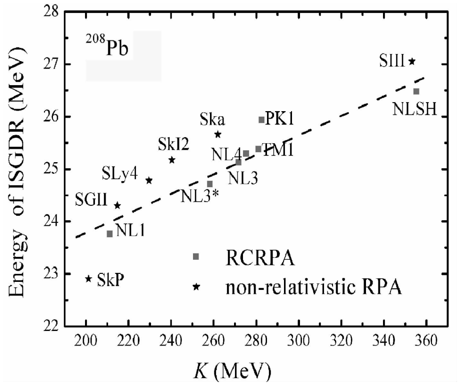

Fig. 1 Energies of the ISGDR in ^{208}Pb in RCRPA as a function of K_{nm} and the results calculated with a number of Skyrme interactions from non-relativistic RPA by Colo. The corresponding interactions are labelled.

we shall study the ISGDR in nuclei in the framework of fully consistent RCRPA. The relation between the nuclear incompressibility and the ISGDR are also discussed. Different type interactions corresponding to incompressibility in the range 200～280 MeV are used. The different type interactions used in this work are: NL1, NL3, NL3*, NL4, TM1, and PK1. In order to simplify our discussion, as a numerical example in the present article we discuss only the doubly magic nucleus ^{208}Pb.

Table 1 lists the results of the self-consistent relativistic and non-relativistic RPA calculations performed for the ISGDR in ^{208}Pb, the recent experimental data is also included. The data include the results given by our fully self-consistent RCRPA and other groups in the literature. The ISGDR experimental data are also included. The two columns refer to the centroid energies of both the low and high-energy sides of the ISGDR mode. From Table 1, it is found that the calculated centroid energies for the high-energy sides are about 1～4 MeV higher than the experimental values. However the values given by the parameter set which can produce the ISGMR data well is about 2 MeV higher than the ISGDR experimental data, it happens for both the relativistic and non-relativistic cases, one possible reason is that one may need higher order contributions, such as 2h-2p configurations[2].

Table 1 The excitation energies for low-energy and high energy ISGDR in ^{208}Pb

	Low(MeV)	High(MeV)
RCRPA, NL1, K_{nm} = 211∶29	10.85	23.76
RCRPA, NL3*, K_{nm} = 258∶28	11.63	24.71
RCRPA, NL3, K_{nm} = 271∶76	11.33	25.13
RCRPA, NL4, K_{nm} = 275∶37	12.38	25.29
RCRPA, TM1, K_{nm} = 281∶0	12.25	25.38
RCRPA, PK1, K_{nm} = 282∶644	11.79	25.93
Colo et al.	10.90	23.9
Shlomo, Sanzhur	15	25
Hamamoto et al.	14	23.4
Expt. [3]	13.26±0.3	22.20 ±0.3
Expt. [4]	13.00± 0.1	22.70± 0.2

Fig. 1 is a plot of energies of the ISGDR in ^{208}Pb as a function of K_{nm} obtained in the RCRPA calculation and also the results calculated with a number of Skyrme interactions from non-relativistic RPA by Colo. From Table 1 and Fig. 1, it is found clearly that only the higher-energy component depends on the value of nuclear incompressibility employed in the calculations, the position of the lower-energy component is completely independent of the K_{nm}. So only the higher-energy component of the ISGDR strength needs to be taken into account for the purpose of extracting the nuclear incompressibility.

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