Neutrino physics is a hot topic in today's particle physics. We thus investigated neutrino production based on the acceleration. Fig. 1 shows the inclusive differential cross sections of pion production from p + Au at an incident beam momentum of 17. 5 GeV/c. We can see that for both π^- and π^+, our results fit the E910 data very well, especially at higher momenta. Pion production of the p + Cu reaction at incident beam momenta of 12. 3 and 17. 5 GeV/c also fits the E910 data very well. From Fig. 1, we can also see that the cross sections at low angles ($0.9<\cos\theta<1$) are evidently larger than those at high angles, especially for energetic pion mesons. Because the energy distributions of the emitting neutrinos are important for neutrino-nucleus experiments, we also plot the energy distributions of the produced neutrinos at low and high angles as shown in Fig. 2. We can see that the produced neutrinos possess different energies from about 1 to 1000 MeV and more. The most probable energy is about 30 to 70 MeV for several GeV incident beam energies. Moreover, we can see that neutrinos from low-angles possess more energy than those from high angles.

The present study of neutrino production based on the proton-linear accelerator is meaningful for the neutrino physics experiments.

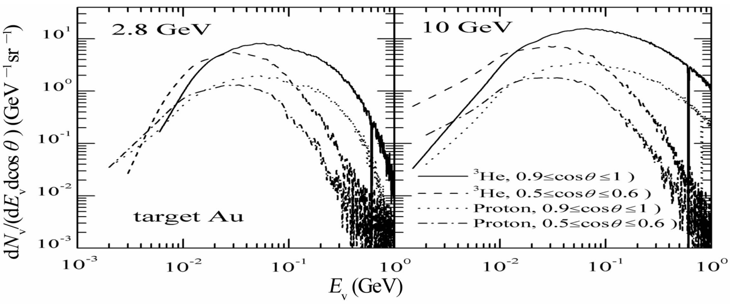

Fig. 2 Energy distributions of neutrino production at angles $0.9<\cos\theta<1$ and $0.5<\cos\theta<0.6$ from positively charged pion decay in P+Au and ^{3}He+Au reactions at incident beam energies of 2. 8 and 10 GeV/u, taken from Ref. [1].

Reference

[1] Yong Gaochan, Chen Xurong, Xu Hushan, et al. , Phys. Rev. , C85(2012)024911.

1 - 9 Effects of Magnetic Field on Spallation Reaction

Yong Gaochan

We have investigated spallation reaction of p+^{197}Au at the incident beam energy of 800 MeV/u. It is found that the external strong magnetic field affects the production of heavier fragments much than the n/p of produced fragments. The n/p of free nucleons is greatly affected by the strong magnetic field, especially for the nucleons with lower energies.

There has been a renewed interest in the study of spallation reactions induced by either nucleons or light charged nuclei, not only nuclear physicists but also astrophysicists and nuclear engineers. The spallation reaction is a kind of nuclear reaction in which a particle (e. g. proton) interacts with a target nucleus. Giving a high energy to the incident proton, the nucleus is then in an excited state and can de-excite by evaporation and/or fission. And then the high number of secondary neutrons are produced. The condition of strong magnetic field may exist in the universe, such as white dwarfs, neutron stars, and accretion disks around black holes. And with the rapid development of laser technology, obtaining strong magnetic field greater than 10^{10} Tesla artificially in terrestrial laboratory is possible. Also the strong magnetic field greater than 10^{14} Tesla can be provided via energetic heavy-ion collisions technically.

Based on the Boltzmann-Uehling-Uhlenbeck (BUU) transport model coupled with a phase-space coalescence afterburner, effects of the magnetic field on the spallation reaction are studied. From Fig. 1 we can see that the magnetic field decreases most of the formations of fragment. This is because fragments are 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.

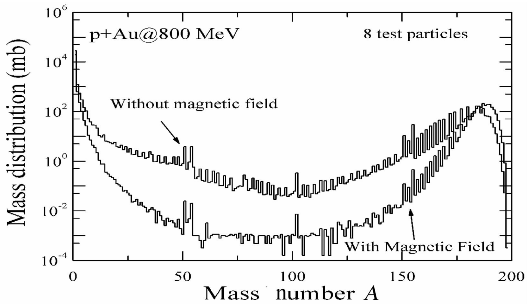

Fig. 1 Mass distribution of fragments in the p+^{197}Au reaction at the incident energy of 800 MeV/u with and without magnetic field, the strength of magnetic field added is 10^{15} Tesla, taken from Ref. [1].

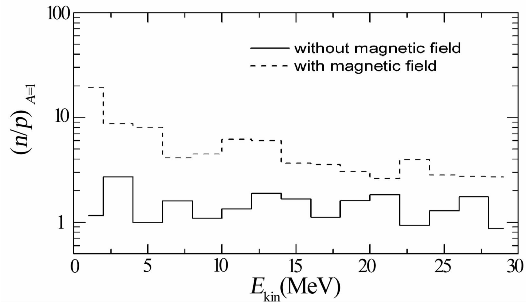

Fig. 2 Neutron to proton ratio of free nucleons in the p+^{197}Au reaction at the incident energy of 800 MeV/u with and without strong magnetic field, taken from Ref. [1].

Reference

[1] Liu Yang, Yong Gaochan, Zuo Wei, Eur. Phys. Lett., 99(2012)42001.

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

Cao Ligang

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