masses of $\chi_{c0}(3415)$ and $\chi_{c2}(3556)$ are far away from the energy range discussed here, the high-mass tail of these resonances only provide one of the backgrounds to the $D\bar{D}$ invariant mass spectrum in the energy range (>3.7 GeV). The amplitudes are in the form,

$$M_{\rm NOR} = g_{\rm NOR}\varepsilon_1^{\mu}\varepsilon_2^{\nu}(T^0_{\mu\nu} + c_{02}T^2_{\mu\nu})F(s),$$
$$M_{\chi_{c0}(2P)} = \frac{ig_{\chi_{c0}(2P)\gamma\gamma}\varepsilon_1^{\mu}\varepsilon_2^{\nu}T_{\mu\nu}g_{\chi_{c0}(2P)D\bar{D}}}{s - m^2_{\chi_{c0}(2P)} + im_{\chi_{c0}(2P)}\Gamma_{\chi_{c0}(2P)}},$$
$$M_{\chi_{c2}(2P)} = \frac{ig_{\chi_{c2}(2P)\gamma\gamma}\varepsilon_1^{\mu}\varepsilon_2^{\nu}\varepsilon_{\mu\nu\alpha\beta}p^{\alpha\beta\rho\lambda}}{s - m^2_{\chi_{c0}(2P)} + im_{\chi_{c0}(2P)}\Gamma_{\chi_{c0}(2P)}}(-g_{\chi_{c2}(2P)D\bar{D}}ip_{1\rho}ip_{2\lambda}).$$

Thus the total amplitude is,

$$M_{\rm Total} = M_{\rm NOR} + e^{i\phi_0}M_{\chi_{c0}(2P)} + e^{i\phi_2}M_{\chi_{c2}(2P)}.$$

With above amplitudes, we can obtain the differential cross sections of $\gamma(k_1)\gamma(k_2)\to D(p_1)\bar{D}(p_2)$. By fitting the experimental data of $D\bar{D}$ invariant mass spectrum and $\cos\theta$ distribution, we can fix the free parameters in the amplitudes. In Fig. 1, we present our best to the $D\bar{D}$ invariant mass spectrum and $\cos\theta$ distribution. From the figure we can conclude that one can include $\chi_{c0}(2P)$ and $\chi_{c2}(2P)$ in present data of $\gamma\gamma\to D\bar{D}$[4].

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1 - 8 Neutrino Production based on Proton Linear Accelerator

Yong Gaochan

We investigated proton- and ^{3}He-induced reactions on a ^{197}Au target at beam energies of 2.8, 5, 10, and 16.587 GeV/u, and found that compared with proton-induced reactions, ^{3}He-induced reactions give larger cross sections of pion production, about 5 times those of the proton-induced reactions. And more importantly, pion production from ^{3}He-induced reaction is more inclined to low-angle emission. Neutrino production via positively charged pion is also discussed accordingly.

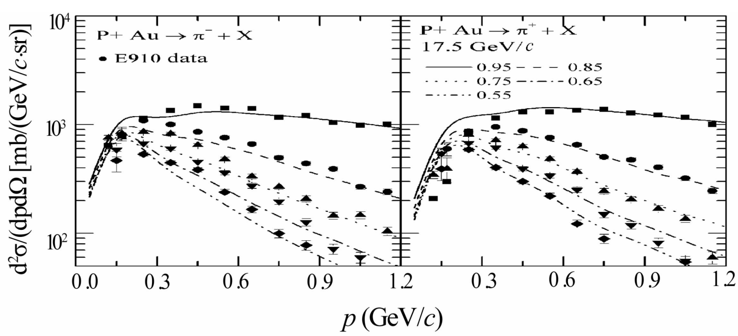

Fig. 1 Production cross sections of π^- (left panel) and π^+ (right panel) from p + Au at the incident beam momentum of 17.5 GeV/c ($E_{\rm beam}\approx$16.587 GeV/u) shown in bins of $\cos\theta$ (relative to beam direction). Numbers in the legend refer to the center of each bin, taken from Ref. [1].

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.

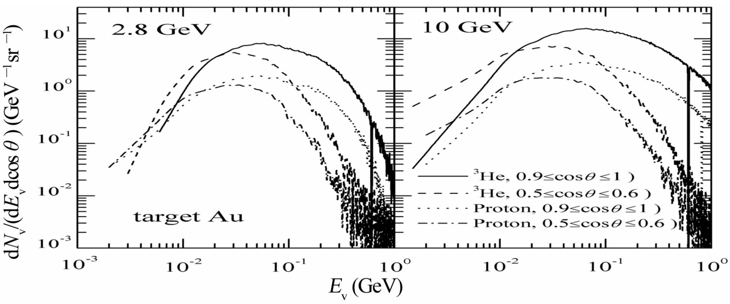

Fig. 2 Energy distributions of neutrino production at angles $0.9<\cos\theta<1$ and $0.5<\cos\theta<0.6$ from positively charged pion decay in P+Au and ^{3}He+Au reactions at incident beam energies of 2.8 and 10 GeV/u, taken from Ref. [1].

Reference

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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