Charged particle evaporation in the stopped pion absorption reactions


The International Conference on Particle Physics and Astrophysics 2017
I. Investigation of the spectra of p, d, t formed in the reaction of stopped pion absorption

II. Calculation of the contributions of evaporative particles into the total charged particle yields for different nuclei

III. Investigation of the A-dependence of the equilibrium temperature parameter

III. Investigation of the A-dependences of the evaporative particle yields
**Introduction**

Investigation on stopped pion absorption

\[ \pi^- + (pn) \rightarrow 2n \quad >90\% \]

\[ \pi^- + A \rightarrow p, d, t \quad ??? \]
Experiment

Target nuclei:

\[ ^{6,7}\text{Li, } ^{9}\text{Be, } ^{10,11}\text{B, } ^{12}\text{C, } ^{28}\text{Si, } ^{40}\text{Ca, } ^{59}\text{Co, } ^{93}\text{Nb, } ^{114,117,120,124}\text{Sn, } ^{169}\text{Tm, } ^{181}\text{Ta, } ^{209}\text{Bi} \]

Energy resolution:

0.6 MeV

Absolute normalization precision:

7%  

Lower energy boundaries:

p - 5 MeV,  
d, t – 10 MeV

PNPI RAS, synchrocyclotron

Measurements conducted up to kinematic boundaries of the reaction
Experimental results

Proton spectra, $^{12}\text{C}$

Dots with errors – this work

I. We investigate yields of p, d, t formed in pion absorption on pp, $^3$H, $^4$He clusters.

\[ \pi^- + (pp) \rightarrow n + p \]

\[ \pi^- + ^3\text{He} \rightarrow n + d \]

\[ \pi^- + ^4\text{He} \rightarrow n + t \]

Primary particle spectrum:

\[ \frac{dY}{dE} = C_1 \cdot Sinh\left(\frac{2m}{\gamma^2} \sqrt{E(E_{\text{max}} - E)}\right) \]
Model. Secondary particles

Preequilibrium particles:

\[ \frac{dY}{dE} = C_1 \sqrt{E(E_0 - E)} \cdot \exp(-E/T_1) \]

Evaporative particles:

\[ \frac{dY}{dE} = C_2 \exp(-E/T_2) \]
Spectra

Proton spectrum description, $^{28}\text{Si}$ (typical spectrum)
Spectra

Triton spectrum description, $^6\text{Li}$ (typical spectrum for light nuclei)
Equilibrium temperatures
Proton yields

Contribution into total yields: ~ 50% for medium, up to 15% for heavy

Fit: $Y \sim \left( A^{2/3} \ast Z \right) / \left( N^p \right)$
Deuteron yields

Contribution into total yields: \( \sim 15\% \) for medium, up to \( 5\% \) for heavy

Fit: \( Y \sim \left( A^{2/3} \times ZN \right) / (Np) \)
Triton yields

Contribution into total yields: $\sim 15\%$ for medium, up to $5\%$ for heavy
Conclusions

I. Model has been developed allowing us to fit energy spectra for p, d, t formed after pion absorption on 17 different targets

II. The model allowed to evaluate contributions of different processes into full particles yields. For the evaporation stage: p: ~ 50% for medium nuclei, up to 15% for heavy nuclei d, t: ~ 15% for medium nuclei, up to 5% for heavy nuclei

III. Data on evaporative d yields extrapolated into the medium-heavy nuclei region
THANK YOU FOR YOUR ATTENTION!
ПРИМЕРЫ СПЕКТРОВ

Пример типичного спектра дейтронов (поглощение на ядре $^{59}$Co)