This experiment uses an intense extracted proton beam in the East Hall \((10^{12} \text{ p/burst})\) and a gaseous target. All information has been obtained from the analysis of the recoiling nucleus \(^4\text{He}\) for the elastic and inelastic production of baryonic states, \(^3\text{He}\) from the dissociation of \(^4\text{He}\); we measure accurately the angle, the energy and the identification parameter of the recoil by means of a telescope of four large area \(E-\Delta E\) semiconductor detectors studying the reactions

\[
p + ^4\text{He} \rightarrow ^4\text{He} + \text{anything} \tag{a}
\]

\[
p + ^4\text{He} \rightarrow ^3\text{He} + \text{anything} \tag{b}
\]

The statistics are now about 100,000 events for reaction (a) including elastic and inelastic (about one half for the inelastic) and 30,000 events for reaction (b).

The elastic cross section (see Fig. 1) exhibits a minimum at \(t = 0.22 \text{ (GeV/c)}^2\) and a double scattering maximum near \(t = 0.34 \text{ (GeV/c)}^2\) with a peak valley ratio of about 4. At first sight this is in agreement with the Glauber predictions and the effect "off mass shell" predicted by Gribov at high energy is not such as it disturbs greatly the double scattering process.

For the inelastic \(p + ^4\text{He} \rightarrow ^4\text{He} + \text{anything}\) process, we are able to reach missing mass between 1 GeV and 2.2 GeV. We give missing mass spectra showing the "bumps" corresponding to masses around 1400 MeV and 1700 MeV for different \(t\) ranges (see Figs. 2, 3, 4, 5, 6). The peak for the 1400 is well pronounced at \(t = 0.18 \text{ (GeV/c)}^2\).
and disappears for $t > 0.39 \text{ (GeV/c)}^2$. The 1700 is not so well pronounced but is always present for $t > 0.13 \text{ (GeV/c)}^2$.

Following a recent experiment \(^1\) on Carbon at similar energies and very low $t$ ($t < 0.05 \text{ (GeV/c)}^2$) the 1400 contribution could be the contribution of a Deck effect, i.e., some coherent dissociation of the incident proton with a low pion emission from a $^4\text{He}$ vertex. The 1700 which does not appear in the experiment on Carbon at very low $t$ could appear at higher $t$ because of the high value ($5/2$) of the spin of the $N^*_1{1688}$ as in another experiment at LBL\(^2\). More extensive measurements in low $t$ region are needed to verify these hypothesis.

![Diagram](image)

A careful analysis of the 1400 widths at different $t$ values, taking into account the missing mass resolution resolution of the experiment is in progress and should carry some additional information on the nature of the Deck effect.

Observing the $^3\text{He}$ spectra of the reaction $p + ^4\text{He} \rightarrow ^3\text{He} + \text{anything}$ we observe a sharp peak at an angle of $84^\circ$ (Figs. 7 and 8), which suddenly appears for $^3\text{He}$ energy $> 24$ MeV that means $p_{^3\text{He}} > 350$ MeV/c. This very strong effect which disappears at lower $p$ value seems difficult to interpret by a quasi elastic (impulse approximation) scattering of incident proton on a $^3\text{He}$ substructure.

The situation suggests a comparison with a recent result of a Saclay group \(^3\) in a $^4\text{He} (\gamma, p\pi^-)$ experiment at 315 MeV incident energy of $\gamma$, in which the $p\pi^- (\Delta_{1236})$ resonance could interact with the remaining nucleon system on a form on a new object.
The observed width (≈ 35 MeV) of this object should be quite different from the Δ (120 MeV width).

A similar situation can be suggested in the Deck diagram Fig. 1 in which final state interaction between $^4$He and $x^*$ could give some similar object before one of its possible disintegrations, in Δ and $^3$He system. If something like a $^4$He$^\Delta$ nucleus pre-exists before the disintegration in the observed channel we should have for high energy $^3$He a kinematics very similar to the $^4$He$^\Delta$ in the two body process $p + ^4$He → $^4$He$^\Delta$ + p.

As the present results seem promising, we ask for further studies at low t, on the Deck and resonance production using new epitaxial Δ E detectors, and at high t, for studies on $^4$He dissociation, using parasitic running as long as the situation in the East Hall is unchanged.

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   $^4$He (γ,px$^*$) Cross Section around Δ (1236)
Figure captions:

Fig. 1 Elastic differential cross section \( p + ^{4}\text{He} \rightarrow p + ^{4}\text{He} \) at 24 GeV/c.

Fig. 2 Missing mass spectrum of the reaction \( p + ^{4}\text{He} \rightarrow ^{4}\text{He} + \text{anything} \) at 24 GeV/c for \(|t| = q^2 = 0.183 \text{ (GeV/c)}^2\). The experimental missing mass resolution is calculated in GeV in the region of elastic scattering and 1.4 GeV missing mass, for the experimental angular resolution and the \( \Delta t = \Delta q^2 \) taken interval, equal to 0.052 (GeV/c)^2.

Figs. 3, 4, 5 and 6

Missing mass spectra of the reaction \( p + ^{4}\text{He} \rightarrow ^{4}\text{He} + \text{anything} \) at 24 GeV for \( t = q^2 = 0.235, 0.313, 0.387, 0.350 \text{ (GeV/c)}^2 \) with the corresponding missing mass resolution as calculated in Fig. 2.

Fig. 7 Appearance of a peak in the recoil angular spectra of \(^3\text{He}\) in the dissociation reaction \( p + ^{4}\text{He} \rightarrow ^{3}\text{He} + \text{anything} \) at 24 GeV/c for different values of \(^3\text{He}\) recoil energy. \( \theta \) is the angle between the forward direction and the emission angle of \(^3\text{He}\).

Fig. 8 Integrated angular spectrum of \(^3\text{He}\) for \(^3\text{He}\) recoil energies between 22 and 40 MeV (343 MeV/c < \( p_3^\text{He} < 416 \text{ MeV/c} \)) in the dissociation reaction \( p + ^{4}\text{He} \rightarrow ^{3}\text{He} + \text{anything} \).
\[
\frac{d^2\sigma}{dq^2dM} \quad \text{mb(GeV/c)^2 GeV}^{-1}
\]

**FIGURE 3**

\[q^2 = 0.235\]
\[\Delta q^2 = 0.082\]
\[ \frac{d^2 \sigma}{dq^2 dM} \text{ mb (GeV/c)}^2 \text{ GeV}^{-1} \]

**FIGURE 4**

\[ q^2 = 0.313 \]
\[ \Delta q^2 = 0.060 \]

\[ \Delta M = 0.193 \]
\[ \Delta M = 0.093 \]
\[
\frac{d^2 \sigma}{dq^2 dM} \quad \text{mb (GeV/c)}^2 \text{ GeV}^{-1}
\]

**Figure 5**

\[q^2 = 0.350\]

\[\Delta q^2 = 0.030\]

\[\Delta M = 0.135\]

\[\Delta M = 0.073\]
\[ \frac{d^2\sigma}{dq^2 dM} \]

\[ \text{mb} \) \text{(GeV/c)}^{-2} \text{GeV}^{-1} \]

FIGURE 6

\[ q^2 = 0.387 \]

\[ \Delta q^2 = 0.045 \]

\[ \Delta M = 0.170 \]
Figure 7