for the capture rate of the above reaction in (b) is recovered. This lends considerable confidence to our method since the necessary consistency is obtained.

Recently the total capture rate for μ capture by ^{3}He was measured to be 2140 ± 180 sec^{-1} by Zaimidoroga et al.[13] Compared with our value of 2130 sec^{-1}, the agreement is embarrassingly good and gives support to the correctness of a universal V-A theory with $g_P \approx 7g_A$.

The details of this calculation together with a wider range of parameter variation will be presented in a forthcoming paper.

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TRANSVERSE MOMENTUM DISTRIBUTION OF PROTONS IN p-p ELASTIC SCATTERING*

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The recent p-p elastic scattering cross sections obtained by the Cornell-Brookhaven group[1] have a strong dependence on both energy and momentum transfer. We shall show that all these p-p cross sections which range in energy from 10 to 30 BeV and momentum transfer squared from 3 to 25 (BeV/c)^2 can be fit by a single exponential in transverse momentum, and that this exponential is the very same exponential that describes the transverse momentum distribution of pions produced in nucleon-nucleon collisions.

In their paper the Cornell-Brookhaven group[1] pointed out that all their scattering cross sections for $\theta_{\mathrm{c.m.}} > 70°$ can be fit by a single exponential. They give the relation

$$\log_{10} X \approx -2(P_0)^{1/2} \text{ for } \theta > 70°,$$

where P_0 is the incoming beam momentum in BeV/c and $X = (4\pi/k\sigma_T)^2 d\sigma/d\omega$. Taking antilogarithms of both sides, we have

$$X \approx e^{-4.6\sqrt{P_0}} \approx e^{-3.4\sqrt{s}}, \tag{1}$$

where $\sqrt{s}$ is the total energy in BeV in the center-of-mass system. It has been pointed out[2] that this equation is in agreement with the statistical model predictions of Fast, Hagedorn, and Jones.[3] The interpretation is that the large forward peak is due to diffraction scattering, and the almost isotropic large-angle scattering is attributed to the statistical model. At 30 BeV the forward peak rises by a factor of 10^{12} above the value given by Eq. (1).

In this Letter we suggest that perhaps most of the enormous forward peak is not due to diffraction scattering, but that it and the large-angle

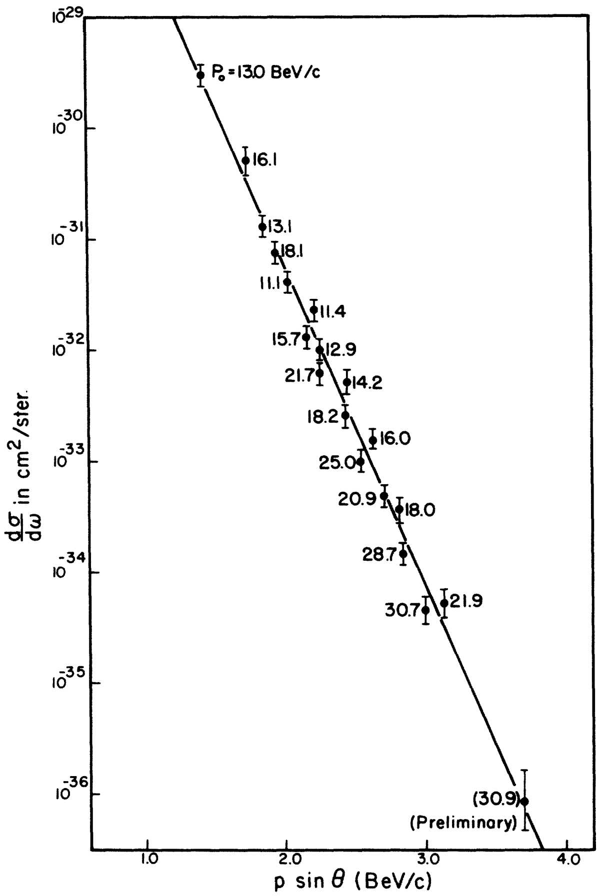

FIG. 1. Proton-proton elastic cross sections measured by the Cornell-Brookhaven group plotted vs transverse momentum. The line is the single exponential $A\exp(-p_\perp/p_0)$, where $A = 34$ mb/sr and $p_0 = 0.151$ BeV/c.

scattering are a manifestation of the same mechanism that gives rise to the familiar exponential distribution of transverse momentum observed in pion production.[4] Specifically, we fit all 18 cross sections of reference 1 by the equation

$$d\sigma/d\omega = Ae^{-p_\perp/p_0}, \tag{2}$$

where $p_\perp = p\sin\theta$ is the transverse momentum. The least-squares solution is $A = 34$ mb/sr and $p_0 = 0.151$ BeV/c. Equation (2) is plotted as a straight line along with the data in Fig. 1.[5] This fit is not perfect since several of the points are off by about two standard deviations. However, except for some small-scale energy or angle dependence, the main feature of the data appears to be this single exponential dependence.

There are two remarkable features of the above fit: (a) The least-squares solution for p_0 is within errors the same decay constant that describes the transverse momentum distribution of pions produced in nucleon-nucleon collisions,[4] and (b) the single exponential of Eq. (2) is a reasonably good fit over a region where the cross section decreases by a factor of 10^7 or for about 20 "half-lives." The fact that Eq. (2) still holds in the region where $X \sim 10^{-4}$ implies that the diffraction peak mechanism does not extend out this far in momentum transfer. In the diffraction region $d\sigma/d\omega$ must be proportional to p^2 and drop off as an exponential in $p_\perp^2$ rather than $p_\perp$. The diffraction peak can be fit by a Gaussian term

$$\exp\{-R^2 p_\perp^2/4\hbar^2\},$$

where R is the rms optical radius of 1.2×10^{-13} cm. There is no reason to expect Eq. (2) to hold in the region of the diffraction peak; however, it is worth noting that the value $A = 34$ mb/sr given by Eq. (2) at $\theta_{\text{c.m.}} = 0°$ agrees within errors with the excess observed by Foley et al.[6]; and furthermore, the sum of the above Gaussian term and Eq. (2) gives a diffraction peak which shrinks with increasing energy at about half the rate which is observed.[7]

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