EVIDENCE FOR TWO COMPONENTS IN HIGH ENERGY pp COLLISIONS (#968)

Presented by E. Malamud
National Accelerator Laboratory*
Batavia, Illinois

Recent hydrogen bubble-chamber experiments at Serpukhov[1] and NAL[2-4] have yielded relatively high accuracy charged particle multiplicity distributions. Many recent efforts[5] to explain the shape of these distributions have dealt with deviations from a simple Poisson distribution (which can be thought of as departures from the behavior of an ideal gas) as measured by $(\langle n(n-1)\rangle - \langle n\rangle^2)^{\frac{1}{2}}$ and higher moments.

An alternate and simpler description[6] is to fit the data as the sum of two Poisson distributions for the number of negative particles (and consequently the sum of two noninteracting separate ideal gases). We have parametrized the data as follows:

$\sigma_1/(\sigma_1+\sigma_2)$ = the fraction of the total inelastic cross section in the lower multiplicity component

$\langle n_1^-\rangle$ = average number of negative particles in the lower multiplicity component

$\langle n_2^-\rangle$ = average number of negative particles in the higher multiplicity component.

We have collected all relevant data and made a fit to this hypothesis.

The results of these three parameter fits are summarized in Table I.

Table I.

Group	p_{lab} (GeV/c)	Data Points	χ^2	C.L.	$\langle n_1^-\rangle$	$\langle n_2^-\rangle$	$\sigma_1/(\sigma_1+\sigma_2)$	σ_1(mb)
Soviet-French	50	8	9.3	23%	1.60±0.08		%	a
Soviet-French	69	9	8.7	19%	0.80±0.17	2.20±0.02	12.5±2.1	3.9±0.7
Rochester-Michigan	102	10	2.3	93%	1.10±0.15	2.49±0.07	23.7±3.2	7.8±1.1
ANL-NAL-Iowa State-MSU-Maryland	205	11	8.3	40%	1.41±0.12	3.50±0.06	30.6±2.1	10.0±0.7
NAL-UCLA	303	13	12.4	26%	1.82±0.12	4.29±0.09	37.3±2.5	11.9±0.8

[a] Fits a single Poisson.

Figure 1 shows the results of these fits. The 50 GeV/c data fits a single Poisson satisfactorily; no additional parameters are needed. The other higher energies make poor fits to a single Poisson but are well represented by a sum of two Poisson distributions as demonstrated by the goodness-of-fit parameters of Table I. It is relevant to note that the fits to a single Poisson become progressively worse at higher energies.

What is one to conclude from these fits? A valid conclusion is that at higher energies the multiplicity distributions do not follow a Poisson distribution as they appear to do at moderate

*Operated by Universities Research Association, Inc. under contract with the United States Atomic Atomic Energy Commission.

energies. The fact that the fit is markably improved by the addition of a second Poisson distribution is not surprising since it involves the addition of new parameters. If the improvement of the fit is fortuitous, then at even higher energies ($\gtrsim$ 400 GeV/c) even two Poisson distributions should be inadequate.

However, it is tempting to speculate that our decomposition into two multiplicity groups has physical relevance. In Fig. 2 we plot the average multiplicities associated with each of these components, as well as the cross section for the lower multiplicity component as a function of energy. It is tempting to identify the lower component as the sum of diffraction dissociation of the target and projectile protons. One would expect, however, a constant cross section rather than the rising one observed.

We have also used hand-drawn curves, shown in Fig. 2, to extrapolate the parameters to 400 GeV, using $\langle n_1^- \rangle = 2$, $\langle n_2^- \rangle = 5$, $\sigma_1 = 13$ mb. The shape of the multiplicity distribution at 400 GeV/c is obtained and shown in Fig. 1. Bubble-chamber data are expected to become available at this energy shortly.

References

[1] Soviet-French Mirabelle Collaboration, #789.

[2] J. W. Chapman et al., #746.

[3] G. Charlton et al., Phys. Rev. Letters 29, 515 (1072).

[4] F. T. Dao et al., #725.

[5] See, e.g., E. L. Berger, An Interpretation of the Multiplicity Distribution at 200 GeV/c, ANL preprint ANL/HEP 7229, July 18, 1972.

[6] D. R. O. Morrison, Review of Many-Body Interactions at High Energy, presented at the Fourth International Conf. on High Energy Collisions (Stony Brook series), Oxford, April 1972.

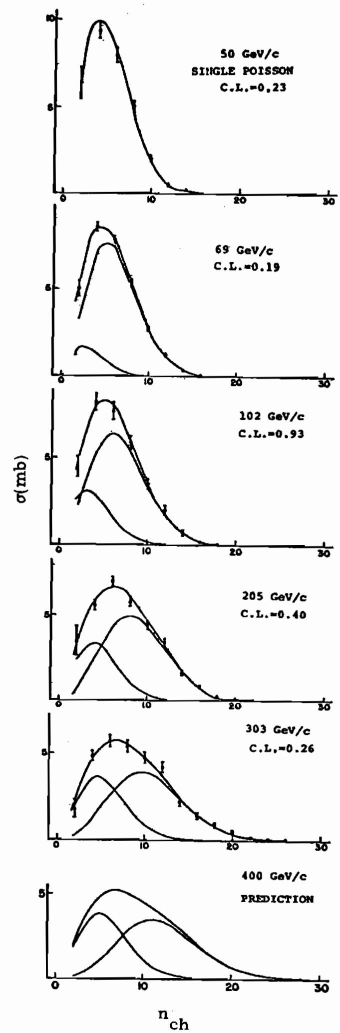

Fig. 1. Fits using parametrization described in text to 50, 69, 102, 205, 303 GeV/c pp charged particle multiplicity distributions. A prediction for 400 GeV/c is also shown.

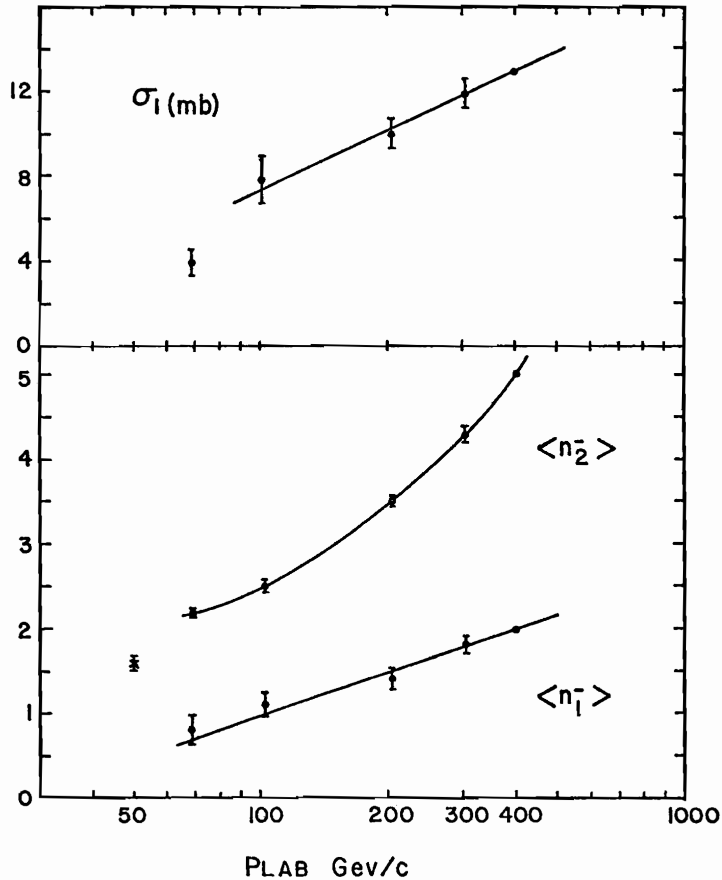

Fig. 2. Plot of $<n_1^->$, $<n_2^->$, σ_1 obtained in the fits vs p_{lab}.