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Authors
Cook, V.
Keefe, D.
Kerth, L.T.
et al.

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Ernest O. Lawrence

Radiation Laboratory

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V. Cook, D. Keefe, L. T. Kerth, P. G. Murphy,* W. A. Wenzel, and T. F. Zipf

Lawrence Radiation Laboratory
University of California
Berkeley, California

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The purpose of this letter is to report experimental results of a search for positive particles with masses in the regions 420-630 m_e[1] and 1050-1500 m_e.[2] The bearing of these results on the existence of such particles clearly involves a discussion of particular models of production and decay, which will not be attempted here.

Positive particles of known momentum emitted at 26.5 deg from an internal heavymet target in the Bevatron were selected according to velocity by a coincidence between two high-pressure methane gas Cerenkov counters[3] and two pairs of time-of-flight scintillation counters 40 feet apart. These counters are constructed so that Cerenkov light at different angles is collected into one of two zones. One zone extends from 0 deg to 6.7 deg, and the other from 7.4 to 20 deg. In this way different groups of particles were detected concurrently and beam purity was improved by anticoincidence methods. Further beam purification was obtained with the use of a scintillation counter which discriminated between the pulse height produced by a single particle and that produced by two particles arriving within 50 mμsec of each other.

To obtain the mass spectrum of the beam, the pressure in the Cerenkov counters and the tuning of the time-of-flight counters were varied. Measurements of the mass spectrum 90 feet from the Bevatron target can be summarized as follows.

At a momentum of 1 Bev/c, the beam was tuned for particles of mass between 420 m_e and 630 m_e in steps of about 50 m_e. For each setting, about 3×10^7 particles (76% protons, 24% π^+ mesons, and 0.1% K^+ mesons) passed through the channel without any coincidence count occurring in the Cerenkov and scintillator system. Figure 1(A) shows the upper limits to the relative intensities of components with different mass values. At a confidence level of 93% the proportion of particles with any mass in this region is estimated to be $< 6\times10^{-8}$ in the secondary beam described.

At a momentum of 2.3 Bev/c the beam (96% protons, 4% π^+ mesons, and 0.2% K^+ mesons) was tuned for particles with masses between 1050 and 1500 m_e. Here, however, there was a significant background counting rate at each point studied. At 2.3 Bev/c a proton can create delta rays above the Cerenkov threshold in the gas counters and so cause a spurious coincidence, since its velocity is also high enough to be acceptable to the time-of-flight circuit. This background rate increases with increasing gas density in the counters, as can be seen from Fig. 1(B). Assuming that a counting rate corresponding to any particular mass value of three standard deviations above background would have been interpreted as significant, one arrives at an upper limit of about 3×10^{-6} for the proportion of particles of mass approximately 1400 m_e in the secondary beam.

FOOTNOTES

*On leave from the Rutherford High Energy Laboratory, Harwell, England.

1. Proc. 1958 Ann. Int. Conf. on High Energy Physics at CERN, page 153 et. seq.

2. Proc. 1960 Ann. Int. Conf. on High Energy Physics at Rochester, page 393 et seq.; T. Yamanouchi, Phys. Rev. Letters 3, 480 (1959).

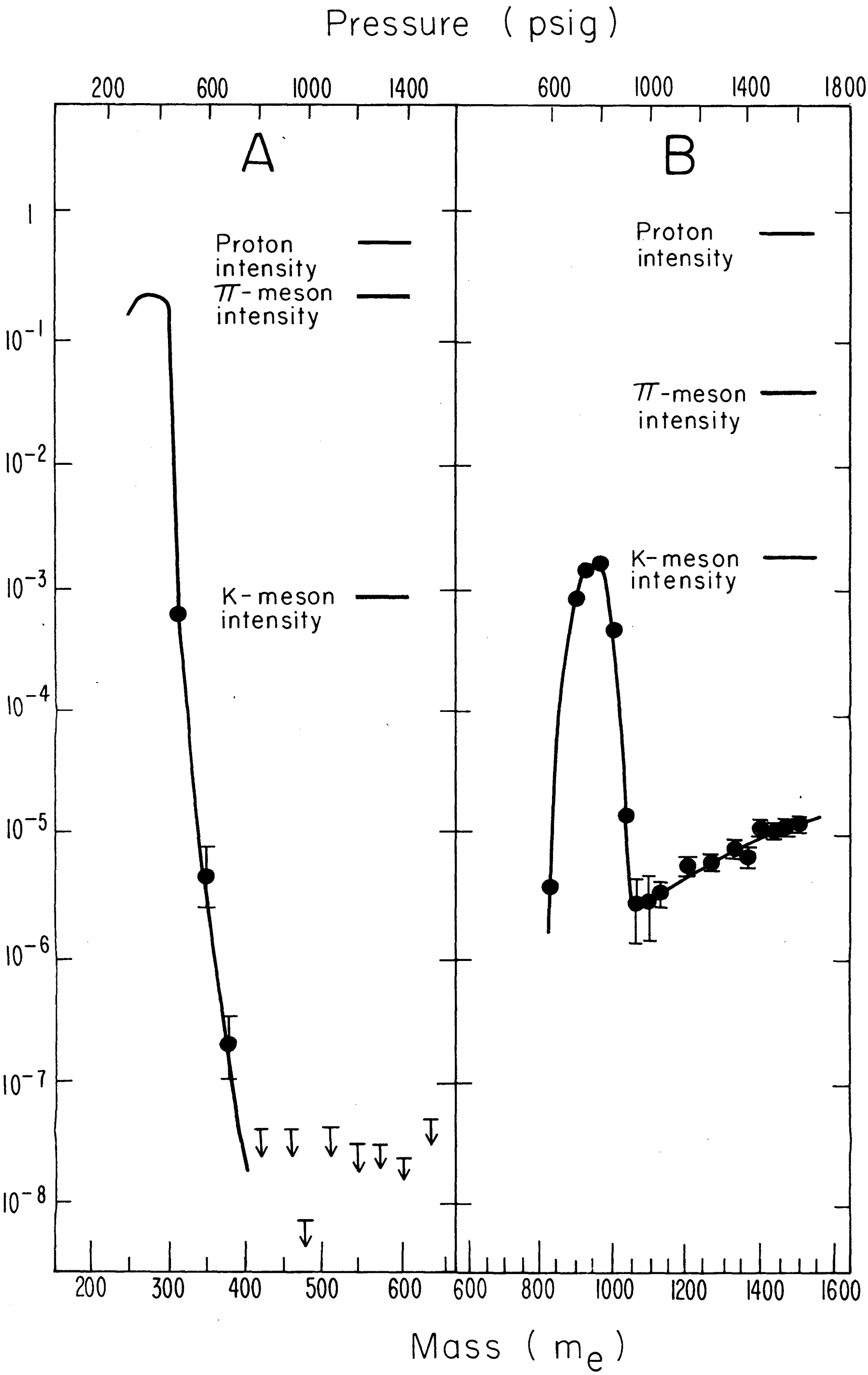
3. B. Cork, D. Keefe, and W. A. Wenzel, Proc. 1960 Int. Conf. on Inst. for High Energy Physics, Lawrence Radiation Laboratory, Berkeley, California, Nov. 1960 IIa 10; V. Cook, B. Cork, T. F. Hoang, D. Keefe, L. T. Kerth, W. A. Wenzel, T. F. Zipf, UCRL-9386, and submitted for publication to Phys. Rev.

Figure Legend

Fig. 1. Coincidence rate in the Cerenkov and scintillation counters normalized to the total flux of particles in the selected beam.

A: Results at 1 Bev/c; no count was recorded for any mass selection between 420 and 630 m_e, as indicated by the arrows. The bar at the tail of each arrow indicates the rate if one count had been obtained.

B: Results at 2.3 Bev/c; the background coincidence rate rises with pressure because of proton-induced delta rays.


Pressure (psig)
200
600
1000
1400
600
1000
1400
1800
A
B
1
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-5}
10^{-6}
10^{-7}
10^{-8}
Proton intensity
π-meson intensity
K-meson intensity
Proton intensity
π-meson intensity
K-meson intensity
200
300
400
500
600
600
800
1000
1200
1400
1600
Mass (m_e)

59077-2