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BEVATRON K-MESONS

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To facilitate the search for K-mesons from the bevatron, two of us (L. T. K. and D. H. S.) have suggested the use of a strong-focusing spectrometer (Fig. 1),[1] consisting of a magnetic quadrupole focusing lens[2] followed by an analyzing magnet. Particles of any desired momentum can be brought to a focus, forming an image of the target at a point behind the analyzing magnet. Emulsion stacks are placed at this point. With this arrangement we have found examples of four types of heavy mesons first established in cosmic ray work.[3] Particles of different mass can be separated according to their ranges in emulsion. For particles of momentum 360 Mev/c, the range of K's is 4.6 times the range of the protons, and pions pass through the emulsion stack at minimum ionization.

A stack of 107 Ilford G.5 600-μ pellicles[4] 3.5 in. by 3.5 in. has been exposed so that 114-Mev K-particles stopped in the center of the stack. The proper time of flight for such particles from the target to the emulsion is about 10^{-8} sec.

This stack has been scanned in a swath across the direction of the meson flux for tracks lying in the plane of the emulsion whose ionization is visibly greater than minimum. Particles stopping in the stack (beyond the position of the swath) have masses less than 1200 m_e. Particles that go all the way through the stack have masses less than 800 m_e.

The tracks are followed until they stop and the endings are examined for decays. To date 300 decays have been observed. Twenty of these are τ^+-mesons whose unique decay into three charged pions is readily identifiable. Among the others, all of which decay into one lightly ionizing secondary, only those with a secondary that is flat or with an ionization obviously higher than minimum have been categorized. Three examples have been found of what is assumed to be the alternate decay of the τ into one charged and two neutral

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pions, with the pion stopping in the emulsion stack. Two events decay into low-energy muons (less than 55 Mev) and are presumably examples of the κ or $K_{\mu 3}$.

To establish the existence of the $K_{\pi 2}$ (θ^{+}, χ^{+}) or of the $K_{\mu 2}$ mesons, either very large emulsions are needed to stop the long-range secondary or else very accurate measurements of the multiple scattering and the ionization must be made. Measurements on four fortuitously flat secondaries at a distance of 5 cm from the decay point revealed that three of the primaries were $K_{\pi 2}$'s and one presumably a $K_{\mu 2}$, as determined by the tentative identification of the secondary as a high energy muon. Excellent calibration on grain count is available from the π-mesons of known energy traversing the same region of the emulsions. From the number of K-mesons found here compared to the number found at about 25 cm from the target,[5] it is unlikely that the mean life of any of the K's seen is less than 3×10^{-9} sec.

In the initial exposure, the momentum resolution as determined from the proton ranges allows a mass determination to $\pm$ 40 m_e on each K-meson. With a few exceptions, all particles with lightly ionizing secondaries fall within a distribution of this width centered about 20 m_e below the average for τ-mesons plotted separately (Fig. 2). In a subsequent exposure the momentum resolution has been improved. The scattered points on the high-mass side of the main distribution may be due to particles that suffered inelastic collisions, or scattered off of the channel. A comparison of the measured τ-meson mass of 974 $\pm$ 6 m_e with the accepted value of 966 m_e[3] indicates a possible systematic error.

This work was done with the encouragement and guidance of Professor Chaim Richman. Most of the scanning was performed by Mrs. Beverly Baldridge, Miss Irene d'Arche, Mrs. Marilyn Harbert, Mrs. Edith Goodwin, and Miss Kathryn Palmer.

It is with pleasure that we acknowledge the help and advice in nuclear emulsion techniques given us by Professor Powell's group at Bristol. The assistance of the Bevatron crew, under the direction of Dr. Edward J. Lofgren, and their skillful operation of the machine are greatly appreciated. This work was performed under the auspices of the U. S. Atomic Energy Commission.

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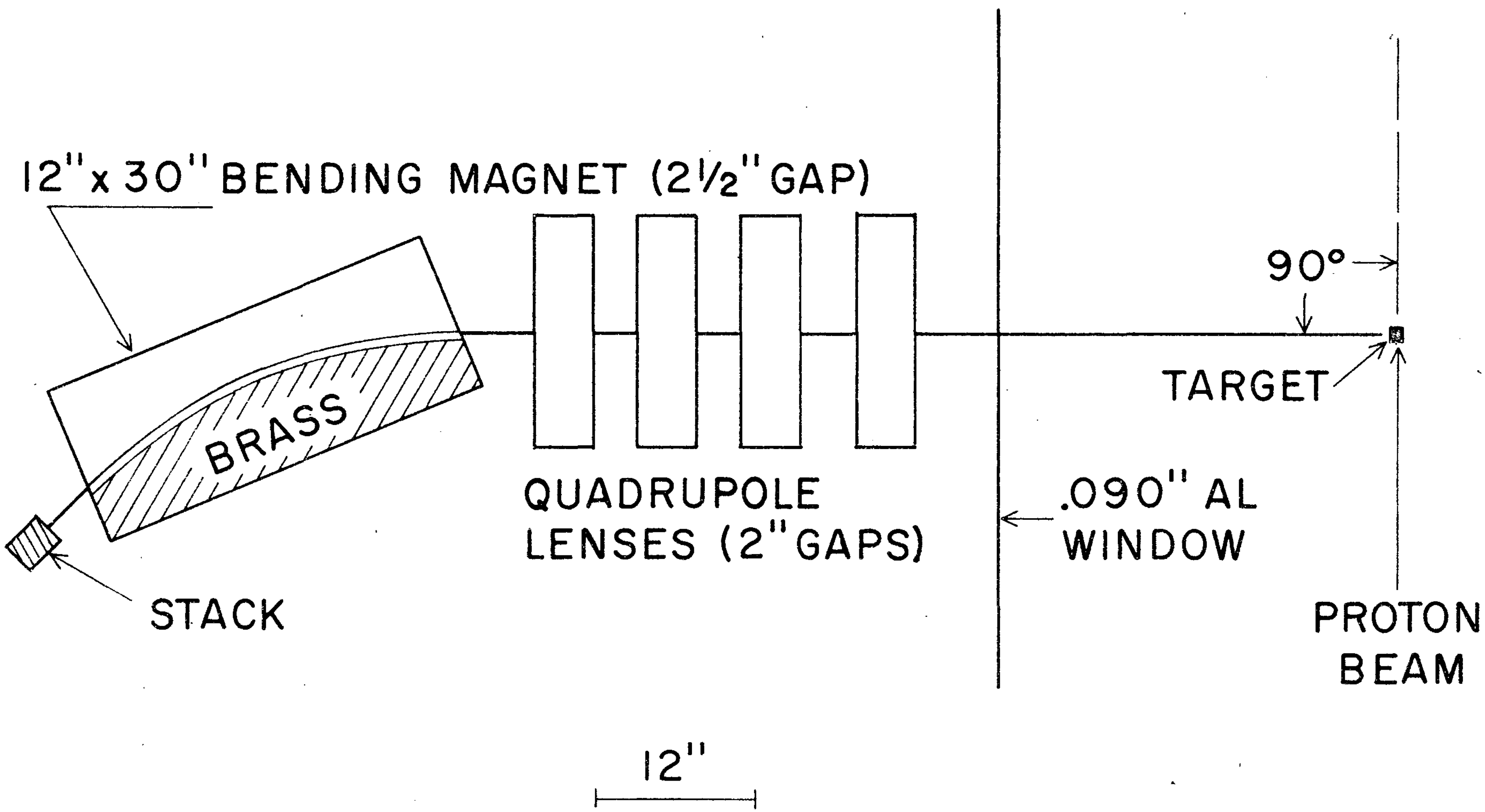
2. E. C. Courant, M. S. Livingston, and S. Snyder, Phys. Rev. 88, 1190 (1952).
3. Padua Conference, Supplemento al Vol. XI, Serie IX del Nuovo cimento, N2 (1954).
4. Birge, Kerth, Richman, Stork, and Whetstone, Techniques for Handling and Processing Emulsion Stacks, University of California Radiation Laboratory Report No. UCRL-2690, September 1954.
5. Proceedings of the 5th Rochester Conference (to be published).

Legends for Figures

Fig. 1 Strong-focusing spectrometer.

Fig. 2 Mass distributions: Upper histogram represents τ-mesons. Crossed squares refer to τ's found non-systematically. Lower histogram is made up of particles decaying into a single lightly ionizing secondary.


12" x 30" BENDING MAGNET (2½" GAP)
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STACK
QUADRUPOLE
LENSES (2" GAPS)
.090" AL
WINDOW
90°
TARGET
PROTON
BEAM
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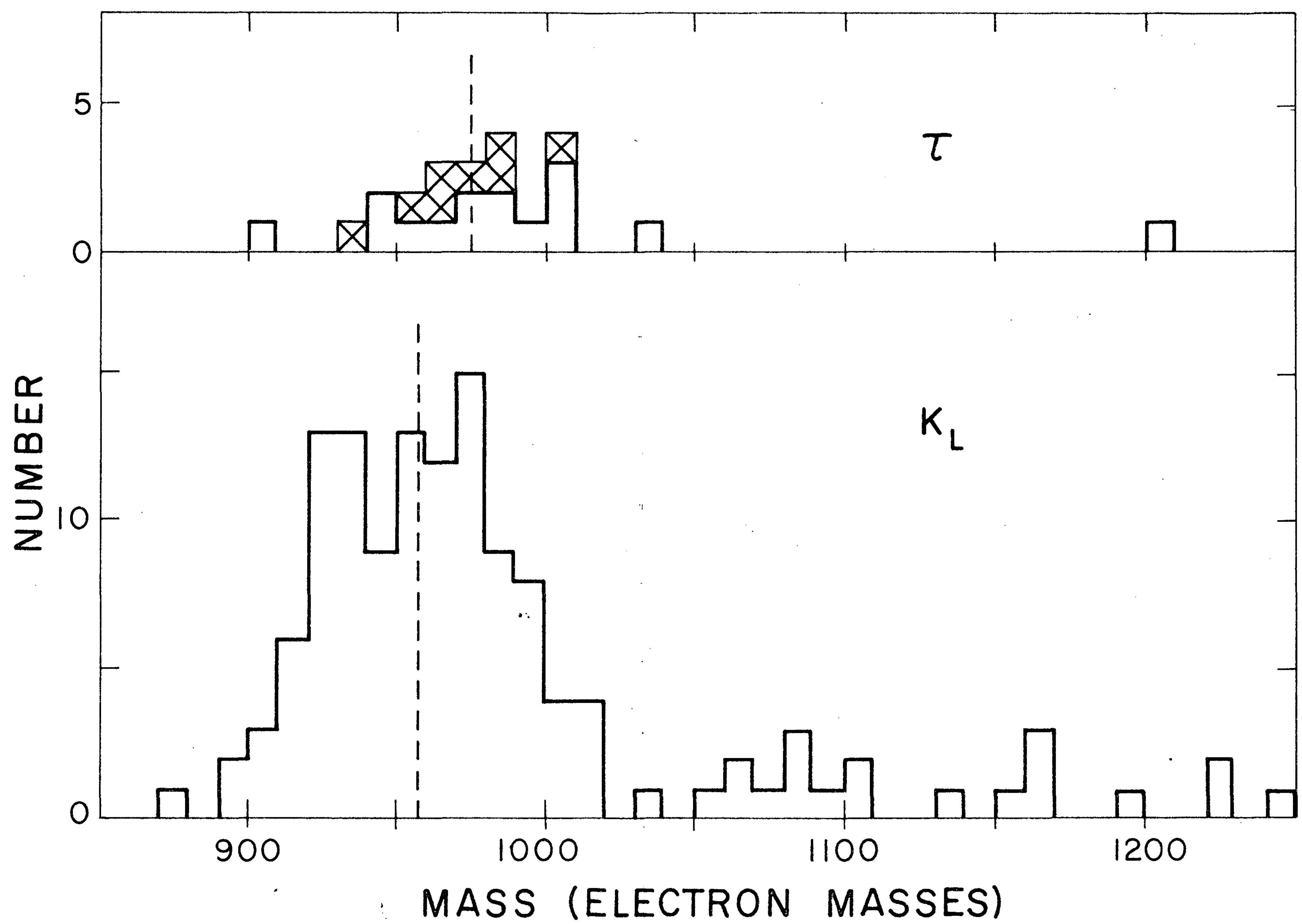

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