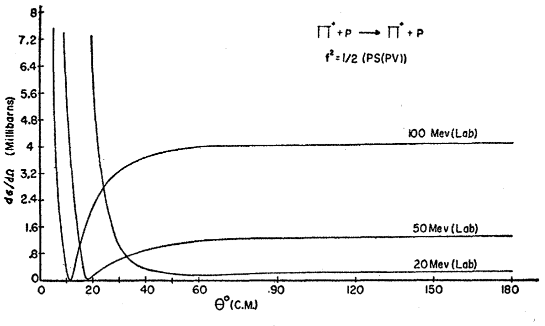

FIG. 2. Differential scattering cross section in the center-of-mass system for the reaction $\pi^+ + P \rightarrow \pi^+ + P$ including electromagnetic effects for the $PS(PV)$ theory. The π meson-nucleon coupling constant $f^2 = \frac{1}{2}$. The curves are labeled according to the π-meson kinetic energy in the laboratory system.

any event, one should be able to obtain useful information concerning the meson-nucleon scattering amplitude by observations on the interference effects with the electromagnetic scattering.

The consideration of this problem arose from a discussion with Professor R. E. Marshak and Mr. A. Messiah. I am indebted to Professor Marshak for further discussion.

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[1] H. A. Bethe and R. R. Wilson, Phys. Rev. **83**, 690 (1951).
[2] These interference effects have also been considered by Dr. M. H. Johnson as a possibility of distinguishing between the various spin 0-meson theories (private communication from Dr. M. H. Johnson).
[3] R. E. Marshak, Revs. Modern Phys. **23**, 137 (1951).
[4] Clark, Roberts, and Wilson, Phys. Rev. **83**, 649 (1951).
[5] R. P. Feynman, Phys. Rev. **76**, 749 (1949).
[6] At higher meson energies the sign of the nuclear scattering amplitude is determined by the second term of the nuclear matrix element, while at very low meson energies the nuclear amplitude for both processes I and II is $\sim +1/2M$. The change of sign of the amplitude for process I occurs at such low meson energies that it is probably not experimentally detectable due to the extremely large electromagnetic scattering in this energy region.

The Velocity of 170-Mev Gamma-Rays*

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AS a test of a high resolution coincidence circuit for experiments utilizing monoenergetic gamma-rays selected from bremsstrahlung,[1] we have measured the velocity of 170-Mev gamma-rays. A bremsstrahlung gamma-ray is counted in delayed coincidence with the electron producing it. 310-Mev electrons in the circulating beam of the Cornell synchrotron strike a thin target and are analyzed after radiation by the magnetic guide field (Fig. 1). A stilbene crystal is located so as to intercept electrons of about 140 Mev. The energy spectrum of the gamma-rays in coincidence with these electrons was measured by use of the Cornell pair spectrometer[2] and was found to correspond to a peak at 170 Mev with a full width at half-maximum of twenty percent or less.[1] The velocity of the coincident gamma-rays was determined by measurement of relative delay time *versus* position of a movable, external, scintillation counter. Transit time differences were measured for four positions (extreme positions had a separation of thirteen meters) using a coincidence circuit with a resolving time of 4×10^{-9} second. The peak of the resolution curve at each position could be determined within 2×10^{-10} second. Cable delay times were calibrated by observing their resonant frequencies under shorted termination in the frequency range from 10 to 500 megacycles.[3] The error in cable calibration is of the order of one-half percent. A plot of distance *versus* transit time gives a straight line whose slope is the velocity of the 170-Mev gamma-rays. A least squares fit gives a value of 2.974×10^{10} cm/sec, with estimated probable error of one percent. This agrees within the experimental uncertainties with the value of c obtained for 0.5-Mev gamma-rays,[3] and with the most probable value of c obtained from measurements at lower frequencies to be 2.998×10^{10} cm/sec.[4]

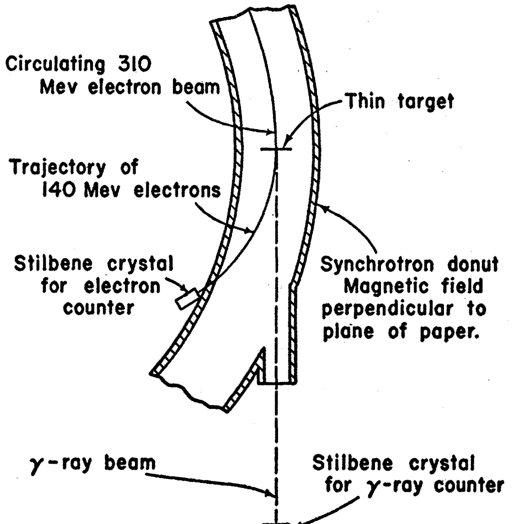

FIG. 1. Experimental arrangement for velocity measurement.

We wish to thank Professor B. D. McDaniel for his helpful advice and encouragement.

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† AEC Predoctoral Fellow.
[1] J. W. Weil and B. D. McDaniel, Bull. Am. Phys. Soc. **27**, No. 1, 7 (1952).
[2] DeWire, Ashkin, and Beach, Phys. Rev. **83**, 505 (1951).
[3] M. R. Cleland and P. S. Jastram, Phys. Rev. **84**, 271 (1951).
[4] J. W. DuMond and E. R. Cohen, Phys. Rev. **82**, 555 (1951).

Elastic and Plastic Properties of Very Small Metal Specimens

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THE elastic and plastic behavior of bulk tin has been investigated by several workers. As a result, quite detailed data are available on the yield stress and creep rate. The yield stress varies, of course, with the crystal plane across which stress is applied and its direction in that plane, but the values for the principal cases of interest are all shears of approximately 0.15 kg/mm²[1] resolved shear stress. From the elastic constants of tin we are thus led to a maximum yield strain of about 10^{-4} before slip occurs in a simple tension experiment. The minimum creep rates observed are about 2×10^{-8}/sec at tensions of about 0.1 kg/mm².[2] This behavior is usually explained in terms of the motion of imperfections, especially of dislocations, since on any reasonable model of a perfect crystal one expects the yield strain[3] to be of the order of 10^{-1}.

It has often been presumed[4] that specimens of very small dimensions ought to have a much larger range of elastic strain than the bulk metal, either because they are free of dislocations, or because the few dislocations present cannot multiply sufficiently to give an observable amount of slip. It occurred to us that this hypothesis could be tested by performing experiments on the thin whiskers which have been observed to grow out from the surfaces of a number of low-melting-point metals.[5] We have therefore made observations on some tin whiskers grown from a tin-plated surface by Mr. S. M. Arnold of these laboratories. Electron microscope observations of many such whiskers, carried out by Mr. C. J. Calbick, of these laboratories, have shown their diameters to be