New Upper Limit of Production Cross Section of Faster-than-light Particles

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Abstract

Using improved technique, a new search for charged faster-than-light particles has been performed. New upper limit of production cross section of faster-than-light particles is found to be 9×10^{-36} square centimeters.

Introduction

Faster-than-light particles (tachyons) are hypothetical particles traveling with a speed always exceeding that of light in vacuum and having imaginary rest mass (2, 4, 5). These properties may be used in search of such particles. If tachyons are electrically charged, this property may be used as well. This is especially true if charged tachyons should emit Cerenkov radiation as ordinary particles sometimes do. This radiation may serve as an identification signal. The present investigation is an improved version of previous experiments to search for Cerenkov light from charged tachyons (1).

It can be shown that a charged tachyon will lose energy very fast due to Cerenkov radiation (1). In a fraction of a centimeter even a very energetic tachyon would radiate practically all of its energy and continue with an energy much less than 1 ev. Although this behavior causes some difficulties for directly observing the particles, it can be used to detect them indirectly. If the tachyons are allowed to pass through an electric field, they will gain energy from the external field. This energy will then be emitted mainly as Cerenkov light which can be detected. This procedure allows observation of possible tachyons over an extended path length of many centimeters far away from any production region.

Measurement

Figure 1 shows a block diagram of the instrument used. Charged tachyons are supposed to pass through the completely separated external fields A and B. Each field region is viewed by a photomultiplier. These are connected in coincidence to reduce background signals, especially those due to microsparks. The coincidence unit gates a multichannel pulse height analyzer registering pulses from one of the photomultipliers. Tachyons would correspond to a peak in the pulse height spectrum since all particles would emit the same amount of energy in the electric field. With the field gradient used, 3 kv/cm, this energy corresponded to about 1000 photons in the sensitive range of the photomultipliers. Taking geometry factors into account, it is estimated that about 100 photons of suitable energy would reach each of the photomultipliers.

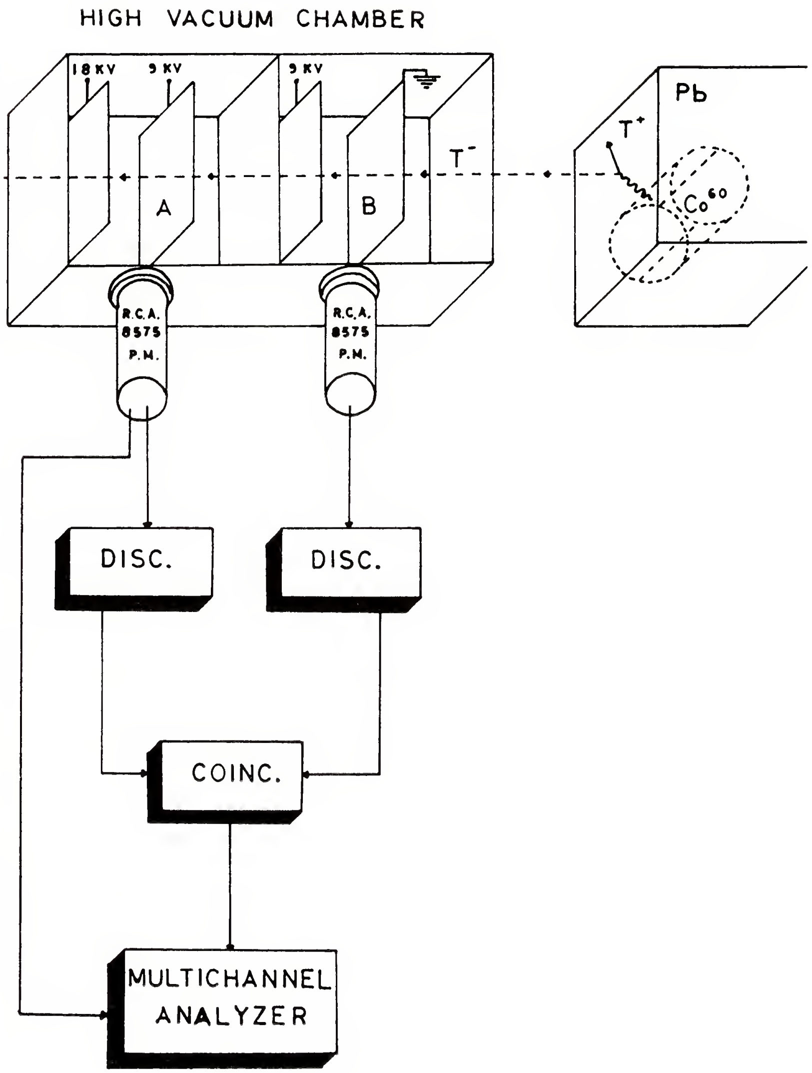

FIGURE 1. *Block diagram of the experimental setup.*

The detector arrangement was calibrated and adjusted in a special setup consisting of a plastic scintillator viewed by the two photomultipliers. Gamma rays from a Cd^{109} source ($E\lambda = 159$ kev) were used to produce pulses suitable for calibration.

Results

Figure 2 gives the spectrum registered by the multichannel analyzer when a 5 Currie Co^{60} source was used as a possible production source of tachyons. The arrow in the figure indicates where the tachyon peak ought to occur according to calibration.

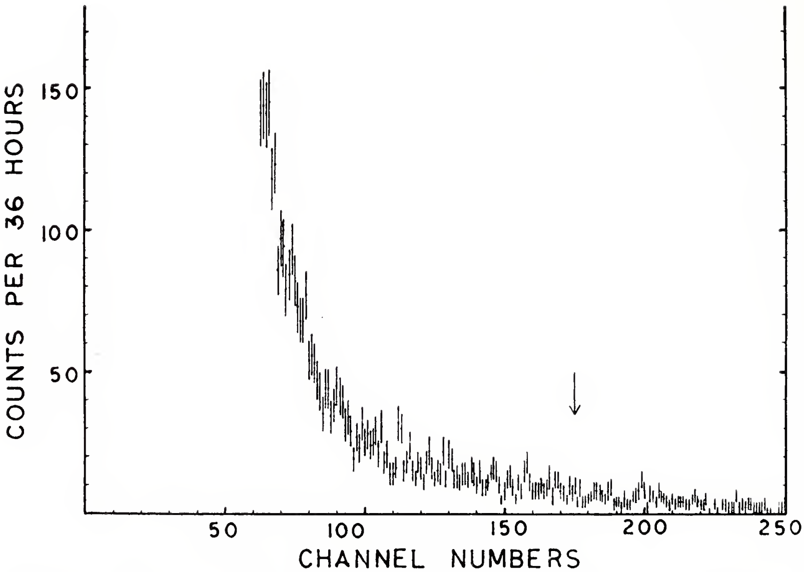

FIGURE 2. *Pulse height spectrum as seen by one of the photo-multipliers and registered by the multichannel pulse height analyzer. The arrow indicates where the tachyon peak ought to occur according to calibration (compare text).*

From arguments similar to those presented in a previous experiment (1), it was possible to calculate a limit of the production cross section of tachyons for photo reactions in lead. An upper limit for the number of tachyons registered in the measurement is taken from Figure 2 to be less than 10 for a 36 hour period. This corresponds to an upper limit of the cross section

$$\sigma \leqslant q \times 10^{-36} \text{ cm}^2$$

The previous limit was 1.7×10^{-33} cm^2 (3). We will continue these experiments to improve the limit; also, a careful investigation of the background is in progress.

Acknowledgment

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Literature Cited

1. ALVÄGER, T., and M. KREISLER. 1968. Quest for faster-than-light particles. Phys. Rev. **171**:1357-1361.

2. BILANIUK, O. M. P., V. K. DESHPANDE, and E. C. G. SUDARSHAN, 1962. Meta relativity. Amer. J. Phys. **30**:718-723.

3. DAVIS, M. B., M. KREISLER and T. ALVÄGER, 1969. Search for faster-than-light particles. Phys. Rev. **183**:1132-1133.

4. FEINBERG, G., 1967. Possibility of faster-than-light particles. Phys. Rev. **159**:1089-1105.

5. SUDARSHAN, E. C. G., 1969. A new formulation of relativistic quantum theory of fields with applications to particles traveling faster than light. pp. 335-343. *In* N. Svartholm [ed.] Elementary Particle Theory. Wiley Interscience Division. John Wiley & Sons, New York.