Highly Directional Detector for Cosmic Ray Particles.

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Summary. — A relatively simple Čerenkov detector is described which will respond to relativistic charged particles only when their directions lie within a well-defined cone. The limits of the cone are determined by the critical reflection of Čerenkov light from parallel faces of the radiator. The semi-angle of the cone may be chosen at will by varying the refractive indices used. It is suggested that the detector might be useful for attempts to detect a directional flux of uncharged primary particles at high altitudes.

1. — Introduction.

A Čerenkov counter has recently been described by Booth, Hereford and Hutchinson (1) in which a sharp energy discrimination for protons of energy of the order of 1 GeV was achieved by using the critical reflection condition from the parallel faces of thin slabs of a radiating material. The counter has been made and tested in a preliminary form. By a simple modification, this counter can be made to have well-defined directional properties. It is intended here to draw attention to its potential usefulness in this form.

2. — Description.

The principle of operation of the counter is shown in Fig. 1. Čerenkov light is produced by relativistic charged particles in a series of parallel slabs of refracting material of refractive index $n_1$, surrounded by a medium of refra-

fractive index \( n_2 \). If the light strikes the surface of the slabs at an angle greater than the critical angle \( \theta_c \), defined by \( n_1 \) and \( n_2 \), it is completely internally reflected and is collected by photomultipliers placed around the edges of the slabs. If it reaches the surface at an angle less than the critical angle, then a large proportion of the light will pass to the medium \( n_2 \) in which it is absorbed by black surfaces. The cut-off at the critical angle is sharp because of the multiple reflections necessary before the light can reach the photomultipliers and because of the direction of polarization of the Čerenkov light.

In the instrument tested, the media \( n_1 \) and \( n_2 \) were polystyrene and air, the absorbing surfaces were black paper, and the light was collected by two photomultipliers in optical contact with two opposite edges of the slabs. The signals from the two multipliers were added in a linear network and the resulting pulse height was recorded. The limitations on the energy resolution of this arrangement have already been discussed (loc. cit.).

In particular it was required that the trajectory of the particles should be very closely perpendicular to the plane of the slabs. A particle travelling at an angle to this direction would produce a cone of Čerenkov light tilted with respect to the slab face normal. If its velocity was such that the Čerenkov angle was close to \( \theta_c \), a fraction of the cone could be critically reflected while the remainder was lost. To adapt the detector for angle sensitivity it is only necessary to require coincidence from the signals of several photomultipliers receiving light from different positions around the edges of the slabs. Particles of sufficiently high velocity travelling normally to the slab faces will