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MEASUREMENT OF THE POLARIZATION OF COHERENT RADIO EMISSION OF EXTENSIVE AIR SHOWERS (EAS)

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The first measurement of coherent radio emission of EAS at 44 and 12.7 Mc, at amplifier bandwidths 4 and 2.6 Mc respectively, have been recently described [1-3]. These measurements confirmed the possibility of registering radio emission of EAS, predicted in papers [4,5] dealing with the search of coherent radio emission of the electron excess. The electron excess appears during the maximum development of the electron photon cascade in the EAS, and its emission is characterized by radial polarization and constitutes ordinary Cerenkov radiation.

It was indicated in [4] that V. I. Gol'danskii has proposed a mechanism whereby the charges in the EAS maximum are separated by the earth's constant magnetic field. This can give rise to synchrotron radiation, the power of which in the long-wave part of the spectrum will depend quadratically on the total number of electrons (positrons) in the EAS maximum. This radiation of the relativistically moving charges will be for the most part, but not completely, polarized in the plane of motion of the bunch, i.e., in the east-west direction.

To separate the radio emission polarized in the east-west direction from the usual Cerenkov radiation, an experiment was carried out at a wavelength 15.0 m with an amplifier bandwidth ~1.4 Mc.

A block diagram of the experiment is shown in Fig. 1. Signals from six dipoles (A_1 or A_2) were fed to a cascade preamplifier 1 and detector 2, and then through amplifier 3 and discriminator 4 to two coincidence circuits 5 and 6. The six dipoles A_1 were oriented east-west, and the other six dipoles A_2 north-south. The centers of the equilateral triangles O_1 and O_2, at the vertices of which were placed trays with Geiger-Muller counters (triggering setup),were at equal distance (36 m) from the centers of the corresponding rows of dipoles.

The simultaneous coincidences in the three circuits (5, 6, 7), corresponding, for example, to counters G_1 and the row of dipoles A_1 (see Fig. 1), were recorded for 17 out of every 24 hours. Every day between 10:00 and 17:00 false coincidences in all circuits (5, 6, 7) were monitored by gradually decreasing the total gain of the amplifier system to avoid amplitude overloading of the final amplifier 3.

The effective solid angle of antennas A_1 and A_2 was ~0.31 sr, and the physical areas of the antennas were ~100 m^2. The noise temperature of the preamplifier was 400°K, and the

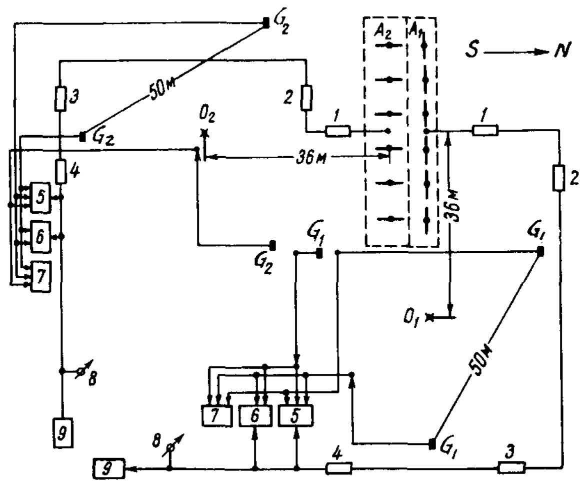

Fig. 1. Block diagram of setup for the measurement of the polarization of coherent radio emission of EAS.

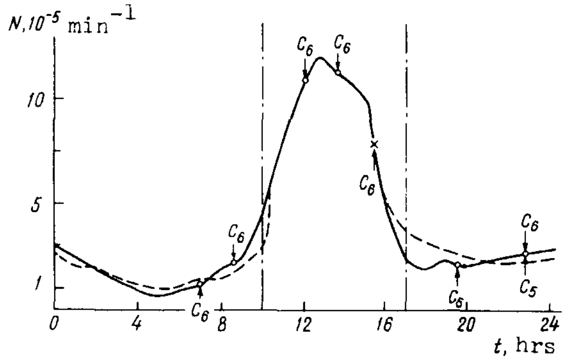

Fig. 2. Change in counting rate N of the radio pulses during the day. o - coincidence with triggering setup O_1 and antenna A_1 in operation (solid curve); x - coincidence with triggering setup O_2 and antenna A_2 in operation (dashed curve); C_5, C_6 - coincidence in circuit 5 or 6, respectively; dash-dot lines delineate the time interval during which amplitude overloading of the final amplifier took place.

minimum flux of the recorded radio emission was ~1.7 x 10^{-20} W/m^{2}Hz.

Figure 2 shows the variation of the counting rate of the radio pulses during the day. The false coincidences in 17 working hours, due essentially to the truly-accidental coincidences between the radio pulses and the true coincidences from the Geiger-Muller counters, were monitored with the aid of coincidence circuit 7, intensity meter 8, and the scaler 9.

The counting rate of the triple coincidences of the pulses from the counters was ~5.1 hr^{-1} at an effective counter area per tray of ~0.1 m^2. In 60 hours of operation of antenna A_1, whose dipoles were oriented in the east-west direction, four true coincidences were recorded. At the same time, in 38 hours of operation with antenna A_1 (between 10:00 and 17:00) not one fourfold coincidence (circuit 5) accompanied by simultanous operation of coincidence circuits 6 and 7 was observed, whereas the counting rate of the radio pulses increased markedly during that time.

Thus, the total number of false coincidences obtained in 38 hours was compared with the calculation. After 42 hours of operation of antenna A_1, not a single true coincidence was recorded by circuit 5 or 6, at the same gain. After 17 hours of operation of antenna A_1 with triggering setup O_2, one true coincidence was observed.

The coherent radio emission [2,3] is thus linearly polarized in the east-west direction. However, observation of linear polarization of the radio emission of EAS in the east-west direction still does not determine the nature of the radiation. Synchrotron, dipole, and current radiation all occur when the moving charges are separated by the earth's magnetic field [4,6], and all these mechanisms produce radiation that is polarized in the east-west direction. New investigations are necessary to separate the contribution made by each of these mechanisms to the total radiation.

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CONCERNING THE POSSIBLE ROLE PLAYED BY GRAVITATION IN THE PROBLEM OF THE MASS OF AN ELEMENTARY PARTICLE

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One of the problems of field theory is to determine the masses of the elementary particles, i.e., to express them in terms of the interaction constants and the universal constants. Modern quantum field theory, however, lacks for this purpose a constant with the dimension of length, or an equivalent constant, and this in particular is the cause of the presence of divergences in the theory. Attempts are being made at present to find the "elementary length," but this still leaves open an old and fundamental question: Does not allowance for gravitation and for the gravitational constant γ solve this problem? In this note we present some arguments in favor of an affirmative answer to this question.

It is known that by taking γ into account one can construct a length, for example, by one of the following methods:

$$l_1 = ec^{-2}\gamma^{1/2} = 1.38 \times 10^{-34} \text{ cm}, \tag{1}$$

$$l_2 = \hbar^{1/2}c^{-3/2}\gamma^{1/2} = \sqrt{137}\, l_1. \tag{2}$$

The fact that these lengths are exceedingly small is the usual argument for refuting the role of gravitation in the structure of elementary particles. We shall show, however, that one of the recently proposed approaches to the mass problem calls for the involvement of a length just of the order of (1) and (2). We refer to the "dynamic model of elementary particles, based on the analogy with superconductivity" by Nambu and Jona-Lasinio [1]. In this model, the fermion mass comes into play with the aid of a mechanism that is formally analogous to the mechanism responsible for the energy gap in the theory of superconductivity, and the mass m and the constant F of the corresponding interaction are connected by the characteristic re-