in each case, by the estimated efficiency of the apparatus for detecting the particular decay mode in question. We conclude that the abundance of mass-550 particles which decay into a light meson is less than about 0.05% relative to μ mesons. On the other hand, the data are not inconsistent with the existence of such particles at the 0.1% abundance level if the charged decay secondary is an electron and the mean life is greater than about 10 milliseconds. The experiment is continuing with the longer gate and some reduction in background.

In comparing our results with those obtained at higher altitudes, it should be noted that the slow-μ intensity increases by a factor 2.2 from our altitude (4700 ft) to, say, 10 700 ft. Thus, even if the X particles were attenuated as rapidly as the nucleonic component (a factor 5), the difference is only a factor 2.3. It should also be remarked that in the experiment of Alikhanian, the particles traversed almost 70 g/cm^2 of Pb before entering the mass spectrometer.

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SHORT γ-RAY BURST FROM A SOLAR FLARE*

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During a balloon flight at Cuba we have observed a short burst of radiation coincident with a Class II solar flare at 1305 UT on March 20, 1958. Associated with this flare were ionospheric disturbances, a magnetic crotchet and earth current disturbance, and solar radio emission at 3 cm and 27 cm. The time sequence of the various effects is shown in Fig. 1.

We believe the observations can be accounted for by electrons on the solar surface accelerated to about 1 Mev during the growth of the flare. The radio spectrum is emitted as betatron radiation from these electrons as they spiral in the intense magnetic fields associated with the sunspot group. These same electrons finally stop in the solar photosphere, where a small fraction of their energy is lost as bremsstrahlung γ rays. This γ-ray spectrum, modified by passage through the earth's atmosphere, accounts for the balloon observation.

The burst was detected with a spherical integrating ion chamber and a single omnidirectional Geiger counter.[1] The response of the two instruments shown in the upper part of Fig. 1, before and after the burst, has a ratio characteristic of cosmic rays at Cuba. The increase occurred almost entirely during one scaling interval of 256 counts and 18 seconds duration. The burst could therefore have been less than 18 seconds in duration. The excess ionization has

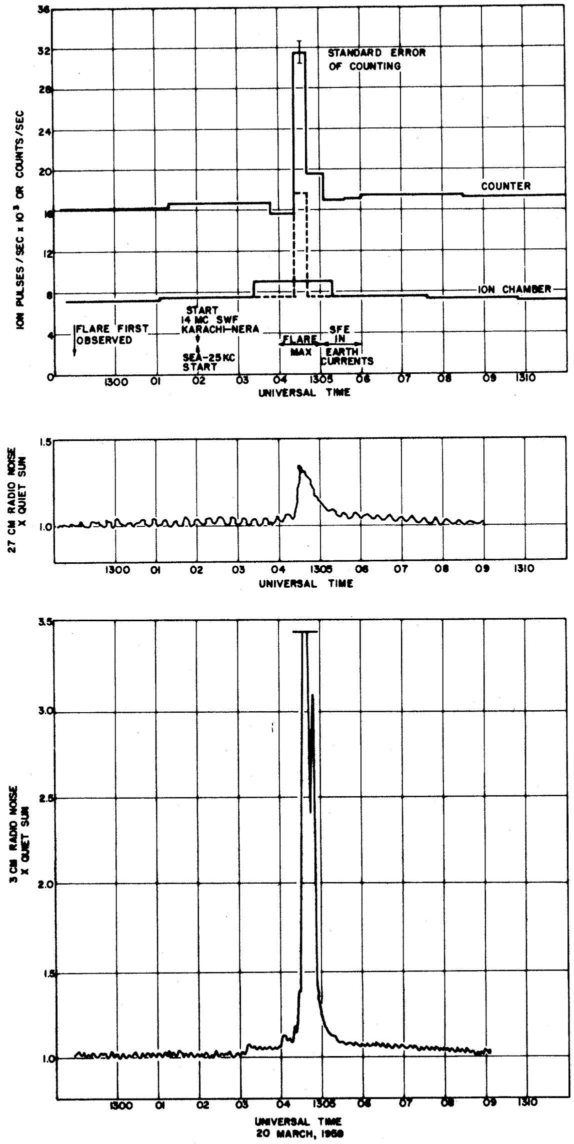

FIG. 1. Upper - response of ionization chamber and counter during flare. Center and lower - solar radio emission recorded at Paris (courtesy J. F. Denisse).

been converted to the 18-second interval (dotted profile in Fig. 1) for comparison with the counter. The ratio of ion-chamber excess divided by counter excess, compared to the ratio for fast singly-charged cosmic rays, is $1.7_{-0.3}^{+0.1}$

We do not attribute the increase to charged particles, as the geomagnetic cutoff energy at Cuba is 8 Bev and we know experimentally that the cosmic ray primaries and associated secondaries at this latitude give a relative ratio 1.0 at 10 $\mathrm{g/cm^2}$ atmospheric depth when compared with the ratio for minimum ionizing particles deep in the atmosphere. The transit time from the sun seems to be identical with the visible photon component of the flare maximum and the radio frequencies. This, together with short duration of the burst and no evidence of a slow decay, does not resemble large cosmic-ray increases associated with solar flares.[2] Singer[3] has reported a small flare effect observed at aircraft altitudes at high latitude, but it does not seem possible to account for his observation by the phenomena reported here. Our ratio is, however, consistent with bremsstrahlung radiated from solar 1-Mev electrons stopping in the hydrogen photosphere and being filtered by the 20 $\mathrm{g/cm^2}$ of terrestrial atmosphere between the sun and the balloon. For γ rays of this average energy, about $\frac{1}{2}$ Mev, the average flux passing through the chamber is 7.5×10^{-5} $\mathrm{erg/cm^2}$-sec. This requires about 2.4×10^{34} 1-Mev electrons stopping in the photosphere.

The radio burst was unusual for its intensity, brevity, and absence of an effect at frequencies less than 500 Mc/sec, and because the higher frequencies were emitted from a region covering $\frac{1}{4}$ of the solar disk. This spectrum is consistent with betatron radiation from 1-Mev electrons in a 1000-gauss field. To produce the observed radio flux of 350×10^{-22} watt-sec/$\mathrm{m^2}$-cycle by the betatron effect requires 2.3×10^{31} electrons radiating independently. To compare with the γ-ray intensity, we may assume that only 10^{-3} of the radio radiation can escape from the region of intense magnetic field and ionized plasma in which the acceleration took place, and that this was essentially scattered out, thus accounting for the large apparent area of emission.

The ionospheric disturbance and magnetic crotchet can be accounted for by uv or x-radiation ionizing the D layer.[4] The ionization produced by the γ rays in the ionosphere is negligible.

We are indebted particularly to J. F. Denisse of the University of Paris, and also F. T. Haddock of the University of Michigan and L. D. de Feiter of the Netherlands Postal and Telecommunications, the Hague, for many details of the solar radio emission and ionsopheric effects. The radio burst is also reported in National Bureau of Standards Solar-Geophysical Data Report for April, 1958, observed at Ottawa. Discussions with Dr. Constance Warwick of National Bureau of Standards, Boulder, Colorado, were of great assistance in assembling the information. Mr. Maas and Mr. Huch of the University of Minnesota and Commander Robert Cochran and the Office of Naval Research were essential in carrying out the balloon operation at Guantanamo Naval Base, Cuba.

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NUCLEON SPECTRUM IN STRONG-COUPLING THEORY*

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Recent measurements of the total cross section of π mesons incident on protons[1] and of photoproduction of π mesons[2-4] have shown resonances at higher energy than the well known $(\frac{3}{2}, \frac{3}{2})$ resonance at 300 Mev.

Pauli and Dancoff[5] have shown that the strong-coupling symmetric pseudoscalar meson theory predicts a set of rotational or isobaric bound states for the nucleon for which the angular momentum j and isotopic momentum t are equal. These states have excitation energies of order $1/g^2$ in the coupling constant g. They are given by

$$E_j = \frac{3}{2}\,\frac{j(j+1)-3/4}{g^2/\kappa a}\,\kappa\,, \tag{1}$$