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[3] G. S. Janes, Tenth Annual Gaseous Electronics Conference, October, 1957 (unpublished).

IONIZING RADIATION ASSOCIATED WITH SOLAR RADIO NOISE STORM*

K. A. Anderson
Physics Department,
State University of Iowa,
Iowa City, Iowa
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Beginning at 1525 U.T. on 22 August, 1958, ionizing radiation appeared at an atmospheric depth of 10 g/cm^2 in time association with a great solar radionoise storm.[1] The response of three balloon-borne detectors is shown in Fig. 1. The rates of the ion chamber and counter telescope are seen to rise by as much as a factor of ten above the cosmic-ray level while the single counter increases by a much smaller factor. In Table I the relative responses of the three detectors are given. These ratios cannot be obtained with x-rays, high-energy γ rays, or electrons. These ratios are wholly consistent with protons having an energy loss no greater than 4.5 times minimum ionization as was determined by comparing their ion chamber to single counter ratio with that for cosmic rays and using Neher's[2] data on average specific ionization. The above energy loss corresponds to a proton kinetic energy of 170 Mev. With protons of this energy it is readily seen how to account for the ratios of Table I in a qualitative way:

(1) The counter telescope to single counter

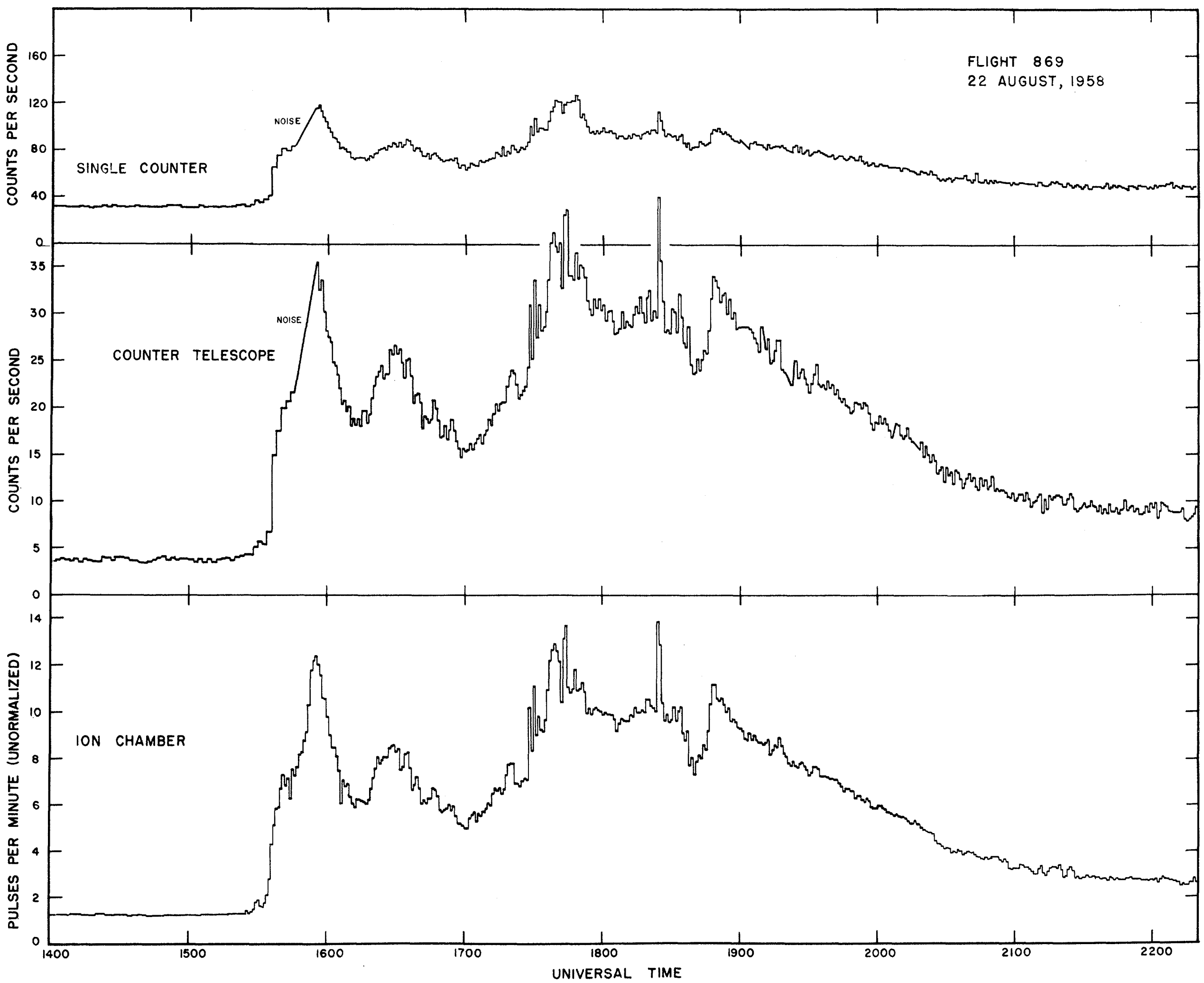

FIG. 1. Counting rates of the three detectors.

ratio should be higher for this energy proton than for cosmic rays due to the strong collimating effect of the atmosphere. Thus the telescope should see a much higher relative increase than the single counter which obtains most of its counts from low zenith angles.

(2) The ion chamber to counter telescope ratio is seen to be about the same as for cosmic rays. It is not higher because the ion chamber is omnidirectional and few protons appear at the lower zenith angles. Although it is seeing relatively fewer particles than the telescope, this is offset by the high specific ionization that protons of this energy possess.

(3) The ion chamber and single counter receive the same relative particle flux increase but since the protons ionize heavily this ratio is considerably larger than for the ordinary cosmic-ray beam.

The extra radiation cannot consist predominantly of alpha particles or other heavy nuclei because the observed energy loss of four times minimum would not be consistent with the strong collimation feature of the radiation. Electrons are ruled out because of the observed very high ion chamber to single counter ratio. For fast electrons this quantity is no higher than that for cosmic rays.

Further information ruling out x-rays was obtained later in the event on a record balloon flight from a sodium iodide scintillation crystal and four-channel kicksorter covering energy losses from 60 to 450 kev. It was found that the total rate of the crystal increased by about a factor of 1.5 while if the extra radiation had been x-rays of the intensity indicated by the ion chamber an increase of several hundred would have been observed.

From one previous balloon flight made at Churchill in 1957, there was strong evidence for the appearance of protons[3] in the 100-Mev energy region during a period of high solar activity but no further confirmation was obtained until the occurence of the present event.

It should be pointed out that the energy determination on the protons made from ion chamber and single counter data and verified by the extent of collimation actually tells little of significance about the proton energy spectrum incident on the atmosphere. This is because the atmosphere above the balloon cuts off the protons completely below about 125 Mev so that if the spectrum is fairly steep the effect produced will correspond to protons of roughly the observed energy.

An interesting feature of the event is the low abundance of electrons and photons. This implies a direct solar origin although the rapid time structure from 1740 to 1900 U.T. seems difficult to account for on this basis alone. These sharp fluctuations might be due to a local modulation effect. The time scale and certain of the details of this event bear a strong resemblance to the x-ray[4] shower observed on August 29-30, 1957, as can be seen from Fig. 2. This suggests that the protons in the present event and the electrons, presumed to give rise to the x-rays in the earlier event, are affected by a common mechanism.

It was definitely established that the radiation present during the August 22, 1958, event was not associated with visible aurorae as sky conditions were excellent for observations. There

Table 1. Relative response of the detectors to solar protons and to cosmic rays.

	Ion chamber to counter telescope ratio	Ion chamber to single counter ratio	Counter telescope to single counter ratio
Cosmic rays prior to 1520 U. T.	5.6×10^{-3}	0.67×10^{-3}	0.12
Extra radiation 1600-1700 U. T.	5.5×10^{-3}	2.0×10^{-3}	0.37
Extra radiation 2000-2100	5.1×10^{-3}	1.9×10^{-3}	0.38

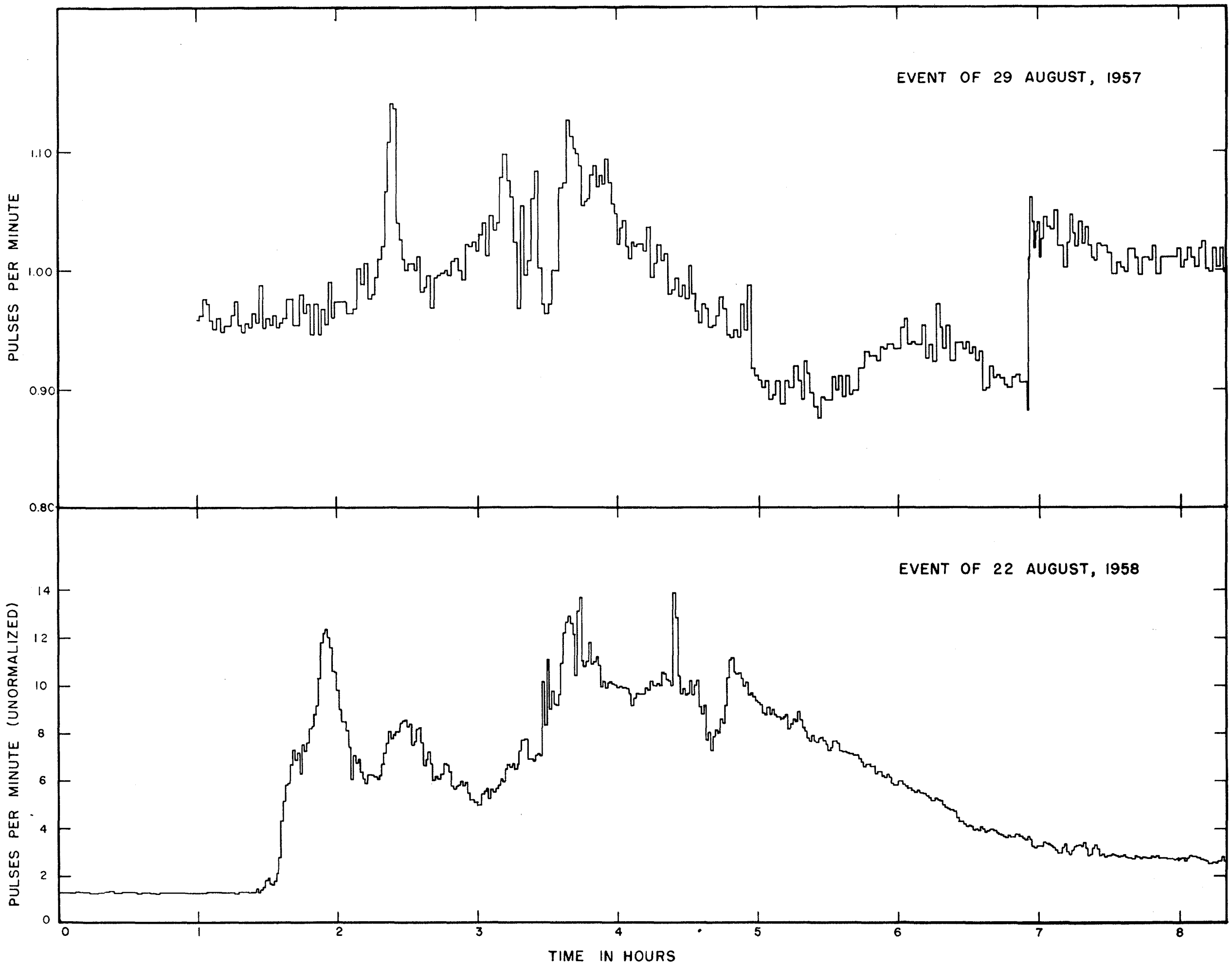

FIG. 2. Ion chamber response to x-ray event of August 29-30, 1957 (top figure), and proton event of August 22-23, 1958 (bottom figure).

was very little if any magnetic disturbance present during this event.

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[1]The author is grateful to Dorothy Trotter of the High Altitude Observatory and to the Canadian Defense Research and Telecommunications Establishment for information on this event.

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DETERMINATION OF THE π-π INTERACTION STRENGTH FROM π-N SCATTERING*

C. Goebel
University of Rochester,
Rochester, New York
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Many people have considered the role of the π-π interaction in π-N scattering, particularly in the pion production process.[1] Among the effects which can be qualitatively argued to be a result of the π-π interaction are the following:

(a) The nonresonant behavior of the $i=\frac{1}{2}$ S-wave phase shift at low energies, which indicates a fairly long range for the S-wave interaction.[2]

(b) The positive value of δ_{13} above ~200 Mev,[3] and the positive rise of the $i=\frac{1}{2}$ scattering amplitude in the region 200 to 500 Mev.[4] Taking into account interactions of only the Born approxi-