A Correlation between the Emission of White Light and Cosmic Radiation by a Solar Flare (*)

K. G. McCracken (**)  
Physics Department, University of Tasmania - Hobart

Summary. — It is pointed out that the majority of the solar flares which were observed to produce increases in the terrestrial cosmic ray intensity were also observed in white light. This is interpreted as evidence that it is only the most energetic flares which produce any appreciable quantity of cosmic radiation, and that the rarity of the cosmic ray flare effect is, at least in part, due to the rarity of very energetic solar flares. Evidence is presented that suggest that cosmic radiation produced in a flare on the east limb of the sun is unable to reach the earth.

1. Observations.

A solar flare is observed as a sudden brightening of the light emitted by a portion of the facular region in the immediate vicinity of a sunspot. For all but the largest flares, the enhanced emission is only appreciable at discrete frequencies such as $H_\alpha$, $H_\beta$, etc. Other phenomena characteristic of large flares are 1) marked broadening of spectral lines, 2) emission of electromagnetic radiation at ultra-violet and radio frequencies, and 3) geophysical phenomena (ionospheric and geomagnetic) attributed to the burst of ultra-violet radiation from the flare. All these phenomena are typical of large $3$ or $3+$ flares, and do not immediately provide an insight into the reason why relatively very few flares result in an increase in the terrestrial cosmic ray intensity.

Apart from the production of cosmic radiation, there is another phenomenon which sets a few large flares apart from the majority of large flares,

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(**) Now at Physics Department, Massachusetts Institute of Technology, Cambridge, Mass.
namely, the emission during the flash phase of a continuous visible spectrum of sufficient intensity to be observable against the photospheric background. Such flares will be called "white light" flares. It is conceivable that all large flares emit a continuous spectrum, but that it is only on rare occasions that it is of sufficient intensity to be observed.

Table I lists the cosmic ray and white light producing flares which have occurred during the past 20 years. It will be noticed that the July, 1946; November, 1949 and February, 1956 flares, all of which produced great cosmic ray increases, were visible in white light. On the other hand, the February 1942 and August 1956 flares, resulting in the two smallest cosmic ray increases, were not observed in white light (*), although the flares were very bright at discrete frequencies.

(*) Note added in proof. - Until recently, I had not seen the paper by M. Waldmeier myself. Gaining access to a copy recently, I notice that he reports that the flare on August 31, 1956 was also visible in white light. Thus, of the five flares which were observed at the time of cosmic ray flare effects, four were "white light" flares. This new information might possibly prevent us from stating that, for those flares producing cosmic rays, the energy invested in the cosmic radiation is a monotonic increasing function of total flare energy. However, the statement that it is only the most energetic flares which produce cosmic radiation still remains valid, and the correspondence between the "white light" and "cosmic ray producing" classes of flares is strengthened.