LETTERS TO THE EDITORS

ASTROPHYSICS

Magnetic Field Associated with a Great Solar Flare

An unusually large solar flare, of intensity 3+, was observed at Mount Wilson on July 16, 1959. The flare was in an active region centered on the spot group at approximately 18° N., 29° W. It showed a predominantly *S*-shaped or double spiral configuration, with marked variations of relative intensity in its various parts. Visual observations of the spectrum showed that the flare commenced abruptly between 21.19 and 21.24 U.T.; maximum was between 22.01 and 22.13 U.T. Lines of Ca II, Na, He and H were observed to be in emission for more than 1 hr.; the width of the Hα emission was greater than 6 A. Emission persisted in the lines of Ca II and of H until after observations were terminated at 01.00 U.T. on July 17.

Beginning at 21.37 U.T., observations were made at intervals of a few minutes with the solar magnetograph modified for 'fine-scanning', and with the spectroheliograph. 14 fine-scan magnetograms, 6 hydrogen spectroheliograms and 49 spectroheliograms of the flare region were obtained during the 3½ hr. of observation.

To acquire data on the detailed variations of the photospheric magnetic field during the progress of flares, the solar magnetograph[1] had been extensively modified, making it possible to scan a limited region of the Sun's disk, 4·5 min. of arc square, with a resolution of 5 sec. The scanning is carried out automatically, with conformal recording on a cathode-ray tube fitted with a camera. The recording spot is drawn out into a short line which is made to slant either to the right or to the left to indicate the magnetic polarity. Intensity of the component of the field in the line of sight is indicated by means of intensity modulation of the trace, changing abruptly at levels corresponding to 5, 10, 20 and 40 gauss. Thus, each magnetogram is a magnetic map, showing the location, polarity and intensity of the detailed magnetic field. With the fine-scan equipment, sequences of such magnetograms can be produced at the rate of four per hour in order to show changes. Although at the time of these observations the apparatus had not been fully perfected in all technical details, it provided valuable data.

A comparison of the 14 fine-scan magnetograms shows no definite change in the magnetic pattern. Thus, these observations provide no evidence that the occurrence of the flare led to the destruction or radical redisposition of the magnetic field. This is not surprising, since the flare is a chromospheric phenomenon occurring at a higher level than the photosphere, to which the magnetic observations pertain. Large variations in the magnetic-field pattern of the photosphere in a few hours would entail material velocities much greater than those normally observed in the photosphere. High velocities in the chromosphere are, of course, not excluded.

Four small flares have been observed since the large flare of July 16. For all these there are 'fine-scan' magnetic observations before, during and after the flares. In no instance was a change in the field apparent.

ROBERT HOWARD
THOMAS CRAGG
HORACE W. BABCOCK

Mount Wilson and Palomar Observatories,
Pasadena, California.
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[1] Babcock, H. W., *Astrophys. J.*, **118**, 387 (1953).

Solar Effects in the Motion of *Vanguard*

A NEW analysis which I have carried out of the complicated period changes of Satellite 1958 β2 (*Vanguard*) shows a correlation with three solar effects: (1) the hour angle of the Sun as reckoned from the perigee point of the orbit; (2) the 27-day variations in solar activity discovered by Jacchia[1]; (3) the total daily solar insolation at the latitude of perigee.

The major atmospheric drag is well known to occur at or very near the perigee point of the elliptical orbit of a satellite, and the observed rate of decrease of period is proportional to the Satellite's area/mass ratio, the air density at perigee, and the square root of the atmospheric scale-height at perigee. Data on the period changes of *Vanguard* are very precise, but nevertheless they show a highly complex periodic variation with time. The dominant variation of the drag of *Vanguard* correlates with the hour angle of the Sun as measured from perigee. A 'diurnal' effect appears to have been first noticed by Jacchia[2]. In the early days of *Vanguard*, in the spring of 1958, the local solar time at perigee was 7:00 or 8:00 a.m., and the average weekly decrease in orbital was only about 0.002 min. Because the perigee advances 4.4 deg. per day and the node regresses 3.0 deg. per day, the right ascension of perigee on the average advances 1.4 deg. per day, as compared with 1.0 deg. per day for the Sun. Thus the length of the 'day' at *Vanguard's* perigee is 360°/0.4° days or 2.5 years. During August, September, and early October of 1958 the weekly period change increased markedly, as the local time at perigee increased from 10:30 a.m. to 1:30 p.m., reaching a peak in October of about 0.007 min. Since then the average change has decreased slowly but steadily to a minimum of only 0.001 min. in July, 1959, when the local solar time at perigee was 8:00 p.m. Table I gives values of the average weekly period decrease as a function of the solar hour angle at perigee. Entries are the ratios of observed period decreases to the average weekly period decrease over the history of the orbit through July, 1959 (–0.0032 min./week).