Perhaps numerical integration in co-ordinates, including cases both near to, and far from, the critical case, could provide additional verification.

On the other hand S. Pines (in conversation with Hori) places importance on whether an analytic solution can be constructed which is valid for all values of the inclination. Now the methods of derivation of the solutions which are valid in the critical case give no reason to believe that they are not valid in the non-critical case. Garfinkel has in fact shown that the solution for the critical case agrees with that for the non-critical case as far as the dominant terms. The dominant terms of the solution valid for the critical case are of order $\sqrt{J_2}$, but the elliptic functions used by Garfinkel, or the elliptic integrals used by Hori, will give another factor $\sqrt{J_2}$ when developed in Fourier series for the non-critical case, so that the solution becomes of order J_2. Garfinkel has begun a complete verification of the comparison, which will be published in a separate paper.

The situation with regard to the critical inclination is, then, that on the one hand it is possible to construct analytical expressions for the motion which are valid for all values of the inclination, but that, on the other hand, if the mean inclination is close to the critical value, then the perturbations in the co-ordinates are of the order of 25 times greater than otherwise.

We are, Gentlemen,

Yours faithfully,

P. J. Message
G. Hori
B. Garfinkel.

Department of Applied Mathematics,
Mathematical Institute,
University of Liverpool, England.

Department of Astronomy,
Faculty of Science,
University of Tokyo, Japan.

U.S. Army Ordnance Ballistic Research Laboratories,
Aberdeen Proving Ground,
Maryland, U.S.A.

1962 April 26.

References

(1) D. Brouwer, *A.J.*, **64**, 378, 1959.
(2) B. Garfinkel, *A.J.*, **65**, 624, 1960.
(3) G. Hori, *A.J.*, **65**, 291, 1960.
(4) Y. Kozai, *Smiths. Contrib. Astr.*, **5**, 53, 1961.
(5) Y. Hagihara, *Smiths. Contrib. Astr.*, **5**, 53, 1961.

Calcium Faculae and Solar Flare Effects

Gentlemen,—

We have examined several calcium spectroheliograms taken during the occurrence of solar flares, in order to study the relationship between the filamentary structure of the chromospheric faculae and that of the flare. The sixty-year Kodaikanal collection provides us with considerable material of several flares at different phases of the outburst. Of these we have chosen for this discussion four flares, two of class 3+ and two of class 2, that have, under good conditions of seeing, complete sequences of spectroheliograms before, during and after the flare. These are the flares of 1916 June 29, 1926 February 22, 1939 September 1 and 1960 December 30. The image scale of the spectroheliograms is 33″/mm. In the case of the flare of 1916 June 29, spectroheliograms having an image scale of 18″/mm, taken at Kashmir, were also utilized. In all the cases examined, the flare is a brightening of a restricted area of the facular field. No correlation exists between the brightness of the original calcium faculae and the probability of occurrence of the flare. While the filamentary nature of the flare is similar to the filamentary background of the calcium faculae, it does not overlap the underlying facular pattern completely. Among the flares examined, we find the flare structure amorphous, having irregular spatial variations in intensity with occasional condensations. We do not see any trace of coarse mottling in the flare, while we can detect mottling of sizes greater than 6″ in the nearby facular field and 4″ at the centre of the disk.

The available sequences of spectroheliograms permit us to study the changes, if any, in the chromospheric facular field, during the progress of the flare. No change in orientation of the filamentary alignments of coarse mottling that form the faculae is seen. Very minor changes, of the kind that take place due to the finite lifetime of the mottling, are present. We have not seen any changes in the facular structure greater than what we would expect elsewhere on the disk.

The very remarkable "spectroheliograms", recently obtained by Leighton[1], of magnetic fields on the solar disk, have shown the almost one to one correlation between the calcium facular field and the longitudinal magnetic field. The technique is sensitive to fields in the range 20–300 gauss. One can conclude on this basis that stability in the calcium facular field during the progress of a solar flare implies that the magnetic field distribution pattern has experienced no change greater than 20 gauss. However, Howard and Babcock[2] have not found any change on magnetograms sensitive over the range 1–20 gauss, obtained during the progress of a 3^+ flare.

The flare sequence of 1960 December 30 has several spectroheliograms taken 2 A to the redward of the normal K_{232} setting. No trace of the flare is seen on these photographs, implying the absence of flare velocities greater than 153 km/sec. As is well known, the facular field in the active centre depicted on K_1 spectroheliograms retains the same configuration as is seen at greater chromospheric heights on a K_{232} spectroheliogram. The K_1 facular field in the flare region suffers no change during the entire period of occurrence of the flare. The similarity between the K_1 and K_{232} facular fields, and the longitudinal magnetic fields of photospheric origin seen on Leighton's spectroheliograms, implies that the spatial magnetic patterns have a columnar structure and that no changes of this field greater than 20 gauss take place during the occurrence of major solar flares.

We are, Gentlemen,

Yours faithfully,

M. K. V. Bappu

L. M. Punetha.

Kodaikanal Observatory.

1962 March.

References

(1) R. B. Leighton, *Ap. J.*, **130**, 366, 1959.
(2) R. Howard and H. W. Babcock, *Ap. J.*, **132**, 218, 1960.