NOTES

THE "FLARE SPECTROGRAPH" IN THE FRENCH IGY PROGRAM

Though changes in shape and brightness of solar flares are well known from observations made in numerous co-operating observatories with spectroheliographs and Lyot-type filters, detailed spectroscopic data are rather scarce. The widening mechanism of the most intense lines, i.e., the Balmer lines, is still open to controversy (Mustel and Severny 1952; Goldberg *et al.* 1954). To derive the radiation processes and physical conditions in the chromospheric layers of flares, really representative spectra are criti-

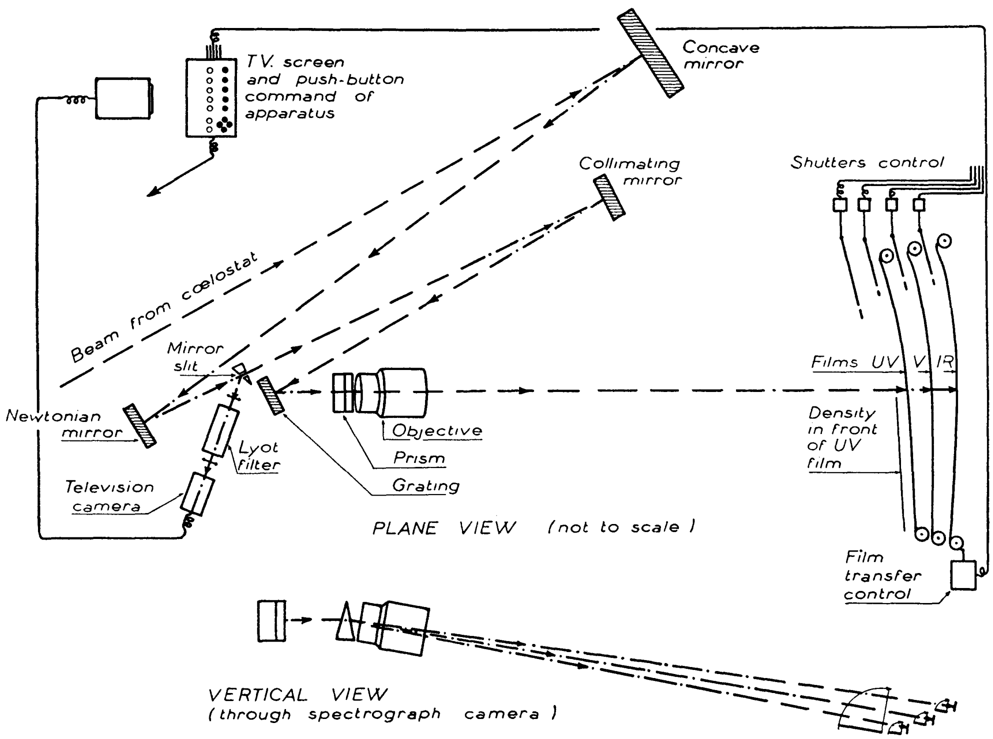

FIG. 1—Schematic arrangement of the French IGY "flare spectrograph"

cally needed; and, because of the heterogeneity of flares and their fast evolution, the complete wave-length range of interest (at least the Balmer series) should be obtained instantaneously, at a given place in the flare image. Obviously, this is not possible with conventional solar spectrographs. Further, the spectra should have sufficient resolving power to yield accurate measurements of line profiles.

To meet these requirements, special instruments have been developed in different observatories (Smith 1957; Svestka 1957). The "spectrographe à éruptions" of the Paris Observatory is described here. It is part of a complete solar laboratory, entirely devoted to the spectroscopic study of flares (and other fast-evolving solar phenomena): the apparatus has been designed at the Paris-Meudon Observatory; it has been erected at the Pic du Midi Observatory to take advantage of the high sky transparency and good seeing of the high mountain and is operated there by Paris astronomers. The project has been supported by the French Comité Central pour l'AGI, by the Paris and Pic du Midi Observatories.

1. *The telescope.*—The optical arrangement is horizontal. Light is collected by a coelostat with a 50-cm silica primary mirror and a 40-cm secondary. It is fed into a Newtonian telescope with a 51-cm concave mirror of nearly 1100-cm focal length and secondary flat, focusing a 10-cm solar image on the slit of the spectrograph. This slit has optically figured steel jaws; the light reflected by the jaws—that is, a field of 0.4 × 0.4 solar diameter—is used for flare detection (see below).

2. *Spectrograph.*—The dispersing element is a 300 grooves/mm Bausch and Lomb reflection grating, simultaneously used in the second, third, and fourth orders, respectively, for the infrared, visible, and ultraviolet range. The three orders are separated by a uviol prism, which is placed between the grating and the camera lens.

The angle between incident and mean diffracted ray (5500 A in the third order) is nearly 60°, corresponding to the blaze properties of the grating. The incident and diffracted beams are thus entirely distinct. Collimation is made by a concave mirror of 400-cm focal length. The spectra are focused by a three-lens objective, made of a single uviol glass and nicely corrected for spherical aberration, coma, and astigmatism. Its focal length is around 400 cm, and it works roughly at $f/30$. The three spectra fall on three distinct 16-mm films, held along the proper focal curves. The mechanical arrangements include a large shutter to close the camera box between exposures; small bladelike shutters in front of each film to allow different exposure times on each one; mechanisms for film transfer; and mechanisms to insure proper tension of the film along the curved focal surfaces. All are electrically driven by motors or electromagnets, and the spectrograph, like the rest of the apparatus, can be handled by a single observer. Some twenty-two spectra are available in the 30-foot rolls used and could be taken with not more than 10 seconds between each spectrum: but 10 or 15 minutes are needed to change the rolls.

Practical performances and working conditions are shown in the following table. The slit-width is 25 μ, and the usable slit length 10 mm (0.1 solar diameter).

Grating Order	Usable Range of Wave Length (A)	Dispersion (mm/A)	Film	Exposure Time (sec)
2	8800–6800	0 33	High Speed IR film (Kodak)	0 5
3	6650–4800	50	Kodak III-F	.6
4	4900–3550	0 66	Kodak II-O	0 3

A small range of wave lengths is lost in the far red because of difficulties in optical and mechanical adjustment. The spectrograph is extremely fast: with the exposure times shown in the table, the films have to be processed with a weak developer, the reduced contrast being rather an advantage in flare spectroscopy. Shorter exposure times have been prevented up to the present by the poor performance of the shutter mechanism at high speed.

To insure correct exposure of the fourth-order film, in both the violet and the ultraviolet range, it has been found convenient to put a neutral density filter in front of the spectrum along the range 4800–4100 A. The filter is made of 35-mm Microfile film. Though it has no defined optical figure, it is so thin and so near focus that it has practically no damaging effect on the quality of the spectrum.

3. *Flare detection.*—The beam reflected by the mirror slit of the spectrograph is fed,

through intermediate optics, to a Lyot-type filter of 0.75 A pass band, centered on Hα. The monochromatic image can be watched visually or through a television camera. It can also be photographed on 35-mm film. With the slow motion of the coelostat, any point of the chromosphere may be centered on the slit, which appears in the middle of the field.

The "flare spectrograph" was completed at the end of May, 1957. The instruments were mounted at the Pic du Midi and adjusted during June and July. In August, spectra of some 10 flares of importances 1–3 were obtained. It is hoped that the apparatus will be continuously operated during the IGY.

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THE SPECTRUM OF TY VIRGINIS, A HIGH-VELOCITY VARIABLE STAR

The spectrum of the irregular variable TY Virginis (α, $11^{h}46^{m}.7$; δ $-5^{\circ}12'$, 1900; $m_v = 8.0$–8.6; HD spectral type K2) was photographed on Kodak 103*a*-O emulsion with a dispersion of 104 A/mm at Hγ at Perkins Observatory on April 19, 1957. Inspection of the plate showed that the spectrum was peculiar in the weakness of almost all the usual absorption features and that the star had a very large positive radial velocity. Later two grating spectrograms were taken on 103*a*-F(3) emulsion with a scale of 55 A/mm. From thirty lines in the red region on these plates, the radial velocity, corrected for the solar motion, was measured as

$$V'_r = +233.1 \pm 2.7 \text{ km/sec (m.e.)} .$$

Since the star is situated at a galactic latitude of $+55^{\circ}$, the component of motion perpendicular to the galactic plane must be large also. The proper motion has been measured at Yale (Barney 1945) as $\mu_\alpha = -0''.025 \pm 9$, $\mu_\delta = -0''.041 \pm 9$.

The general appearance of the blue region of its spectrum (see Fig. 1) indicates that TY Vir is of spectral type G. The line ratios, particularly 4215/4226 and 4376/4383, are characteristic of a supergiant. Probably the best approximate type that can be assigned at present is G3p I*b* on the MK system. This type seems consistent with the color estimated qualitatively from the intensity gradients of the spectrograms, which suggest a color index of about $+1$.

The absorption features which show the greatest weakening can be seen from the figure to include the atomic lines Ca 4226, Fe 4325, and Fe 4383 together with the blue CN band having its head at 4215 A. This weakening, combined with the star's large radial velocity and high galactic latitude, places TY Vir among the stars of population II. It is interesting for this reason to compare the spectrum of TY Vir with the spectra of stars in the globular clusters M13 and M92, as reproduced by Deutsch (1955). The spectrum of TY Vir resembles most closely that of star III-13 in M92.

During the period of these observations, the magnitude of TY Vir remained close to 8.1, as estimated visually. The only extensive photometric observations published