CYANOGEN LINES AND FACULA MODELS

(*Research Note*)

B. M. TRIPATHI and K. SINHA

U.P. State Observatory, Manora Peak, Naini Tal, 263129, India

(Received 3 November, 1985; in final form 7 April, 1986)

Abstract. Predicted equivalent widths and profiles of facular CN lines are used here as a diagnostic tool for different model atmospheres.

1. Introduction

The deeper layers of the Sun's atmosphere, viz., those of its photosphere, sunspots, and faculae, are poorly understood (Chapman, 1981) and the behaviour of absorption lines in a facula has been studied in far less detail (Badalyan, 1980).

The intensities of weak molecular lines are sensitive to such physical conditions as the run of temperature and gas pressure in the region of line formation. As the CN radiation provides a detailed map of the minimum temperature region of the Sun's atmosphere (Sheeley, 1981), we picked up some extremely weak lines of the red and violet systems of this molecule for the present work.

2. Method

Observations for the CN molecules are not available for faculae, though the molecule presents several identifiable features in the photospheric spectrum (Grevesse and Sauval, 1973; Sneden and Lambert, 1982).

Faculae being hotter than photosphere, they can be expected to show weaker than photospheric lines for the unionised molecules. Evidence for such an assumption exists in the case of the molecule CO (Polonskij, 1966). We compare here the equivalent widths obtained from different facular models with those from a photospheric model. Obviously, a facular model yielding larger than photospheric result, would need improvements.

The method of equivalent width calculations is the same as in the paper by Sinha and Tripathi (1986). The molecular parameters, the elemental abundances, etc., used here were checked by us (Sinha and Tripathi, 1986). All the calculations refer to the centre of the solar disk.

In the literature, different facula models are encountered. They consider the facula either as a homogeneous average structure or a medium with fine structure. The homogeneous average facular models do not consider the facula to be limited in the horizontal direction whereas those which deal with the fine structure of facula take into account its horizontal extent as well. Covering these aspects we selected six models which are given below alongwith the abbreviation used hereinafter:

Solar Physics **106** (1986) 43–46.

F_1: Chapman (1979); F_2: Caccin and Severino (1979); F_3: Stenflo (1975); F_4: Shine and Linsky (1974); F_5: Stellmacher and Wiehr (1973); F_6: Schmahl (1967).

The first three are the fine structure models and the latter three belong to the homogeneous category. The temperature-optical depth run in these models is shown in Figure 1. The model based photospheric results and the photospheric model reported here shall be referred to by the symbol P. We decided to choose the Holweger and Müller's (1974) photospheric model for the reasons enunciated in Lambert (1978) and Sinha (1984). Additionally, in recent years this model is being considered good for several work dealing with the solar photosphere (Sauval *et al.*, 1984 and references cited therein).

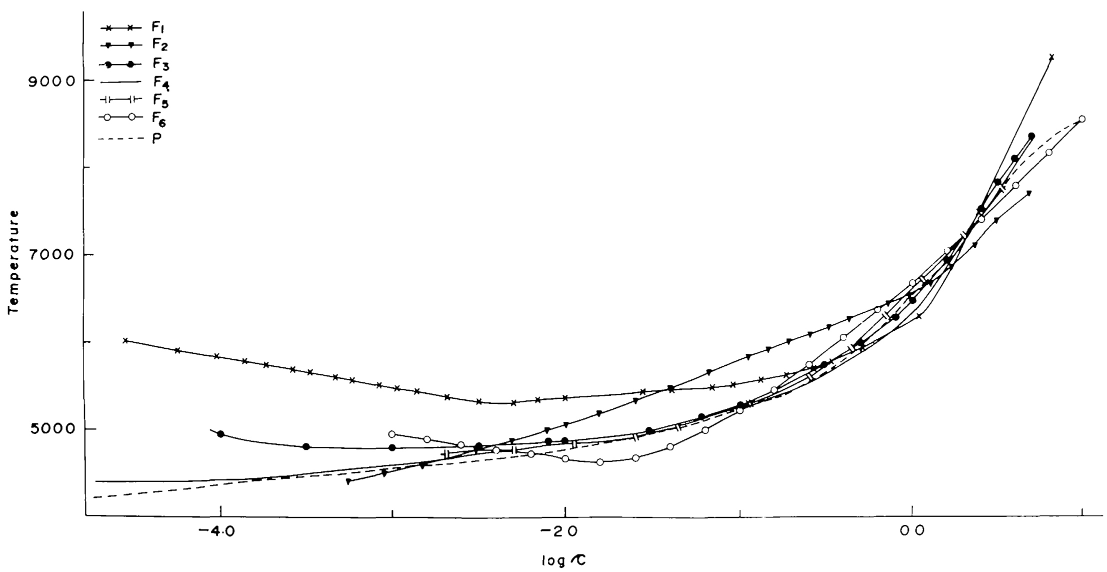

Fig. 1. Temperature versus optical-depth run in the chosen facular and the photospheric models (cf. Section 2).

3. Results and Discussions

The calculations were performed for 22 lines of the (0–0) band of the red system lying on different portions of the linear part of the curve of growth and also for the 16 lines of the (0–0), (1–1), and (2–2) bands of the violet system. The wavelengths, etc., for all these randomly chosen lines were taken from Grevesse and Sauval (1973).

The calculations show the sensitivity of the lines to different models. It is also noted, as shown below, that some facular models give larger than photospheric values of equivalent widths (P), contrary to expectations (cf. Section 2). The equivalent width of a facular line was divided by the corresponding photospheric value and all such results for a band system in each model were averaged separately for the ratio (facula/photosphere). For the red system the results for the F_1, F_2, F_3, F_4, F_5, and F_6 models are 0.25 ± 0.03, 0.28 ± 0.01, 0.66 ± 0.01, 1.04 ± 0.02, 2.06 ± 0.08, and 2.24 ± 0.09, respectively, whereas for the violet system the same are 0.39 ± 0.06, 0.35 ± 0.08, 0.80 ± 0.04, 0.83 ± 0.05, 1.47 ± 0.29, and 1.55 ± 0.21. Lacking observations of facular CN lines we are unable, at the moment, to say which model is a good representation.

Profiles of the 11072.620 Å $Q_1(20)$ line in different facular models are presented in Figure 2. Also given in this figure is the calculated profile marked *P* for the Holweger and Müller's (1974) photospheric model. It can be noted that the *rest intensity effect* observed by Stellmacher and Wiehr (1973) is not reproduced in the calculations.

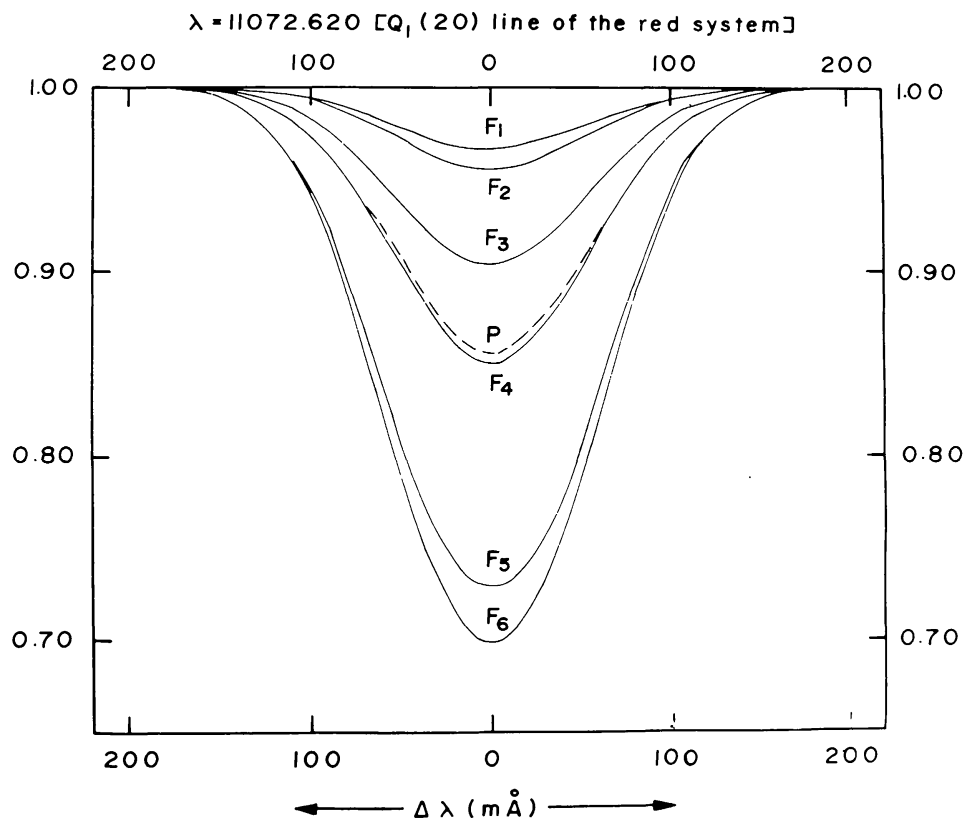

Fig. 2. Profiles of a CN line calculated in different model atmospheres.

In brief, with the help of the CN lines, it should be possible to construct good models for the solar faculae. For such studies, high quality facular spectra for the infrared would be very much helpful. Also a listing of quality CN lines from good photospheric atlases such as the one by Delbouille *et al.* (1981) may be of much value.

Acknowledgement

The authors are thankful to the referee for his helpful comments and improvements in the quality of the contents.

References

Badalyan, O. G.: 1980, *Soviet Astron. AJ* **24**, 78.

Caccin, B. and Severino, G.: 1979, *Astrophys. J.* **232**, 297.

Chapman, G. A.: 1979, *Astrophys. J.* **232**, 923.

Chapman, G. A.: 1981, in Frank Q. Orrall (ed.), *Solar Active Regions,* A Monograph for Skylab Solar Workshop III, Associated University Press, Colorado, p. 43.

Delbouille, L., Roland, G., Brault, J., and Testerman, L.: 1981, *Photometric Atlas of the Solar Spectrum from 1850 to 10000 cm*$^{-1}$, Kitt Peak National Observatory, P.O. Box 26732, Tucson, Arizona 85726–6732, U.S.A.

Grevesse, N. and Sauval, A. J.: 1973, *Astron. Astrophys.* **27**, 29.

Holweger, H. and Müller, E. A.: 1974, *Solar Phys.* **39**, 19.

Lambert, D. L.: 1978, *Monthly Notices Roy. Astron. Soc.* **182**, 249.

Polonskij, V. V.: 1966, *Soviet Astron. AJ* **9**, 664.

Sauval, A. J., Grevesse, N., Brault, A. J., Stakes, G. M., and Zander, R.: 1984, *Astrophys. J.* **282**, 330.

Schmahl, G.: 1967, *Z. Astrophys.* **66**, 81.

Sheeley, N. R., Jr.: 1981, in Frank Q. Orrall (ed.), *Solar Active Regions*, A Monograph for Skylab Solar Workshop III, Associated University Press, Colorado, p. 27.

Shine, R. A. and Linsky, J. L.: 1974, *Solar Phys.* **37**, 145.

Sinha, K.: 1984, *Bull. Astron. Soc. India* **12**, 172.

Sinha, K. and Tripathi, B. M.: 1986, *Bull. Astron. Soc. India* (in press).

Sneden, C. and Lambert, D. L.: 1982, *Astrophys. J.* **259**, 381.

Stellmacher, G. and Wiehr, E.: 1973, *Astron. Astrophys.* **29**, 13.

Stenflo, J. O.: 1975, *Solar Phys.* **42**, 79.