Note on Apparent Changes in the Spectrum of η Carinæ.

By F. E. Baxandall, A.R.C.Sc.

(*Communicated by the Director, Solar Physics Observatory.*)

Records of the spectrum of this star have been published by Miss Cannon,* Sir David Gill,† and Moore and Sanford.‡ The first partakes more of the nature of a general description of the spectrum rather than a detailed analysis. In the two latter, detailed lists of lines are given, and in each case a reproduction of the spectrum is added, Gill's plate showing both a slit spectrum and an objective prism spectrum, and Moore and Sanford's a slit spectrum only. In each case the slit spectrum has a comparison spectrum of iron, so that the two spectra, taken at an interval of thirteen years, are readily comparable. Miss Cannon describes the spectrum of η Carinæ as consisting of both dark and bright lines or bands, the dark-line spectrum being of class F5 and the bright lines or bands being similar to those of Nova Aurigæ. The spectra were described as varying considerably on different plates. Miss Cannon says: "On the best plates the system of dark lines is well defined and the bright bands are not numerous. On some plates the dark lines appear inconspicuous, and nearly the whole spectrum is crossed by bright lines. On other plates dark lines are distinctly seen on the edges of shorter wave-length of the bright bands."

Although the Harvard analysis was prior to Gill's, that observer does not refer to the Harvard results, and it would appear that, as the Harvard volume was not published until 1901, the same year as Gill investigated his spectra, he had not had access to Miss Cannon's description of the spectrum. This point is mentioned here because Gill makes no reference whatever to the spectrum containing dark lines, and treats it as purely a bright-line spectrum. As Moore and Sanford, in their more recent paper, also refer to the spectrum of η Carinæ as "essentially a bright-line" one—and their reproduced spectrum apparently shows only bright lines, with no dark lines or continuous spectrum,—three alternatives seem to present themselves. Either (1) the spectrum had undergone a change between the dates of the Harvard and Gill's spectra—apparently an interval of some five years; or (2) the Harvard observers had, in some way or other, misinterpreted some of the intervals between bright lines as dark lines, and measured them as such; or (3)§ the exposures used by Gill and Moore and Sanford had been such as to fail to record the dark lines and continuous spectrum obtained by the Harvard observers. That the second alternative is the most likely

* *Ann. Harv. Coll. Ob.*, **28**, 175, part ii., 1897.
† *Monthly Notices R.A.S.*, **61**, Appendix, p. 66, 1901.
‡ *Lick Obs. Bull.*, **8**, 55, 1913.
§ This alternative was added after the return of my note from the Cape Observatory.—F. E. B.

one is suggested, though by no means proved, by the fact that in the interval between Gill's and Moore and Sanford's investigations the spectrum has not altered, in so far as it seems to be, at both epochs, a bright-line spectrum.

Although, however, Gill's spectra of 1901 and Moore and Sanford's of 1913 show only bright lines, a comparison of their reproduced spectra appears to show a few changes in the relative intensity of some of the lines common to the two spectra. These may be now referred to in detail.

Lines (λ M. and S.) 4233·30 pFe. / 4244·25 Unknown. Gill's spectrum (objective prism) shows these two as equally strong. His tabular intensities are 7, 7. Gill's spectrum (with slit) shows the two components of the pair as being nearly equal in intensity. His tabular intensities are 5, 7. Moore and Sanford's spectrum shows 4244·25 as much the stronger line. Their tabular intensities are 5, 8.

Lines (λ M. and S.) 4372·72 Unknown, / 4385·49 pFe. / 4394·84 Unknown. Although these are all given in Moore and Sanford's tables, only the first two are detectable in the reproduction, 4385·49 being much the stronger line. Their tabular intensities are 0, 2, 0. Gill, however, only records the third (4395·8) in his tables, and gives intensity 3.

In the objective-prism spectrum shown in fig. 2 of his plate, all three lines are distinctly shown, and if we adopt his estimated intensity (3) for the 4395·8 line (M. and S.'s λ is 4394·84), the intensities of the others would be 4373 line, Int. 1. / 4385 line, Int. 2½.

Thus, as a comparison of intensities from the two records, tabular and photographic, we have:—

λ M. and S.	Intensity. M. and S.'s Tables.	M. and S.'s Plate.	Gill's Tables.	Gill's plate. (Fig. 2).
4372·72	0	0	...	1
4385·49	2	2	...	2½
4394·84	0	Not visible	3	3

The reproductions are in each case direct enlargements from the original spectra, and there appears to be no reason to doubt the reality of the differences shown. In Gill's plate, 4395 is certainly the strongest line of the three; in Moore and Sanford's, 4385·49 is quite the outstanding line of the three.

Lines (λ Gill.) 4665 Unknown. / 4811·6 Unknown. In Gill's plate (fig. 2) 4665 is a little stronger than 4811·6. The intensities for these in his table are

{3 1. In Moore and Sanford's reproduction 4814·78 (M. and S.'s λ) is quite an outstanding line, whereas there is only the merest trace of a line in the region of 4665.

There may be other differences in the two published spectra, but as the bright bands are mostly crowded together, and in Gill's spectrum are more or less diffuse, it is difficult to detect genuine changes. Enough has been pointed out, however, to show what an interesting spectrum it is, and more light would probably be shown on the variations if other spectra of the star could be taken with fairly high dispersion at intervals of a few years, to compare with the admirable spectrum published by Moore and Sanford. The spectrum is of a type almost unique, in that it represents a reversal of most of the strongest enhanced lines of α Cygni (silicon and magnesium notably excepted), with the addition of several very conspicuous lines which have not yet been identified with lines of any terrestrial element.

On the Spectrum of η Argûs. By Joseph Lunt, D.Sc.
(Plate 18.)

(*Communicated by S. S. Hough, M.A., F.R.S., H.M. Astronomer at the Cape.*)

In a MS. note* sent to the Cape Observatory, Baxandall calls attention to apparent changes in the spectrum of η Argûs which he noticed on comparing photographs of the spectrum taken at the Cape in 1899 † with others taken in 1913 ‡ at Santiago.

He calls attention to the variations noted by Miss Cannon § in the Arequipa photographs, and suggests that the spectrum should be examined with fairly high dispersion at intervals of a few years, as the type of spectrum is almost unique, and contains conspicuous lines which have not been identified with lines of any terrestrial element.

The photographs examined by Miss Cannon were taken between the end of 1891 and the end of 1899, therefore not much earlier than the Cape plates; they show much greater variation, according to Miss Cannon's description, than the later plates exhibit, particularly as regards the occurrence of dark lines, as the following quotations show:—"Taking only the dark lines into consideration, the spectrum would be classed F5G. Considering only the bright lines, there is a marked resemblance to the spectrum of Nova Aurigæ as photographed on 1892 February 17."

"Different aspects appear on different plates. On the best plates the system of dark lines is well defined, and the bright

* Now published, p. 619, *supra*.
† *M.N.*, 61, Appendix (66). ‡ *Lick Observatory Bulletins*, 8, 55, 134.
§ *Harvard Annals*, 28, 175. (For later notes see *H.A.*, 76, 36–37.)