the nature of the problem a little clearer, and if it has helped to close any of those paths which, however inviting, can lead to no solution. In conclusion, the paper may be summarised thus :—

§ 1.	Introductory.
§ 2.	Elementary explanation of aberration *in vacuo*.
§§ 3, 4.	Theory of Airy's water telescope.
§§ 5–7.	Theory of aberration when the image is formed by a mirror.
§§ 8, 9.	Theory of aberration in the case of meridian observations by reflexion.
§ 10.	Reconciliation of the result of §§ 5–7 with Veltmann's theorem.
§ 11.	Proof of Veltmann's theorem.
§ 12.	Distinction between the astronomical and physical principles involved.
§§ 13, 14.	Function and values of the velocity of light.
§ 15.	Consideration of the physical conditions.

Spectroscopic Comparison of o Ceti with Titanium Oxide.
By A. Fowler. (Plate 19.)

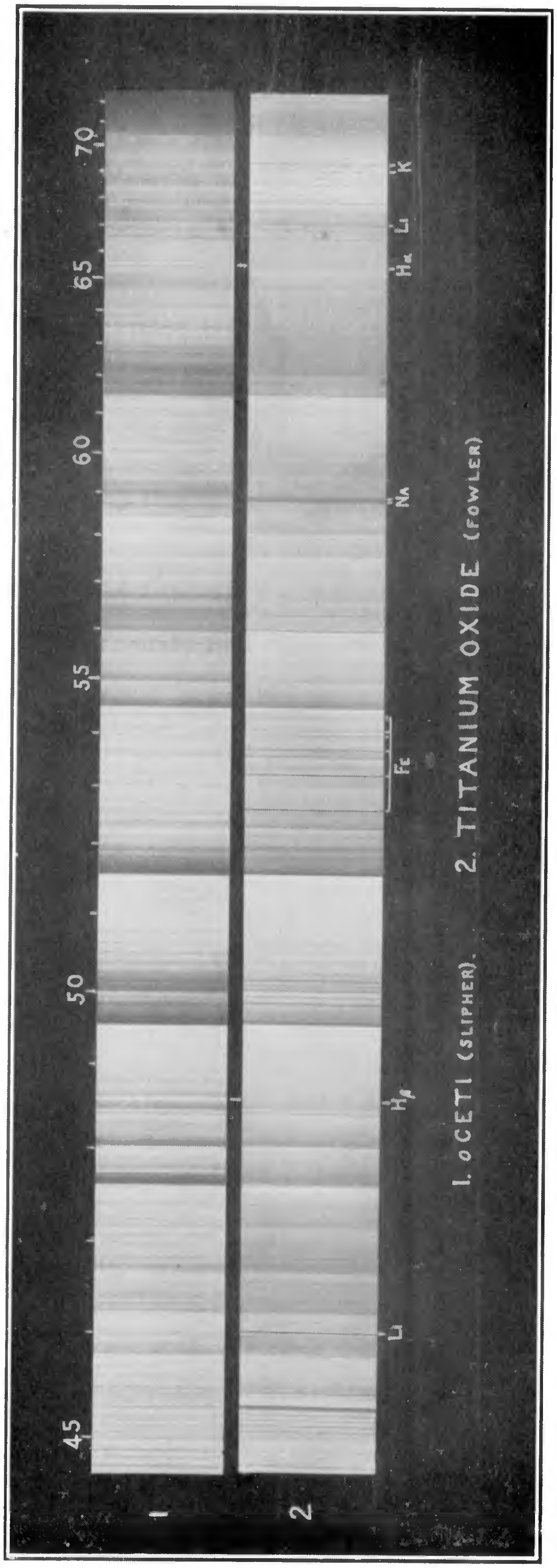
It has already been shown that nearly all of the characteristic flutings of the Antarian or Third Type Stars are produced by the absorption of titanium oxide.* The chief purpose of the present note is to give an additional comparison which strikingly illustrates the truth of the identification.

Having no adequate instruments for the photography of stellar spectra, I appealed to Mr. Slipher, of the Lowell Observatory, for permission to utilise his excellent photograph of the spectrum of *o* Ceti, which is admirably adapted for the purpose in view because it extends from the extreme visible red to the violet.† Mr. Slipher not only consented to this use of the photograph, but very kindly forwarded a special copy for reproduction. The resulting comparison with the fluted spectrum of titanium oxide is shown in Plate 19, in which the stellar spectrum is about five times the scale of the original negative.

The titanium oxide spectrum was photographed on one of Wratten's panchromatic plates with a Littrow spectrograph, giving a dispersion not too great for appropriate comparison with the star. It was obtained from the flame of the electric arc when a considerable quantity of the substance was volatilised between iron poles, and shows a few lines of iron and titanium in addition to the flutings. The D lines of sodium, the red and blue lithium lines at 6708 and 4602, a group of potassium lines about 5800, and the red

* *Proc. Roy. Soc.*, vol. 73, p. 219 (1904). *Monthly Notices* (reprint), App., vol. lxiv. p. 16 (1904). *Proc. Roy. Soc.*, vol. 79, p. 509 (1907).

† *Astrophys. Jour.*, vol. 25, p. 236 (1907).



SPECTROSCOPIC COMPARISON OF *o* CETI WITH TITANIUM OXIDE.

potassium lines 6939, 6911, appear as impurities. The spectrum is reproduced as a negative in order to correspond with the dark flutings which occur in the spectrum of the star.

Although different instruments were employed in photographing the stellar and terrestrial spectra, the dispersions chanced to be nearly proportional throughout the entire range covered by the flutings. A very satisfactory adjustment of the two was made by giving a slight inclination to the titanium photograph and to the copying-board on which the enlargement was made, according to the method first employed by King.*

It will be seen that the two spectra are for the greater part identical, and that the identification of the flutings is consequently independent of precise determinations of wave-lengths, which are indeed not yet available in the case of the stars. A general indication of the positions of the various flutings, however, will be gathered from the scale marked on the photographs. The wave-lengths of the more conspicuous flutings, as determined from the titanium oxide spectrum,† are also shown in the appended table.

Wave-lengths of Principal Flutings of Titanium Oxide.

	7054·5 7087·8 7125·5
	6651·5 6681·0 6714·1 6748·0 6782·0 6815·1 6850·5
Dunér's Band 1	6357·9 6384·4 6416·0 6448·2 6479·4 6512·8 6544·5
Dunér's Band 2	6158·86 6186·77 6215·35
	5760·15 5811·28 5863·55
Dunér's Band 4	5597·92 5629·53 5661·68
Dunér's Band 5	5448·48 5496·79
Dunér's Band 7	5167·00
,, ,, 6	5240·71
Dunér's Band 8	4954·78 5002·88
Dunér's Band 9	4761·08 4804·55 4848·20
Dunér's Band 10	4584·62 4626·49 4668·82

In each group the more refrangible component is the strongest, except in the case of the third, where 6479·4 is the strongest member of the group.

The new comparison makes an additional contribution to the analysis of the third type spectrum in showing the titanium oxide origin of numerous bands occurring in the red end of the spectrum, the details of which were not recorded by Vogel and Dunér in

* *Science*, 8, 454 (1898). See also Fowler and Eagle, *Astrophys. Journ.*, vol. 28, 284 (1908).

† *Proc. Roy. Soc.*, vol. 73, p. 219.

their visual observations. As stated by Mr. Slipher, the photographic spectrum of *o* Ceti "stops so suddenly at λ7040 as to leave little doubt that another of these bands begins at that point and outruns the sensitiveness of the plate into the red." It is now perfectly clear that this marks the beginning of the group of flutings in the extreme red at λ 7054. The three component bands have in fact been separately identified by Newall and Cookson in α Orionis,* and they are also well seen in a photograph of the spectrum of this star which Mr. Slipher has been good enough to send for inspection. Several narrow bands in the stellar spectrum which fall between 7054 and the strong band beginning at 6159 are also seen to be identical with bands of titanium oxide.

The titanium oxide flutings are evidently reproduced in their entirety in the stellar spectrum, but, as I have previously pointed out, Dunér's band 3, and possibly band 1, is still not completely accounted for. Band 3 begins about 5862, on the more refrangible side of D, and is apparently much darker than the fluting at 5863·5 in the titanium spectrum; Dunér's observations also indicate that in some cases this is one of the strongest bands in the third type stars. Continued search for the possible origin of this band has yielded no definite result. An alternative, and perhaps sufficient, explanation is to suppose that the titanium fluting in this region is made more conspicuous by the inclusion of some metallic lines which remain to be identified.

It now seems quite probable, however, that Dunér's band 1, so far as it is represented in *o* Ceti at least, may be sufficiently explained by the titanium fluting at 6479·4, as there is a close correspondence of the stellar and titanium spectra about this region. The same explanation may apply also to the band in other stars, as the fact that Dunér recorded it in only 22 out of the 297 stars which he so carefully observed suggests that it is comparatively feeble, and only shows itself when the band spectrum is strongly developed, or the star is of more than average brightness.

Besides the bands, the spectrum of *o* Ceti shows bright lines of hydrogen (H_α and H_β appearing in the photograph reproduced), and certain metallic lines. Some of the latter have been shown by Mr. Slipher to be due to vanadium, and the photographs in Plate 19 suggest that others are due to iron and titanium. The D lines of sodium are unexpectedly weak in the star, seeing that they are so strongly marked in α Orionis and other stars of the third type; in reply to my inquiry as to whether they were bright or dark in *o* Ceti, Mr. Slipher states that an examination of the negatives seems to show that they are present as dark lines.

I have pleasure in acknowledging the skilled assistance which has been rendered by Mr. T. Banfield in the preparation of the photographs for reproduction.

* *Monthly Notices*, vol. lxvii. p. 482 (1907).