NOTES FROM OBSERVATORIES

The Nebula NGC 5253

by

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In the course of recent photometric studies of elliptical nebulae in the Southern sky, undertaken with the Radcliffe 74-inch telescope, I included in my list the system NGC 5253, described as elliptical in the Shapley-Ames catalogue. Direct photographs on blue plates, and using the $H\alpha$ combination of a 103a—E plate with a Wratten filter No. 25 have been obtained. These photographs (see Plate V) demonstrate that this classification is quite incorrect. The appearance is that of a number of ill-defined nuclei divided by absorption lanes. The photographs reproduced show only the nucleus of the system and do not show up a much fainter bar structure extending from the *Nf* to the *Sp* sector.

The special interest of the system lies in the fact that the supernova, Z Centauri of 1895 occurred either very close to, or within this nebula. The position was given by Pickering[1] as following the nebula by $1^{s}.7$ and $24''$ north of it. This would identify the nova with the faint image visible about $30''$ away from the centre of NGC 5253 in the *Nf* direction.

The spectra of the nova and the nebula have been discussed by a number of investigators. Miss Cannon[2] described the spectrum of the nova as being quite unlike that of any other observed. She remarked that it "resembles Class R. A wide absorption band extends from about the wavelength 4640 to 4750, and another has a centre at about 4227. Numerous dark lines are present as in spectra of Class N. On 1895 December 19, the spectrum was observed by Professor Wendell with the 15-inch equatorial of this Observatory, and was thought to be monochromatic, closely resembling that of the adjacent nebula".

The exact meaning to be attached to this last sentence is sufficiently obscure to defy interpretation by later writers. Ludendorff[3] thought the stellar spectrum sufficiently unusual to deny it classification as a nova, but Hubble and Lundmark[4] found nothing unusual about the light curve and regarded the star as a *bona fide* nova. Of the nebular spectrum they remark "It seems to belong to the kind typical of spirals and other non-galactic nebulae: a strong continuous spectrum of approximately the type G without bright lines or bands".

The nebula was reclassified as Sa[5] at a later date, and Mrs. Gaposchkin undertook a discussion of the spectrum of the star and of the nebula.[6] She put forward the view that the stellar spectrum consisted of tremendously broadened bands much displaced to the blue, and this view was confirmed by W. A. Johnson[7] by microphotometer studies of the original plate. Johnson quotes a value of + 450 km/sec for the velocity of the

nebula. Mrs. Gaposchkin's conclusions about the nebular spectrum are somewhat obscure, for, immediately after quoting the opinion of Hubble and Lundmark given above she says "It seems to be the general opinion that NGC 5253 is an extra-galactic system, showing the not uncommon feature of localised bright lines".

The fact that a good density could be obtained in a short time with the *Hα* combination suggested to me that the system might be gaseous, and, at my request, Mr. J. Churms obtained a spectrum of the nebula on the night of 1952 April 20—21 using the Cassegrain spectrograph of the Radcliffe Observatory. The exposure was 5 hours on a 103a-F plate with a dispersion of 46A/mm at 4300A. The result fully confirmed the conjecture, and the following lines were observed, *in emission*, with no trace of a continuum.

	Line	*Strength (eye estimates on plate)*	*Measured Velocity kms/sec*
	6584	5	+ 426
Hα	6563	150	+ 435
N1	5007	150	+ 381
N2	4959	50	+ 363
Hβ	4861	25	+ 402
Hγ	4340	20	+ 402
Hδ	4102	5	+ 417
			Mean + 404 ± 6

Corrected to the Sun this gives a velocity of + 405 ± 6 km/sec. (*cf.* the value quoted by Johnson). The spectrum is thus that of a typical planetary of moderate excitation.

At maximum brightness the magnitude of Z Centauri was 7·2. If it was an ordinary nova its absolute magnitude at maximum would have been about – 7·0 giving a distance, neglecting absorption, of about 6,000 parsecs. Hence, in this case, NGC 5253 would be an ordinary planetary nebula belonging to the Galaxy, although with the high latitude of + 30°. The high velocity, which is greater than the velocity of escape from the Galaxy rules this out as a possibility.

If Z Centauri was a supernova, its absolute magnitude at maximum brightness must have been about – 14·3. Neglecting absorption we obtain a distance estimate of 200,000 parsecs, while if absorption, estimated at 0·5 magnitudes, is included, the distance becomes 160,000 parsecs. If we reduce the observed velocity to the Galactic Centre we obtain + 208 km/sec. and this, on the basis of the velocity-distance relation gives a distance of 380,000 parsecs. This argument is weak, since the velocity is small: it is merely included to demonstrate the absence of any conflict among the data.

The second alternative is thus clearly the correct one: Z Centauri was a true supernova in the system NGC 5253 having a distance of the order of 200,000 parsecs. This means that the nuclear region shown in the photograph has dimensions of the order of 20—30 parsecs.

There remains the problem of the nebular spectrum: if we were merely concerned with the present state of affairs we might follow a remark of Zwicky's[8] where, concerning an interesting extragalactic system, he said:

"The whole nebula seems to consist of gas and may have about $5 \cdot 10^7$ times the brightness of the Sun concentrated in the emission lines only. It must be a nebula that contains very few and exceedingly hot stars, that are invisible, and a vast amount of gas that is excited by these stars".

This explanation would be very attractive in the present case were it not for the following facts: the system has an NGC number and must, therefore, have existed before the outburst of Z Centauri. It cannot be a system like the Crab Nebula which is presumed to be the final stage of a supernova. Moreover, observations quoted above suggest that at about the time of the nova outburst the nebular spectrum was that of a normal spiral. It appears probable, therefore, that the spectrum of the nebula has changed during the last 50 years. The dimensions of the nebular nucleus are too large for it to have been traversed by any material shell from the nova in the time available. The most reasonable hypothesis is, therefore, that the strong outburst of radiation close to the nucleus of the nebula has, in some way, excited the interstellar gas clouds in the system. It may be that other spiral systems with emission nuclei (e.g. NGC 5236) have acquired them by a similar mechanism.

References

(1) *Harvard Circ.*, No. 5.
(2) *Harvard Annals*, **76**, 37, 1913.
(3) *A.N.*, **217**, 172, 1922.
(4) *P.A.S.P.*, **34**, 292, 1923.
(5) *Harvard Annals*, **88**, No. 4, 100, 1934.
(6) *Ap. J.*, **83**, 173, 1936.
(7) *Harvard Bull.*, **902**, 11, 1936.
(8) *Problems of Cosmical Aerodynamics*, 185, 1951.

NOTES

Comet Notes

Comet Mrkos 1952 c, whose discovery was briefly referred to in our last issue, has continued under observation and is now moving rapidly south. Dr. L. Kresák gives the following orbit in *UAIC* 1365:—

T	1952 June 9·0271 U.T.	
ω	145°·0478	1952·0
Ω	121 ·8187	
i	112 ·1822	
q	1·288325	

Another new comet, 1952 d, was discovered by Peltier at Delphos, Ohio, on June 24. It was then of the tenth magnitude and has since been seen in this country as a round coma about 4′ diameter with central condensation. A preliminary orbit from a five-day arc is given by Cunningham in *UAIC* 1366:—