

THE APPEARANCE OF THE GUM NEBULA

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According to Brandt et al. (1971), the center of the Gum Nebula is at a distance of 460 parsecs from the Sun. The outer dimensions quoted by these authors are $40^\circ \times 90^\circ$, and they suspect that the inner boundary of the emission region lies at about 100 parsecs from the Sun. They assign a radius of 360 parsecs to the nebula, which they suspect of being slightly flattened, with the huge volume of $1.4 \times 10^{63} \text{ cm}^3$! Obviously, tremendous amounts of energy must have been available to ionize so large a volume. Brandt estimates that 10^{52} erg of energy were required to do the job. The Wolf-Rayet star γ^2 Velorum and the O5f star ζ Puppis would obviously not be equal to this task. However, I wish to challenge the distances and dimensions quoted by Brandt et al.

First of all, I question the assumption that the Gum Nebula complex is as large as suggested by Brandt et al. The quoted dimensions of $40^\circ \times 90^\circ$ seem like gross overestimates, since they are based on the assumption that some minor outlying patches of nebulosity fix the outer boundary of the region of ionization; 35° seems like a more reasonable value for the diameter of the complex. We should stress the non-homogeneous appearance of the nebular complex. There is a region of brightest nebulosity centered upon γ^2 Velorum, a WC8 star. It has an apparent diameter of 9° , to which would correspond a radius for the Strömngren sphere of ionization of about 50 parsecs at the estimated distance of 460 parsecs. It seems quite reasonable that γ^2 Velorum would supply sufficient energy to keep this part of the nebula going. The section near ζ Puppis must similarly be ionized and made luminous by the intrinsically very brilliant O5f star, the brightest O-star in the heavens in apparent magnitude!

Other speakers at the Symposium, notably Gott and Ostriker and also Upton, have questioned the distance of 460 parsecs assigned by Brandt et al. to the pulsar and to the B-association that contains γ^2 Velorum.

My general impression is that Brandt et al. have overestimated the dimensions of the Gum Nebula complex, that their distance to the central pulsar of 460 parsecs is rather on the large side and that they have underestimated the likely contributions from γ^2 Velorum and ζ Puppis.

The section of the Gum Nebula that is covered by the radio supernova remnant and the area near the pulsar both show a highly filamentary structure

on the nebular photographs. The sample applies to the section further out, as distinct from the smoother appearance of the nebula near γ^2 Velorum. It seems reasonable to accept the estimate that not more than 1% or 2% of the total volume is filled with gas and free electrons. The "clumpiness factor" for the part of the Gum Nebula identified with the supernova remnant may be 100, or greater.

The multiple-origin character of the Gum Nebula seems assured. The big problem is now what parts of the Gum Nebula are produced principally by traditional ultraviolet thermal radiation and what parts mainly by processes directly related to the supernova outburst. These matters can be decided only by careful observational studies of the spectra of different parts of the Gum Nebula; one can be certain that the nebular spectrographs and interferometers are going to be very busy starting in November, 1971, when the Gum Nebula will be well placed for observations from southern hemisphere observatories, Cerro Tololo, La Silla and Las Campanas Observatories in Chile, Radcliffe Observatory in South Africa and Mount Stromlo and Siding Springs Observatories in Australia. Related radioastronomical work at all accessible wavelengths, X-ray observations and cosmic ray studies, as well as Lyman-alpha observations are obviously desired. The general properties of the spiral features for the section of the Milky Way that contains the Gum Nebula must be studied with minimum delay, for there are obviously present many optical and radio features that lie at distances greater than 1000 parsecs, far beyond the nearby Gum Nebula and its associated phenomena. A comprehensive study of the distribution and radial velocities of the OB stars in the section seems especially urgent.

Reference

Brandt, J. C., Stecher, T. P., Crawford, D. L., and Maran, S. P. 1971, Ap. J. (Letters), 163, L99.

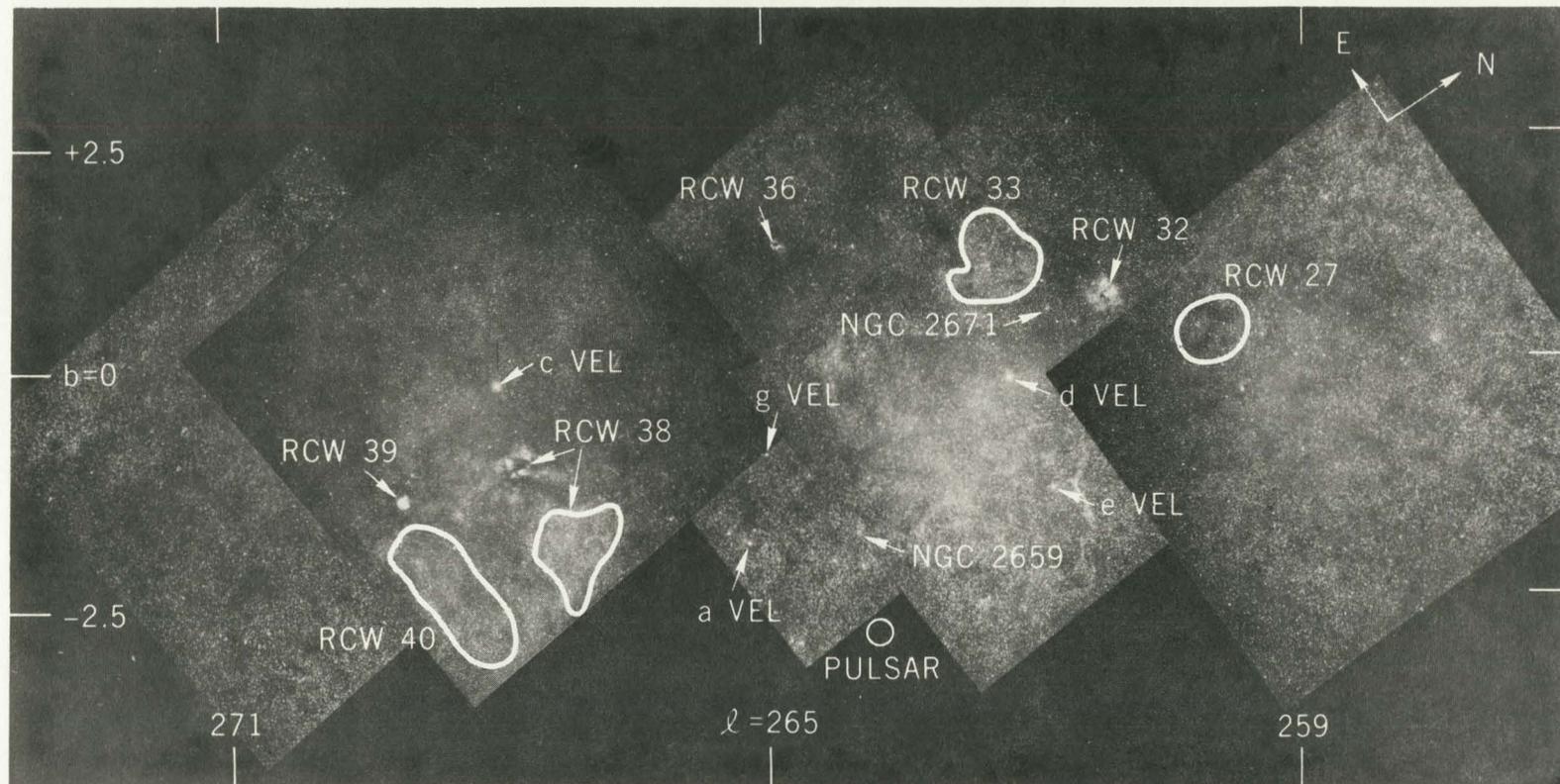


Figure 1. A composite of red 098-02 plates in a region of the Gum Nebula, as obtained by Gaston Aryaya with the Schmidt telescope at Cerro Tololo Inter-American Observatory.

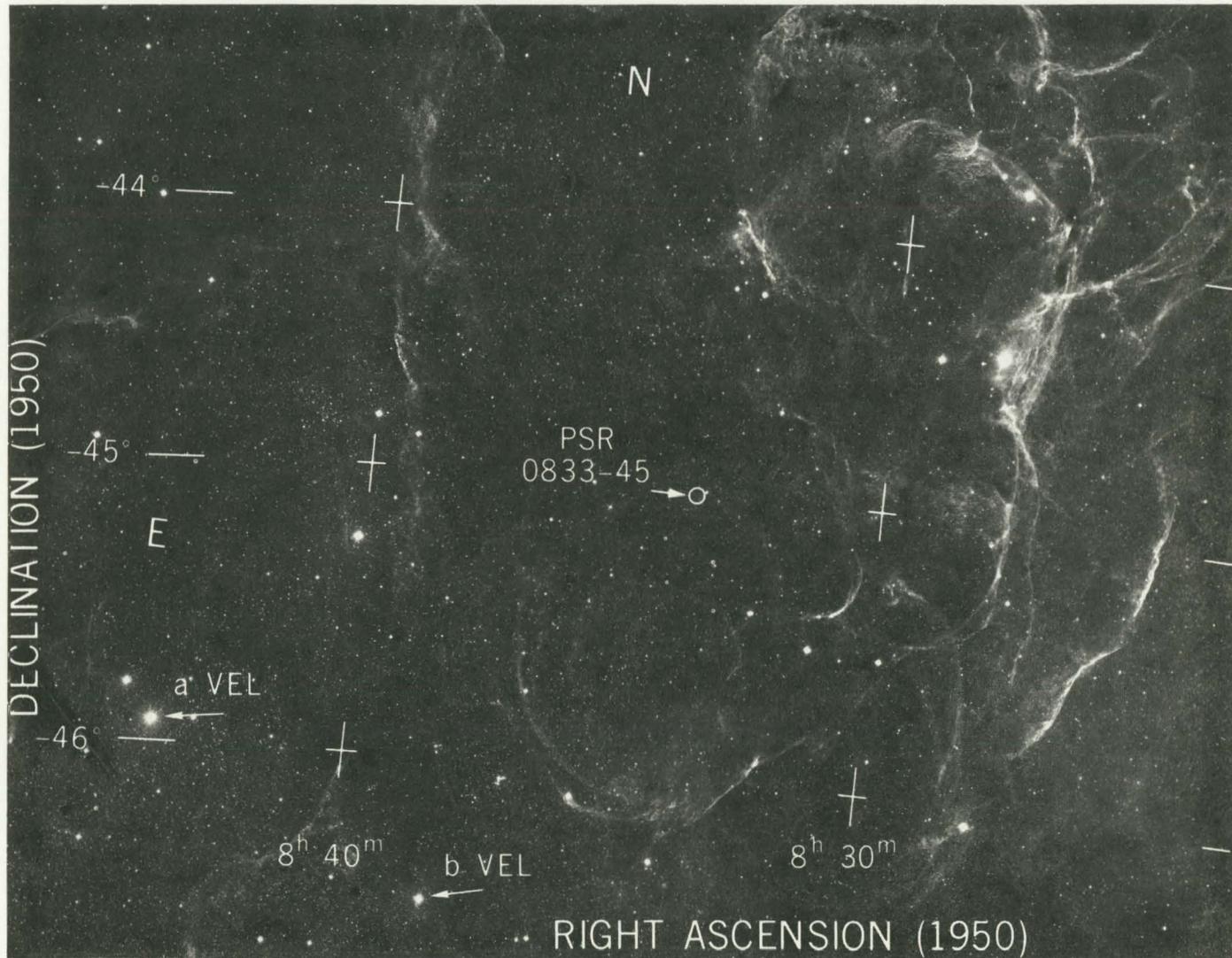


Figure 2. Photograph of the UV network of nebulosity associated with the Vela pulsar and supernova remnant. (B. J. Bok, Schmidt telescope at C.T.I.O.)

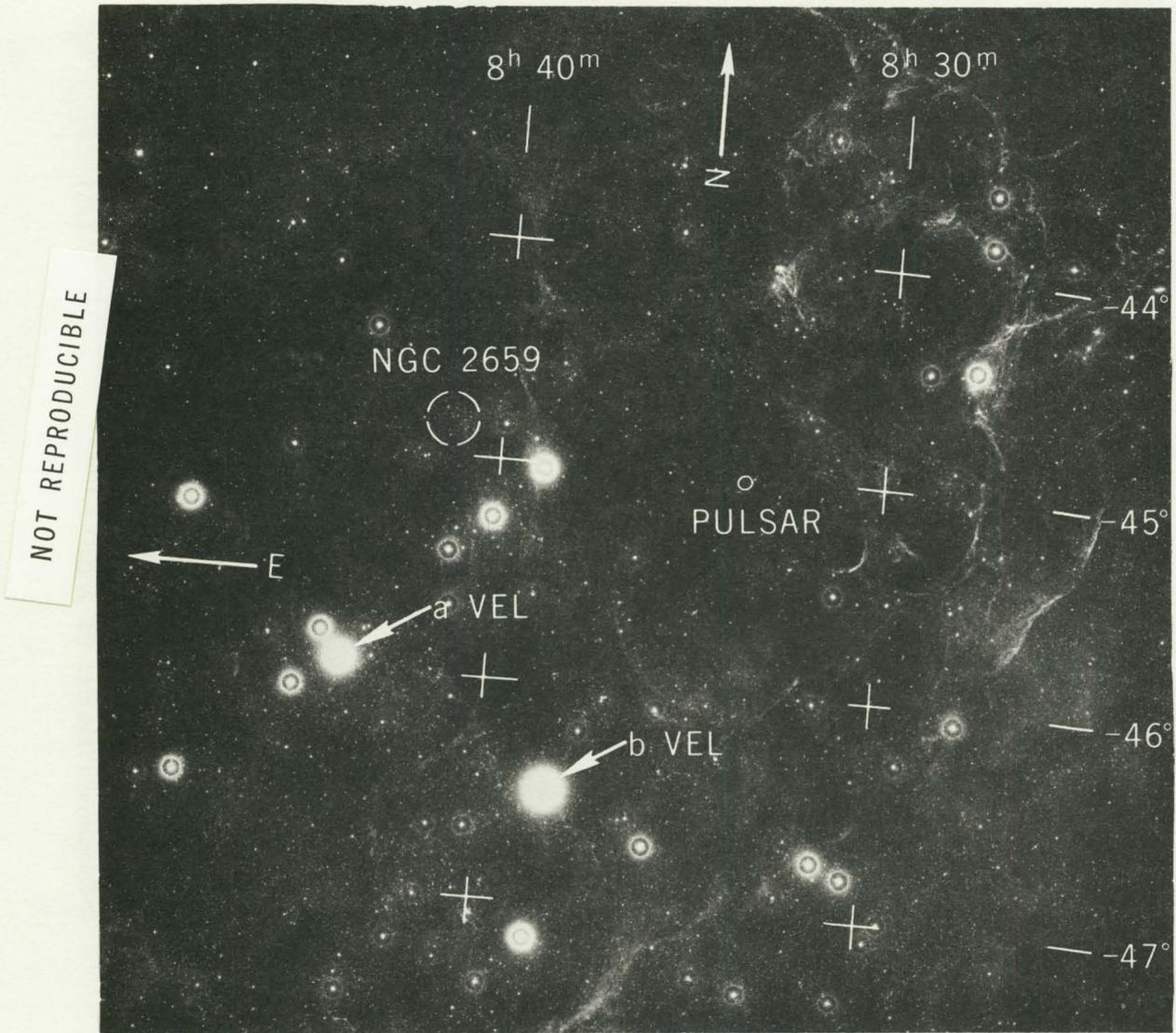


Figure 3. The region of Figure 2; 90-minute exposure on 098-01 emulsion, with RG2 filter. (B. J. Bok, Schmidt telescope at C.T.I.O.)