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A DISCUSSION OF THE GROUND-BASED RADIO OBSERVATIONS

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I wish to present a somewhat different interpretation of the radio observations. By way of preamble, I would like to remind ourselves of Bok's comment that this is not one single nebula, but rather it appears to be composed of several different entities.

I have examined all the southern surveys in the continuum, recombination line, H I, and OH. About 20 surveys are available altogether, although half of these do not go far enough in longitude or latitude to cover the region we are especially concerned with today.

Figure 1 shows a diagram by Mathewson, Healey, and Rome (1962) at a wavelength near 21 cm with a beamwidth of 0°.8. It shows a large extended region near the equator with some compact centers, covering a latitude range from -8° to +4°; this is the region of "the small Gum Nebula," the bright portion. A similar result was obtained in recent 11-cm observations at Parkes by Day and others. I have done some computations on a preliminary form of their diagram, but these observations have not yet been published.

The striking point is the large amount of high-frequency radio emission from this region, the "small nebula." In fact, the total is comparable with the amount seen in the direction of the Carina spiral arm, leading to the suggestion that there is much more in this direction than just the Gum Nebula. Hugh Johnson also remarked earlier that this region is somewhat reminiscent of an end-on spiral arm.

The continuum results at longer wavelengths have essentially been shown in the previous talk by Alexander. I believe that at all frequencies it is the fairly small nebula that we are seeing. At the lower frequencies, the antenna resolutions are not as good, and therefore the nebula of small angular size is going to spread out on the sky and resemble the shape of the big nebula. Again, in 21-cm H I data and in recombination-line observations the smaller feature can be seen, but not the large Gum Nebula.

I submit that the outer part of the Gum Nebula has not been seen in any radio observations so far, and only the inner part has been observed. I don't think it is justifiable to work out any parameters for the whole Gum Nebula through taking an average over the whole solid angle subtended by the big nebula. There appears to be a large difference in density between the small nebula and the big one.

The possibility of such a density difference has not been mentioned by the earlier speakers. It may well be, for example, that most of the electrons that are doing the pulsar dispersion in this region are in the smaller volume occupied by the brighter nebula. In that case, we do not need as much ionization as has been suggested.

I believe the problem is more complicated than has been suggested so far. We need more observations in the whole region, both radio and optical, and I think we should reserve judgment on some points as far as properties of the whole nebula are concerned.

Reference

Mathewson, D. C., Healey, J. R., and Rome, J. M. 1962, Aust. J. Phys., 15, 354.

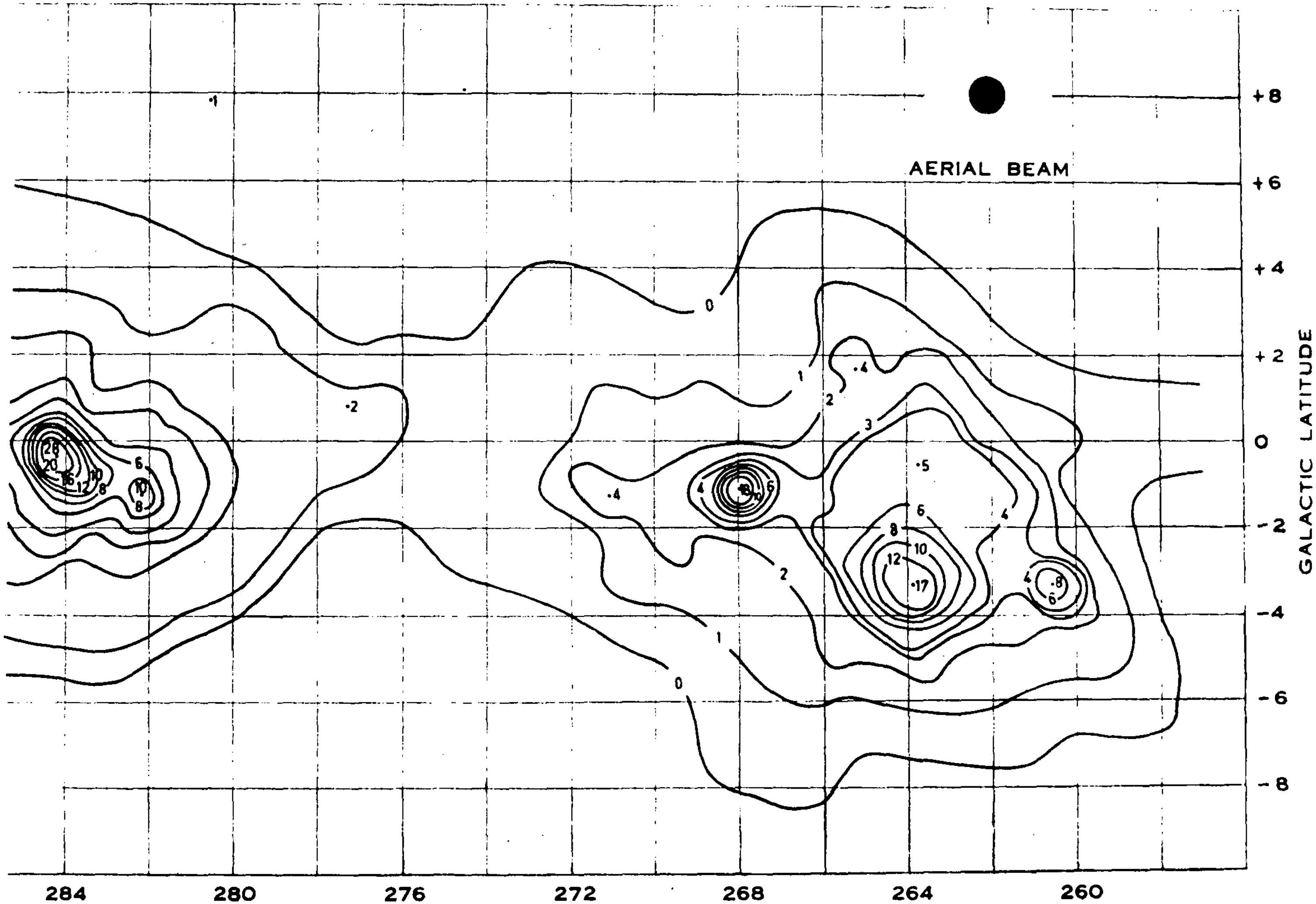

Figure 1. Isophotes of portion of the Southern Milky Way at 1440 MHz, with 50 arc min beamwidth (Mathewson, Healey, and Rome 1962).

DISCUSSION

R. McCray: What is the distinction between the large nebula and the small nebula?

F. J. Kerr: The diameter of the small nebula is about 30° and the diameter that has been suggested for the large nebula is 90°.

H. M. Johnson: It seems to me that the deductions so far made to compare dispersion and emission measures and to get the so-called clumpiness factor (X) – must still be very uncertain. I don't think the factor 65 is at all well-established. It is my personal opinion that it could be different by a factor of 10, and my only credential is Bart Bok's encouragement.

B. J. Bok: Your work on Orion changed the whole picture.

Johnson: The Orion region is so much denser that it doesn't necessarily have the same sort of structures that we are seeing here. In particular, Orion is concentrated toward the center, whereas this region seems to be hollow toward the center. So it seems to me that both the kind and the amount of clumpiness could be different.

A. K. Dupree: What recombination line sources did Dr. Kerr refer to?

Kerr: In Tom Wilson's catalog there are three sources in this general region.

J. K. Alexander: The temperatures from the recombination lines range from 7000°K to 11,000°K, and there are about five transitions that have been measured in the 6-18 cm wavelength range.

R. N. Manchester: I would like to make two points. First, for the pulsars used in the Gum Nebula model described by Brandt (other than PSR 0833-45), the dispersion measures are those obtained when the pulsars were discovered at Molonglo. There the instrument is limited to a bandwidth of 4 MHz at 408 MHz and dispersions were measured from analog recordings. Consequently the dispersion measures obtained are not very accurate. For example the Molonglo value for PSR 0818-13 was 25 ± 10 whereas I now obtain 40.8 ± 0.2. Similarly for PSR 1929 + 10 we have 8 ± 4 and 3.176 ± 0.003. One point in favor of Brandt's discussion is that the error tends to be independent of the size of the dispersion measure and so proportionally smaller for pulsars with large dispersion measures. However, for PSR 0736-40, which is one of the pulsars that was used, the Molonglo observers quote an error of ±10% but say that the measurement was made from "a few weak pulses," so, in fact it is probably not very accurate.

In principle, it is of course possible to measure these dispersion measures more accurately at Parkes or elsewhere. However, the large estimated errors in declination and period together with the weakness of many of the pulsars (the east-west arm of the Molonglo cross has over five times the collecting area of the 210-foot antenna at Parkes) make the measurements difficult. The second point is more fundamental and probably impossible to overcome; it is that the observed dispersion measure (even when accurately determined) does not necessarily yield a representative value of the mean electron density in the nebula. Because of irregularities in the medium, distances obtained from dispersion measures are probably uncertain by at least a factor or two. For example, Brandt et al. (1971) quote a "clumpiness factor" of 65 for the Gum Nebula. If the clump or filament diameter were about 1 pc, then the average line of sight would only intercept about 6 filaments. Obviously this number is very uncertain. However, it is clear that one must expect large differences in dispersion measures from pulsars at a given distance, especially when they are behind or within something like the Gum Nebula.

T. P. Stecher: I would like to propose an observational test. Certainly around gamma Vel and zeta Pup there would be a small H II region formed long ago, with the standard temperature of 10,000 °K. If the Morrison and Sartori picture is correct, that H II region should be unaffected by the blast, as it was already ionized. Thus it would remain relatively cool, and recombination lines would be observed from it.