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NEBULOSITY ASSOCIATED WITH THE POWERFUL INFRARED AND RADIO SOURCE G333·6–0·2

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SUMMARY

An emission nebulosity has been detected at the position of the infrared object in the radio H II region G333·6–0·2. The infrared and optical objects have about the same size (11 arcsec). The optical velocity is approximately the same as the H109α velocity. The optical object is probably heavily reddened.

Becklin *et al.* (1973) have found G333·6–0·2 to be the most luminous H II region known in the wavelength range 1–25 μ. The object was known previously as a radio continuum source at 5 GHz and 408 MHz (Goss & Shaver 1970; Shaver & Goss 1970a), an H109α emission source (Wilson *et al.* 1970) and a source of radio molecular lines (Goss, Manchester & Robinson 1970; Johnston *et al.* 1972). The source has also been observed at 21 cm (Goss *et al.* 1972). The spectrum has been studied from 8 μ to 13 μ and a neon abundance derived (Aitken & Jones 1974). The infrared observations indicate thermal emission from optically thin dust with (in the model of Aitken & Jones) extinction in a thicker, cold, dust envelope. The source has an apparent diameter of 3·1 arcmin at 408 MHz (Shaver & Goss 1970b). However, the infrared component is compact with a diameter of 11 arcsec (Becklin *et al.* 1973) which corresponds to 0·2 pc at the kinematic distance of 4 kpc (Goss *et al.* 1972). No optical counterpart of the source has been previously reported.

A number of direct photographs have now been obtained. All of them were taken at the Newtonian focus of the SAAO Radcliffe 1·88-m reflector in 1973 September and 1974 June. A 103aE+GG11 plate (Plate I(a)) shows the presence of a small diffuse nebulosity about 36 arcsec Spr the position of the infrared source given by Becklin *et al.* No other obvious nebulosities are seen on the plate (30 × 40 arcmin). The nebulosity was confirmed on two further plates, IaE+RG630 and IN+RG8.

Offsets kindly sent to us by Drs Aitken and Jones suggested that the infrared object was closer to the nebulosity than is indicated by the published position. The infrared photometer described by Glass (1973) was therefore used to scan the area at the Cassegrain focus of the 1·88-m reflector. The scanning was carried out at 2·2 μ and 3·4 μ. It was found that the infrared source (which was confirmed to have large J–K and K–L indices) coincided closely with the position of the observed nebulosity. Professor Becklin and his colleagues have kindly written to us confirming that the published position is incorrect. They find that their infrared source coincides with our nebulosity.

The nebulosity is of somewhat irregular shape. On the deepest E plate its approximate dimensions are 15 × 5 arcsec. This is close to the size of the infrared source (11 arcsec diameter) as obtained from scans (Becklin *et al.* 1973).

The near infrared photograph (IN+RG8, Plate I(b)) shows that whilst the nebulosity is present, its structure is different from on the E plates. In particular there are star-like objects within the nebulosity which are not seen on the E plates. If these are early type stars, rough magnitudes suggest $E_{B-V} \approx E_{V-I} > 3$ mag. Thus the nebulosity and associated stars are probably highly reddened. Quantitative measurements of the reddening would be desirable to place restrictions on possible models for the source. There are few optical determinations of the reddenings of compact H II regions though Feast (1974) found $E_{B-V} \sim 3{\cdot}6$ for the optical counterpart of G345·4–0·9 (H2–3).

A spectrum (140 Å mm^{-1}) of the nebulosity was obtained with a Carnegie image tube on the grating spectrograph at the Cassegrain focus of the 1·88-m reflector. This showed (weak) Hα and [N II] 6583 emission. Hβ emission was not seen. Since with this equipment Hβ appears stronger than Hα for an unreddened nebula this indicates that some reddening is present. Two spectra were obtained on successive nights covering the Hα region at 43 Å mm^{-1}. Measurement of Hα and [N II] 6583 on these plates yields a mean radial velocity of -40 ± 5 km s^{-1} or -38 km s^{-1} with respect to the local standard of rest (this latter as used in the H109α survey of Wilson *et al.* 1970). On each night two spectra were obtained of the planetary nebula IC 4642 which is in the same part of the sky. Measurement of Hα on each of these four plates yields a mean velocity of $+46 \pm 5$ km s^{-1}. This agrees well with the published velocity of the object, $+44$ km s^{-1} (Campbell & Moore 1918; Evans 1964). The standard error quoted for IC 4642 and the new nebulosity was obtained from an intercomparison of the four plates of IC 4642. The optical velocity of the new nebulosity is 10 km s^{-1} greater than the H109α velocity ($-48{\cdot}3 \pm 0{\cdot}9$ km s^{-1}, Wilson *et al.* 1970). This is only twice the optical standard error. Furthermore the optical velocity presumably refers to a smaller region of the nebula than the H109α velocity and the velocity dispersion within a given nebula can be ~ 15 km s^{-1} (e.g. Smith & Weedman 1971). In view of these considerations there is satisfactory agreement between the optical and H109α velocities.

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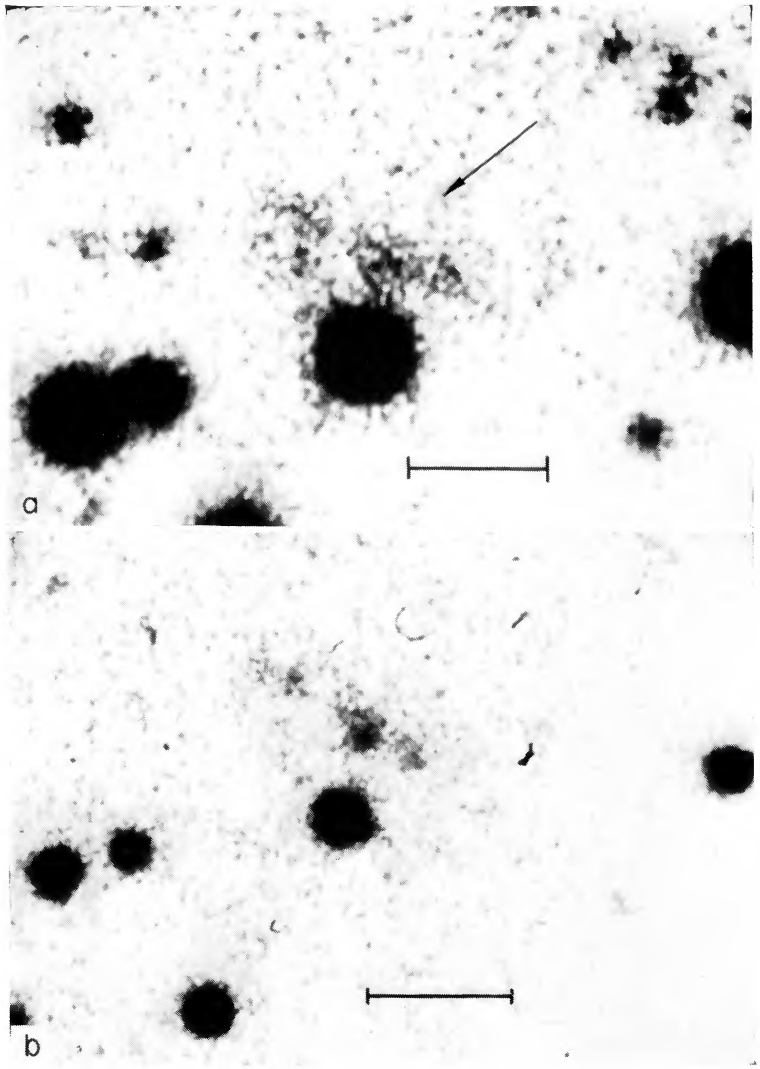

PLATE I. (*a*) *The region of G*333·6–0·2 *from a* 103*aE*+*GG*11 *plate. The nebulosity is arrowed on Plate I* (*a*). (*b*) *The nebulosity on a IN*+*RG*8 *plate. North at top, east at left. The scale bars correspond to* 10 *arcsec.*

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