RADIO OBSERVATIONS OF H II REGIONS IN M33*

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Abstract. The Westerbork Synthesis Radio Telescope was used to map the continuum radiation of M33 at 1415 MHz. Of 67 radio sources with fluxes $S > 1.8$ mJy (3σ), 60% coincide with Hα sources. These are all intrinsically stronger than $4 \times$ the Orion nebula, i.e., they are giant H II regions. The two strongest sources, NGC 604 (58 mJy) and NGC 595 (20 mJy), are similar to W51.

A map of the continuum radiation of M33 at 1415 MHz has been obtained using the Westerbork Synthesis Radio Telescope. The object was followed across the sky by 4×20 interferometers during 4×12 h. The resulting synthesized beam is $23'' \times 45''$, the field of view 0.5 deg, corresponding to 80 pc $\times$ 160 pc and 7 kpc, respectively, if one adopts a distance of 720 kpc. The rms noise σ was 0.6 mJy per synthesized beam.

The map shows a large number of small sources, virtually all point sources. It shows neither a continuous arm structure (such as in M51), nor a nucleus, indicating that perhaps little nonthermal action is going on in M33. The radio map was compared to a high quality, narrow filter Hα photograph, obtained by J. Boulesteix and G. Comte from the Marseille Observatory at the Obervatoire de Haute Provence. Out of the 67 sources in the radio map with fluxes $S > 3\sigma (= 1.8$ mJy) 60% appear to coincide with objects in the Hα photographs. It is assumed that these sources are all H II regions; they will be called 'the identified sources.' Even a significant fraction (27%) of the 100 sources with $2\sigma < S < 3\sigma$ show a good correlation in position with H II regions. All identified sources appear unresolved or hardly resolved with the exception of the two strongest sources: NGC 604 (58 mJy) and NGC 595 (20 mJy). These two sources will be dealt with separately. Some of the major conclusions about the other sources are as follows.

(1) The number of sources, $n(S)\,\mathrm{d}S$, increases strongly with decreasing flux, S, approximately as $S^{-3.1}\,\mathrm{d}S$. Extrapolating to lower flux limits it appears possible to explain most of the flux from M33 in the 21-cm continuum as being of a thermal origin.

(2) To obtain the diameter of the point sources it was assumed that the optical diameters equal the radio diameters. From the diameter and the flux one then derives n_e(rms) and the linear diameter d and all the quantities that follow therefrom (excitation parameter $u \propto n_e^2 d^3$, mass of ionized gas $M \propto n_e d^3$; emission measure $EM \propto n_e^2 d$). The masses of ionized gas run up to $2 \times 10^5\ M_\odot$, the diameters up to 120 pc, and the required ionizing flux to the equal of five O5 stars. (It should be pointed out that all identified sources are intrinsically stronger than $4 \times$ the Orion nebula, which classifies them as giant H II regions.)

(3) There is a clear correlation between the surface density (by number) of H II regions and the surface density of H I.

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(4) The surface density (by number) of H II regions decreases outward. It is highest between 1 and 2 kpc. (However, the surface density within 1 kpc is poorly determined.) The decrease in surface density is probably even more pronounced in the large H II regions.

The two outstanding nebulae, NGC 595 and NGC 694, have ionized gas masses of 5×10^5 and 22×10^5 $M_\odot$, sizes of 140 and 270 pc, and they require for their excitation 11 and 33 O5 stars, respectively. These values are rather similar to those of the (super) giant galactic H II region W51. However, they appear small compared to complexes such as 30 Doradus in the Large Magellanic Cloud and object 44 in NGC 2403.

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