20cm Observations of a SNR Candidate in M31

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Abstract

We present our results from 1. GHz radio observations the SNR candidate in M31, GLG123. These observations were made with the VLA in the A configuration on April 9, 2006. We obtained about 1 hour on source. We detect GLG123 and find a flux density of 7.25 mJy. Then we compute the spectral index index to be α = -0.849, which verifies that it is an SNR.

Introduction

GLG 123 is a luminous source in the nearby galaxy M31 which is believed to be a supernova remnant. This object was identified at 90 cm in the wide-field study of M31 carried out by Gelfand et al. (2005). A rough spectral index (90/20 cm) for this source was calculated based on previous survey observations at 20 cm. The observations described here allow us to map the structure of the emitted flux from the radio source and calculate a more reliable spectral index of this source. Finally, utilizing the known distance to M31 and the observed angular dimensions, we can estimate the linear size of GLG 123.

Observations & Imaging

A 75 minute observation at 1.465 GHz in A configuration was made of the SNR candidate GLG123 and a phase calibrator was observed every 15 minutes. 3C48 was used as a flux density calibrator. The source will be referred to as M31SNR. For the total intensity image of M31SNR with a cell size of 0.25 and an image size of 256 x 256, our beam size was 1.28 x 1.12 and the average rms level was 0.047 mJy/beam. This process was repeated to create images of Stokes' QUV. It is important to note that the beam size for M31SNR is on the order of the size of M31SNR itself.

Results

We began by finding the average rms of each image. For M31SNR, our value was 0.047 mJy/beam (with a beam size of 1.28 x 1.12) which is also higher than the expected value of 0.021 mJy. For M31SNR, we used tvbox to define a circle of radius as close as we could to that of the visible flux of M31SNR and *imstat* to obtain the value for the flux density. AIPS reported a flux density value of 7.25 mJy. Once the values for the noise of each image and flux density were known, we were then able to determine our signal-to-noise ratio. M31SNR had a signal-to-noise ratio of 154. We also ran jmfit on the source and found that it was unlikely to be resolved with our resolution and so the size can be given by the beamsize – 1.28" x 1.12".

For the M31 SNR, it was possible to convert its angular size ('') using the small-angle formula (Eq. 1.1) to determine a linear size (in the same units as D_{M31}) for the source.

$$d_{linear} = \frac{d_{angular('')}\left(D_{3C441,M31}\right)}{206,265} \tag{1.1}$$

For a distance of 780 kpc to M31 and angular dimensions of 1.28” x 1.12”, we computed the linear size of M31SNR to be 4.8 pc x 4.2 pc. This is smaller than the value of <20 pc x <17 pc given in Gelfand et al. (2005), however, the source was unresolved in their data and it is likely that the source is still unresolved in our data, too.

A final, important calculation was determining M31SNR’s spectral index which would confirm or deny its current candidacy as a supernova remnant. In combination with the flux density at 90 cm, which was 26.01 mJy, we were able to use our result of the flux density at 20 cm and the simple relation in Eq 1.2 to determine the spectral index, α.

$$S \propto \nu^{\alpha} \tag{1.2}$$

Therefore, we use the following expression for our measurement at 20 cm and the Gelfand et al. (2005) flux density at 90 cm:

$$\frac{s_{20}}{s_{90}} = \left(\frac{\nu_{20}}{\nu_{90}}\right)^{\alpha} \tag{1.3}$$

We get a value for a=-0.833. This value differs slightly from the value of -0.76 found by Gelfand et al. (2005), but it is in the range of -1.0 and -0.3 which would confirm GLG123 is a supernova remnant!

References

Gelfand, D. et al. 2005, ApJS, 159, 242

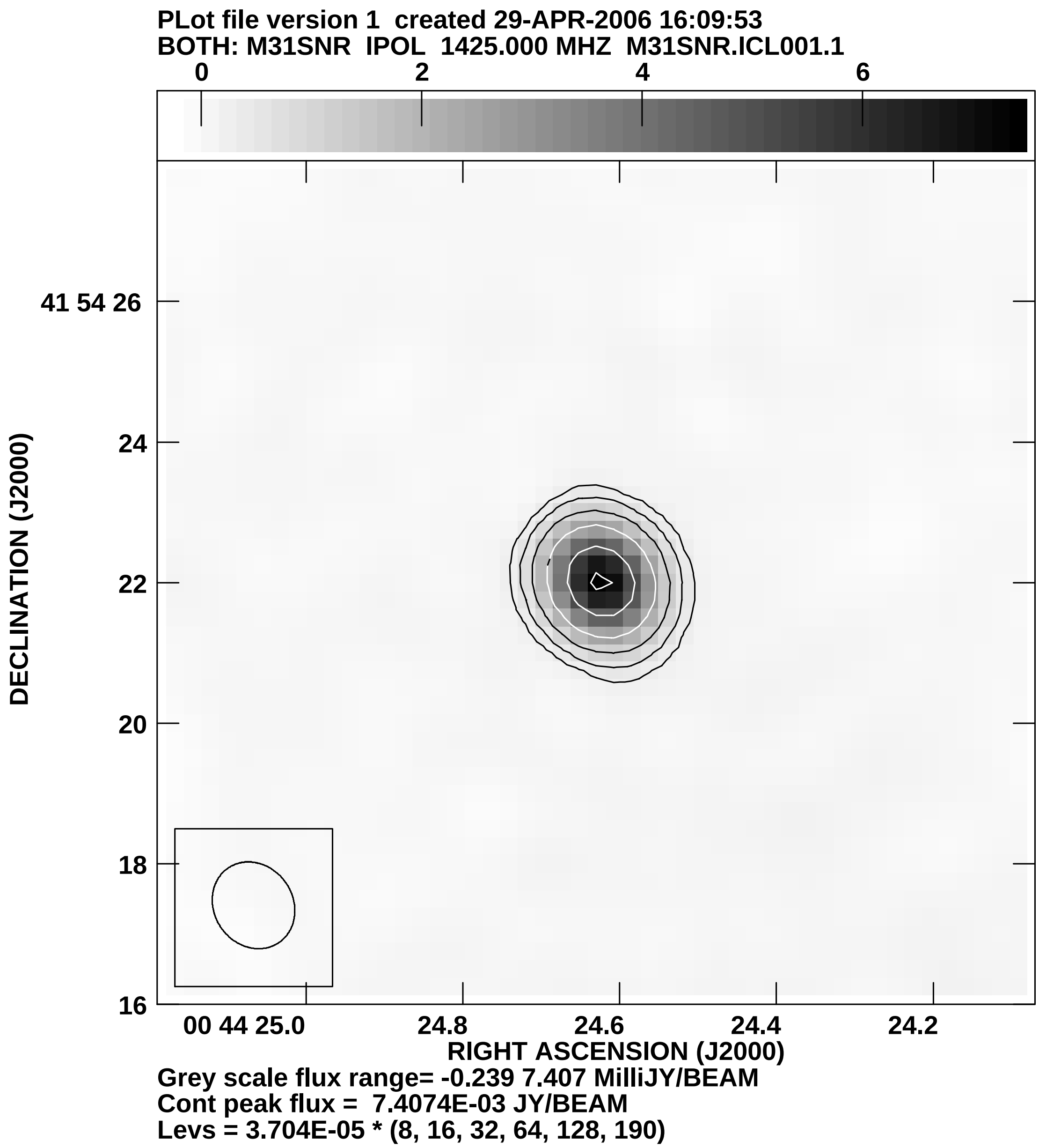

Figure 1: A 1.4 GHz continuum image of the SNR in M31. The resolution of our image is 1.28 x 1.12" and the source is unresolved at this current resolution. The rms level in our image is 47 microJy/beam and contours represent 6, 12, 25, 50, 100 and 150 times the rms level.