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Tick tock – the 12.2 GHz methanol masers in G9.62+0.20

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Abstract. The bright interstellar methanol masers at 12.2 GHz and 6.7 GHz were discovered in 1987 and 1991 respectively. It was soon established that many were quite variable. Goedhart, Gaylard & van der Walt (2003) reported that one source, G9.62+0.20E, exhibited flares at 12.2 and 6.7 GHz that appeared to be periodic, repeating every 246 days. Since then, monitoring of this and other possibly periodic sources has continued with the 26-m Hartebeesthoek telescope. We discuss here the full 12.2 GHz time series data of G9.62+0.20 through 2006. The data quality has been much improved by telescope upgrades. Flares in the main maser peak continue, the repetition rate remains close to that originally determined.

Keywords. radio lines: ISM, stars: formation

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1. Introduction

The discovery of apparently regular brightness variations in the 6.7 GHz methanol masers in G9.62+0.20 by Goedhart, Gaylard & van der Walt (2003), and in several other sources by Goedhart, Gaylard & van der Walt (2004), came as a surprise.

Monitoring of G9.62+0.20 at 12.2 GHz showed that the relative amplitude of the variations was much greater than at 6.7 GHz. The regularity of the flaring contrasted with the repetitive but aperiodic flaring of G351.78-0.54 at 6.7 GHz reported by Macleod & Gaylard (1996) and Goedhart, Gaylard & van der Walt (2004). A period of 246 days gave the best fit to the data available to Goedhart *et al.* (2003) and permitted the mapping of the source during a flare by Goedhart, Minier, Gaylard *et al.* (2005) at 12.2 GHz using the VLBA. This showed that existing masers spots brightened during a flare, but no changes in morphology occurred. Monitoring has continued at both 6.7 and 12.2 GHz, and we report on the latter here.

2. Observations

During this period of monitoring with the 26-m Hartebeesthoek telescope, the main reflecting surface was replaced with more accurate solid panels. The aperture efficiency at 12 GHz fell from 0.20 to 0.10 before rising to 0.45 when the new panels were aligned. In addition, the 12 GHz receiver was converted from single to dual polarization, the 1x256-channel spectrometer was replaced with a new 2x1024 channel spectrometer and the telescope control system was converted from minicomputers to PC's running Linux.

Calibration during these major changes was based on contemporaneous monitoring of Virgo A (which is partly resolved), 3C123, 3C218 and the maser source G351.42+0.64, which was previously found to show little variation. The minimal variation seen in weaker peaks of G9.62+0.20 provided an internal consistency check.

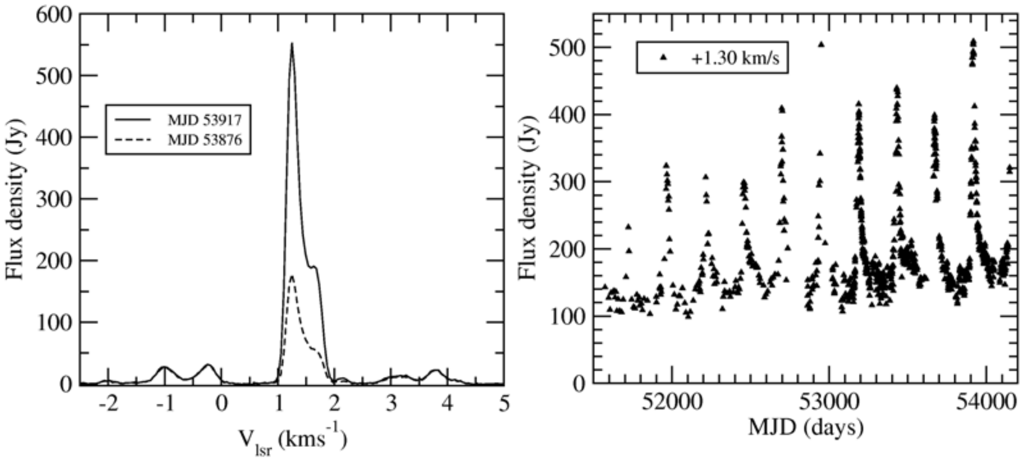

Figure 1. Spectra of G9.62+0.20 at the minimum and maximum of a recent flare, and the time series of the brightest maser peak.

3. Results

Typical spectra obtained with the upgraded 26-m telescope are shown in figure 1. It can be seen that only the maser peaks at velocities between 0.5 and 2.5 kms^{-1} flare strongly at 12.2 GHz. The program Period04 of Lenz & Breger (2005) was used to obtain the periodogram of the strongest peak using the time series shown in figure 1. The full data set gave a period of 243.0 days, the first half 242.2 days and the second half 242.5 days. Epoch-folding was used as an alternative period tester, the L-statistic of Davies (1990) being employed. The results are consistent with a period of 243 to 244 days. Plots of the folded time series showed that a shorter period, such as 242 days, provides the best alignment of the rising edges of the flares, but a longer period, such as 244 days, best aligns the falling edges, owing to differences in flare duration.

4. Discussion

Despite almost every piece of hardware and software involved in the monitoring having been replaced, the large amplitude flares remain. Within present experimental uncertainty they appear to have an unchanging period. The extreme regularity of the phenomenon over seven years argues for a strongly deterministic cause. The length of the interval between flares suggest orbital motion of a secondary object around the primary forming star could be the origin of the regular variations. However this possibility needs to be evaluated in the context of the different types of light curves seen in other methanol masers showing similar regularity.

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