# Ultra-precise monitoring of a class I methanol maser

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In collaboration with:

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Periodic class II methanol masers are an enigmatic and poorly understood phenomenon (about 30 such sources are known). The Australia Telescope Compact Array (ATCA) has been used to carry out a monitoring campaign of G331.13-0.24, which included class I maser at 9.9 GHz. Unexpectedly, the project resulted in numerous improvements of the data reduction software and procedures (done in response to the oddities seen in the monitoring data) and enabled control of the systematics at an unprecedented level.

- Simultaneous monitoring of the 9.9 GHz (class I) and 6.7 GHz (class II) methanol masers (which have different pumping mechanisms) in an attempt to distinguish variations in seed radiation vs. pumping.
- First long-term monitoring of a class I methanol maser
- The two masers are not co-located, but seen projected onto the same HII region (see the next poster for an image)
- The 6.7 GHz maser in the source has a period of about 500 days. The period is not well-defined because the majority of spectral features have quasi-periodic behaviour with notable changes from one period to another.
- The 9.9 GHz maser has a very simple spectrum with just one component well described by a Gaussian.
- One 2h observation about every 20 days for about 7 years
- High 488 Hz spectral resolution (< 15 m $s^{-1}$ at 9.9 GHz), good SNR and profile fit allowed us to accurately measure the radial velocity

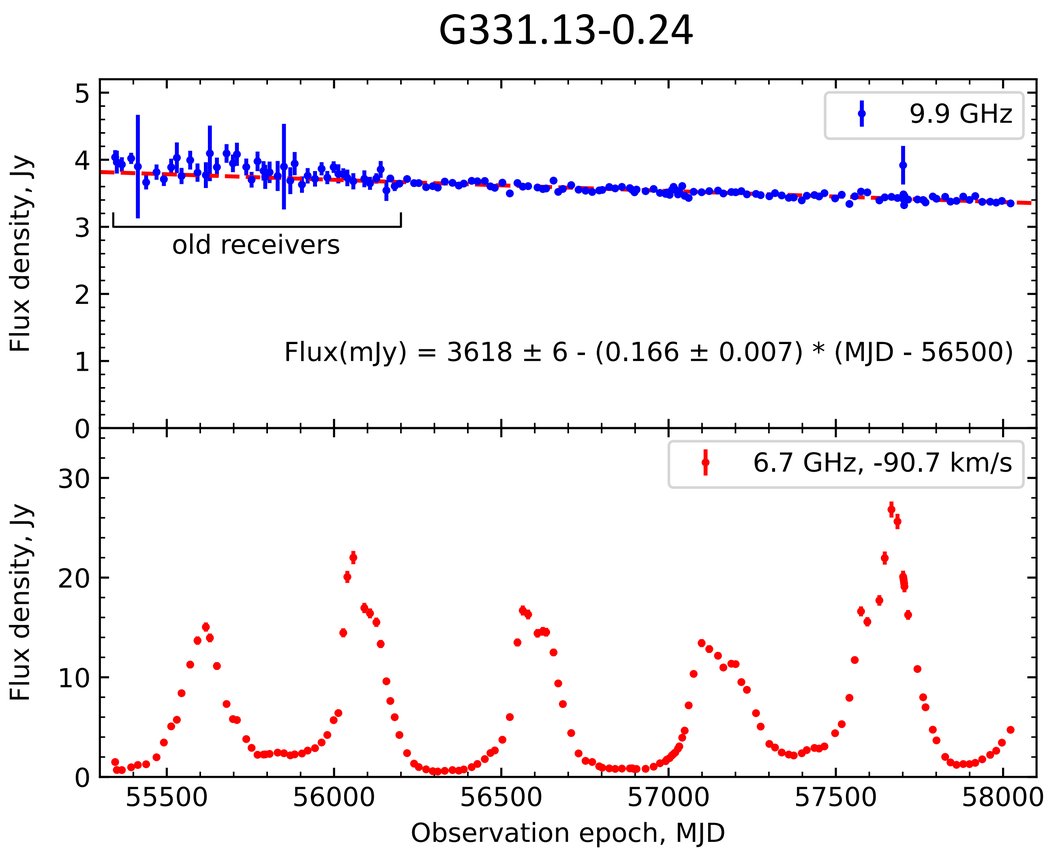


**Figure 1:** Flux density time series for the 9.9 GHz maser (top) and the most periodic feature of the 6.7 GHz maser (bottom). Note a steady decline of the flux density at 9.9 GHz.

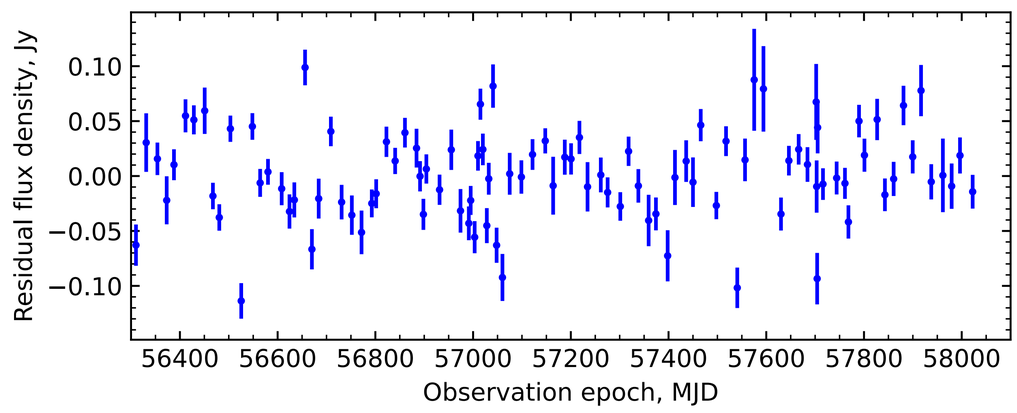


**Figure 2:** Residual flux density of the 9.9 GHz maser after the linear trend shown in Fig. 1 has been removed.

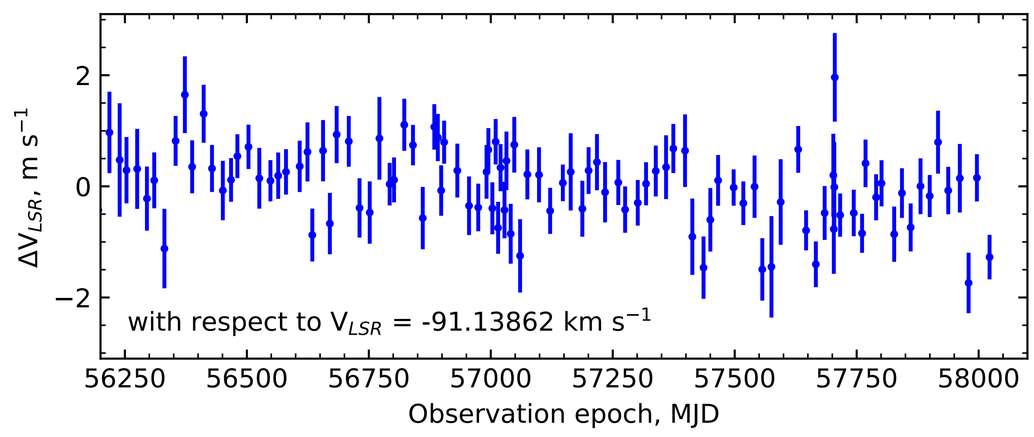


**Figure 3:** Radial velocity time series. There could be a periodic wobble with the period close to that of the 6.7 GHz maser.

## Results

- The class I methanol maser at 9.9 GHz shows a very stable decline of the flux density at the rate of 166±7 μJy $day^{-1}$.
- No periodic flux variation was found at a similar period to the class II maser (the residual has a weak annual variation which is believed to be instrumental).
- The radial velocity is stable down to about m $s^{-1}$ level, but there could be a marginal (comparable to the level of the systematics in the residual) periodic component with the period of 475±22 days, close to that of the 6.7 GHz maser in the source.
- Lack of observed acceleration implies the minimum distance between the maser and the YSO (between 120 and 4300 au for a 10 $M_\odot$ YSO).
- No hyperfine split was detected which suggests preferential excitation of a single hyperfine transition.



FOR FURTHER INFORMATION

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https://www.narrabri.atnf.csiro.au/people/vor010/presentations/iaus380monitoring.html