Understanding periodic flares of methanol masers

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Introduction

The discovery of a small number of periodically variable 6.7-GHz methanol masers has been an intriguing find of the last decade. The theory of these periodic flare events is still in an early stage of development, but appears to require the presence of multiple high-mass stars forming, or substantial inhomogeneities in the accretion disc around a single high-mass star (e.g. van der Walt et al. 2009; Sobolev et al. 2007). Using the Australia Telescope Compact Array, by simultaneous monitoring of two, differently pumped, maser transitions of methanol, we hope to be able to determine the source of the variability: the infrared radiation which pumps the 6.7-GHz maser quenches the emission of the 9.9-GHz maser. Hence if both transitions have correlated flares, the origin of the variability is the underlying continuum emission.

The target source: G331.13-0.24

- One of the few known periodically variable 6.7-GHz masers (see Figure 1) with the longest period of about 512 days among all such masers.
- The only currently known star-forming region which hosts both the periodically variable 6.7-GHz methanol maser and a 9.9-GHz methanol maser.
- Masers are projected onto an HII region (see Figure 2) and are not co-located. Flares of different 6.7-GHz spectral features are delayed with respect to each other by up to two weeks.
- The pumping mechanisms of the 9.9-GHz and 6.7-GHz masers are in conflict: the former is pumped by collisions and the latter by infrared radiation.
- Both 9.9-GHz and 6.7-GHz masers are expected to react the same way to the change in continuum emission.

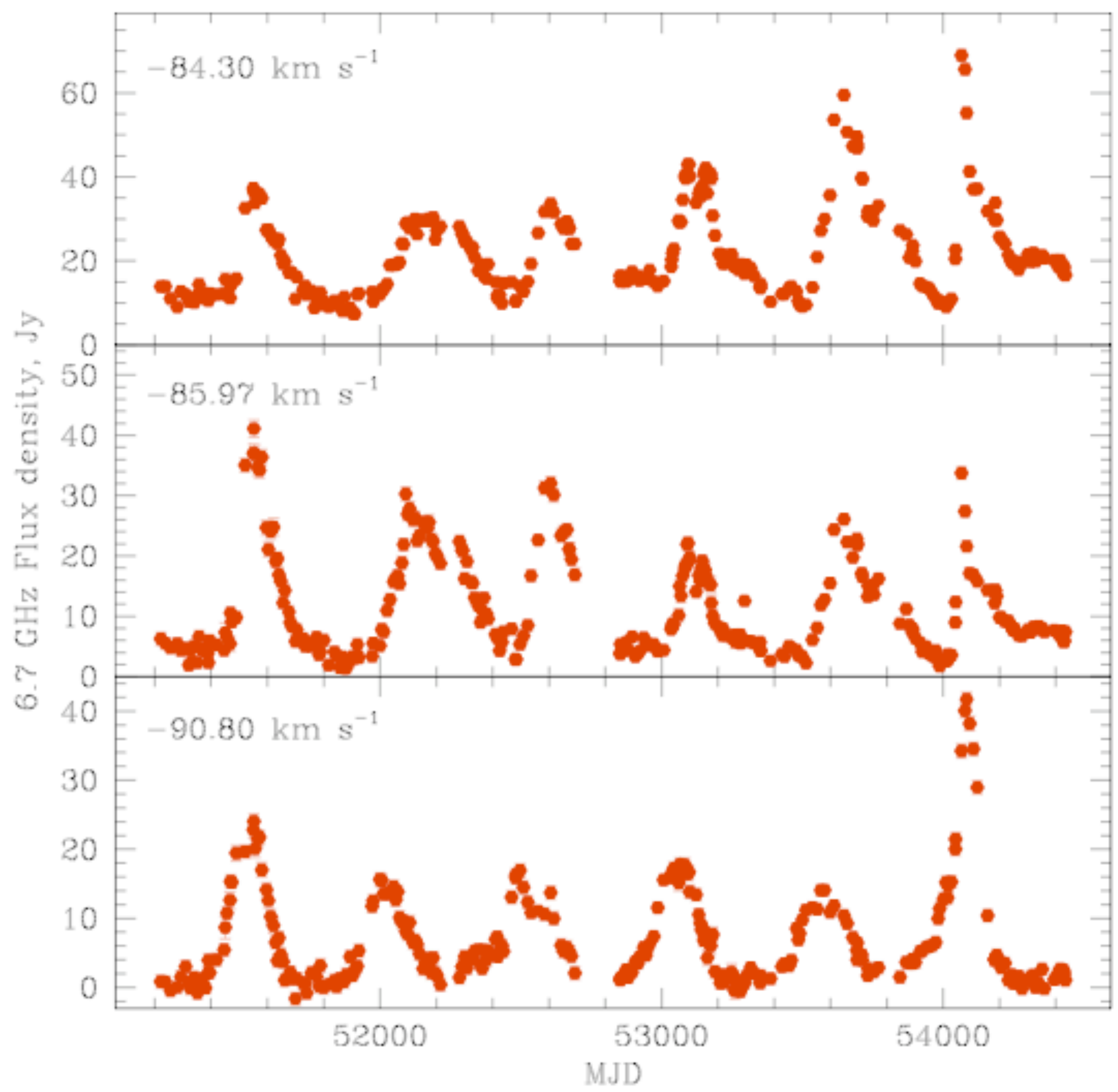

Figure 1: Light curves for selected spectral features of the 6.7 GHz maser in G331.13-0.24 obtained with Hartebeesthoek radio telescope (Goedhart et al. 2004 and some more recent monitoring data obtained by the same team)

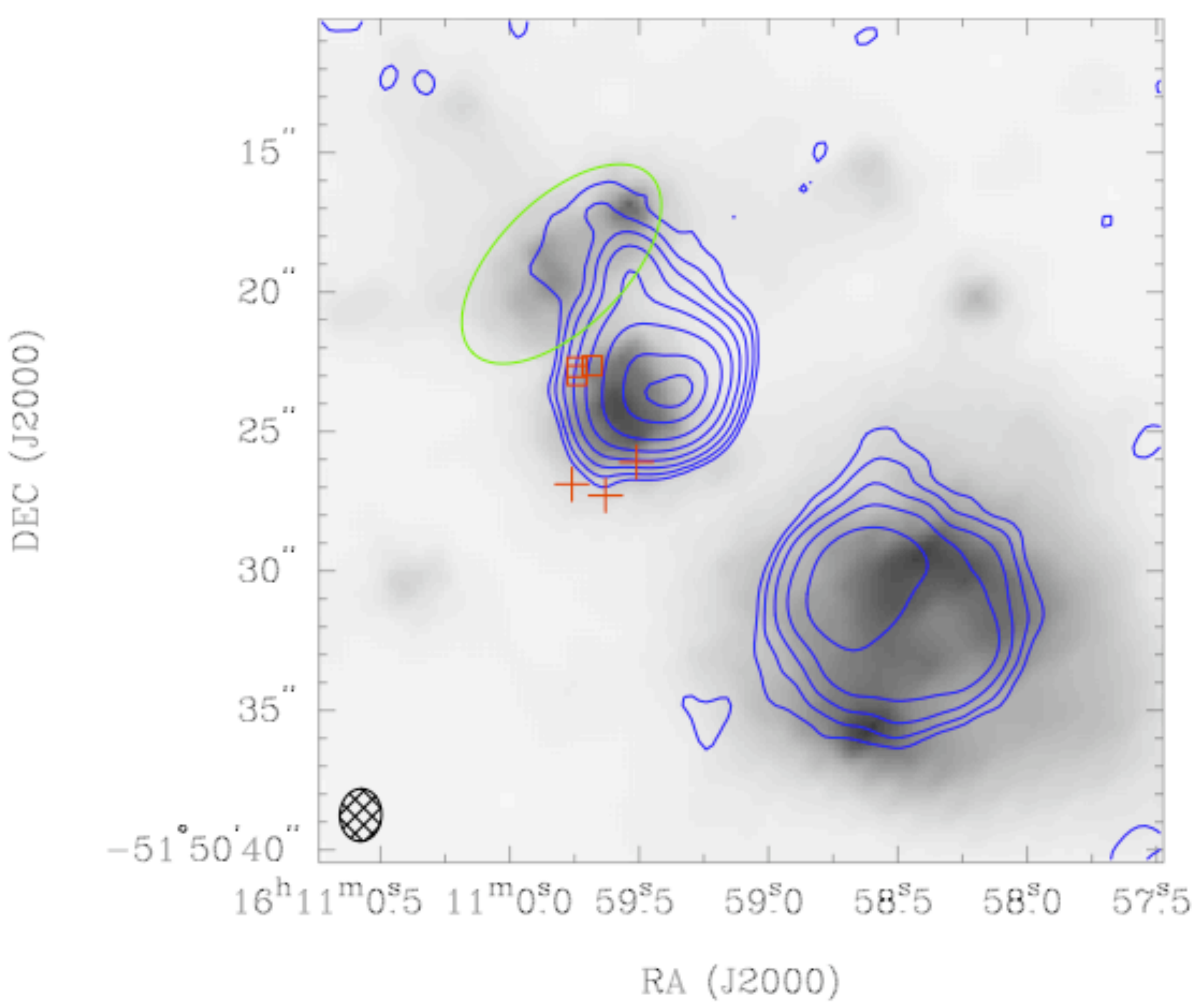

Figure 2: The morphology of G331.13-0.24. Background is the 4.5-μm Spitzer IRAC image (green ellipse shows the area of a notable excess of the 4.5-μm emission), open squares show positions of the different features of the 6.7-GHz maser, crosses represent different position measurements of the 9.9-GHz masers (for more information see Voronkov et al. 2010). The 8-GHz continuum image of Phillips et al. (1998) is shown by contours.

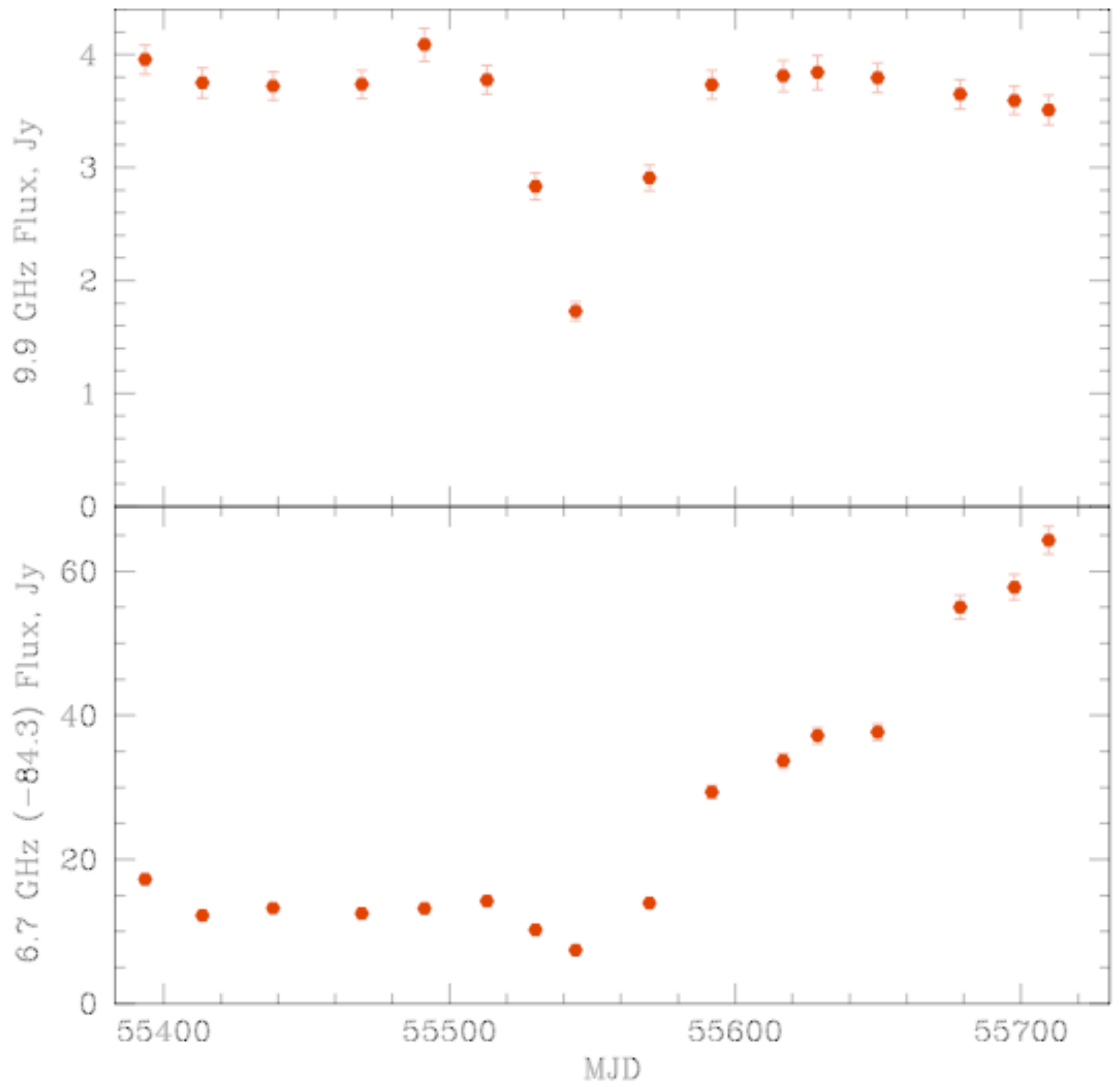

Figure 3: Results of the ATCA monitoring of masers in G331.13-0.24: light curves of the 9.9-GHz maser and one of the strongest spectral features (-84.30 km s^{-1}) at 6.7-GHz.

Conclusion

We present the first year of monitoring data which has revealed a quasi-simultaneous dip in the light curves of both transitions. This dip likely points at dimming of the HII region. There is also a hint of a monotonic fall of the 9.9-GHz flux towards the end of the time series, which is coincident with the rise of the 6.7-GHz flux (-84.3 km s^{-1} feature). Unlike for the dip, this points to a pumping disturbance (most likely a boost of the infrared flux).

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References

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Acknowledgements

The Australia telescope is funded by the Commonwealth of Australia for operations as a National Facility managed by CSIRO. This research has made use of data products from the GLIMPSE survey, which is a legacy science program of the Spitzer Space Telescope, funded by the National Aeronautics and Space Administration. We also used data obtained with the Hartebeesthoek 26-m radio telescope.

Further information

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