

Understanding periodic flares of methanol masers

Maxim Voronkov

(Maxim.Voronkov@csiro.au)

CSIRO - Australia Telescope National Facility

in collaboration with

S.Goedhart, J.L.Caswell, S.P.Ellingsen, A.M.Sobolev, M.Gaylard, A.B.Ostrovskii

Sydney - Astrofest, 04.11.2008

Understanding periodic flares



S.Goedhart, J.

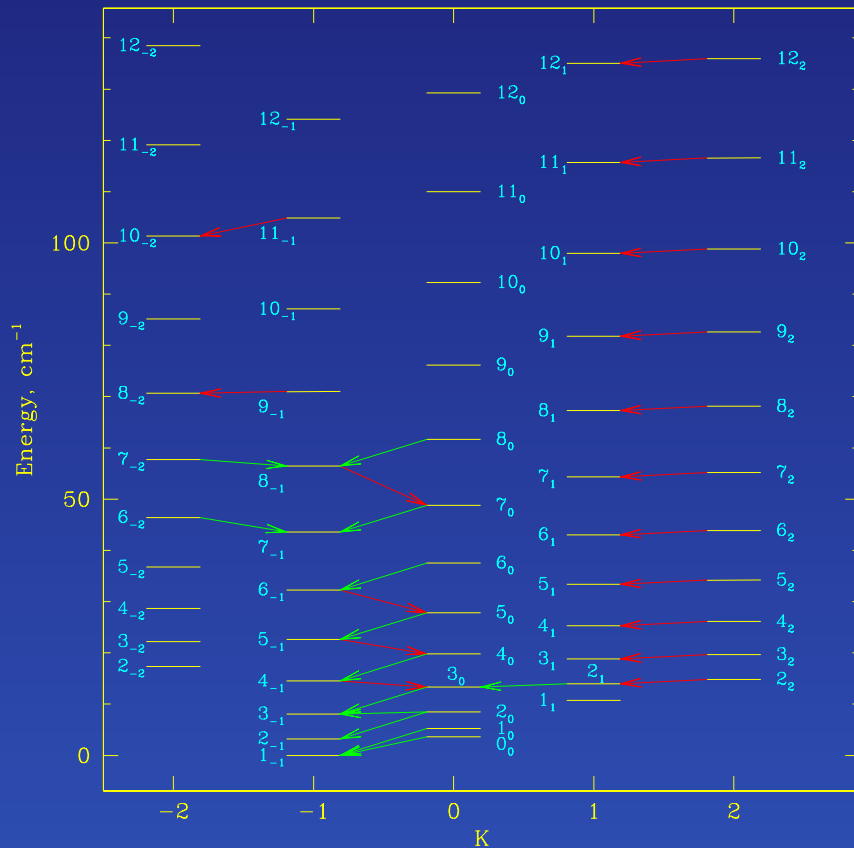
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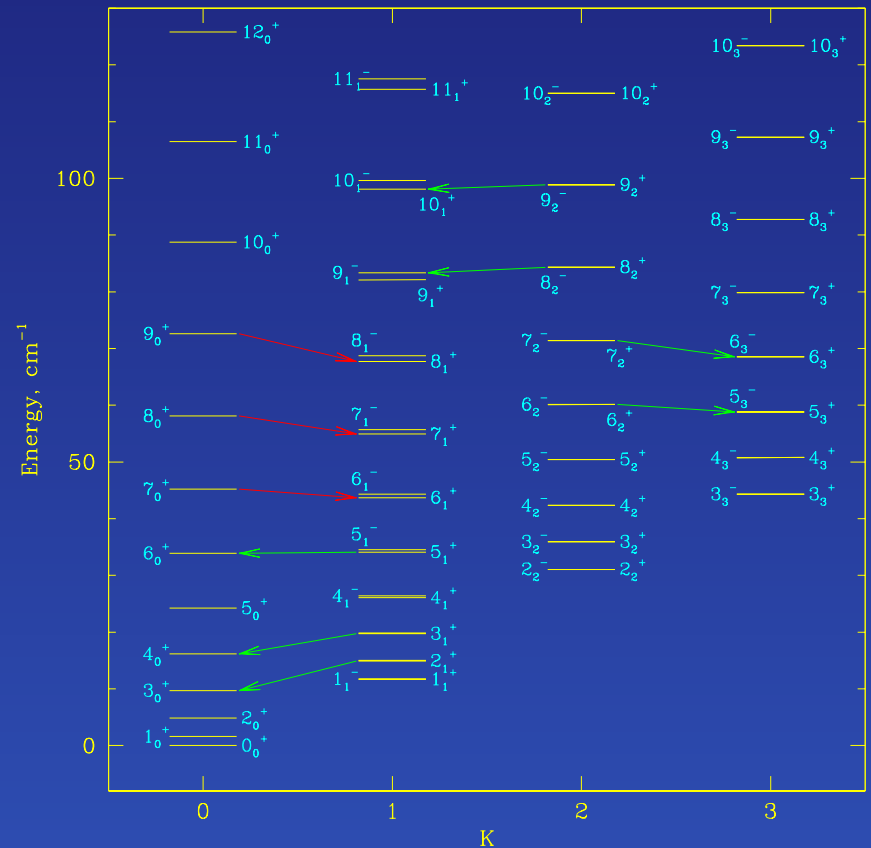
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Energy levels of methanol

E-methanol



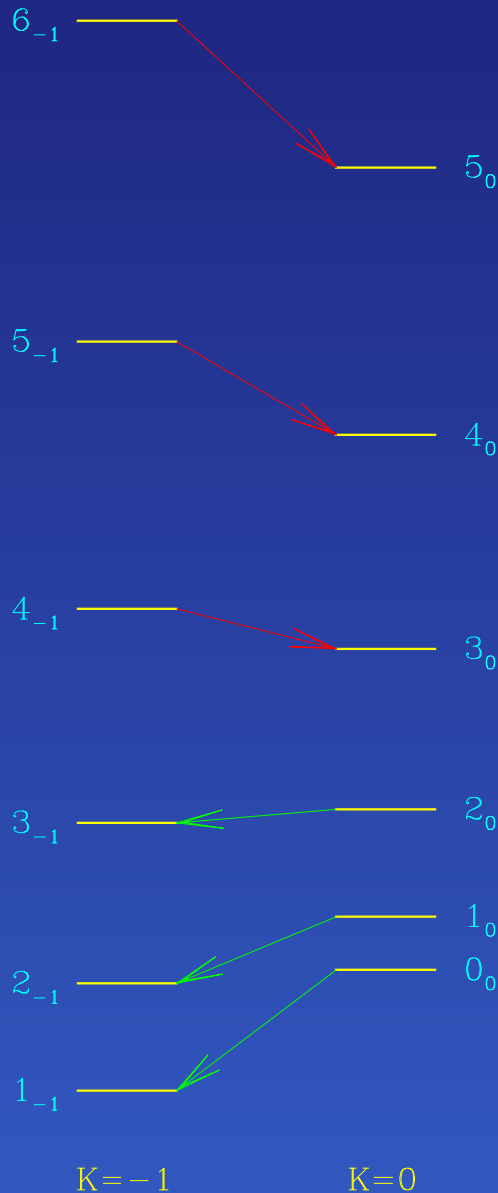
A-methanol



Class I (red arrows) Found away from infrared sources/protostar locations

Class II (green arrows) Found associated with infrared sources/protostar locations

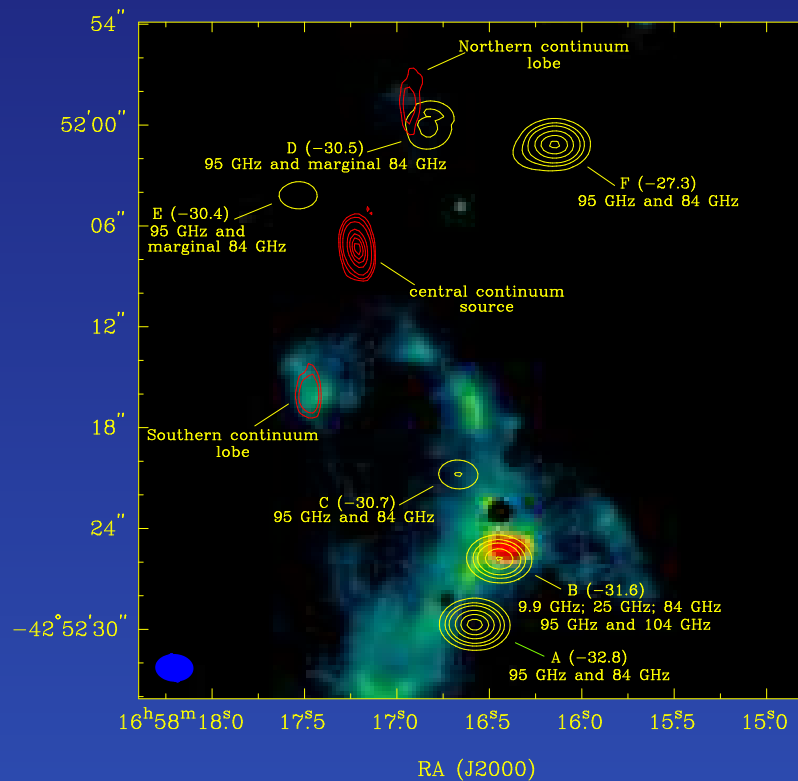
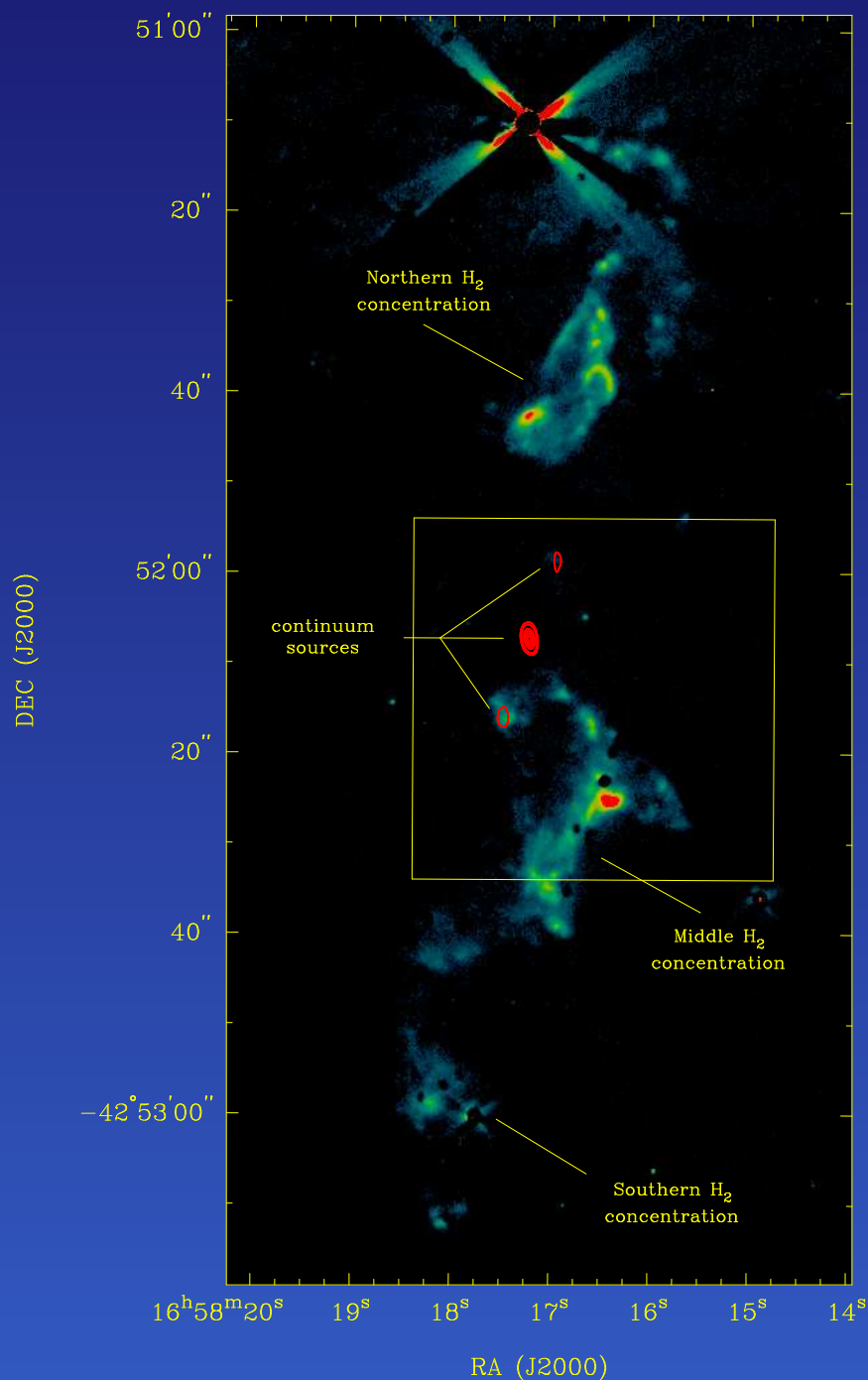
Pumping



- Class I masers \Rightarrow collisional pumping
- Class II masers \Rightarrow pumping by the dust radiation
- Strong masers of different classes should never co-exist in the strict theoretical sense (or co-propagate in other words)
- Masers of different classes are often present in the same star-forming region at some distance from each other. A projection to the same apparent direction is also possible
- The case of weak masers requires a special study

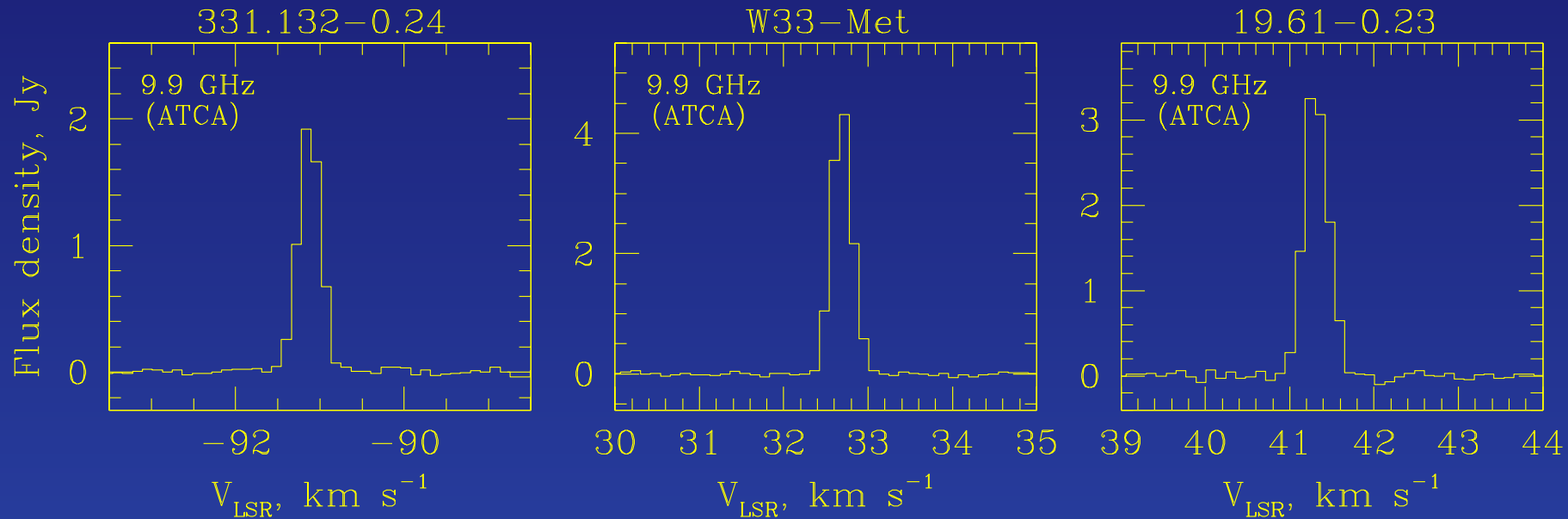
Class I masers and outflows

G343.12-0.06 (IRAS 16547-4247)



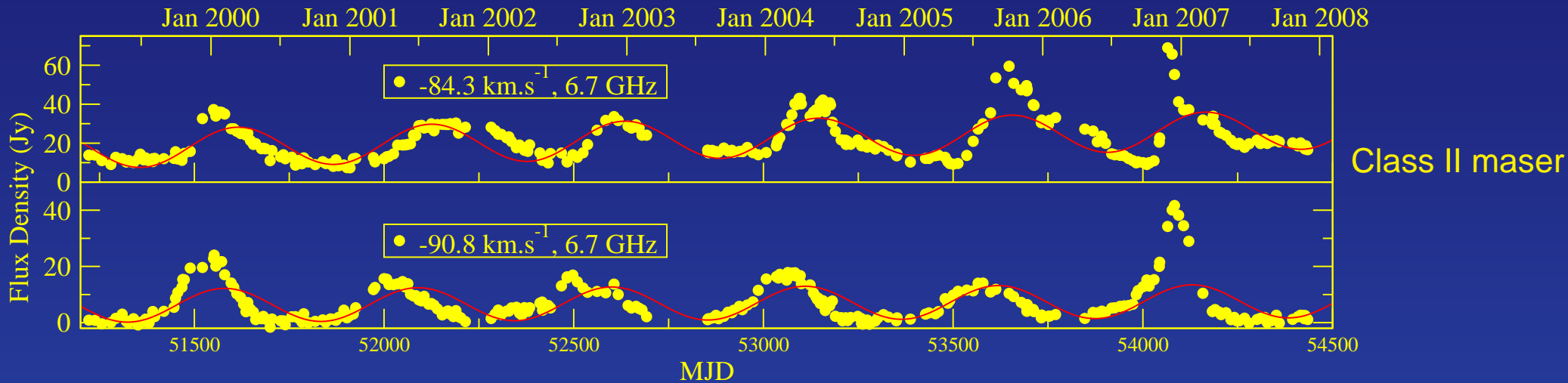
- This source is one of the best cases where an association of class I masers with outflow has been demonstrated
- More info in Voronkov et al. (2006).

ATCA search for 9.9 GHz masers



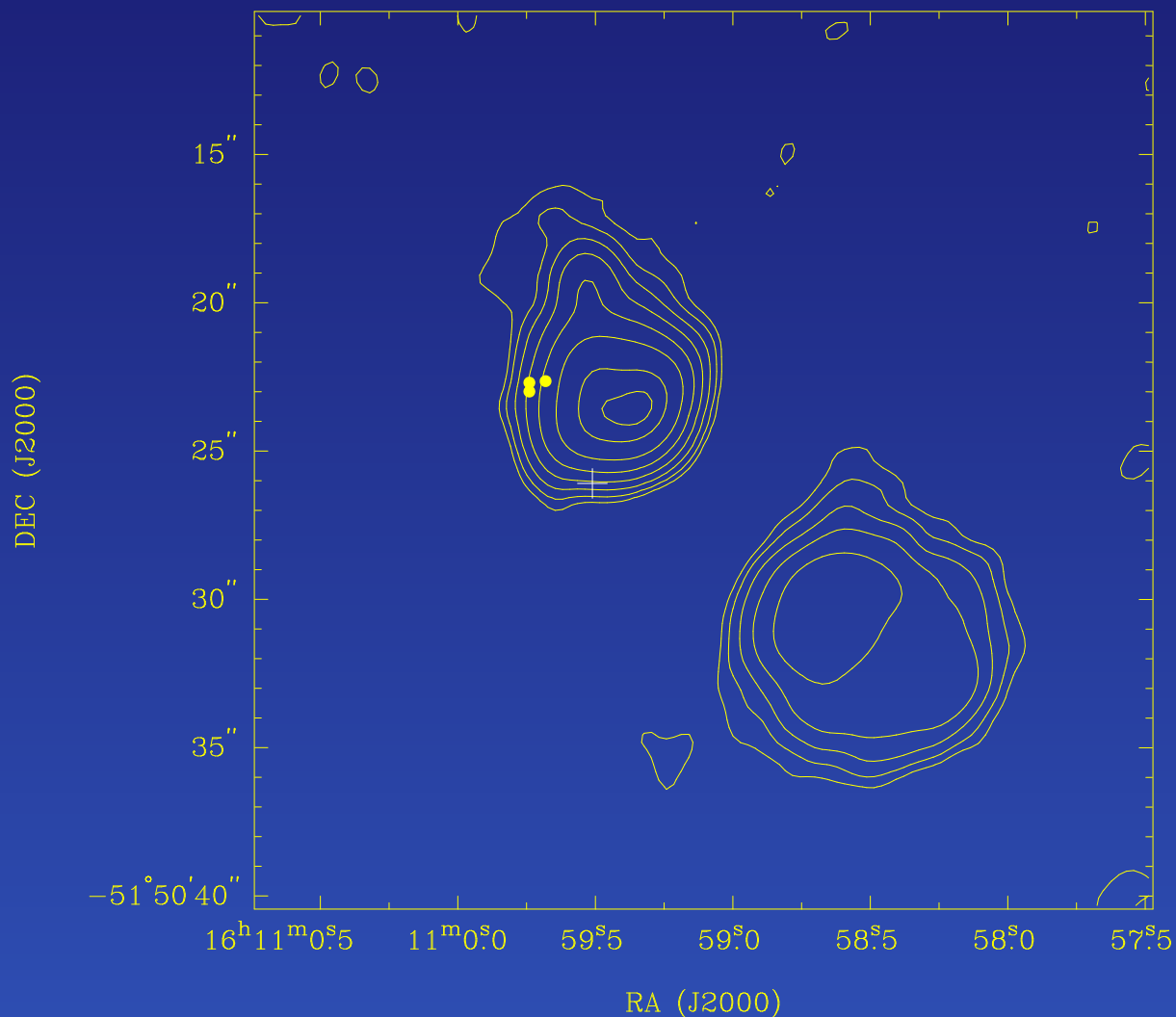
- Quite rare: 3 detections from 47 sources observed
- Models predict that 9.9 GHz masers appear in the most energetic conditions and are very sensitive to the change of the physical parameters

Periodic flares of the 6.7 GHz maser in G331.132–0.24



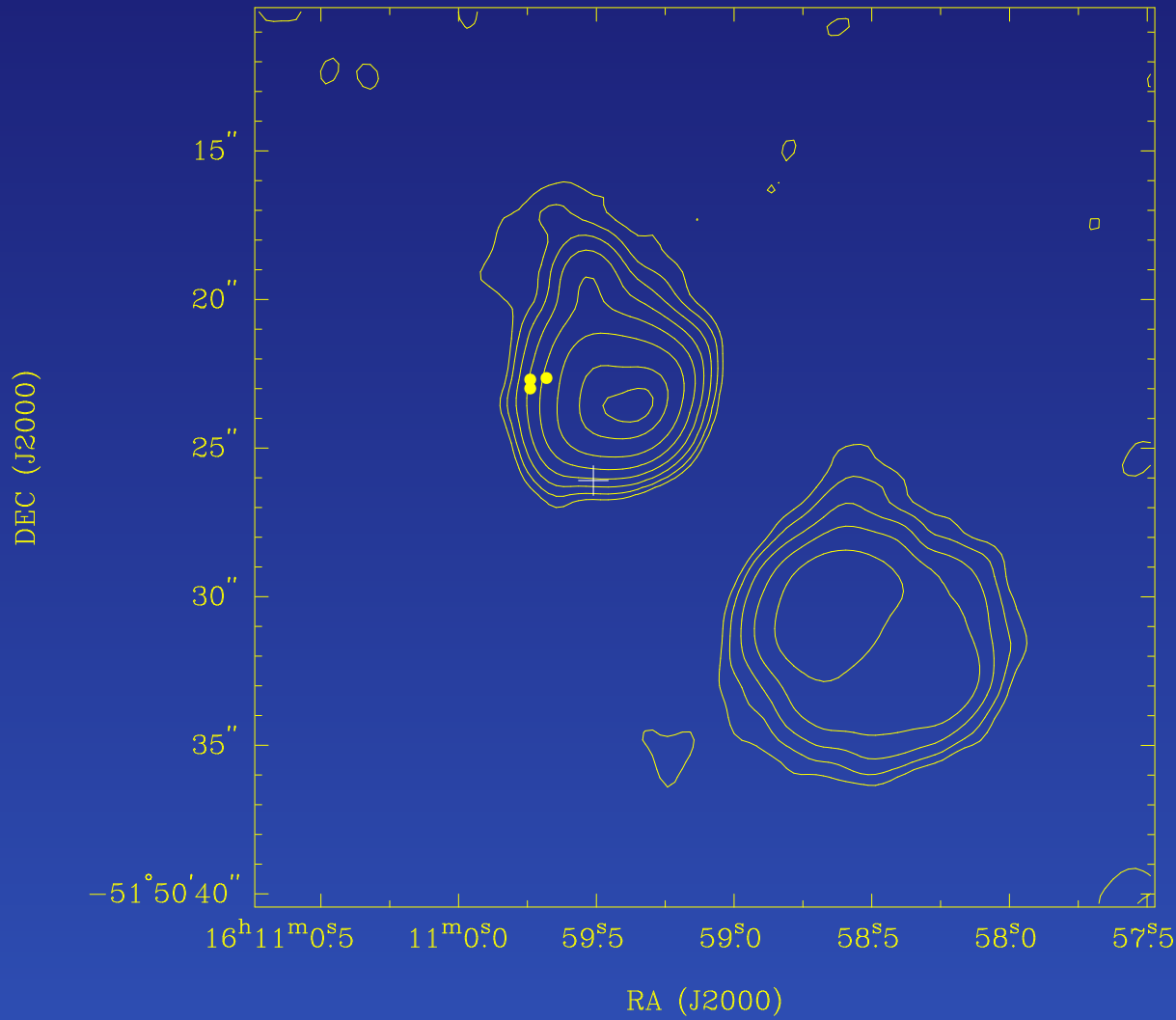
- 7 class II methanol masers at 6.7 GHz are known to show periodic flares
- The nature of these flares still remains a mystery
- A limited number of astrophysical processes can give periodicity: orbital motion, proto-stellar rotation and pulsation, precession of the jet-outflow system
- G331.132–0.24 is the only periodically variable class II maser which has a known 9.9 GHz (class I) maser in the vicinity

Position of masers with respect to the 8.4 GHz continuum in G331.132–0.24

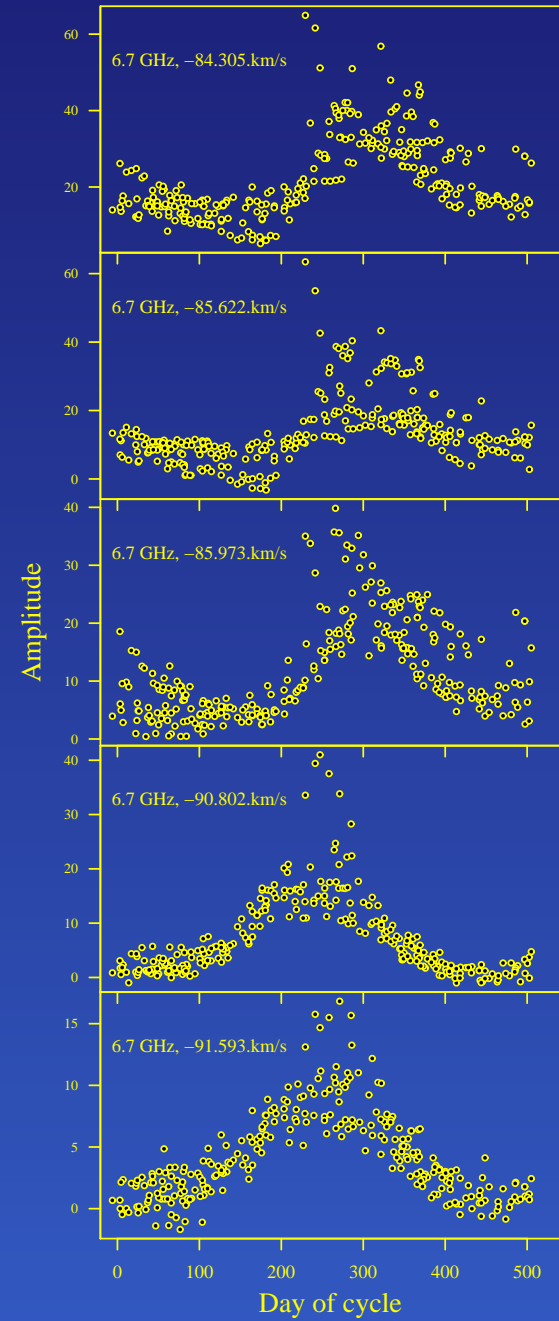


- Observations of 6.7 GHz masers (filled yellow circles) and 8.4 GHz continuum by Phillips et al. (1998)
- Position of the 9.9 GHz maser (white cross) has been determined in the original ATCA observations when this maser was discovered
- Class I and class II masers have different pumping mechanisms and react on a pumping disturbance in the opposite sense

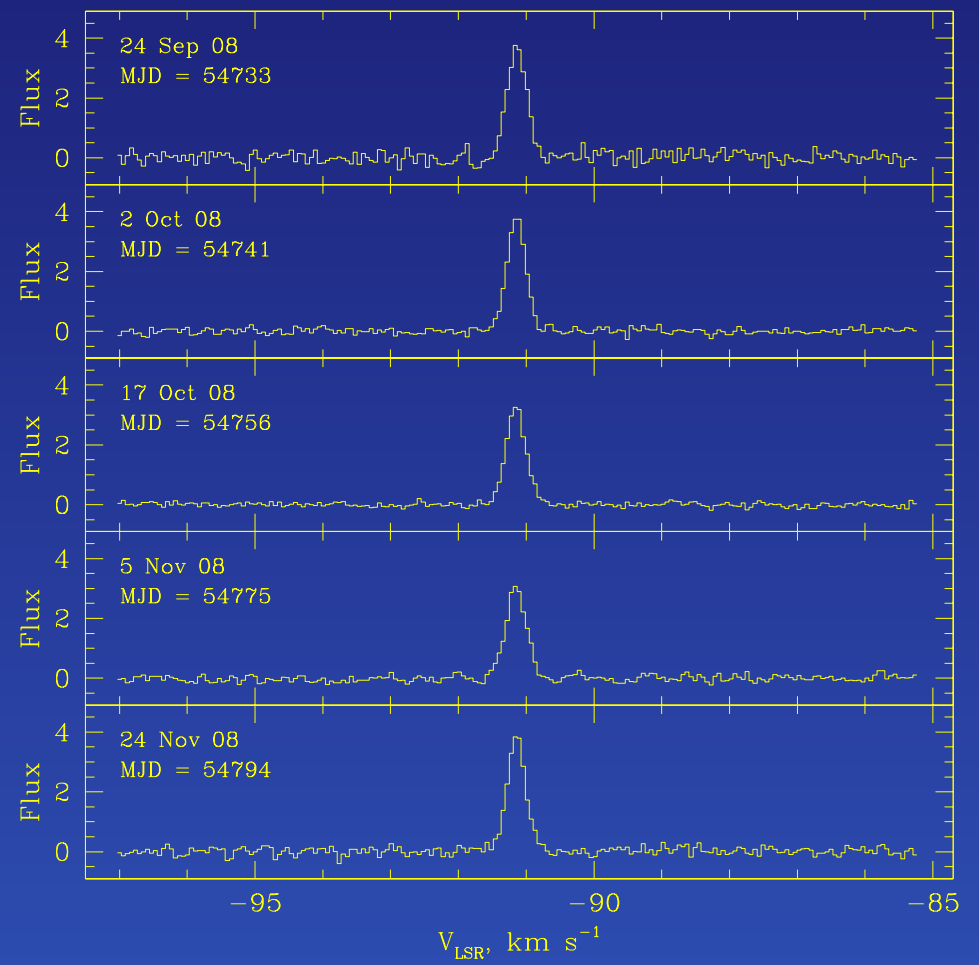
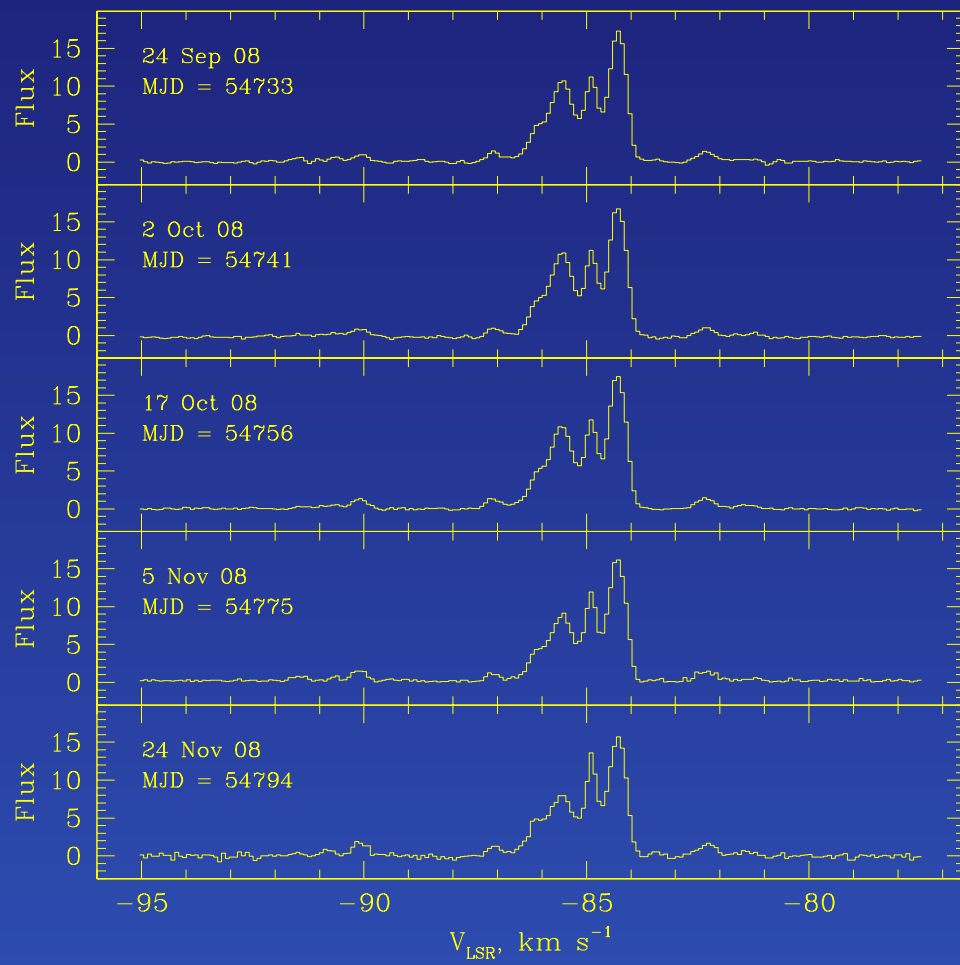
Position of masers with respect to the 8.4 GHz continuum in G331.132–0.24



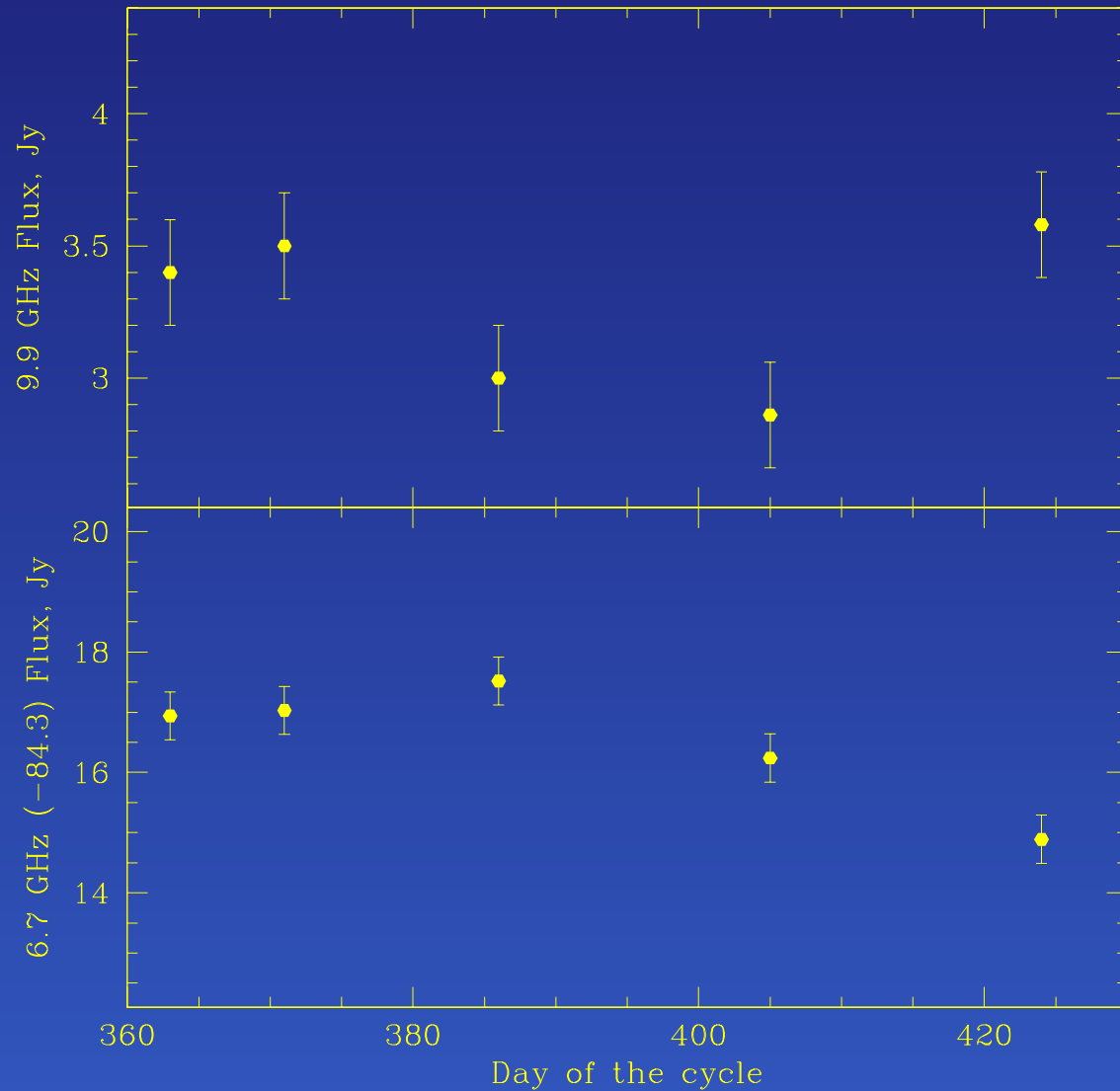
Goedhart et al. data ⇒



Most recent results of the monitoring: spectra

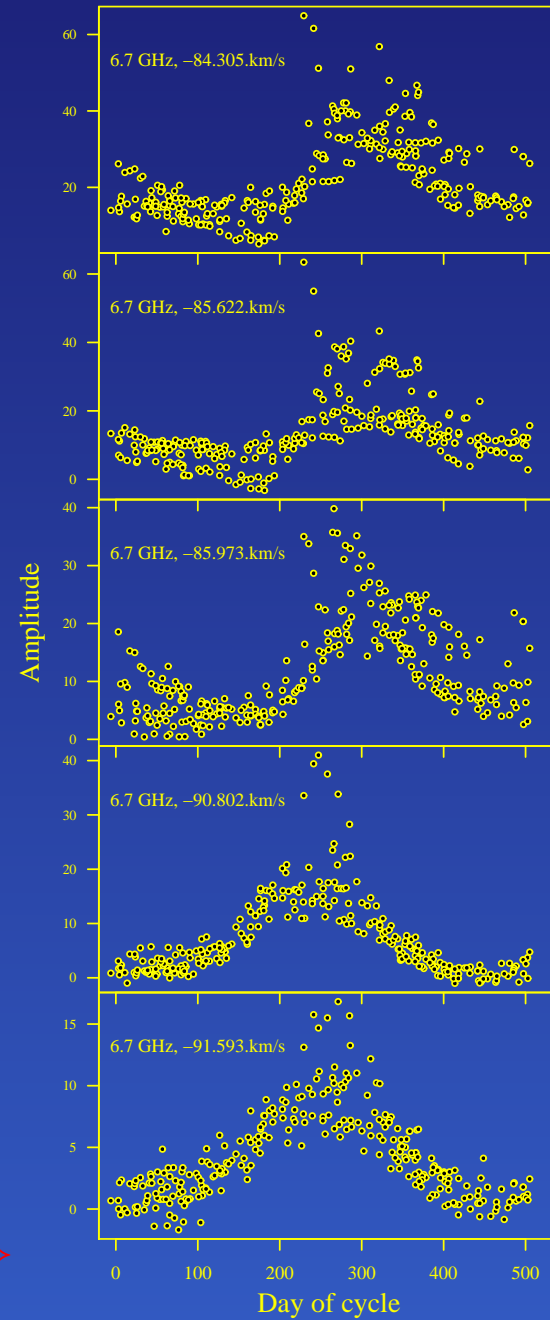


Most recent results of the monitoring: time series



New ATCA data \uparrow

Goedhart et al. data \Rightarrow



Summary

- There are a few 6.7 GHz methanol masers (class II), which show periodic flares
- G331.132–0.24 has both 6.7 GHz and 9.9 GHz masers making it a good candidate for monitoring
- We found that 9.9 GHz maser may be variable in this source (variations are just over 1σ)
- But we hope to find the first periodically variable class I maser after we have more data
- Combined monitoring of class I and class II transitions may shed light on the nature of periodic flares
- At least we should be able to distinguish between variability of the underlying continuum and variability of the pumping