

Methanol Masers* as tools to study high-mass star formation

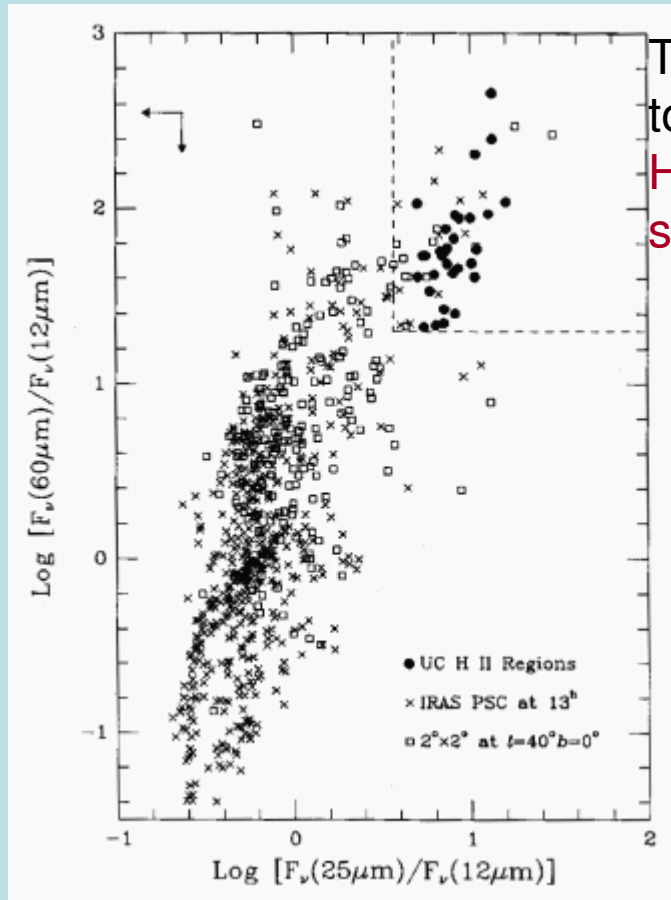
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*In this talk: 12.2 and 6.7GHz galactic masers

Organisation of studies (and of my talk!)

	“Global” studies	Particular studies
Masers	Lum. Function, structure of MW, maser modelling, ...	Discs, polarisation, location of protostars, ...
Hosts of masers	SEDs, follow-up,...	NGC7538, IRAS20126, S255, ...

Hosts of methanol masers (I)



Wood & Churchwell 1989

Targeted searches have tried to characterise the hosts:

High-mass stars in early stages of evolution

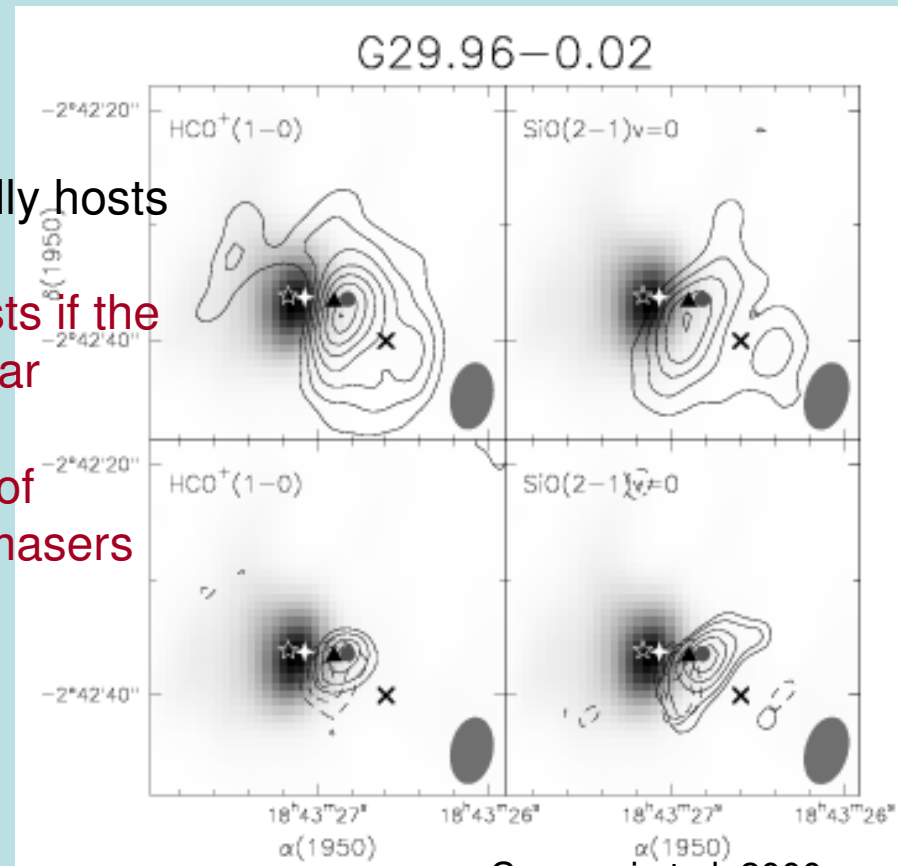
	Global	Particular
Masers		
Hosts		

Hosts of methanol masers (I)

Some hosts are not really hosts
of methanol masers:

Difficult to study the hosts if the
associations are not clear

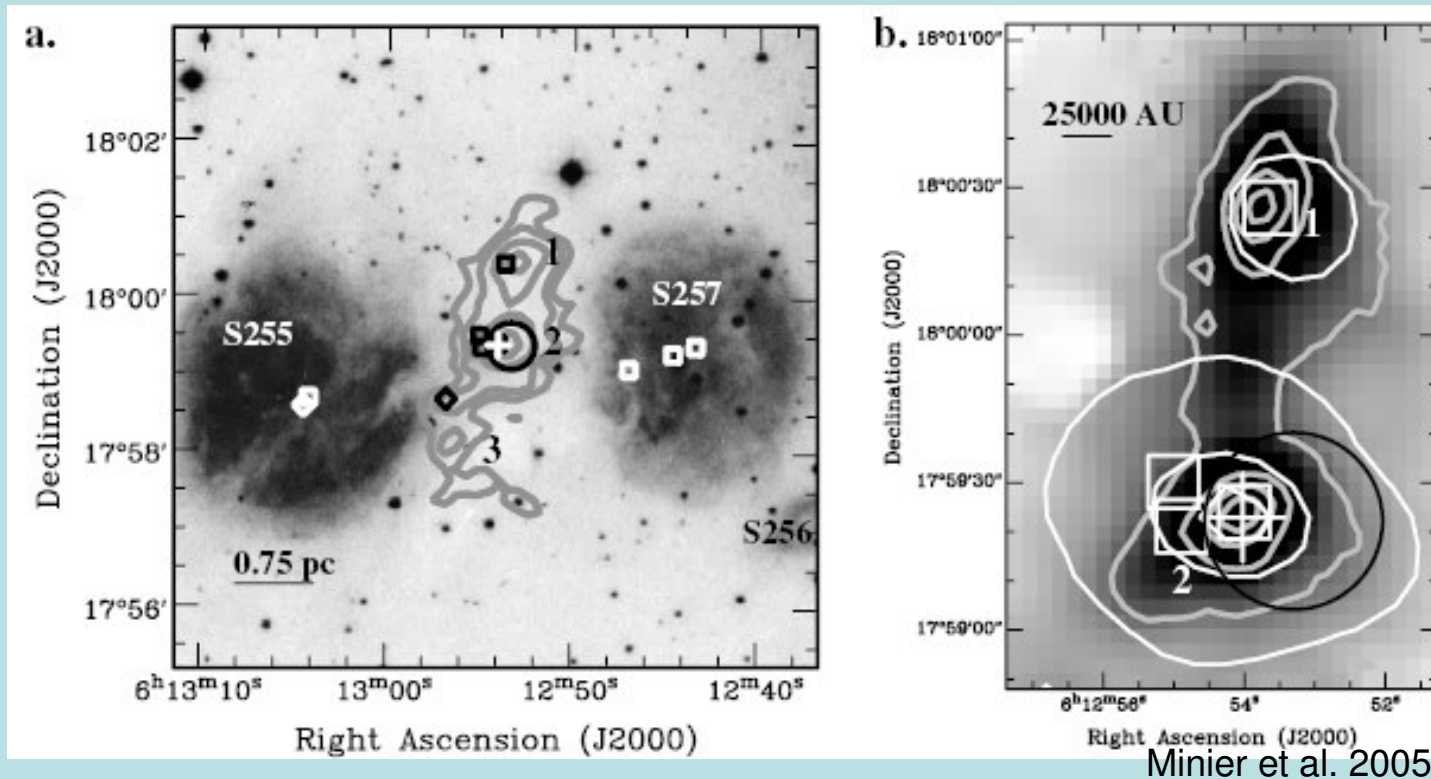
Not yet clear what kind of
objects host methanol masers



	Global	Particular
Masers		
Hosts		

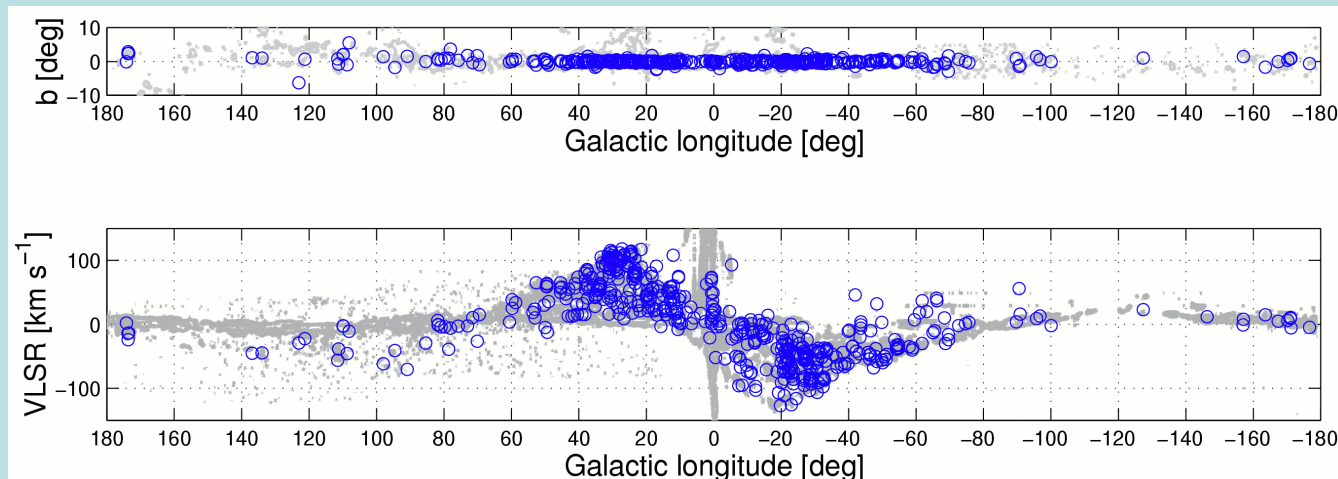
Hosts of methanol masers (II)

S255 - S257: protocluster marked by methanol maser



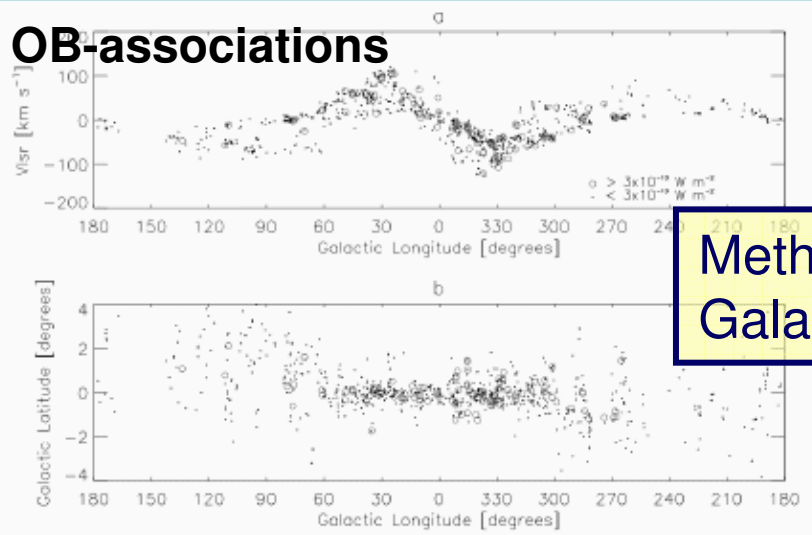
	Global	Particular
Masers		
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Methanol masers in the Milky Way



Pestalozzi et al. 2005

OB-associations

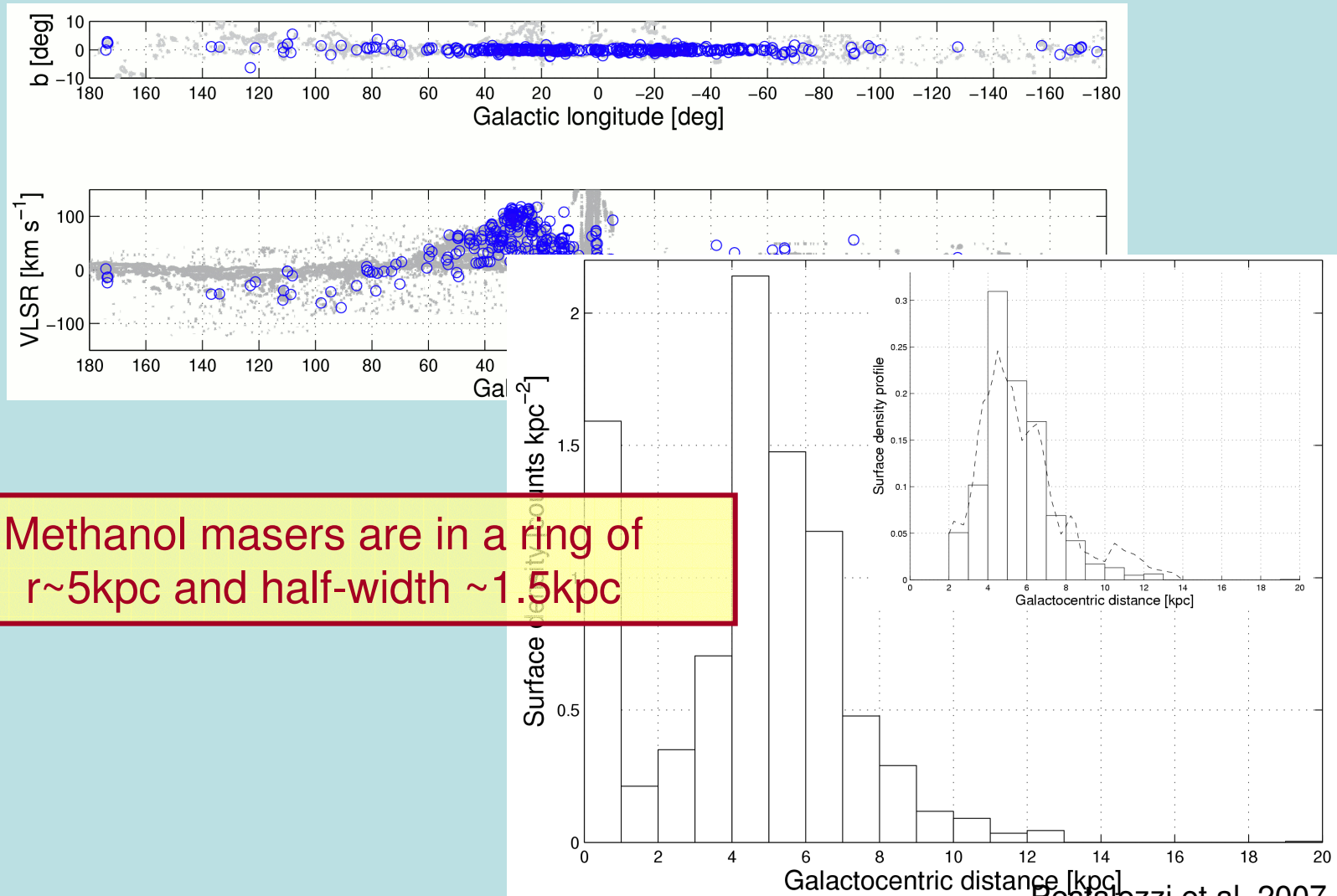


Bronfman et al. 2000

Methanol masers show same Galactic distribution as high-mass protostars

	Global	Particular
Masers		
Hosts		

Methanol masers in the Milky Way

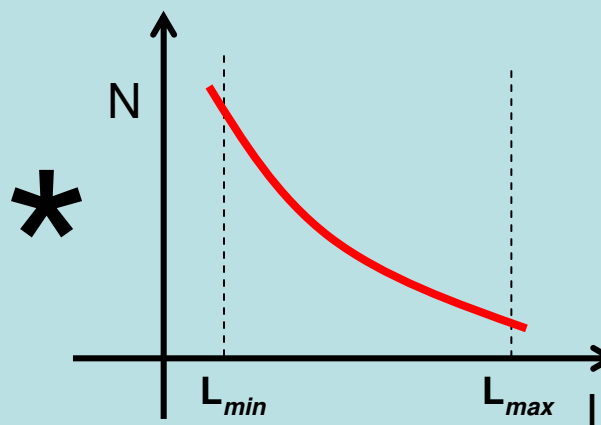
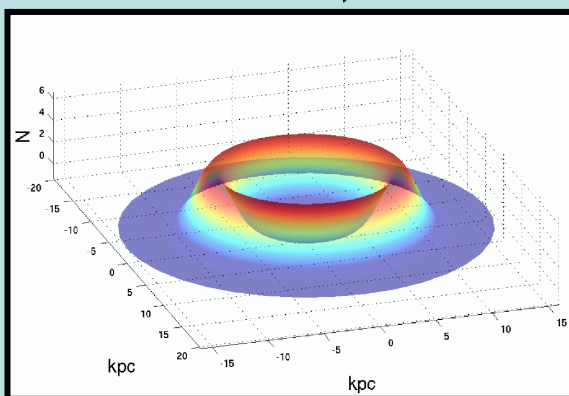
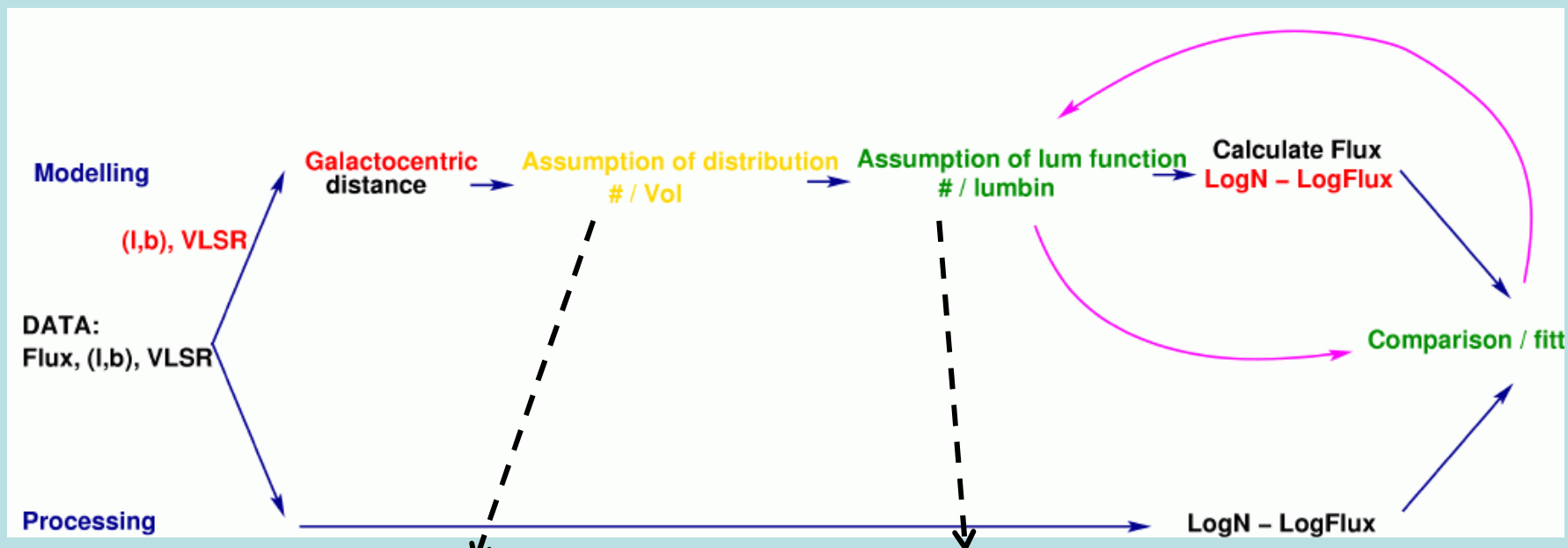


Methanol masers are in a ring of $r \sim 5 \text{ kpc}$ and half-width $\sim 1.5 \text{ kpc}$

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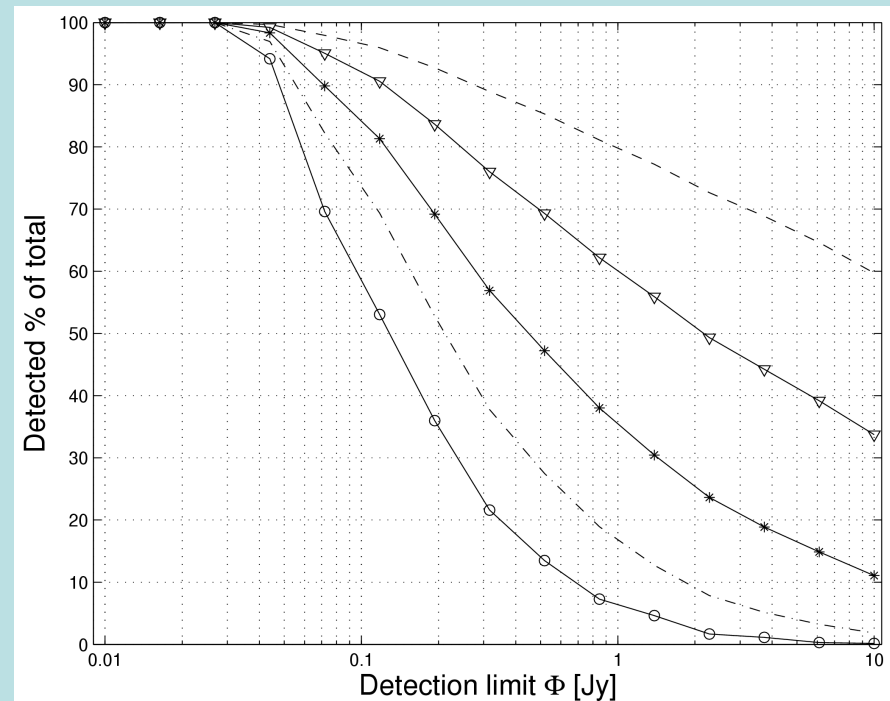
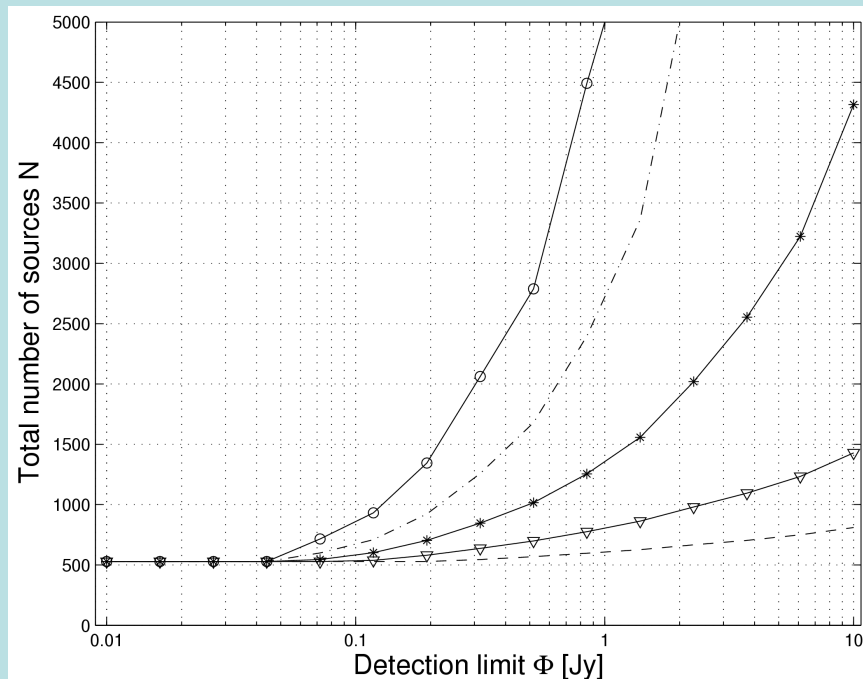
Pestalozzi et al. 2007

Luminosity function: idea



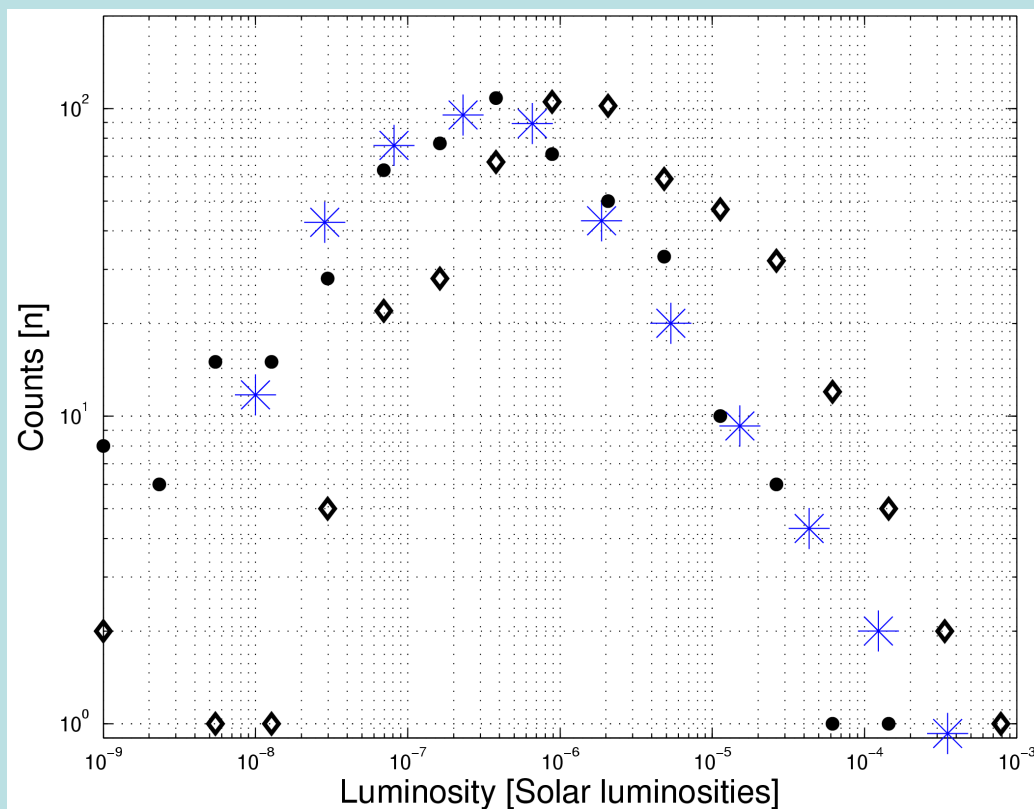
	Global	Particular
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Real luminosity function?



	Global	Particular
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Hosts		

Real luminosity function?



Single power-law, index between -1.5 and -2
Total number of sources ~1500-2000

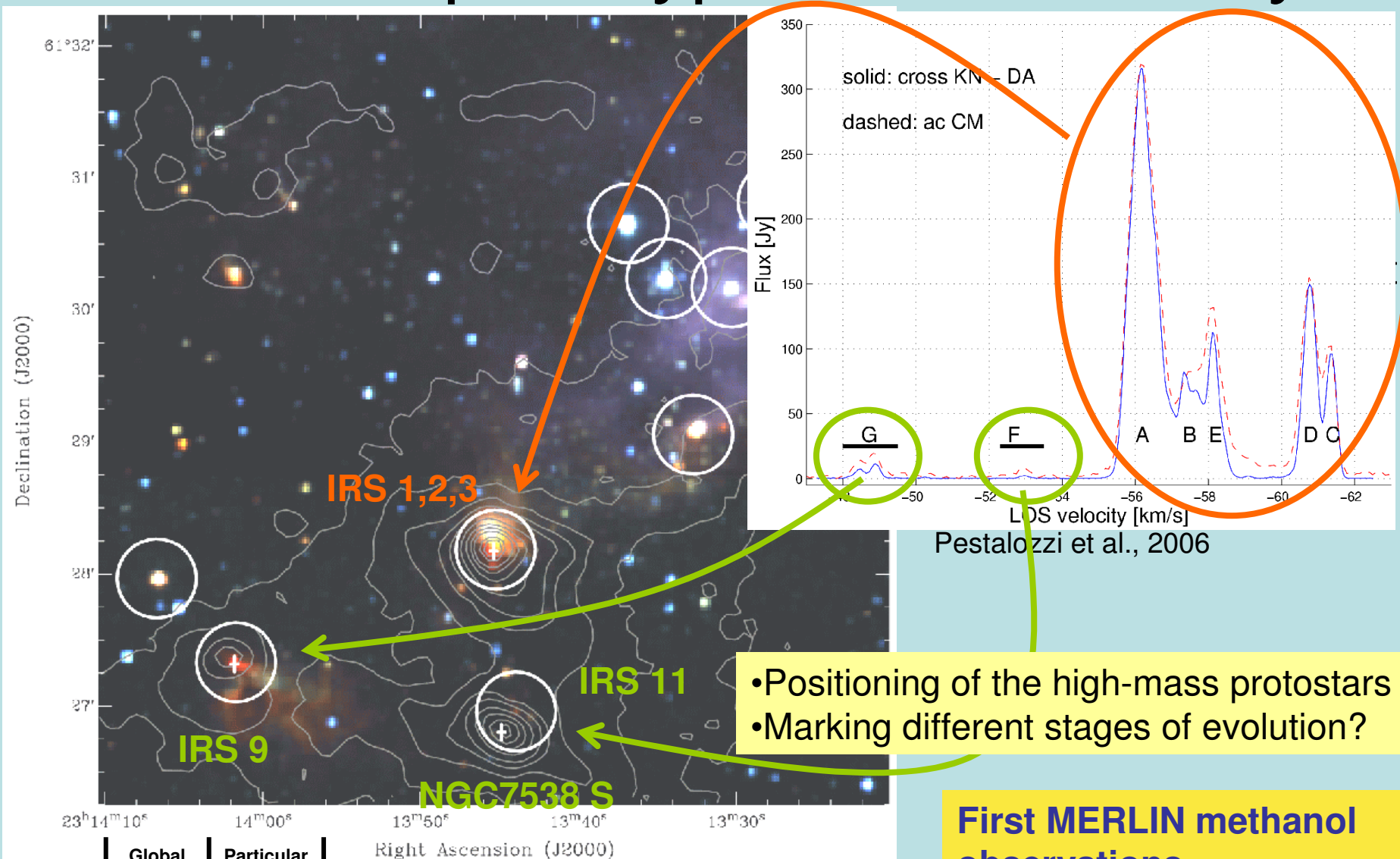
More questions than answers:

Is there a “switch-on” luminosity?
What does lum function of the
maser mean?

...

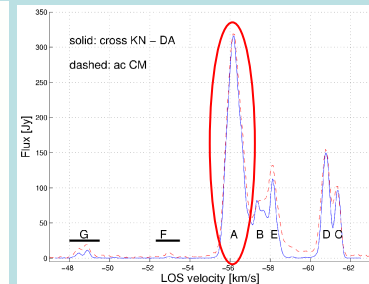
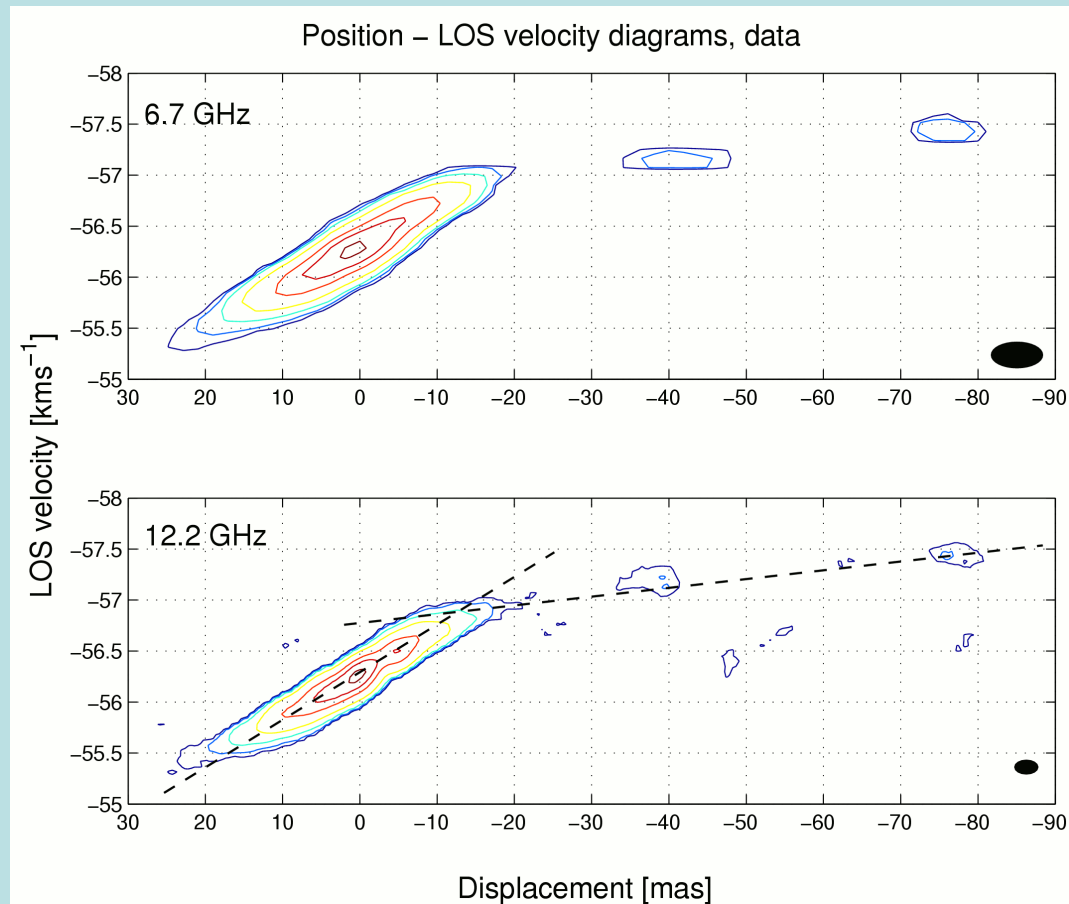
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NGC7538: prototype for case study



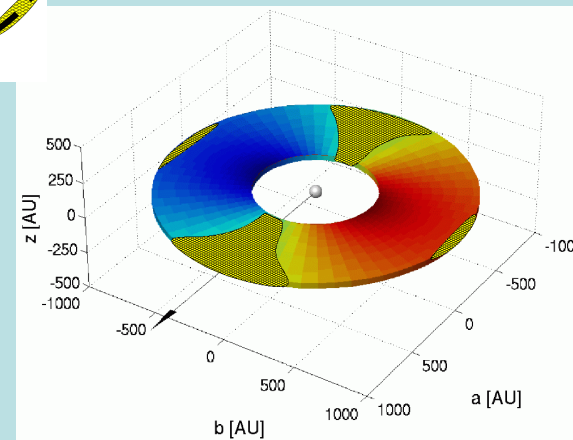
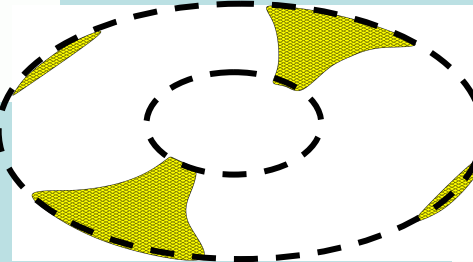
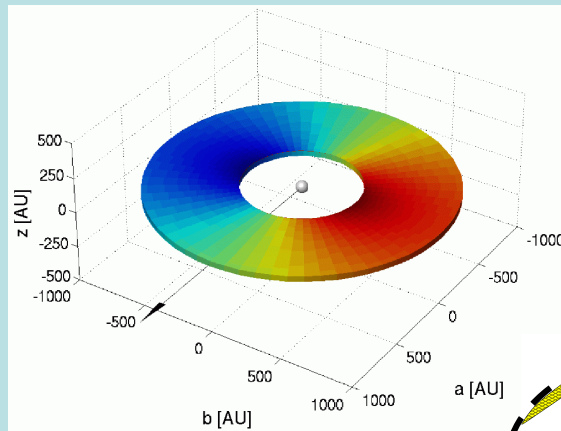
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Hosts		

The disc signature



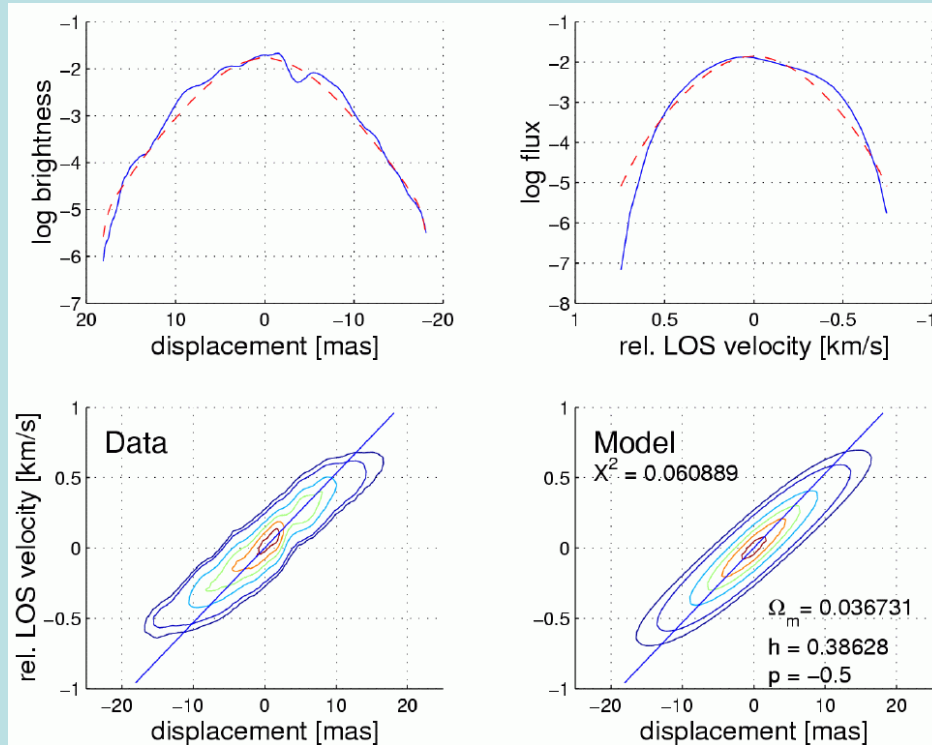
	Global	Particular
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Hosts		

The disc signature



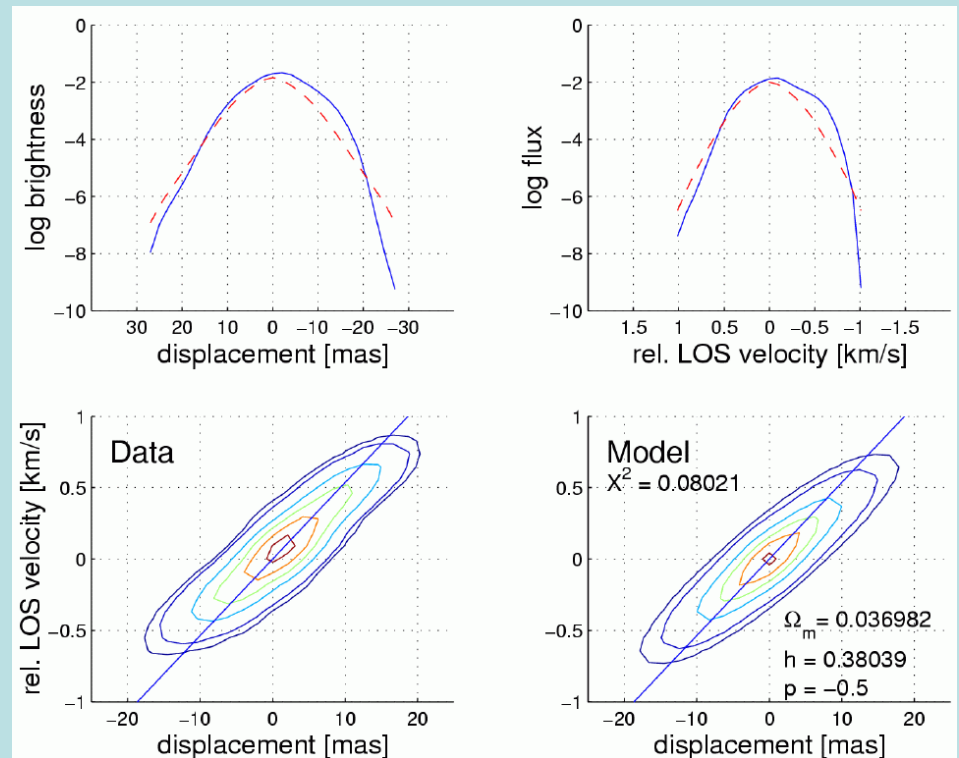
	Global	Particular
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Hosts		

The disc signature



6.7 GHz

12.2 GHz



	Global	Particular
Masers		
Hosts		

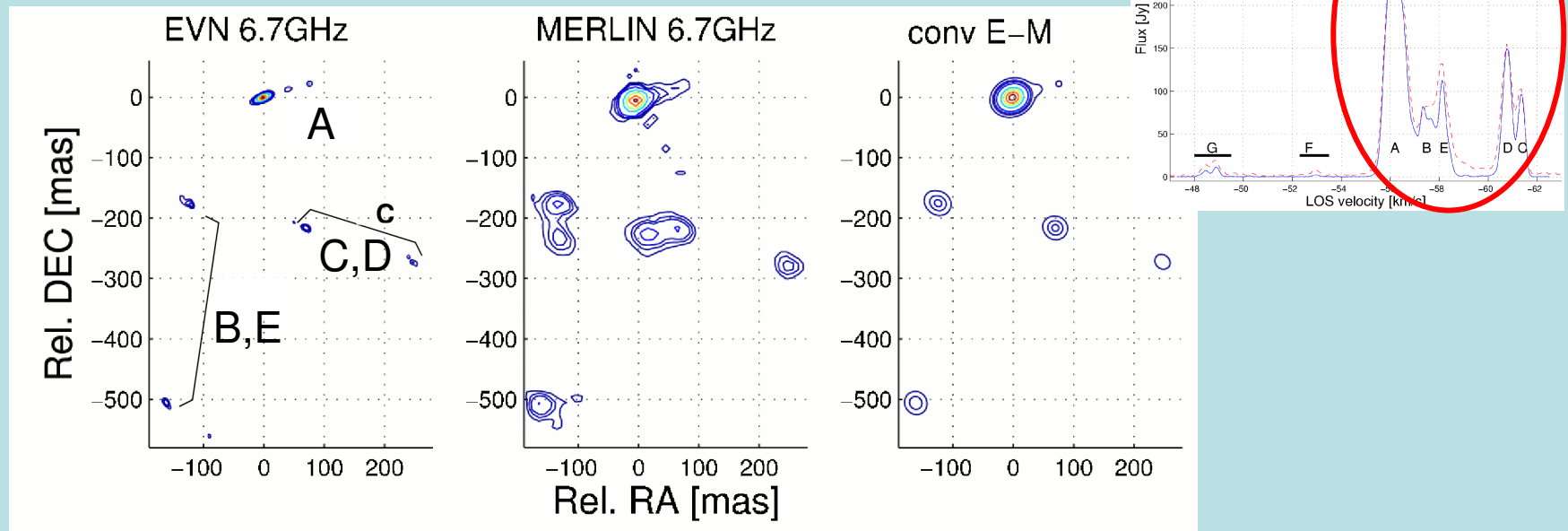
Particular study – general conclusion

- Smooth, Symmetric, Continuous emission in space and LOS velocity:
differential rotation
- This **excludes** solid body rotation and a bipolar outflow geometry
- Preliminary mass: **6-30 solar masses**

	Global	Particular
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Hosts		

Still to be exploited

- Extended Emission

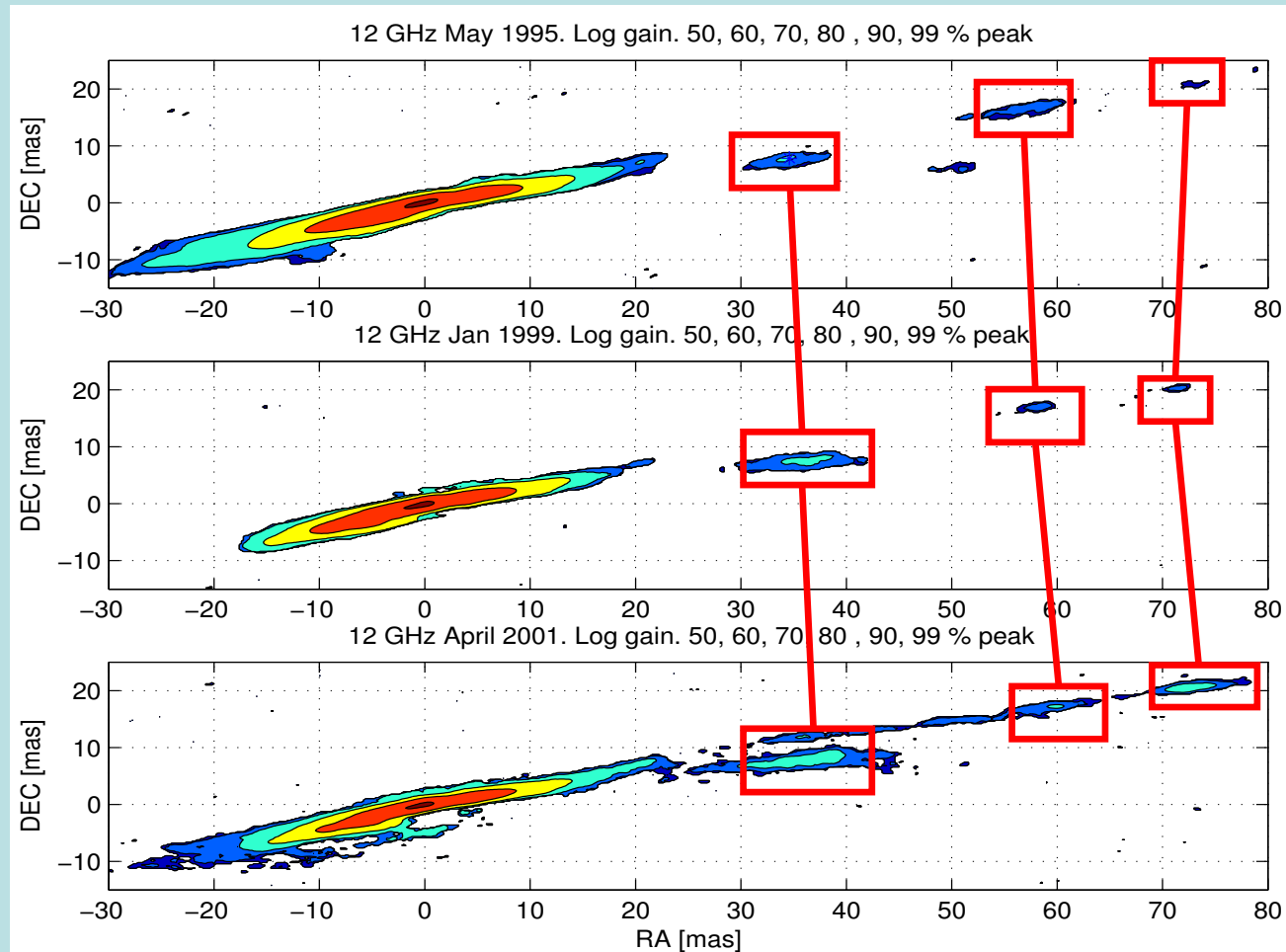


Methanol masers are not spots!

	Global	Particular
Masers		
Hosts		

Still to be exploited

- Proper motion



	Global	Particular
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Hosts		

Summary and future

- Study of hosts requires unique associations
- Statistical studies provide important insights for the maser studies
- Particular studies can guide to general conclusions

- MMB: ultimate census
- Structure of the Galaxy, Multi wavelength follow-up
- Identification of hosts on large samples

	Global	Particular
Masers		
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List of collaborators

A. Chysostomou and J. Collett (Univ of Herts, UK)

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J. Conway, R. Booth, A. Jerkstrand (Onsala, Sweden)

S. Kraus, G. Weigelt (MPIfR, Bonn)

J. De Buizer, La Serena, Chile

The MMB team

Thank you