



Ionized Winds from Massive YSOs

Melvin Hoare

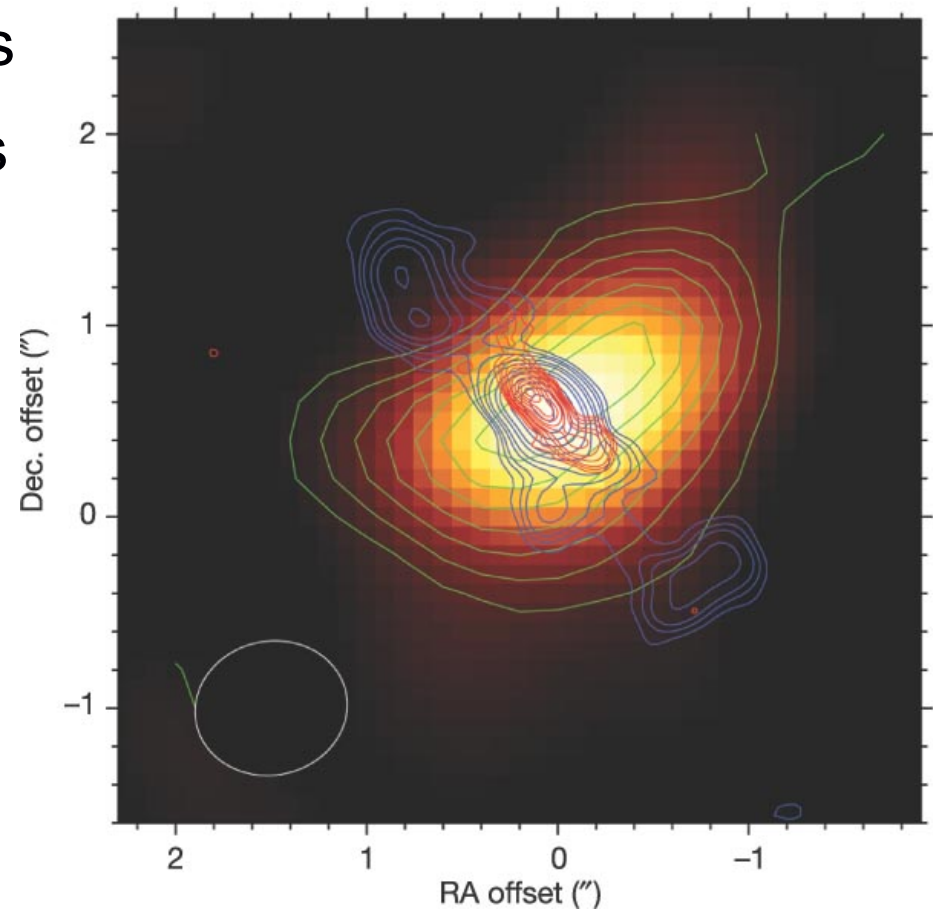


Outline



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- Massive YSOs and MHD jets
- Radiatively driven disc winds
- Evolutionary scenario
- e-MERLIN Legacy Survey



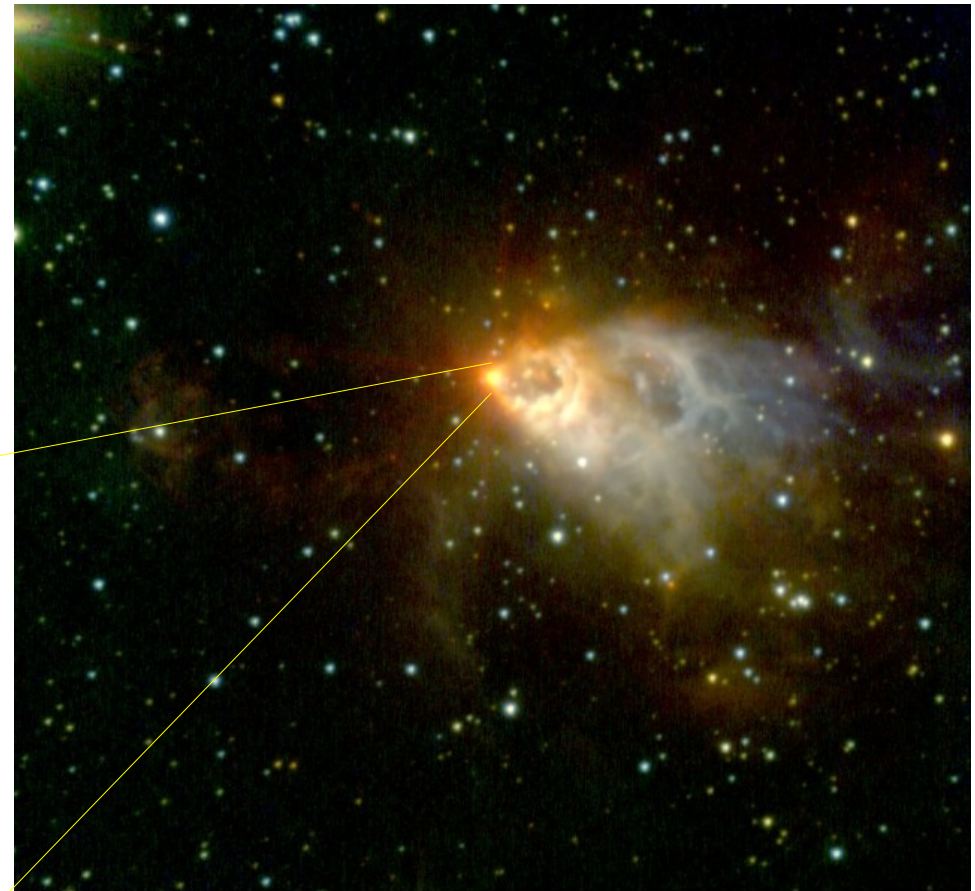
Cep A2: Curiel et al. (2006)

Patel et al. (2005)

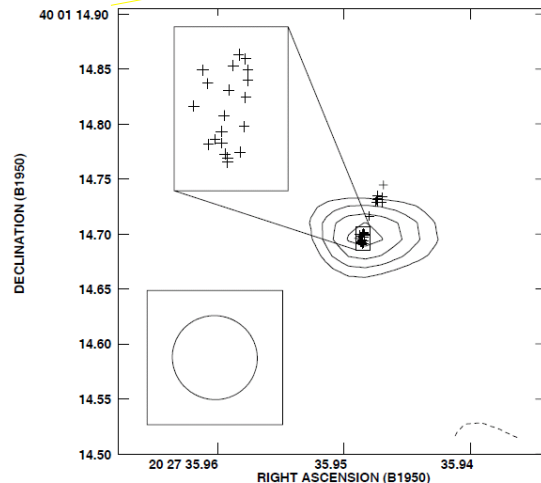


Massive Young Stellar Objects

- Luminous ($>10^4 L_{\odot}$) embedded IR point source
- bipolar molecular outflow ($\sim 10 \text{ km s}^{-1}$)
- ionised wind ($\sim 100 \text{ km s}^{-1}$)
- often in form of a jet



Gemini Observatory/Colin Aspin

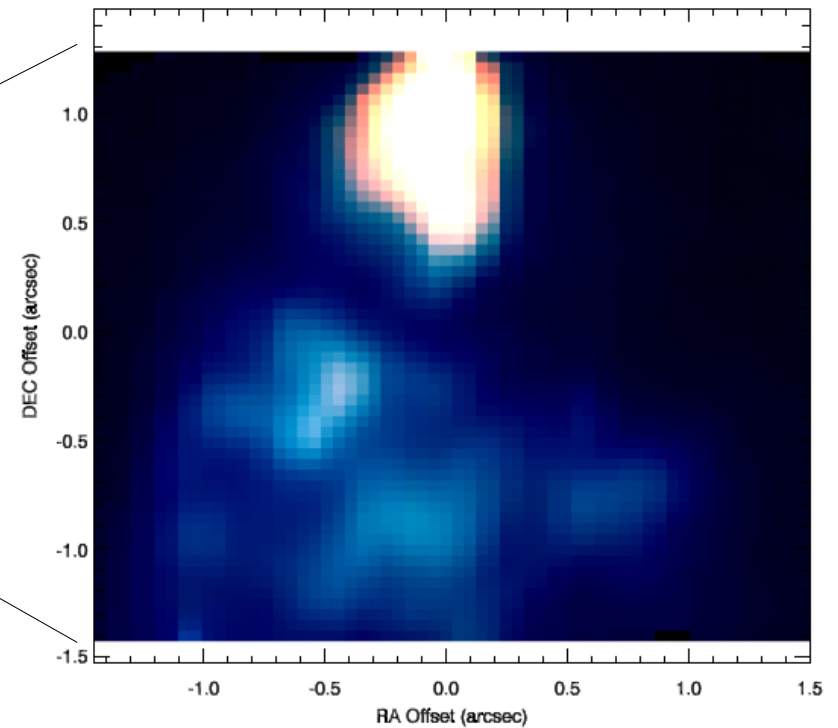
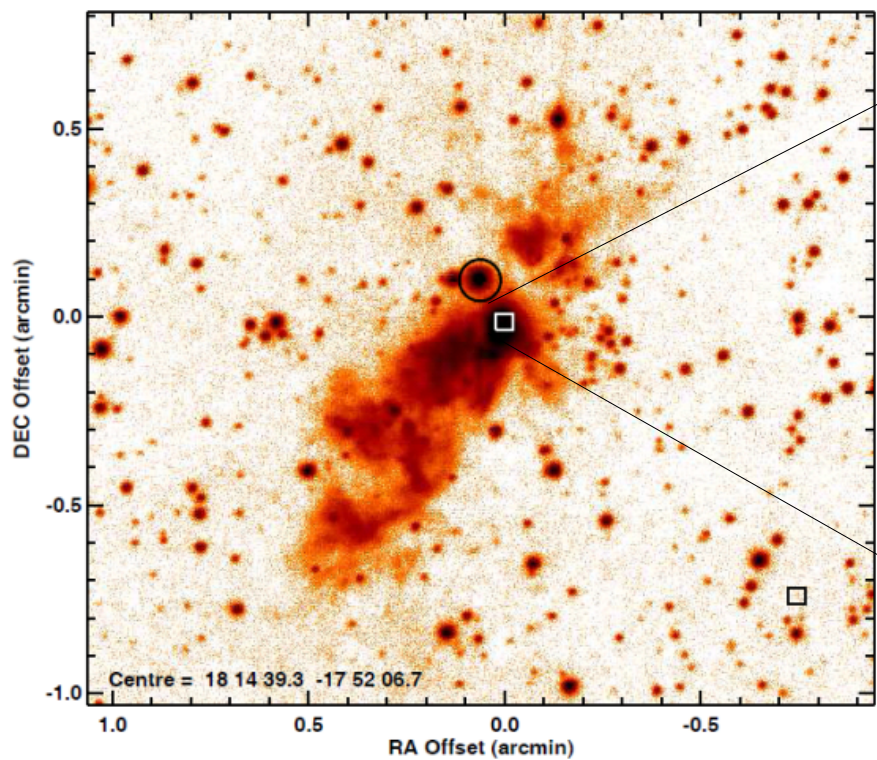


GL 2591: Trinidad et al. (2003)



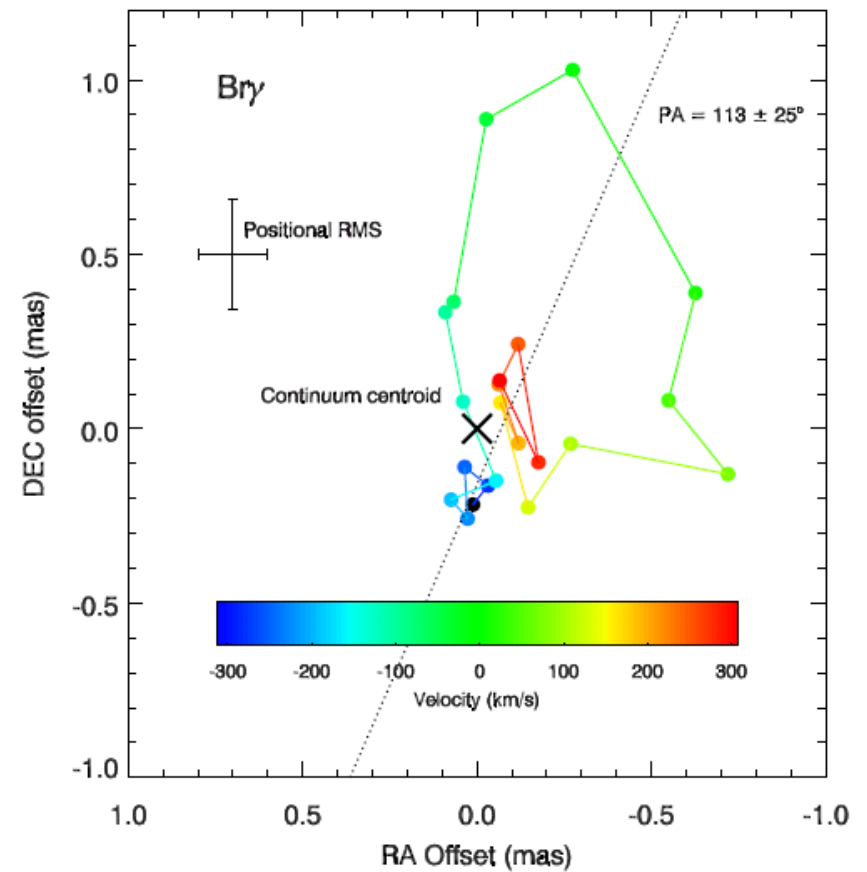
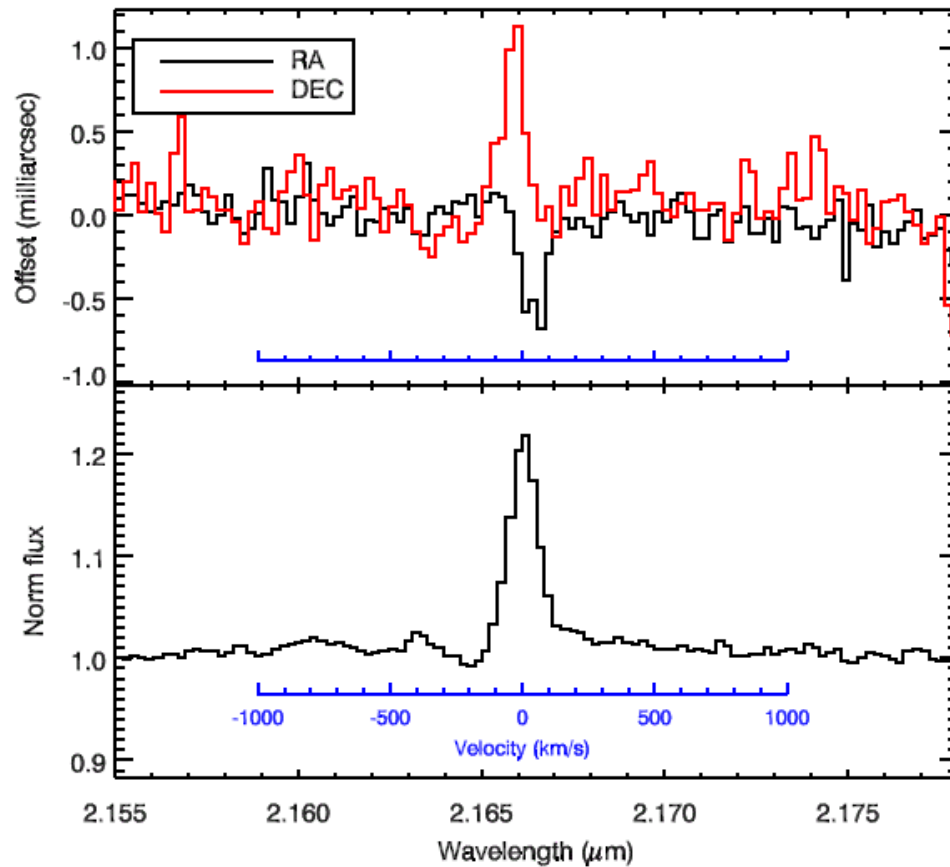
Near-IR Jet Studies

- LGS AO IFU study of Br γ emission line in W33A on Gemini-N gives 0.1 arcsec resolution





Spectro-astrometric jet detection



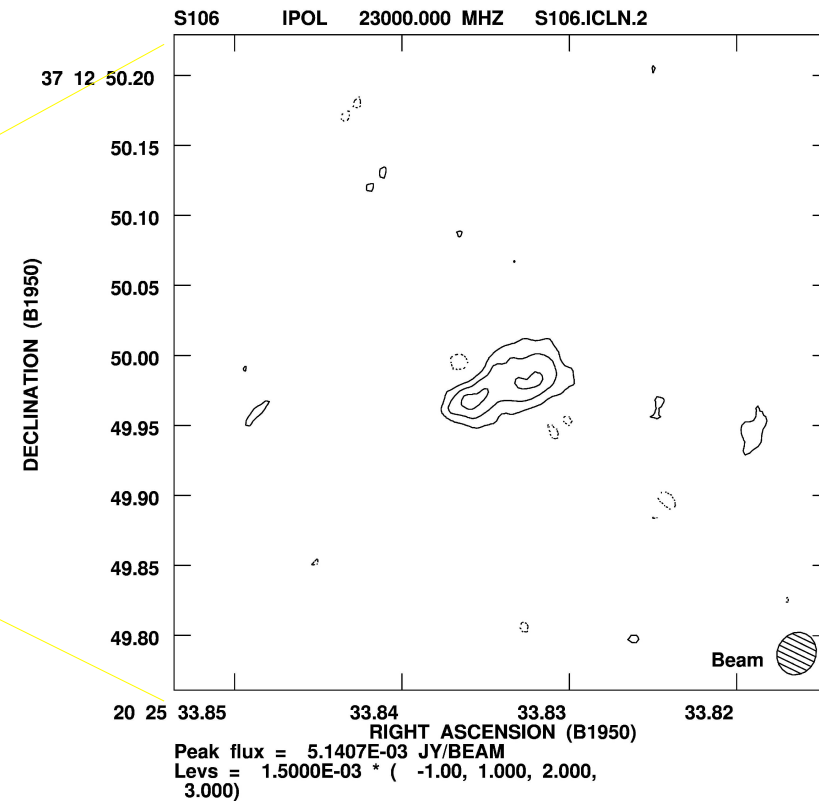
W33A Davies et al. (2010)

Disc Winds



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- MERLIN discovery of elongated radio continuum perpendicular to outflow in the massive YSO S106IR



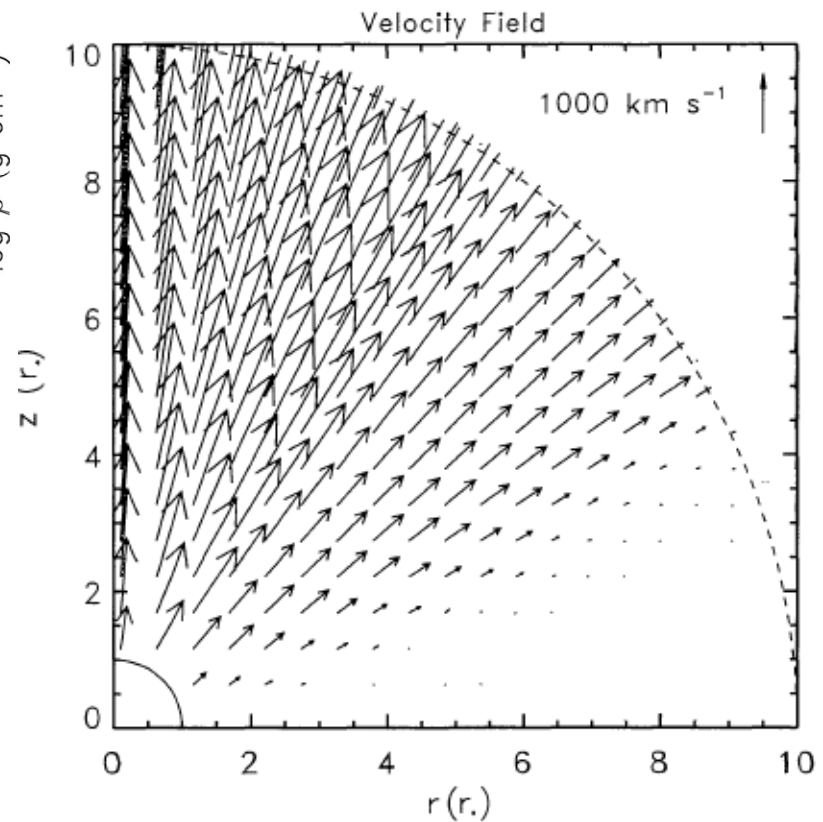
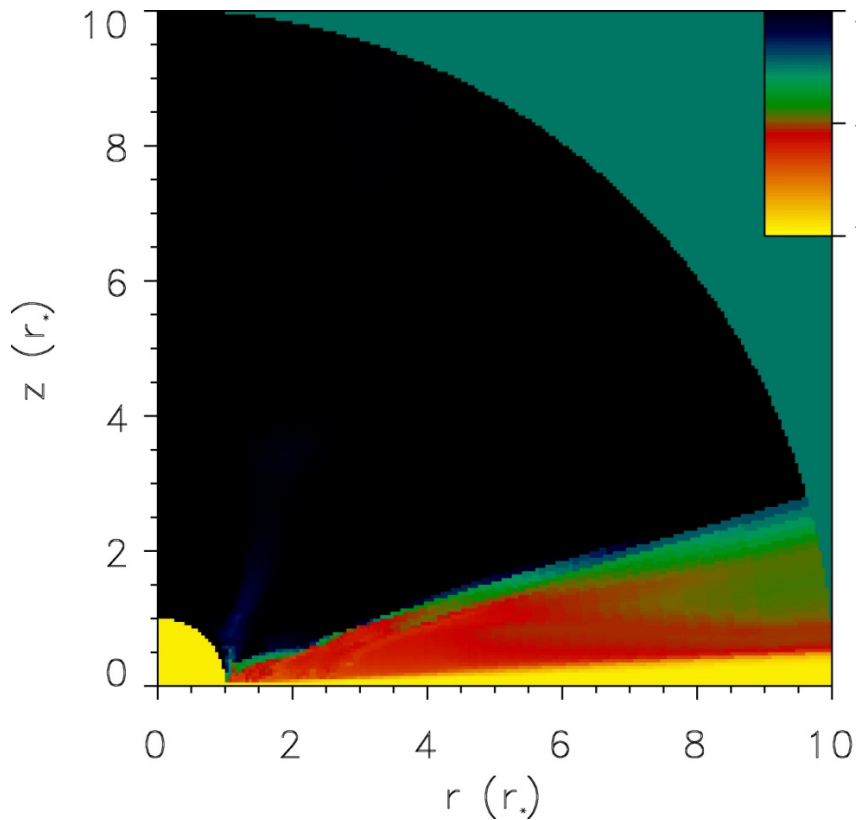
Hoare et al. (1994); Gibb & Hoare (2007)

Radiation driven disc wind



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- Radiation pressure from star and inner disc drives gas on disc surface sideways

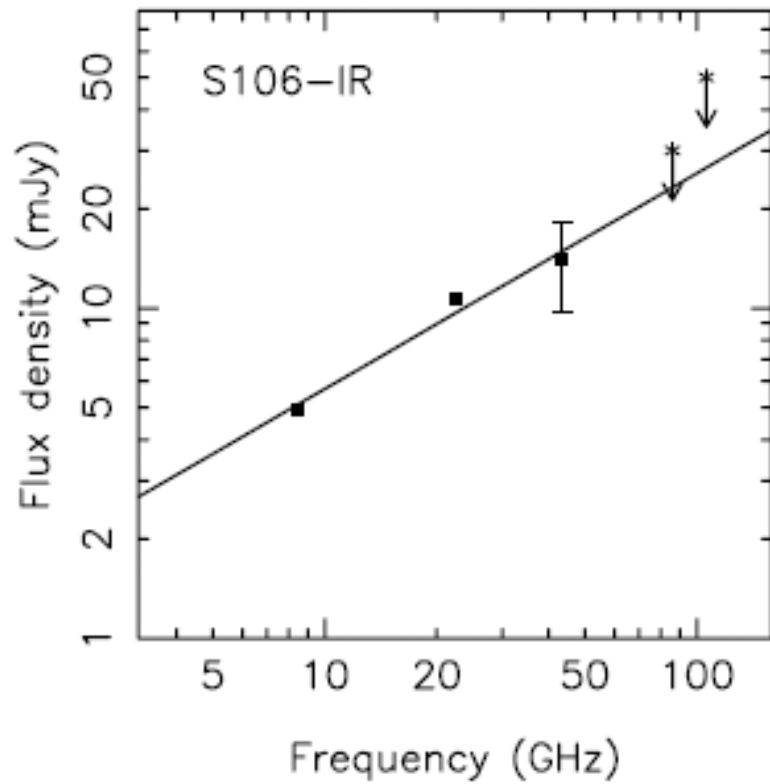


Drew, Proga & Stone (1998)

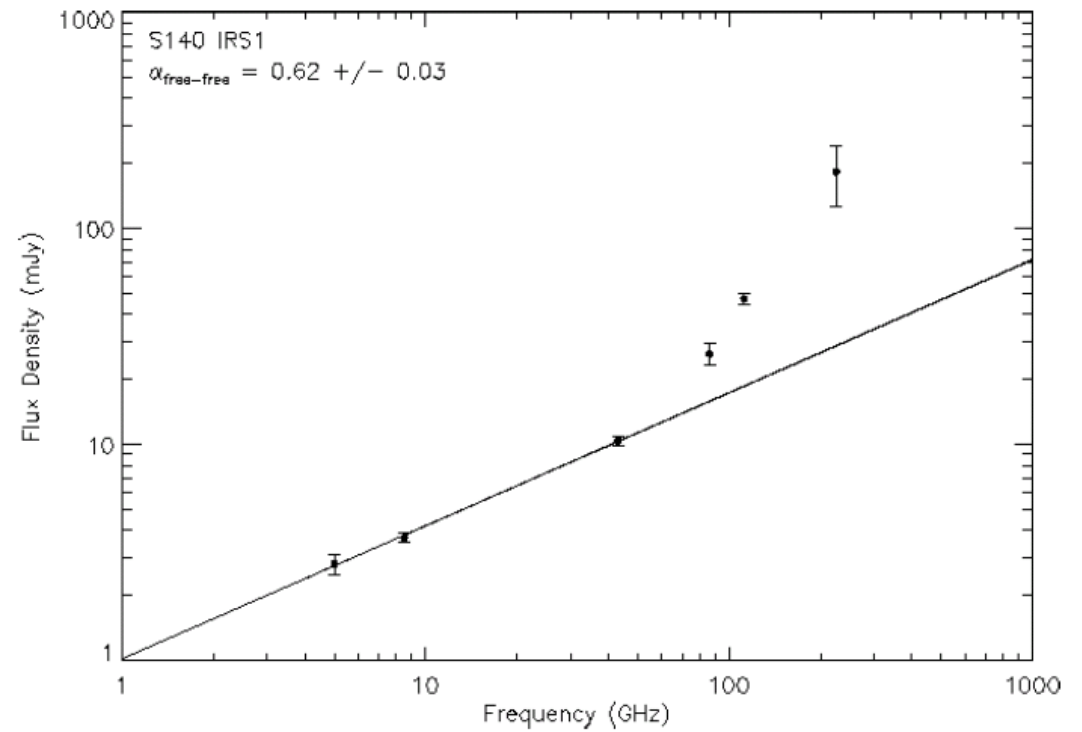
Wind Spectra



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Gibb & Hoare (2007)



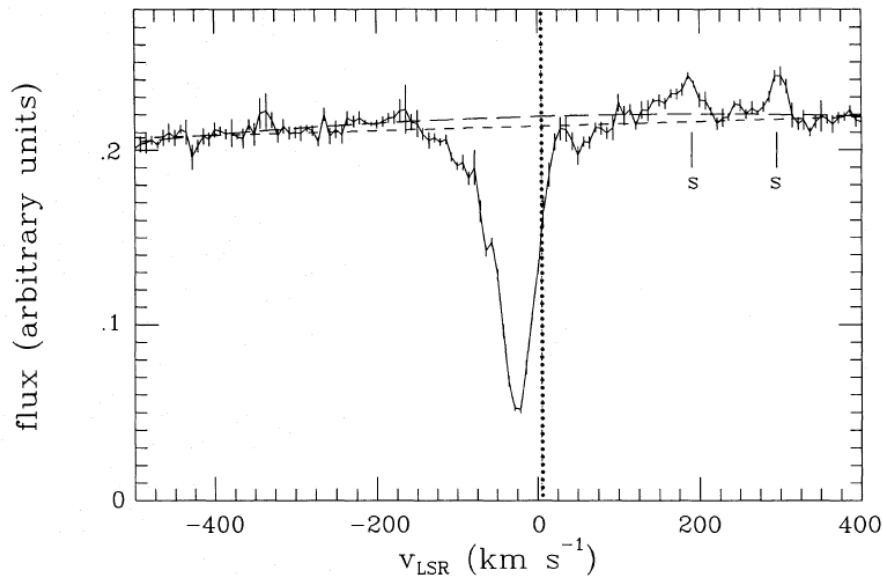
Maud et al. (in prep)

IR line wind diagnostics

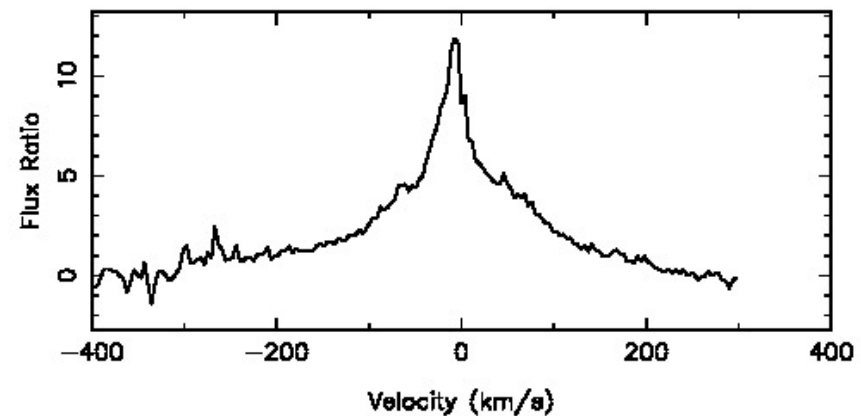
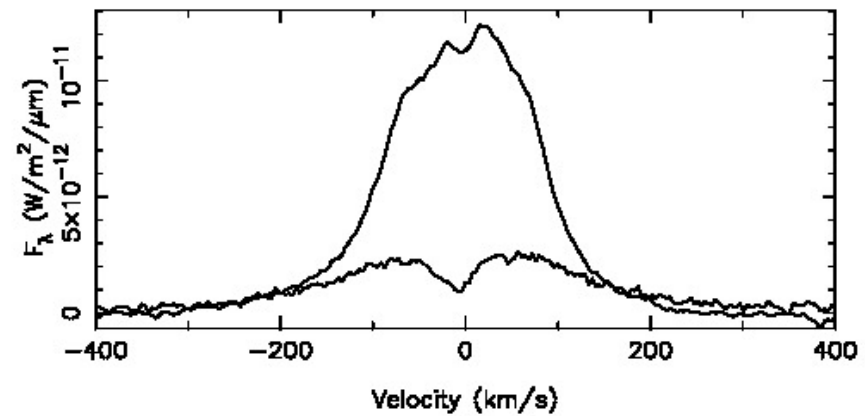


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- Ratios of Brackett series lines indicate broad optically thick component
- P Cygni He I absorption



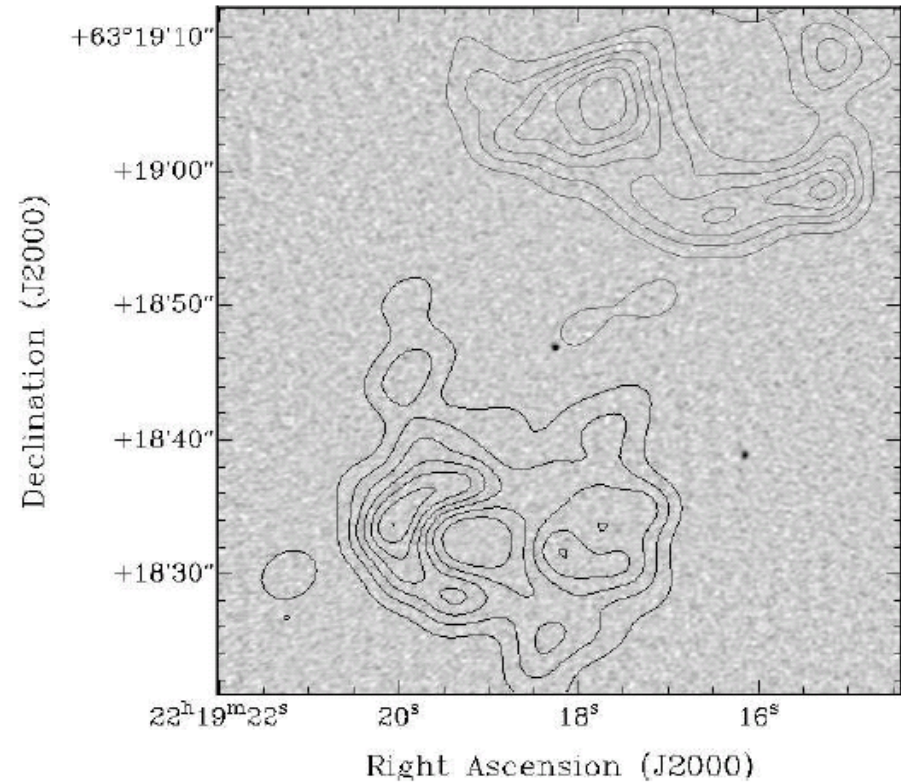
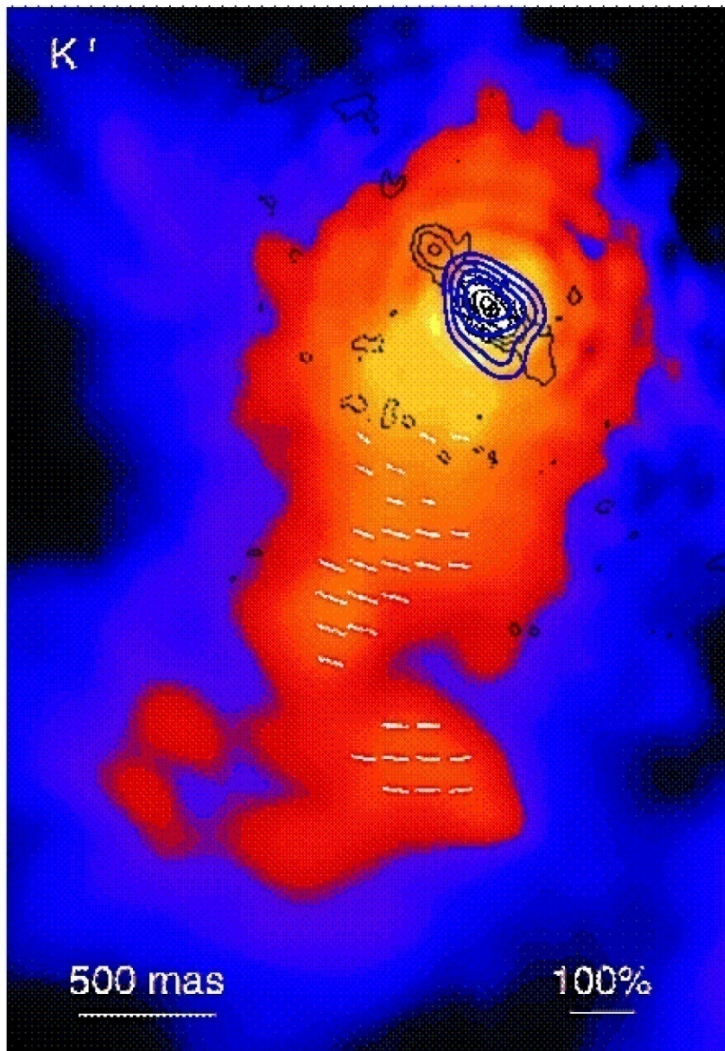
S106IR (Drew et al. 1993)



S106IR (Lumsden et al. submitted)



S140 IRS 1: Disc Wind Confirmed!



Bipolar CO Outflow from OVRO

Image: 2 μ m speckle image (Schertl et al. 2002)

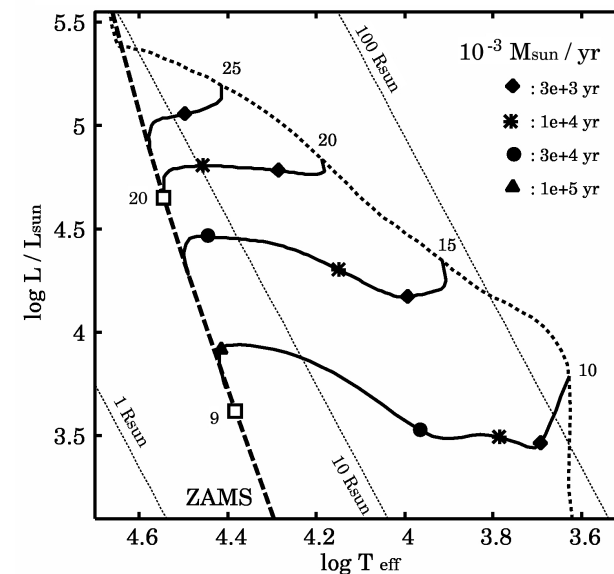
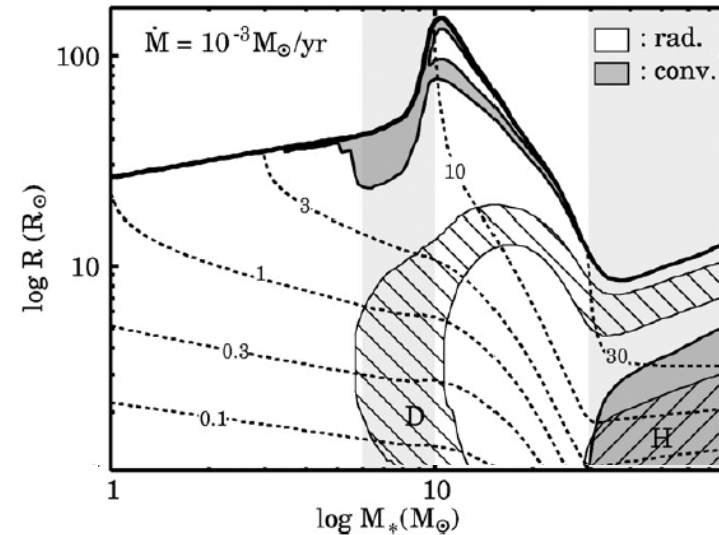
Black contours: MERLIN 5 GHz (Hoare 2006)

Blue contours: CARMA 1.3 mm (Maud et al., in prep)



MYSO evolution

- MYSOs are swollen by ongoing accretion and cool until they reach $M \sim 30 M_{\odot}$
- When swollen have convective outer layers and could host strong magnetic fields and drive MHD jets
- When contracting to MS could host radiatively driven disc wind

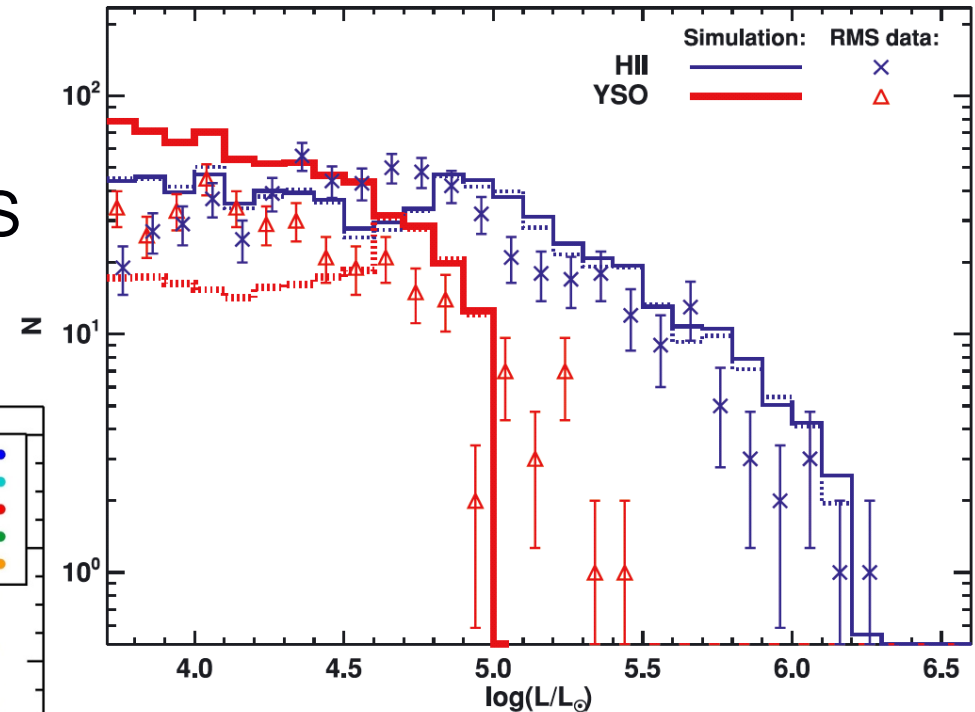
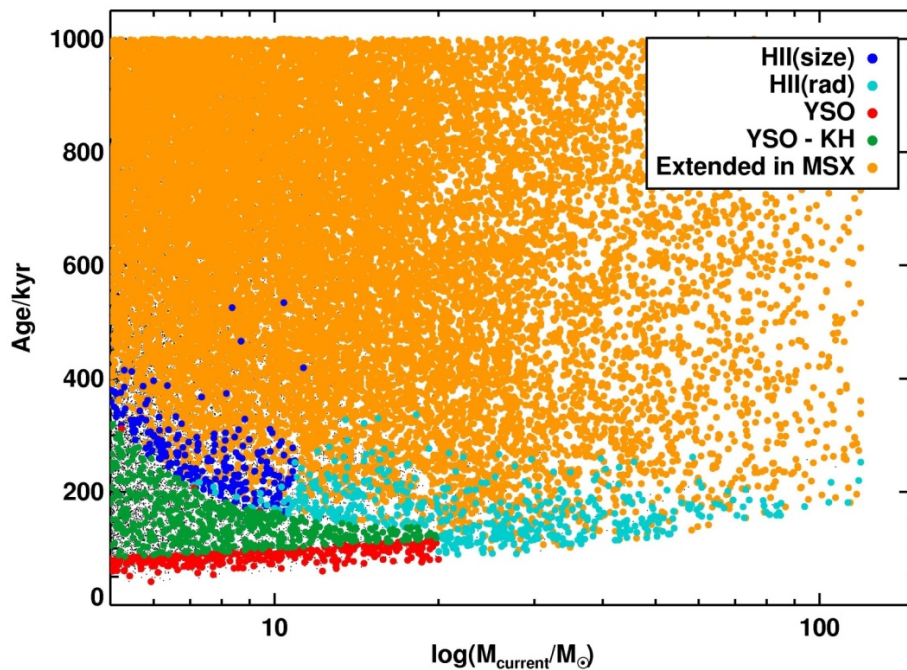


Population Synthesis



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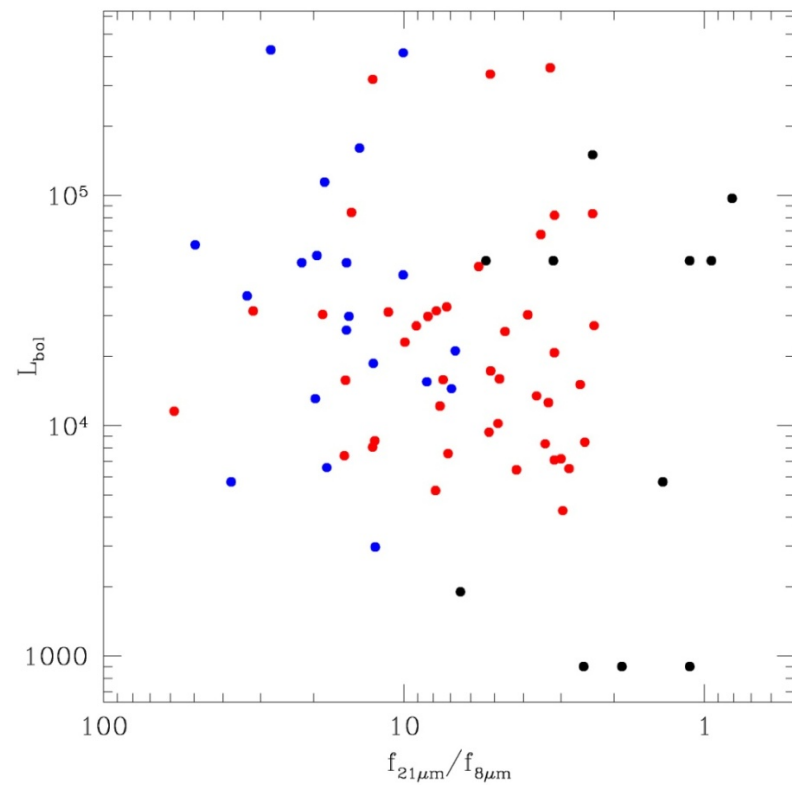
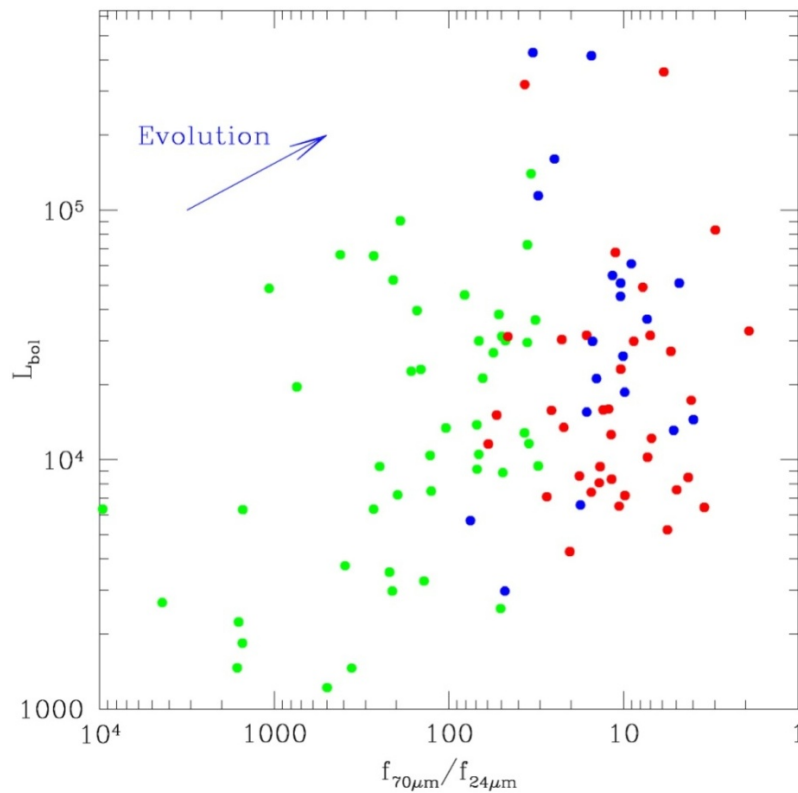
- Galaxy wide simulation of luminosity distribution of MYSOs and UCHIIs from RMS survey (Davies et al. 2010)





e-MERLIN Legacy Survey

- 4.8-6.8 GHz continuum + CH₃OH maser polarization
- 0.04" (300 AU) resolution for d<7 kpc sample of 75 targets



● IRDC sources

● MYSOs

● UCHIIs

● Herbig Be stars

Summary



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- Massive YSOs exhibit disc winds as well as MHD jets
- This could be explained in an evolutionary picture
 - in early phases MYSOs are swollen, cool, convective and drive jets
 - later the star contracts, heats up and radiatively drives a disc wind
- Test with e-MERLIN survey of large, well-selected sample covering mass and age range
- Joint studies with ALMA if we add Goonhilly 30 m dishes to e-MERLIN

