# A search for polarised emission in jets from high-mass protostars

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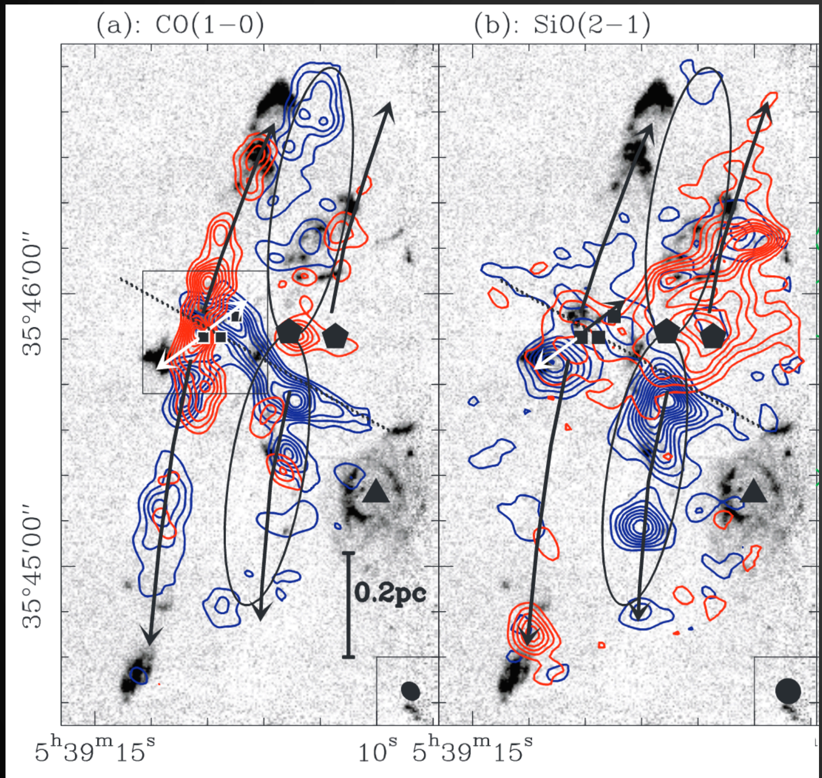
Artist's conception of the massive forming star W33A

Gemini Observatory, artwork by Lynette Cook

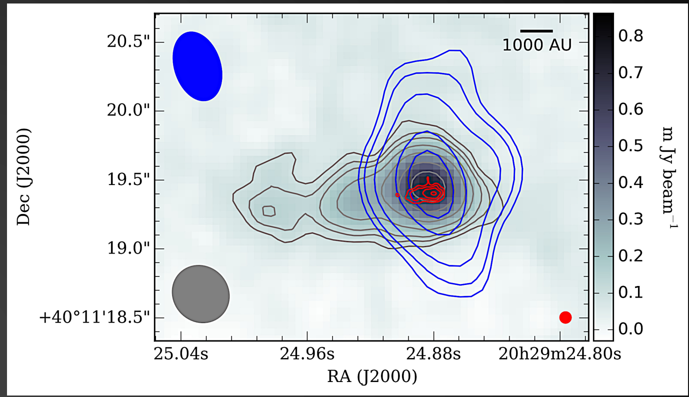
# Tracers of protostellar jets from massive stars

Molecular transitions (e.g. CO, SiO)



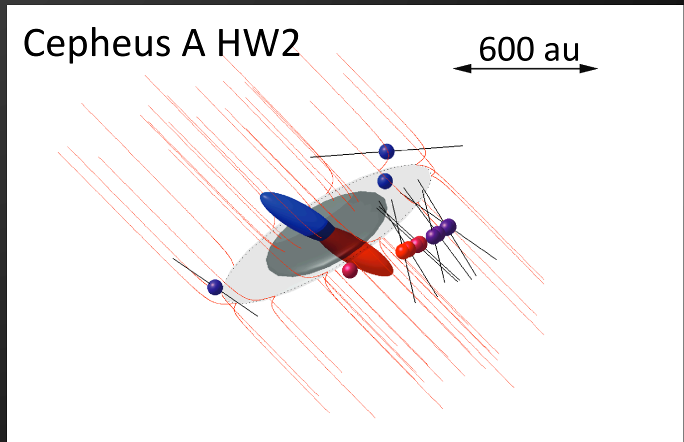

Beuther et al. (2002)

Radio continuum (perp. to disk in blue)




Johnston et al. (2013, in prep.)

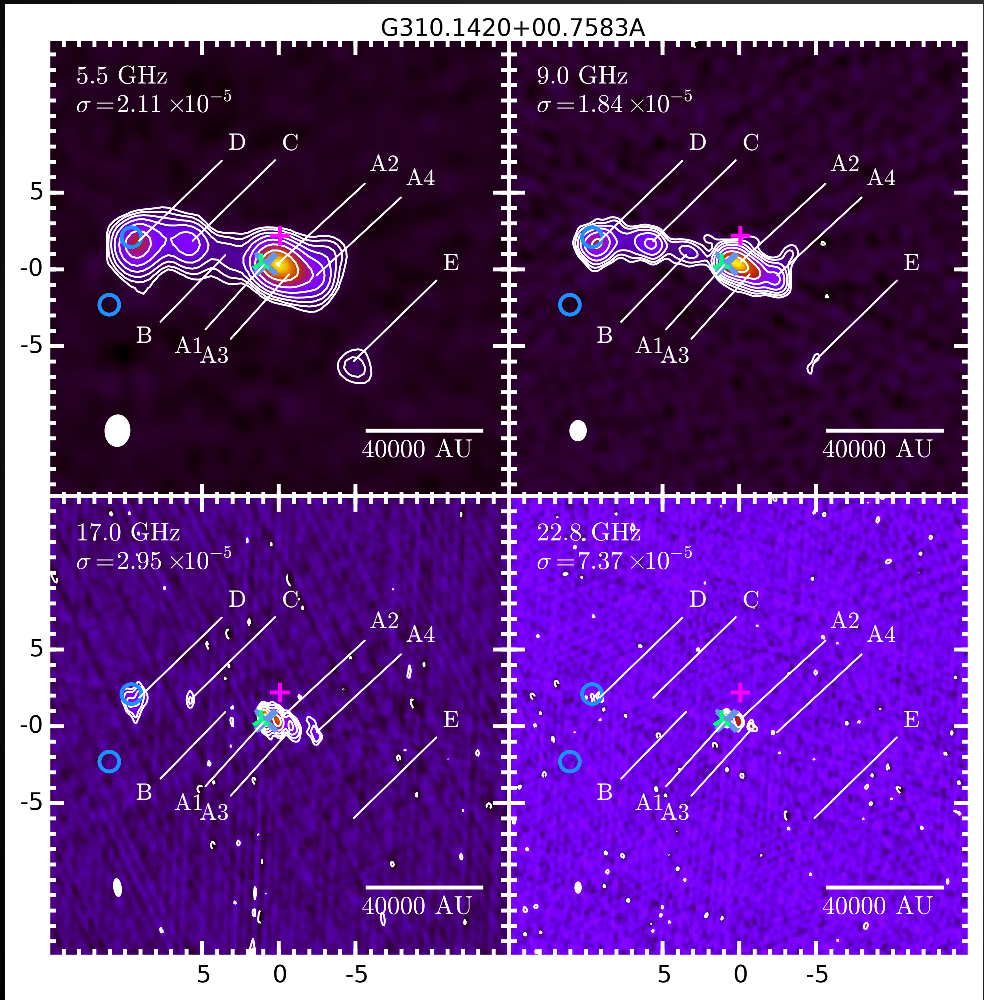
Maser polarisation (in disk)

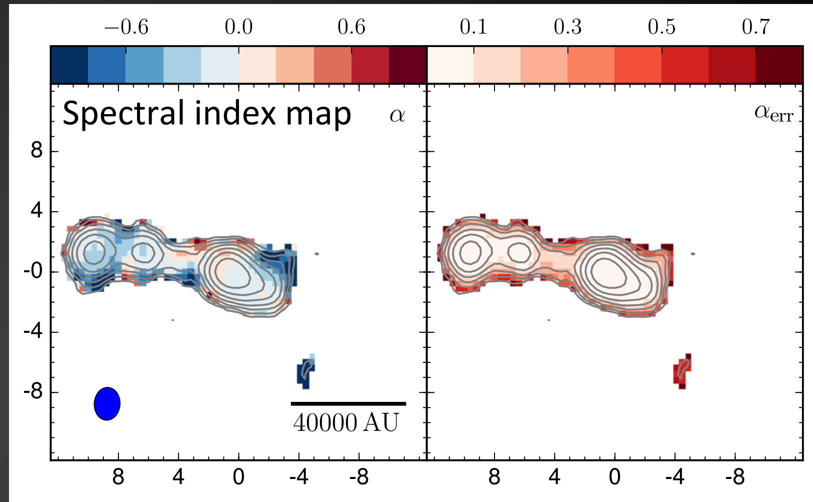


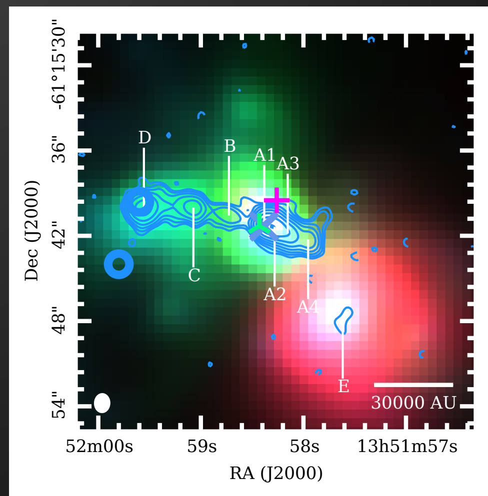

Vlemmings et al. (2010)

# Non-thermal ionized jets from massive stars

Multi-frequency ATCA cm continuum observations



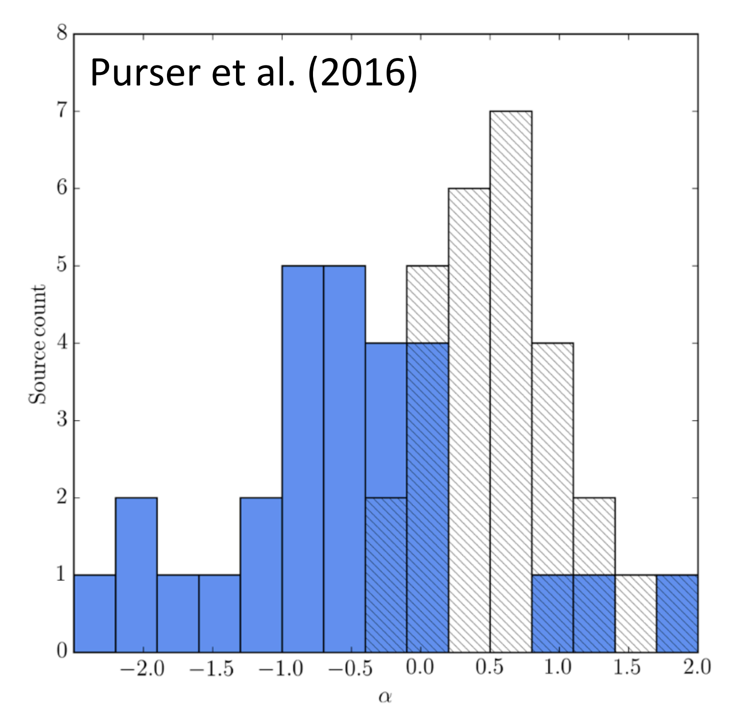




Purser et al. (2016)

# Non-thermal ionized jets from massive stars

Spectral index of
cm continuum from massive young stars




Hatched: jet-like sources **Blue**: jet knot/lobes

75% of observed jet lobes had negative spectral index

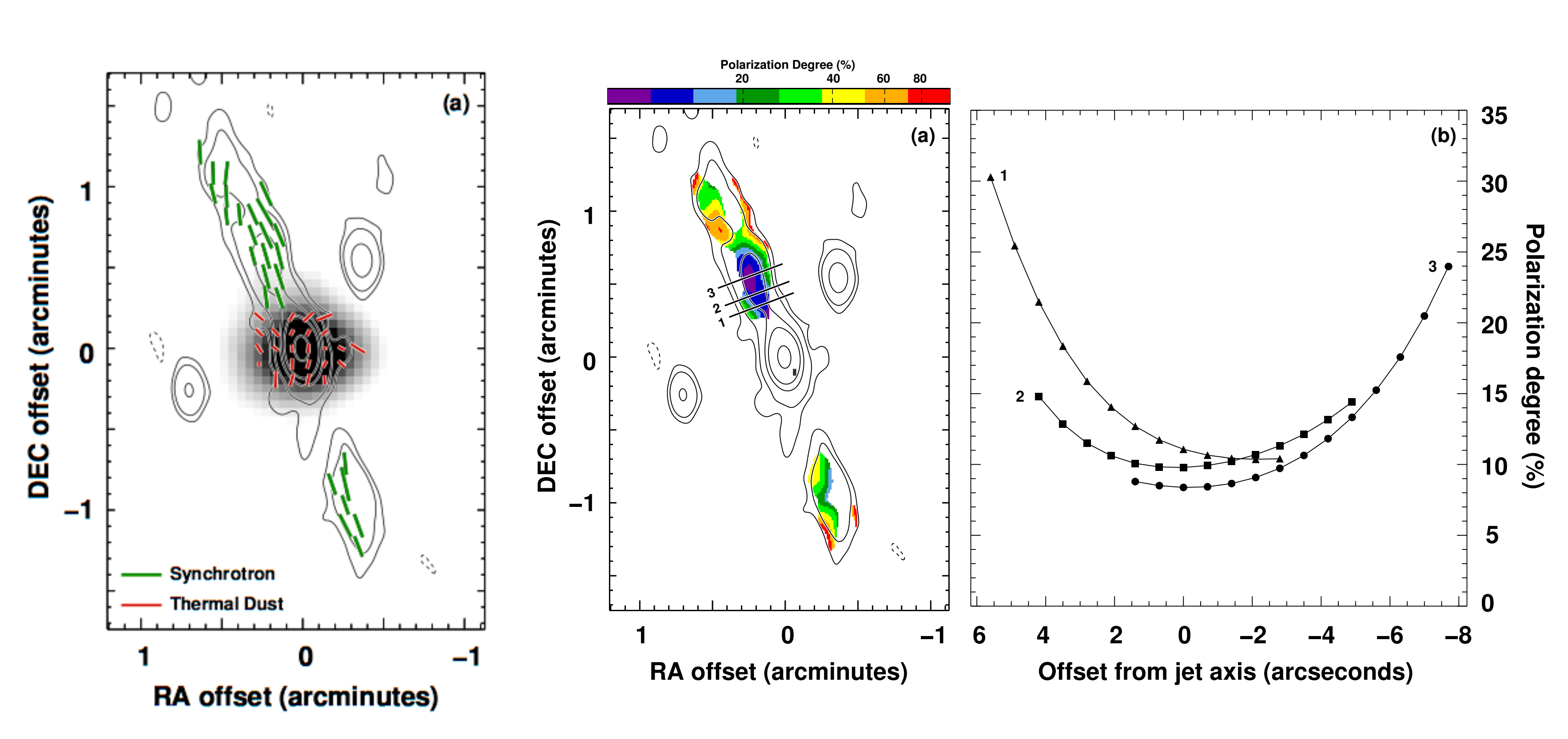
Non-thermal synchrotron emission from shocks in jet or where jet impacts on surrounding cloud

**Questions:**

Why is synchrotron emission only seen towards some jets and not others?

How is ~500-1000 km/s material accelerated to relativistic speeds? (Fermi/Diffusive shock acceleration?)

# HH 80-81:THE example of linear polarisation in a protostellar jet




Polarisation degree: 10-30%

Carrasco-Gonzàlez et al. (2010)

# Our e-MERLIN observations

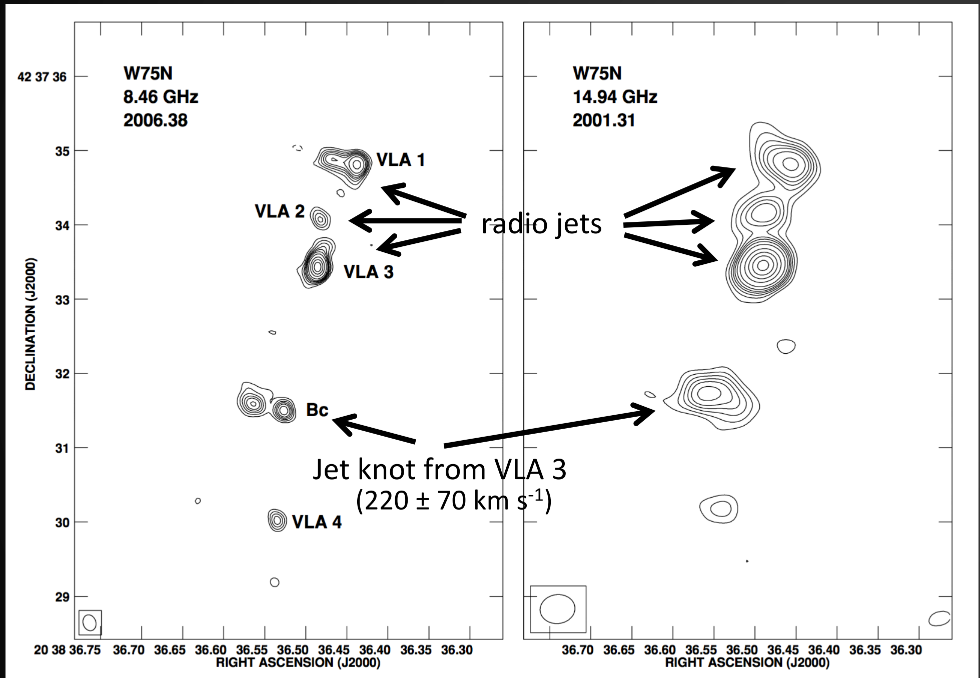
- Observations of three massive forming stars:
  1) W3 ($H_2O$)-TW
  2) Cepheus A 2
  3) W75 N
- L band 1.5 GHz (1.31-1.76 GHz)
- 450 MHz bandwidth
- Including Lovell telescope
- Spatial resolution ~0.15 ″
  (~100-200 au at 0.7-1.3 kpc)
- **Expected noise:**
  ~10 μJy/beam

# W75 N = nearby region containing massive young stellar objects (YSO)

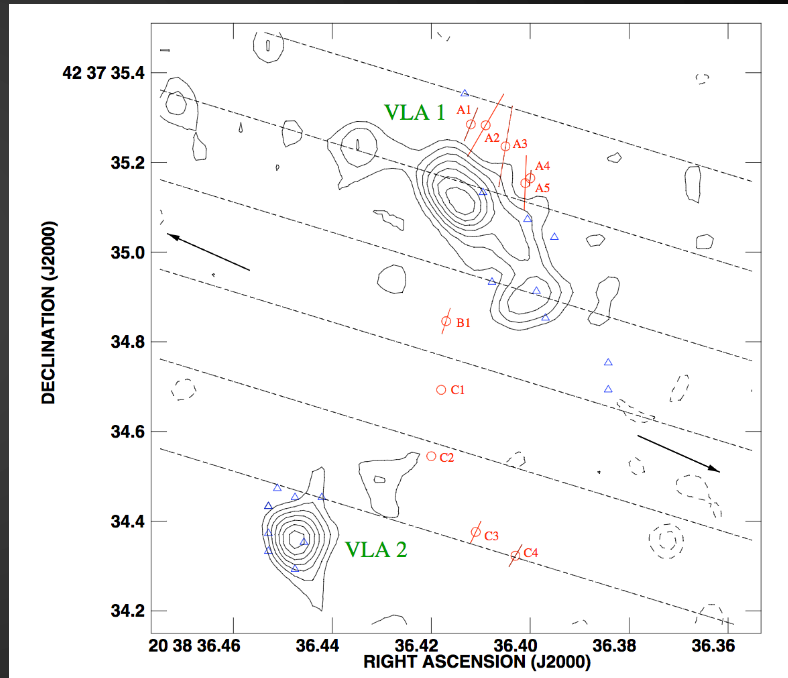
distance = 1.3 kpc (Rygl et al. 2012)

VLA 1-3: ZAMS B0-2 stars (Shepherd et al. 2004)

VLA 1 likely powers large-scale outflow (Hunter et al. 1994; Shepherd et al. 2003)




Carrasco-Gonzalez et al. (2010)

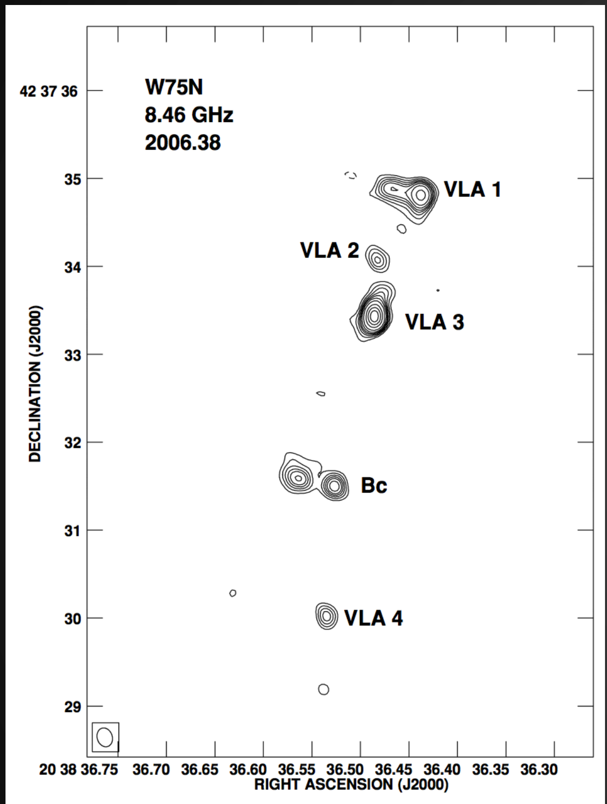



Water and 6.7GHz methanol masers and 1.3cm radio continuum

Surcis et al. (2009)

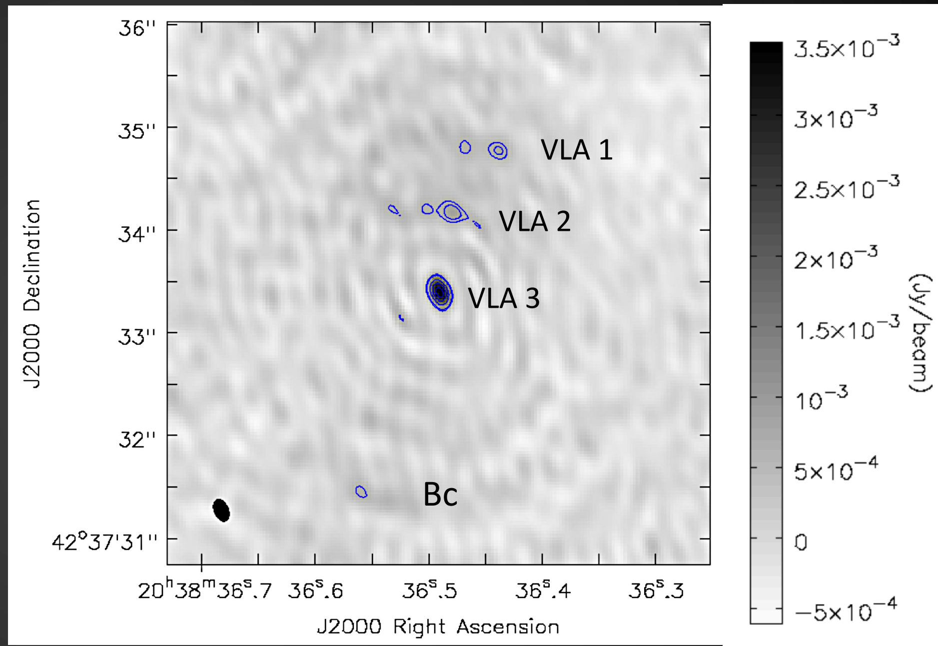
# Results: Total intensity images

8.5 GHz VLA




Carrasco-Gonzalez et al. (2010)

1.5 GHz e-MERLIN




Beam: 0.22 x 0.14” PA:22.1°

VLA 3 is a point source at L band
< 0.077 x 0.054"  or <100 x 70 au

Unfortunately, no polarised emission detected (beautifully empty Q,U and V maps!)

# Results: no linear polarisation detected

Linear fractional polarisation is <17% in VLA 3

VLA 1: < 75 %
VLA 2: < 66 %
VLA 3: < 17 %
Bc : < 91 %

Obviously need better sensitivity for these sources

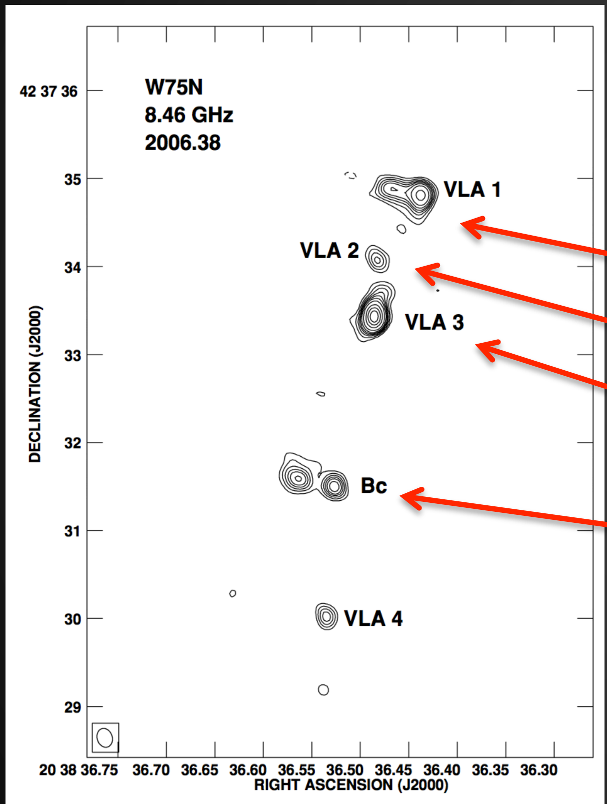
Upper limits determined from peak intensity of source and 4 x map rms

Possible explanations of the low-polarisation degree for non-thermal emission:

1. **Knots are more turbulent than in the HH80-81 jet**
   → more disorganised magnetic field
   → lower polarisation degree

2. **The knots have high electron densities or magnetic fields**
   → strong Faraday rotation of polarisation angle
   → lower polarisation degree (in wide band)

# Results: spectral indices




Previously, 8.5 – 15GHz spectral index of VLA 1 had suggested possible non-thermal emission

$\alpha = 0.09 \pm 0.03$

$\alpha = -0.03 \pm 0.06$

$\alpha = 0.2 \pm 0.03$

$\alpha = 0.3 \pm 0.05$

Spectral indices calculated with larger frequency baseline are all **thermal**

Calculated spectral indices between 1.5 and 15.0 GHz data

# Summary

- e-MERLIN observations of three massive forming stars with jets to search for linearly polarised emission
- L band observations at 1.5 GHz
- Spec. res. ~0.15" (100-200 au at 0.7-1.3 kpc)
- First results for W75N region
- Linearly polarised emission is not detected (<17% for core VLA 3)
- Spectral indices for core and knots are all consistent with free-free emission
- Conclusion: move on to other two objects!