The first synchrotron jet resolved towards a post-AGB star.

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8/11/13, Playa del carmen.

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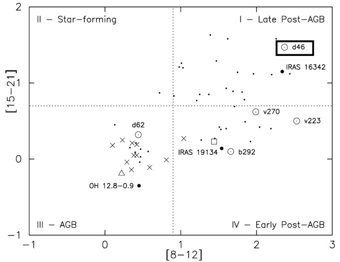
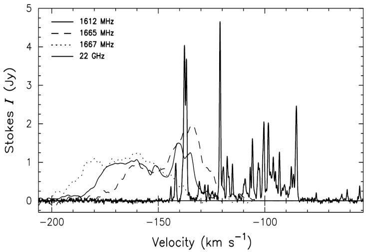
Outline

Deacon et al. 2007

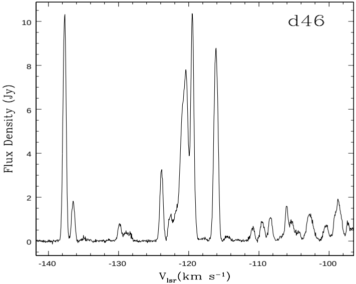


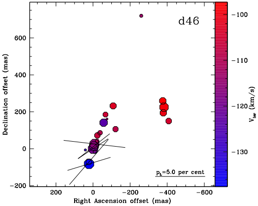


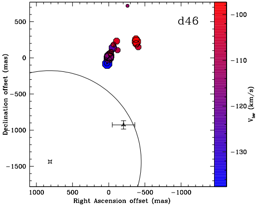
IRAS 15445−5449

- Near kinematic distance: 7.1 kpc.
- OH maser emission. Irregular line profile.
- High-velocity H_2O maser emission.
- Radio continuum emission.

H_2O maser spectrum. (Pérez-Sánchez et al. 2011)







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Mid-Infrared (Lagadec et. al. 2011)

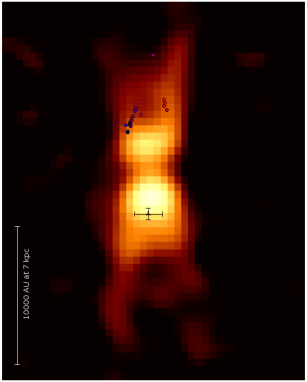


Figure: Pérez-Sánchez et al. (2011).

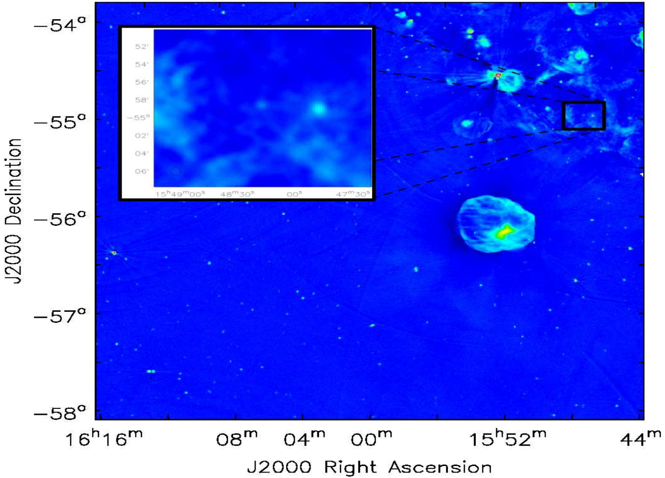


Figure: Radio-continuum 0.8 GHz. Murphy et al. 2007

Previous radio continuum emission

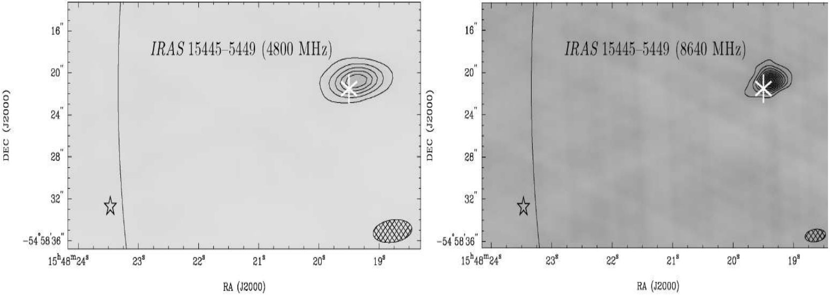
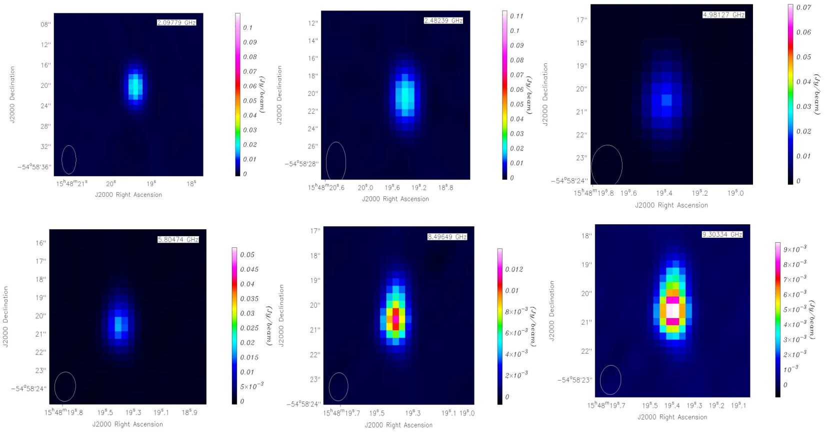


Figure: Bains. et al. 2009

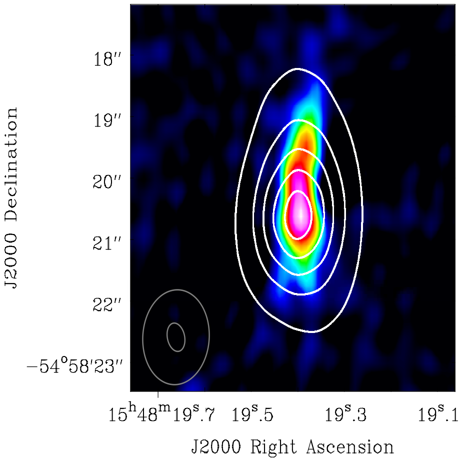
New radio continuum observations, 2012.

- 12-h observation run using the 6A ATCA array configuration (extended configuration).
- 2 GHz bandwidth at 22.0, 9.0, 5.0 and 2.2 GHz.
- Reduction and calibration of the data done using MIRIAD.


2.09779 GHz
2.48239 GHz
4.98127 GHz
5.80474 GHz
8.49649 GHz
9.30334 GHz
J2000 Declination
J2000 Right Ascension
(Jy/beam)

22 GHz radio-continuum emission.

Pérez-Sánchez et al. 2013.



- Previous observations:
  - 1998/1999 observations $\rightarrow \alpha = -0.85 \pm 0.05$ (Deacon et al. 2007)
  - 2005 observations $\rightarrow \alpha = -0.34 \pm 0.24$ (Bains et al. 2009)

- Our new observation yield a spectral index $\alpha = -0.56$ between 5.0 GHz and 22 GHz.

Synchrotron Radiation

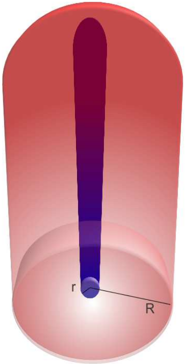
Synchrotron emission

Relativistic electrons

- Source of the electrons
  - Ionization by the star radiation field? Radiative transfer $T_\star = 12000$ K (Bains et al. 2009)...
  - Strong shocks (J-shocks)

Strong magnetic field

- Fermi shock acceleration



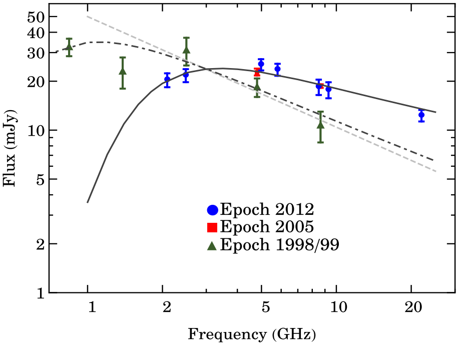


Figure: Pérez-Sánchez et al. (2013)

$R = 1000$ AU
$r = 500$ AU
$T_e = 6000$ K
$n_e = 3.5\times10^4$ cm^{-3}

Analysis of the results

Spectral index

- $\alpha = -0.63 \pm 0.01$

Energy equipartition

$U = U_E + U_B$

Mimimum B-field

$B_{min} = 5.43(D/7.1\text{kpc})^{-2/7}$ mG

Minimum Energy

$E_{min} = 4.75 \times 10^{43}(D/7.1\text{kpc})^{3/7}$ erg

B-field at $R_\star = 2$au

$B_\phi \approx 18.3(D/7.1\text{kpc})$ G.

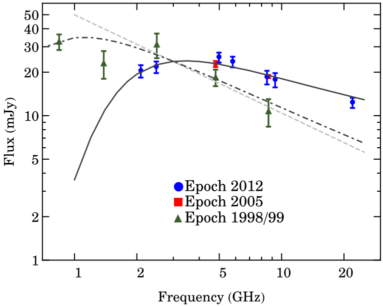


Figure: Pérez-Sánchez et al. (2013)

Assuming that

- Synchrotron emission remained nearly constant betweem 1998 and 2012.

- Increase of the emission measure by a factor of 3
  - ...*increase of the electron density by a factor of 2 in 7 yr.*
- The rapid initial increase of the emission measure implies the jet.

Conclusions

- The resolved synchrotron emission is consistent with the bipolar morphology observed at the IR.
- Minimum-energy calculated for the jet is within the typical range the E_k measured from observations of molecular outflows ($10^{42} - 10^{46}$ erg, Bujarrabal et al 2001).

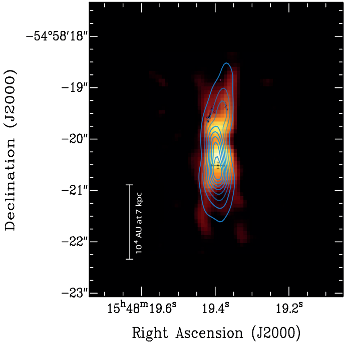


Figure: Pérez-Sánchez et al. (2013)

- The jet is collimated by a large scale magnetic field.
- The jet is shaping the CSE of IRAS 15445-5449.
- Source of the magnetic field?
  - *Not known... yet*
- Launching mechanism?
  - *Not known.... yet*
- Water fountains would have the conditions to produce synchrotron emission...
  - *More observations are required to prove it.*