Multi-frequency VLBI studies of the OVV quasar NRAO 530

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in collaboration with

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Introduction

**kpc scale:**
- A core jet structure in P.A. -50°, double lobes in the E-W direction

**pc scale:**
- Oscillating jet consists of a number of emission components north to the core

**A well know OVV:**
- $z = 0.902$, 1 mas $\rightarrow$ 7.8 pc
- Erratic and strong broad-band variability
- $\beta_{\text{app}} \approx 10^{-40}$ c

**Morphology:**
- **kpc scale:**
  - A core jet structure in P.A. -50°, double lobes in the E-W direction

- **pc scale:**
  - Oscillating jet consists of a number of emission components north to the core
Data collection

- Main calibrator in 2007 Sgr A* observing campaign:
  - 2007/5/15-24
    - 22 GHz (10 days)
    - 43 GHz (10 days)
    - 86 GHz (10 days)

  See my poster for other results from this campaign

- Mojave 15 GHz (1999-2009, 17 epochs)
component identification: an example

Jet components

Core

15 GHz, 2007
Spectra and spectral evolution

- Core identification: the compact component at the south end
- $B \approx 76 \cdot \delta$ mG based on SSA
- systematic change of $\alpha$ along the jet

Core separation
Core location \( r_{\text{core}} \) varies with \( \nu \): 
\[
r_{\text{core}} \propto \nu^{-1/kr}
\]

\((K_r \text{ is related to the electron energy distribution, B-field, and the electron number density})\)

Synchrotron self-absorption, \( K_r = 1 \)
$\nu$-dependent positions of components

**Epoch: 2007.4**

<table>
<thead>
<tr>
<th>Id.</th>
<th>$\Delta r_{22/43}$ [mas]</th>
<th>$\Delta r_{43/86}$ [mas]</th>
</tr>
</thead>
<tbody>
<tr>
<td>$d$</td>
<td>-0.17±0.02</td>
<td>-0.09±0.03</td>
</tr>
<tr>
<td>$e$</td>
<td>-0.12±0.03</td>
<td>…</td>
</tr>
<tr>
<td>$f$</td>
<td>-0.14±0.04</td>
<td>…</td>
</tr>
</tbody>
</table>

- Two-dimensional shift for component $f$ (>4$\sigma$ for P.A.)
Inter-day Variability: flux density

- Outer jet components
- Inner jet components

- The probability for variability for most components is low
- $m < 4\%$ for the core, and $m < 20\%$ for the jet
Jet kinematics at 15 GHz

Physical parameters:
- apparent speeds $\beta_{\text{app}}$: 2-26 c
- inter-day variability $< 170$ c
- $\Gamma_{\text{min}} = \delta_{\text{min}} = 14.1$
- $\theta_{\text{cri}} = 4.1^\circ$ (for comp. $f$)

Core separation vs. time
Jet kinematics at 15 GHz

P.A. swing for comp. d, e, h, and i

P.A. keeps nearly constant for comp. f, g, j

P.A. vs. time
Morphology evolution: jet wobbling

- Visible only in the innermost regions
- Similar to many others, like NRAO150, BL Lac etc.
Summary

➢ One-sided core-jet structure with spectral evolution

➢ 2-D position shifts along the jet, some of which are probably due to the core-shift

➢ Variations of flux density and structure on daily time-scales:
  flux density: \( m < 4\% \) for the core and \( m < 20\% \) for the jet;
  jet speeds < 170 c

➢ evolving jet ridge line, a consequence of 3-D motion
Thank you!