Ultra-compact blazar AO 0235+164

QUASARS AT ALL COSMIC EPOCHS
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Based on multi-frequency VLBI and single-dish radio observations we find kinematical and geometrical parameters of the source, which suggest significant jet acceleration and collimation within 1 mas of the 7 mm core. The extremely high brightness temperatures measured with space interferometer indicate presence of an unresolved core substructure

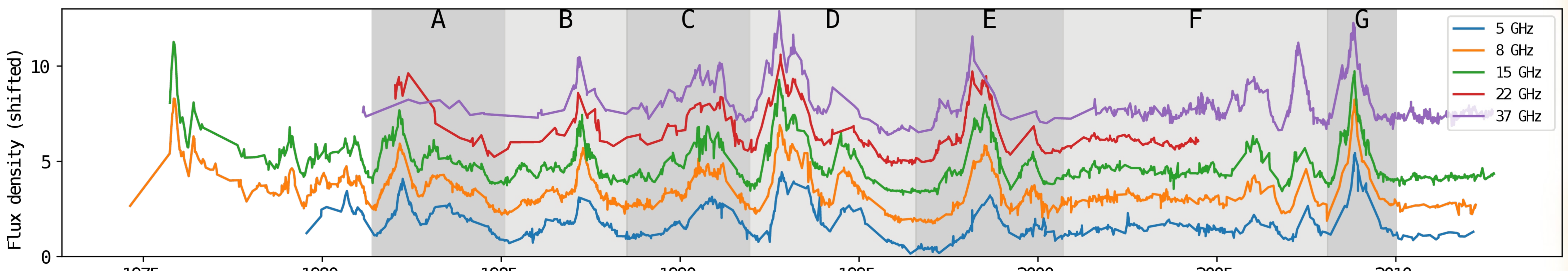
Observational data

•Single-dish light curves
Univ. of Michigan Radio Observatory (5, 8, 15 GHz)
Metsahovi Radio Observatory (22, 37 GHz)
Owens Valley Radio Observatory (15 GHz)

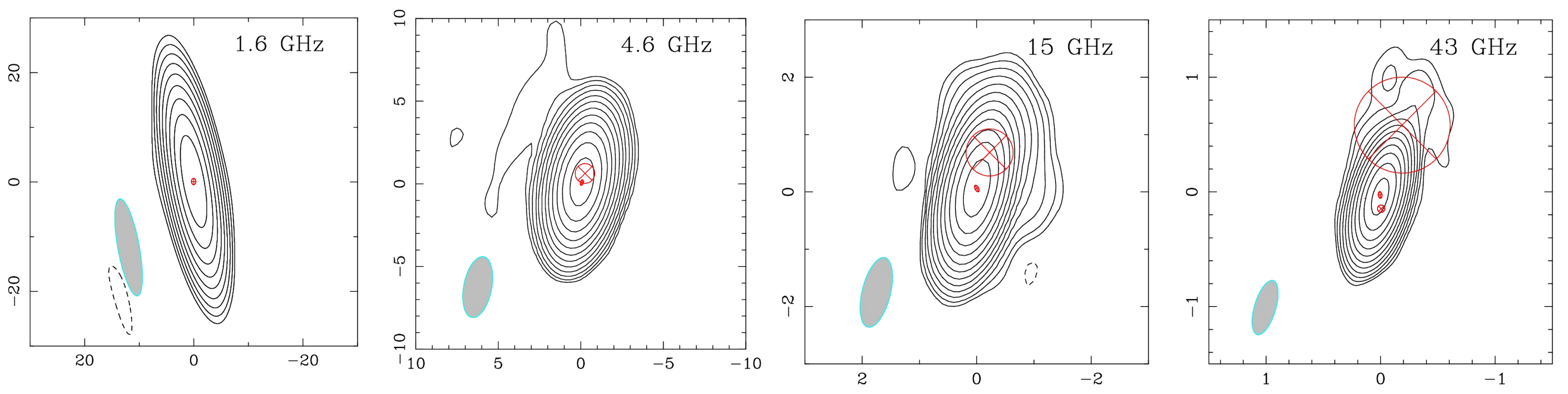
•Multi-frequency VLBI
VLBA (2008-09-02): 4.8 - 43 GHz
EVN (2008-10-19): 1.6 - 8.4 GHz

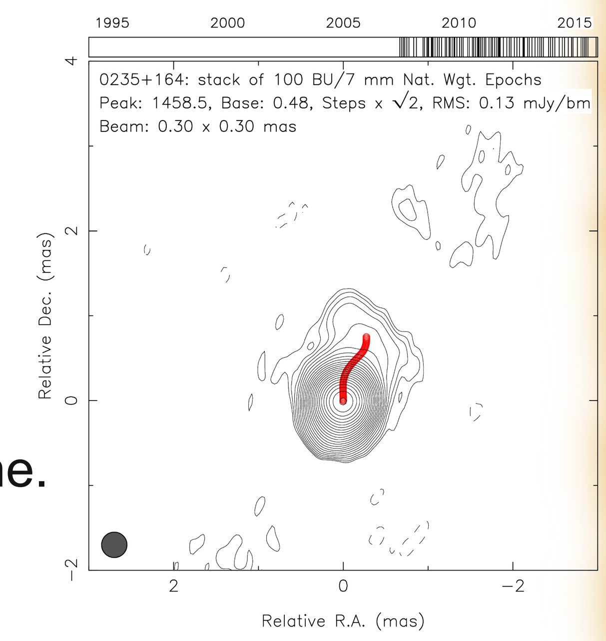
•Multi-epoch VLBA at 43 GHz
Data by Boston University blazar group (100 epochs)

•Radioastron Space-VLBI
12 epochs, 1.6 - 22 GHz, baselines up to 14 Gλ



Light curves of 0235+164. The time lags of the flares depend on frequency as $\Delta T \sim \nu^{-1.1\pm0.4}$

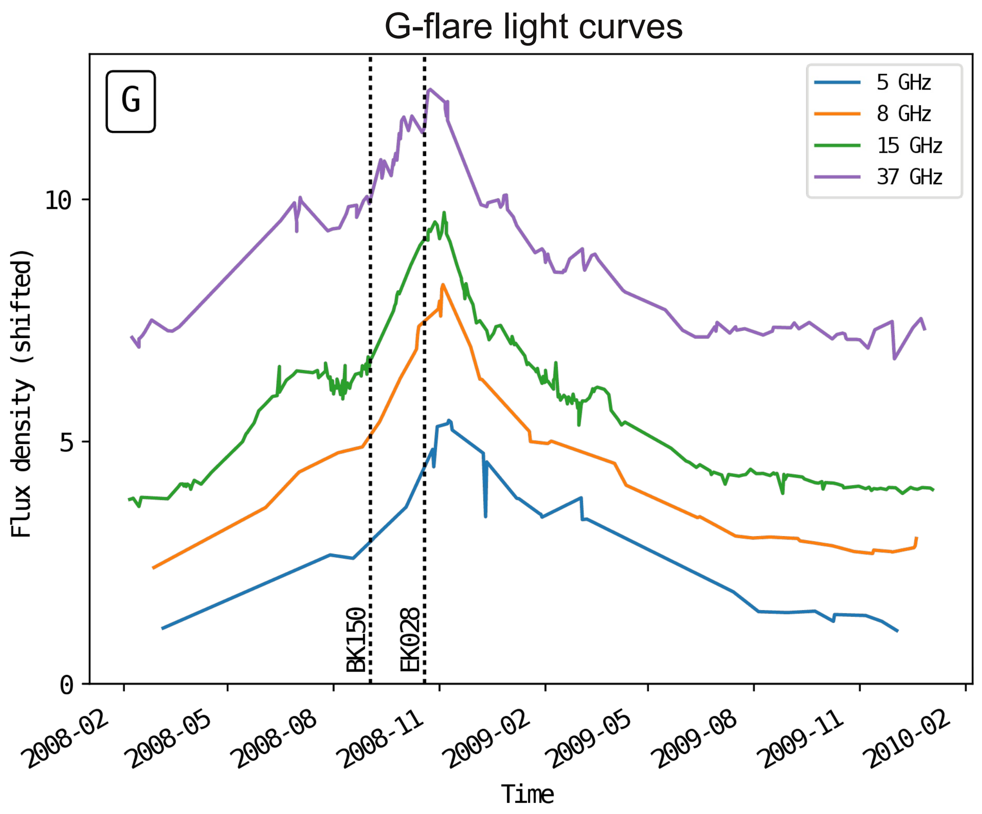


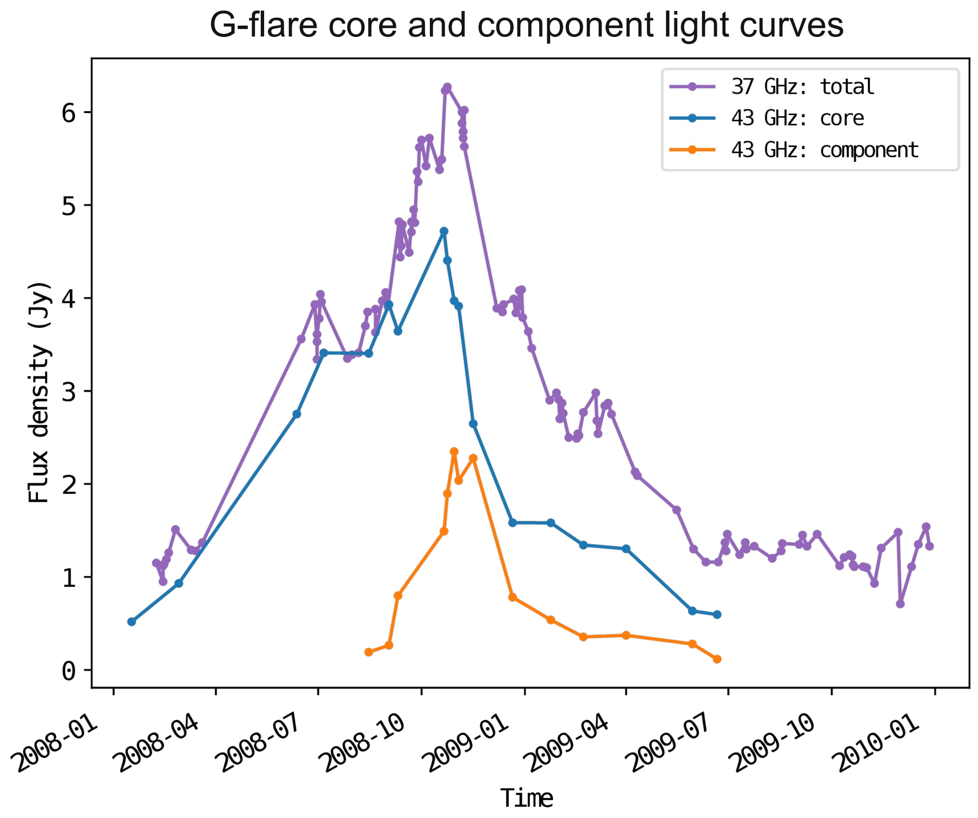


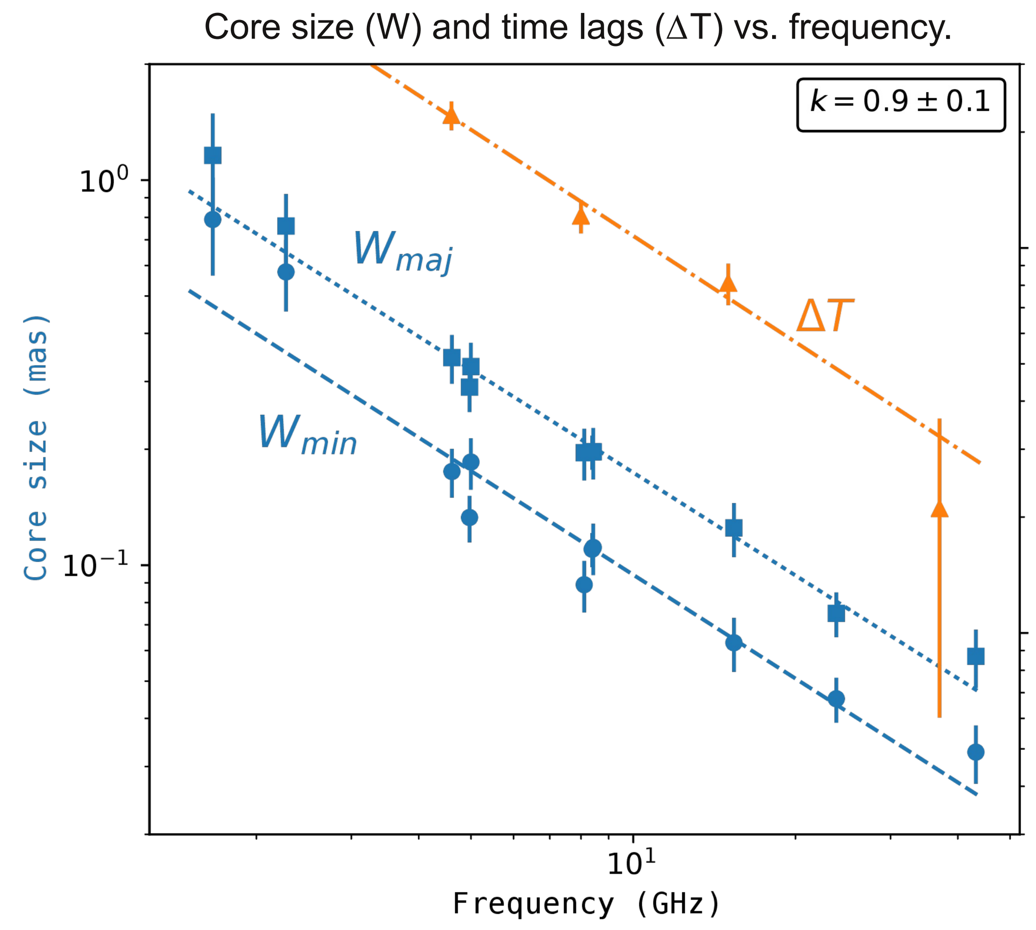
CLEAN maps with model components and stacked 43 GHz image with ridgeline.

Time lags and core size

Time lags of the flares at different frequencies are found using Gaussian process regression. VLBI structure is modeled with elliptical and circular Gaussian components.

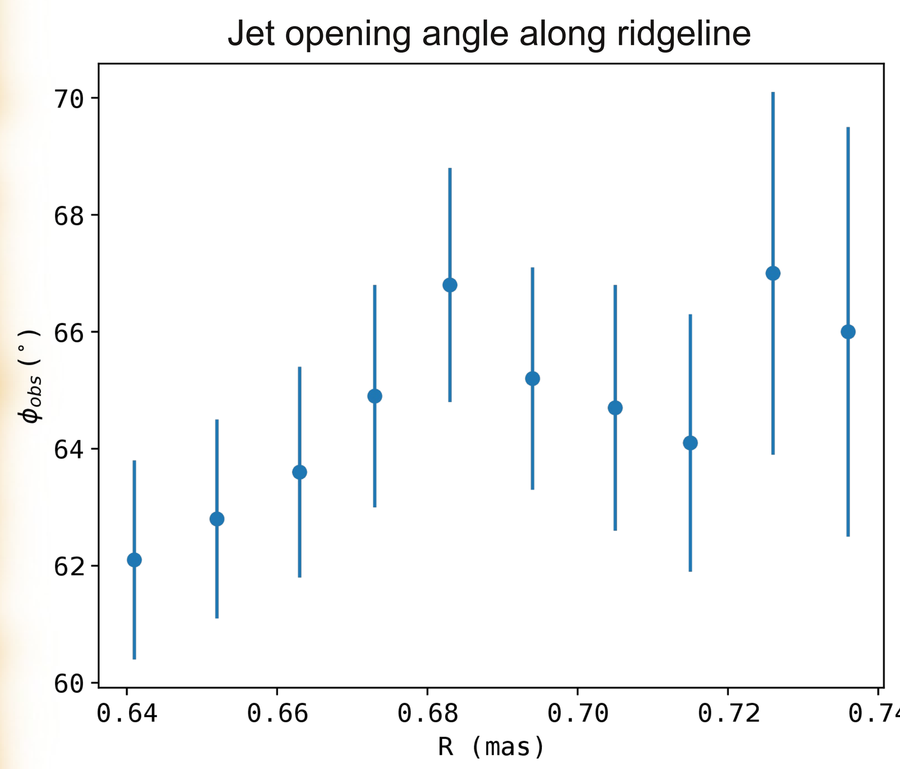


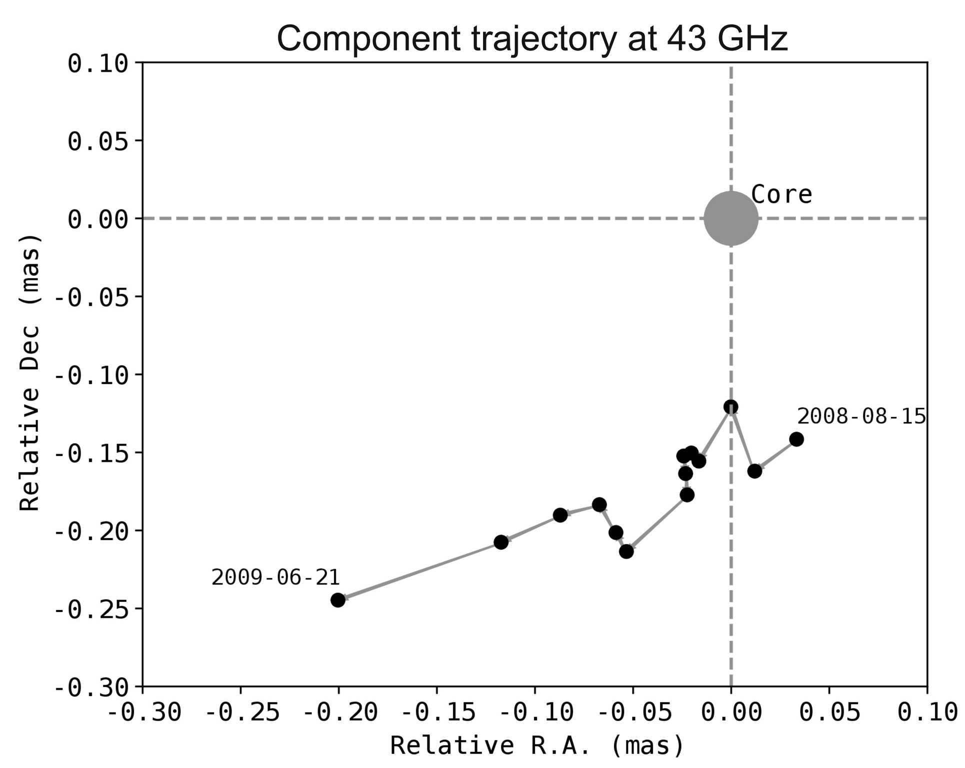


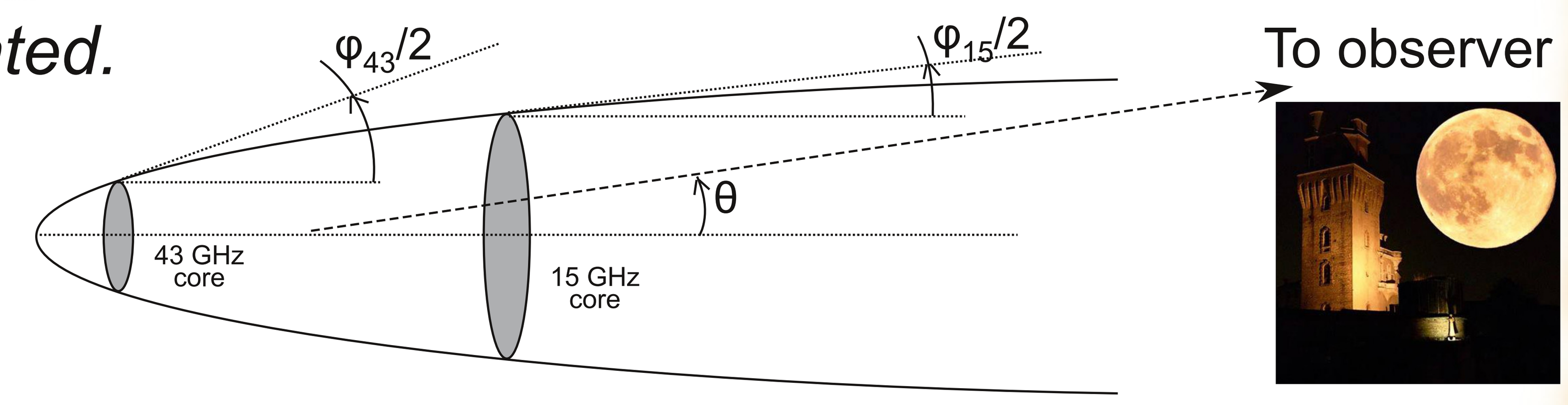


Jet geometry and kinematics

Stacked image is used to find jet opening angle φ.
Doppler factor δ, Lorentz factor Γ and viewing angle θ are estimated.







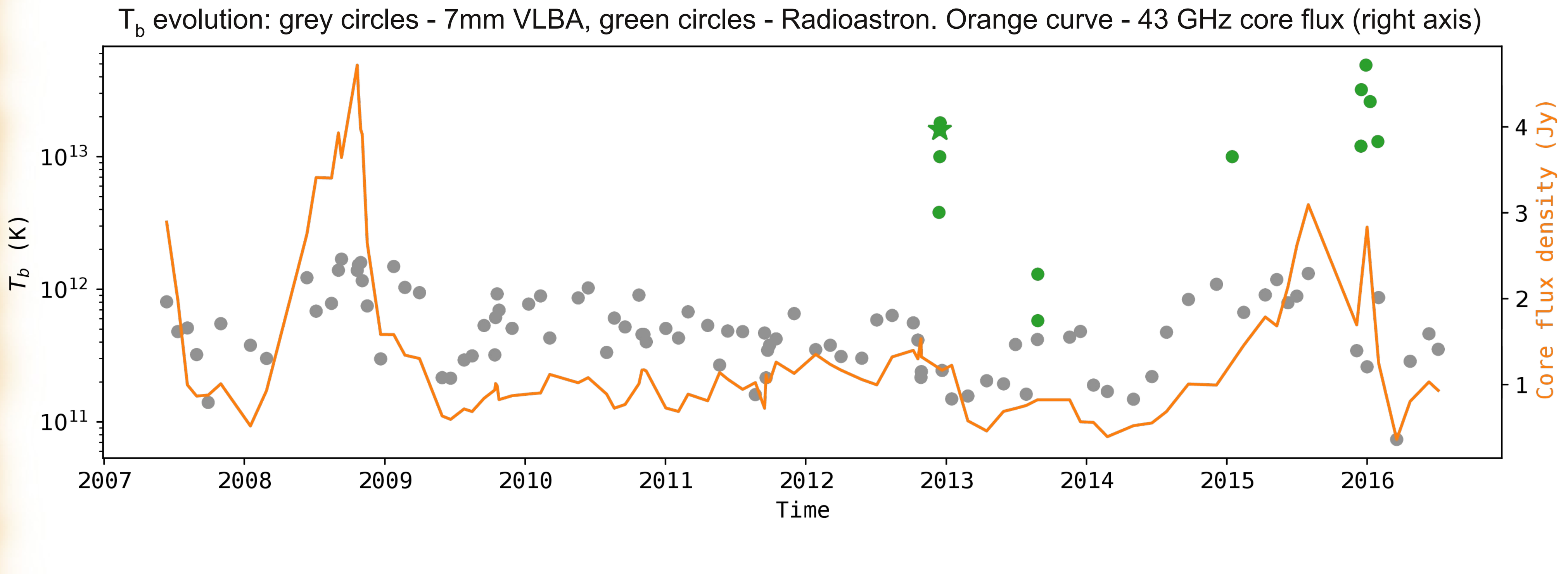
Schematic illustration of collimated jet with $\varphi_{15GHz} < 2\cdot\theta < \varphi_{43GHz}$

- Core is resolved (with mean axes ratio ~0.5)
- Core size and flares time lags ~ $\nu^{-0.9}$
- Core $\delta\sim10$, $\Gamma\sim5$, $\theta\sim1.2^o$, $T_{b,int}\sim10^{11}$ K
- Component $\delta\sim30$, $\Gamma\sim18$, $\theta\sim1.2^o$ => acceleration
- Jet $(\varphi_{obs})_{7mm}=65^o > (\varphi_{obs})_{2cm}=30^o$ => collimation
- $T_b \sim 10^{13}$ K => unresolved core substructure

Brightness temperatures

measured using VLBI models and visibility amplitudes on longest RadioAstron baselines

T_b evolution: grey circles - 7mm VLBA, green circles - Radioastron. Orange curve - 43 GHz core flux (right axis)



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More details available online at https://goo.gl/BxjId8

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