Ultra-compact blazar AO 0235+164

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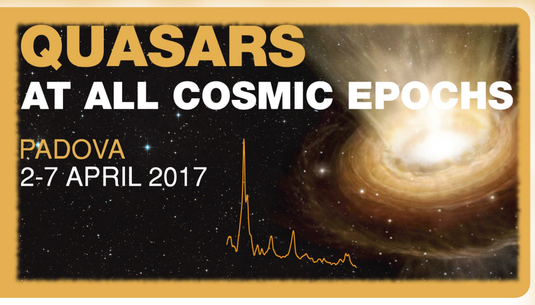


Based on muti-frequency VLBI and single-dish radio observations we find kinematical and geometrical parameters of the source, which suggest significant jet acceleration and collimation within 1 mas of the core. The extremely high brightness temperatures measured with space interferometer indicate presence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

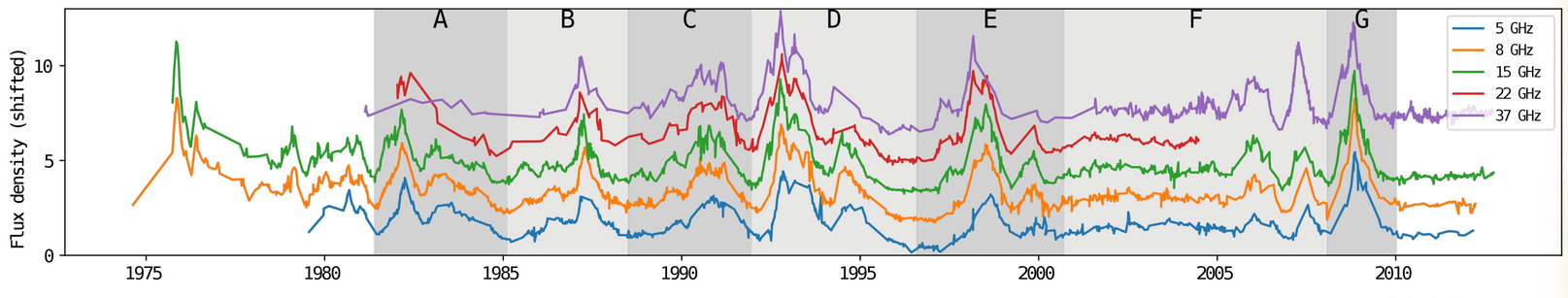
Observational data

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

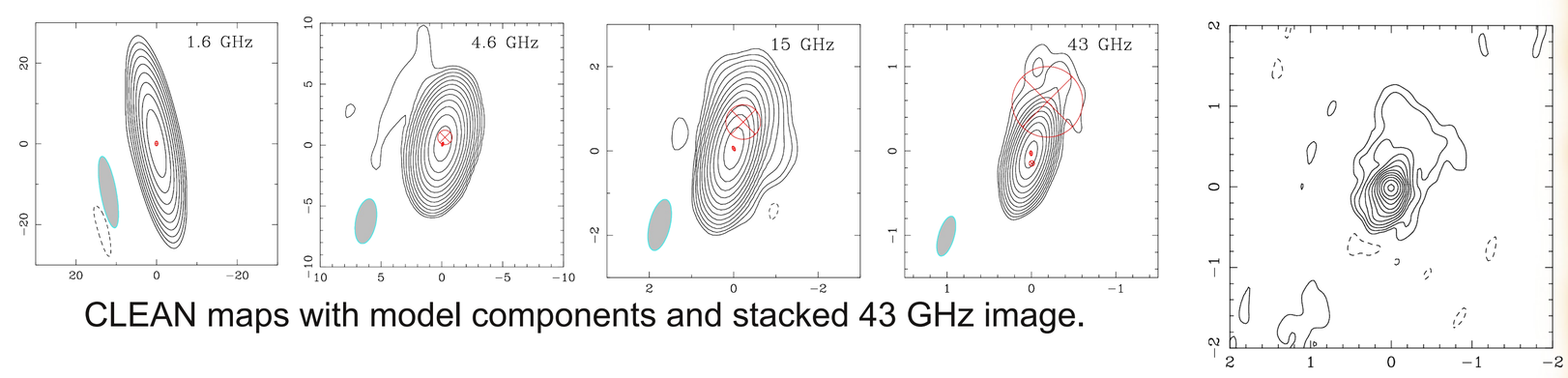
•Multi-frequency VLBI
BK150 (2008-09-02): VLBA; 4.8 - 43 GHz.
EK028 (2008-10-19): BD, ON, WB, MC, EF, TR, SV, ZC, HH, SH, UR, NT, JB; 1.6 - 8.4 GHz

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

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



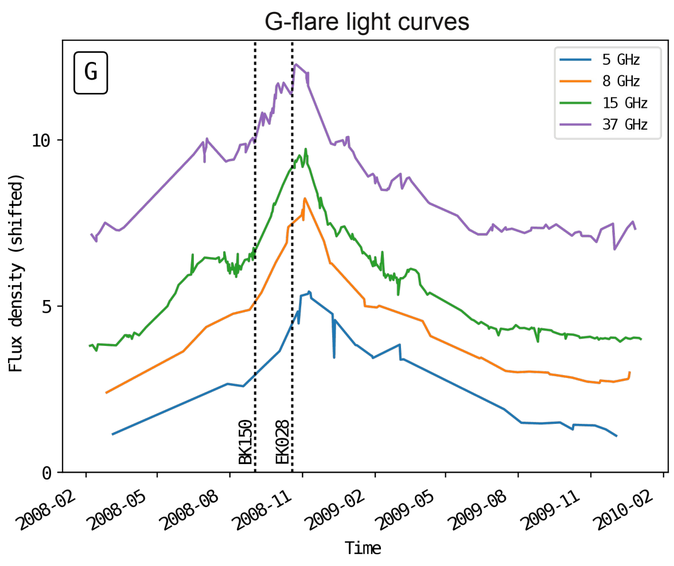
Light curves of 0235+164. The time lags of the flares depend on frequency as $\Delta T \sim \nu^{-1.1\pm0.4}$

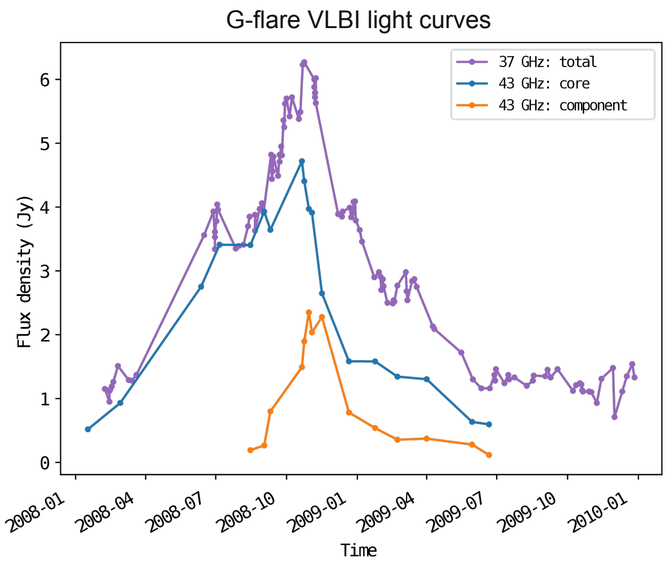


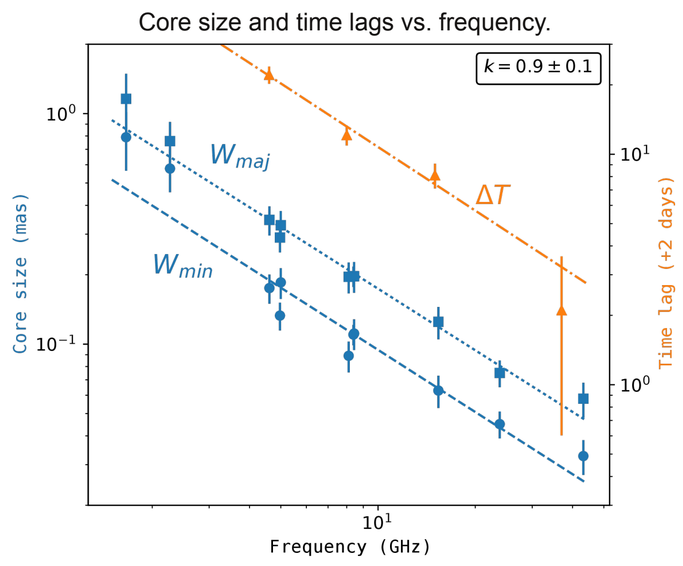
CLEAN maps with model components and stacked 43 GHz image.

Time lags and core size

Time lags of the flares on different frequencies found using Gaussian process regression.
VLBI structure is modeled with elliptical and circular gaussian components (core+jet).

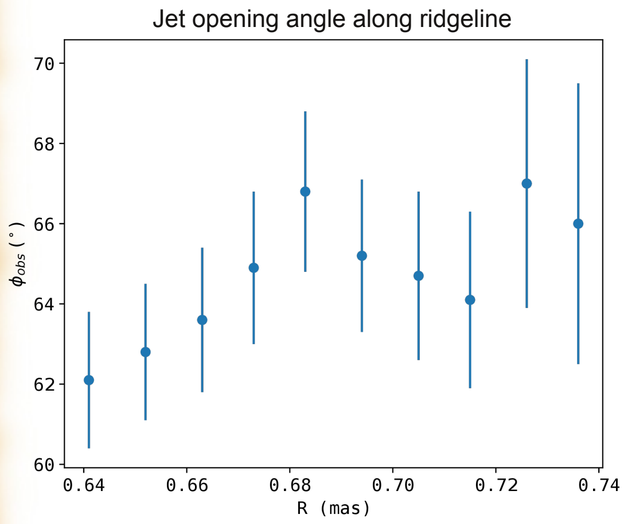


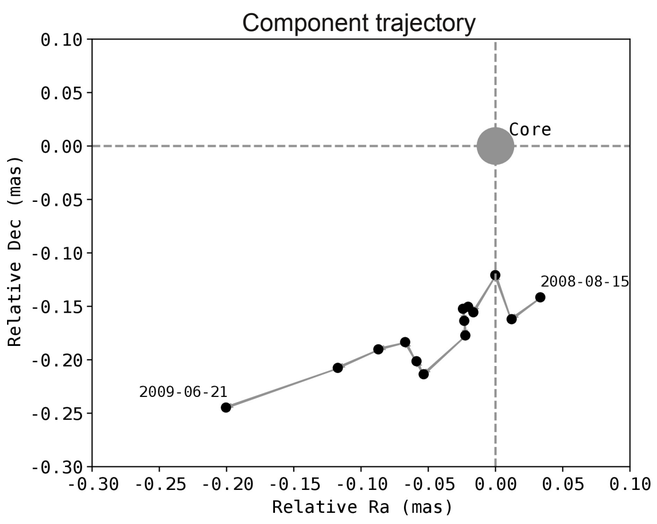


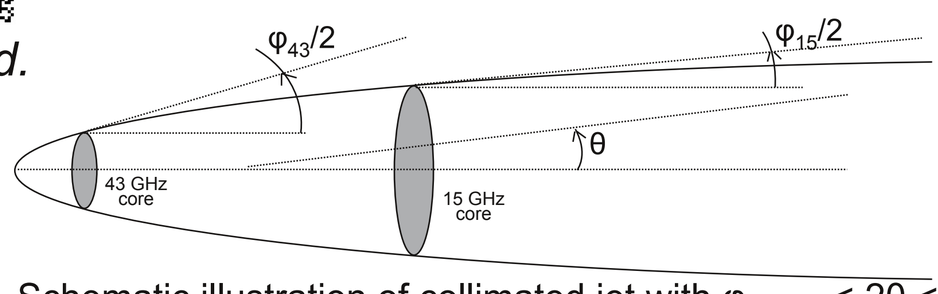


Jet geometry and kinematics

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



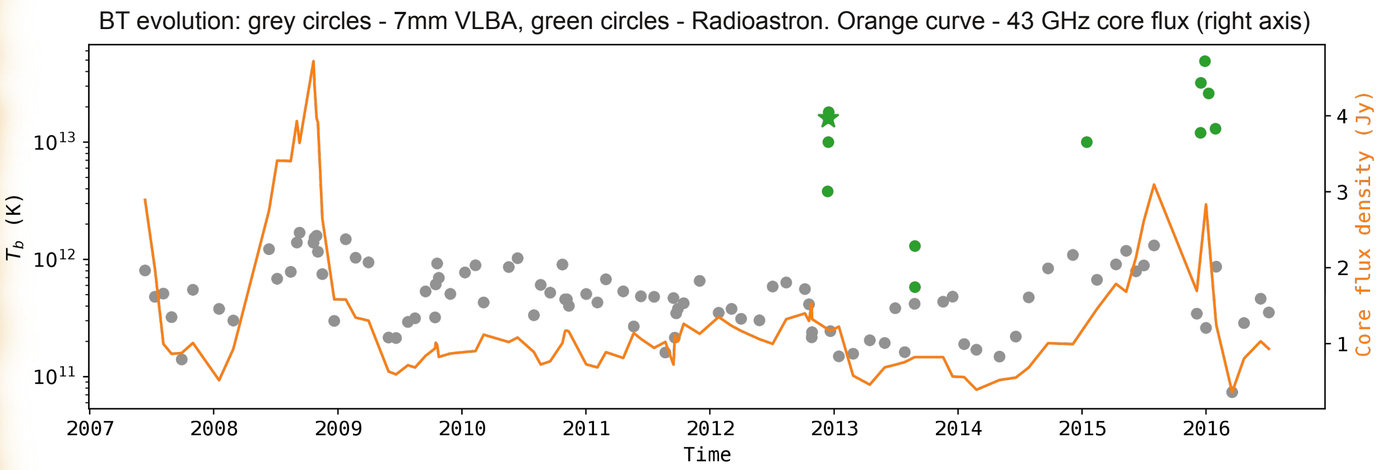




Schematic illustration of collimated jet with $\varphi_{15GHz} < 2\theta < \varphi_{43GHz}$

Brightness temperatures

measured using VLBI models
and visibility amplitudes on longest Radioastron baselines



- Core is resolved (with mean axes ratio ~0.5)
- Core size and flares time lags ~ $\nu^{-0.9}$
- Core $\delta \sim 10$, $\Gamma \sim 5$, $\theta \sim 1.2^o$, $T_{b,int} \sim 10^{11}$ K
- Component $\delta \sim 30$, $\Gamma \sim 18$, $\theta \sim 1.2^o$ => acceleration
- Jet $(\varphi_{obs})_{7mm} = 65^o > (\varphi_{obs})_{2cm} = 30^o$ => collimation
- Tb ~ 10^{13} => unresolved core substructure

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

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