МФТИ

MIPT/PHYSTECH

Moscow Institute of Physics and Technology

Analysis of variability of quasars' radiation

Julia Kiseleva,
B02-001, Department of General and Applied Physics, MIPT
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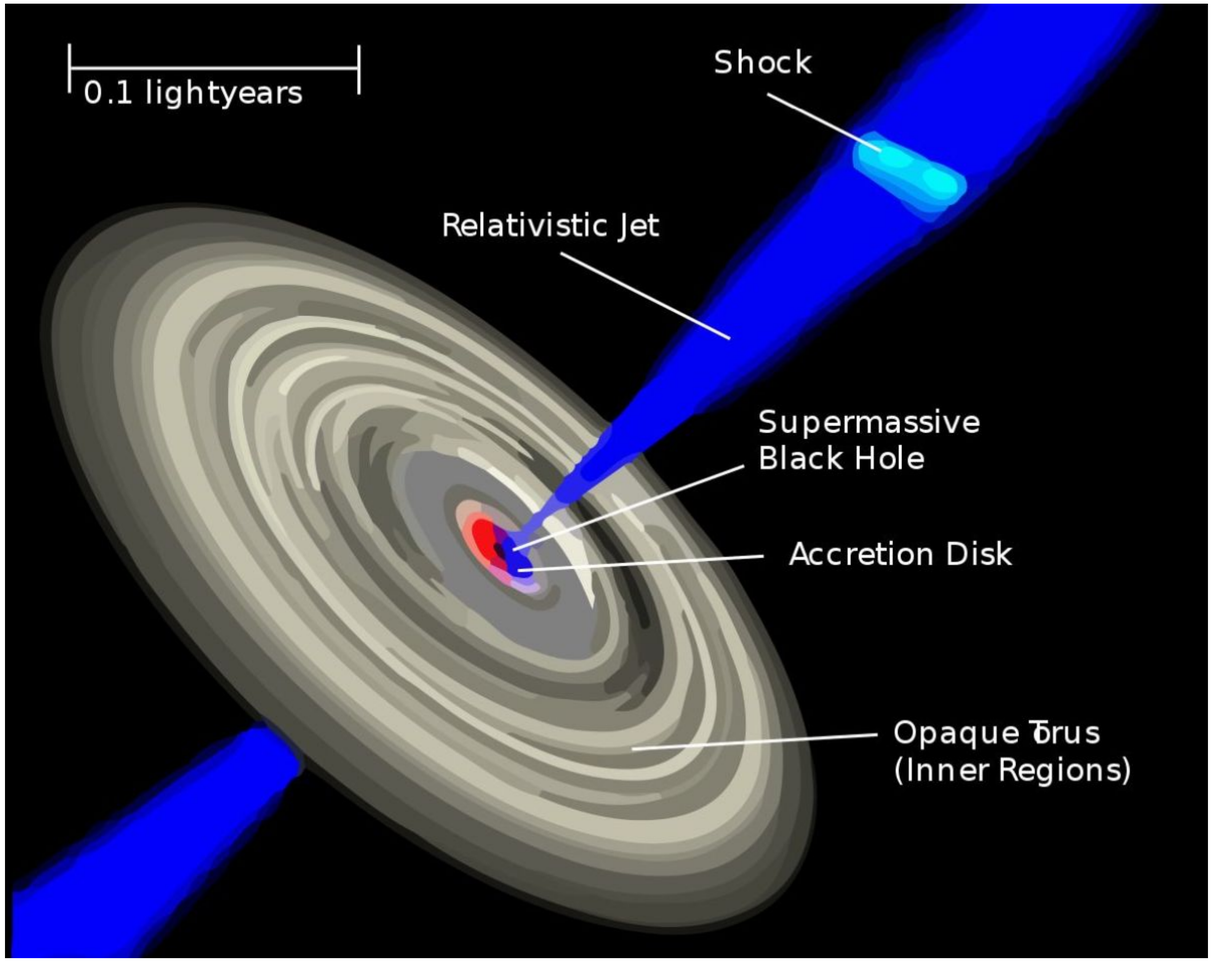
Plan

1. Quasars and superliminal motion
2. Characteristics of investigated quasar
3. Obtained images (using Python)
4. Gaussian modeling and component velocity calculation
5. Variability of radiation
6. Jet’s kinematics

Quasars and superliminal motion

In astronomy, superluminal motion is the apparently faster-than-light motion seen in some radio galaxies, quasars and some other space objects. Bursts of energy moving out along the relativistic jets emitted from these objects can have a proper motion that appears greater than the speed of light. All of these sources are thought to contain a black hole, responsible for the ejection of mass at high velocities. There is a pretty easy physical explanation of this “phenomena” connected with geometry of the quasar.



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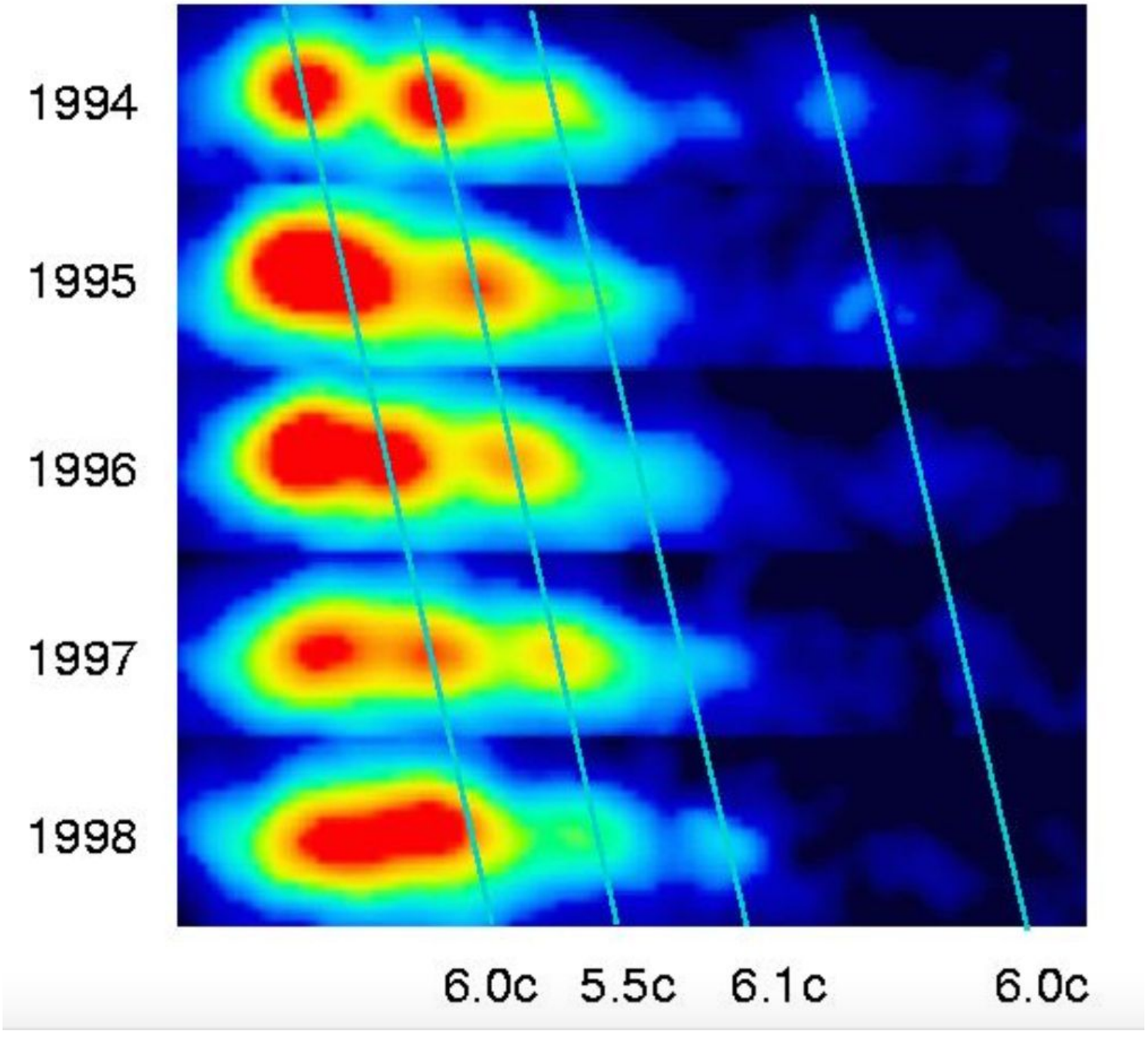
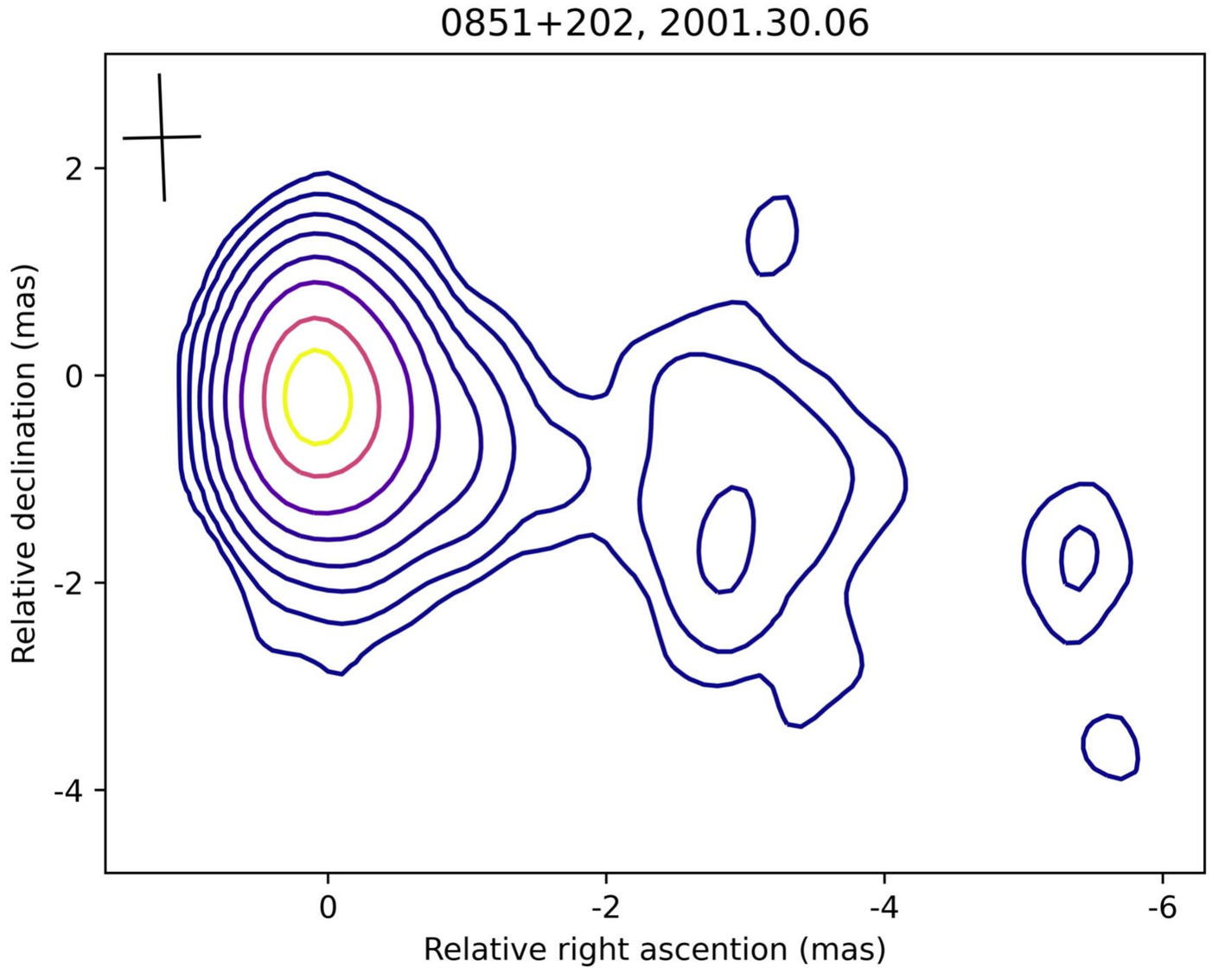


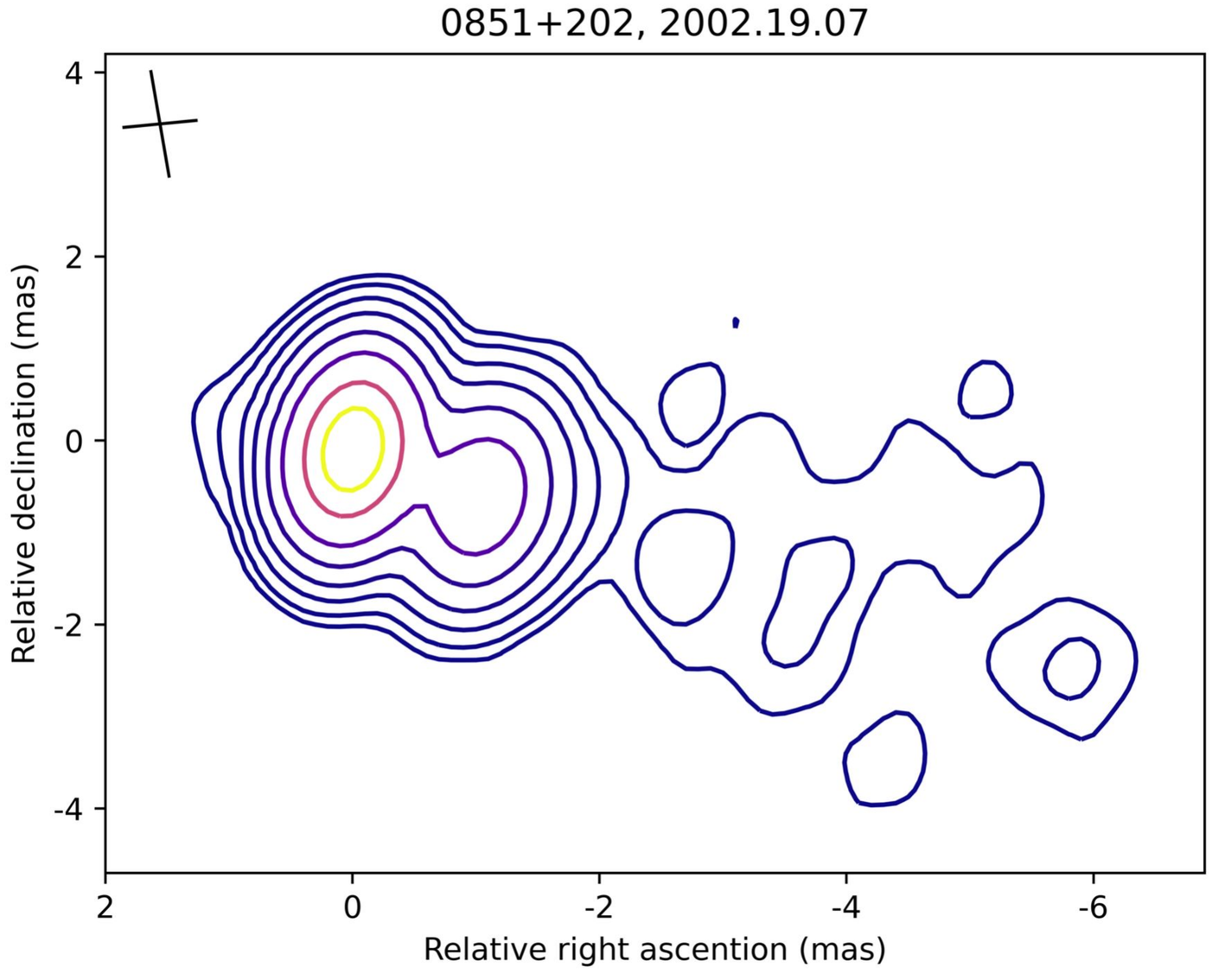
Characteristics of investigated quasar

- OJ 287 -- active galactic nuclei, in the center of which seem to be a system of two supermassive black holes.
- z = 0.306 (red shift)

Obtained images



Obtained images



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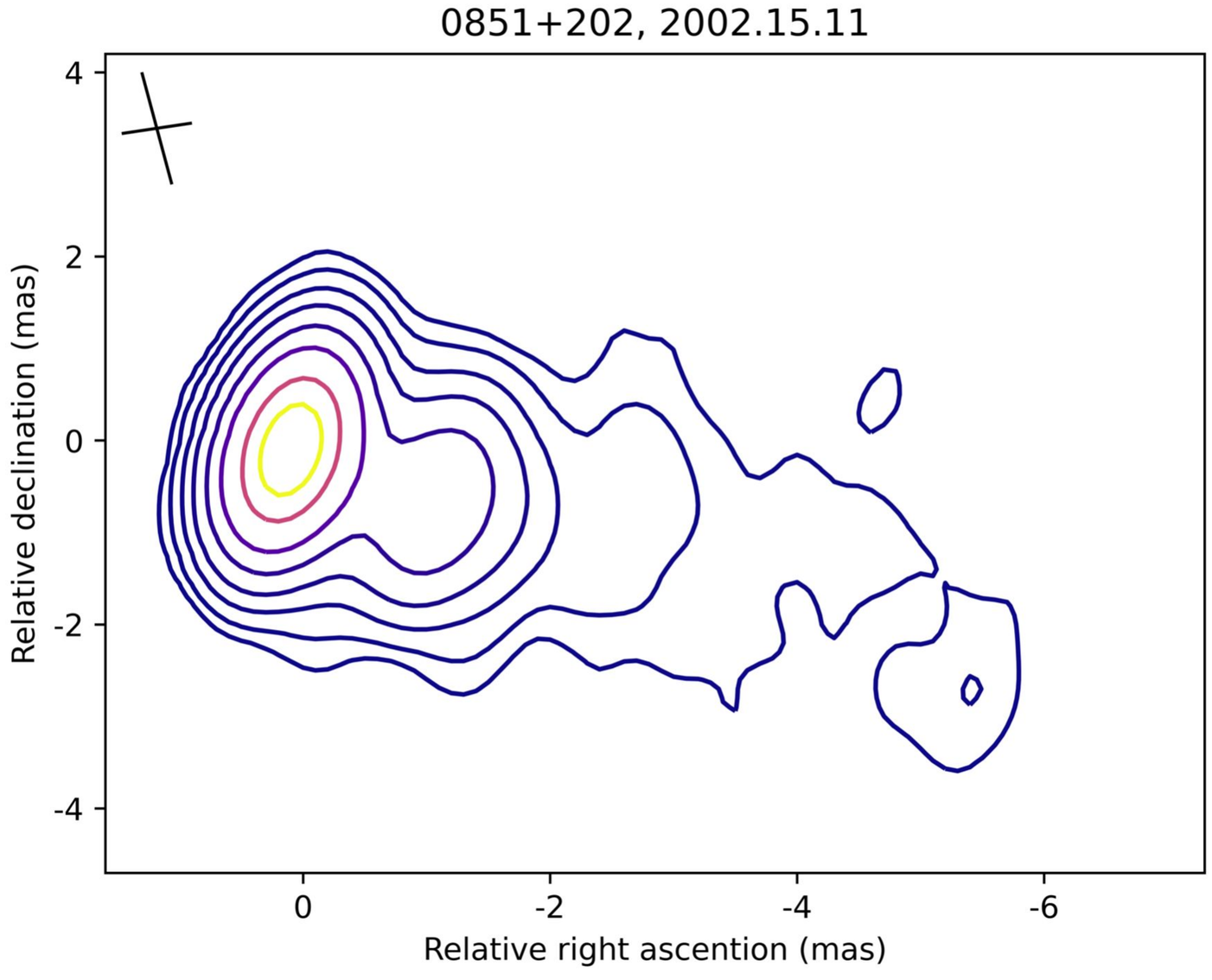

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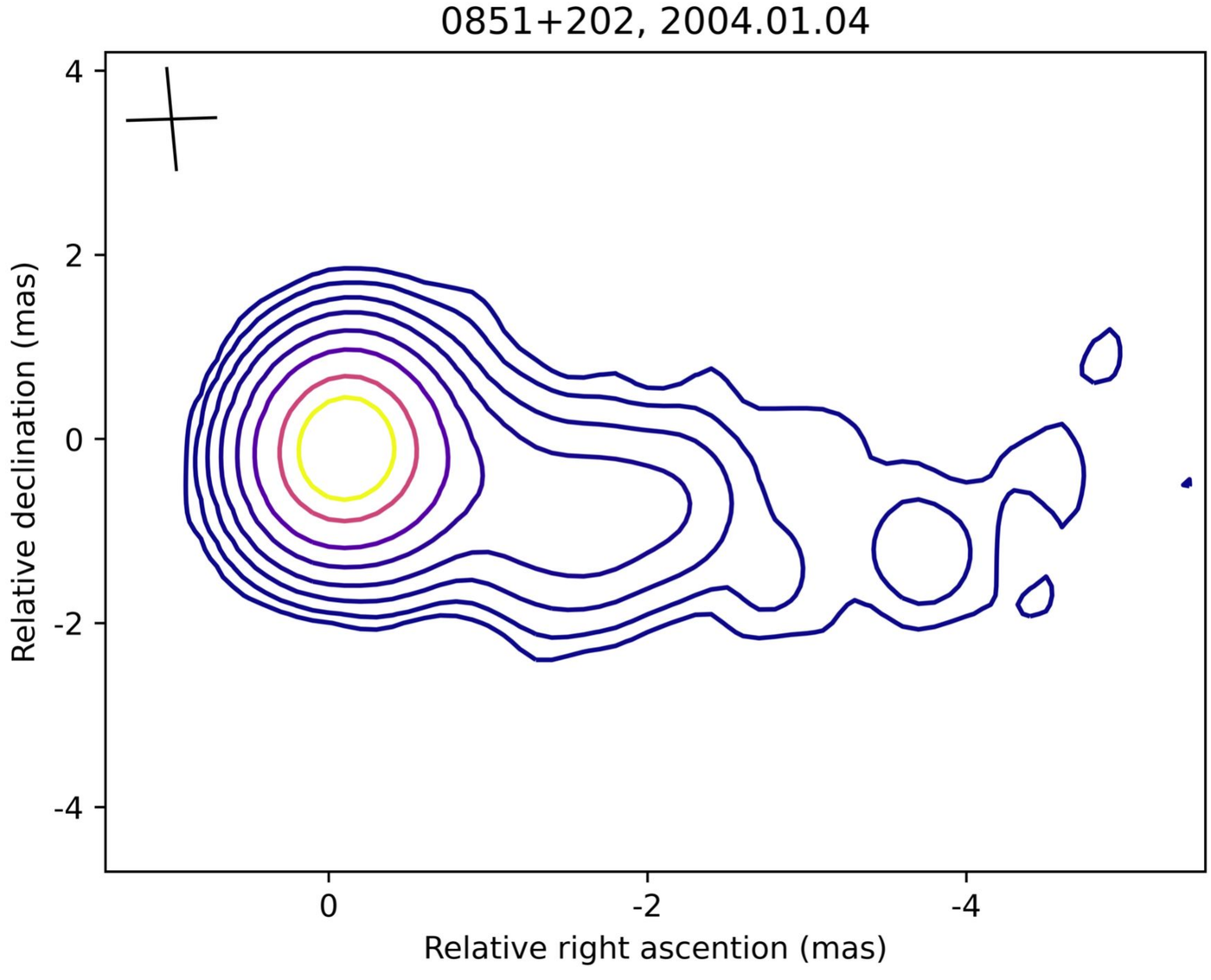

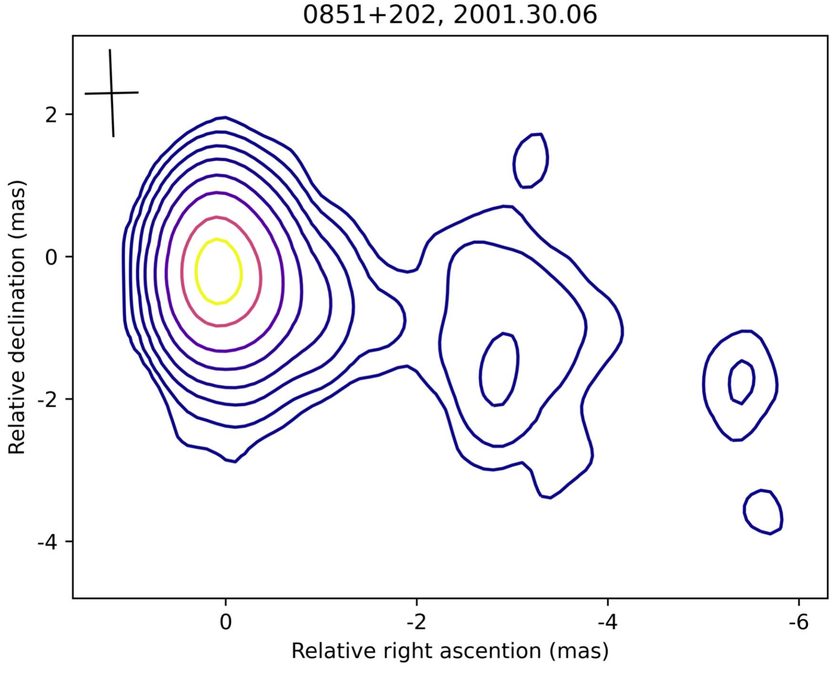
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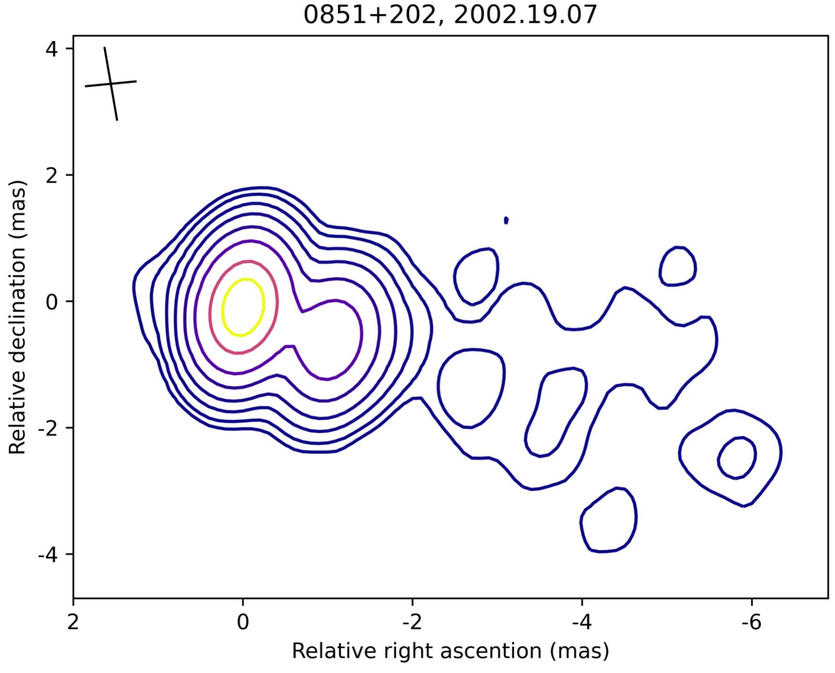
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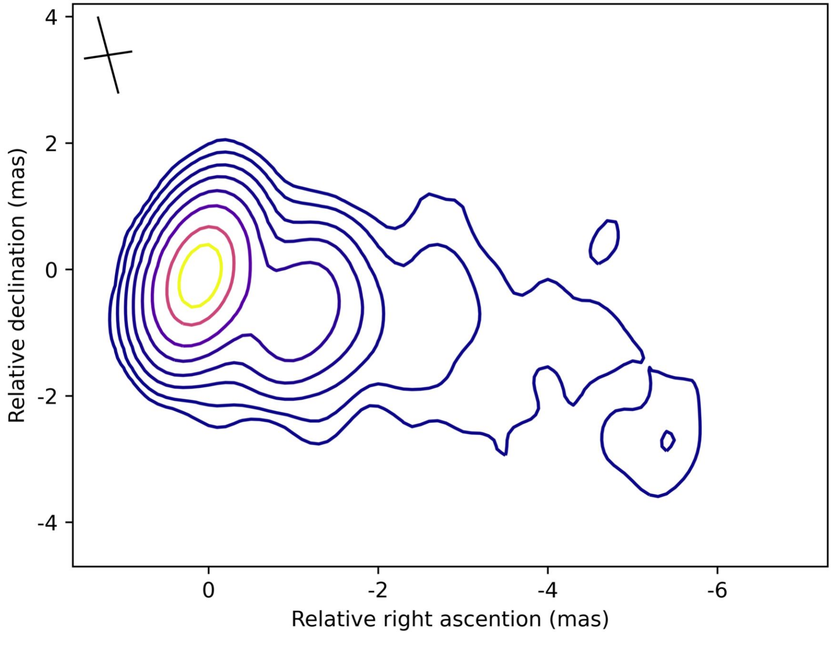
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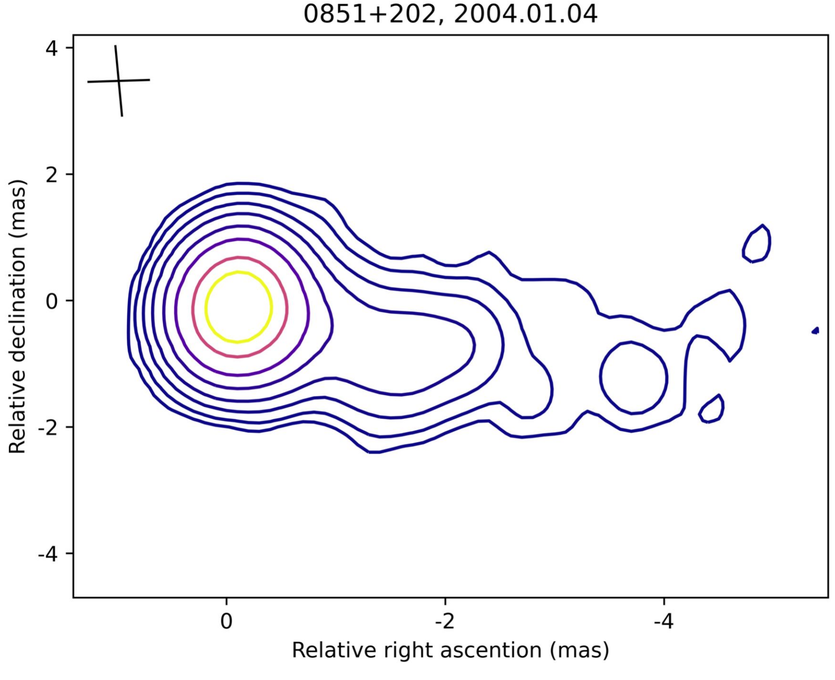
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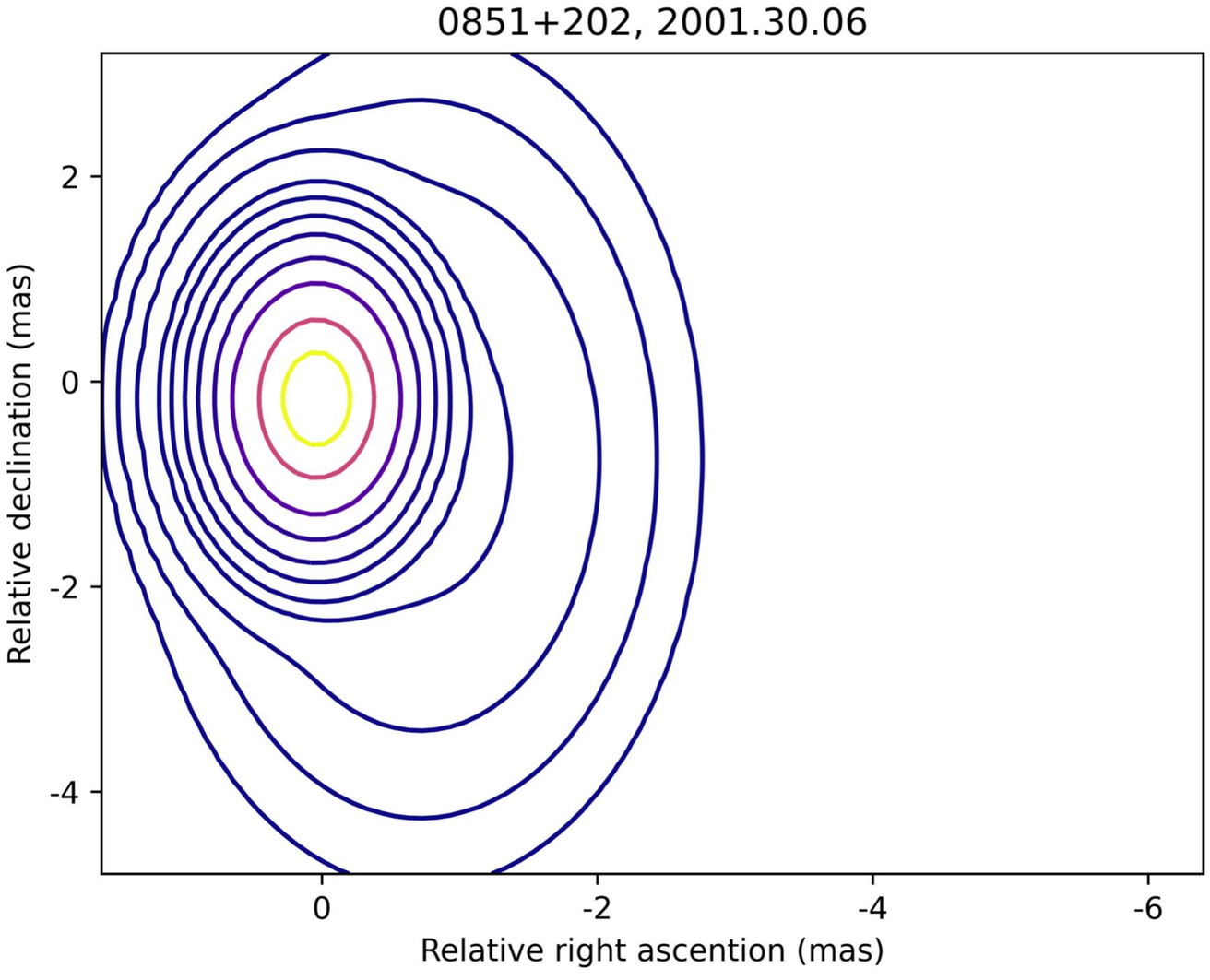
Gaussian modeling



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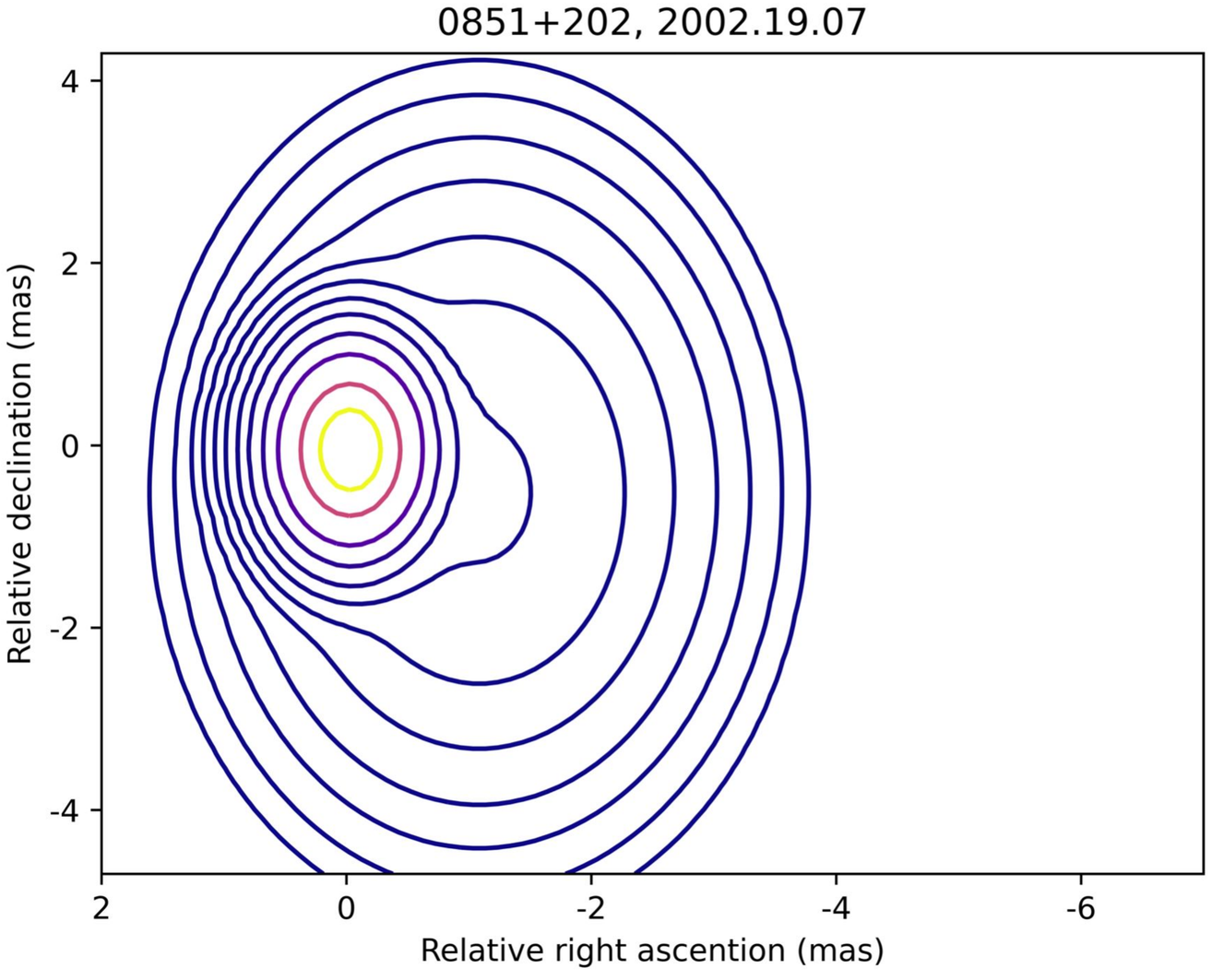

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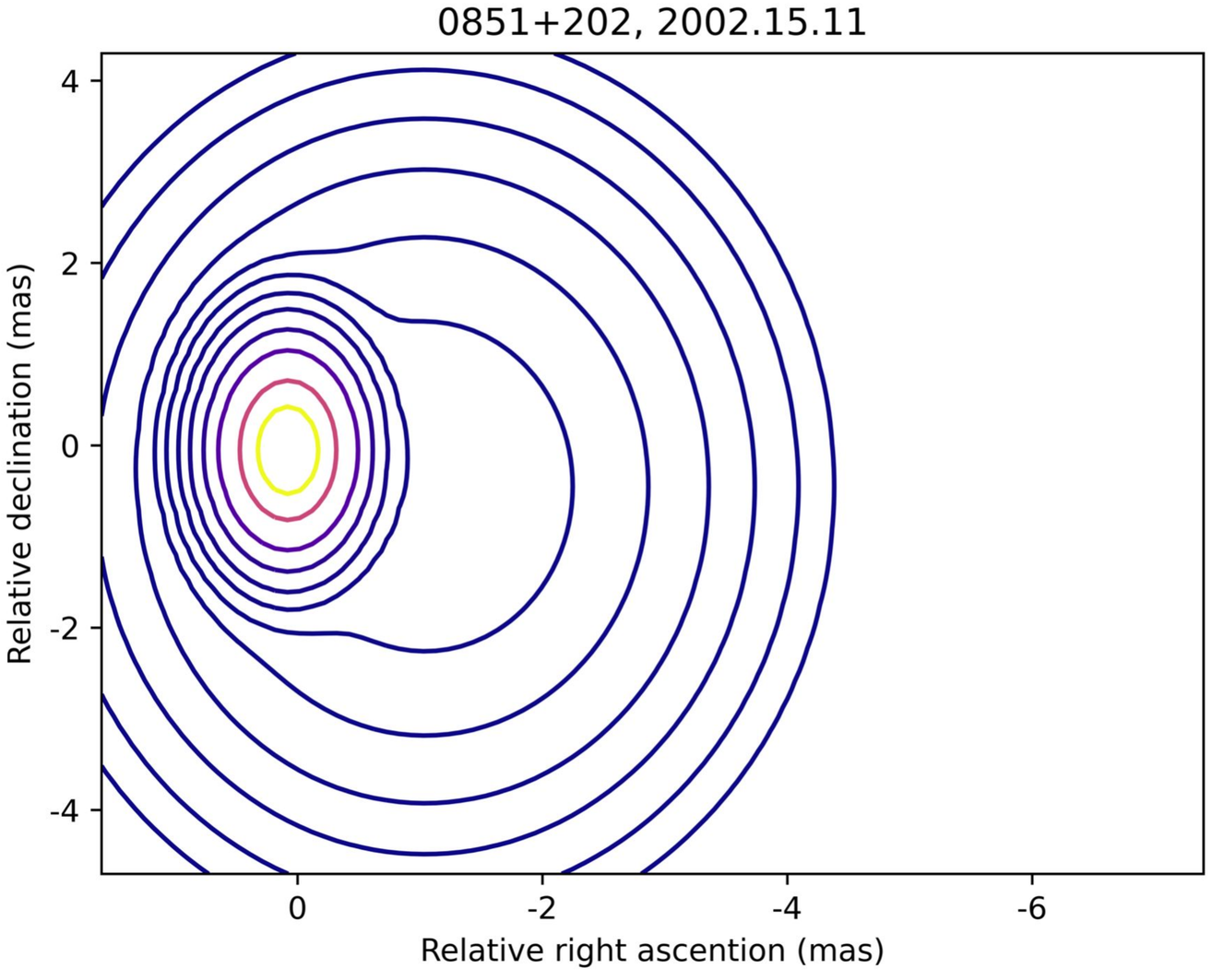

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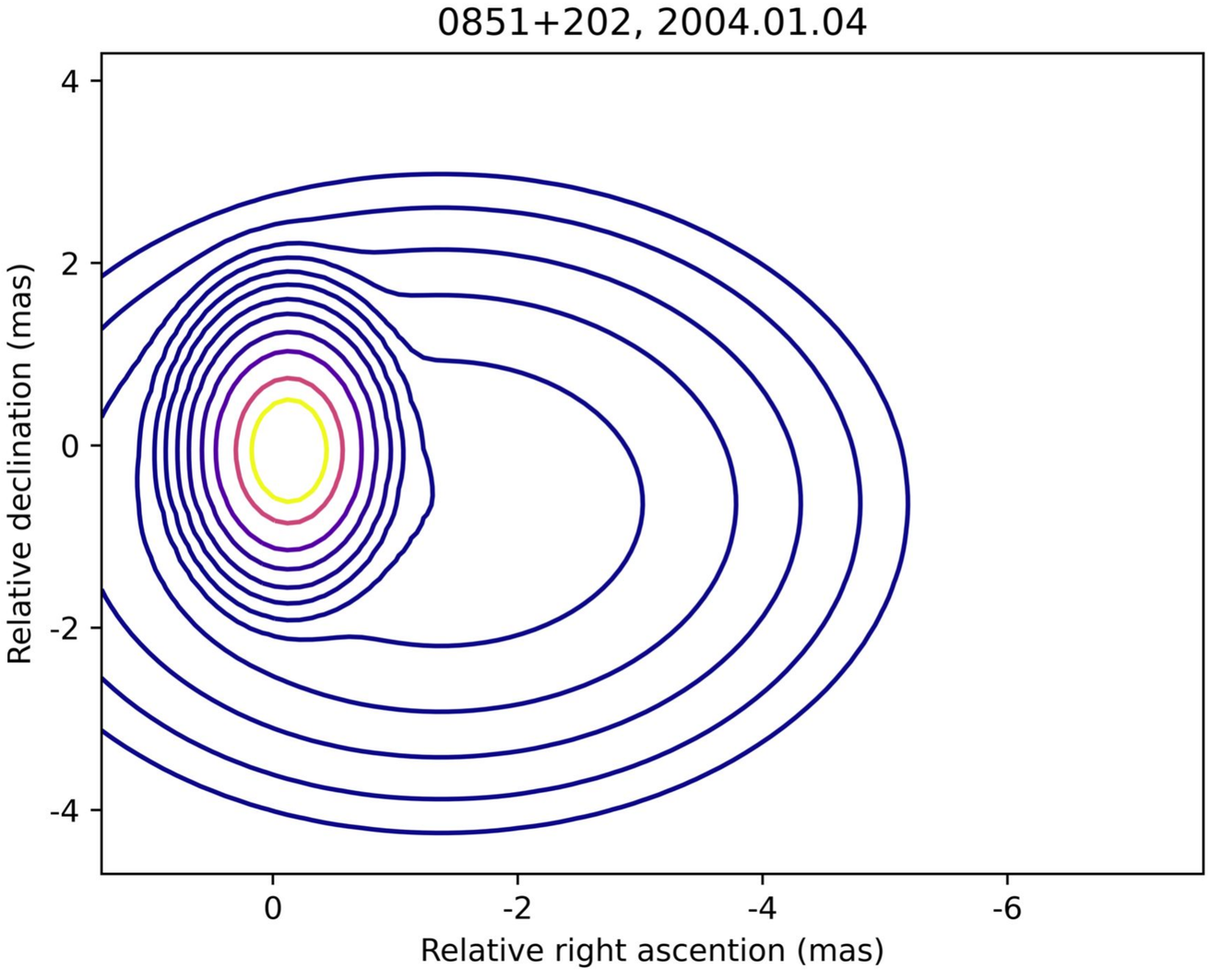

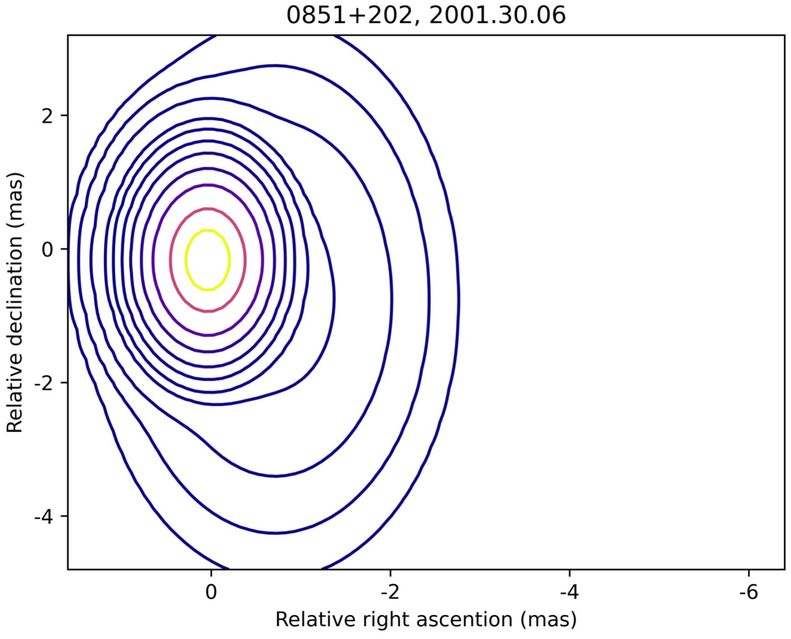
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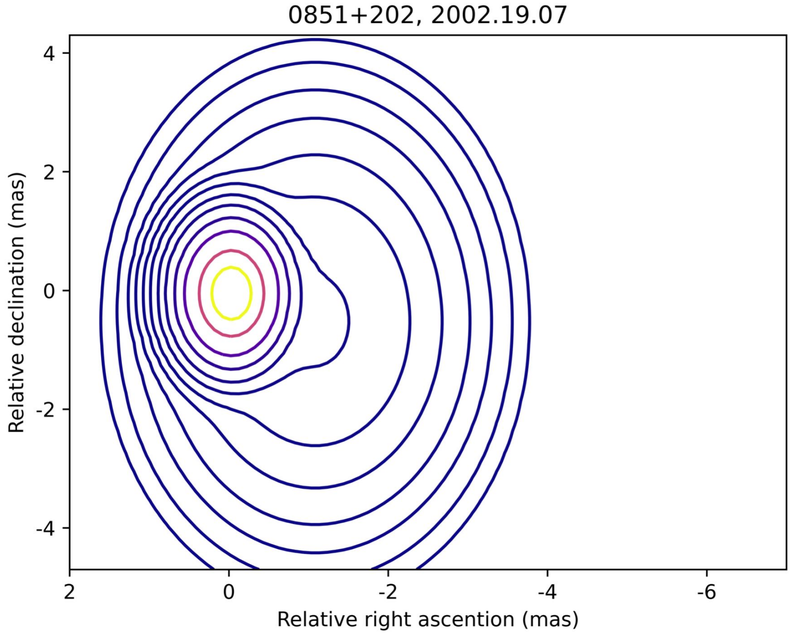
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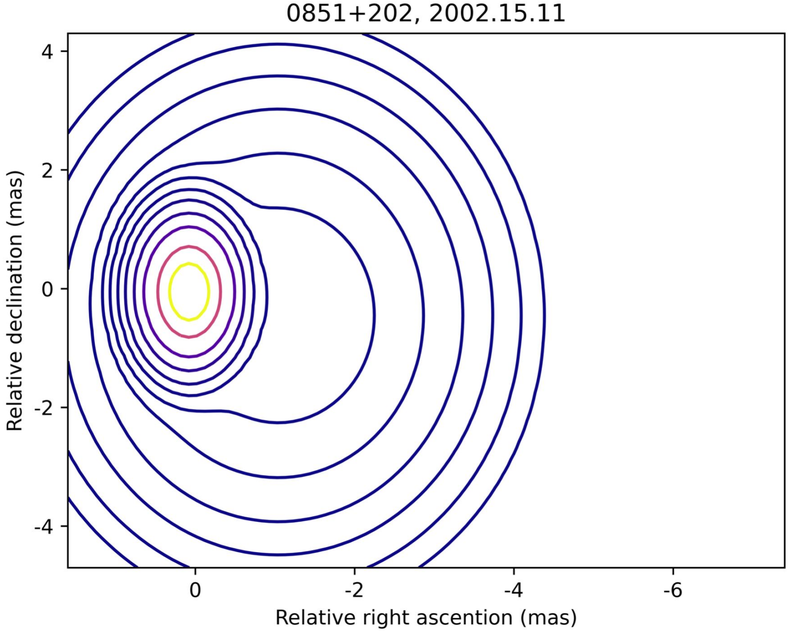
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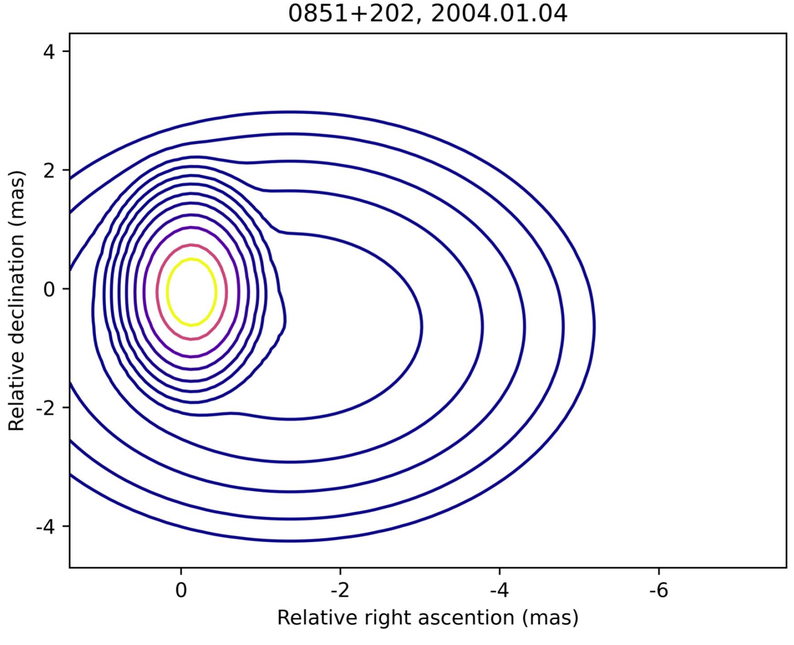
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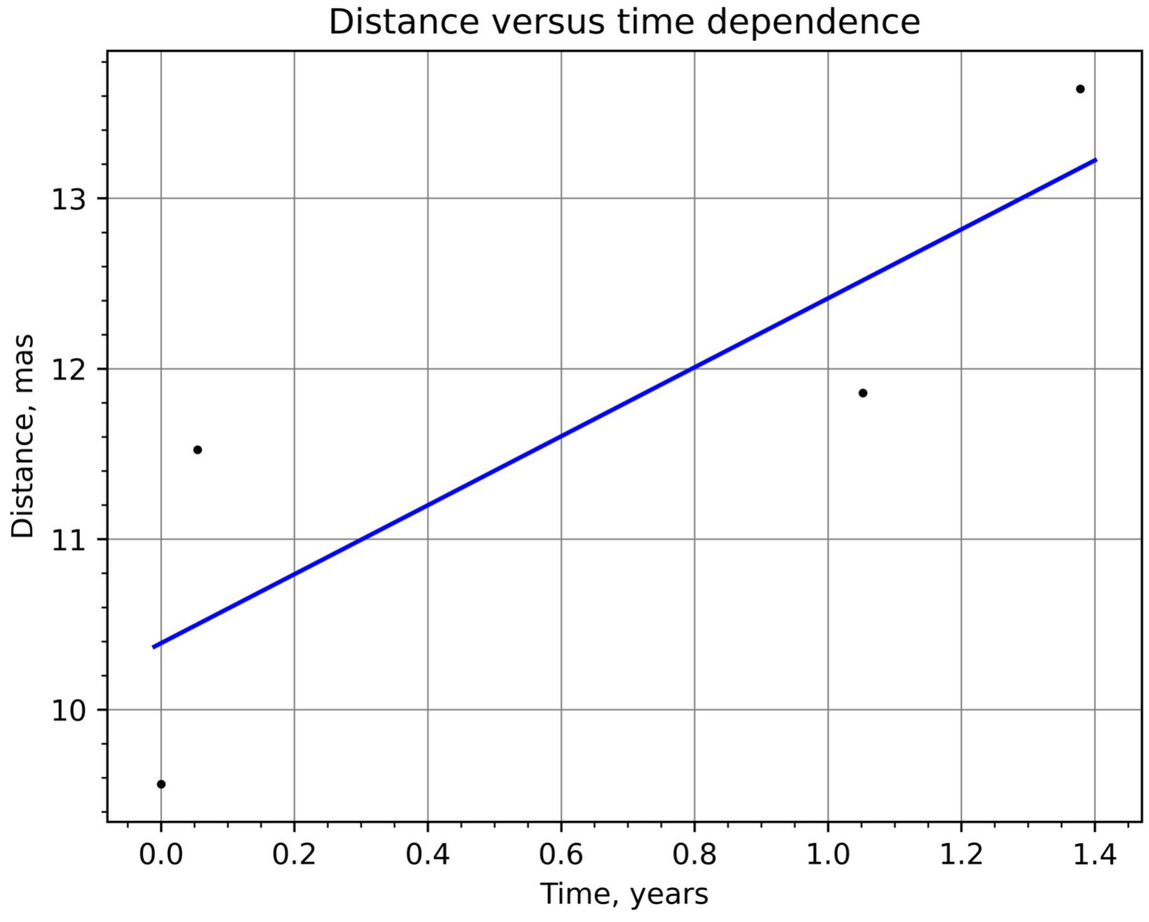
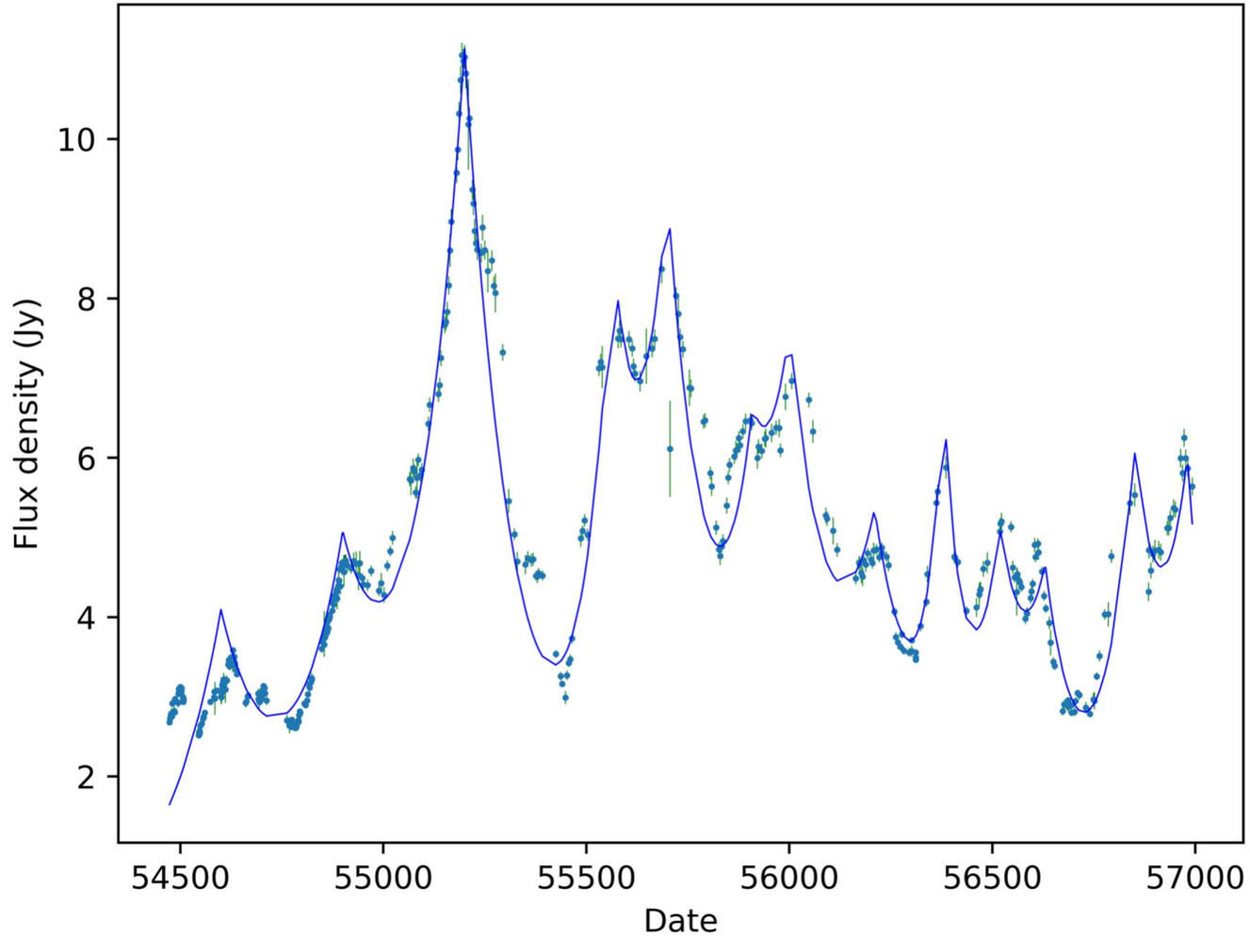
Component velocity calculation

$$k = 2.023 \pm 0.736 \ \frac{mas}{year}$$

$$v_{app} = 2.642 \pm 0.965 \ \frac{mas}{year}$$



Variability of radiation



$$\Delta S(t) = \begin{cases} \Delta S_{\max} e^{(t-t_{\max})/\tau}, & t < t_{\max} \\ \Delta S_{\max} e^{(t-t_{\max})/1.3\tau}, & t > t_{\max} \end{cases}$$

$$T_{\mathrm{b,var}} = 1.548 \times 10^{-32} \frac{\Delta S_{\max} d_{\mathrm{L}}^2}{\nu^2 \tau^2 (1+z)}$$

$$D_{\mathrm{var}} = \left[\frac{T_{\mathrm{b,var}}}{T_{\mathrm{b,int}}} \right]^{1/3}$$

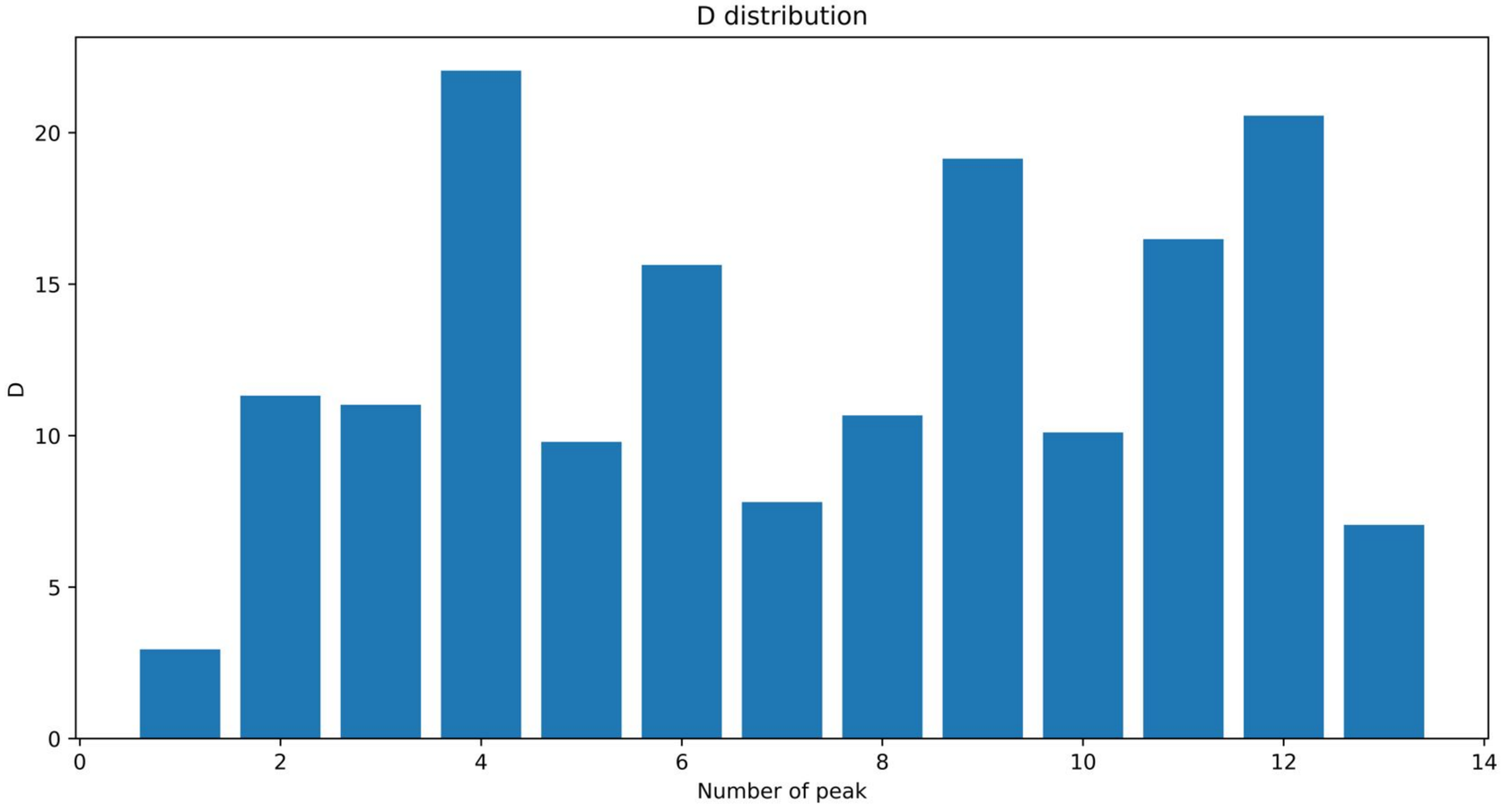
$$\Gamma_{\mathrm{var}} = \frac{\beta_{\mathrm{app}}^2 + D_{\mathrm{var}}^2 + 1}{2 D_{\mathrm{var}}}$$

$$\theta_{\mathrm{var}} = \arctan \frac{2\beta_{\mathrm{app}}}{\beta_{\mathrm{app}}^2 + D_{\mathrm{var}}^2 - 1}$$

Kinematics of the jet

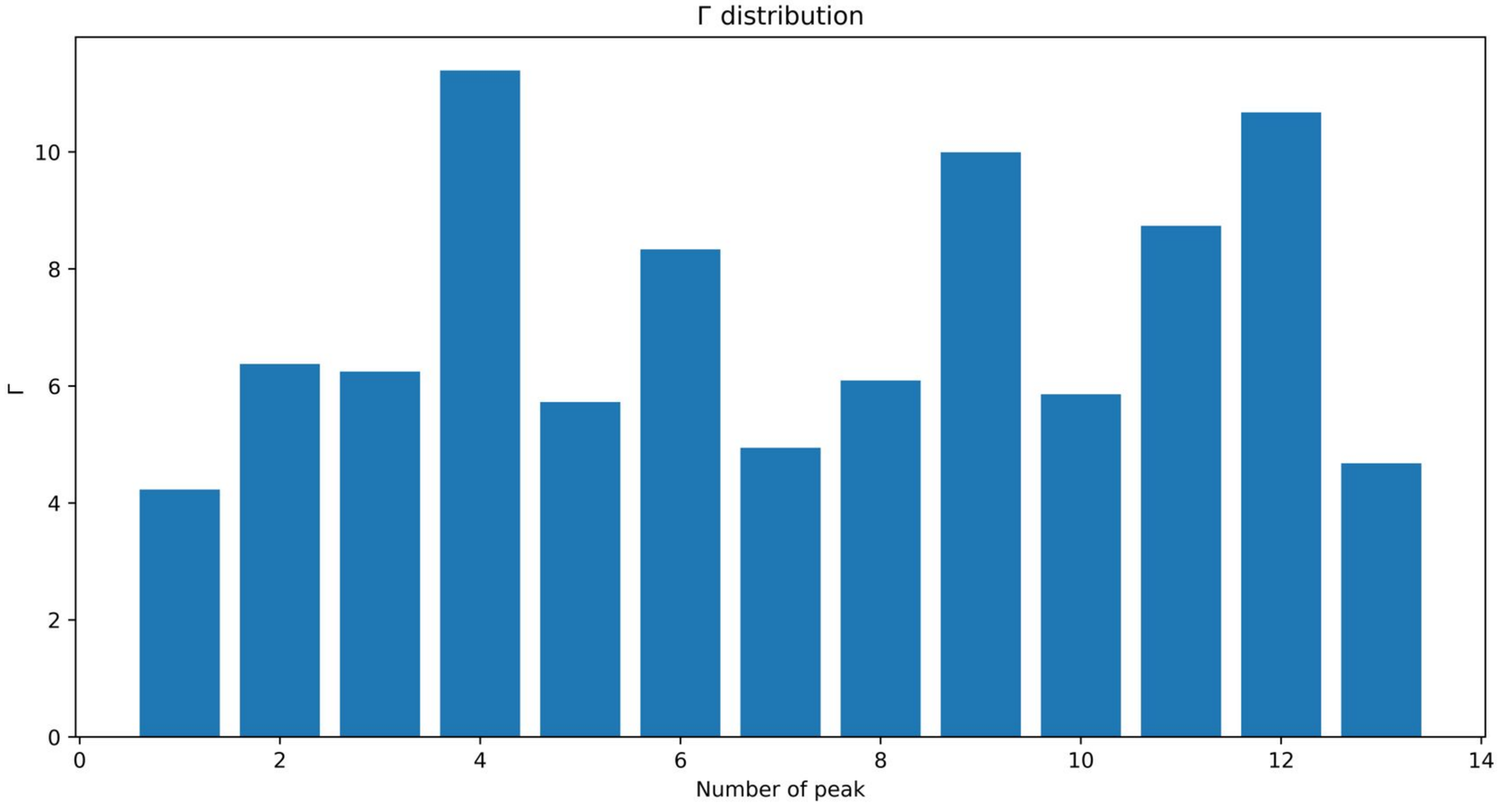
β	D	Γ	θ, rad	θ,°
3.90419	2.945460397664364	4.229979363541781	0.328369649585929	18.814195041463492
3.90419	11.319226471174266	6.37709598926575	0.054917166050817 46	3.1393341137480553
3.90419	11.016965997147508	6.2456505436267 9	0.057513529377524436	3.295282498233823
3.90419	22.050459496080535	11.393537255622753	0.01560096962514 9019	0.8938697158328327
3.90419	9.794929667066727	5.726602974806213	0.070748873142683 09	4.053611836382202
3.90419	15.633631363522158	8.336295103349558	0.030179450212219763	1.729155125185389
3.90419	7.806456777862537	4.94356589532475	0.1034866548109762	5.929348556596152
3.90419	10.666786928273375	6.094761421766324	0.060916526629765086	3.490259878481828
3.90419	19.1436048538587	9.9960354718573	0.020506616822991 48	1.1749425960493844
3.90419	10.10604858671961	5.856637071228 5245	0.066996342512875 6	3.838607668800664
3.90419	16.489758197540592	8.737387823322806	0.027280486502356774	1.563056739648652
3.90419	20.56515485018235	10.677485697711255	0.017859368847006476	1.0232664597008942
3.90419	7.057356440635417	4.679441944151783	0.121313983486993 56	6.9507792497244925

Kinematics of the jet



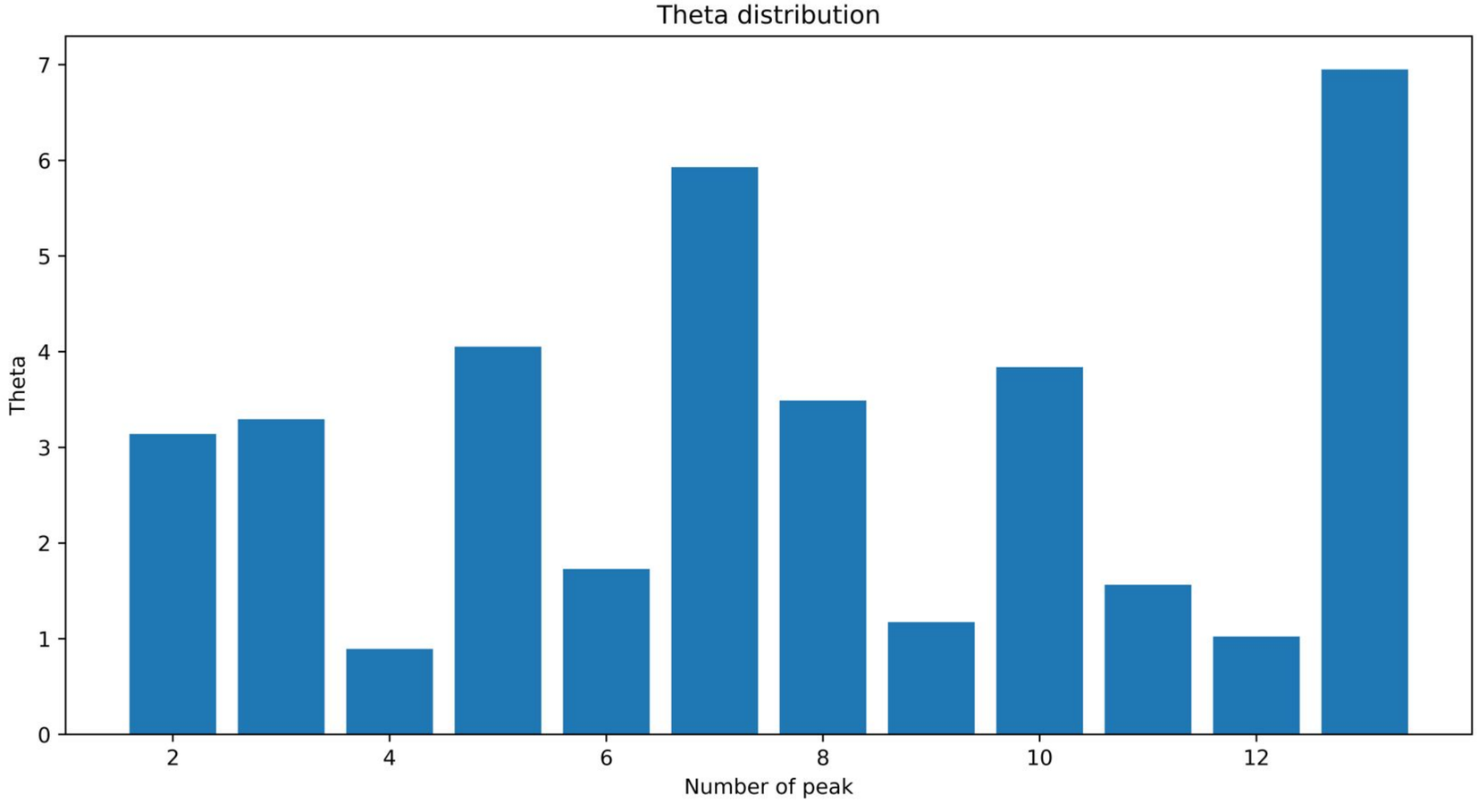
$$D_{mid} = 12.661$$

Kinematics of the jet



$$\Gamma_{mid} = 7.176$$

Kinematics of the jet



$$\theta_{mid} = 3.09$$