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Study of the Evolution of Superluminal Components of the Blazar PKS 1510-089

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Relativistic AGN Jets

- Radio emission: Synchrotron;
- Very Long Baseline Interferometry;



- Relation between proper motion and apparent velocity:

$$\beta_{app} = \frac{D_L}{(1+z)} \frac{\mu}{c} = \frac{\beta \sin \theta}{1 - \beta \cos \theta},$$

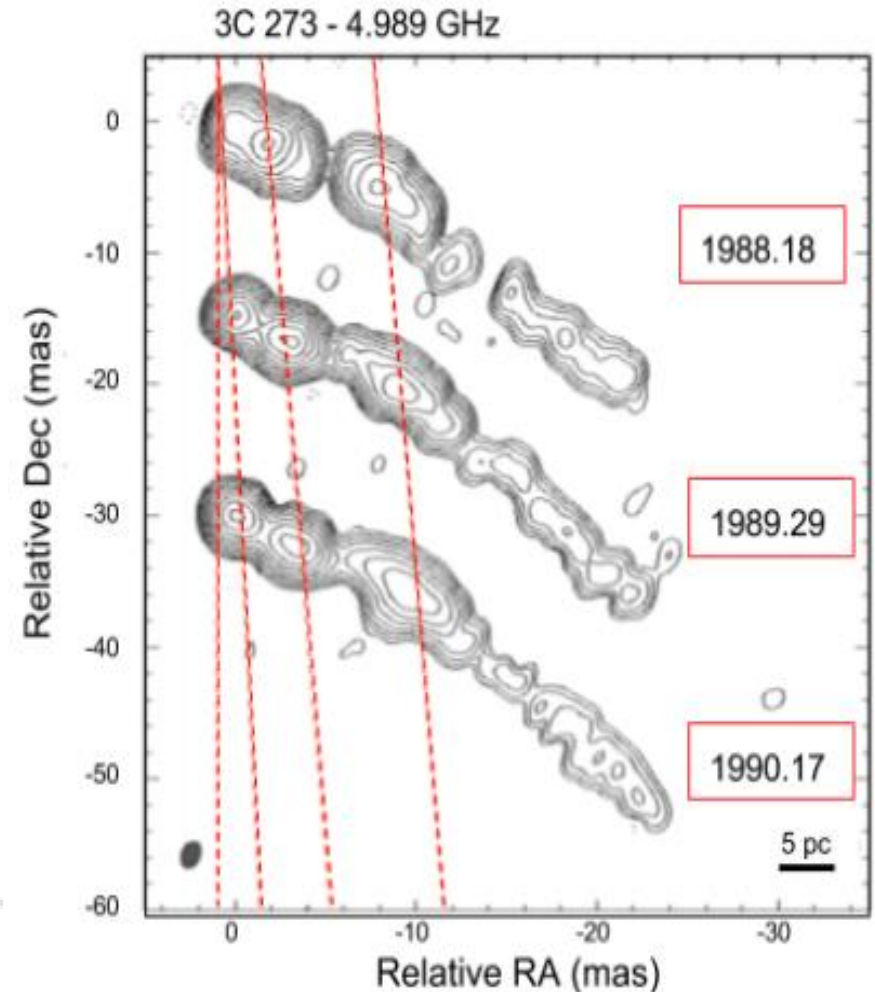


Figure: P.C. Abraham & Carrara.

Main Goals

- Identify the components in the parsec scale jet of the Blazar PKS 1510-089 along different epochs;
- Present a kinematic scenario for these components;
- Traditional methods fit the components as elliptical gaussians based on initial conditions;
- We used the Cross-Entropy method : uses the real image as input data. (Rubinstein 1997, 1999 and Caproni et al. 2011)

Methods and Database

- Cross-Entropy :
 - Iterative method that fits bidimensional gaussians on the image plane;
 - Input parameters:

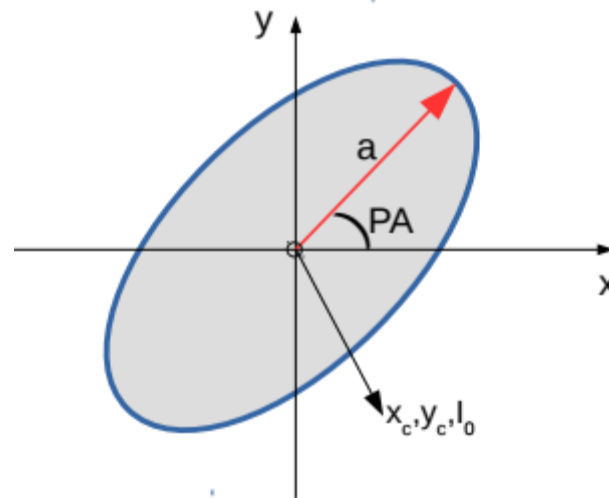
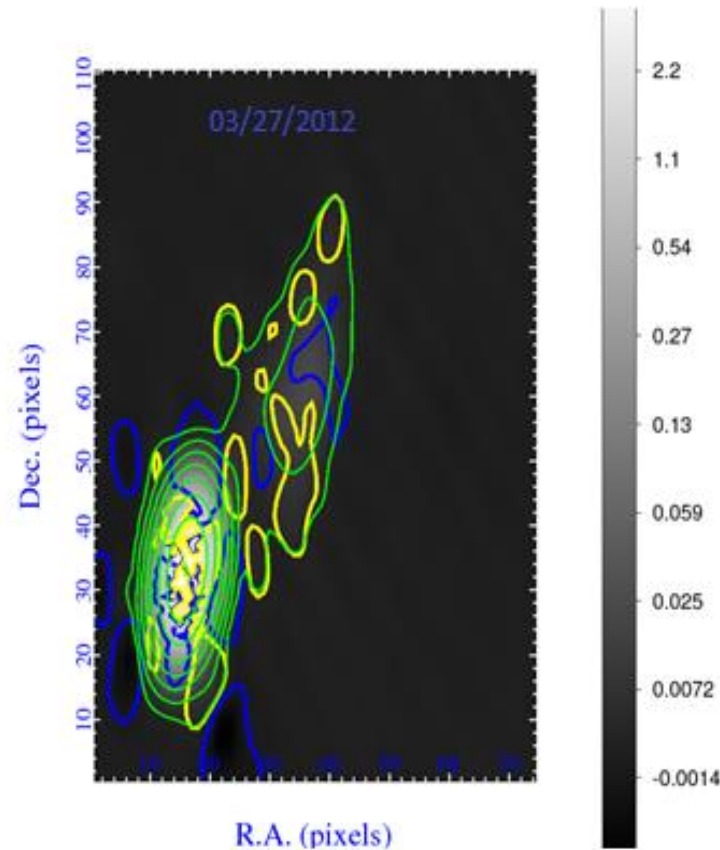


Figure: P.C. Motter.

- 15 GHz VLBA images from the MOJAVE Project (Lister et al. 2009) obtained between 2011-2012;

Choice of the best number of components in each epoch:

– Residual map:

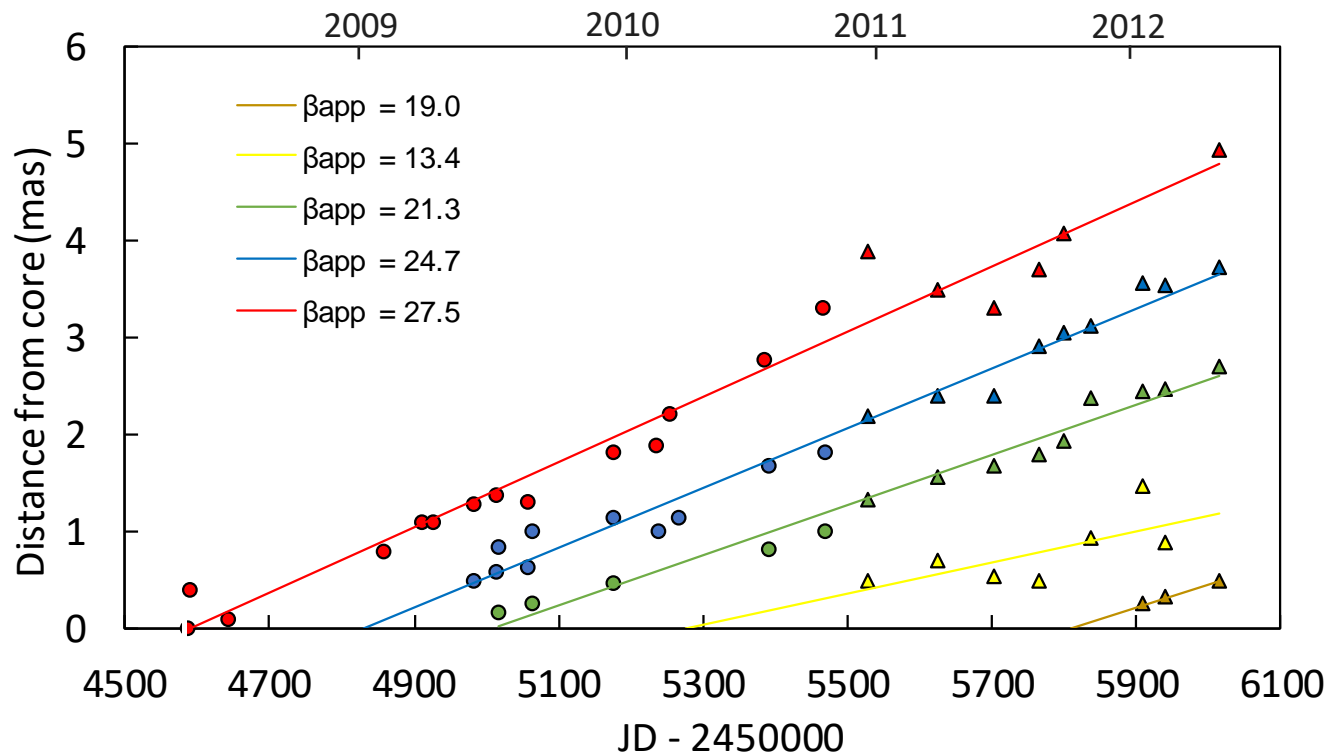


– Merit function :

$$S_{prod}(k) = \bar{R}(k) \times \frac{1}{N_{pixel}} \left\{ \sum_{m=1}^{N_{pixel}} (R_m(k) - \bar{R}(k))^2 \right\}$$

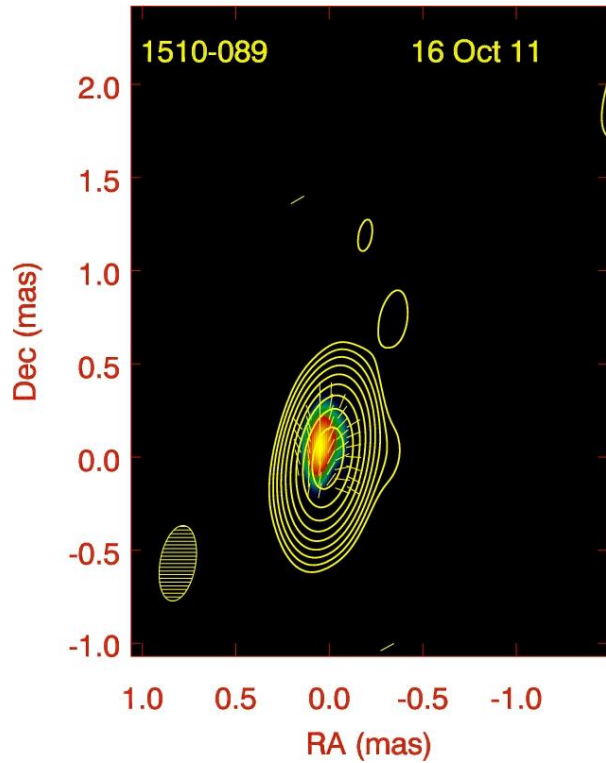
Preliminary Results

- Kinematic results:



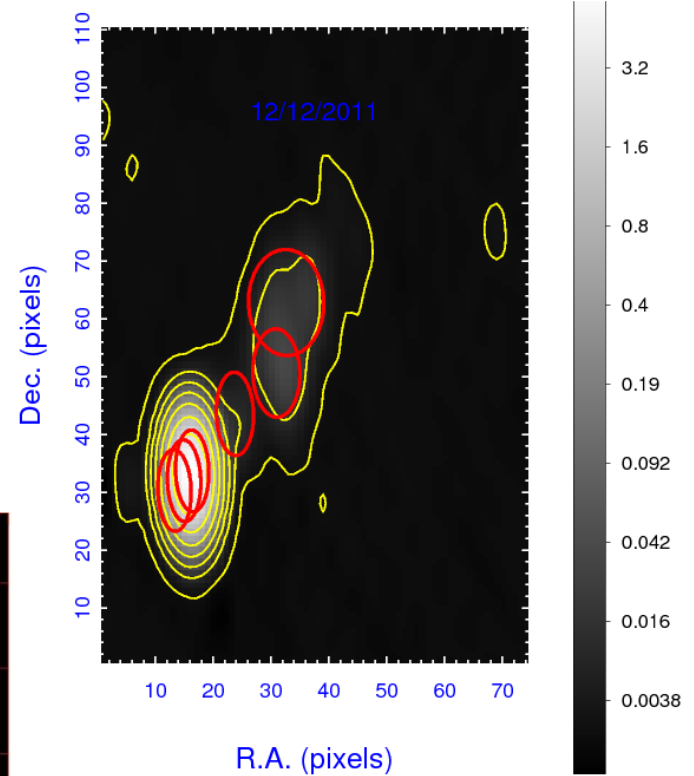
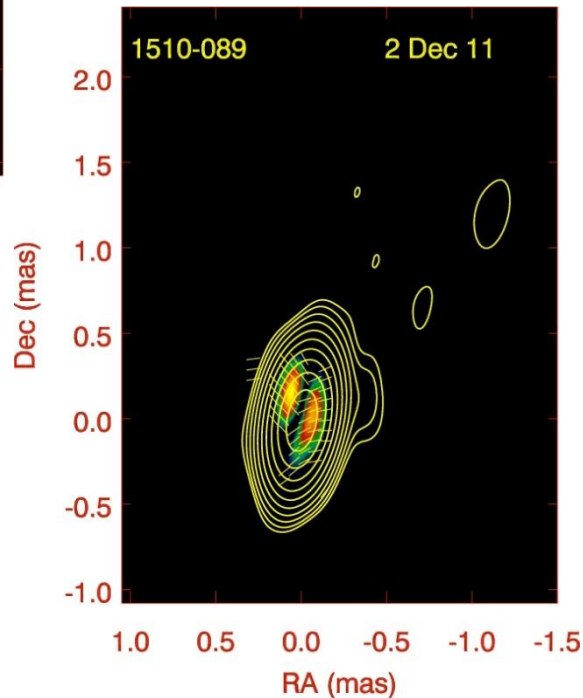
- Circles: Lister et al. 2016
- Triangles: this work.

Preliminary Results



43 GHz: The VLBA-BU-Blazar Program.

1 pixel = 0.01 mas



15 GHz
1 pixel = 0.1 mas