Relativistic Jets in Astrophysics

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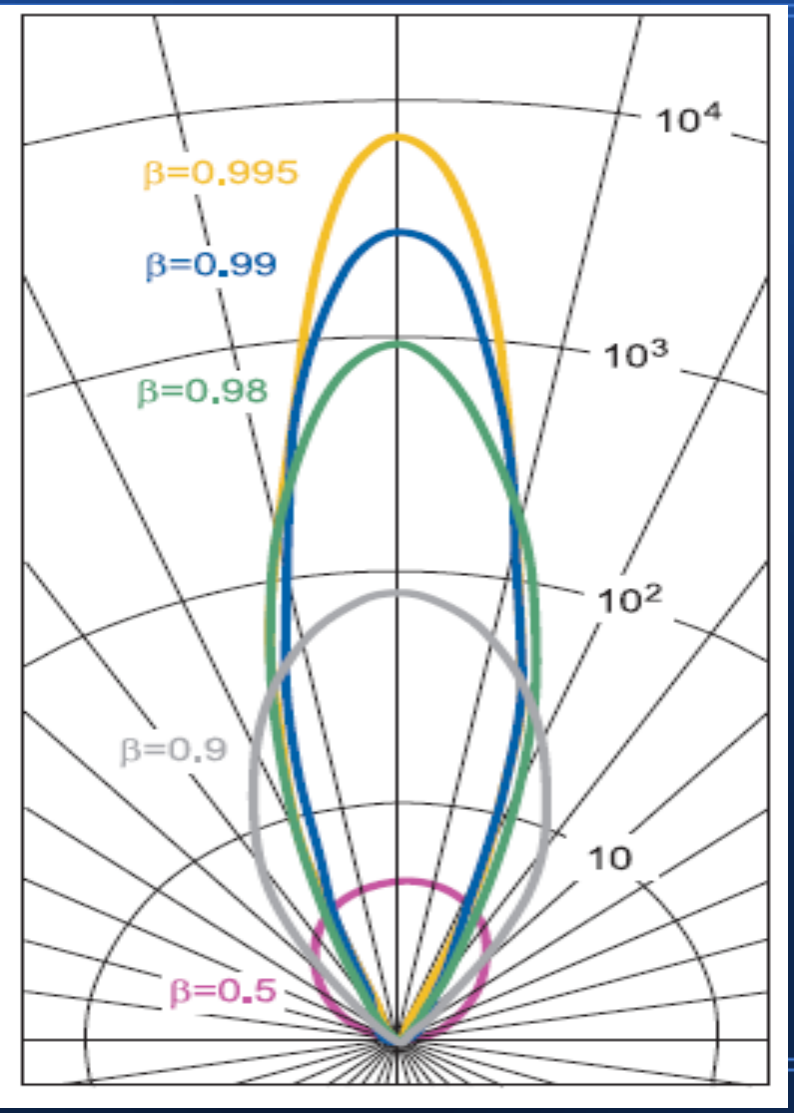
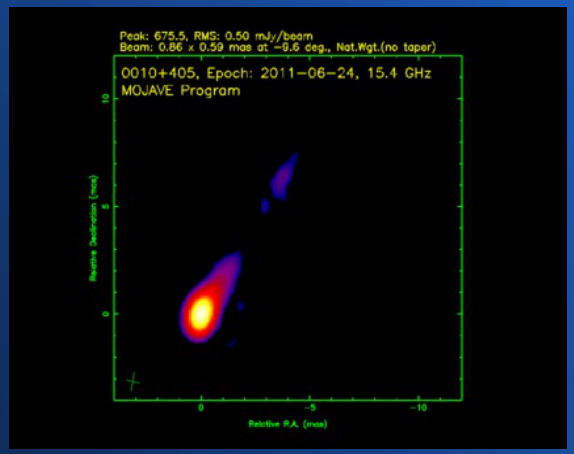
Relativistic effects
- Examples

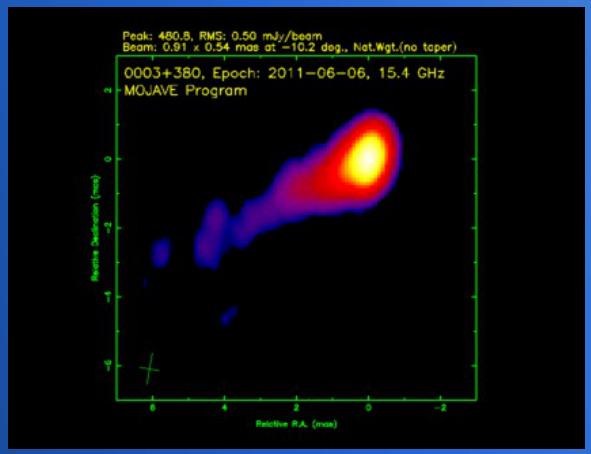
Doppler Boosting

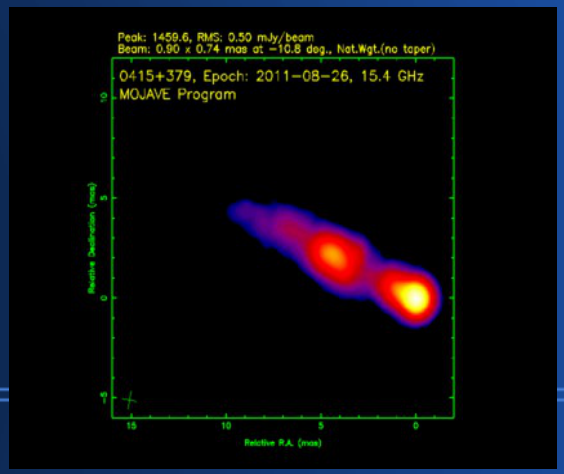


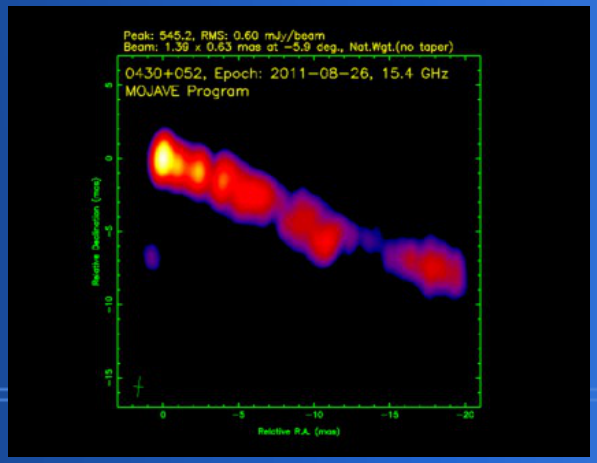
Kellermann et al. (2007)

- Explains one-sidedness of blazar jets in parsec scale:

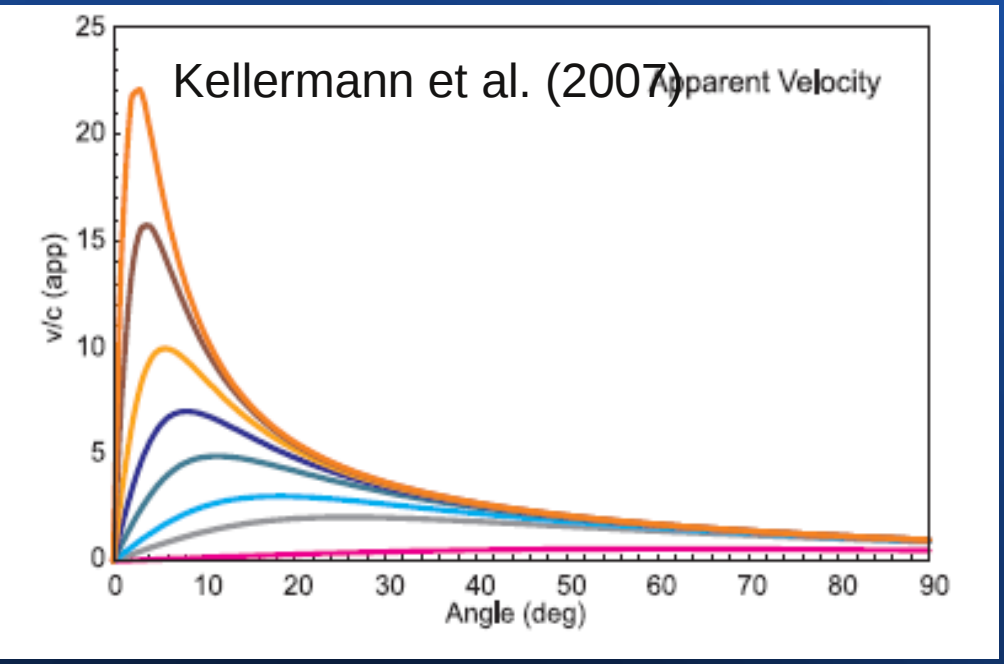




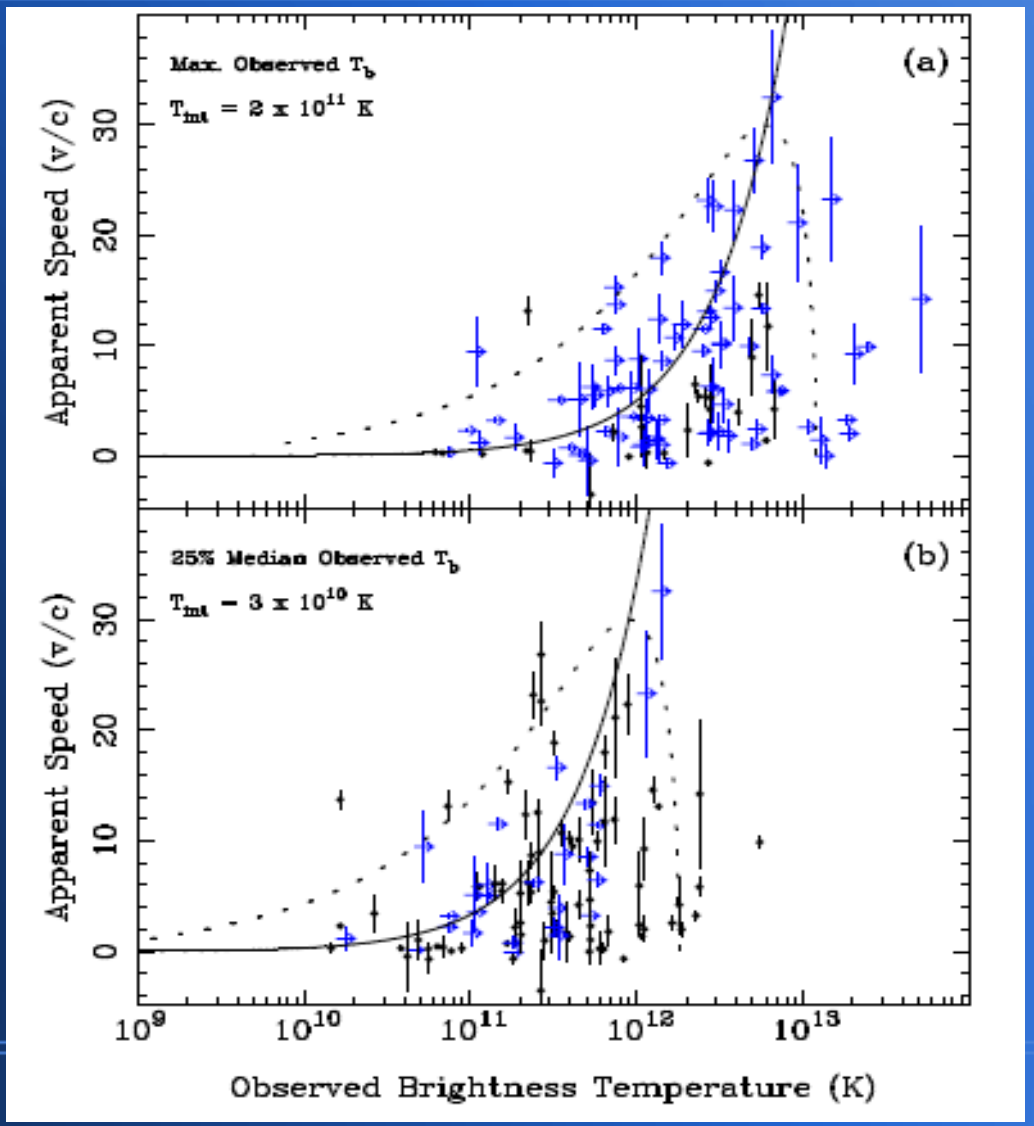




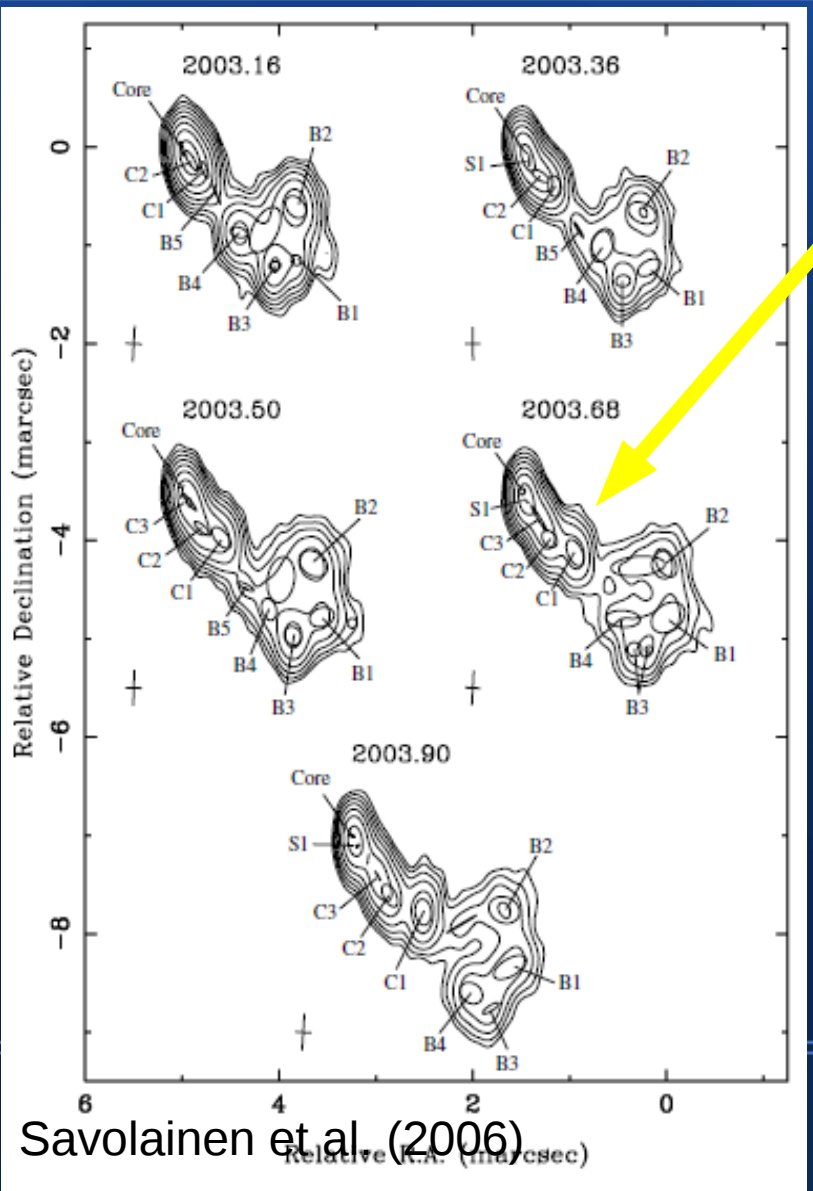
Superluminal motion



Red: = 0.5c, grey: = 0.9c, light blue: = 0.95c, green: = 0.98c, purple: = 0.99c, yellow: = 0.995c, brown: = 0.998c, orange: = 0.999c

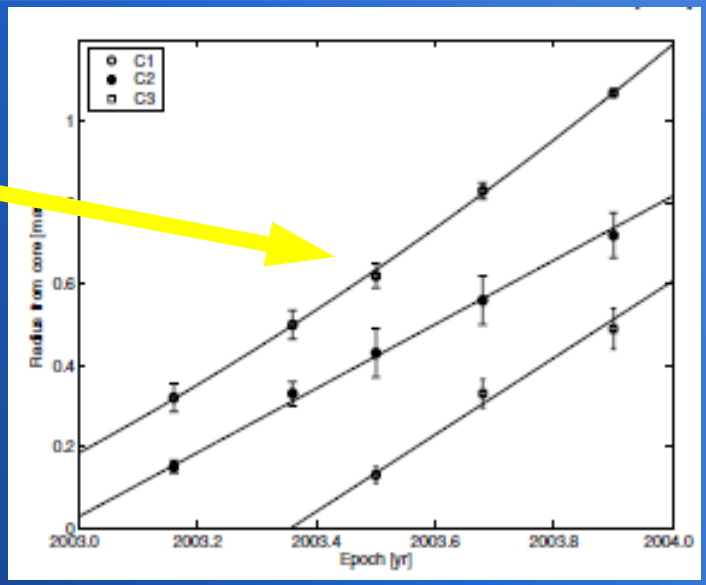


Superluminal motion in 3C273 - example



Savolainen et al. (2006)

Feature C1 moves at μ = 1.01 mas/yr



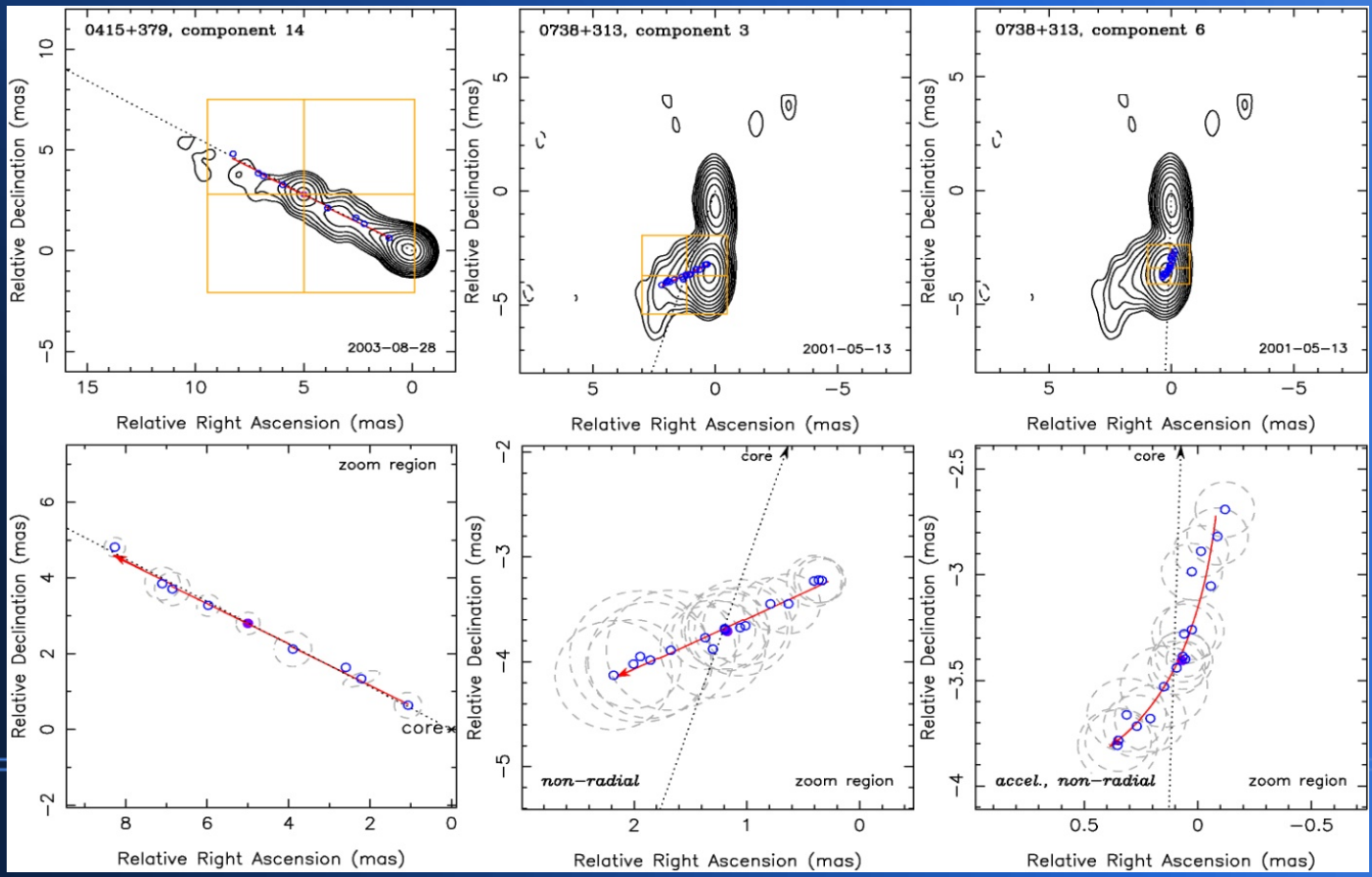
- 3C 273 is at distance of d_L = 735 Mpc
- Apparent speed of C1 is then $\mu\, d_L / (1+z)$ = 1.01 x 4.848e-9 x 735e6 x 3.0857e16 / (1.158 x 60x60x24x365) = 3.1e9 m/s = 10.1c !
- $\Gamma_{min} = (1+\beta_{app}^2)^{1/2} = 9.8$

Superluminal motion in AGN - statistical results

- Lister et al. (2009) measured accurate kinematics of 526 features in 127 pc-scale jets:

Middle epoch Stokes I image:

Component trajectory:



Superluminal motion in AGN - statistical results

Dispersion of β_{app} within indivual jet is >3 times smaller than the overall dispersion among all jets → there is a characteristic speed describing each jet and observed proper motions reflect that speed

Assuming a reasonable parent luminosity function of radio-loud AGN, one can study what kind of Lorentz factor distribution can produce the observed apparent speed distribution.

- Max β_{app} distribution peaks at ~10c and ranges up to 50c → upper end of the jet Lorentz factor distribution ~50
- Single-valued Γ-distribution ruled out