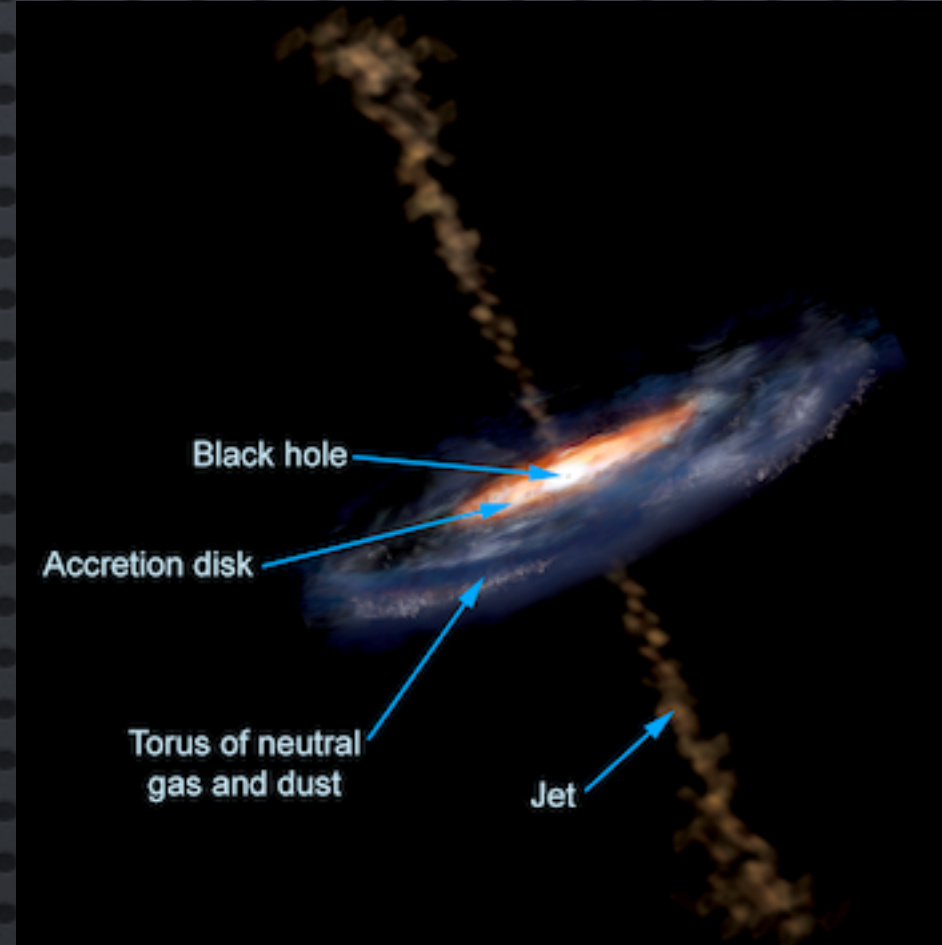




INVESTIGATING THE RELATIONSHIP BETWEEN VLBI JET SPEEDS AND THE KINETIC POWER OF THE JET

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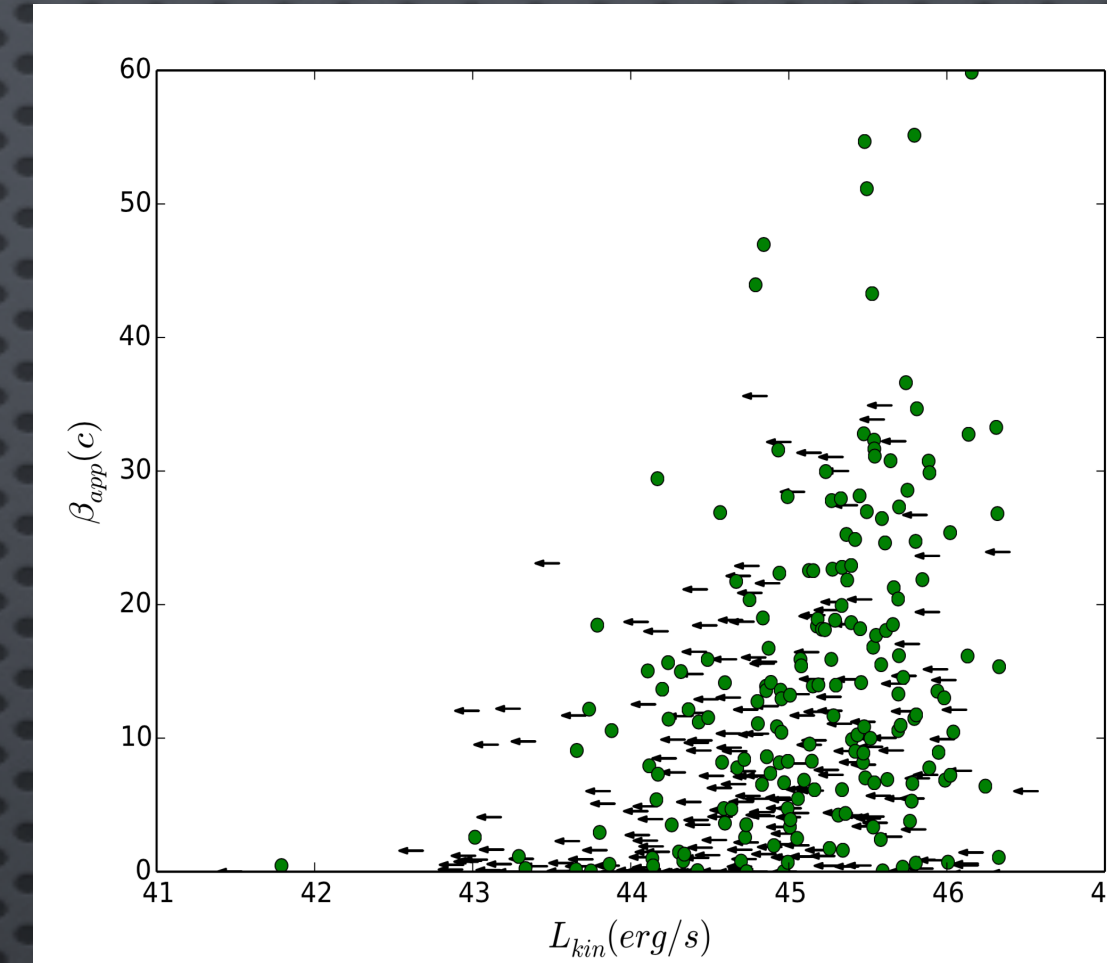
WHAT ARE ACTIVE GALACTIC NUCLEI?

Active Galactic Nuclei (AGN) are powered by the accretion of matter onto a supermassive black hole in the center of a galaxy.

They are among the most energetic phenomena in the universe, emitting radiation throughout the entire electromagnetic spectrum, from radio waves all the way to gamma rays.

Radio-loud AGN (RL AGN) emit bipolar large-scale jets of relativistic plasma which propagate away from the SMBH and into radio-emitting lobes.

JET SPEED-POWER CONNECTION



We have looked at a large sample sources with measured β_{app} . At left, we show the remarkable 'envelope' in the L_{kin} - β_{app} plane (Keenan et al., in prep.).

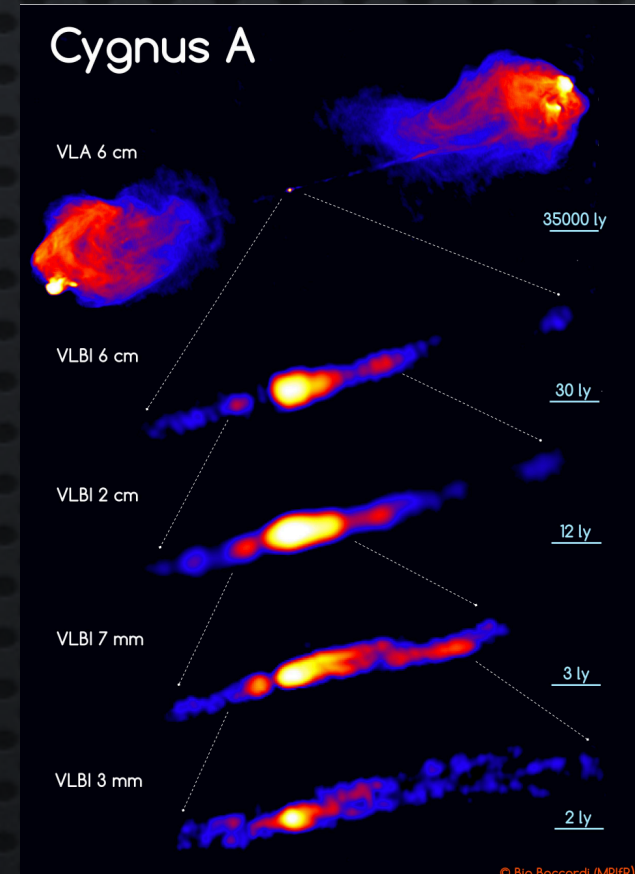
The observed 'envelope' is thought to be due to an intrinsic connection between L_{kin} and Γ , as β_{app} depends only on Γ and θ , and has a maximum value of Γ .

What is the nature of the apparent envelope of β_{app} set by L_{kin} ? Is there a characteristic value of Γ that can be quantified?

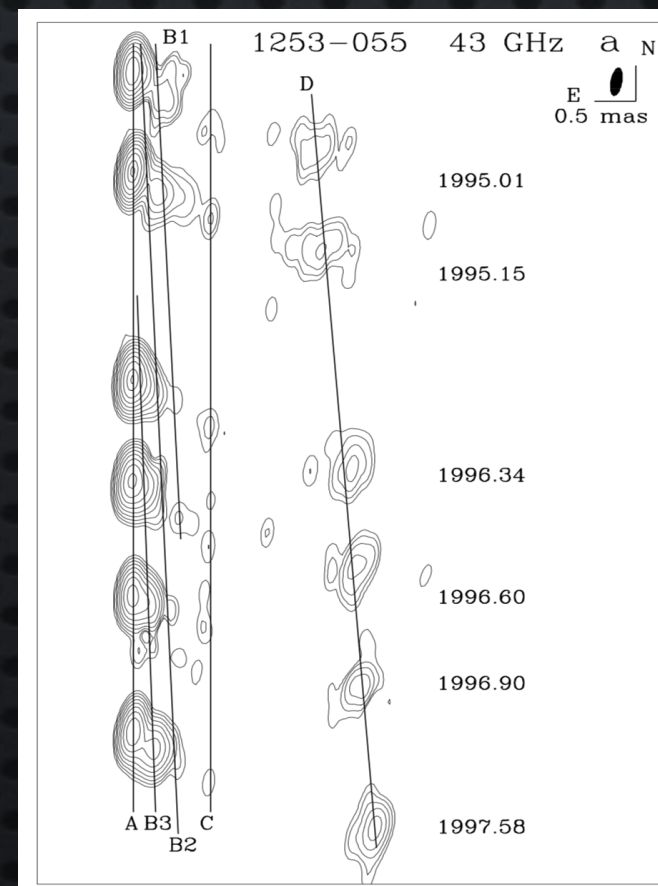
VLBI PROPER MOTIONS

VLBI monitoring programs measure the apparent superluminal motion of features within the jet by fitting the features with Gaussian components and tracking the position of each feature over a period of time.

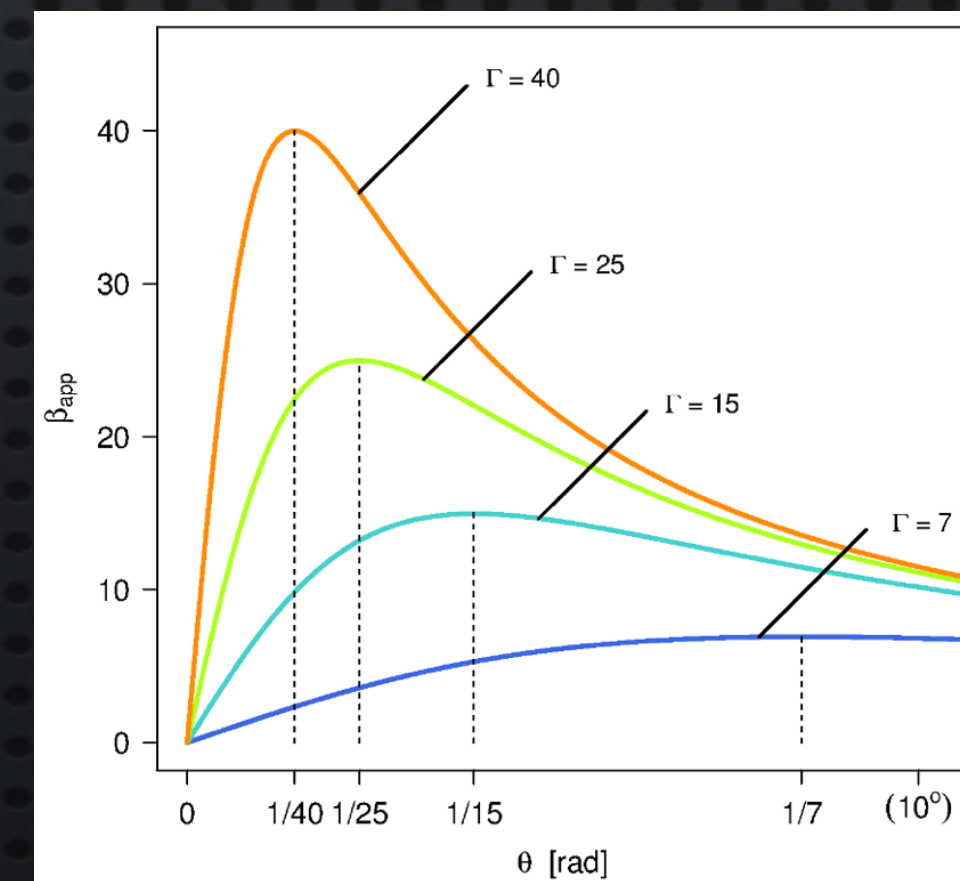
The apparent velocity can reach speeds greater than the speed of light for angles < 90 degrees to the line-of-sight, with a maximum apparent equal to the bulk Lorentz factor Γ .



The radio galaxy Cygnus, different instruments and different wavelengths probe different scales (Boccardi 2017)



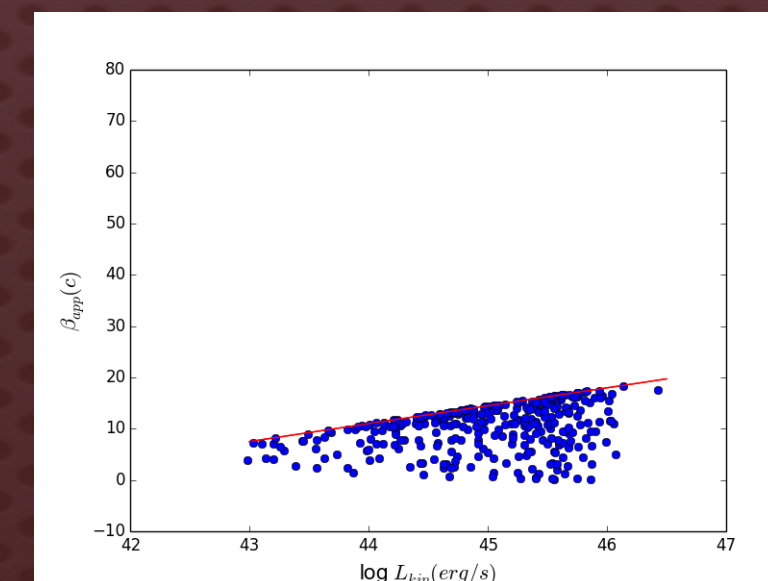
An example of a typical VLBI monitoring project on 1253-055 at 43 GHz (Jorstad+ 2001)



The apparent velocity as a function angle. Note that the maximum $\beta_{app} \sim \Gamma$ as denoted by the dotted lines

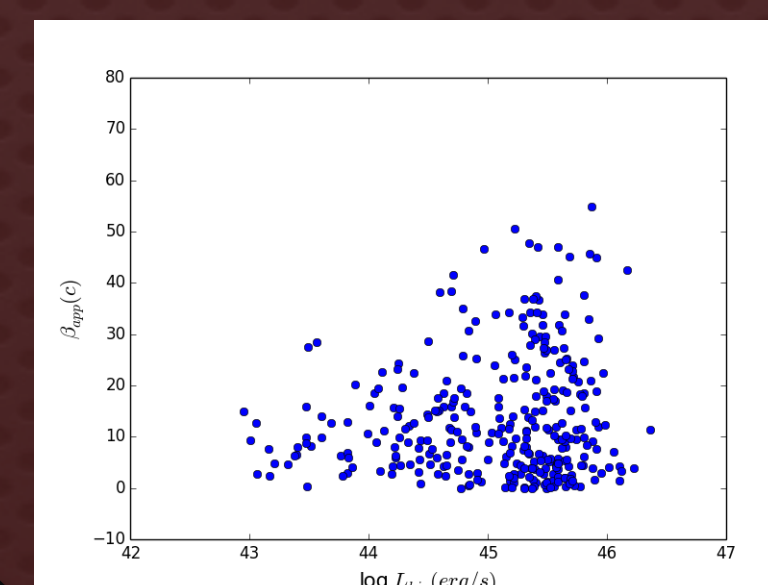
PRELIMINARY RESULTS

Is there a one-to-one relationship?



$$\Gamma = \alpha L_{kin} + \beta$$

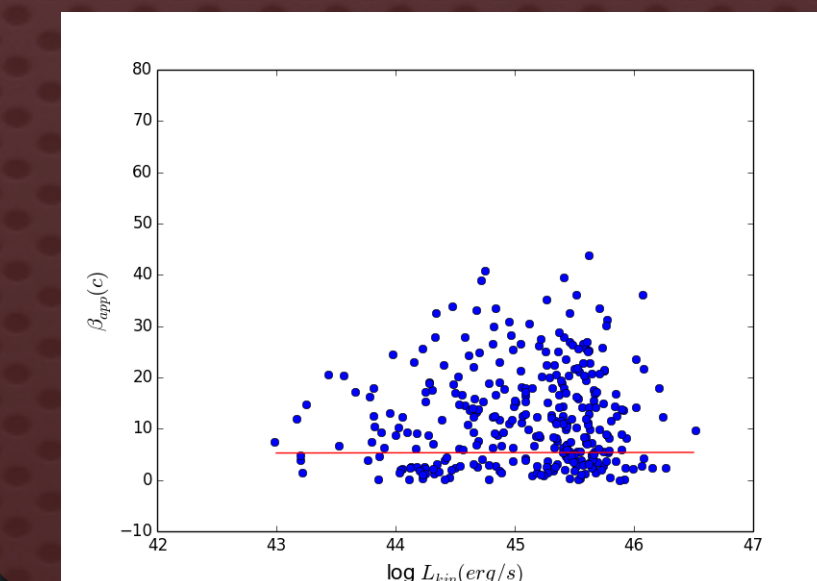
Powerlaw with linear index and Γ_{max}



$$p(\Gamma) = N \Gamma^{-(\alpha L_{kin} + \beta)}$$

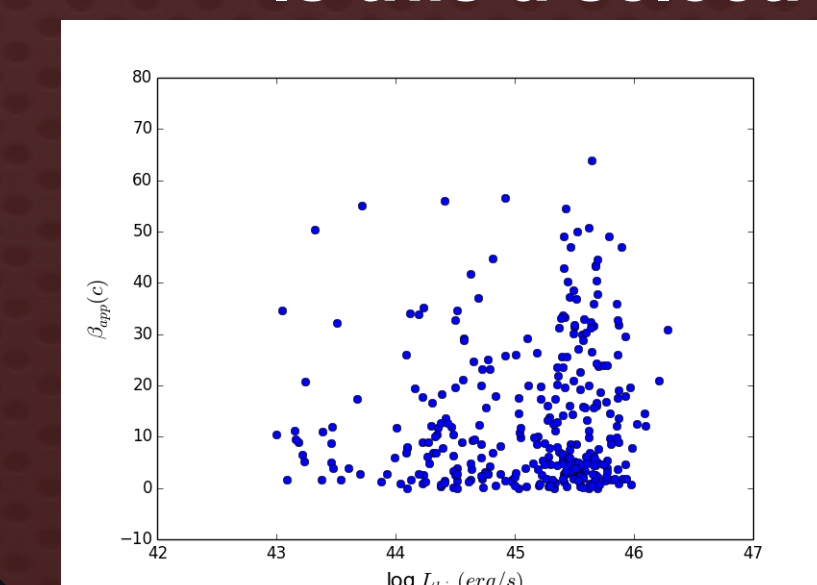
$$\Gamma_{max} = \text{unif}(1, c L_{kin} + d)$$

Is there a characteristic value for Γ ?



Truncated Gaussian with $\mu = \alpha L_{kin} + \beta$

Is this a selection effect?



No dependence on L_{kin}
 $p(\Gamma) = N \Gamma^{-\alpha}$