Variation of AGN Jets Celerity Due to Compton Rocket Effect in a Complex Photon Field

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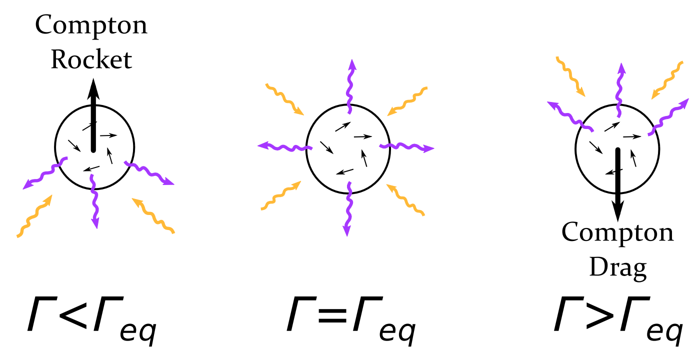
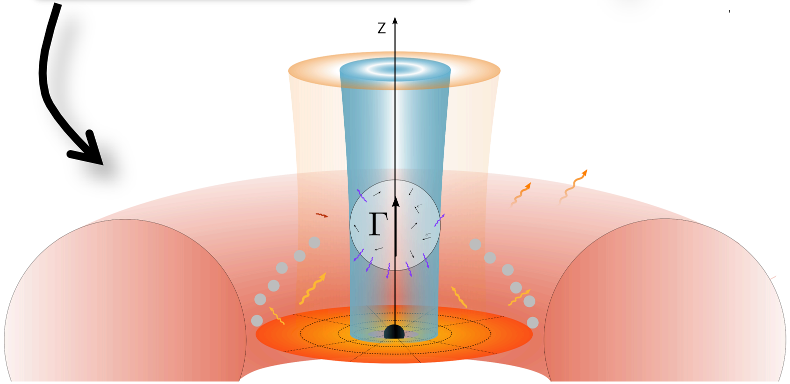
Compton Rocket: thrust applied to a plasma due to the inverse Compton radiation of its relativistic particles (see also Compton drag).
In the **two-flow paradigm, pairs** in the inner jet **stay relativistic** along the jet thanks to interaction with the MHD outer jet (through 2nd order Fermi processes). In this situation, the **Compton rocket process dominates the dynamics** and determinates the inner jet velocity.

In the case of **inverse Compton scattering** ( ) on an **external photon field** ( ), the radiation goes mainly backward to the photon source (due to relativistic aberration) in the bulk rest frame. As the external radiation field changes in the bulk rest frame depending on the bulk Lorentz factor Γ, this sets an **equilibrium bulk Lorentz factor Γ_{eq}** for which the soft photon flux becomes null in the rest frame.

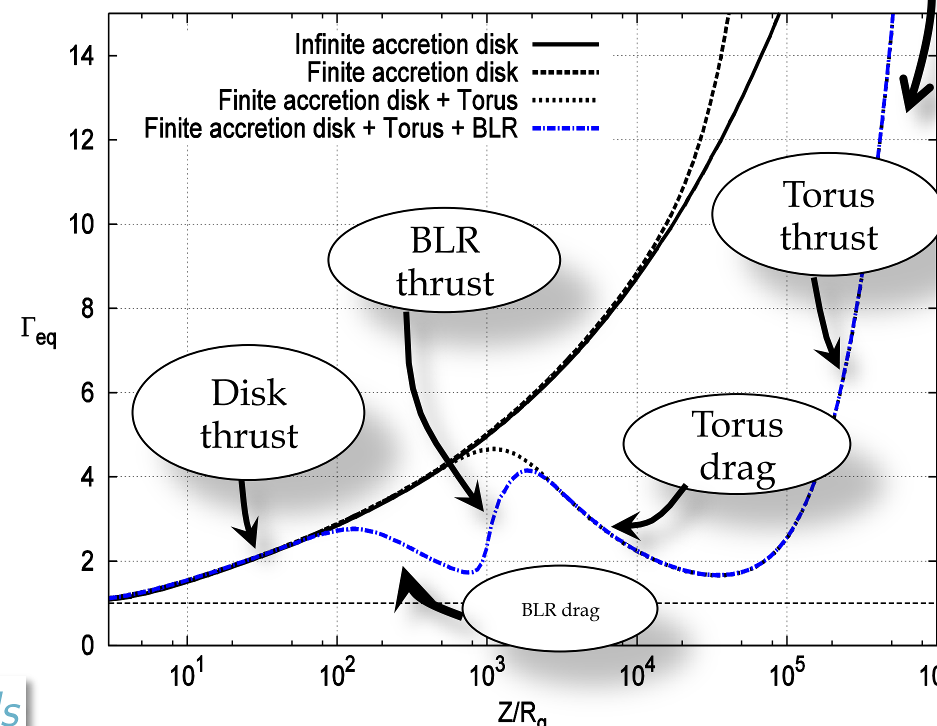


Energy source = relativistic particles ≠ Radiation pressure

AGN with several photon sources + *Compton Rocket* = *Variation of Γ along the jet...*

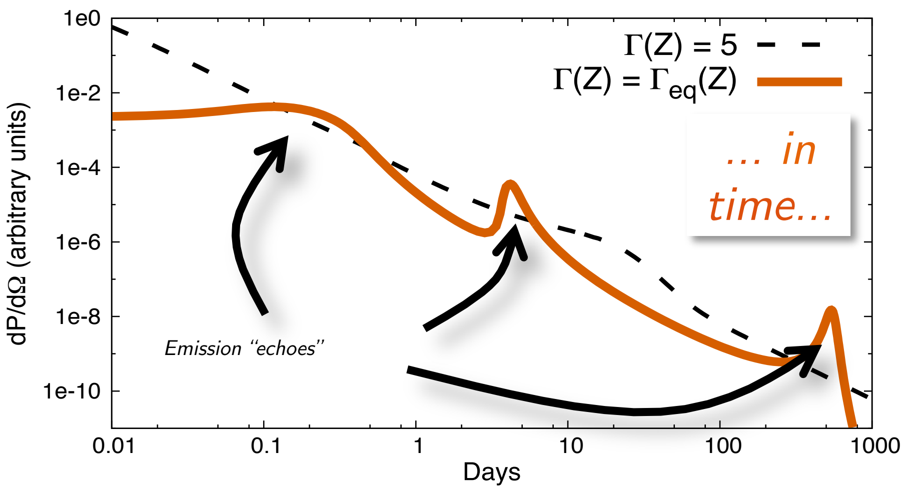


Top: Sketch of the complete model in the two-flow paradigm (inner highly relativistic jet and outer MHD jet) with the photon field of an accretion disc, a dusty torus and a broad line region.
Right: Resulting $\Gamma_{eq}(Z)$ for the different radiative sources and their effects.

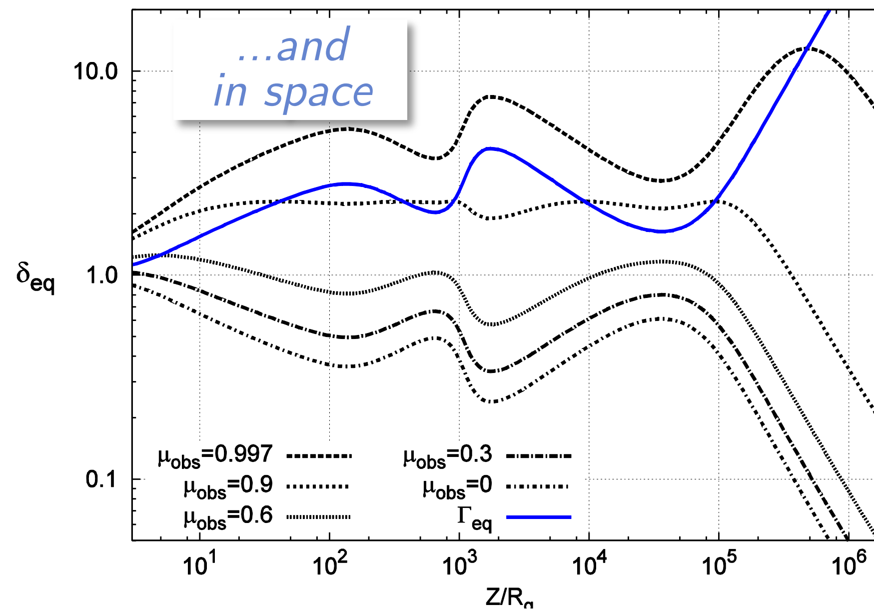


... which leads to...

...modulation of the emission...

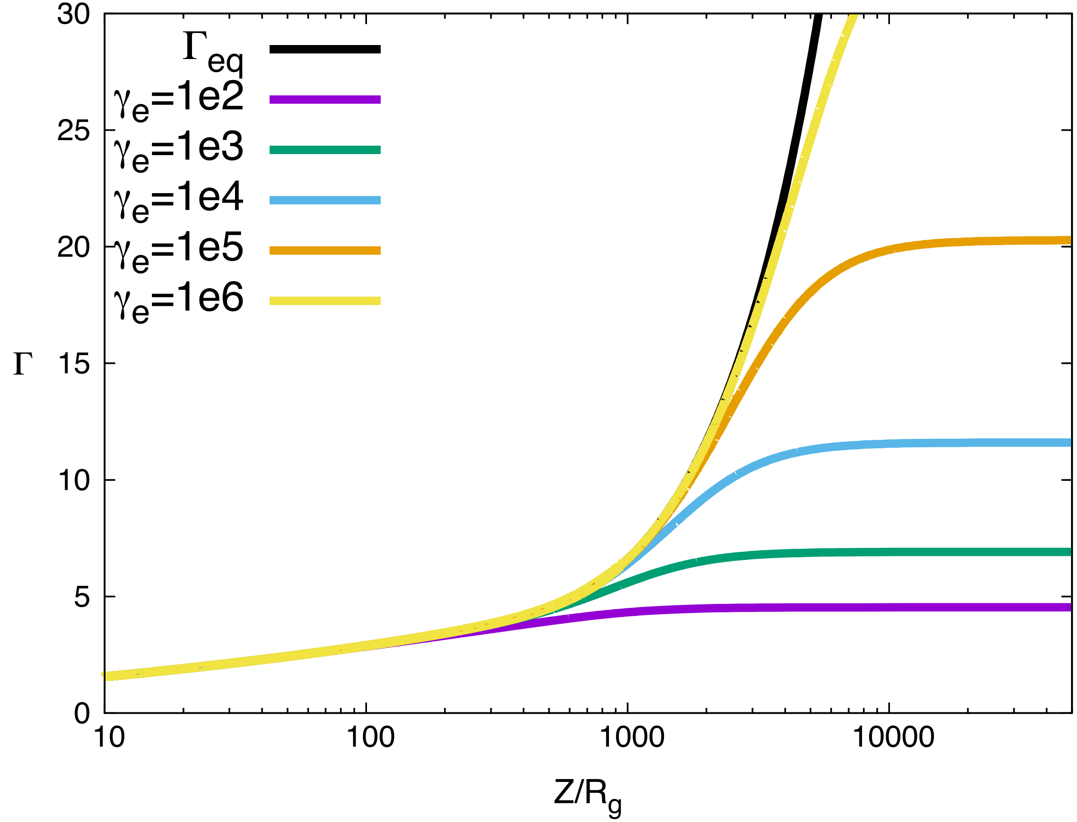


Emission received by an observer from a blob source launch at the base of the jet at t=0 and moving forward with a bulk Lorentz factor Γ. Compared to a constant Γ=5, **the case $\Gamma = \Gamma_{eq}$ shows «echoes» at different timescales.**



Black lines show the apparent equilibrium Doppler factor δ_{eq} for different $\mu_{obs} = \cos i_{obs}$ in function of the jet altitude in the case (Finite disk + Torus + BLR) seen above. **Emission is enhanced where δ_{eq} is maximal.**

Even though Γ_{eq} depends only on the sources geometry in the Thomson regime but the terminal velocity (as measured by VLBI for example) depends on the jet energetics.
Here the variation of $\Gamma(Z)$ for an accretion disk alone and a jet filled with leptons of energy γ_e.
As one can see, final values of Γ compatbile with observations are obtained for very reasonable values of γ_e



More information on the two-flow model on T. Vuillaume's talk on Thursday. More information on the Compton rocket process and its effects in Vuillaume et al 2015, submitted to A&A.