Disk-Jet Connection in Active Supermassive Black Holes

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- Radio Quasars
- Jet power moderately correlates with disk luminosity.
- Jet production efficiency $< \eta_{\text{jet}} > \simeq 7.1^{+25.3}_{-5.5} \times 10^{-3}$
- ~2 orders of magnitude lower than blazar estimates

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The Role of Supermassive Black Holes in the Universe



- Supermassive black holes co-evolve with galaxies (e.g. Kormendy & Gebhardt 2001; Merritt & Ferrarese 2001)
- Their radiation and/or jets affect the surrounding gas from galactic to cluster SCALES (e.g. Fabian '12).
 - How disks, jets, and BHs are connected?

Disk Luminosity & Jet Power



- Utilizing SDSS-NVSS radio quasars
- Jet power moderately correlates with disk luminosity.

 $\log P_{\rm jet} = \log L_{\rm disk} + (-0.81 \pm 6.2 \times 10^{-3})$

Jet production efficiency

$$\eta_{\rm jet} \equiv \frac{P_{\rm jet}}{\dot{M}_{\rm in}c^2} = \frac{P_{\rm jet}}{L_{\rm disk}/\epsilon}$$

- disk rad. efficiency $\varepsilon = 0.1$
- from the correlation,
 - $<\eta_{\rm jet}>\simeq 7.1^{+25.3}_{-5.5}\times 10^{-3}$

Comparison with Blazars



- Blazar spectral studies suggest
 - $\eta_{jet} = 1 \sim 10$ (Ghisellini+'14 for FSRQs, YI & Tanaka '16 for HBLs)
- But, assuming minimum electron Lorentz factor $\gamma_{min} \sim 1$.
- If $\gamma_{min} = m_p/m_e$, η_{jet} will be ~0.01 (YI & Tanaka '16).
- More pairs per one proton would also reduce the power estimation based on blazar spectral fit.