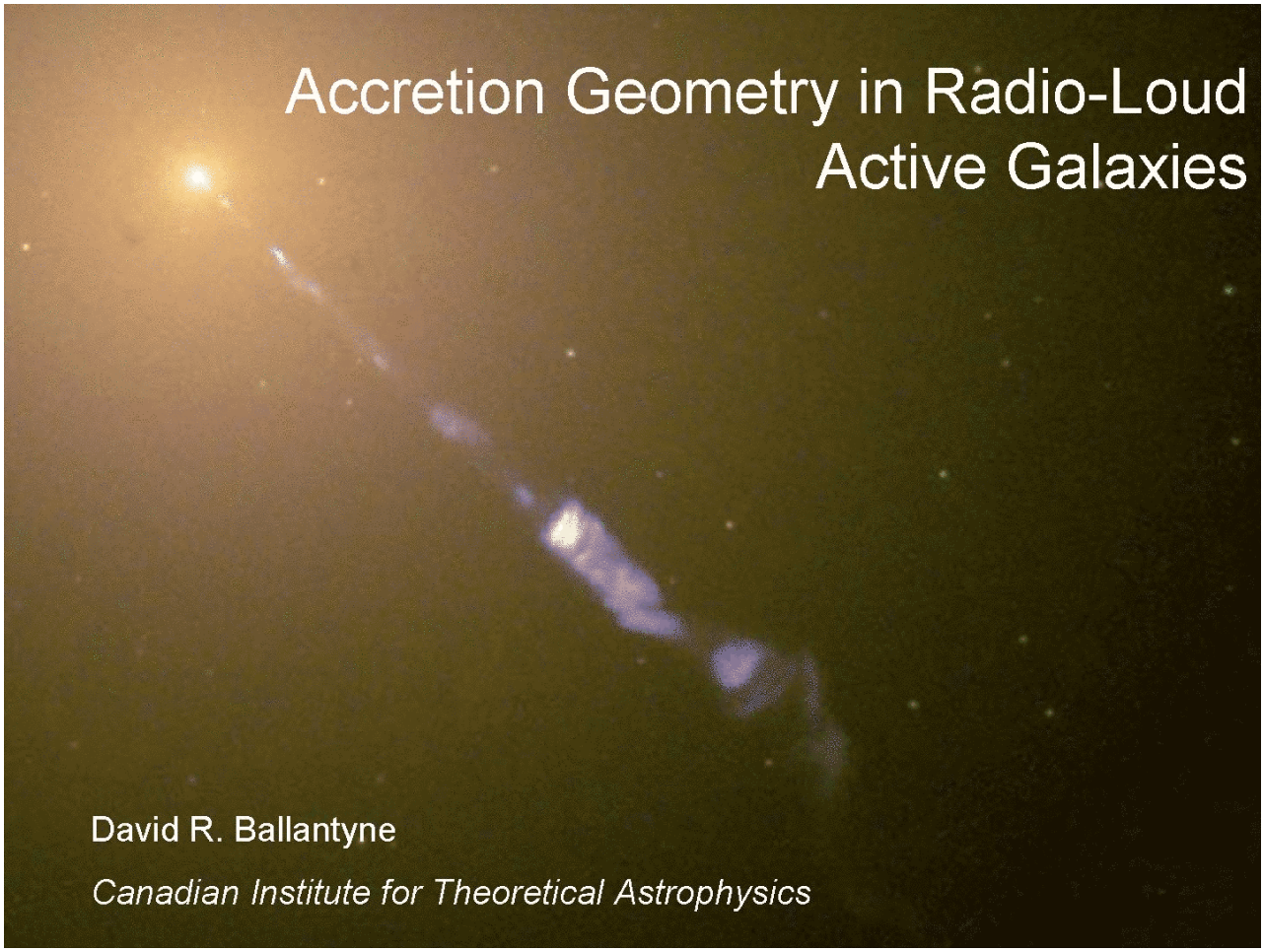
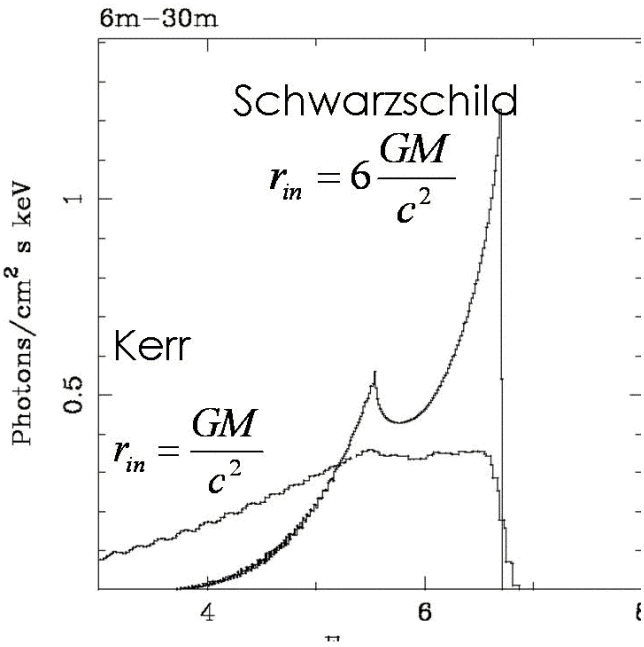


X-ray Reflection

- Features in the reflection spectra of AGN give info on accretion geometry
- Especially if a broad Fe Kα line is observed
- Want to use these features to explore any differences between radio-loud and radio-quiet AGN

Fabian et al (2000)

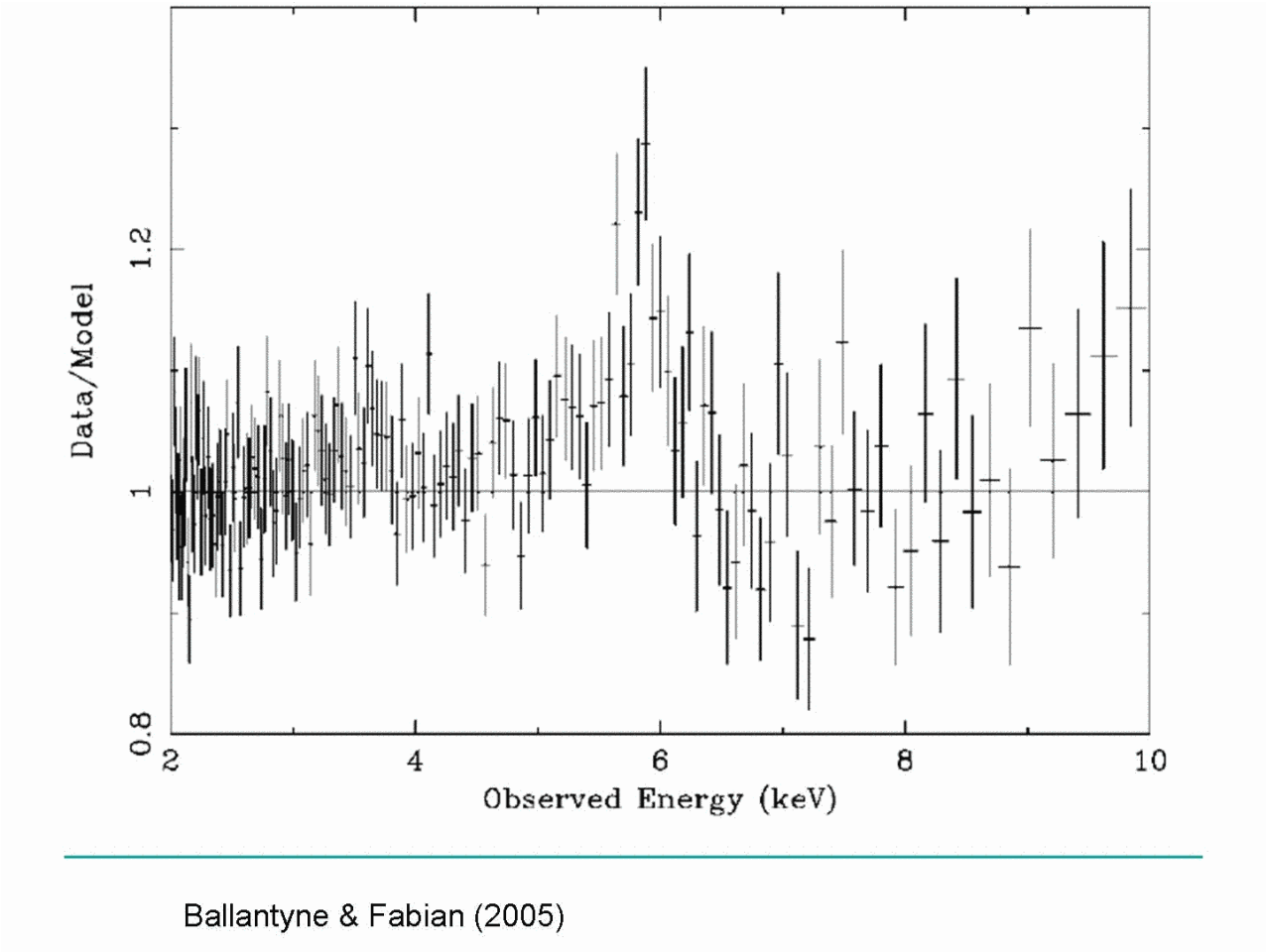


Early Results

- Observations in the 1990s with *ASCA* & *BeppoSAX* indicated that broad-line radio galaxies (BLRGs) had weaker reflection features & Fe K lines than RQ Seyferts.
- Interpretation (truncated accretion flow? jet dilution? ionized disks?) hindered by lack of bright sources and low quality spectra

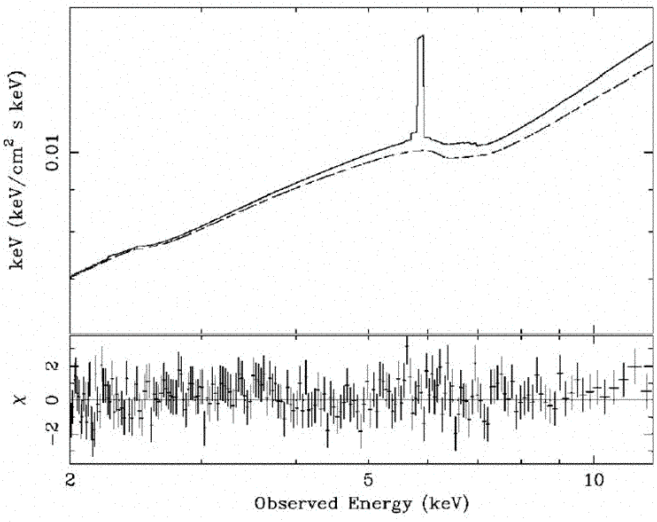
XMM-Newton Results from 4C 74.26

- 4C 74.26 (z=0.104) is a low-luminosity radio-loud quasar with large (10') radio lobes
- $L_{bol} \approx 2 \times 10^{46}$ erg/s
- Lack of counter-jet gives inclination limit of $<49^{o}$
- From width of broad-lines, $M_{BH} \sim 4 \times 10^{9} M_{\odot}$
- *XMM-Newton* observation lasted 35 ks
- Observed luminosity and M_{BH} give an Eddington ratio of ~0.04



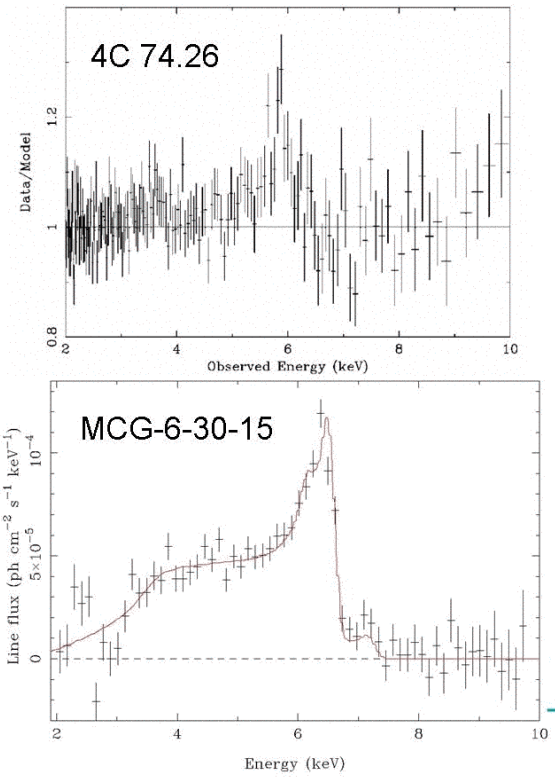
Ballantyne & Fabian (2005)

- Best fit model requires a moderately ionized reflector extending within the ISCO for a Schwarzschild hole
- Models with larger disk radii require a smaller inclination angle
- Creates problems with the physical size of the radio lobes
- Partial covering solutions difficult to rule out, but give poorer statistical fit
- Needs to be confirmed!



Ballantyne & Fabian (2005)

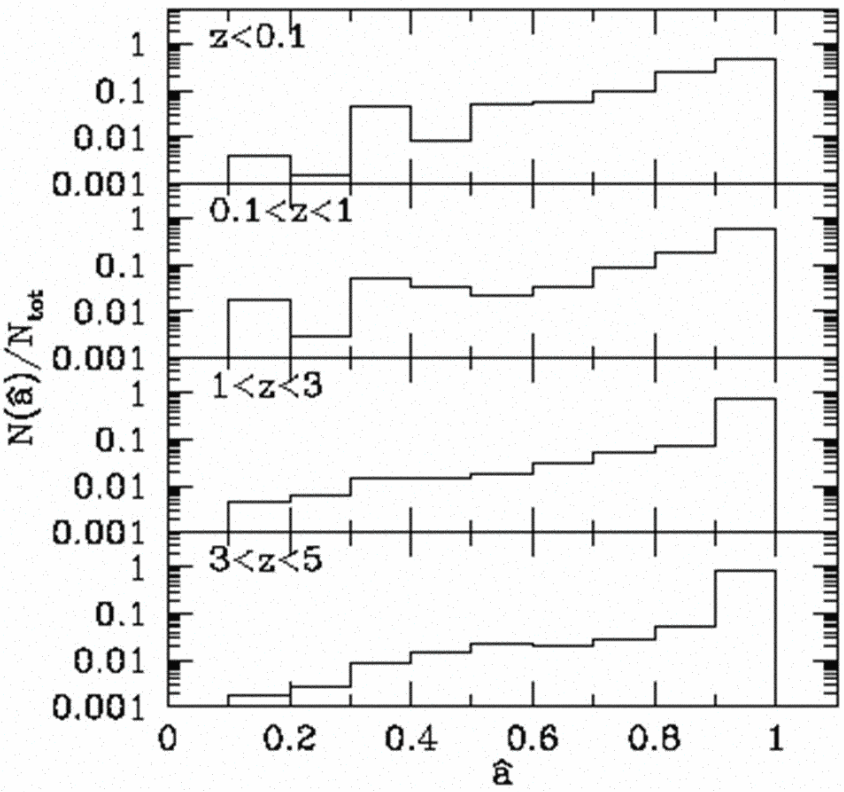
Implications for Jet Formation



- Taking the 4C 74.26 results at face value, we can ask the question: why does this source produce a powerful radio jet and a similar one like MCG-6-30-15 does not?

Jet Formation I. Spin

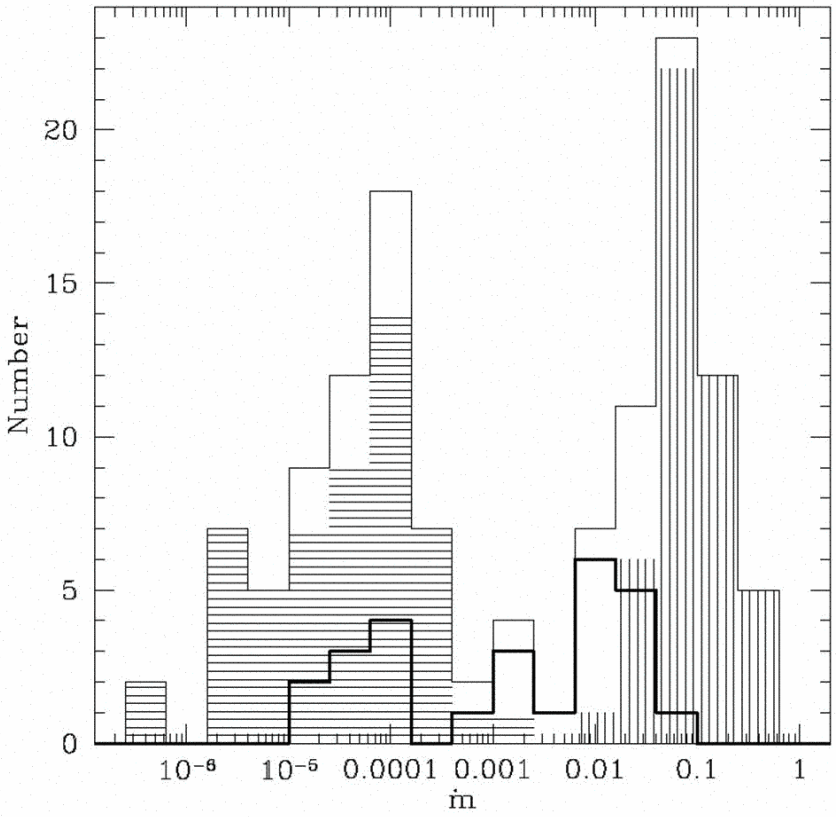
- Often thought that black hole spin determines whether a source is RL or RQ (Wilson & Colbert 1995)
- But, the Fe K lines in both 4C 74.26 and MCG-6-30-15 seem to require a spinning black hole
- Also, radio emission in accreting black holes is quenched when moving from low/hard to high/soft => not a spin effect
- Finally, models of black hole growth indicate all black holes are likely spinning



Volonteri et al. (2005)

Jet Formation II. Accretion Rate

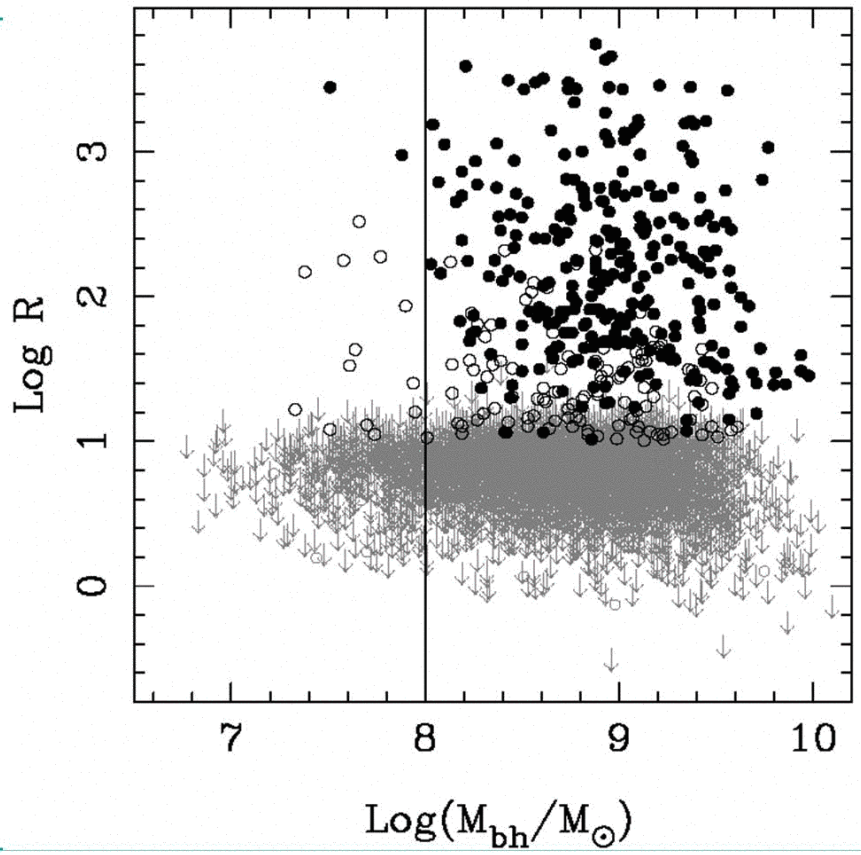
- The radio emission from galactic black holes is quenched as the accretion rate increases above ~0.02 Eddington (Maccarone 2003)
- Moreover, LLAGNs are often seen to be radio-loud (Ho & Peng 2001)
- Yet, clearly other BLRGs (e.g., 3C 120) and radio-loud quasars (e.g., 3C 273) are accreting above the galactic black hole cutoff and producing radio jets.



Marchesini, Celotti & Ferrarese (2004), but see Jester (2005) about selection effects

Jet Formation III. Black Hole Mass

- Clearly not relevant to Galactic black holes, but 4C 74.26 has a black hole perhaps ~10^3 larger than MCG-6-30-15
- Some surveys of AGN black hole mass show that radio-loud objects prefer having larger black hole masses than radio-quiet (e.g., McLure & Jarvis 2004). Still controversial.
- What changes with black hole mass? Why would it be important for AGN?



McLure & Jarvis (2004)

Jet Formation IV. *H/r*

- For a simple thin Shakura-Sunyaev disk, increasing M_{BH} increases the disk scale-height *H* and thus *H/r*
- If low-state Galactic black holes and LLAGNs have radiative inefficient accretion flows (i.e., an ADAF) close to the black hole, then it will also have a large *H/r*
- A larger *H/r* may enhance the poloidal magnetic field in the inner part of disk, which seems necessary to launch jets (Meier 2001)
- A combination of *H/r* and magnetic field strength & configuration may explain the observed trends on how jets are launched

Assertions

- Necessary (but not sufficient?) conditions for powerful jet formation:
  - Spinning black hole
  - Large *H/r* in the inner accretion flow

- Upcoming:
  - Should ULXs be radio-loud? (Ballantyne, in prep.)