From Observations to Physics: Cosmological Evolution of Radio Galaxies

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Objectives

theoretical predictions ↔ observations ↔ intrinsic properties
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theoretical predictions \[\leftrightarrow\] observations \[\leftrightarrow\] intrinsic properties

KDA & KA models:
* Kaiser, Dennett-Thorpe & Alexander, 1997
* Kaiser & Alexander, 1997

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theoretical predictions ↔ observations ↔ intrinsic properties

Radio luminosity $L$
Size $D$
Redshift $z$

Kaiser, Dennett-Thorpe & Alexander, 1997 (KDA)
Kaiser & Alexander, 1997 (KA)
Objectives

theoretical predictions \[\downarrow\] observations \[\downarrow\] intrinsic properties

Radio luminosity $L$
Size $D$
Redshift $z$
Jet power $Q$
External density structure $\rho_x = (\rho a^\beta) r^{-\beta}$
Source age $t$
Lobe pressure $p$

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Catalogues

- **3CRR**
  Laing, Riley & Longair (1983)

- **BRL**
  Best, Röttgering & Lehnert (1999)

- **7CRS**
  McGilchrist et al. (1990)
  [see also Lacy et al. (1999), Grimes et al. (2004)]

**flux-limited complete samples**
Lobe pressure $p$

Minimum energy requirements:

$$ p^{7/4} \propto L \cdot D^{-3} $$
Lobe pressure $p$

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$$p^{7/4} \propto L D^{-3}$$

CSS/GPS

10 kpc – max linear size

(Alexander 2000)
Lobe pressure $\rho$
Lobe pressure $p$

From the KA model:

$$p = f(Q, \rho a^\beta) \cdot t^{(-\beta-4)/(5-\beta)}$$
Lobe pressure $p$

From the KA model: $\beta = 1.5$

$$p = f(Q, \rho a^\beta) \; t^{(-\beta-4)/(5-\beta)}$$

For individual source:

$$Q = \text{const}$$

$$(\rho a^\beta) = \text{const}$$
Lobe pressure $p$

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$$p = f(Q, \rho a^\beta) \cdot t^{(-\beta-4)/(5-\beta)}$$

$\beta = 1.5$

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$(\rho a^\beta) = \text{const}$

$$x \ [\%] = \frac{t_{i+1} - t_i}{t_{max}}$$
Lobe pressure $\rho$

![Graph showing the evolution of lobe pressure with redshift.](image)
Lobe pressure $p$

- red – observed
- blue – expected
Lobe pressure $p$

red – observed
blue – expected
Lobe pressure $p$

red – observed
blue – expected

$z < 0.3$

$z > 0.3$
Lobe pressure $\rho$

red – observed
blue – expected

z < 0.3

z > 0.3
Size evolution $D$
Size evolution $D$

red – observed
blue – expected

$z < 0.3$

$z > 0.3$
Size evolution $D$

red – observed
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Size evolution $D$

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$z < 0.3$

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Size evolution $D$

red – observed
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z < 0.3

z > 0.3

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Conclusions

• Redshift evolution.
• Size cut-off much earlier than expected – Mpc sources are rare!
• New low-redshift sample to analyse.
• Pressure evolution affected only by size?