Non Blazar Quasars

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Blazars Through Sharp Eyes
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Malaga, Spain

with
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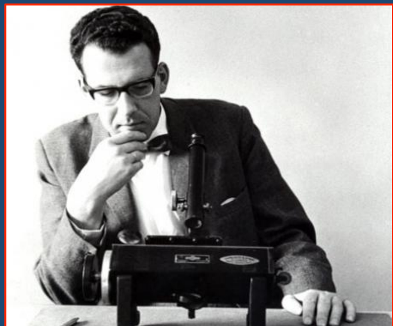
Quasi-stellar Galaxies
aka
Radio Quiet Quasars



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THE EXISTENCE OF A MAJOR NEW CONSTITUENT OF THE UNIVERSE: THE QUASI-STELLAR GALAXIES

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ABSTRACT

Photometric, number count, and spectrographic evidence is presented to show that most of the blue, starlike objects fainter than $m_{pg} = 16^m$ found in color surveys of high-latitude fields are extragalactic and represent an entirely new class of objects Members of the class called here quasi-stellar galaxies (QSG) resemble the quasi-stellar radio sources (QSS) in many optical properties, but they are radio-quiet. The QSG brighter than $m_{pg} = 19^m$ are 10^3 times more numerous per square degree than the QSS that are brighter than 9 flux units. The surface density of QSG is about 4 objects per square degree to $m_{pg} = 19^m$.

"In spite of all these facts being known to him in 1964, Sandage attempted one of the most **astounding feats of plagiarism** by announcing the existence of a major new component of the Universe: the quasi-stellar galaxies"
Fritz Zwicky, 1971

- Is there a continuous distribution of radio luminosity or are there two separate populations of QSOs?
  - Radio Loud Quasars
  - Radio Quiet Quasars

Radio Loud and Radio Quiet Quasars: One or Two populations?

Separate Population

- Kellermann et al., 1989, 1994
- Miller, et al, 1990, 1993
- Sopp & Alexander, 1991
- Stocke et al. 1992
- Visnovsky et al., 1992
- Peterson, 1997
- Kukula et al., 1998
- Goldschmidt et al. 1999
- Krolik, 1999
- Kembhavi & Narlikar, 1999
- Ivezic, et al., 2002, 2004
- Laor, 2004
- Jiang et al. 2007
- Zamfir et al., 2008
- Balokovic et al., 2012
- Kimball et al., 2011
- Condon et al., 2013

Continuous Distribution

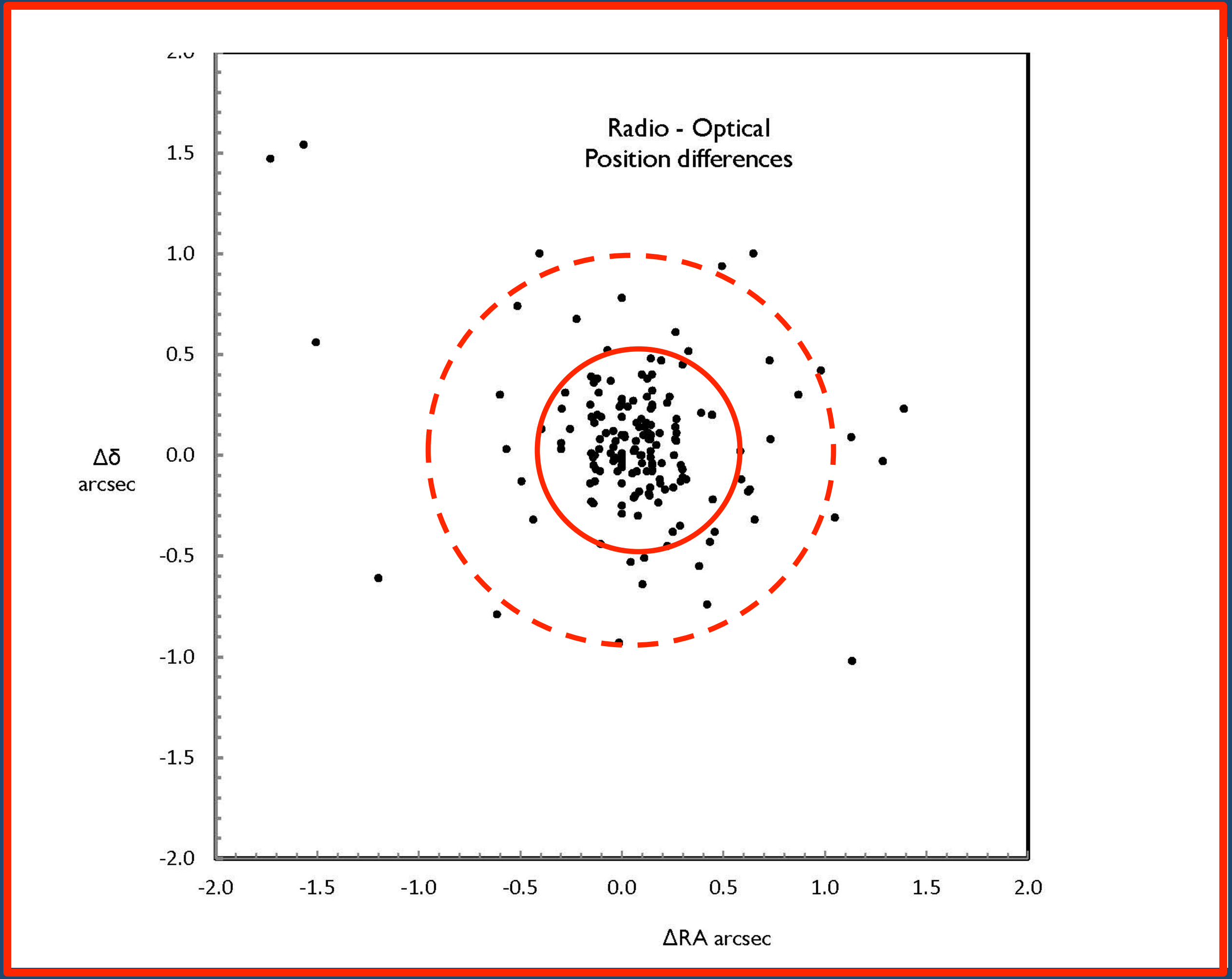
- Becker et al. 1995
- White et al. 2000
- White et al. 2007
- Lacy et al., , 2001
- Cirasuolo, et al. 2003
- Wals et al. 2005
- Barvainis, et al., 2005
- Rafter et al., 2009
- Mahony et al. 2012
- Singal et al, 2011
- Bonchi et al. 2013

JVLA Observations of SDSS QSOs

Kimball et al. 2011

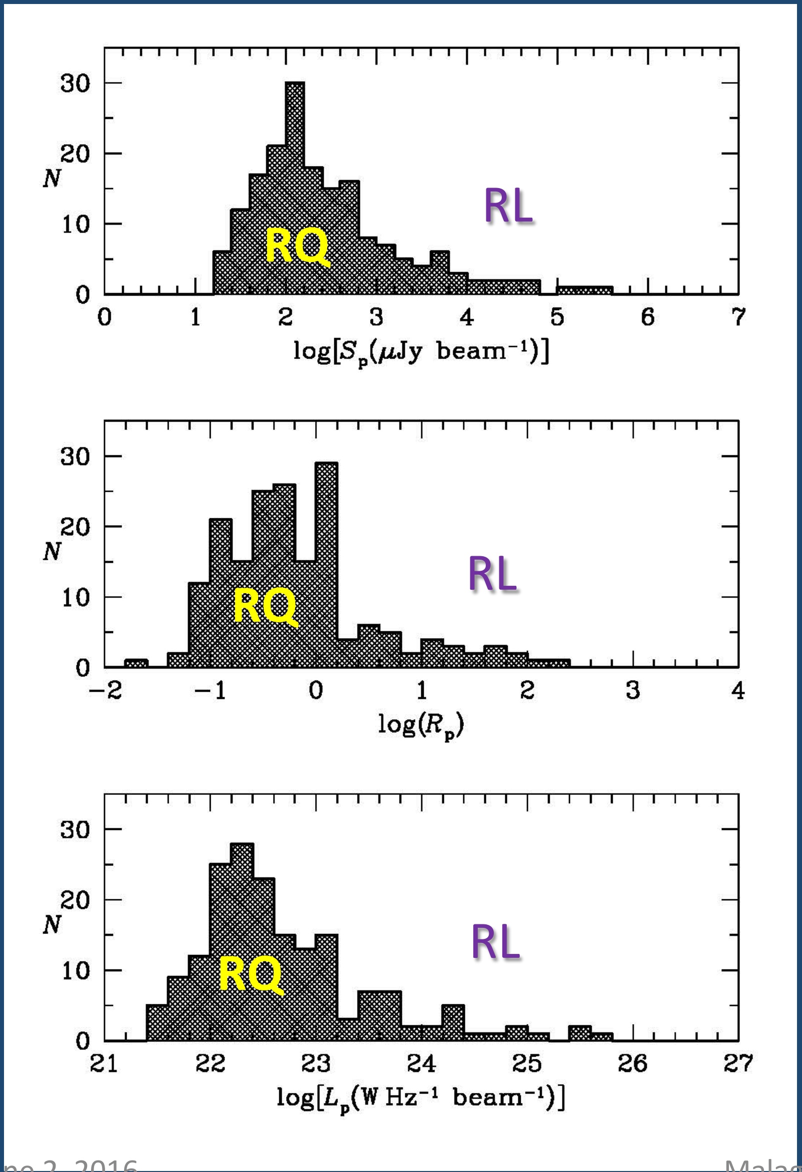
- 179 (178) SDSS QSOs
- $14<i<19$
- $0.2<z<0.3$; $M_i < -23$
- $5<\nu<7$ GHz
- $\sigma \sim 6$ μJy [S > 20 μJy]
- All but 2 QSOs S > 20 μJy
- Mostly unresolved
- 13/18 (S > 5 mJy) extended

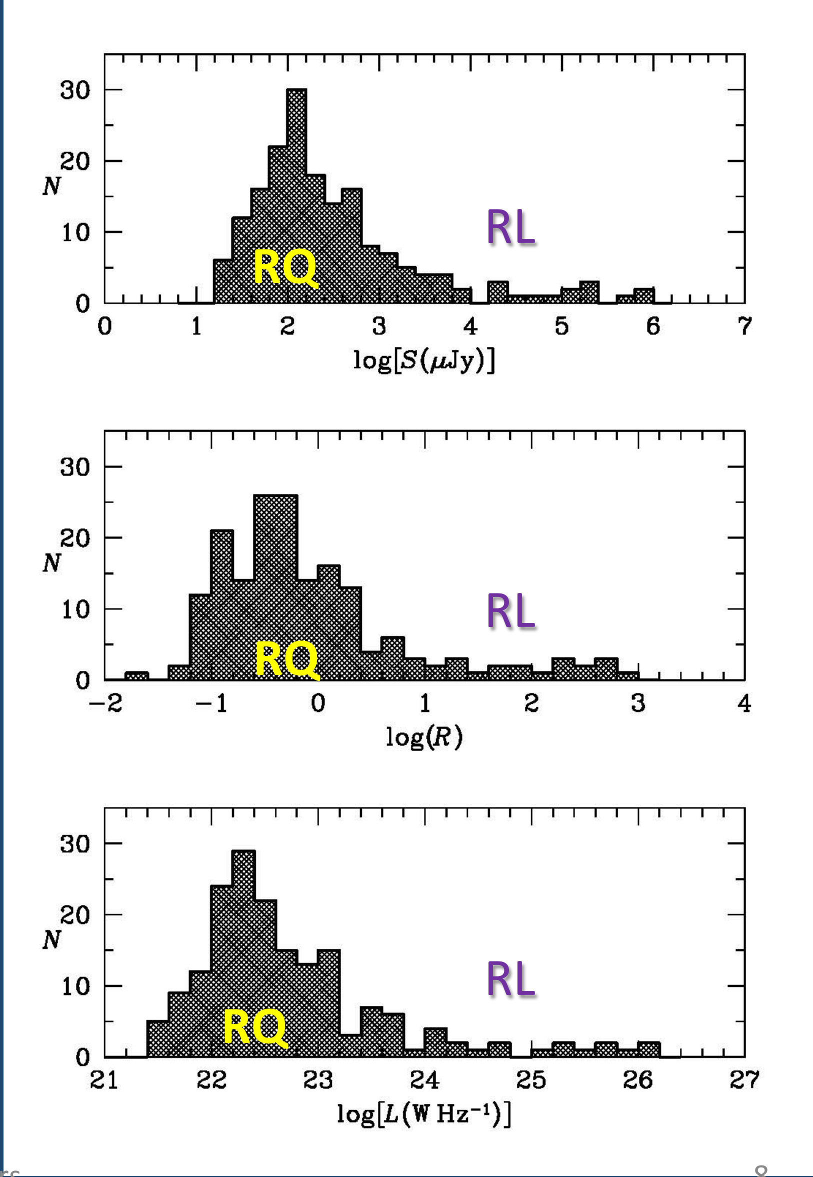
Radio/Optical Distribution



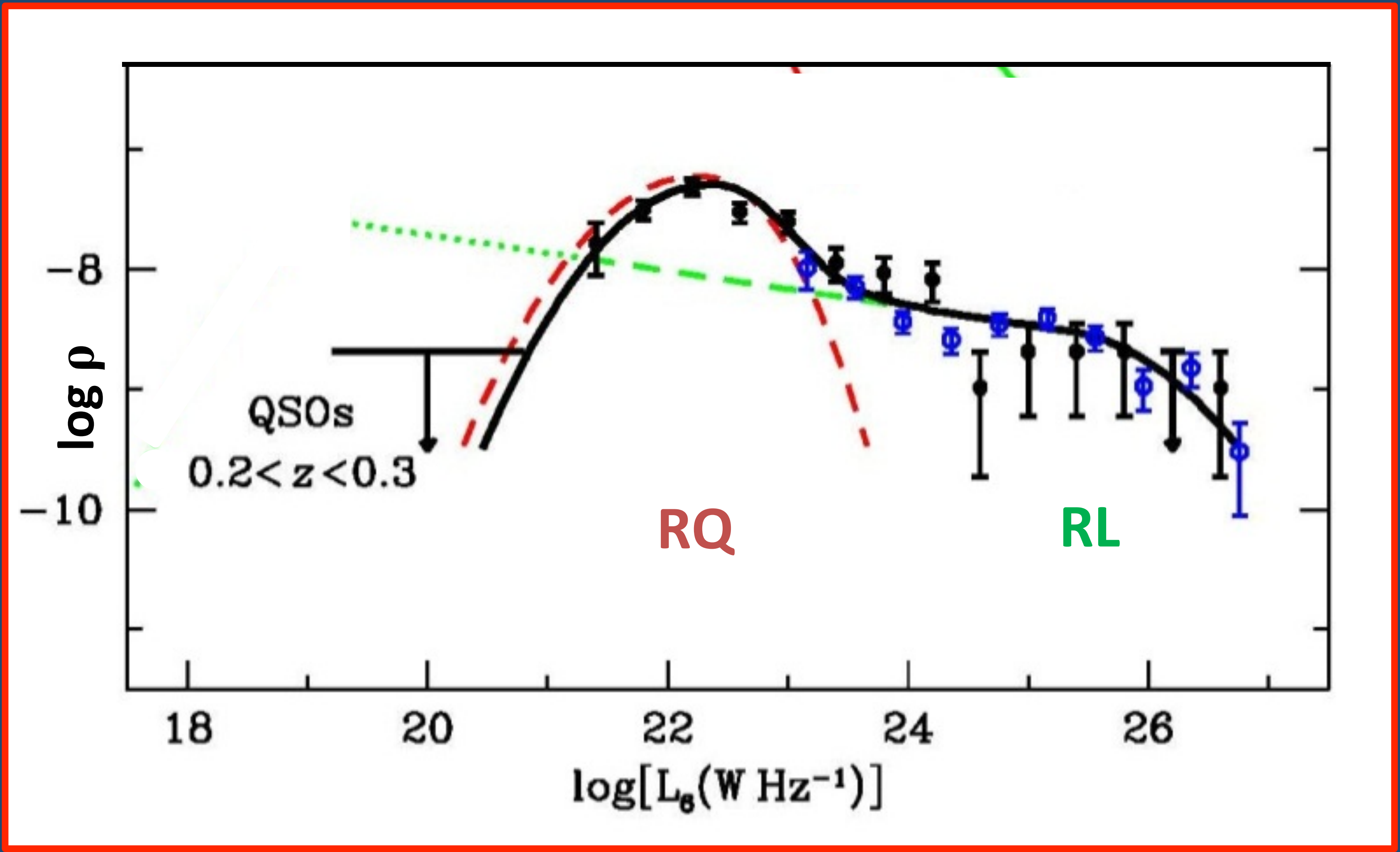
Peak Values

Integrated Values



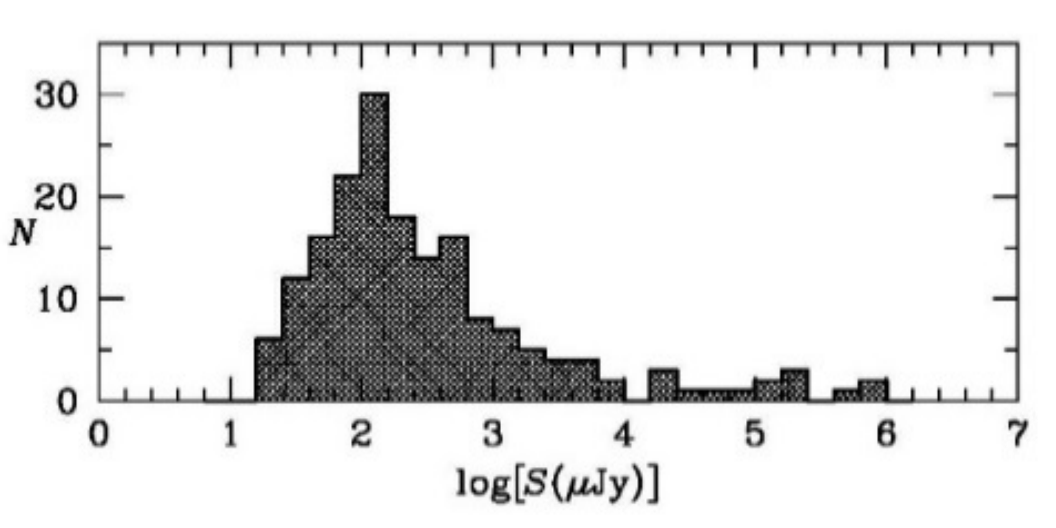


Quasar Radio Luminosity Function



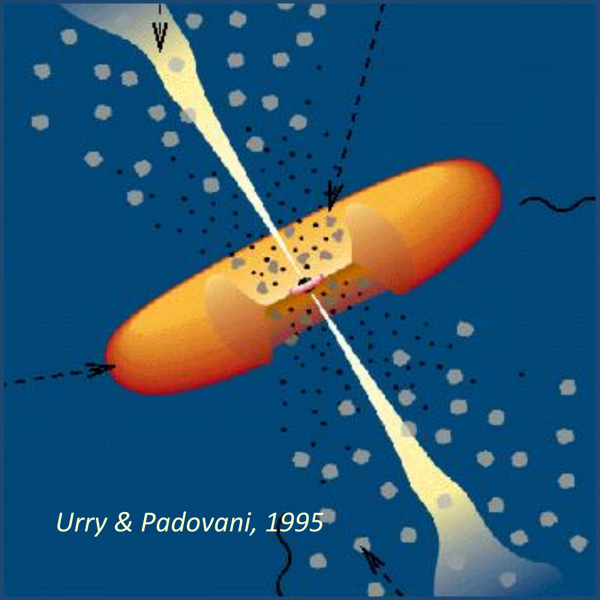
Radio Loud & Radio Quiet Quasars

- Radio loud and radio quiet quasars reflect two distinct populations
  - Radio Loud QSOs associated with a SMBH & Large scale structure - Blazars
  - Radio Quiet QSOs probably associated mostly with star formation in host g
    - L ~ 10 $^{22.5}$ W/Hz
    - Unresolved: No ev
- The inability to previou o
  - Inhomogeneous op
  - Wide range of z/ev
  - The use of radio/X
  - Inappropriate definition of RQ – P >10^{23} W/Hz, R < 1
  - The lack of sufficient sensitivity to detect the peak of the RQ distribution in QSOs



Why Are Only Some Quasars Powerful Radio Sources?

- Intermittent radio activity
- Absorption
  - free-free
  - SSA
- Host galaxy
- SMBH: Mass - Spin
- Influence of companion SMBH
- Relativistic Beaming -
  - Scheuer and Readhead, 1979
  - Too many radio loud sources
  - Observed source count grossly inconsistent



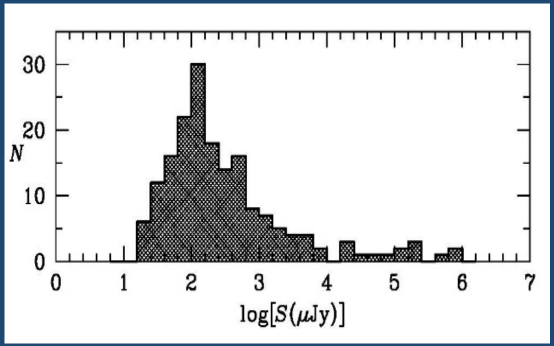
Urry & Padovani, 1995

Are there too many radio loud quasars? 10%

- For [illegible] ~ 10, HPBW ~ 0.1r ~ 0.01 sr; if isotropic ~ 0.1% radio loud
- Lorentz factor distribution – st … aw
  - Volume limited sample 1 < [illegible] <2 (Lis … 1997)

- Jets have finite width
- Jets are bent and/or different ejection angles
- Bulk flow may be smaller than pattern flow
- Optical emission may also be beamed
- Obscuring torus of unified models may lead to orientation bias – (*Barthel, 1989*)

Are RLQs the result of beaming?



$N(S) \propto S^{-x}$

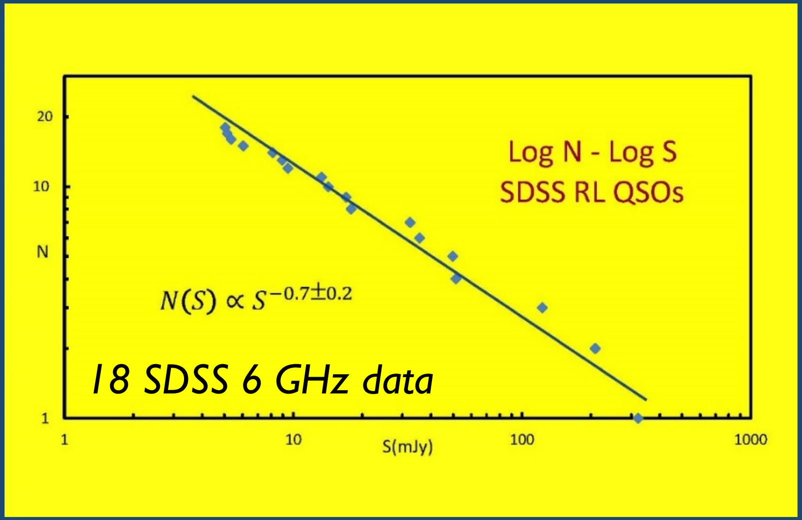
$x = 1/p - \alpha$

3

$2 < p < 3$

$-1 < \alpha < 0 \qquad S \propto \nu^{\alpha}$

$N(S) \propto S^{-1/3}$ to $S^{-1/2}$



- Small sample
- Low luminosity
- Unbeamed contrubtion

Counts from Other QSO Samples

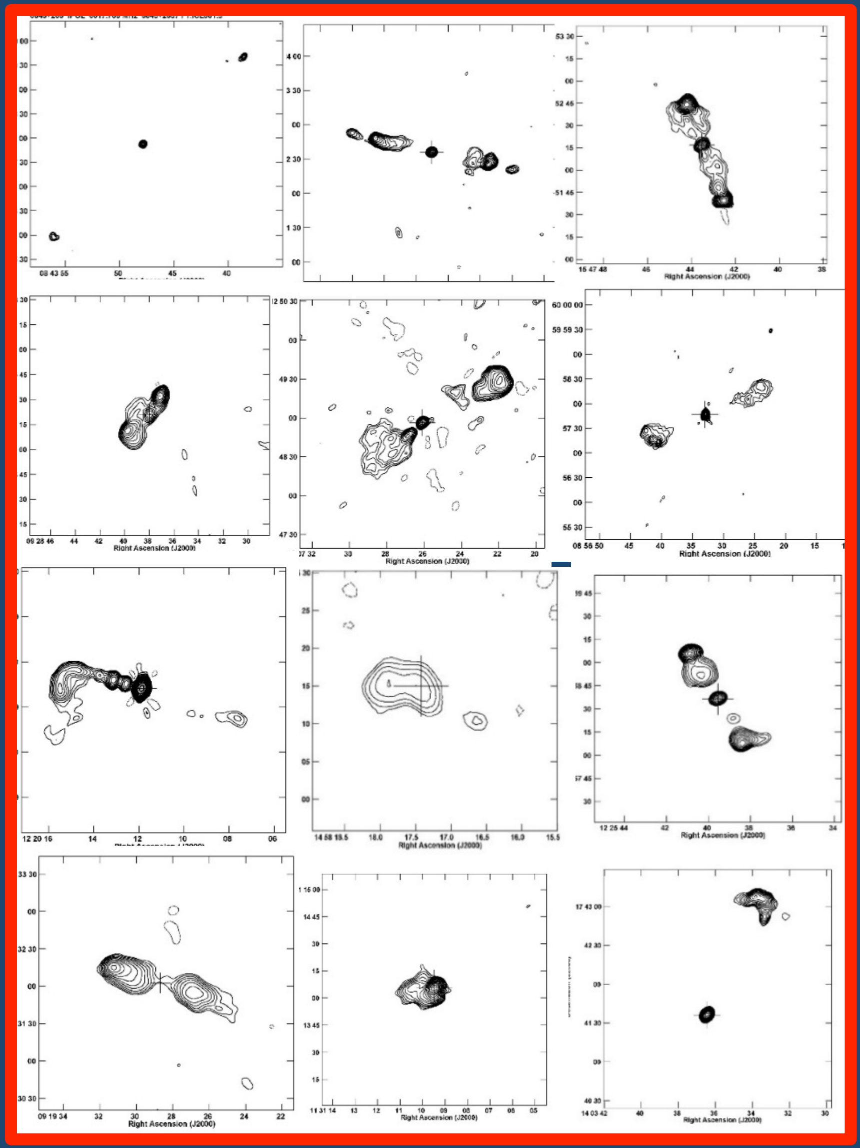
- $0.25 < z < 0.45$
- 163 SDSS
- $S_{1.4\ GHz} > 2.4$ mJy
- $N(S) \propto S^{-0.2 \pm 0.02}$

- $1.8 < z < 2.5$
- 191 SDSS QSOs
- $S_{1.4\ GHz} > 2.4$ mJy
- $N(S) \propto S^{-0.01 \pm 0.02}$

$N(S) \propto S^{-0.33}$ to $S^{-0.5}$

RL QSOs with Extended Structure

- RQ quasars "all" unresolved
- 13/18 RL quasars have extended structure
- Some one-sided
- Some symmetric
    - – No Doppler boosting!
- Cannot be accommodated by beaming models



Summary

- Most QSOs are not strong radio sources
- Two flavors
  - Radio Loud Quasars ----- SMBHs
  - Radio Quiet Quasars ---- Star formation in host galaxy
- Much of published discussion based samples of RQQs based on RLQs with $L \geq 10^{23}$ W/Hz or R>10
- Relativistic beaming probably important for parsec scale luminosity of RLQ
  - Does not explain the kpc/Mpc scale structure

Thank you