Luminosity and density evolution of extragalactic radio sources

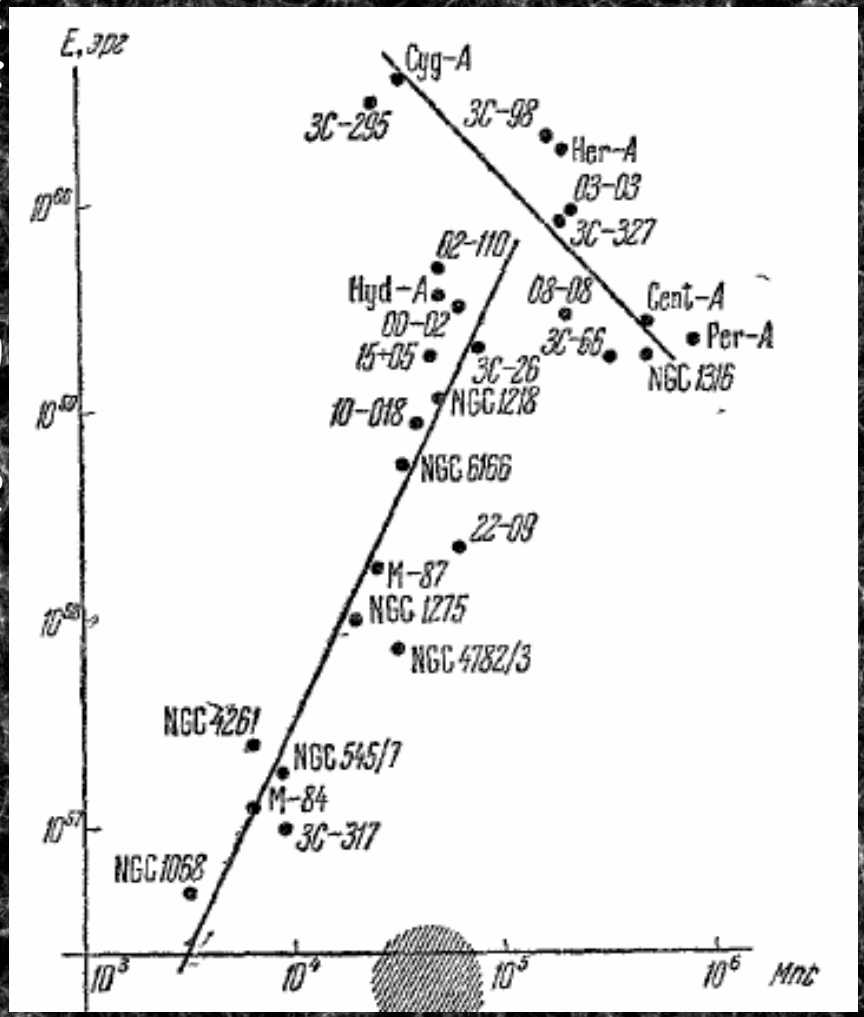
Evgeniya Kravchenko

Puschino Radio Astronomy Observatory, Russian Federation

41st YERAC, Manchester, July 18-20 2011

Prelude

- FRI – FRII dichotonomy
- Unified model (by Jakson & Wall)
- Environment
- GHz-peaked-spectrum sources
- Sources ancestors
- Clear CMB-maps



Shklovskii I.S., 1963, SVA, 6, 645

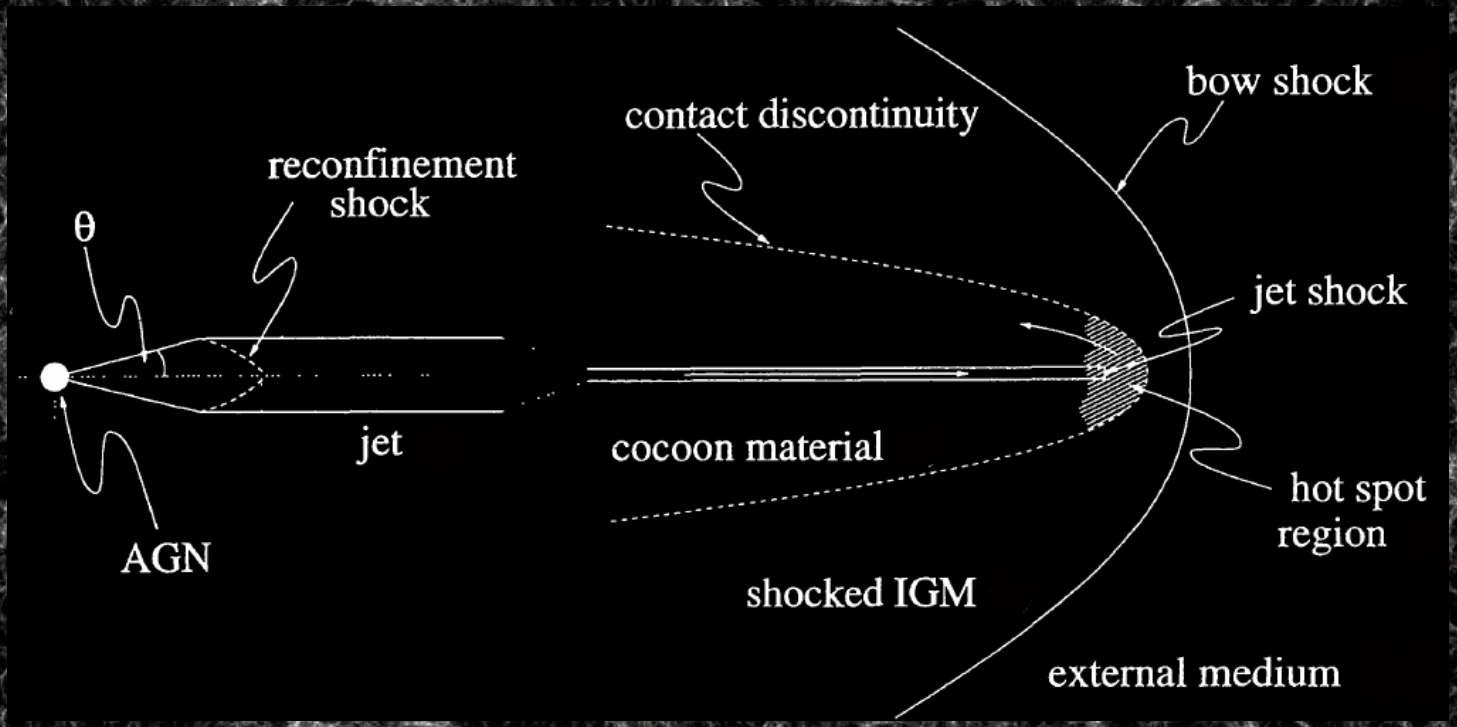
FRII evolution I Theory

$$L_{rg} \sim (t^3 Q)^{2/7}$$

$$P \sim Q^{31/28} t^{-5/28}$$

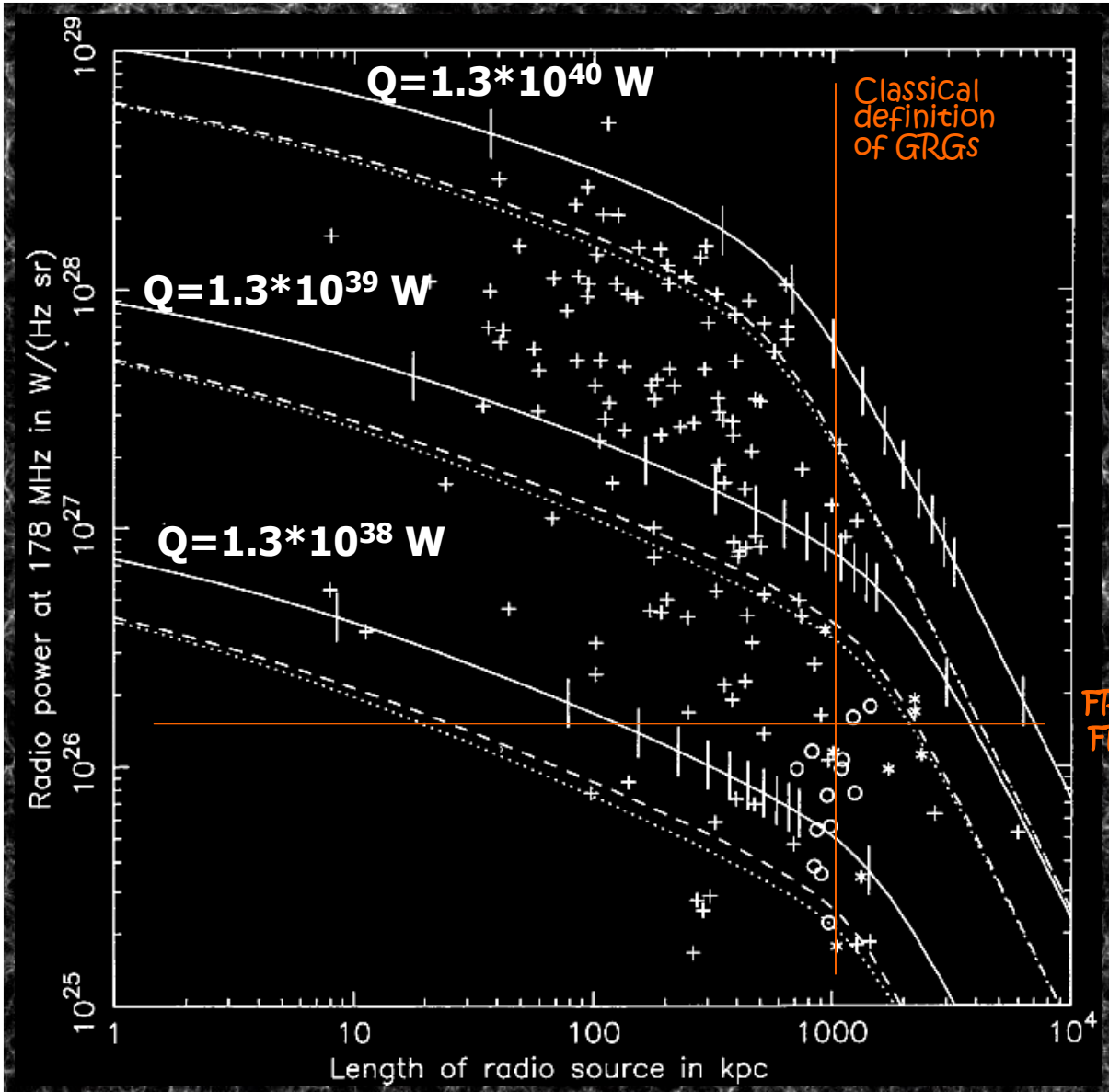
Q – kinetic energy of the jet
t – life time of the source
P – radio luminosity

A simple model for a radio-source's luminosity evolution assumes that Q remains constant as t increases.



"Self-similar model for extragalactic radio sources", Kaiser&Alexander, MNRAS, 286, 1997, Kaiser&Best 2007

FRII evolution II Theory + Data



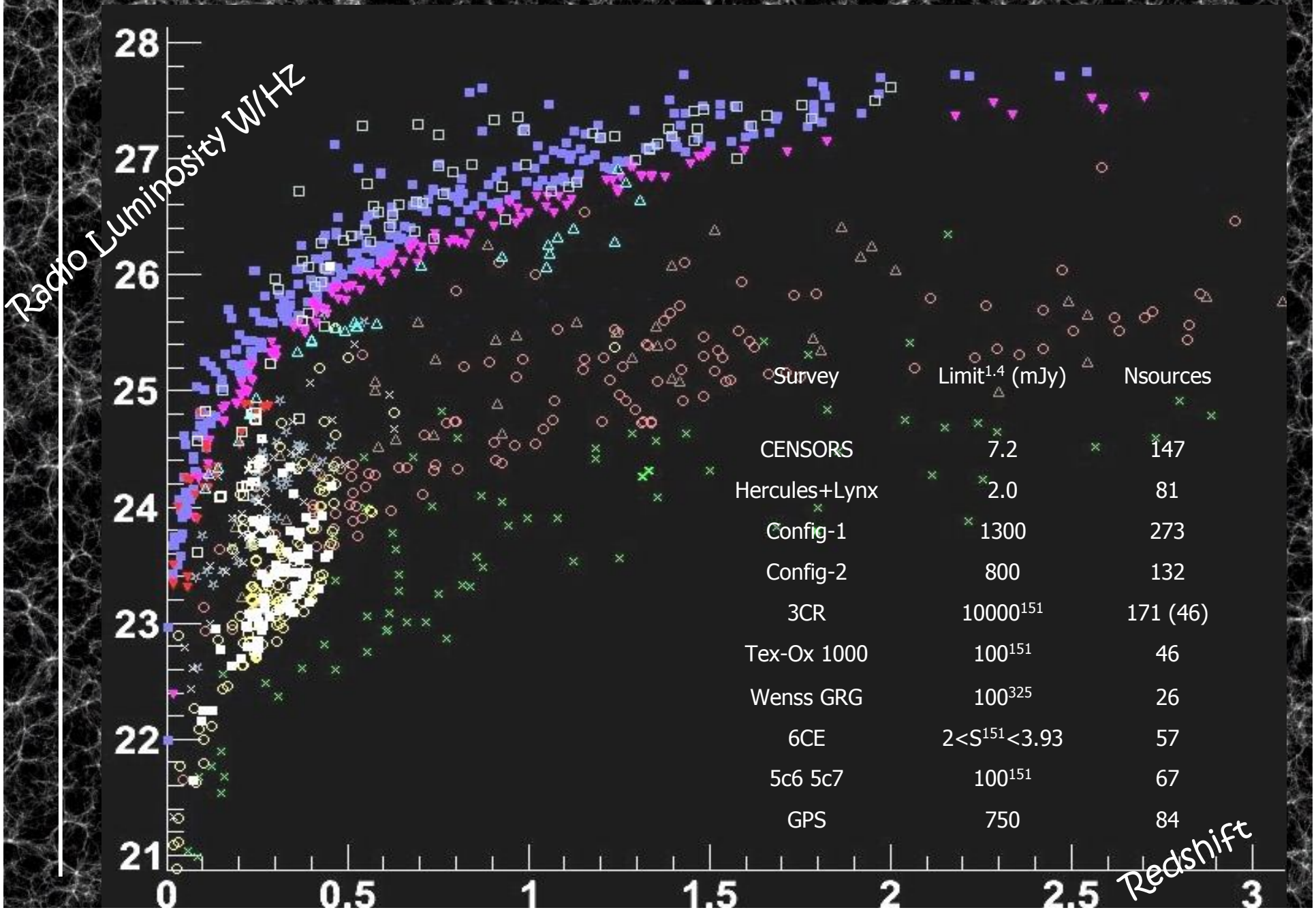
"Evolutionary tracks of FRII sources through the P-D diagram", C.R.Kaiser & J.D.Alexander & P.Alexander, MNRAS, 292, 1997

QSO -> FRII ->FRI

Q_{jet} transition ~ 10^{37} W/Hz

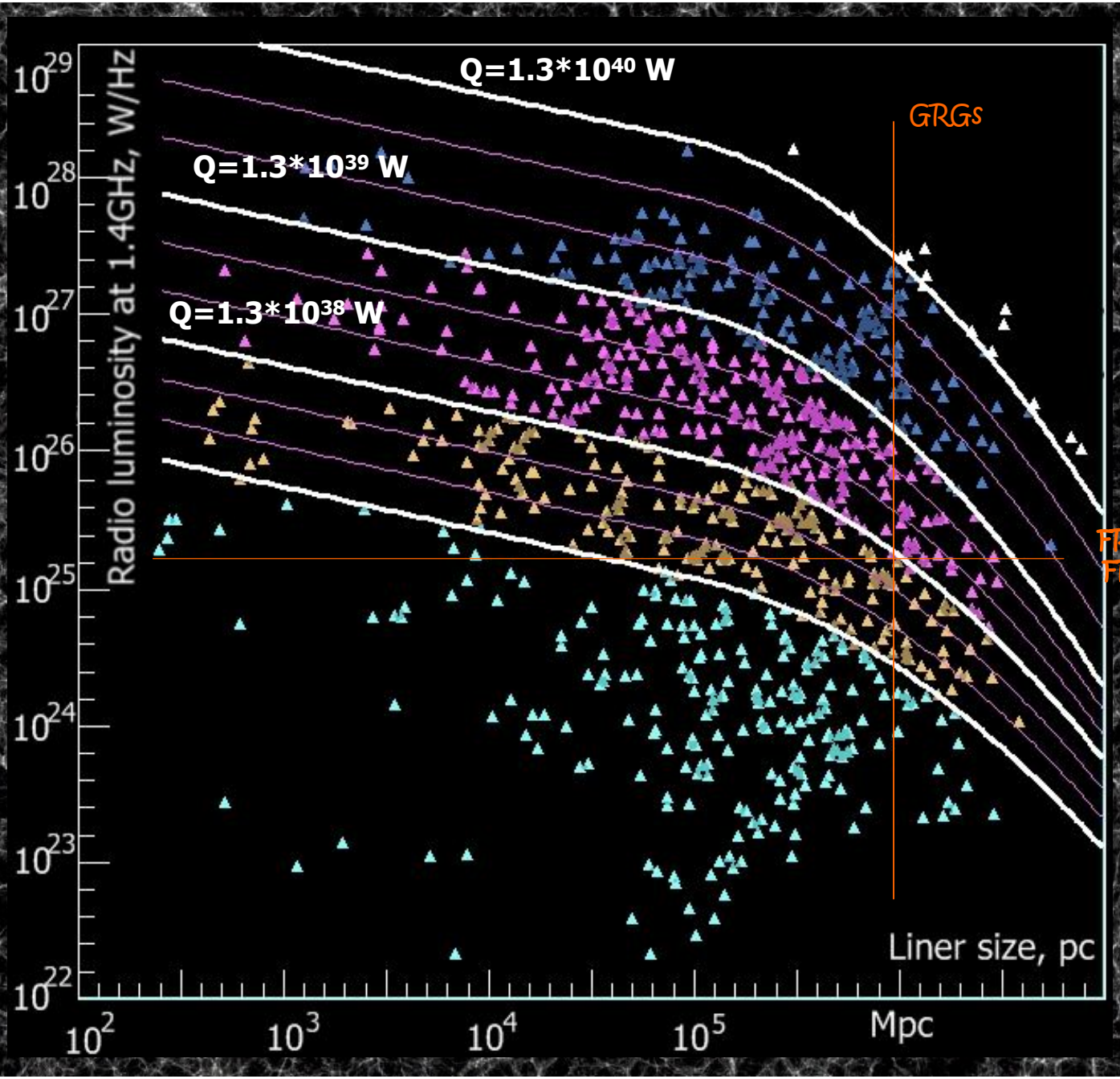
GRGs are last stage of galaxy evolution

Radio sources samples

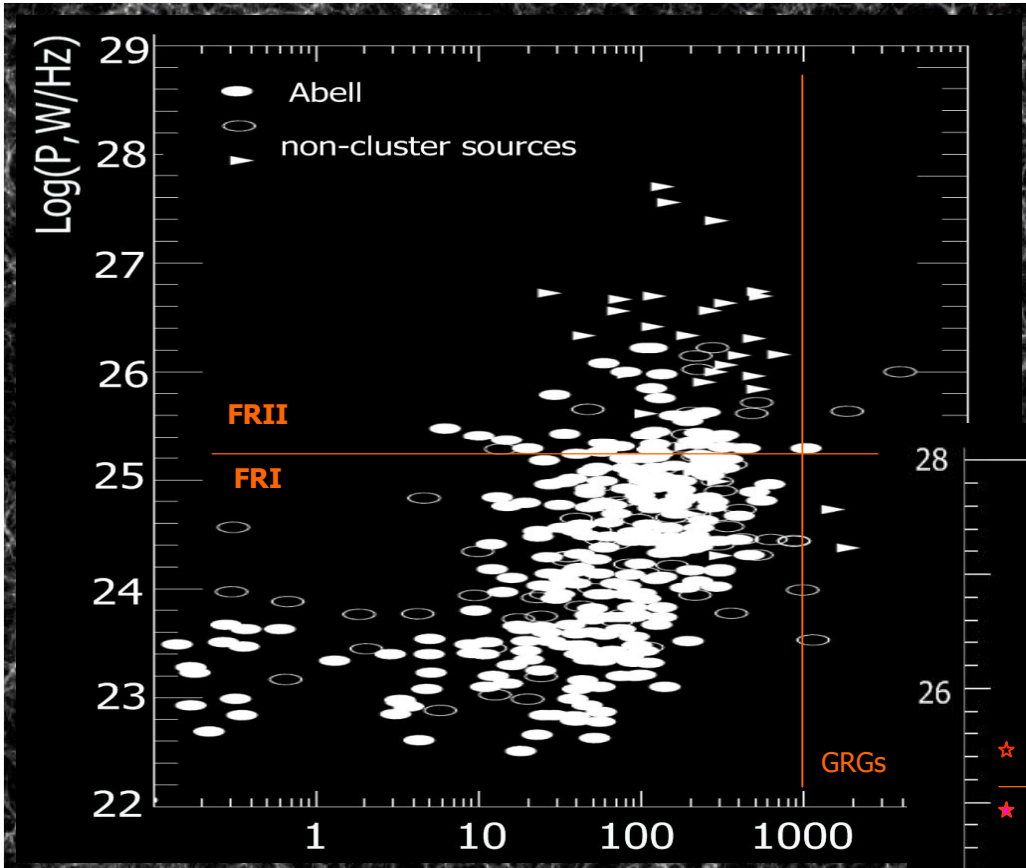


Survey	Limit$^{1.4}$ (mJy)	Nsources
CENSORS	7.2	147
Hercules+Lynx	2.0	81
Config-1	1300	273
Config-2	800	132
3CR	10000^{151}	171 (46)
Tex-Ox 1000	100^{151}	46
Wenss GRG	100^{325}	26
6CE	2<S^{151}<3.93	57
5c6 5c7	100^{151}	67
GPS	750	84

FRII evolution III Data



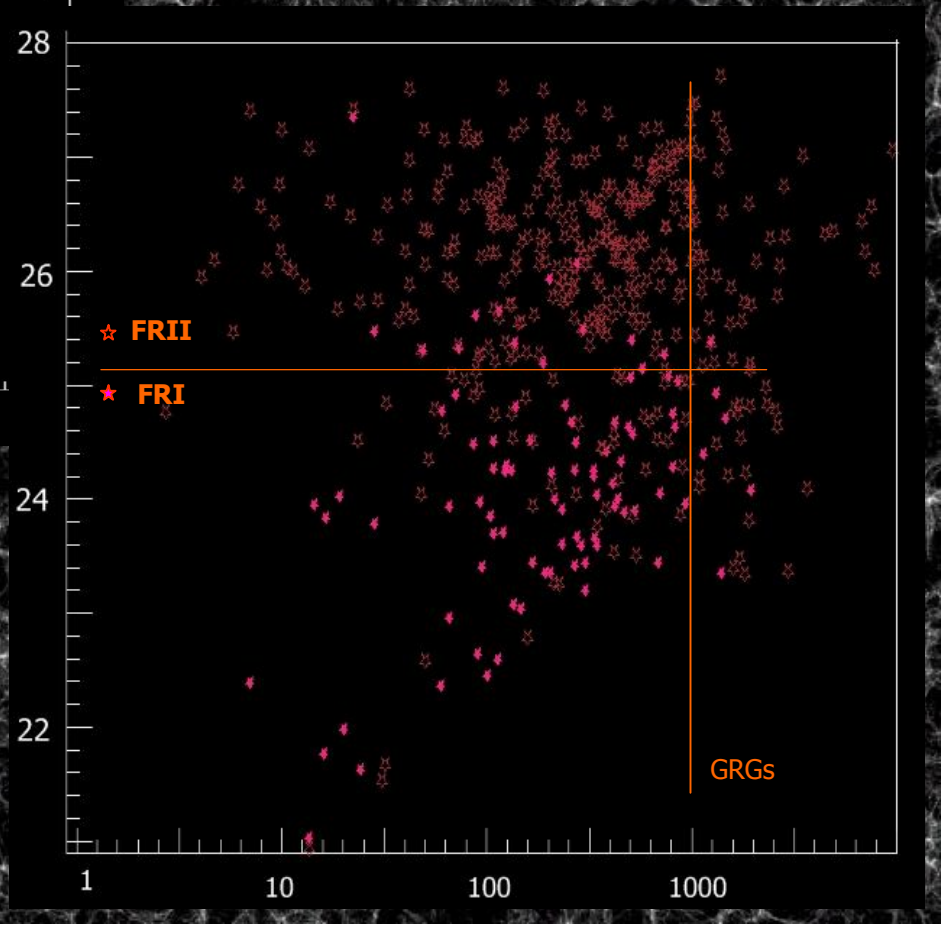
FRI – FRII transition + environment



FRII at low z are members of poor groups, but can be met in rich clusters (with low X-luminosity)

FRI are members of rich old clusters/groups mostly

This indicates that environment is not only reason for growing radio galaxy in to the giant



P-D tracks

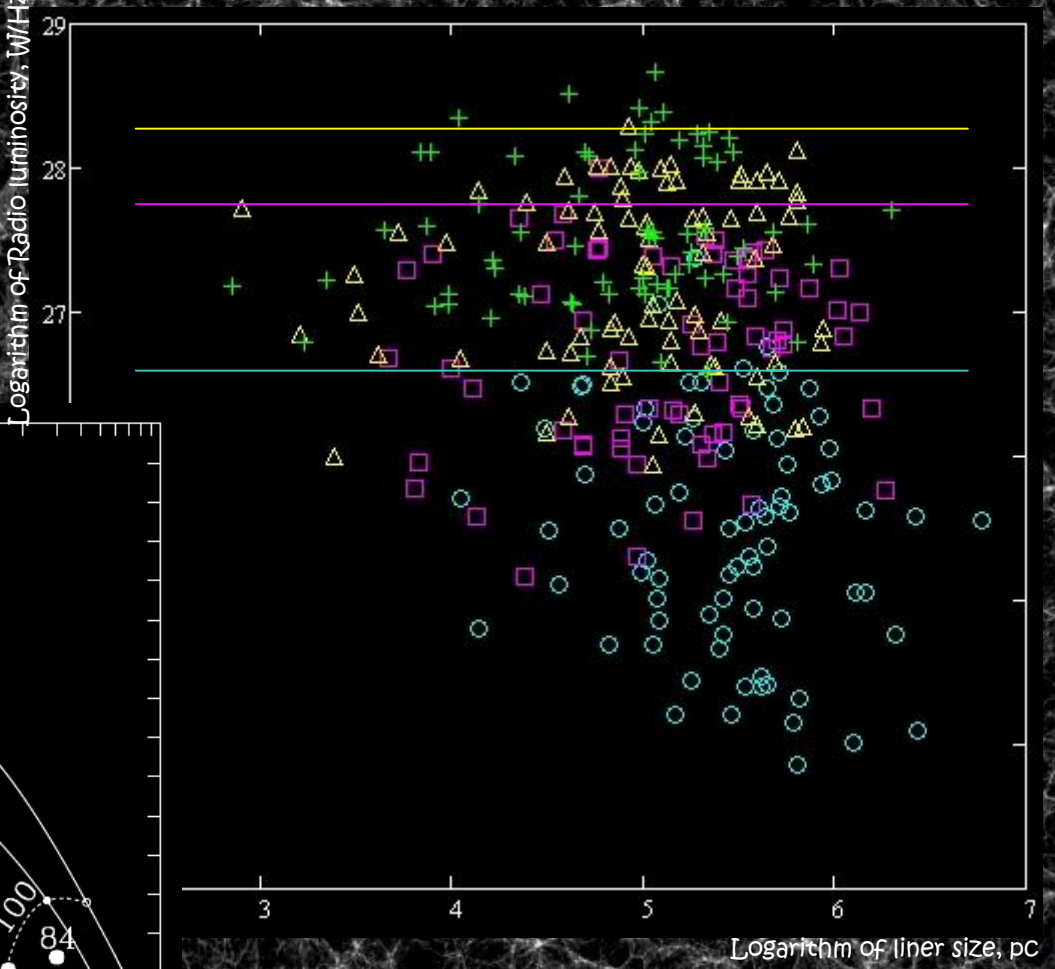
More distant sources selected by the surveys are more radio luminous, and correspond to the high-Q population

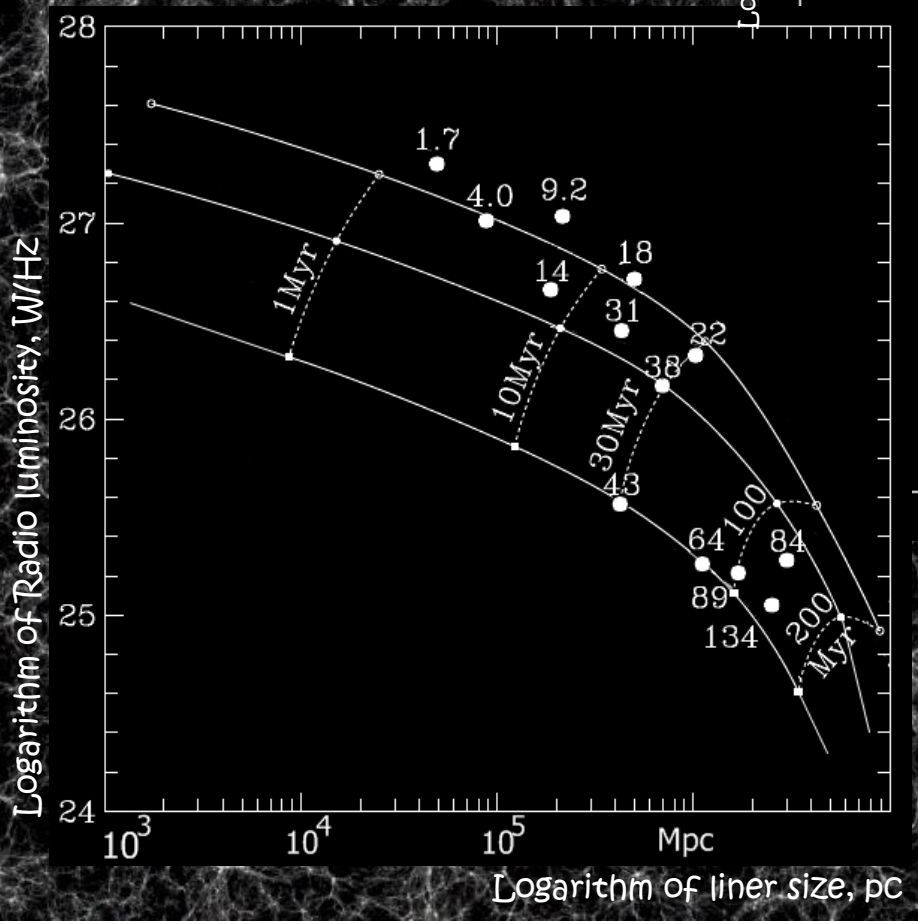
$0 \le z \le 0.3$

$0.3 \le z \le 0.73$

$0.6 \le z \le 1.35$

$1.35 \le z \le 4$





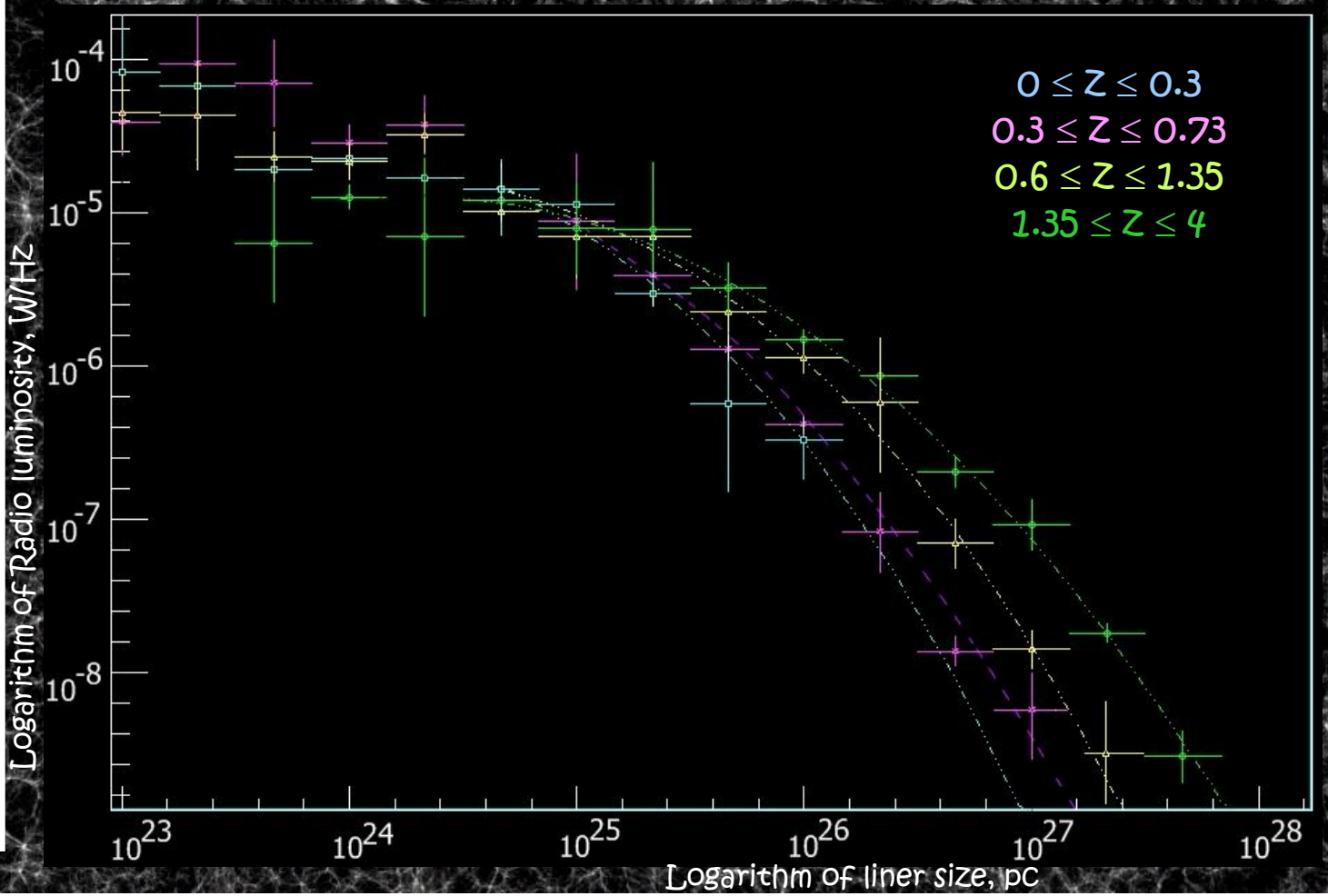
"Giant Radio Sources in View of the Dynamical Evolution of FRII-Type Population. II. The Evolutionary Tracks on the *P–D* and $u_c - E_{tot}$ Planes", J.Machalski, K.T.Chyzy and M.Jamrozy, *ACTA ASTRONOMICA* Vol. 54 (2004) pp. 391–403

Radio luminosity function

The RLFs defines using the 1/Vmax technique, in which, for each P–z bin, the space density of sources is given by

$$\rho_m(L,0) = \sum_{i=1}^{N} \left(\frac{1}{V_m}\right)_i$$

$$\sigma_m = \left[\sum^{N} \left(\frac{1}{V_m}\right)_i^2\right]^{1/2}$$

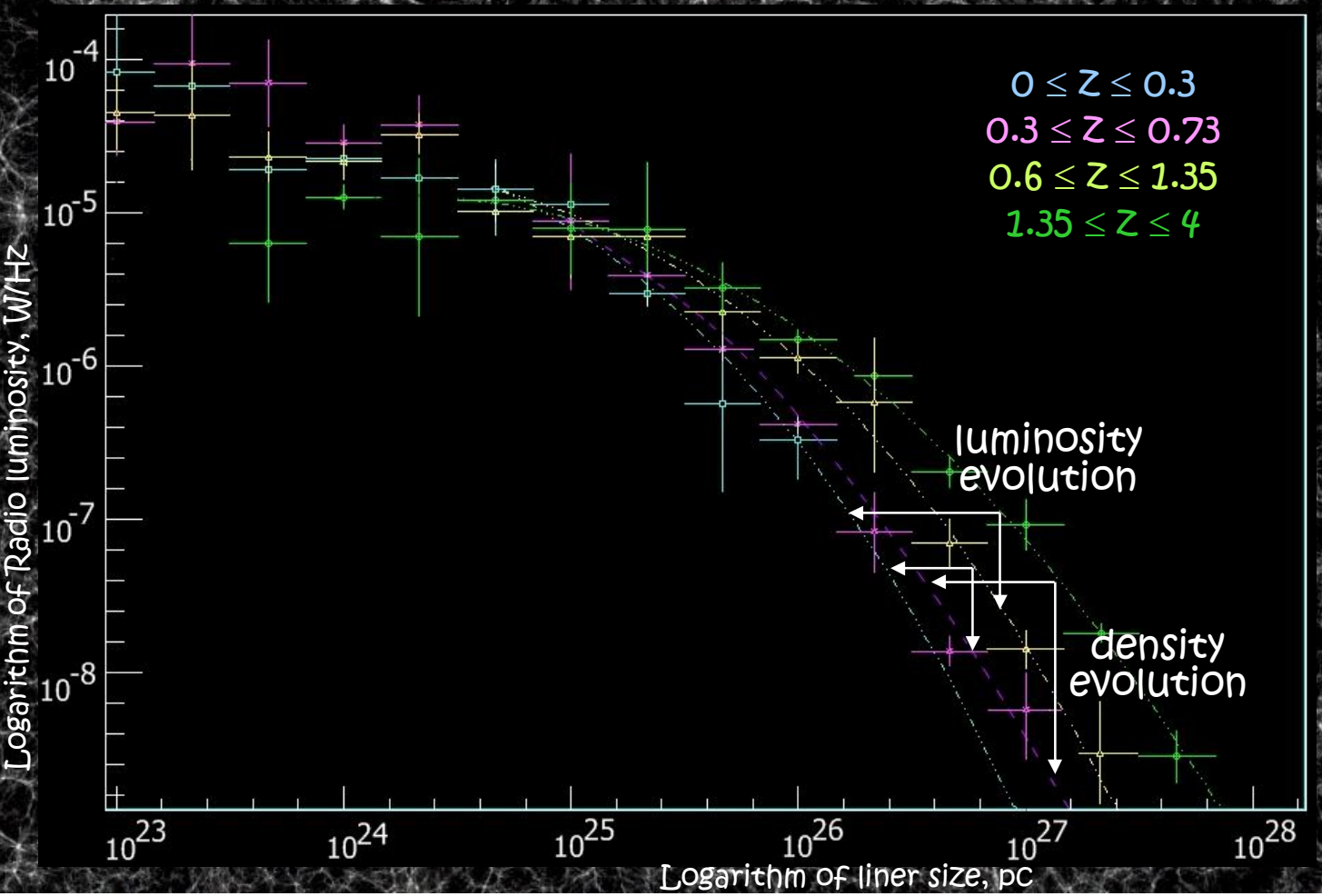


Radio luminosity function

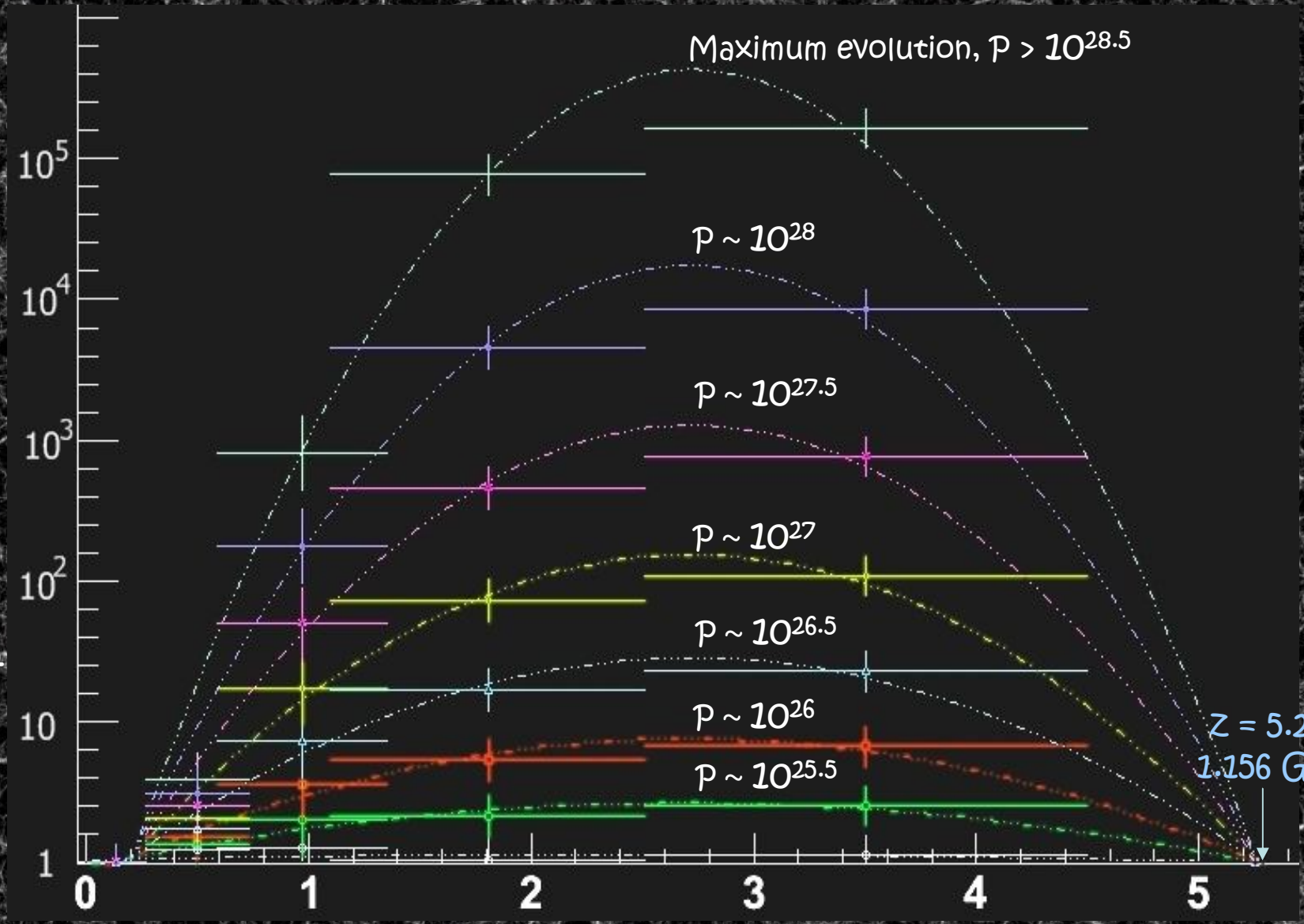
The RLFs defines using the 1/Vmax technique, in which, for each P–z bin, the space density of sources is given by

$$\rho_m(L,0) = \sum_{i=1}^{N} \left(\frac{1}{V_m}\right)_i$$

$$\sigma_m = \left[\sum^{N} \left(\frac{1}{V_m}\right)_i^2\right]^{1/2}$$

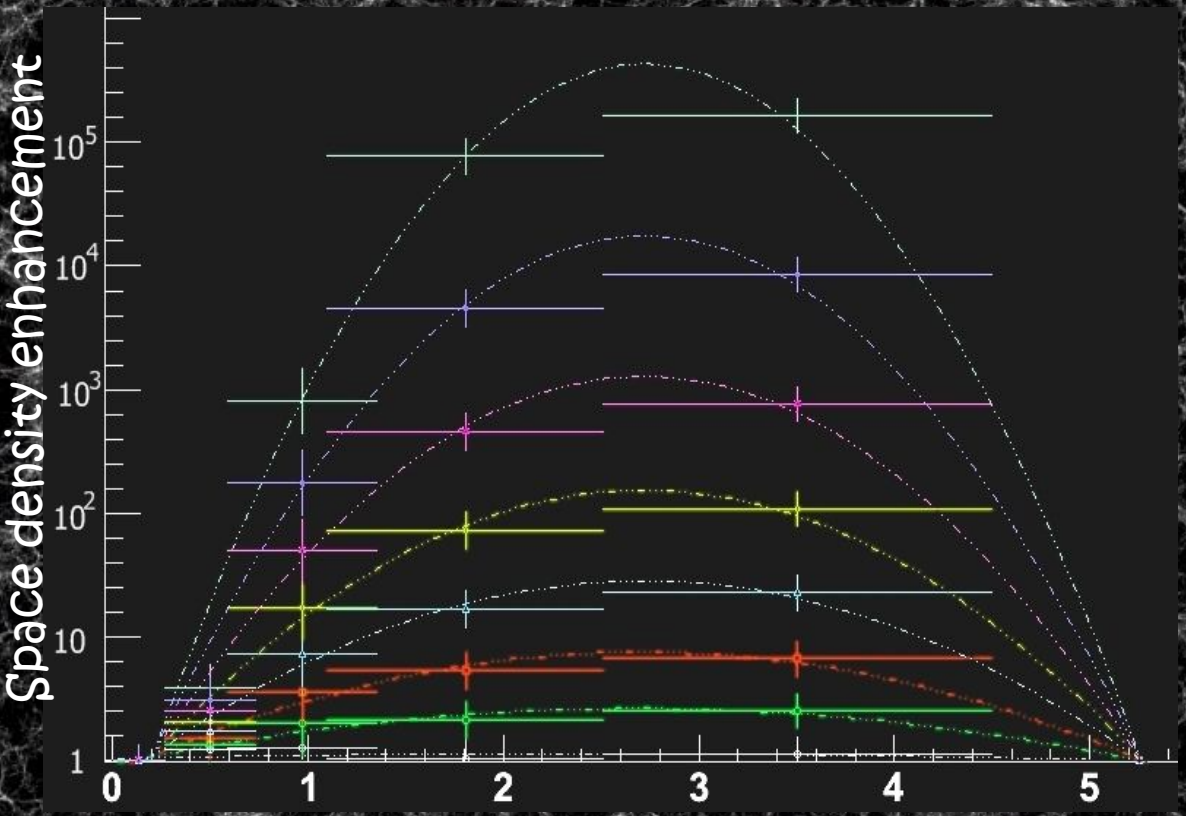


Space density enhancement



Space density enhancement = ratio of the radio luminosity function at const P and local radio luminosity function

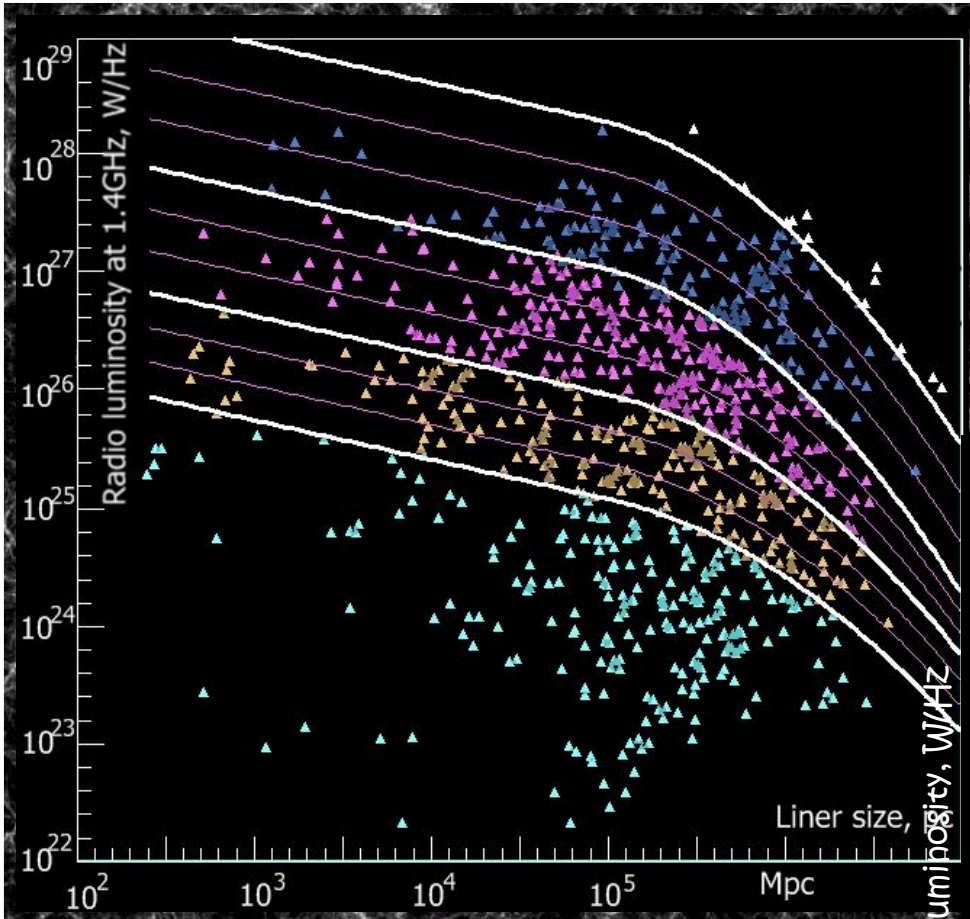
Space density enhancement



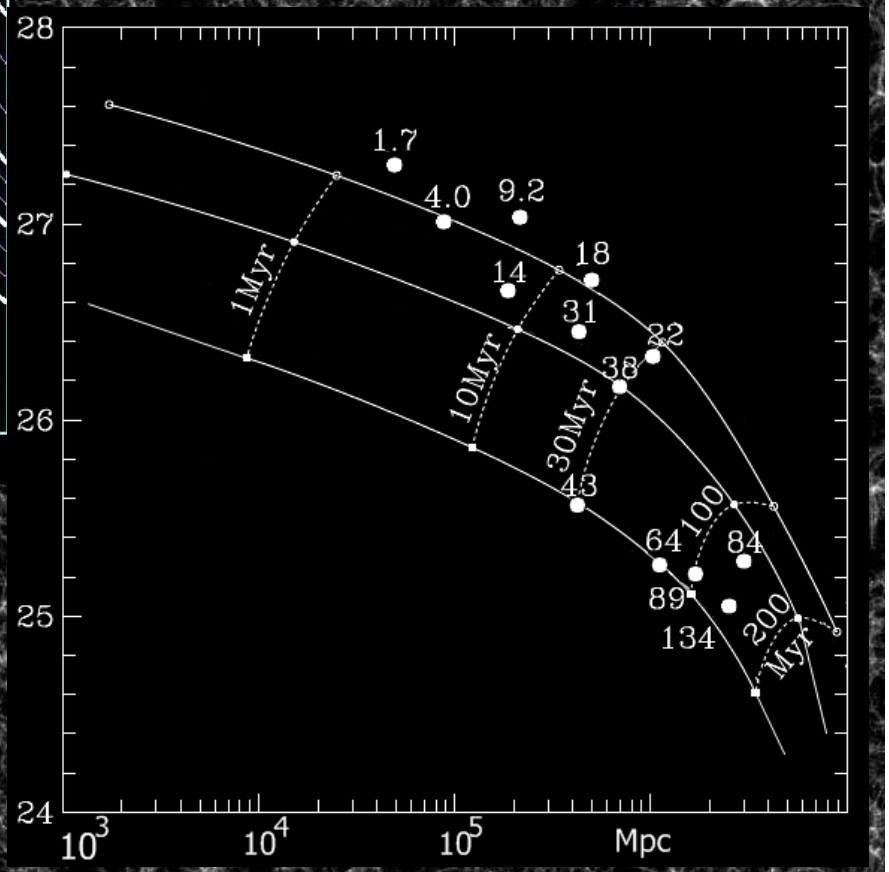
Why such behavior?

- The life time of source in early ages (compact phase) much lesser of its evolutionary phase
- Once the lobes extend beyond the core region, the radio luminosity of the source always decrease
- Simple calculations of the time of source expanding indicate its average life time ~ 10^8 years

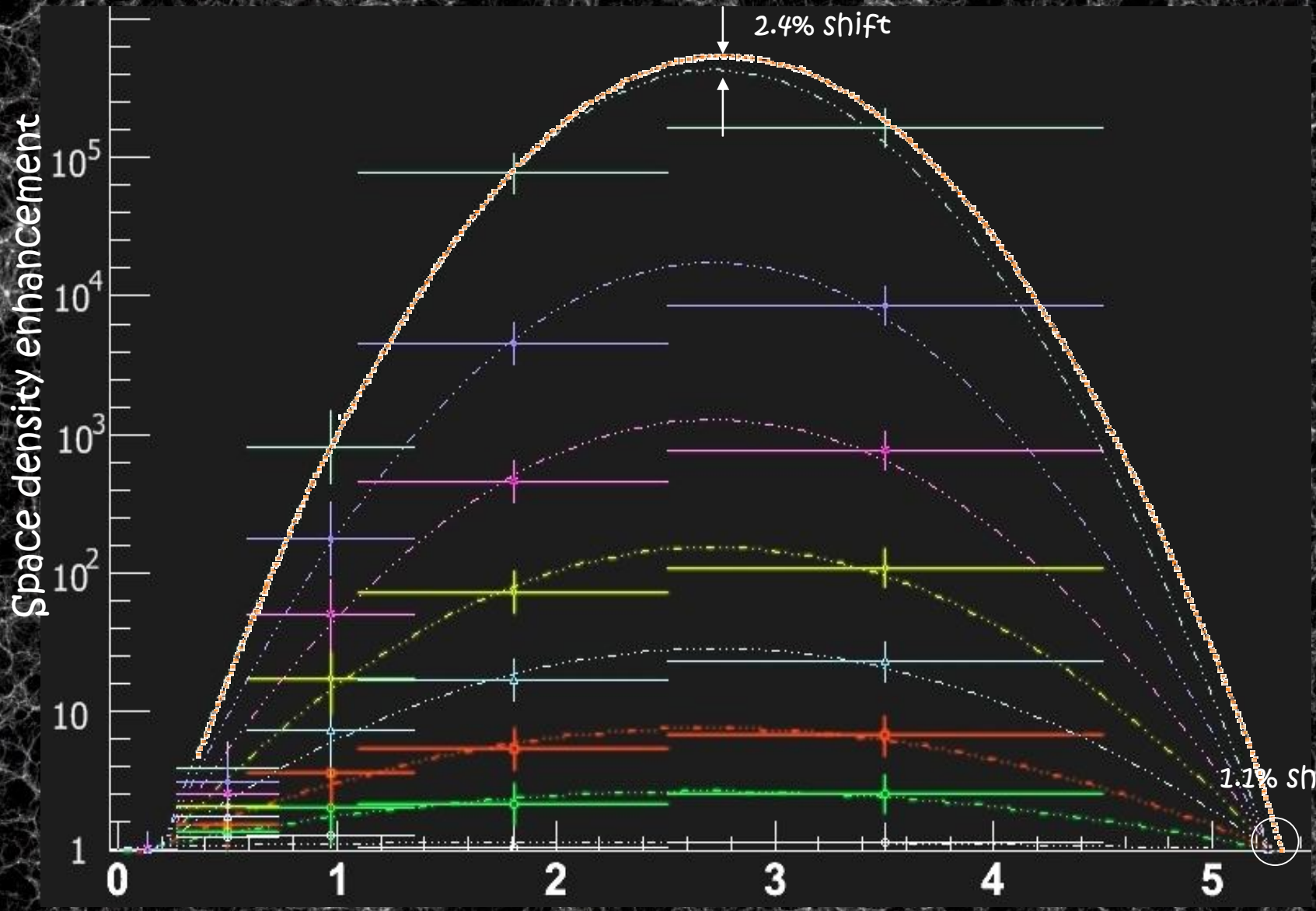
Back in time & space for fifty Million years

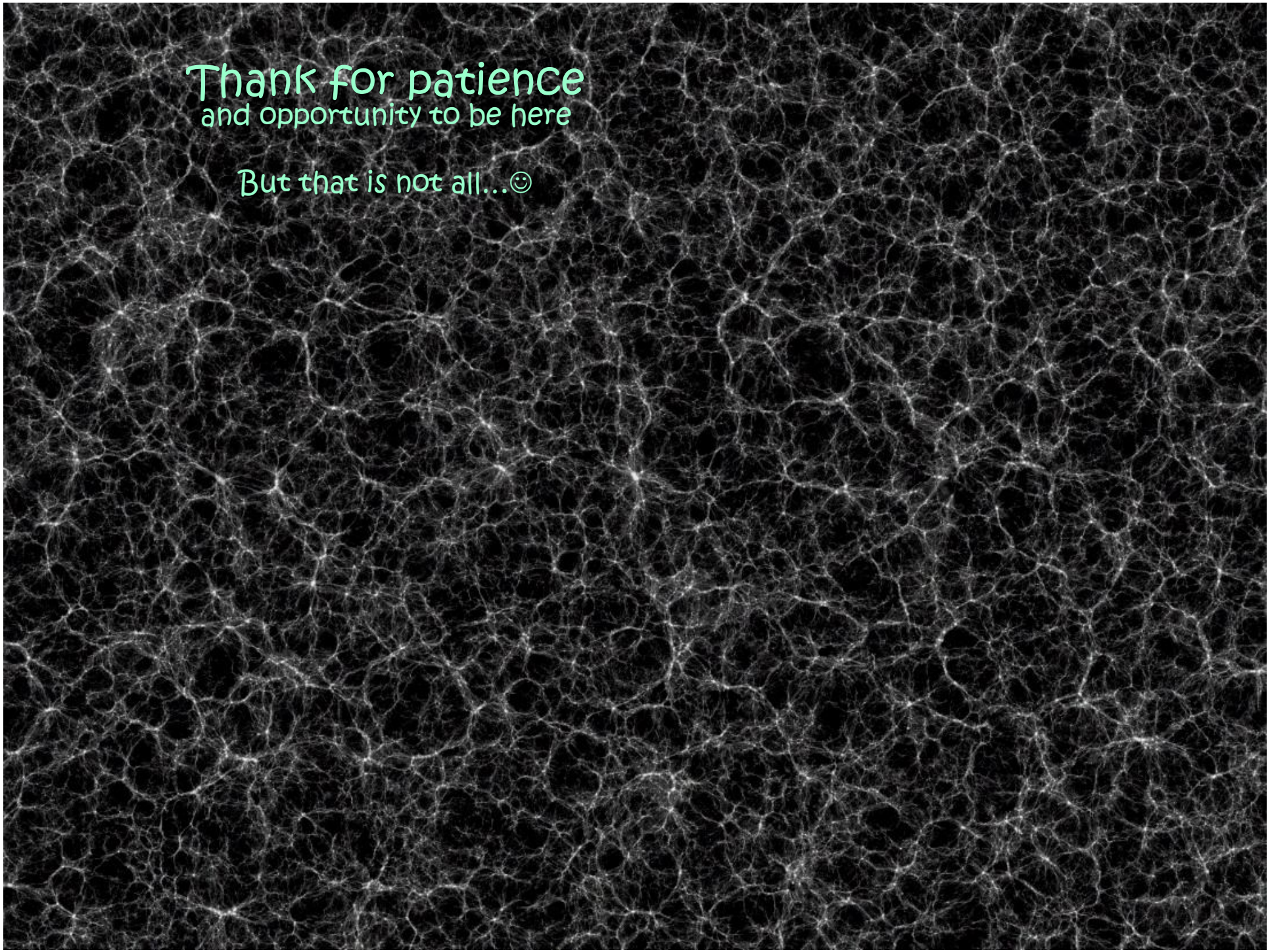


Back in past for 50 Myr



Tiny advance

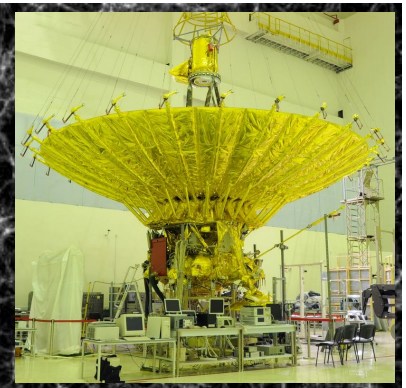


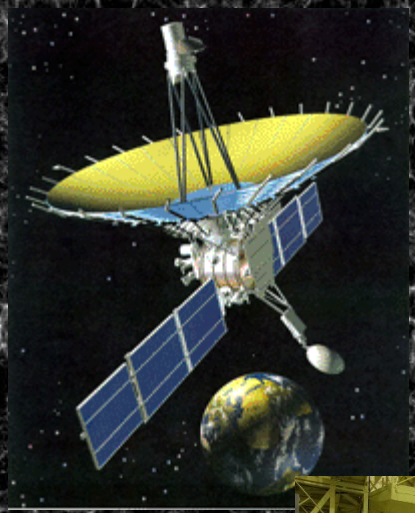

Thank for patience
and opportunity to be here
But that is not all...☺

RadioAstron
Space VLBI Mission

Band (GHz)	0.327	1.665	4.830	18-25
Band width (MHz)	4	32	32	32
Fringe size (mcas)	540	106	37	7.1-10
Min.cor.flux (mJy)	10	1.3	1.4	3.2

0.00001" angular resolution



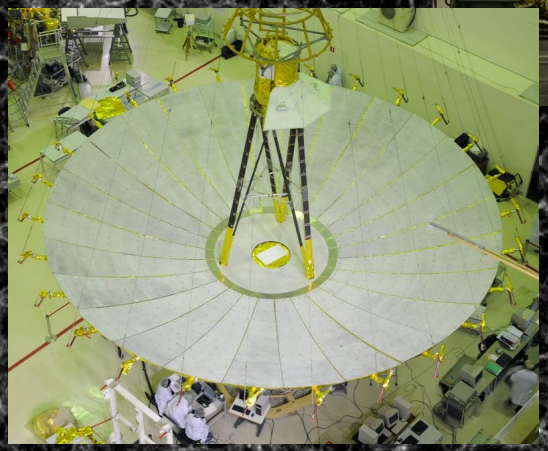


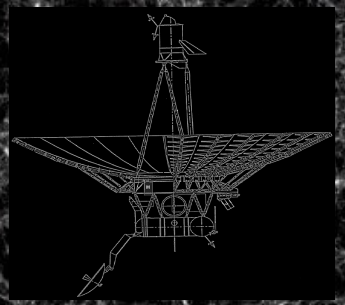
Key science objectives:

Active galactic nuclei (super massive black holes, event horizon, particle acceleration, brightness temperature limits, Faraday rotation, magnetic field, cosmic rays, super luminal motion, new physics)

- Cosmology, red shift dependencies, dark matter, dark energy
- Regions of star and planet formation (masers and Megamasers)
- Black holes of stellar masses and neutron stars
- Interstellar and interplanetary medium
- Fundamental astrometry and high accuracy coordinate system
- High precision measurements of the Earth gravity field

The spacecraft will be controlled from two sites in Russia, Bear Lakes and Ussuriisk. The tracking station in Pushchino is tested successfully and ready for operations. The following radio telescopes are planned to participate in the first interferometric observations - fringe search - after successful engineering in-orbit-checkout phase: Arecibo, Badary, Effelsberg, GBT, Medicina, Noto, Svetloe, Zelenchukskaya.





http://www.asc.rssi.ru/radioastron/