Mapping the Cosmic Evolution of Fermi Blazars

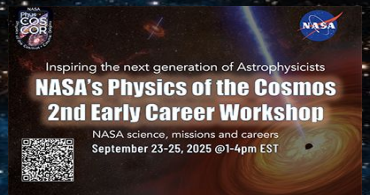
Garima Rajguru, Clemson University

Lea Marcotulli, Desy

Marco Ajello, Clemson University

Meg Urry, Yale University

CLEMSON UNIVERSITY



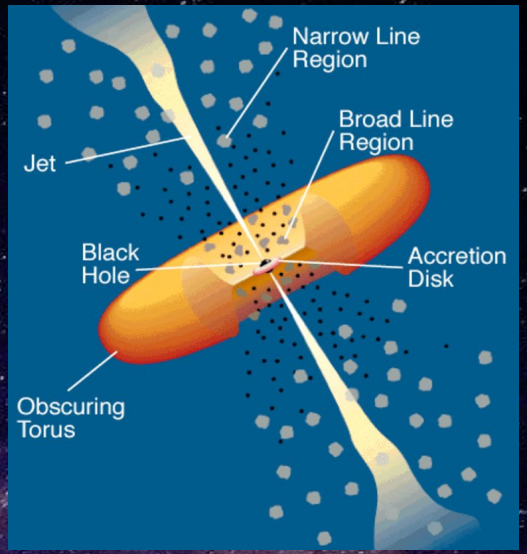
Counting Experiment

What are we counting?

- **Blazars -** Jet points along our line of sight.
- Two types- FSRQs and BL Lacs.

How does counting give us information about evolution?

- Counting the number of objects per unit comoving volume and luminosity interval gives us the Luminosity Function (LF).



Urry and Padovani 1995

Luminosity Function of Blazars

Luminosity Function encodes evolution - Blazar LF is not well constrained

Blazars are good cosmological probes - High luminosities and large redshifts

Open Question - Do FSRQs and BL Lacs have the same evolution?

Application - Contribution of blazar emission to the extragalactic γ-ray background (EGB)

Cavaliere & D'Elia 2002.
Ajello et al. 2014. Ajello et al. 2015.

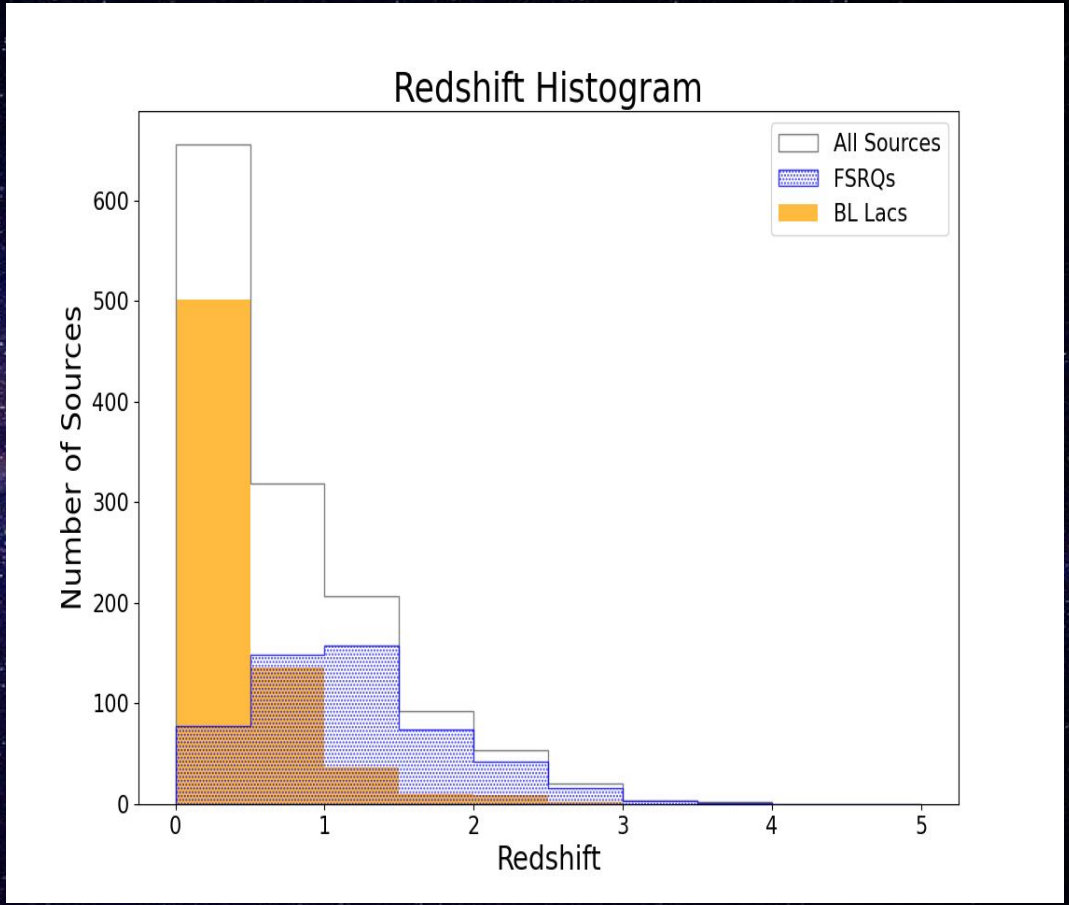
Dataset

2680 Sources from Fermi LAT 8-year Source List (Marcotulli 2020).

Larger than previous samples (Ajello+14/15 ~400). Would lead to remarkable improvement in LF determination.

100 MeV-1 TeV range. Extragalactic sources.

Classification	Number of sources
FSRQ	519
BL Lacs	1035
BCU	561



Marcotulli, L., Di Mauro, M. and Ajello, M., 2020.

Evolution

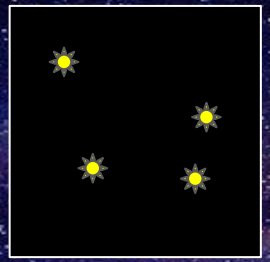
LF Models

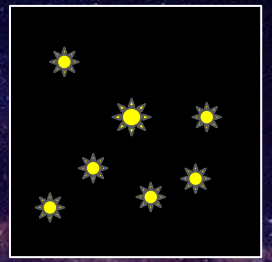
Local Universe

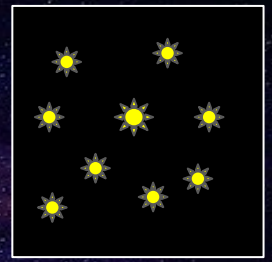
Intermediate time

A long time ago in galaxies far far away…

Pure Density Evolution (PDE)





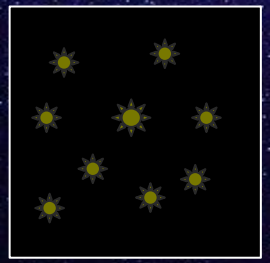


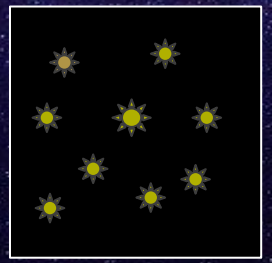
z=0

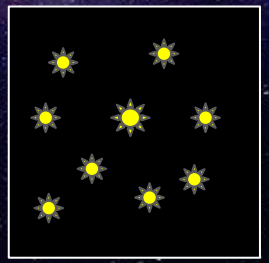
z=1

z=2

Pure Luminosity Evolution (PLE)

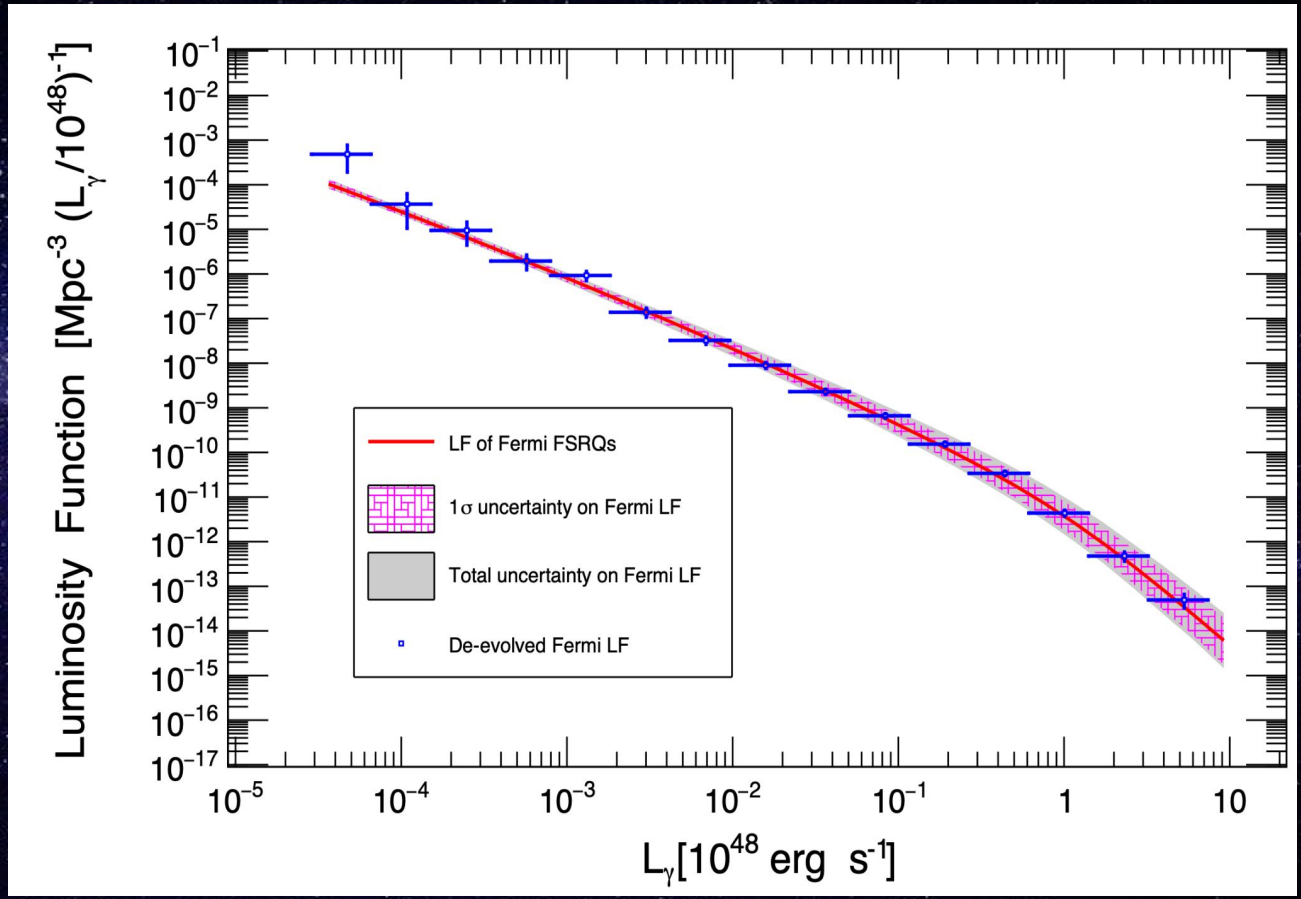






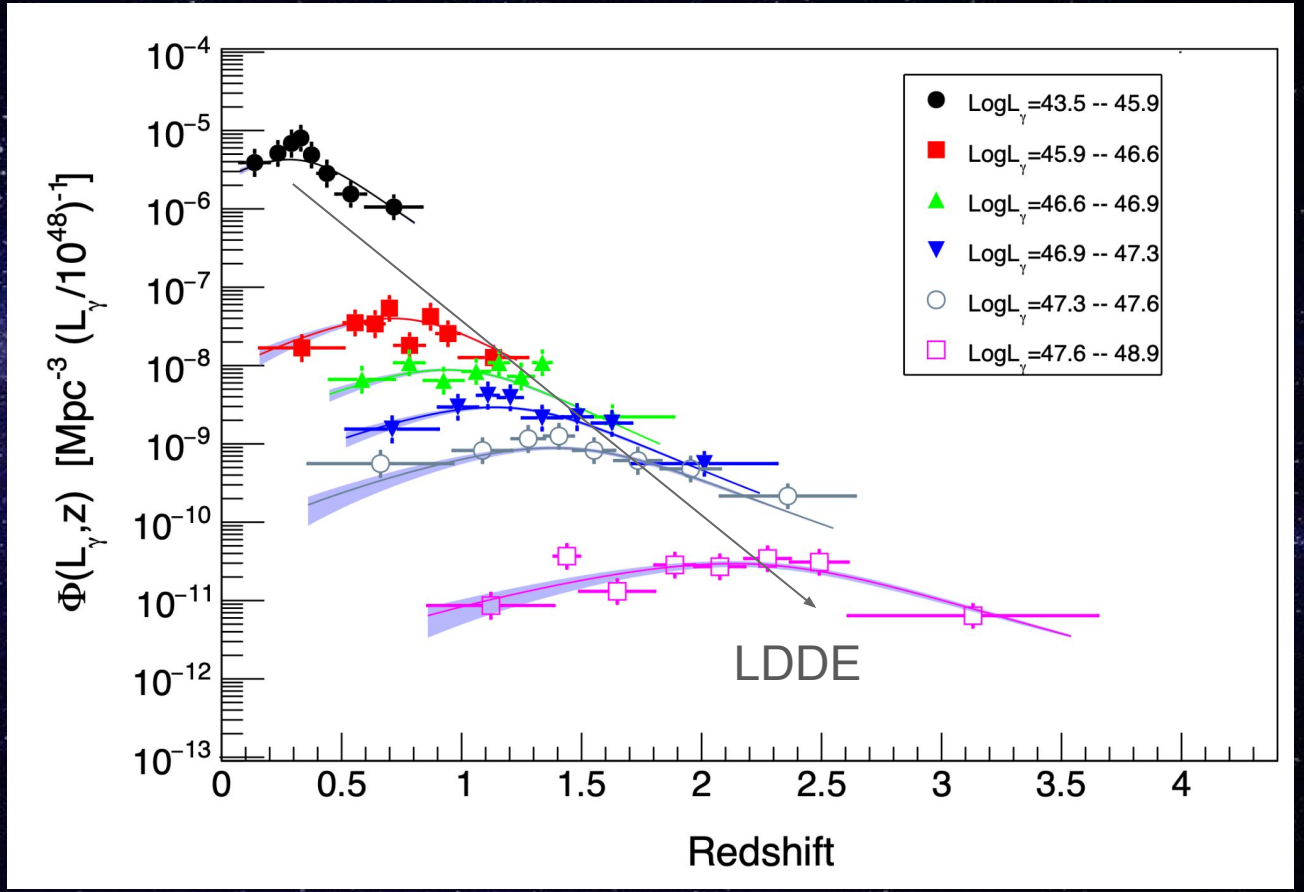
Luminosity Function at z=0

- Best-fit LF has double PL shape.
- Spans 2 orders of magnitude lower in luminosity than previous studies.



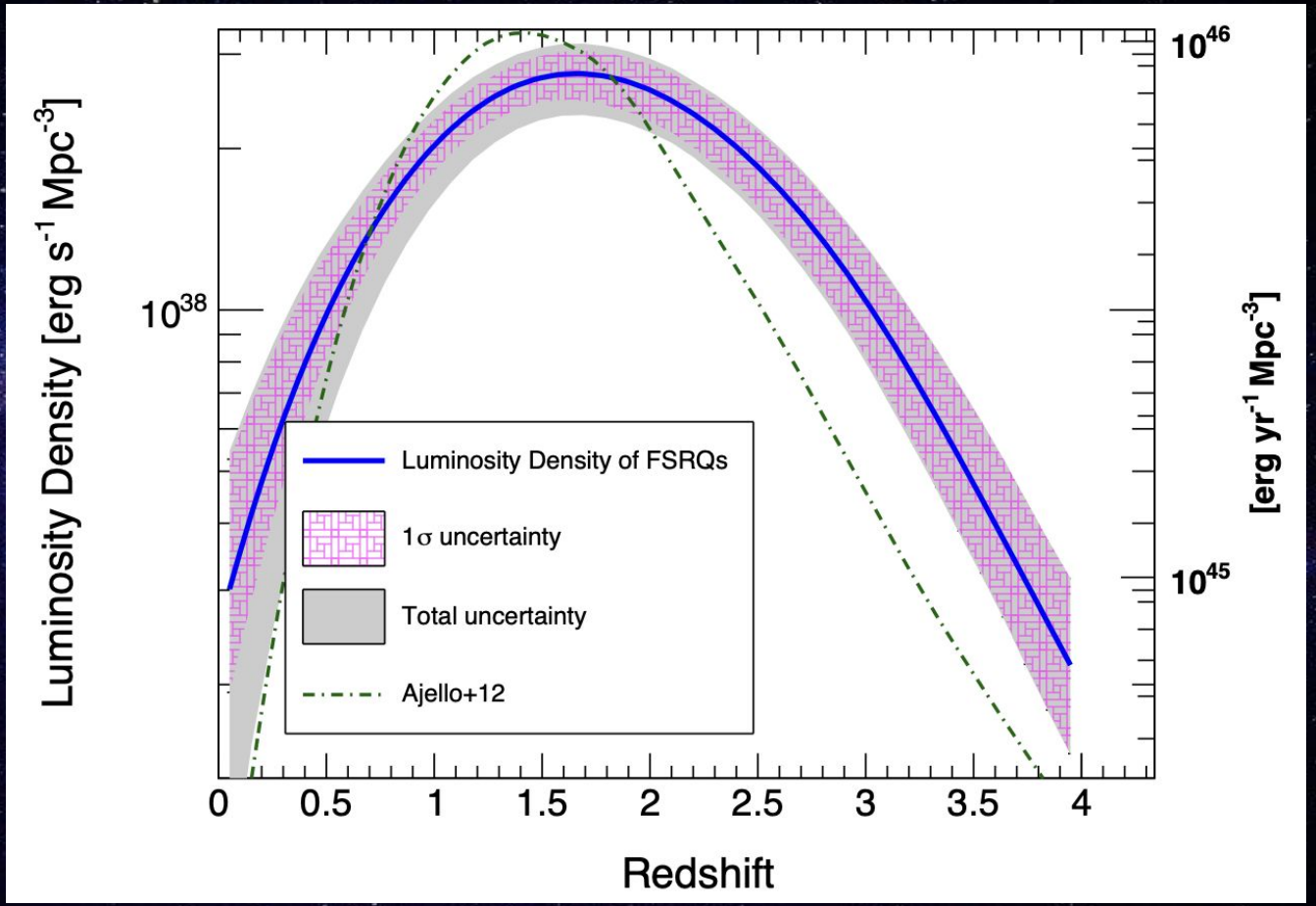
Evolution of Luminosity Function

- Luminosity Dependent Density Evolution (LDDE).
- Positive evolution.



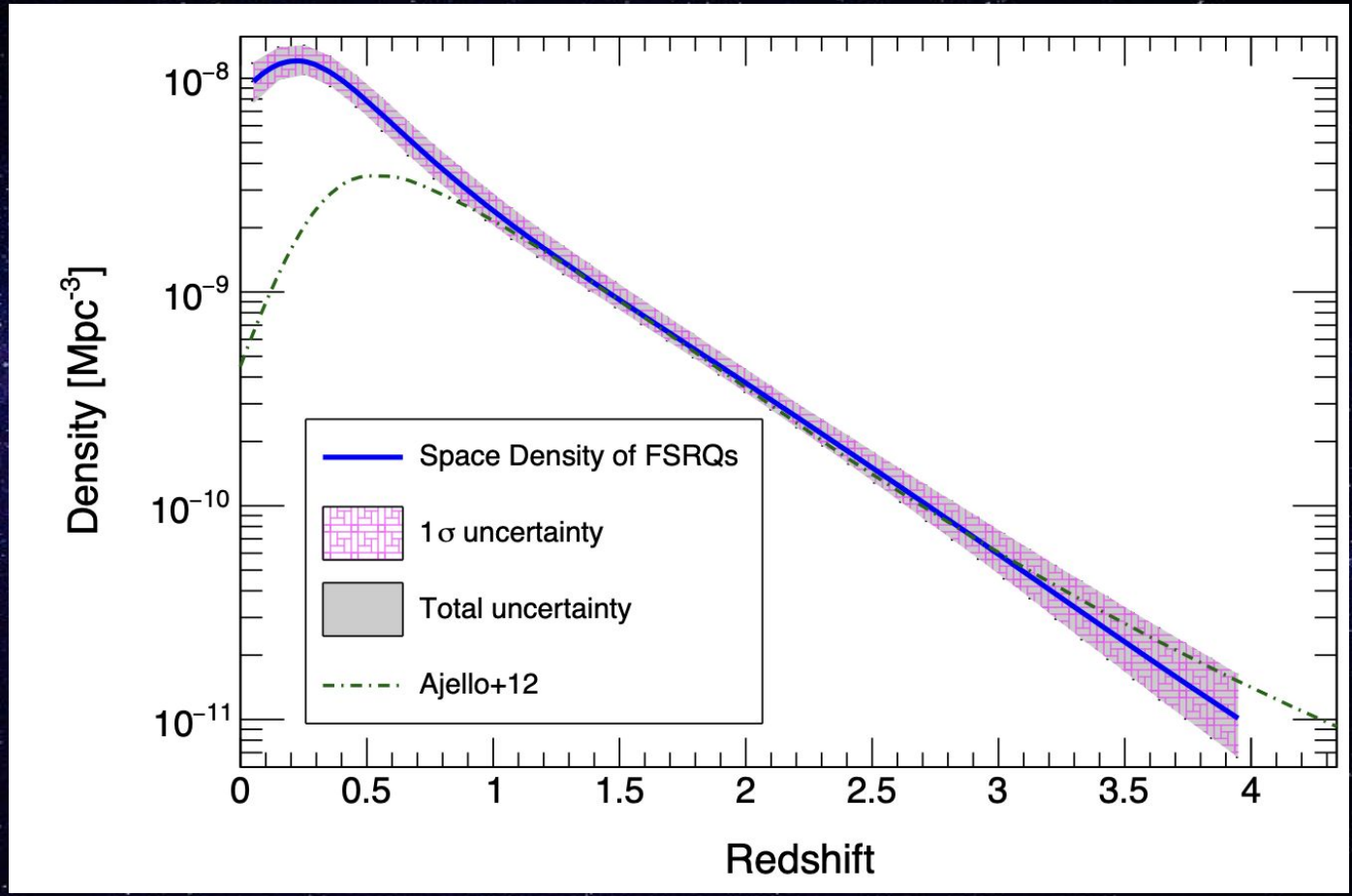
Luminosity Density of Blazars

Luminosity density peaks between redshift 1-2.



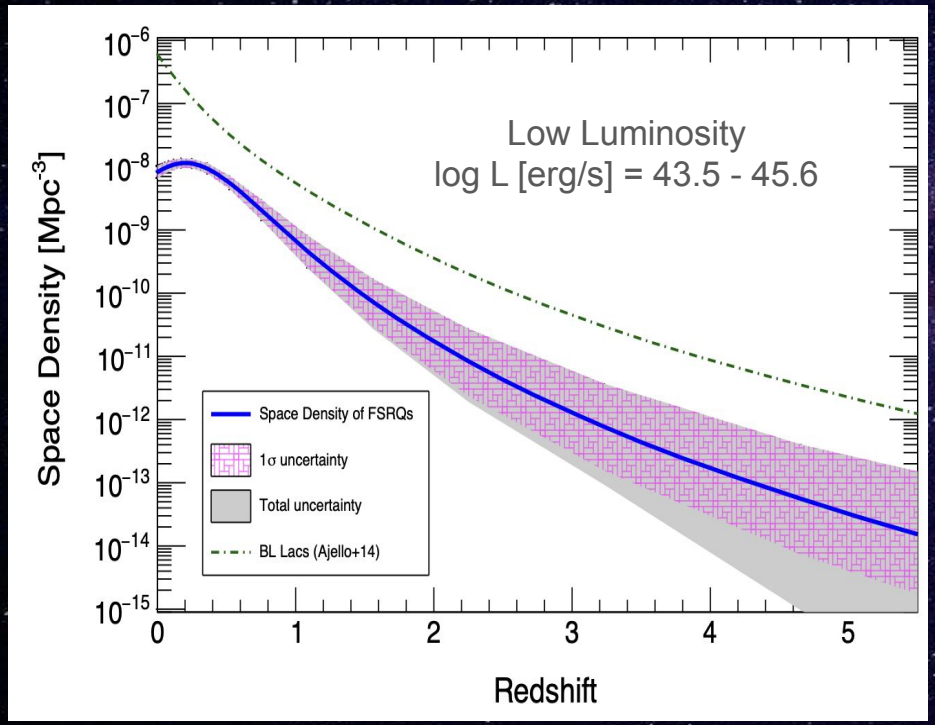
Density of Blazars

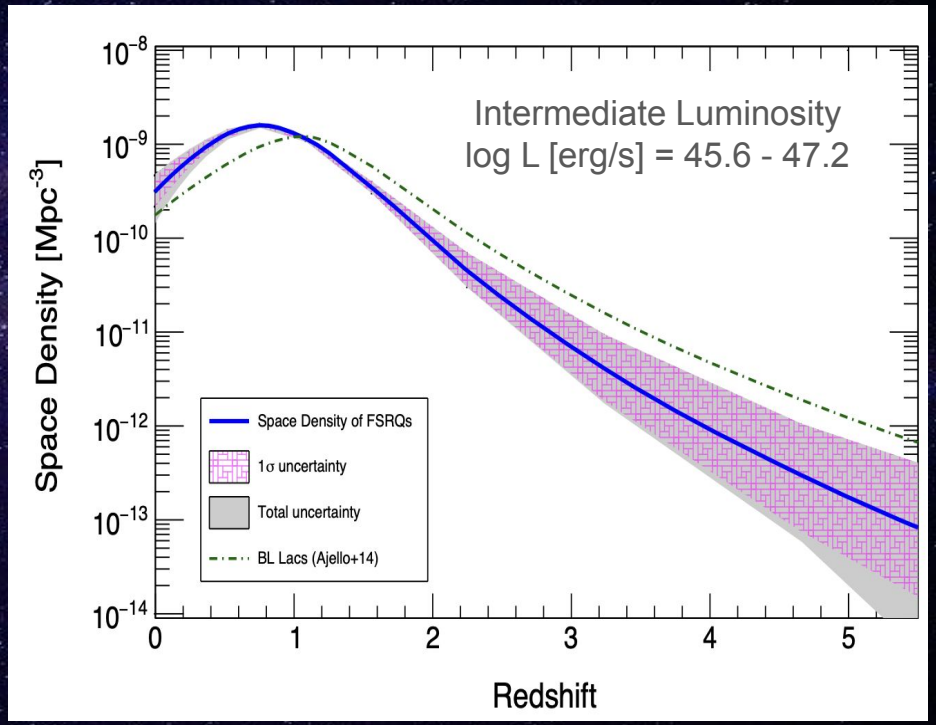
The density of FSRQs vs redshift.



Comparison with the Evolution of BL Lacs

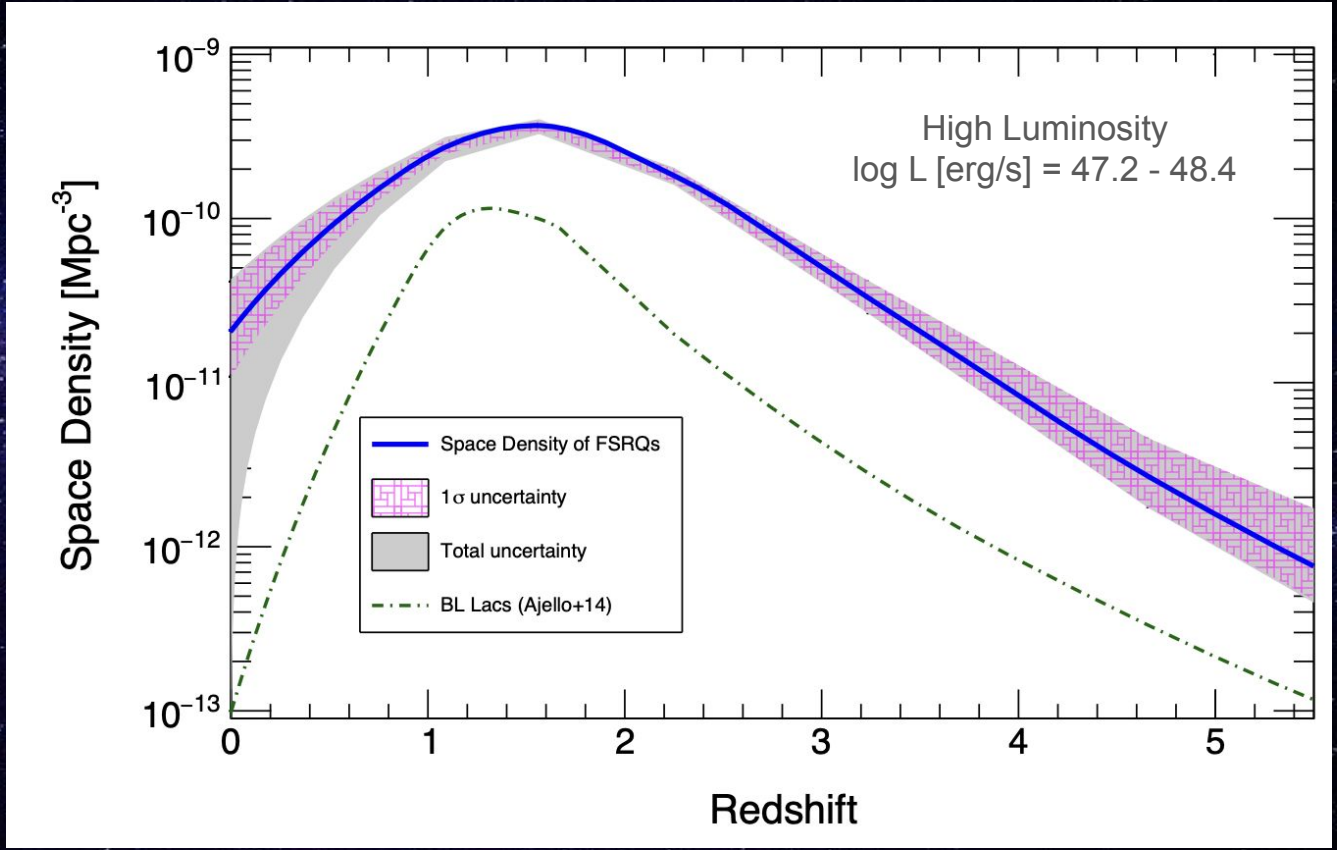
The surprising similarity between the evolution of FSRQs and BL Lacs.





Comparison with the Evolution of BL Lacs

Similarity in the shape of the evolution of both FSRQs and BL Lacs.



Conclusion

LF follows a double power-law shape.

LF extends to 2 orders of magnitude lower in luminosities than previous studies.

LF is best represented by LDDE.

Similarity between the LF of FSRQs and BL Lacs.

Future Work: analysis of BL Lacs.

Thank You :)