Seeking the Epoch of Maximum Luminosity for Dusty Quasars

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In collaboration with D. Weedman and L. Sargsyan
Under review at ApJ

Reminder: what is quasar?

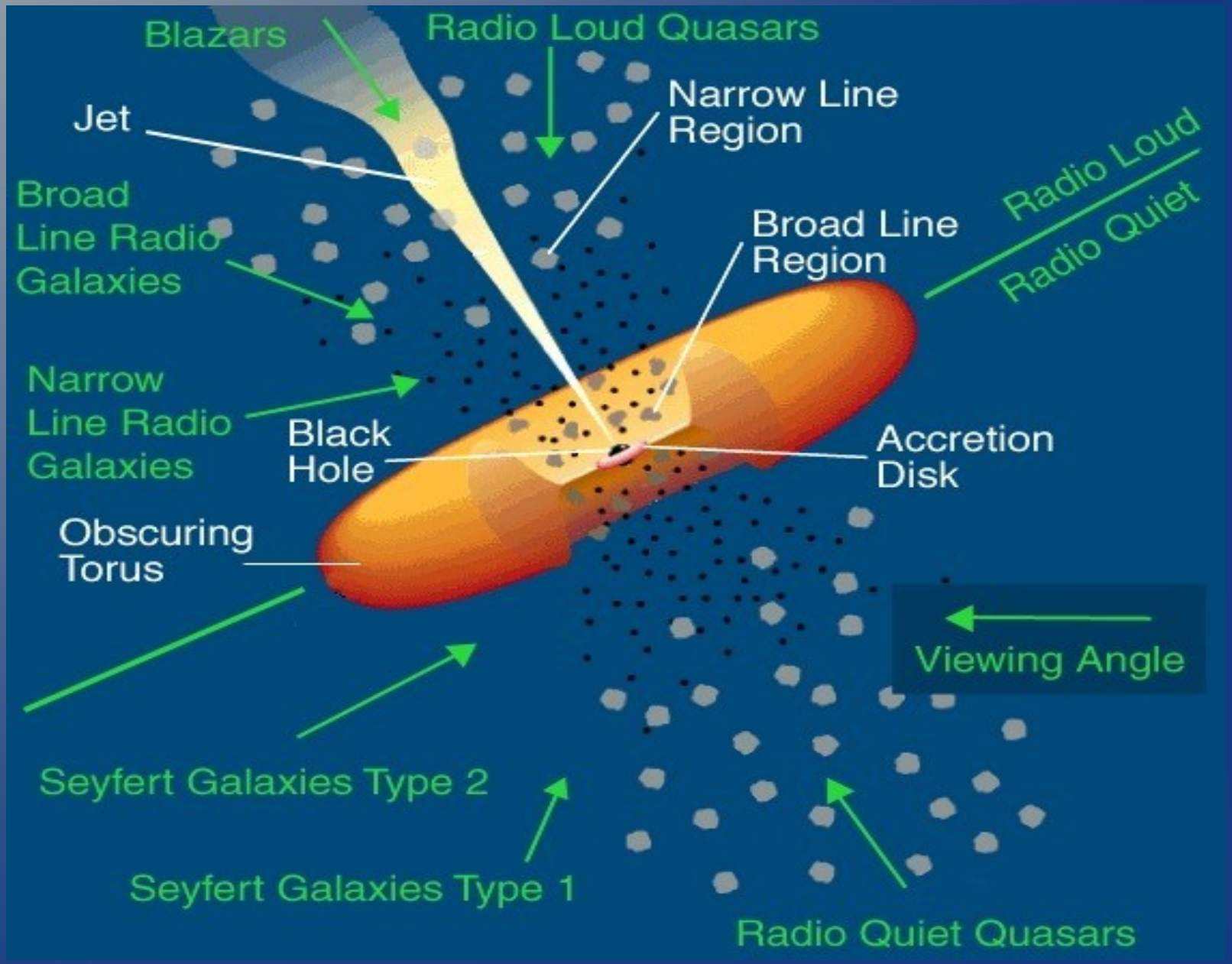
- Quasi Stellar Radio Source, discovered in 1950s
- Maarten Schmidt explained the spectrum in 1963

  => very distant objects
- From the high variability

  => very compact objects
- Supermassive black hole with accretion disc around.

  Yakov Zeldovich, Igor Novikov and Edwin Salpeter

Accepted Model of the Quasar



Our Fundamental Questions

- When and How did the First SMBHs of 10^9 Solar Masses Form?
- When and How did the Dust Form in the Universe?

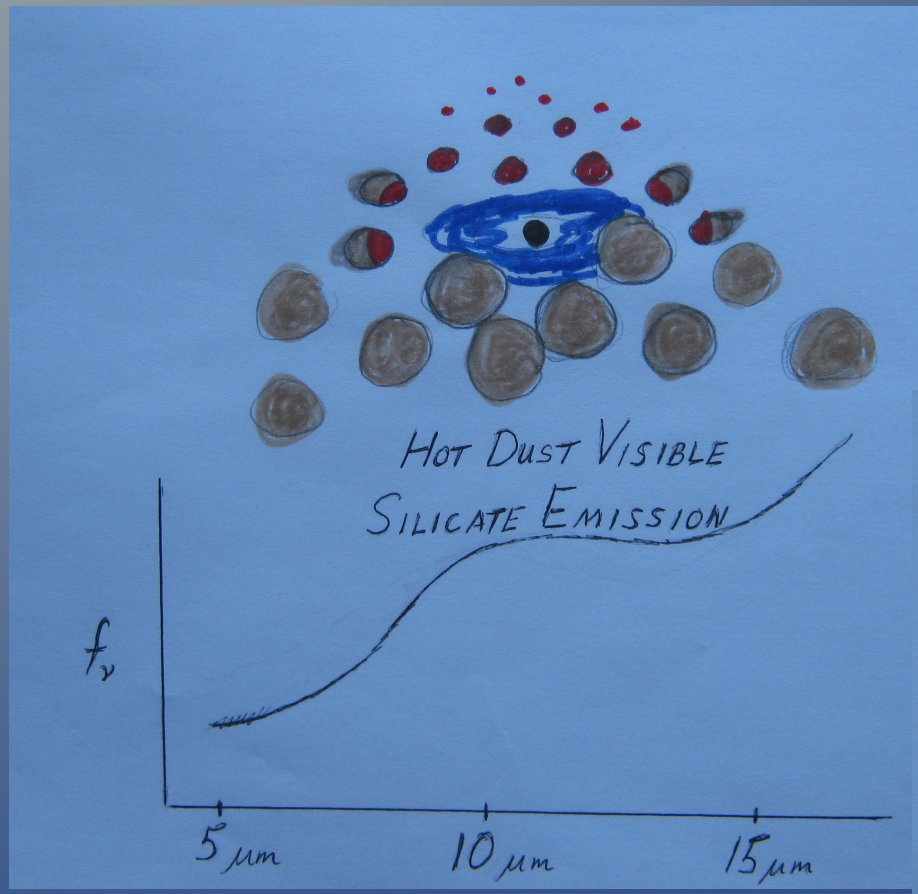
Currently Accepted Evolutionary Scenario

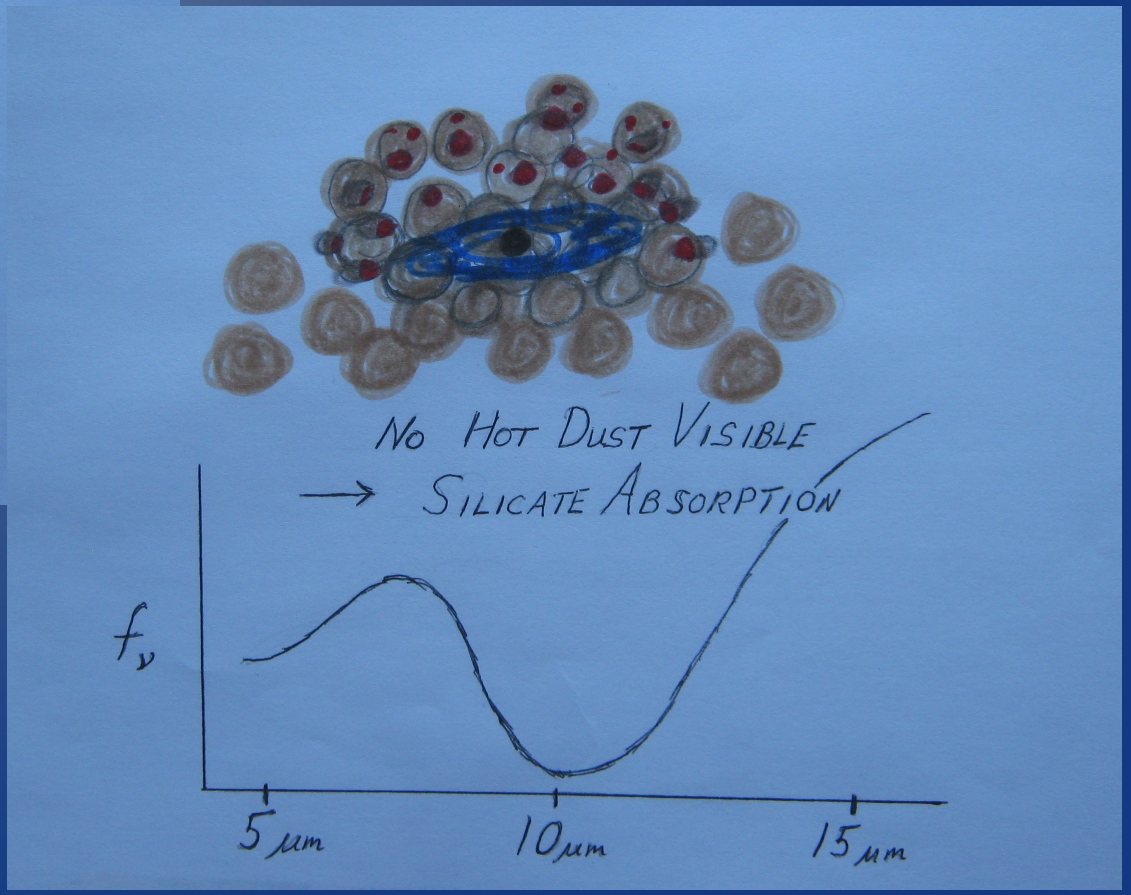
- Galaxies form
- Gather mass
- Merge (starburst triggering, bigger BH)
- Reach the activity peak at z of ~ 2-3 (based on UV luminosity)

- Will There be Such a Peak When Looking in IR?

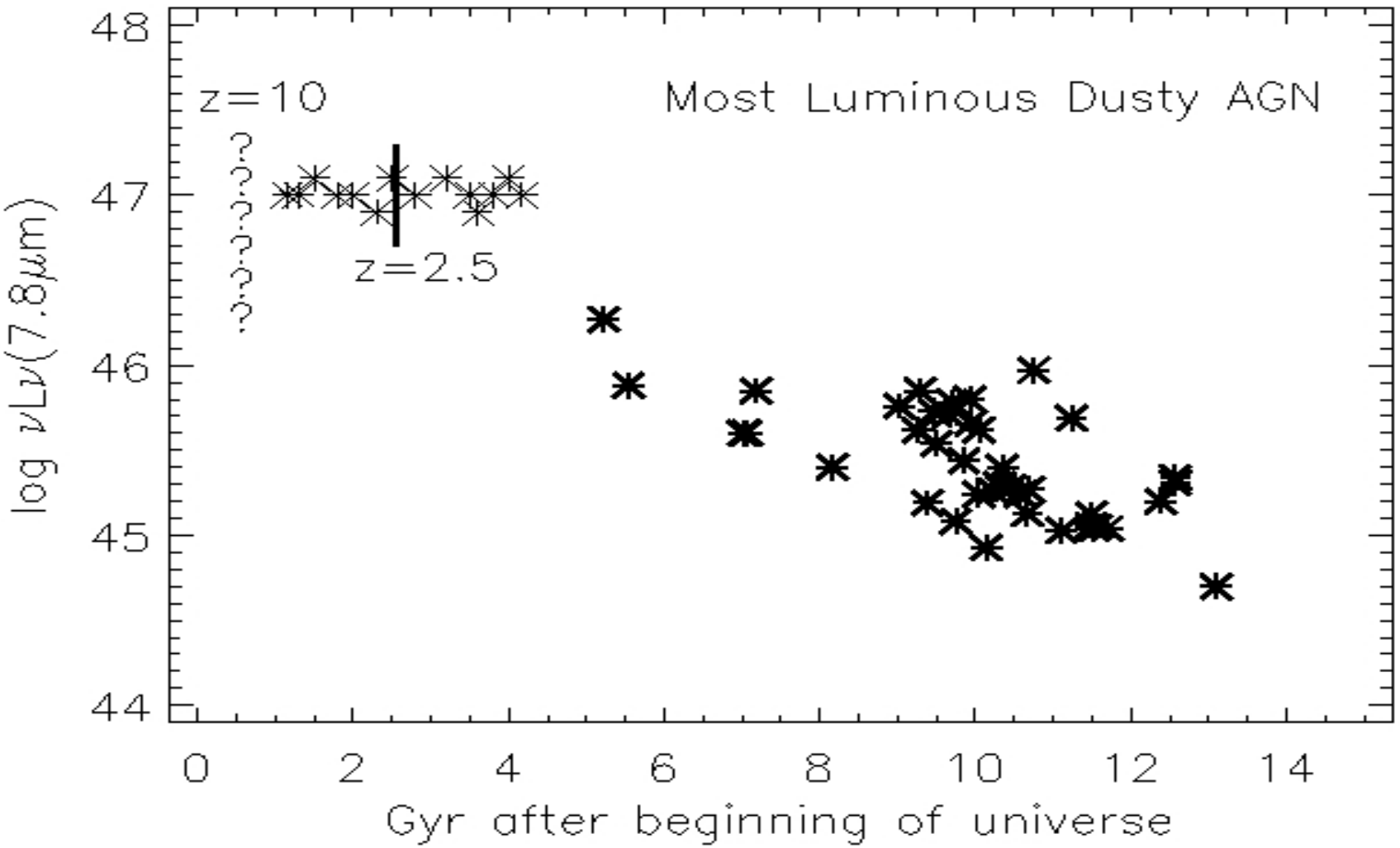
Galaxy Merging and Dust

Dust in Quasar





Dust Luminosities of Quasars and Ultraluminous Infrared AGN determined from Spitzer spectroscopy and SDSS/WISE



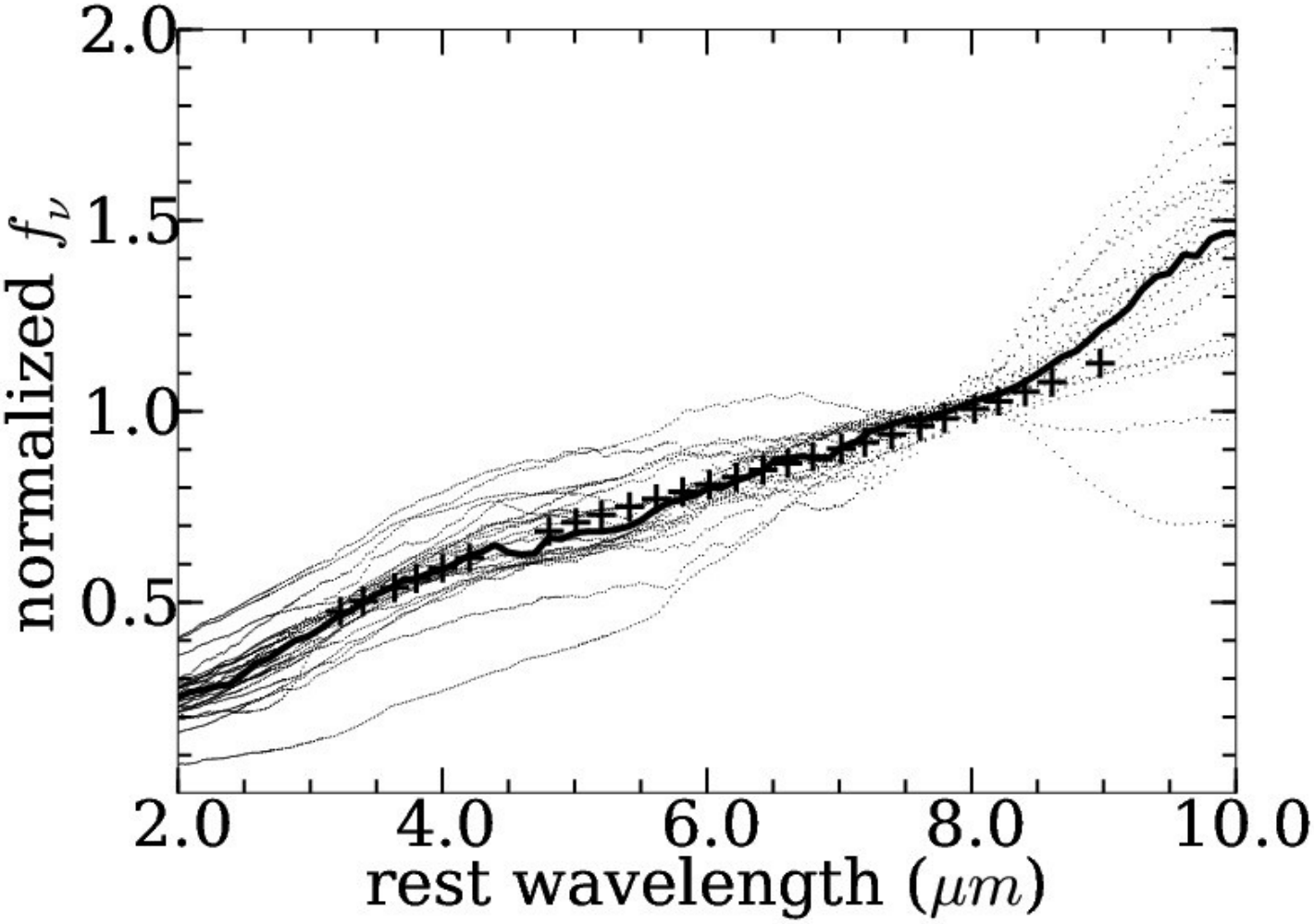
Data Sources

SDSS
Telescope in
New Mexico

SDSS compilation from - Shen et. al., 2011, ApJS 194, 45

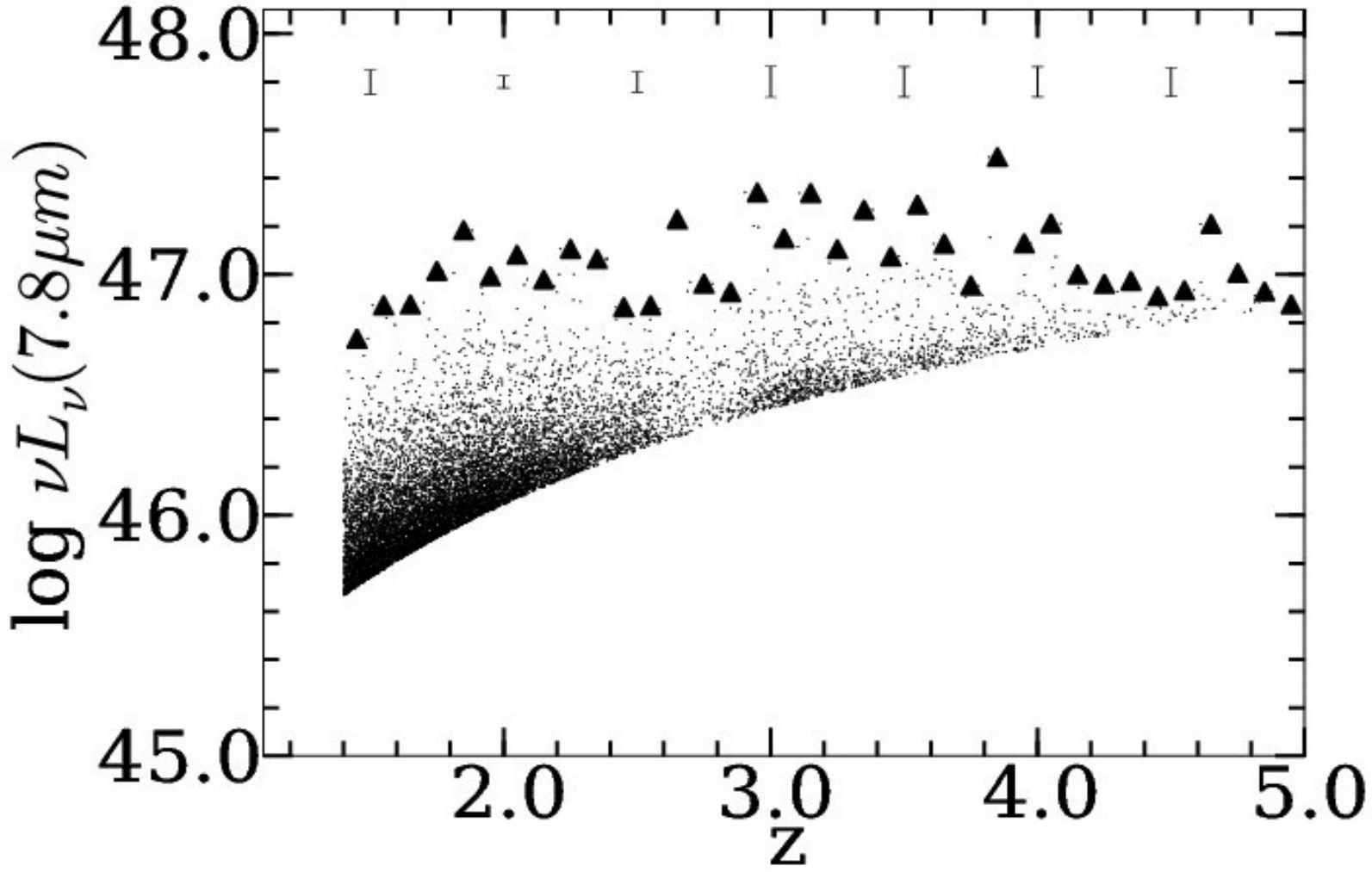
WISE –
launched in
2009 captures
the sky in IR

IR Template (Spitzer Spectra of optically discovered SDSS quasars).

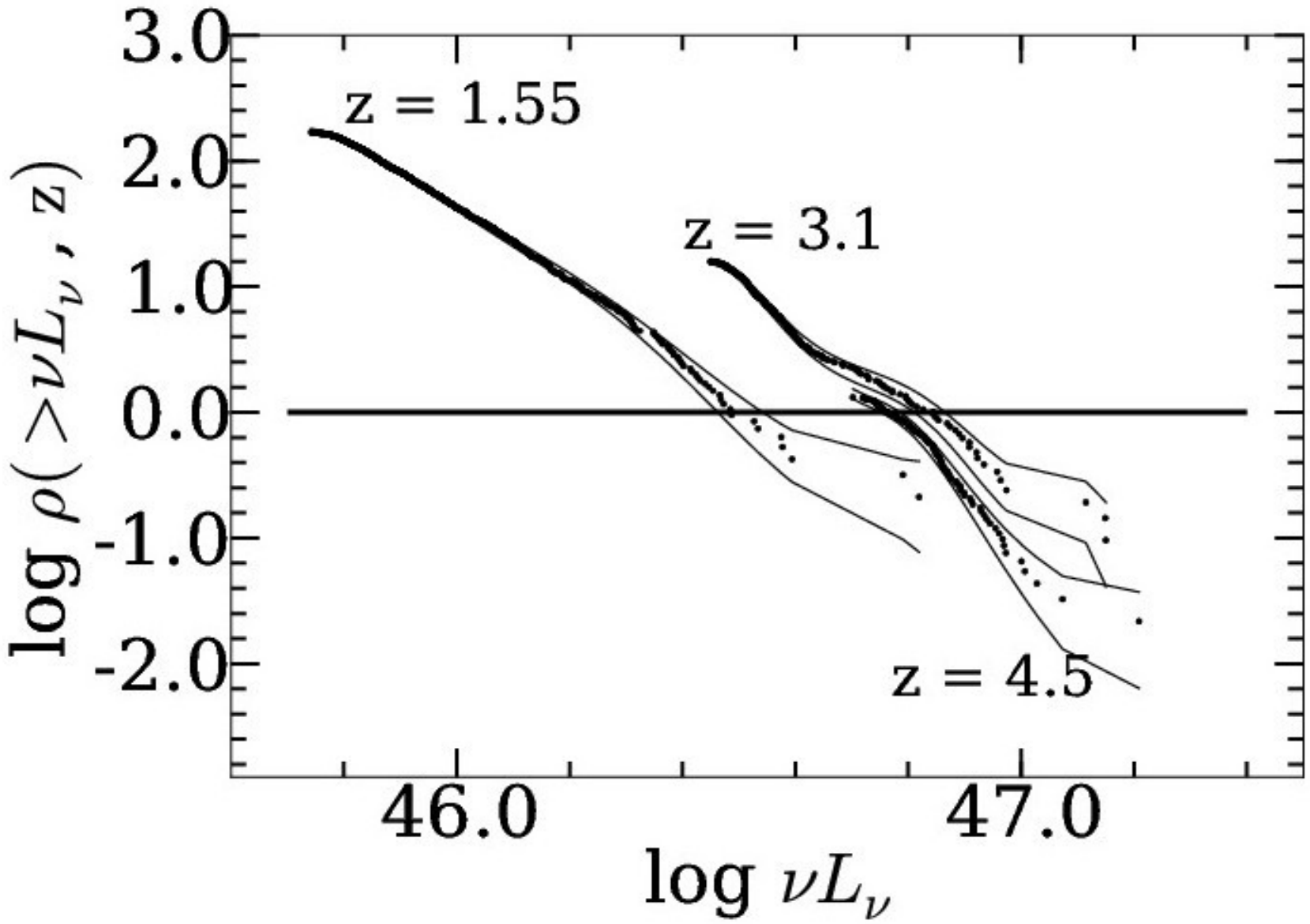


Template from - Weedman et. al., 2012, ApJ 761, 184

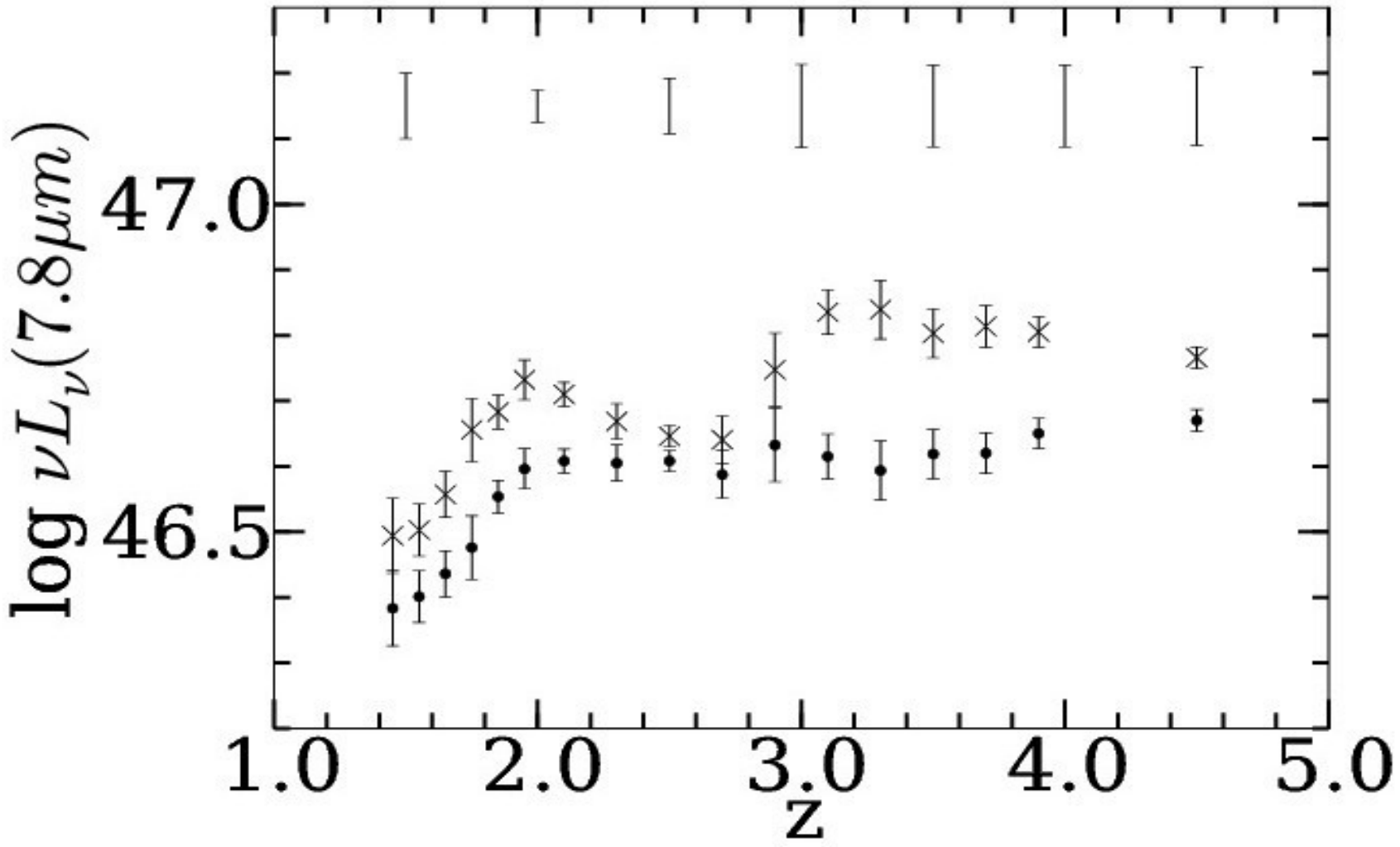
IR Distribution



Luminosity Functions

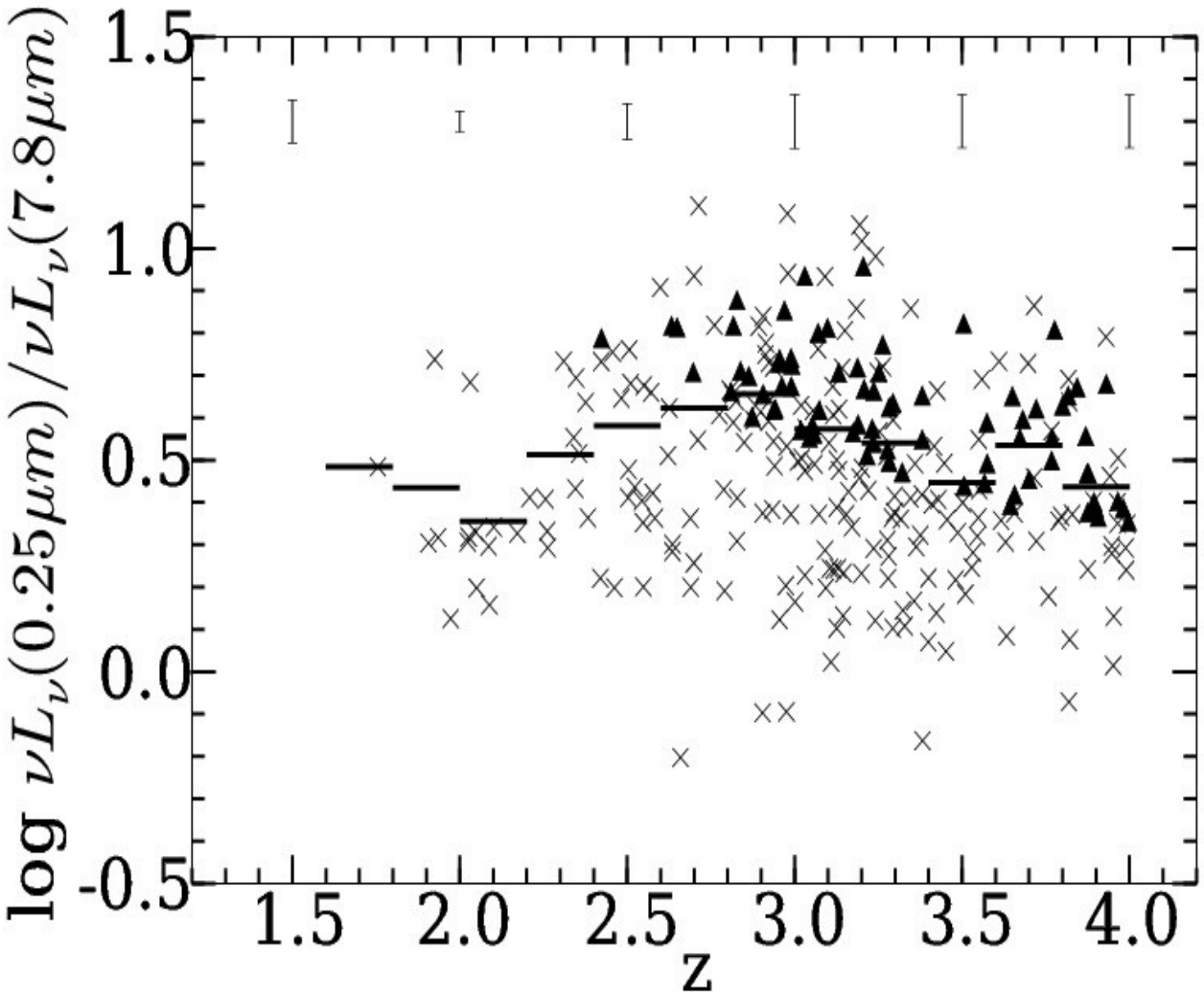


IR Luminosity Evolution

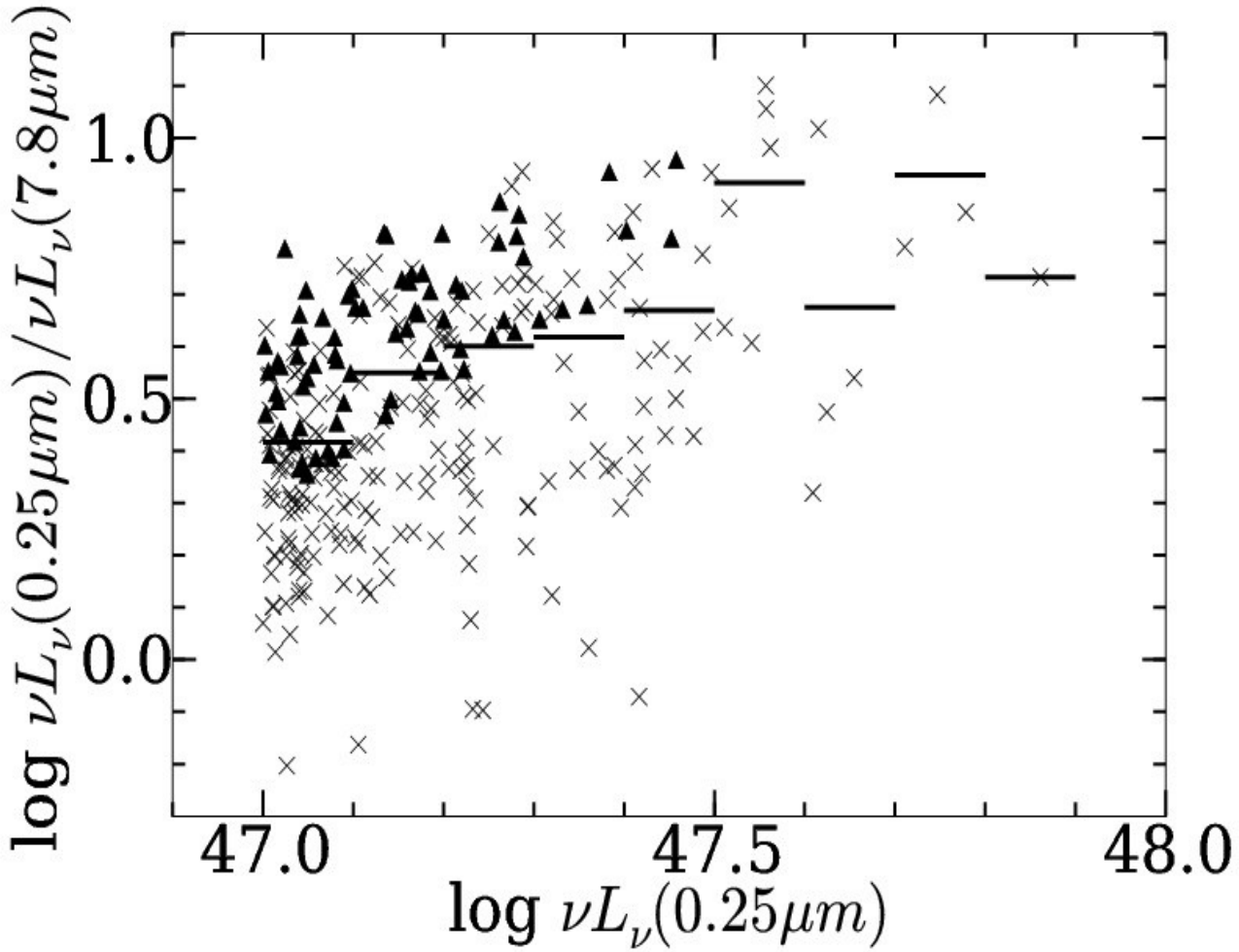


The difference between z = 2 and z = 4
halves the time
available for massive galaxy and black hole
formation (down to 1.5 Gyr from the
beginning
of the Universe at z = 4 from 3.2 Gyr at z = 2)

Comparisons With UV

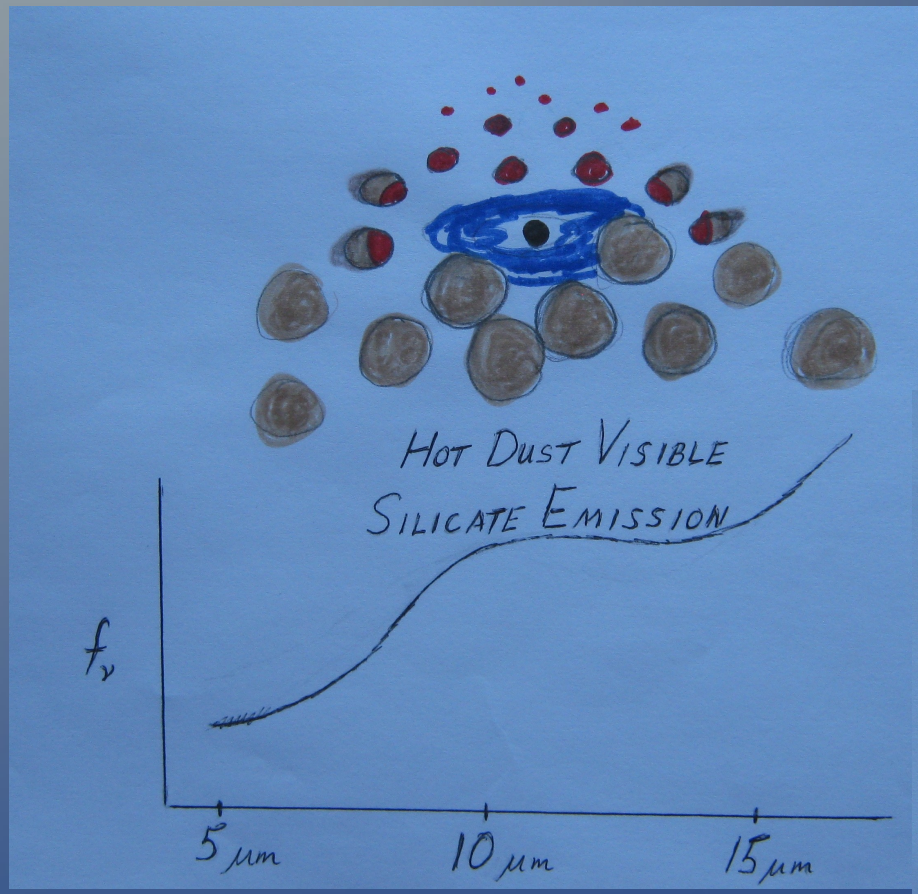


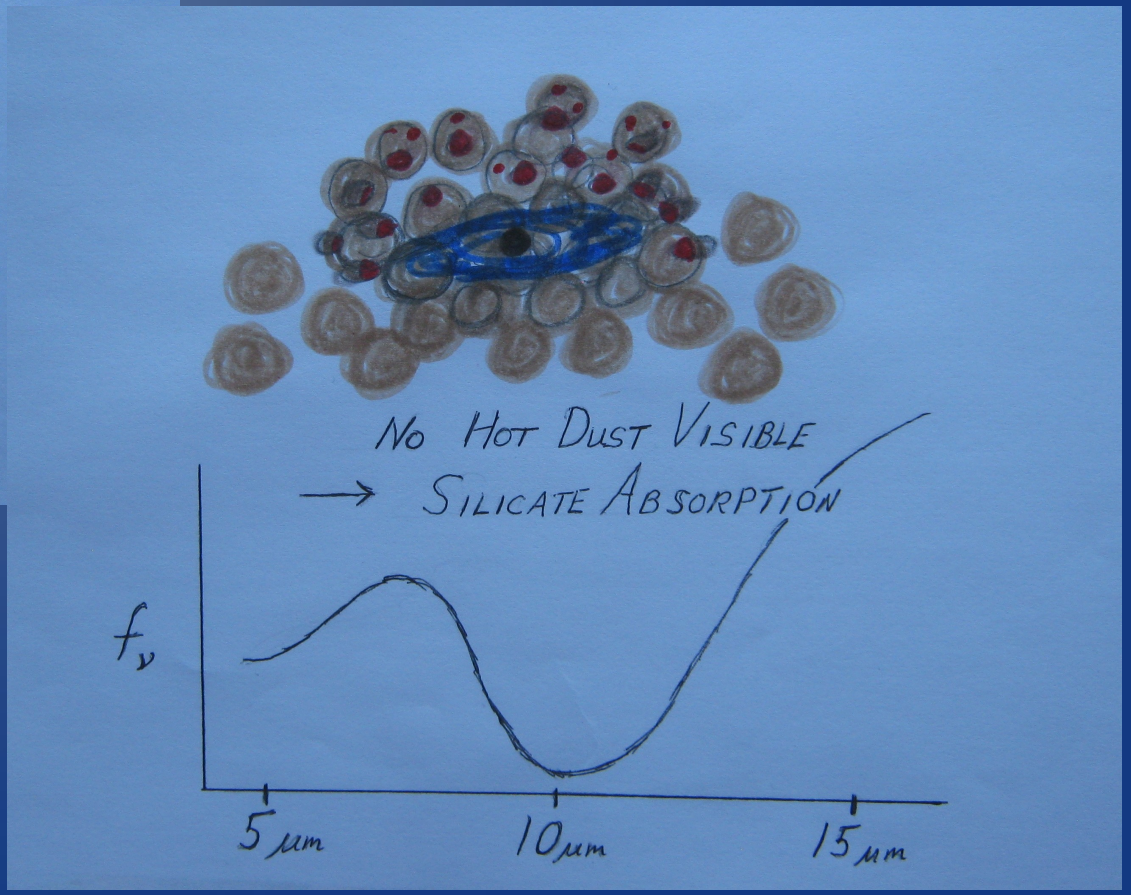
Comparisons With UV



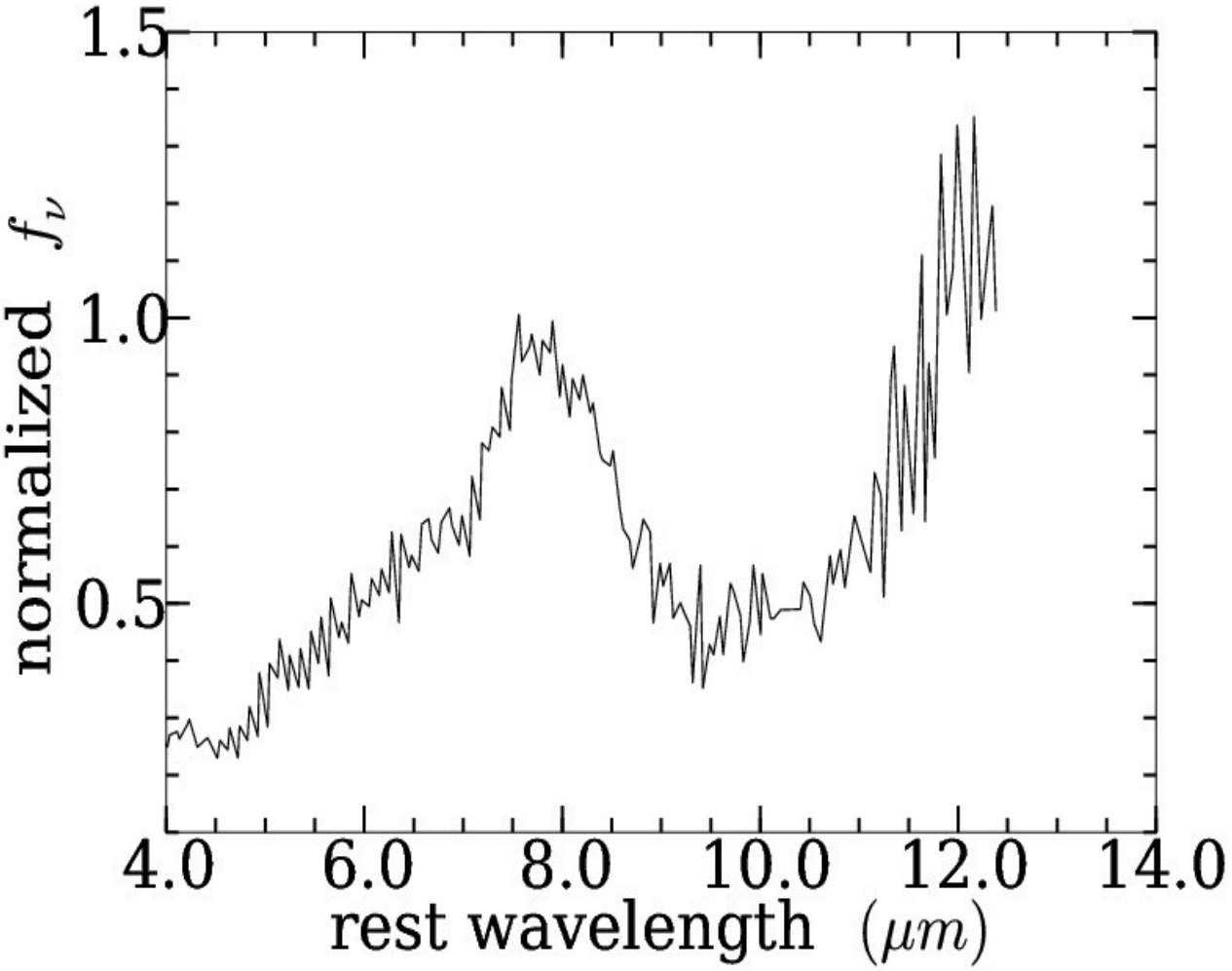
Dusty merger scenario - Hopkins et. al., 2006, ApJ 639, 700.
Narayanan et. al., 2010, MNRAS 407, 1701

Dust in Quasar

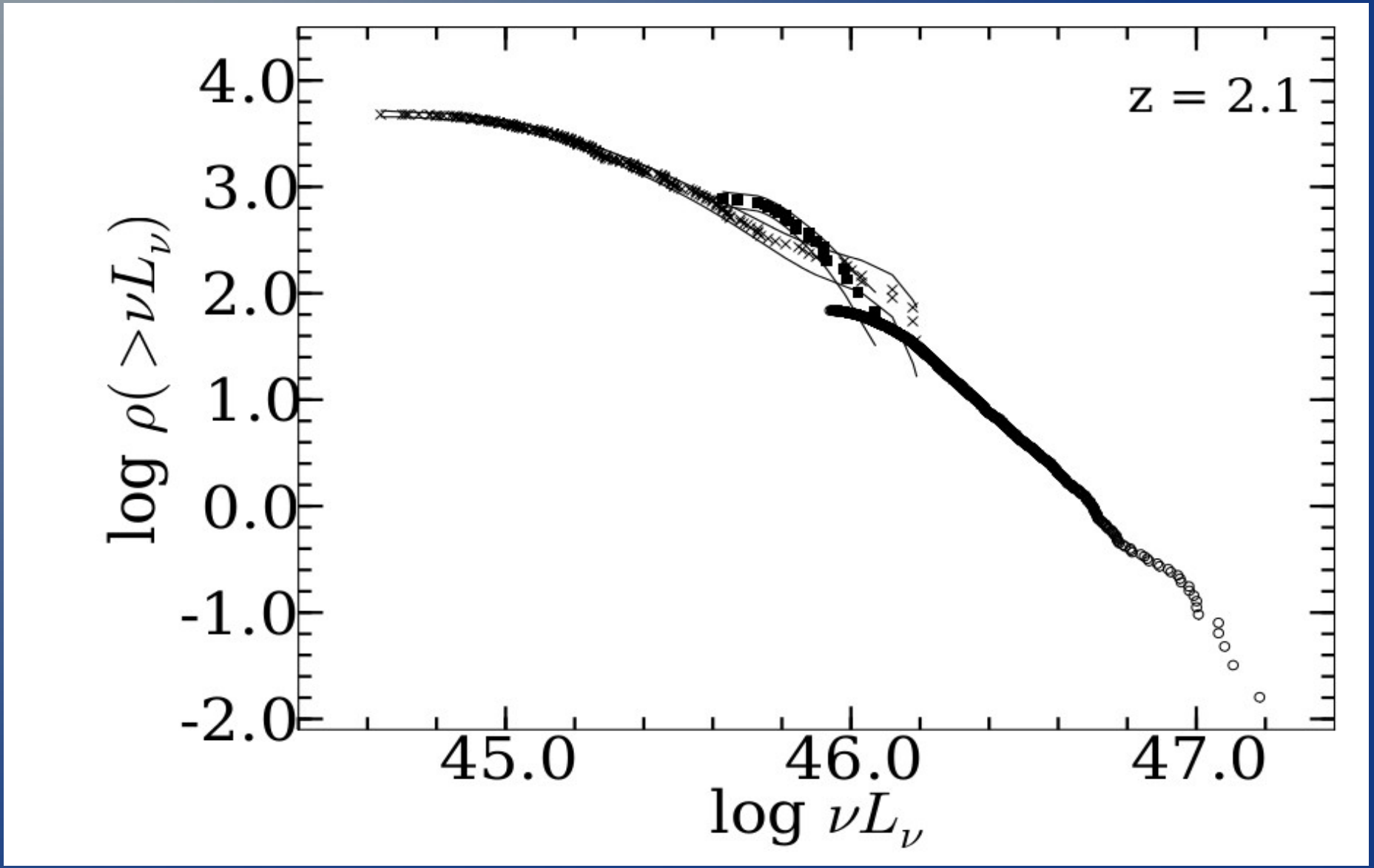


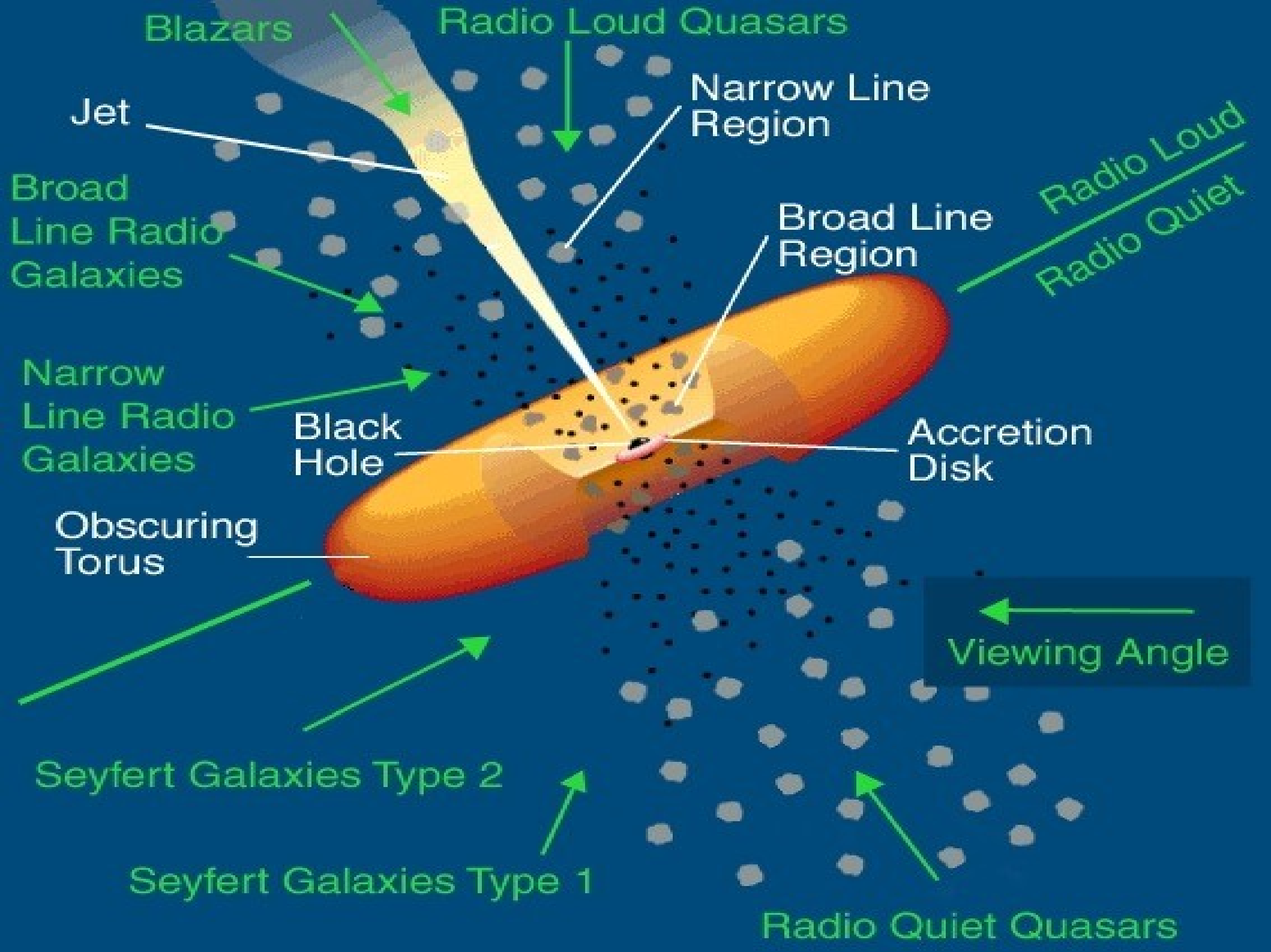


Average BOOTES Spectrum



Lfs of Obscured and Unobscured Quasars




Blazars
Radio Loud Quasars
Jet
Narrow Line Region
Broad Line Radio Galaxies
Broad Line Region
Radio Loud
Radio Quiet
Narrow Line Radio Galaxies
Black Hole
Accretion Disk
Obscuring Torus
Viewing Angle
Seyfert Galaxies Type 2
Seyfert Galaxies Type 1
Radio Quiet Quasars

Summary

- No Luminosity Peak in IR up to at Least z~5.
- Comparisons with UV do not Show any Significant Trend with Redshift in Dust Content.
- There are as Many Obscured Quasars Out There as the Unobscured Ones.


BIKE
LANE