Quasar/IGM Science from Big BOSS

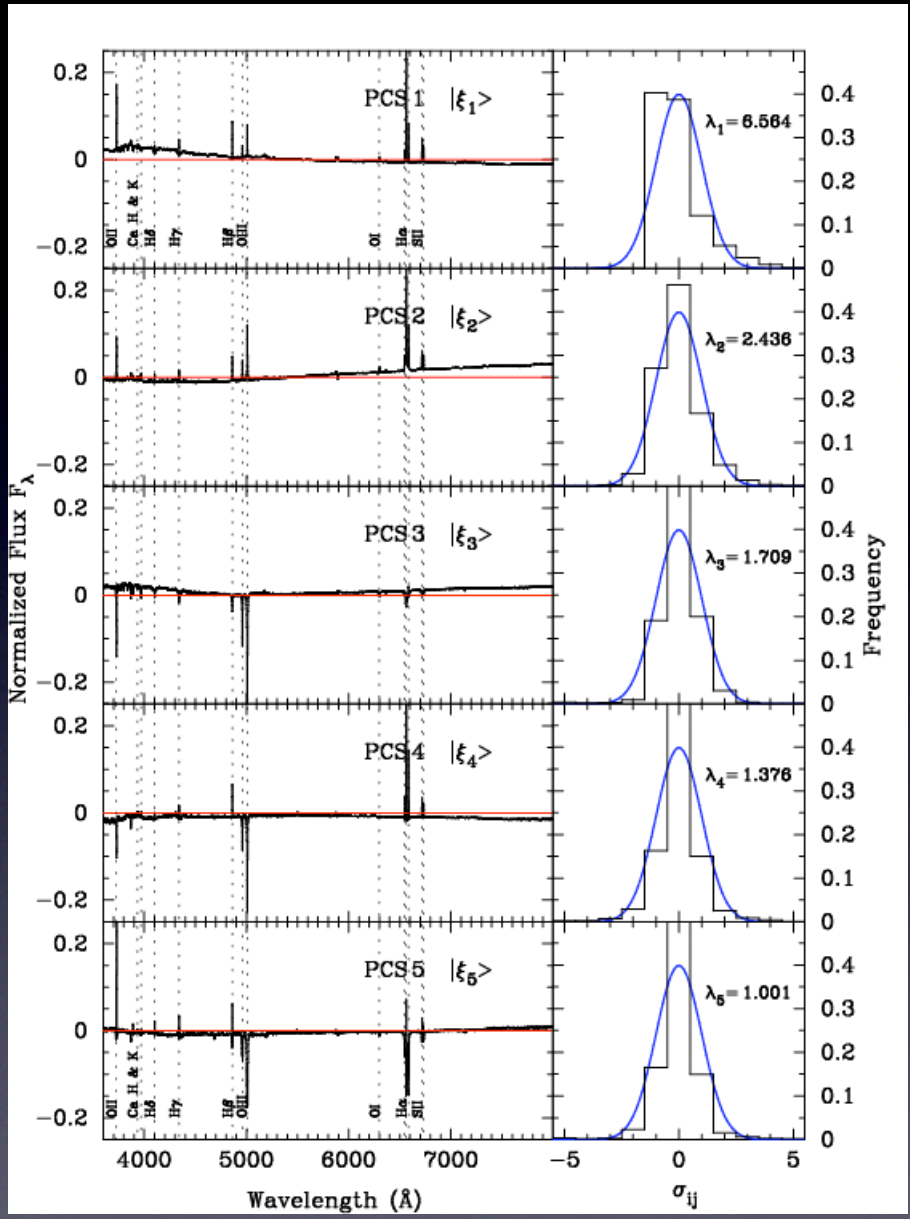
- Galaxy Spectrum by PCA
- BigBOSS supernova spectroscopic survey
- Quasar Science (Black Hole Mass)
- IGM Science (Ly alpha Forest) => this talk
- Covered by BigBOSS friends: BAO, Nuetrino Mass, Proximity effect

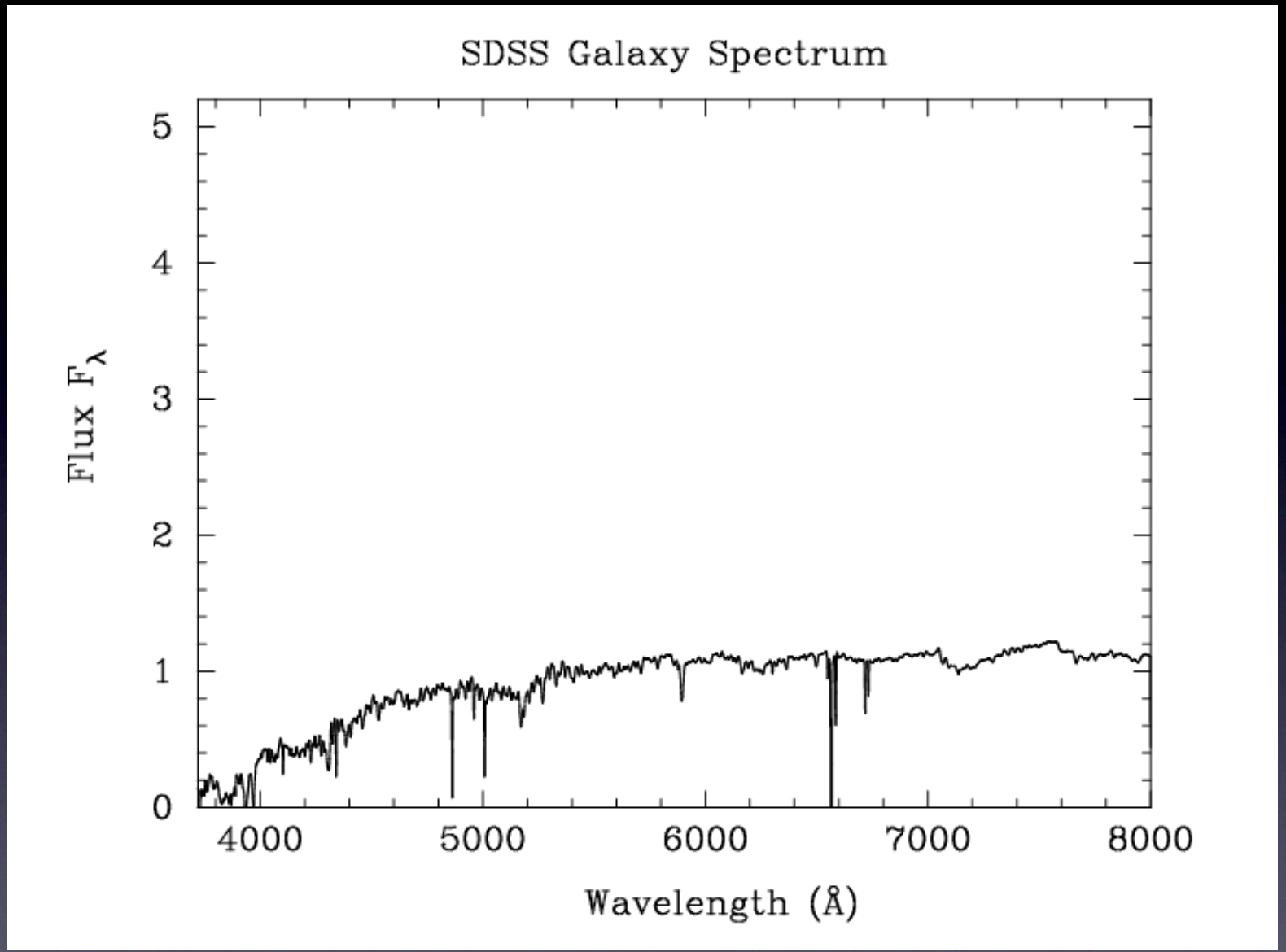
Eigenspectra

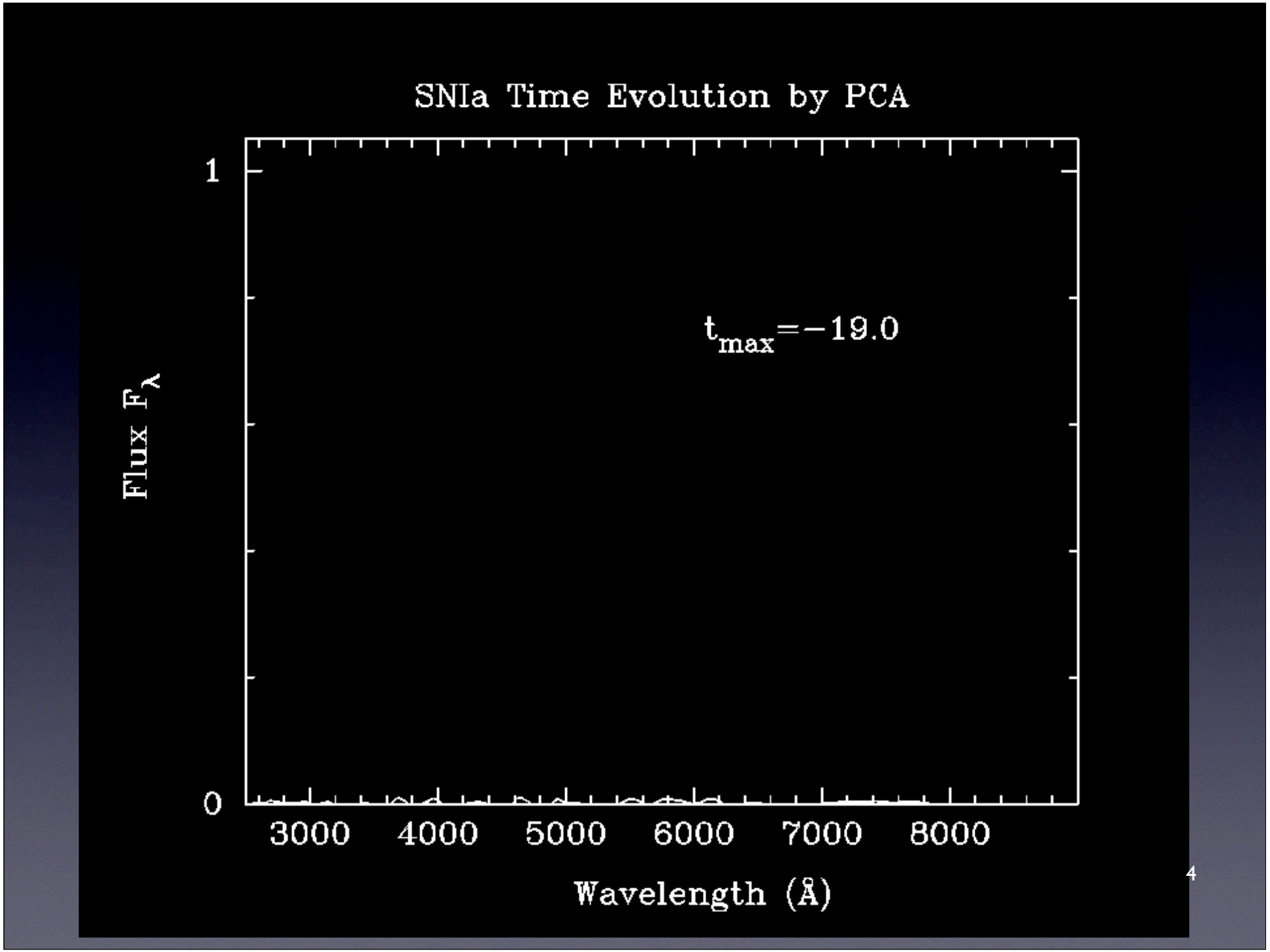
$$\vec{S} = \vec{\mu} + \sum_{j=1}^{n} c_j \vec{\xi}_j$$

$$\vec{\xi}_i \cdot \vec{\xi}_j = \delta_{ij}$$

- ~ 90% of residual goes to first 3 components
- Coefficient distribution is not gaussian

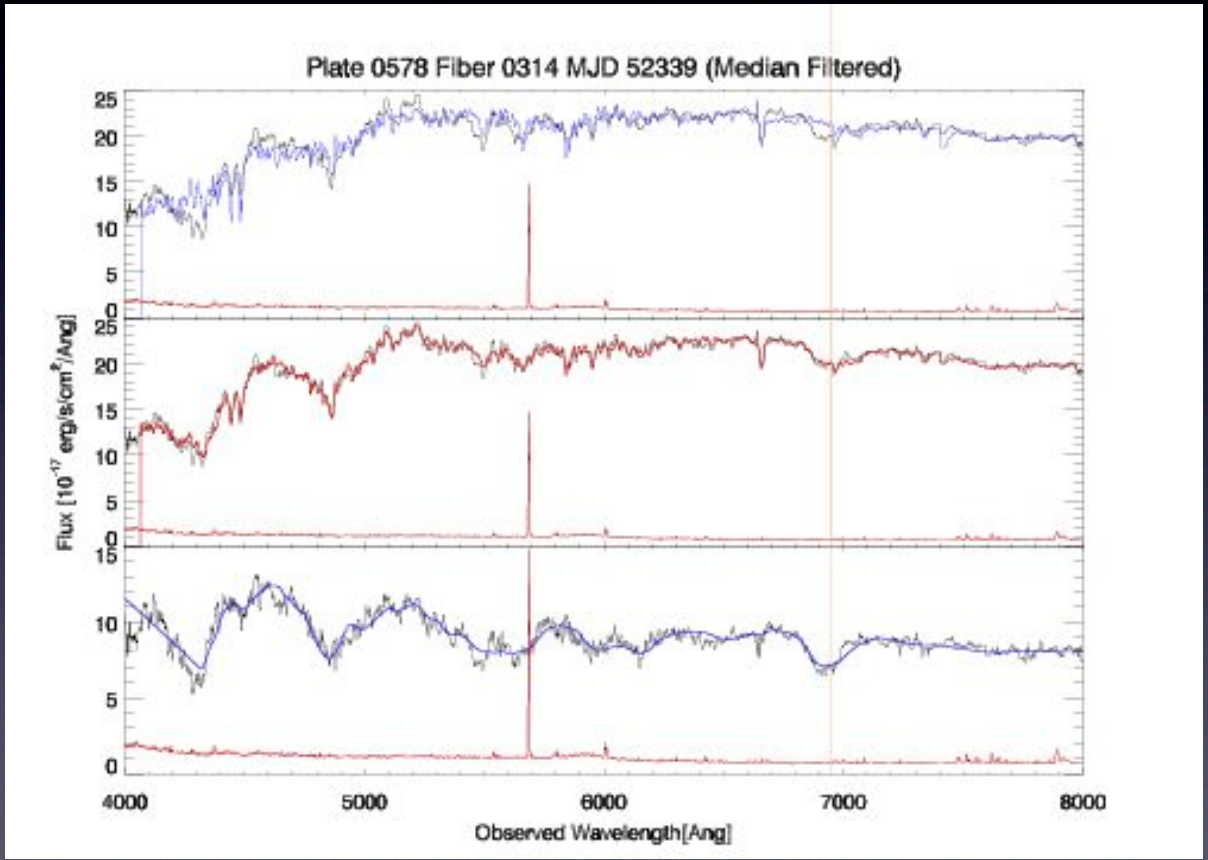


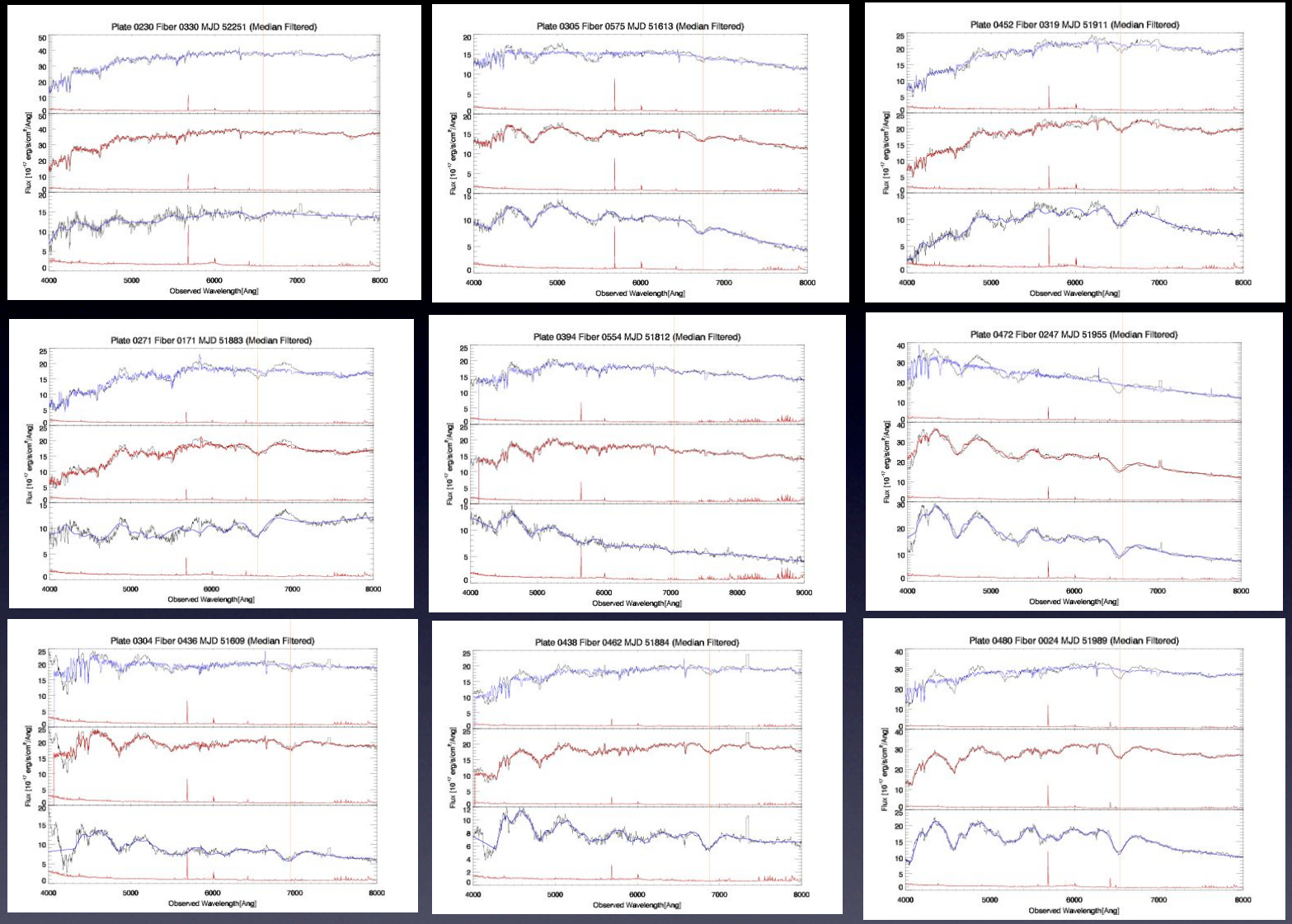

SDSS Galaxy Spectrum
Flux F_λ
0
1
2
3
4
5
4000
5000
6000
7000
8000
Wavelength (Å)


SNIa Time Evolution by PCA
1
0
Flux F_λ
t_{max}=−19.0
3000
4000
5000
6000
7000
8000
Wavelength (Å)

Supernova Ia from SDSS DR7

Janos Botyanszki, Kimberly Aller,
Josh Meyers (code), Nao Suzuki(eigen spectra)

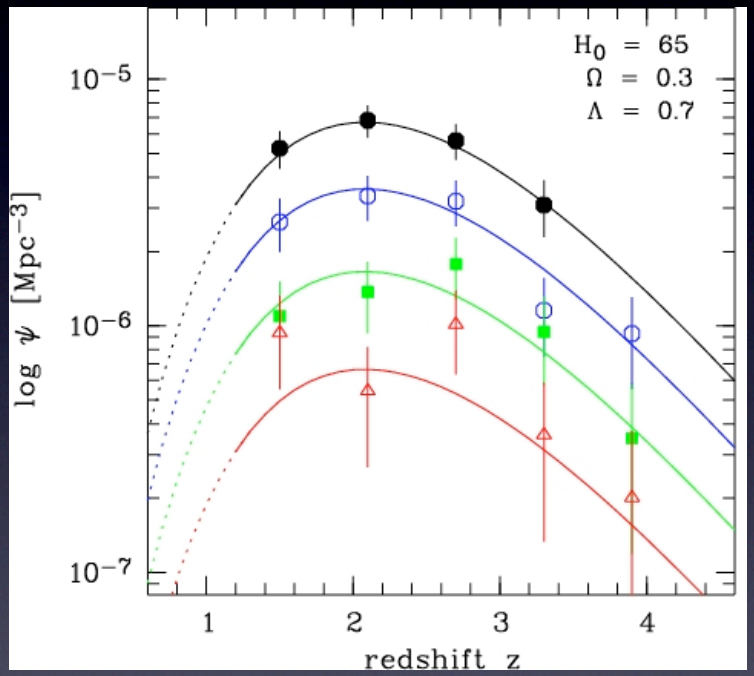


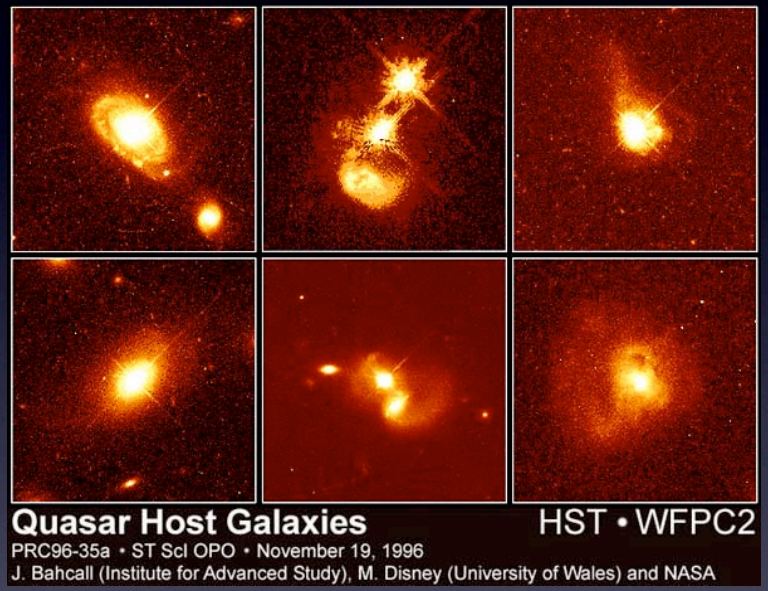


SDSS DR7 : 1 SNIa / 6000 Galaxies

BigBOSS : with 50 million galaxies => 10,000 SNe Ia

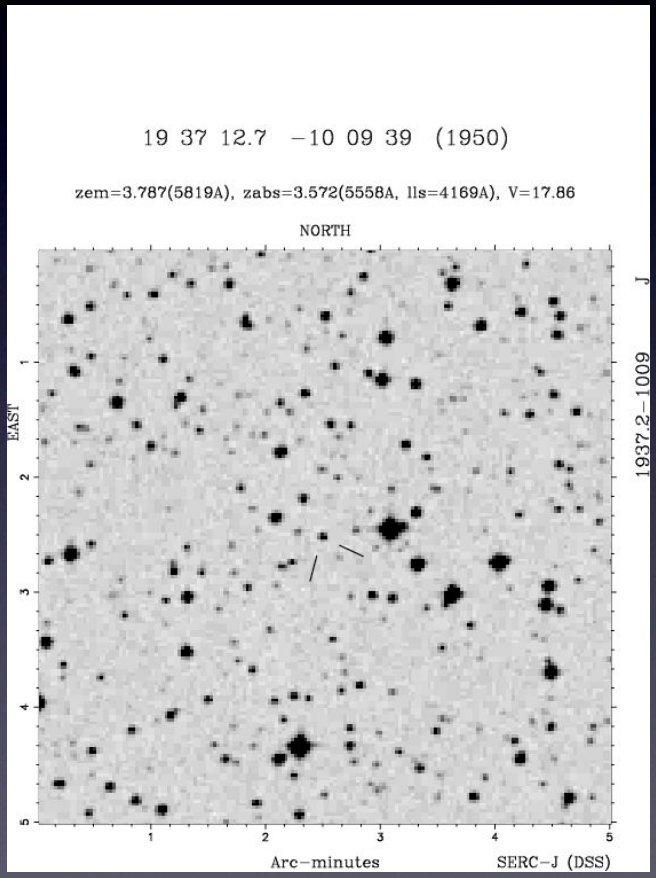
Quasar Basics 1: Number Density Evolution

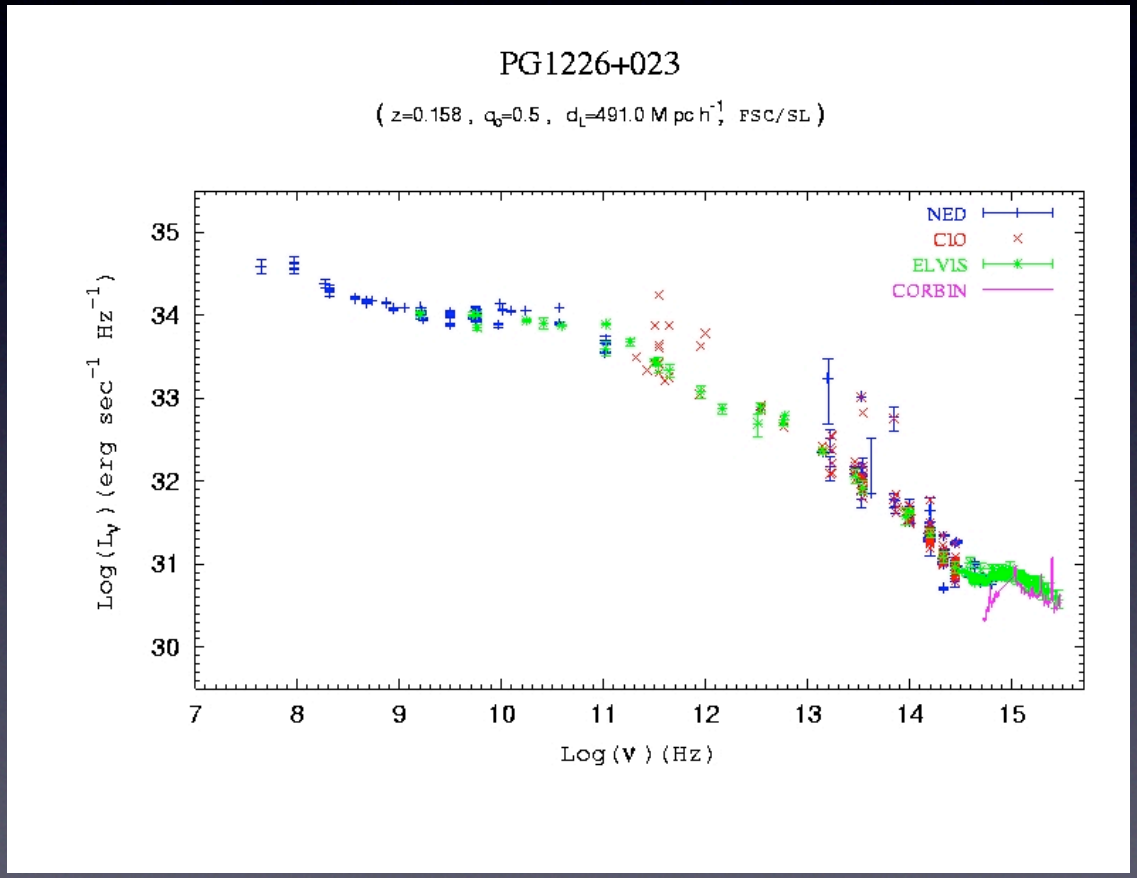




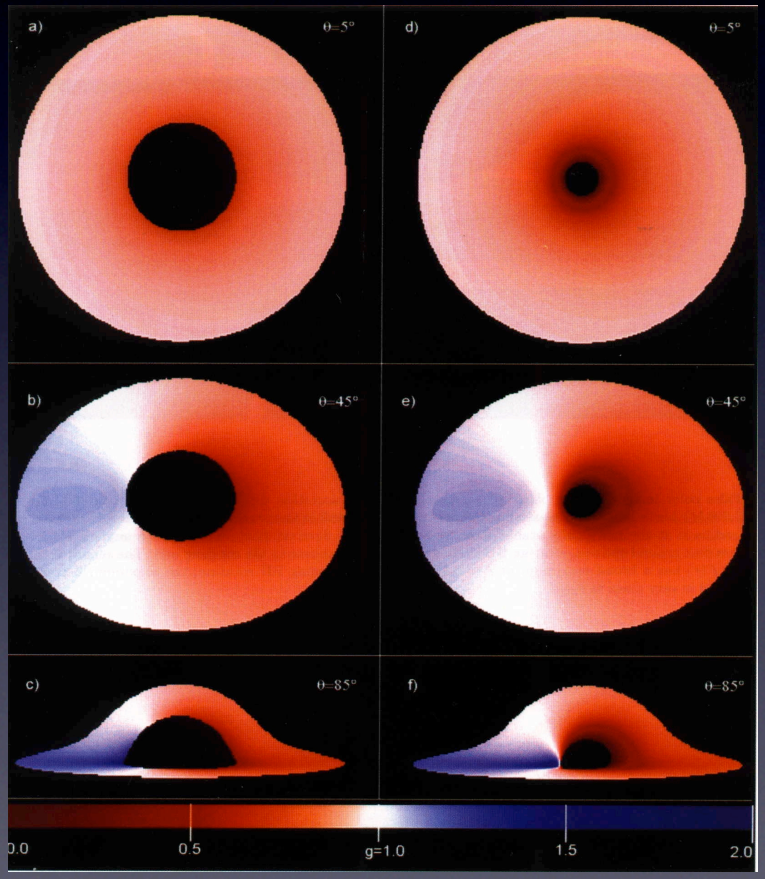
- Red (M < -27) Green (M < -26) Blue (M< -25) Black (M < -24) : Combo-17 Survey (MPG/ESO 2.2 m : Wolf et al. 2003)

Quasar Basics 2 : SED
UV Excess



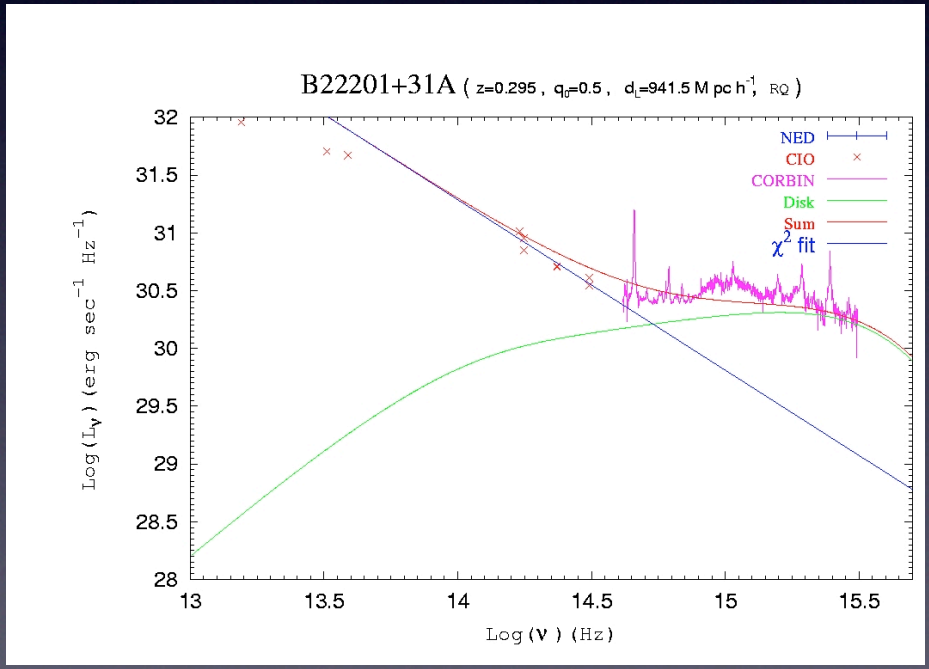


Physics of UV Excess

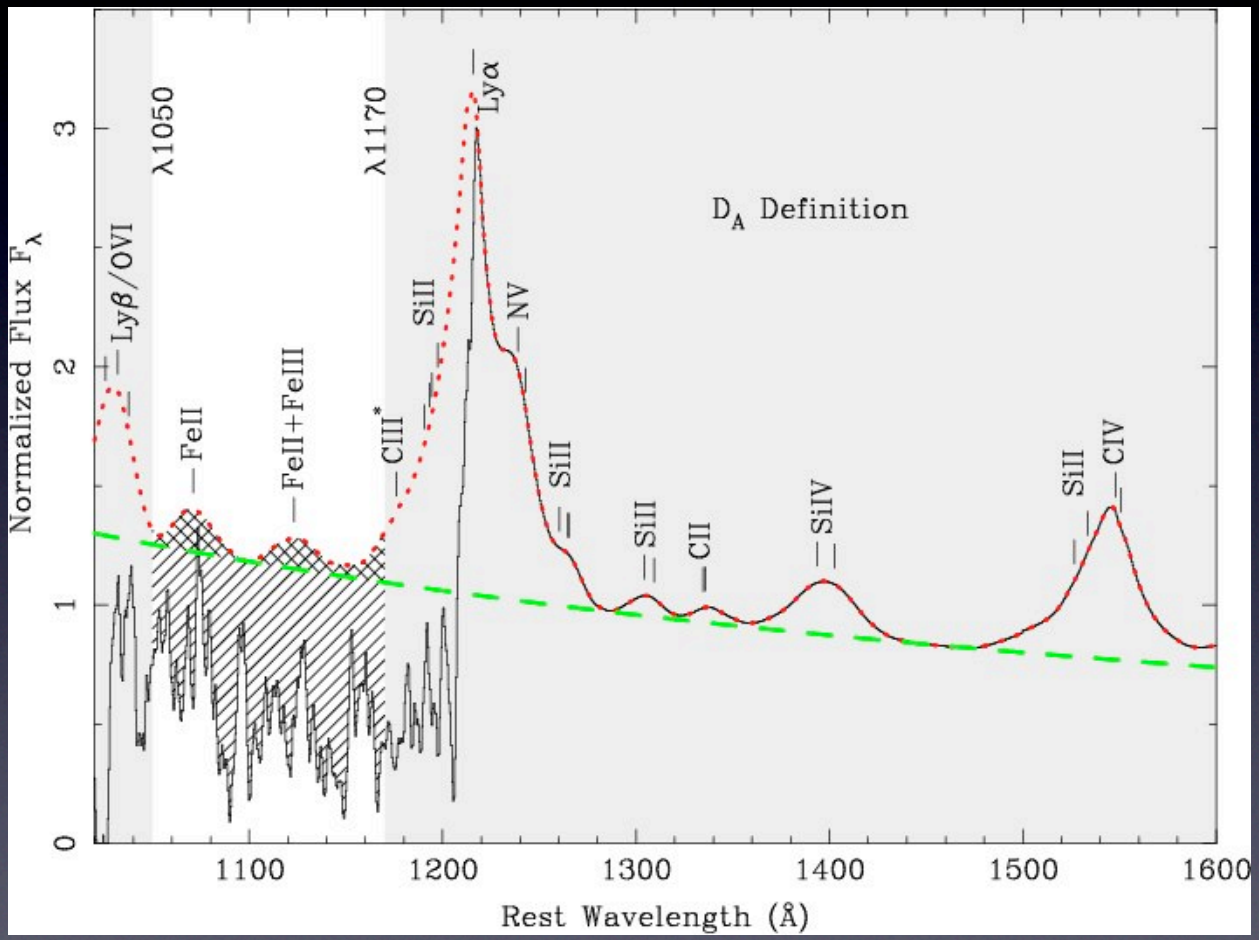


Accretion disk surrounds the super massive black hole

SED(Mass, Accretion Rate)

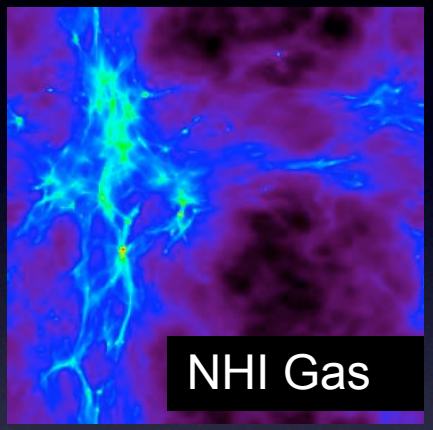


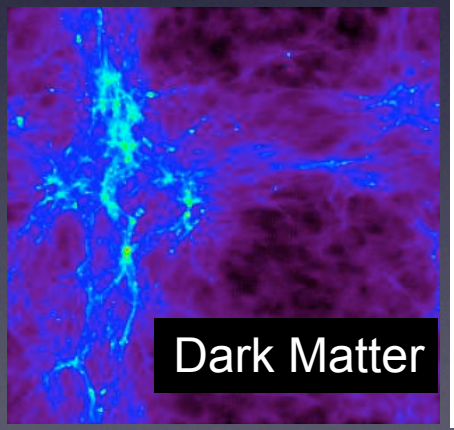
Ly alpha Forest

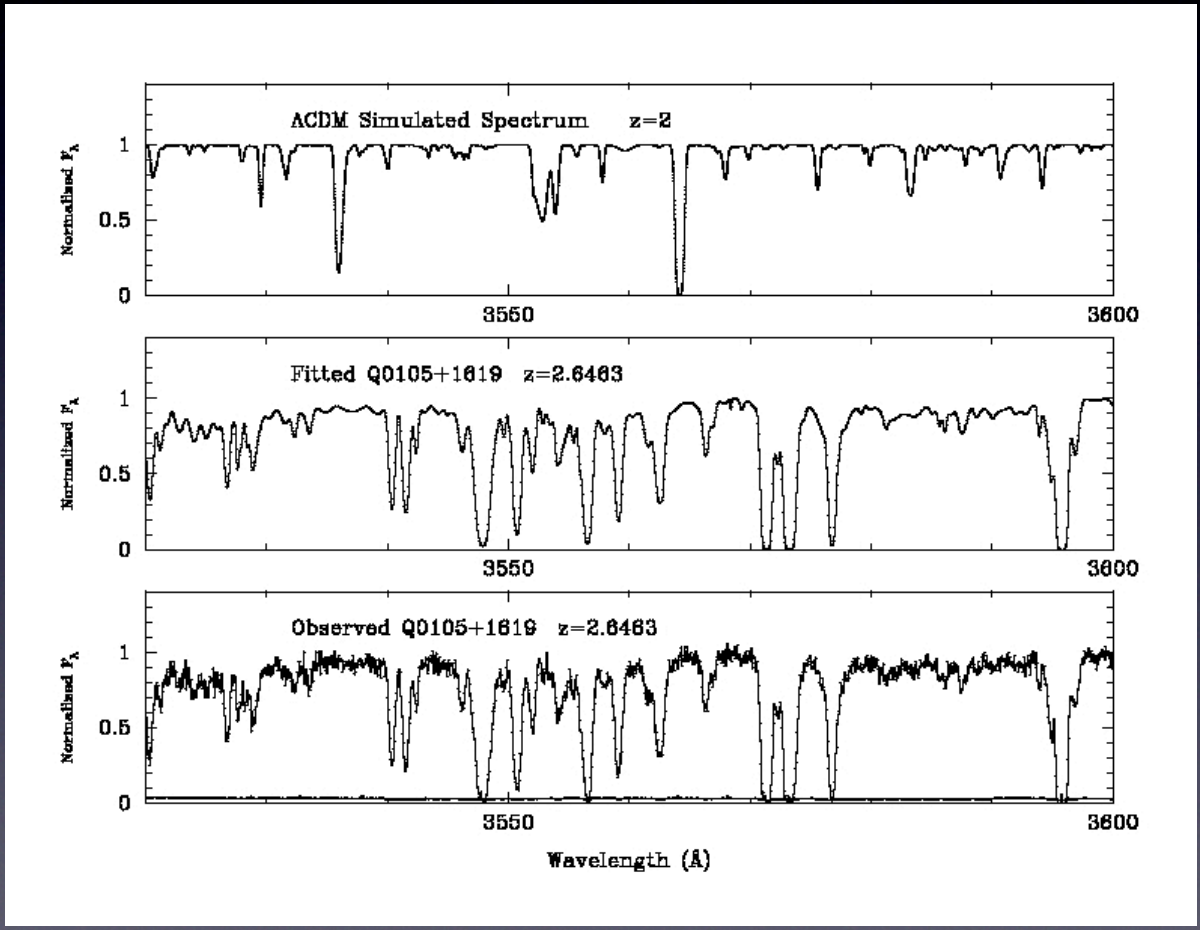


Extracting Cosmological Parameters

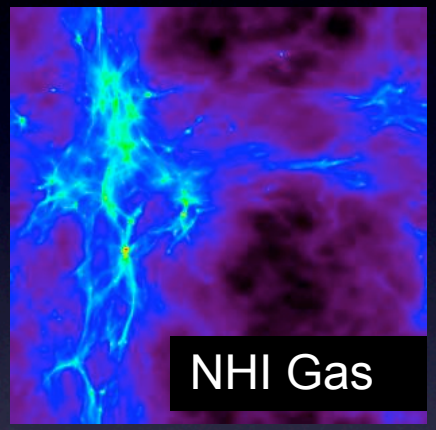
Simulation vs. Observation

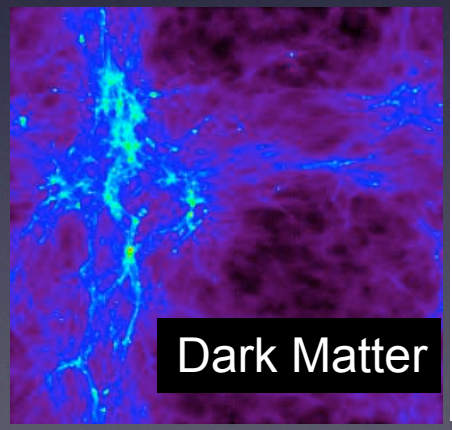




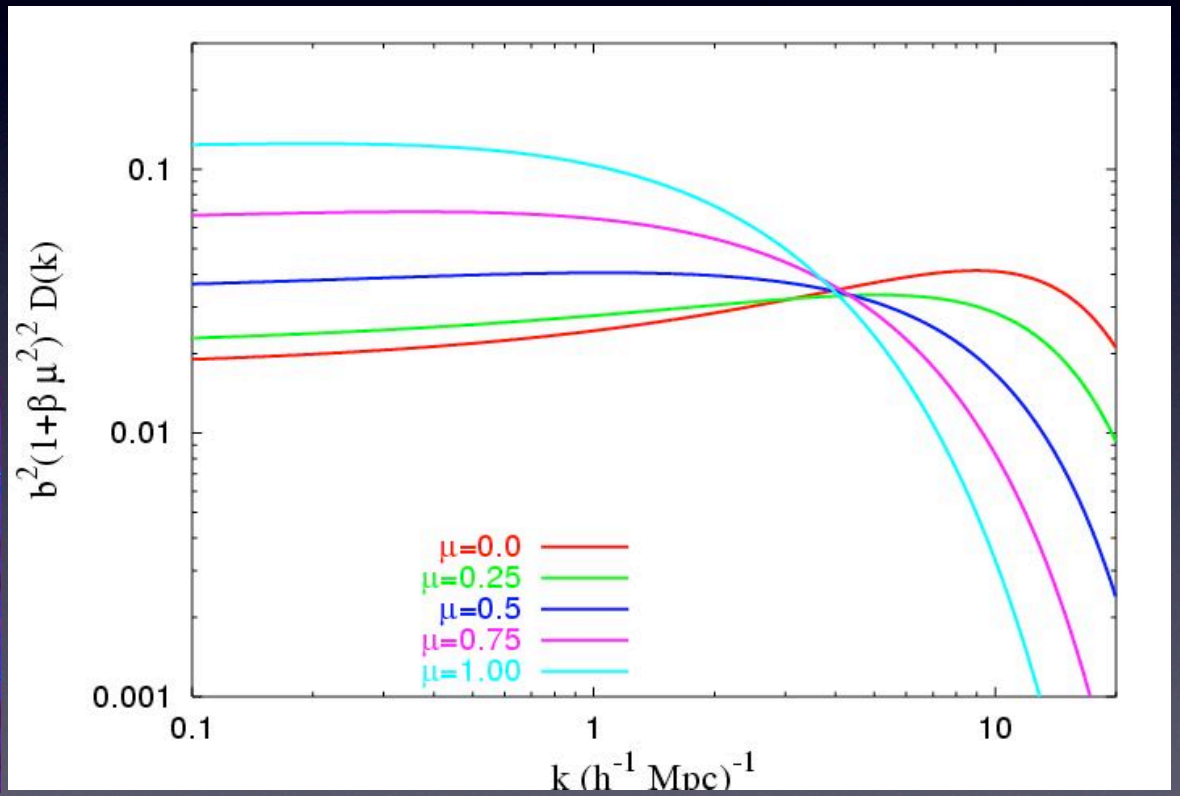


Mass Power <=> Flux Power
(Simulation: bias <= translator)

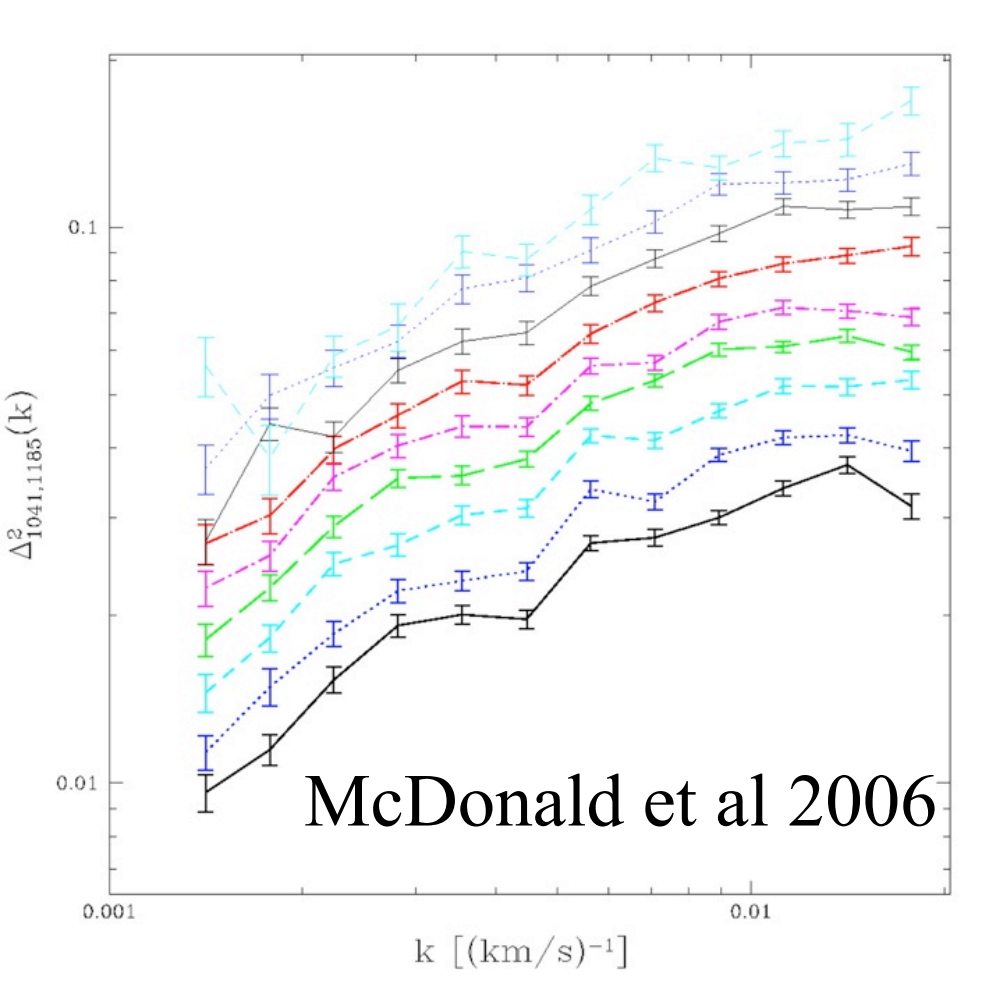




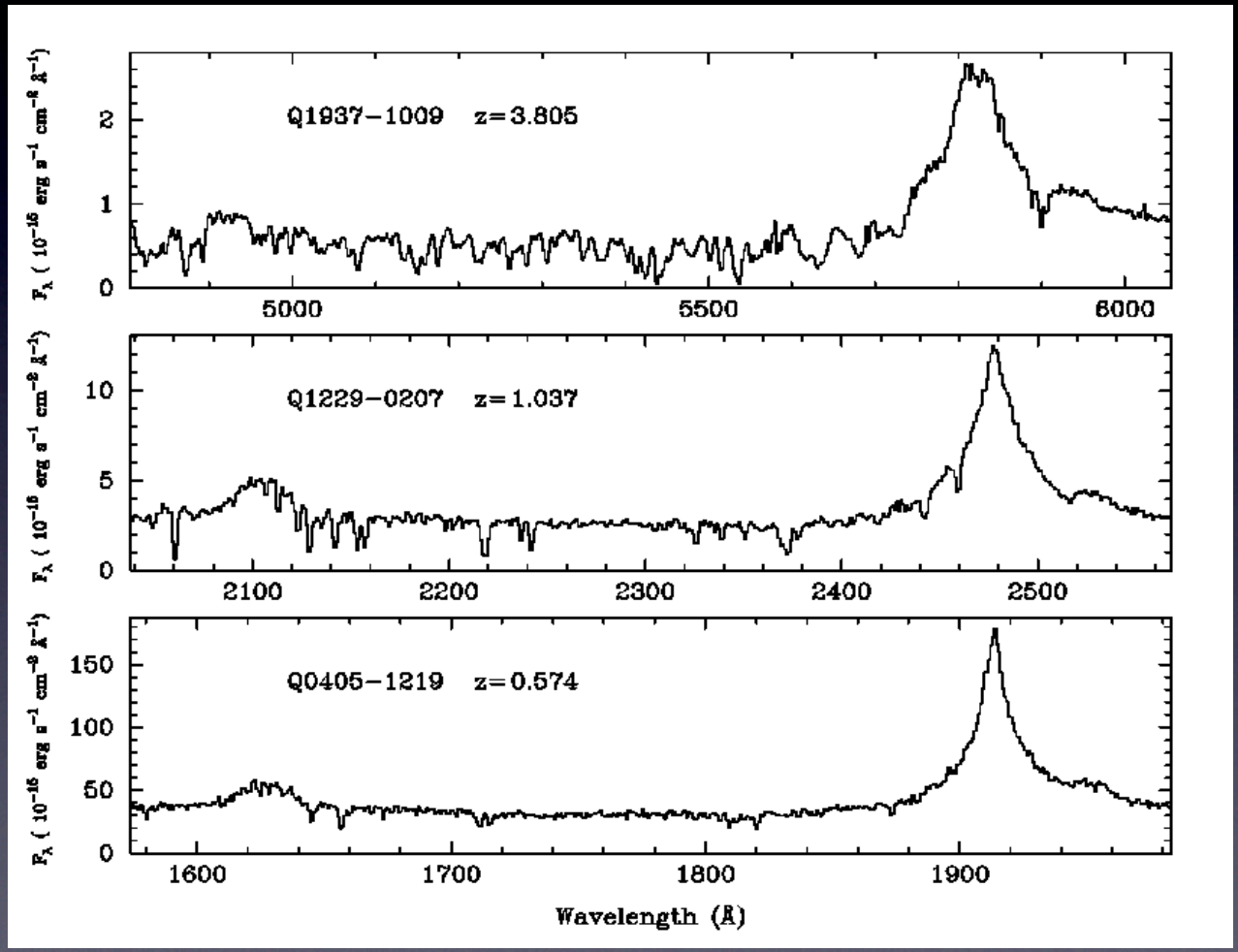
$$P_F(k,\mu) = b^2(1+\beta\mu^2)^2 P_L(k) D(k,\mu)$$



Flux Power Spectrum from SDSS



Ly alpha Forest Evolution



IGM Physics

$$n_{HI}\Gamma = n_p n_e \alpha_{rr}(HI, T)$$

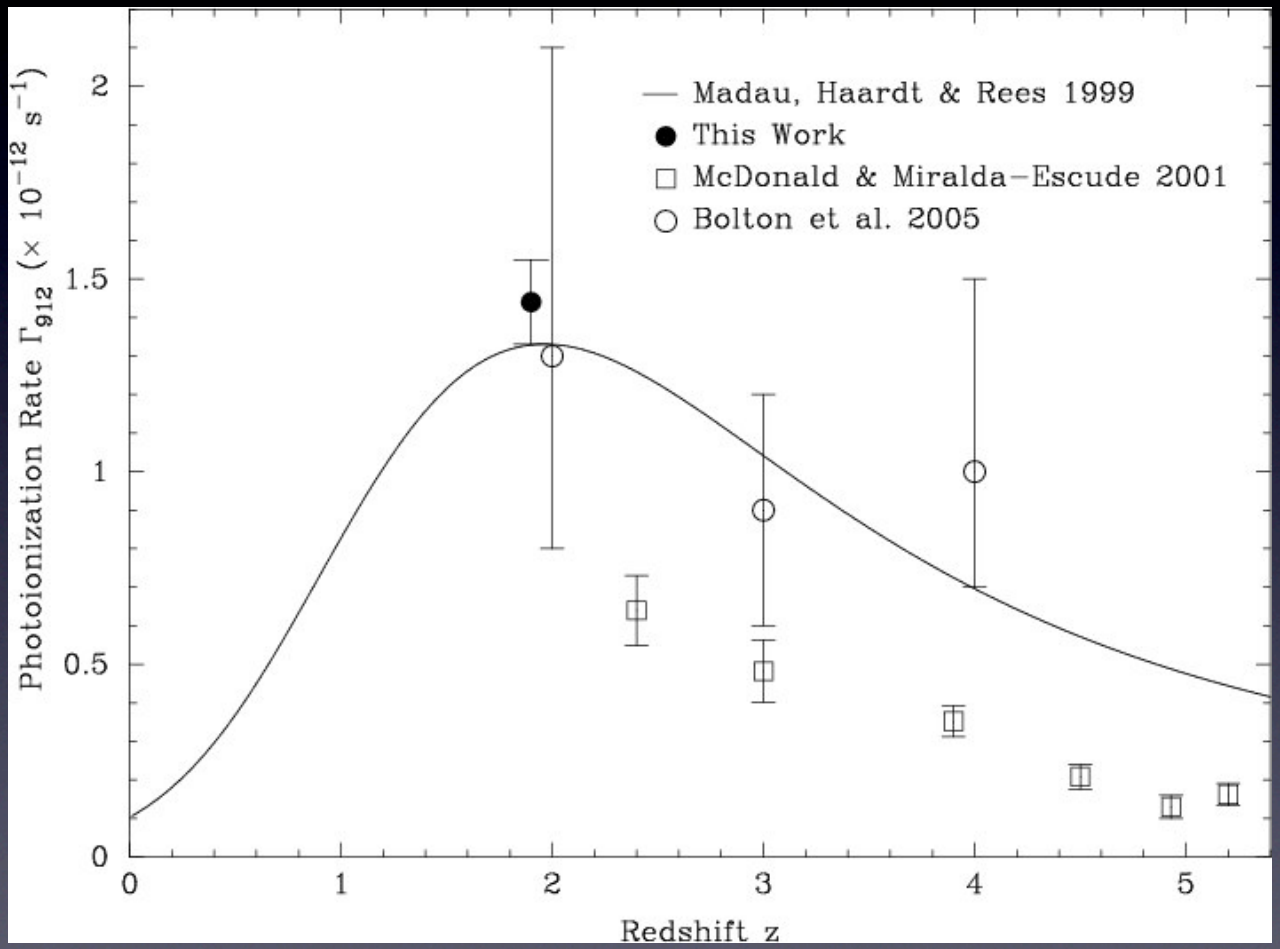
$$X_{HI} = \frac{n_{HI}}{n} \qquad n \sim n_p \sim n_e \sim \delta\rho$$

$$\overline{\rho} \propto (1+z)^3$$

$$X_{HI} = \frac{n\alpha_{rr}}{\Gamma} \qquad \frac{\delta\rho}{\overline{\rho}} \propto g(z) \sim \frac{1}{(1+z)}$$

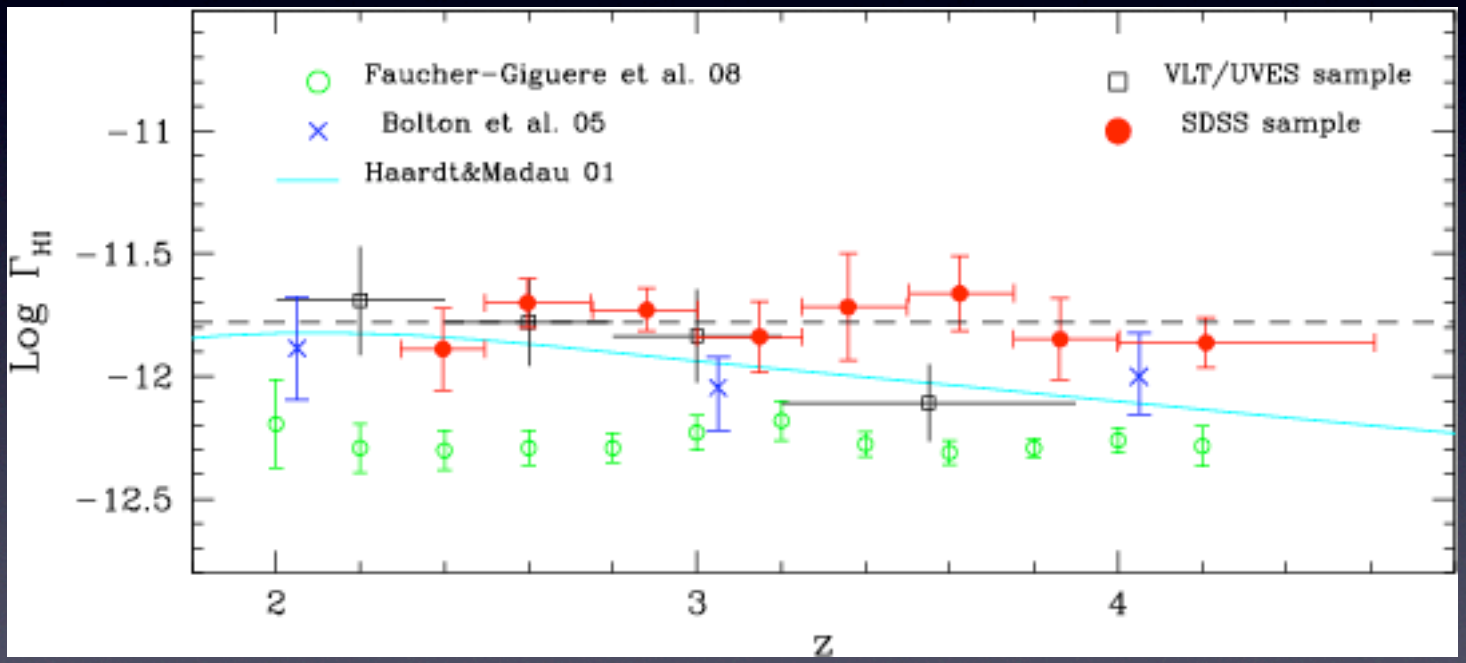
$$X_{HI} = \frac{\alpha_{rr}}{\Gamma}(1+z)^3 g(z) \sim \frac{\alpha_{rr}}{\Gamma}(1+z)^2$$

Ionization Rate : 5 years ago



Ionization Rate : 2009

Dall'Aglio et al 2009

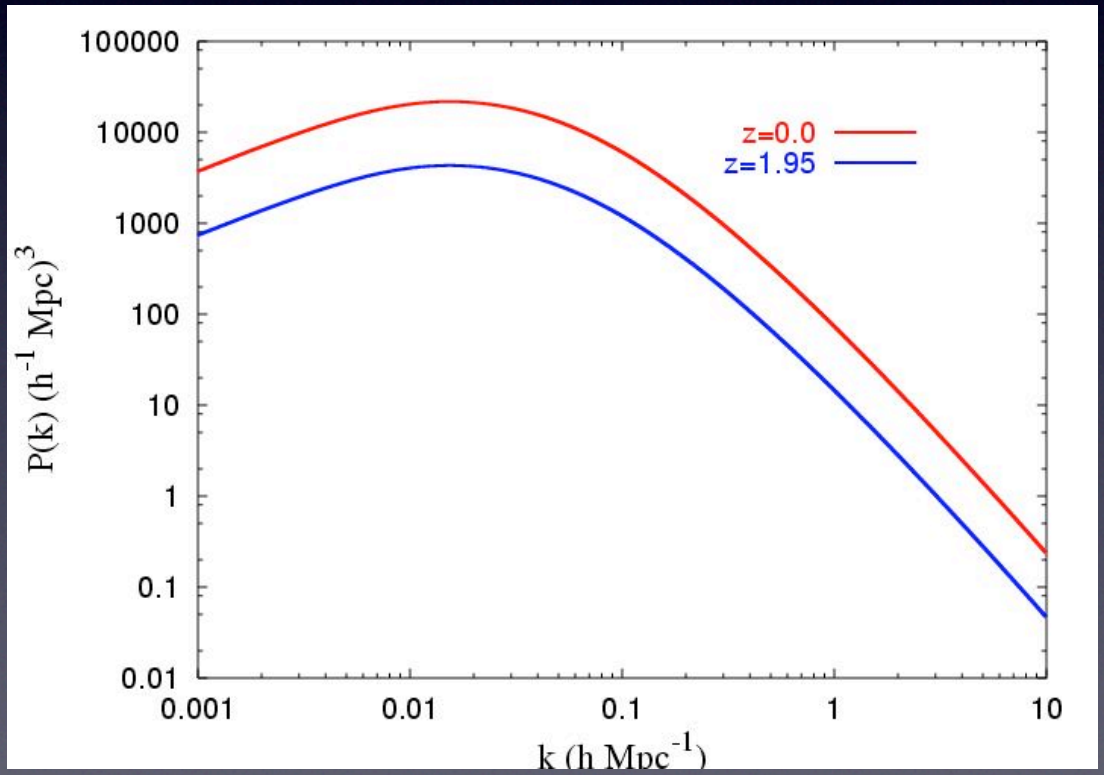


Flux Power Amplitude Measurement
Mass Power Spectrum

$$\frac{\delta\tau}{\tau} = \delta(x)$$

$$\delta(k) = \frac{1}{2\pi}\int \delta(x) e^{-2\pi i k x} dx$$

$$P(k) =< \delta^2(k)$$

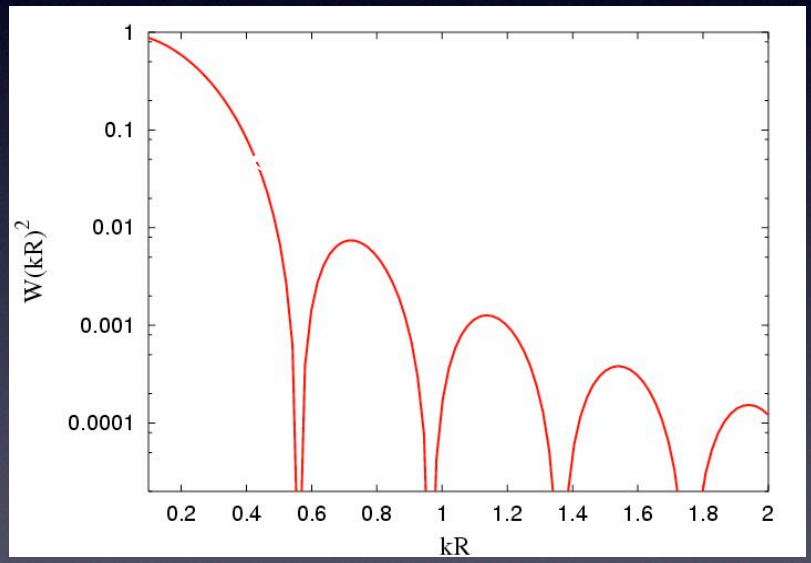


Flux Power Amplitude

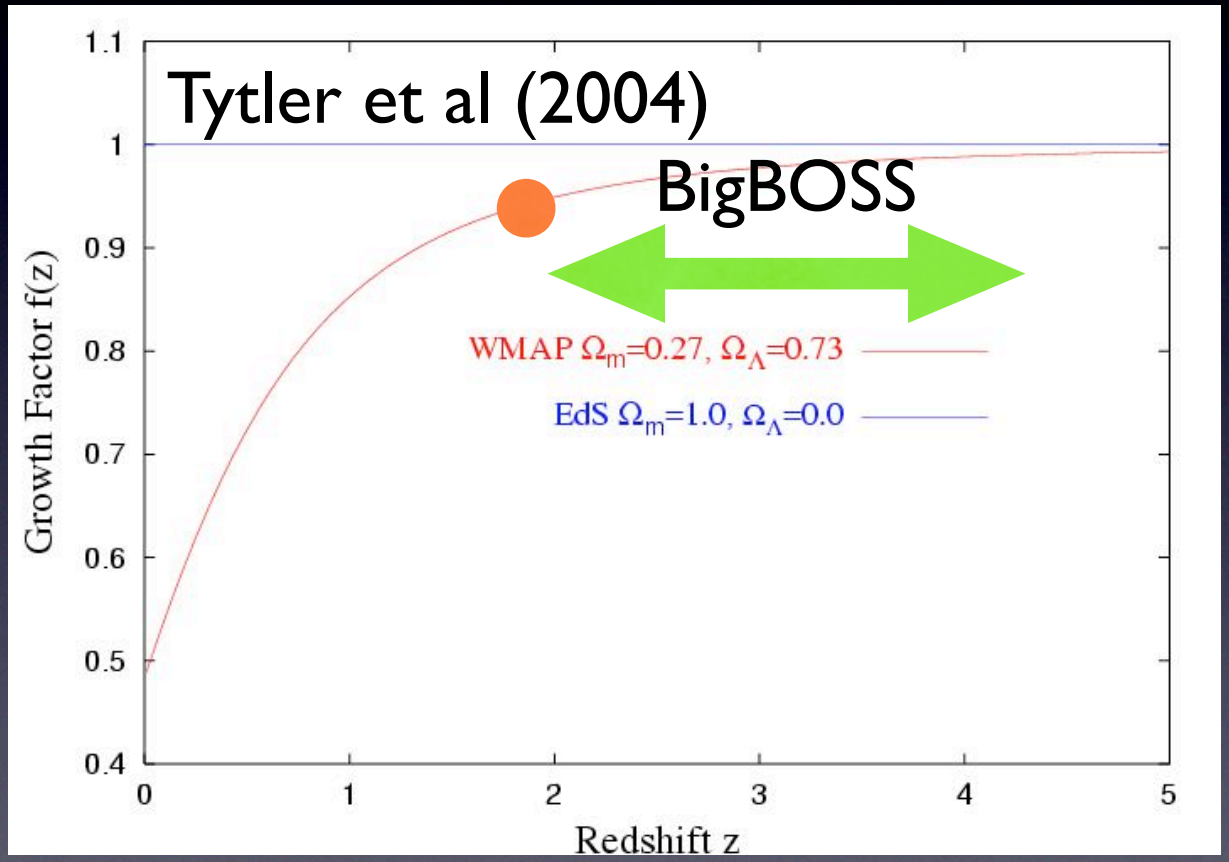
$$\sigma = \frac{< F >^2}{2\pi} = \int P(k) W^2(kR) dk$$

$$W^2(kR) = \frac{2(1 - cos(kR))}{(kR)^2}$$

$$R = 150 Mpc \quad \sigma_{150}$$



Growth Factor



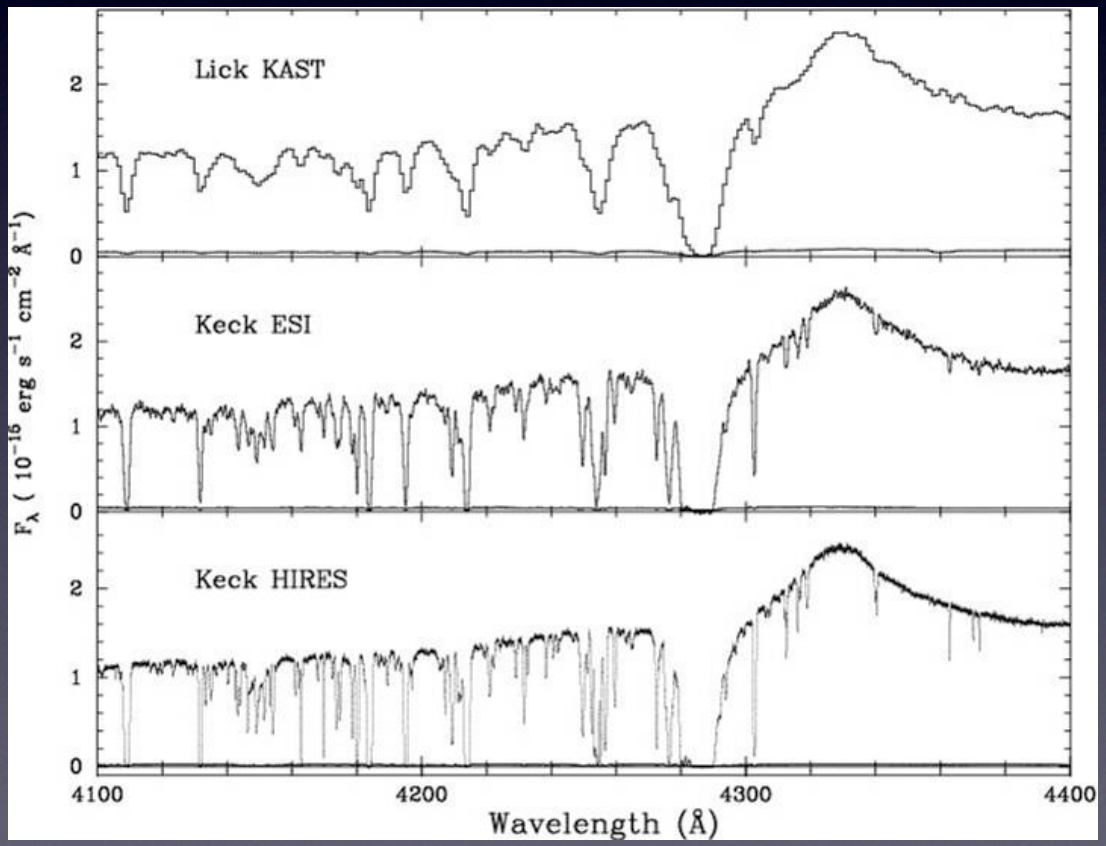
Summary
BigBOSS : Ly alpha Forest

- Ly alpha Forest BAO : Anze, Shirley, Nic's talk
- Neutrino Mass : Anze's talk
- Proximity Effect : Gabor's talk
- H/He Reionization : Gabor's talk
- Growth Factor : Eric's talk + this talk
- Spectral Index, Mass Power Amplitude etc!!!

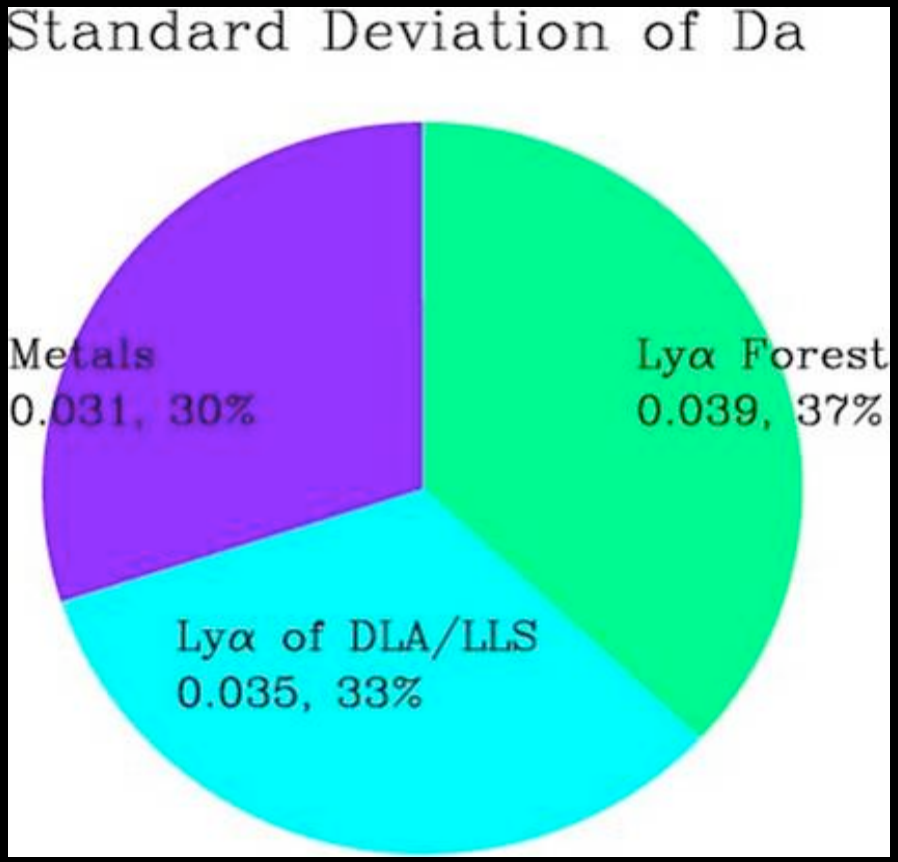
Basics of Spectroscopy

$$R = \frac{\lambda}{\Delta\lambda}$$

$$v = \frac{\Delta\lambda}{\lambda} c$$



- SDSS R=2,000
- v=150km/s
- LRIS R=3,000
- v=100km/s
- ESI R=4,200
- v=72km/s
- HIRES R=37,500

v=8km/s

Can we remove metals/DLAs?