Understanding Density Bias and Redshift Space Distortions in the Large Scale Clustering of the Lyman-alpha Forest

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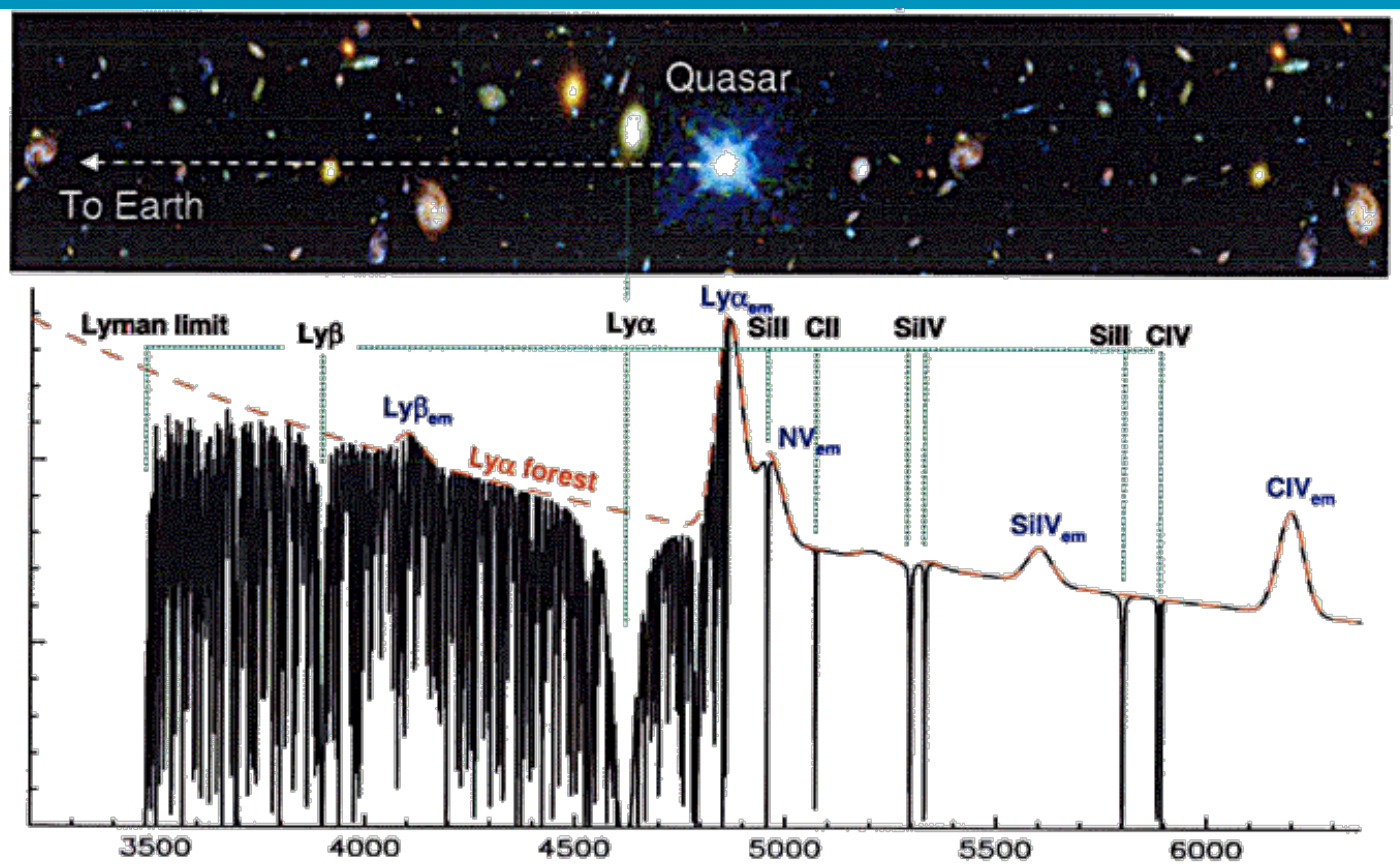
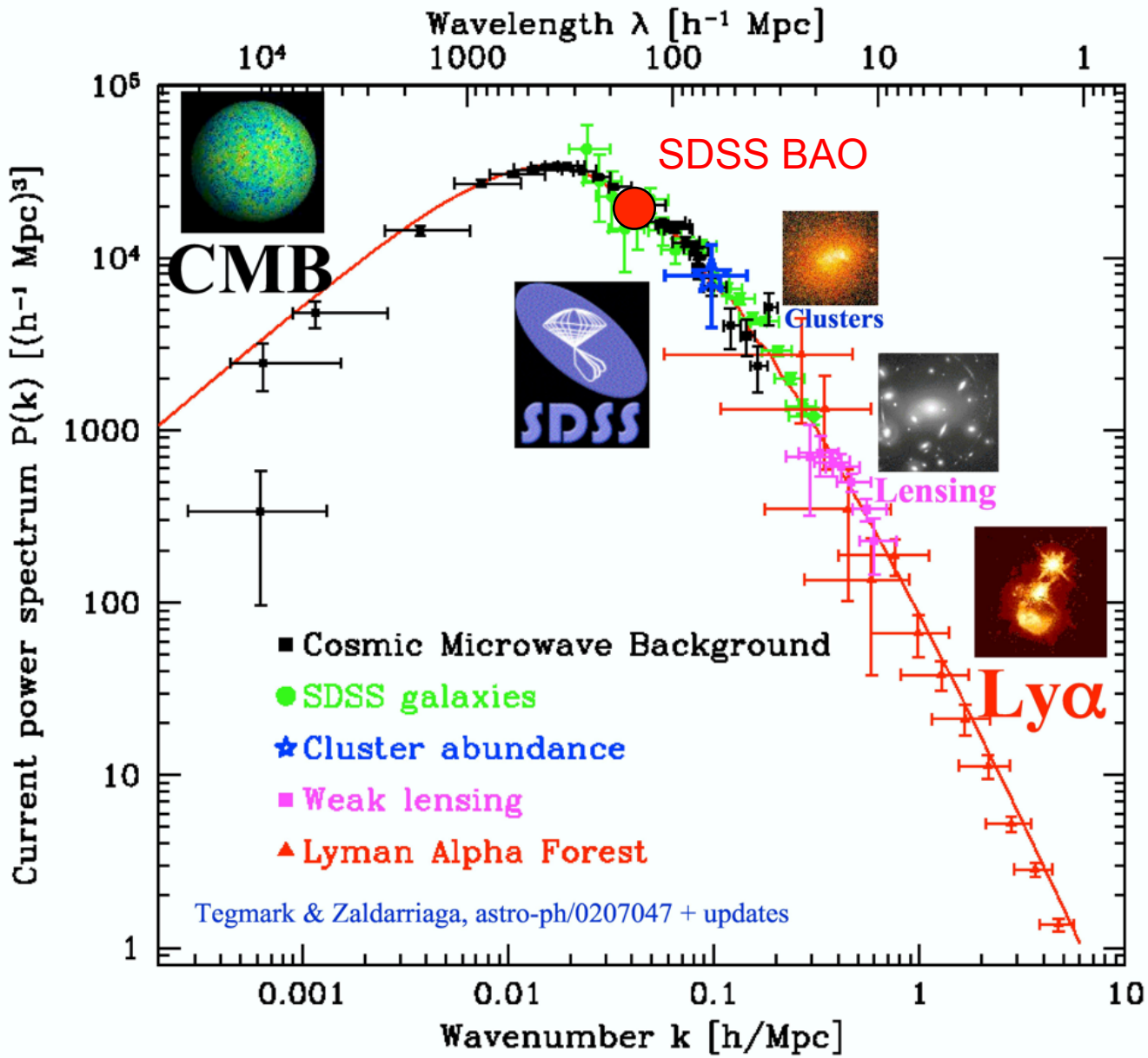
Quasar Absorption Lines



Eso.org

Measure: $F = e^{-\tau}$ → $\tau = A(1+\delta)^{\alpha}$

Power Spectrum



Max Tegmark
Univ. of Pennsylvania
max@physics.upenn.edu
TAUP 2003
September 5, 2003

Bias

$$P_F(\vec{k}) = b^2\left(1+\beta\mu_{\vec{k}}^2\right)^2 P_{DM}(k) + P_N$$

What we measure

What we'd like to measure

Taylor Expansion:

$$F/F(0) \approx 1 + b\delta + b_\eta \eta$$

$$\beta = b_\eta / b$$

Bias Parameters:

$$b = \frac{1}{F}\frac{dF}{d\delta}\bigg|_{\eta=0} \qquad b_\eta = \frac{1}{F}\frac{dF}{d\eta}\bigg|_{\delta=0}$$

McDonald 2003

Peak Background Split

$$\rho \rightarrow \rho(1+\delta)$$

$$H_0 \rightarrow H_0[1-\frac{1}{3}f(z=0)\delta_0]$$

$$\Omega_{m0} \rightarrow \Omega_{m0}[1+(1+\frac{2}{3}f(z=0))\delta_0]$$

$$\Omega_{DE} \rightarrow \Omega_{DE}(1+\frac{2}{3}f(z=0)\delta_0)$$

$$1+z \rightarrow (1+z)(1+\frac{1}{3}\delta(t)-\frac{1}{3}\delta_0)$$

$$\sigma_8 \rightarrow \sigma_8\frac{g'(z'=0)}{g(z=0)}(1-\frac{1}{3}\delta_0)$$

PBSplit – Work in Progress

Rerunning simulations…

Analytical

Seljak: analytic form for bias from flux PDF

Response to long overdense mode: $$\delta_s^g = \left(1 + \frac{34}{21}\delta_l\right)\delta_s$$

Large Scale Overdensity: $$\delta^n = (\delta_s^g + \delta_l)^n$$

Optical Depth Bias: $$b_\tau = \frac{\partial \tau}{\partial \delta_l} = \nu_2 \left\langle \delta \frac{d\tau}{d\delta} \right\rangle + \left\langle \frac{d\tau}{d\delta} \right\rangle$$

Flux Bias:

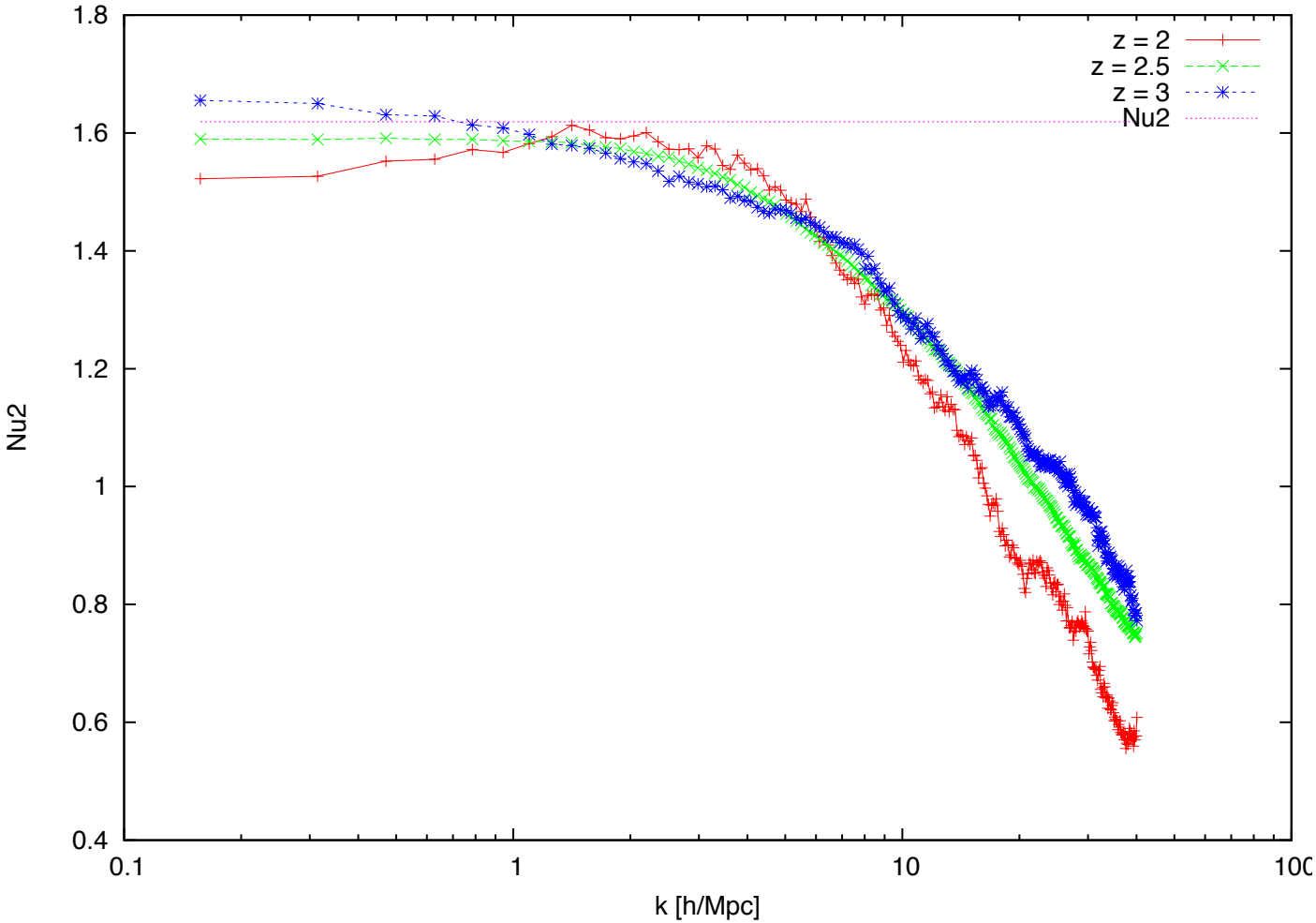
$$b_F = \alpha \langle F \ln F \rangle + \alpha(\nu_2 - 1)\left\langle F \ln F \left[1 - (-\ln F / A)^{-\alpha^{-1}}\right]\right\rangle$$

Velocity Bias:

$$b_v = \langle F \ln F \rangle$$

Seljak 2012

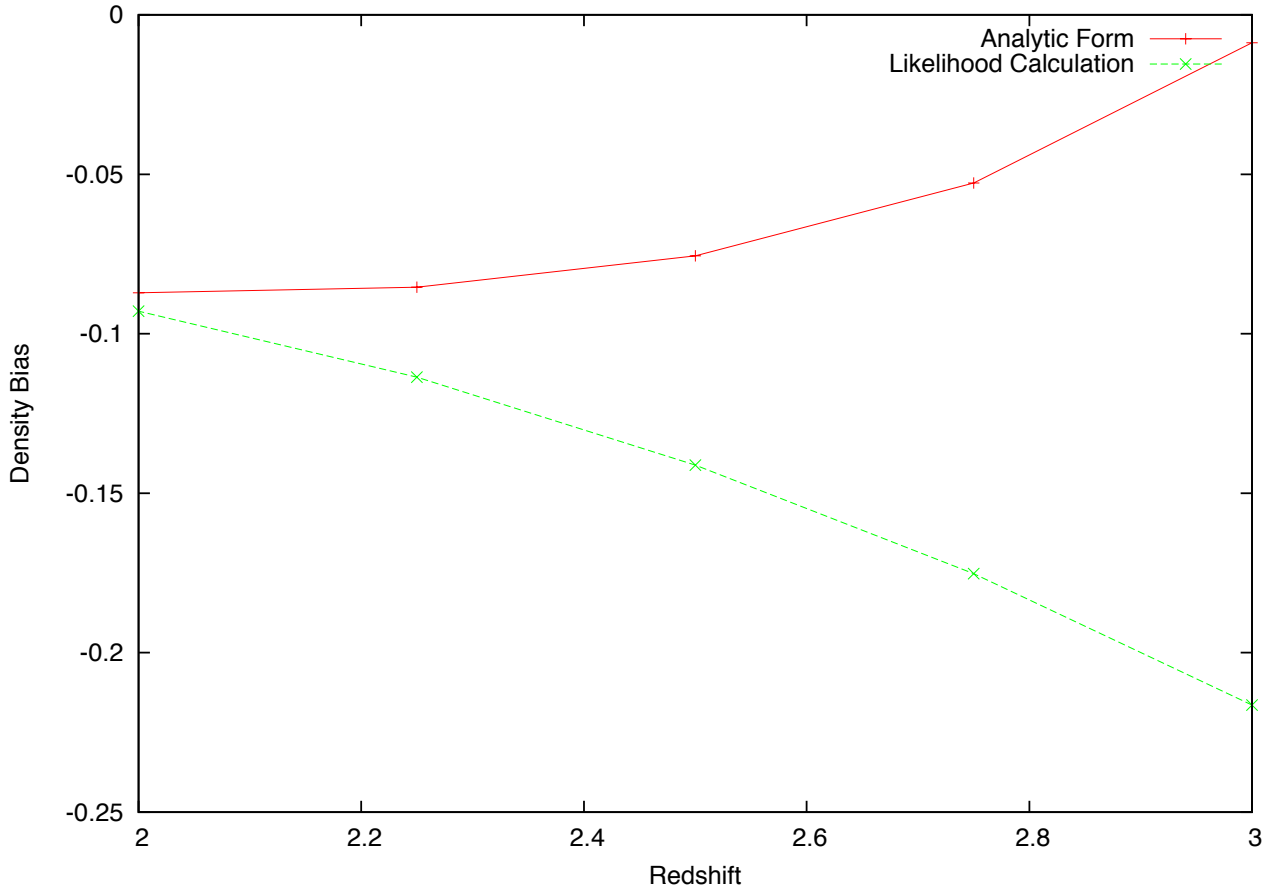
Analytical - Preliminary



$$\delta_s^g = \left(1 + \frac{34}{21}\delta_l\right)\delta_s$$

Cieplak et al. In prep

Analytical - Preliminary



$$b_F = \alpha\langle F \ln F\rangle + \alpha(\nu_2 - 1)\left\langle F \ln F\left[1 - (-\ln F / A)^{-\alpha^{-1}}\right]\right\rangle$$