Reionization and Cosmological Parameters

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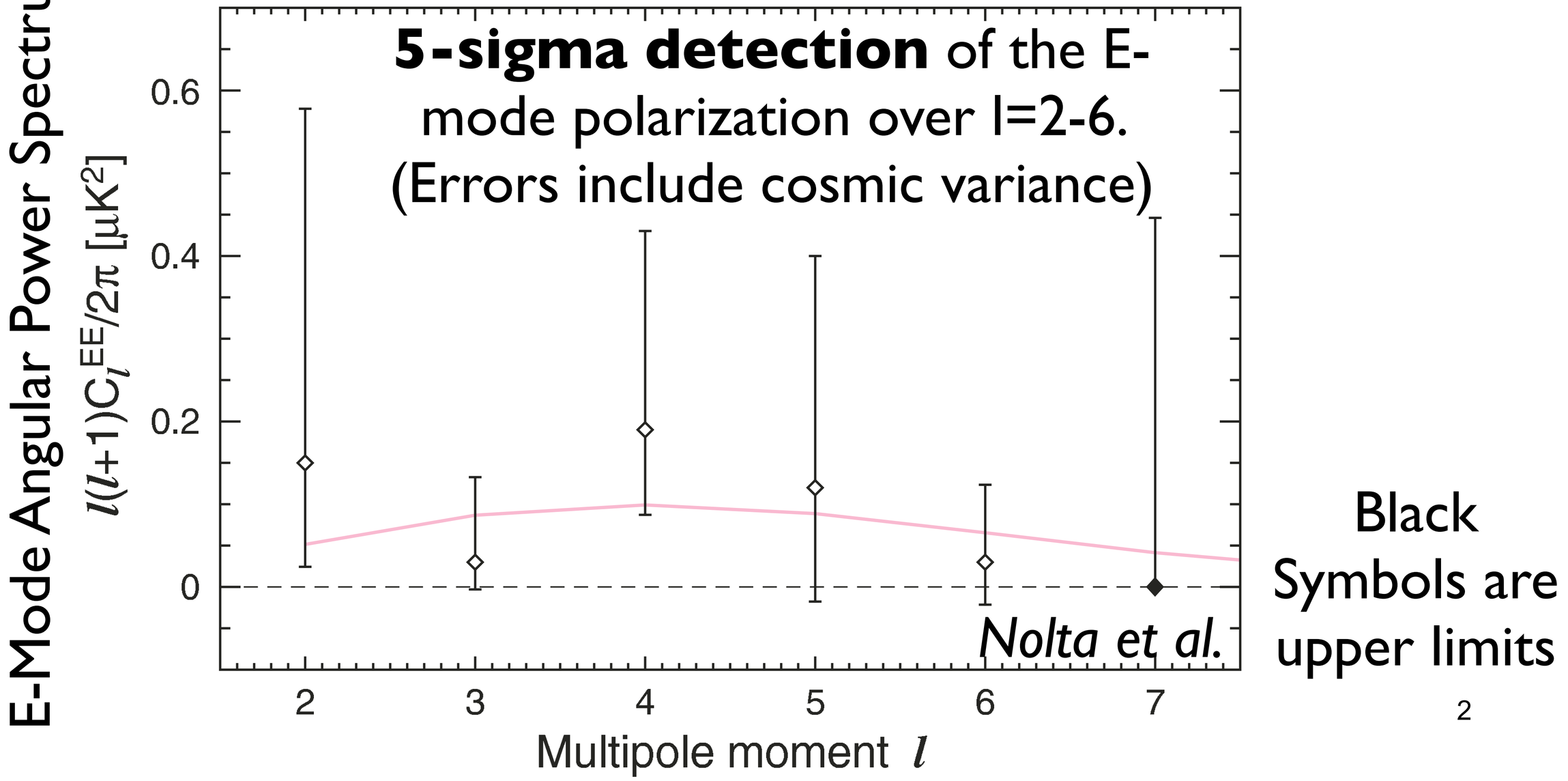
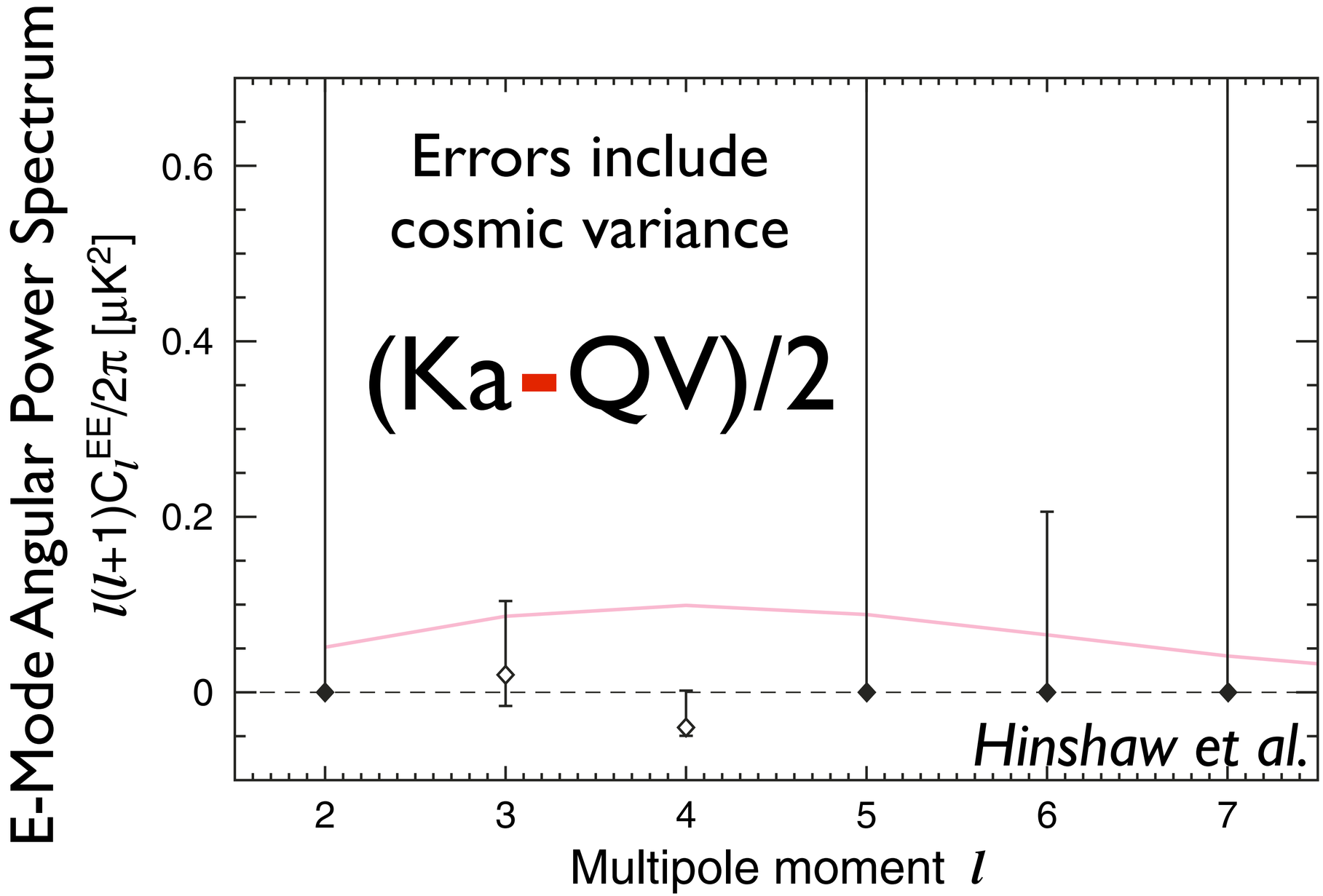
5-Year E-Mode Polarization Power Spectrum at Low l



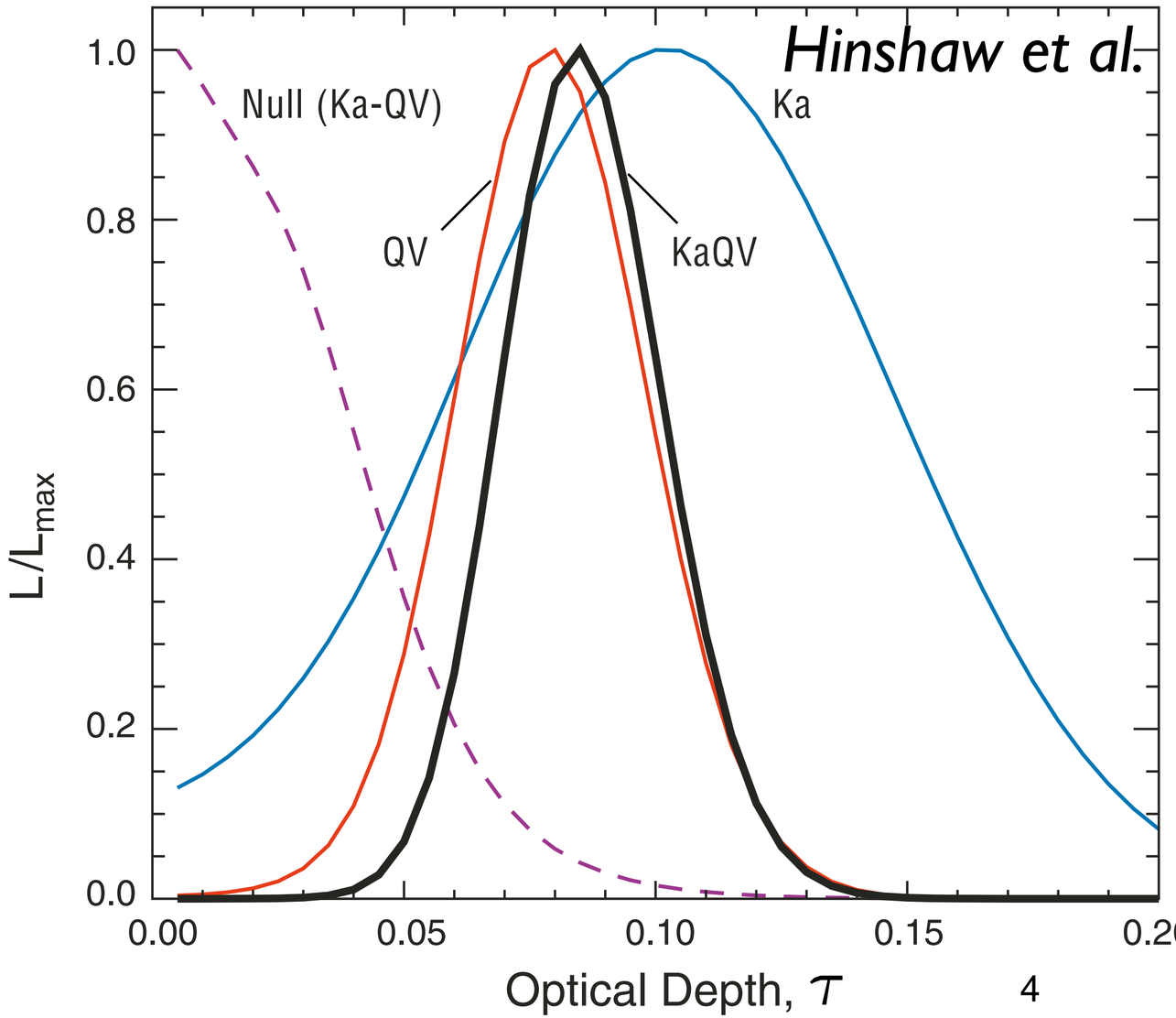
The signal is on the sky, baby...



Black Symbols are upper limits

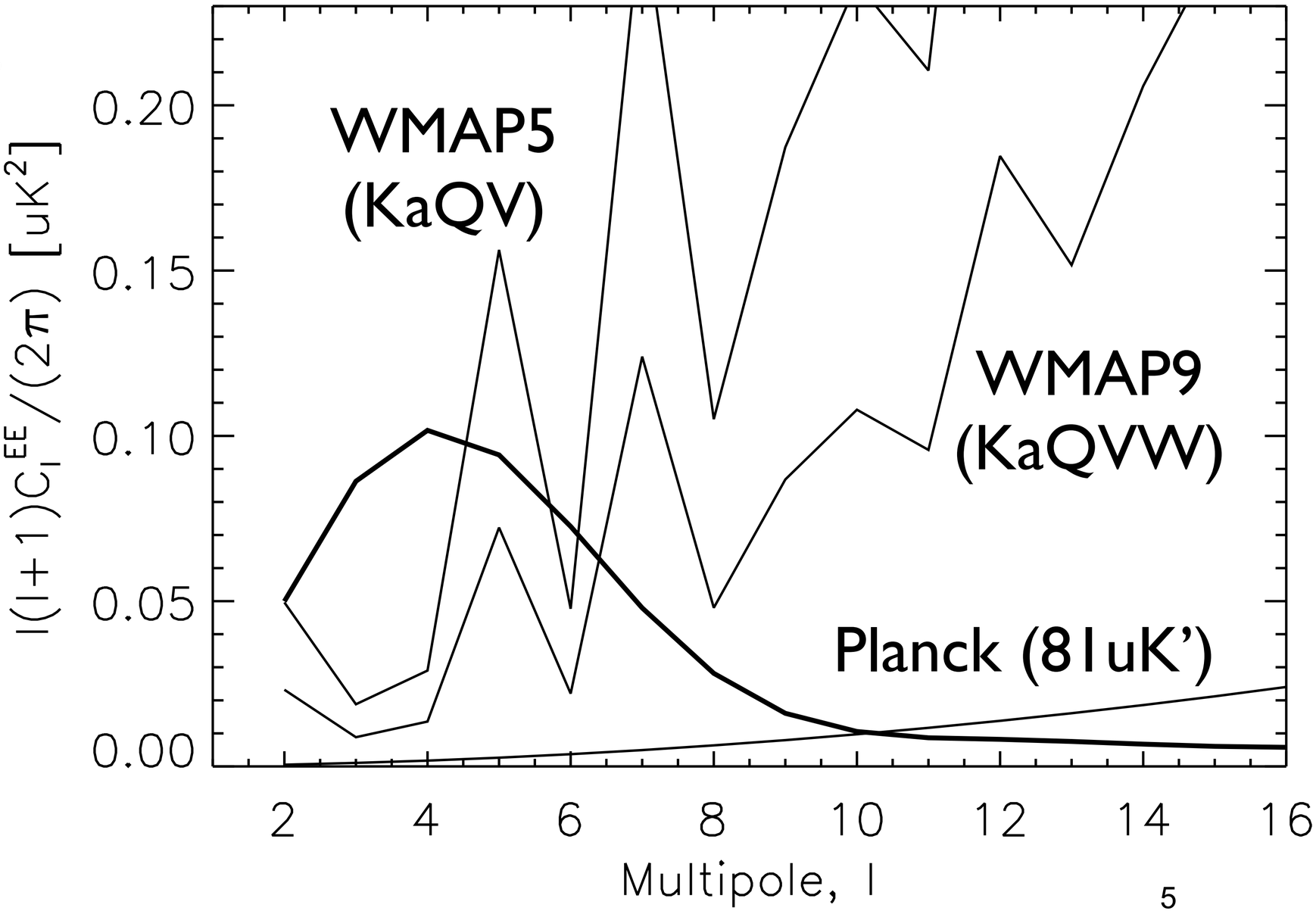
Measuring The Optical Depth of the Universe

- Optical Depth measured from the E-mode power spectrum:
- Tau(5yr)=0.087 +/- 0.017
- Tau(3yr)=0.089 +/- 0.030 (Page et al.; QV only)
- 3-sigma improved to 5-sigma!
- **What is WMAP actually measuring?**

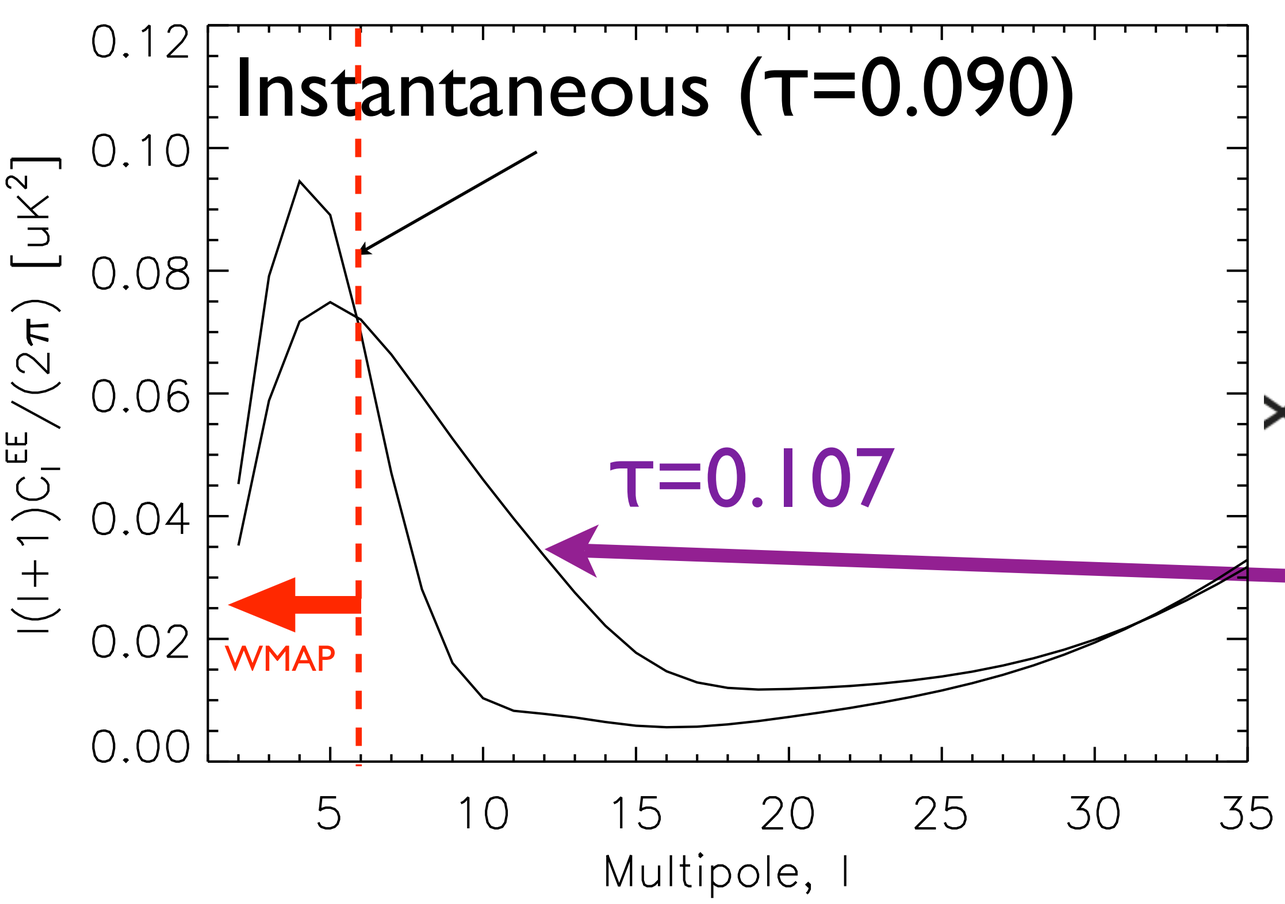


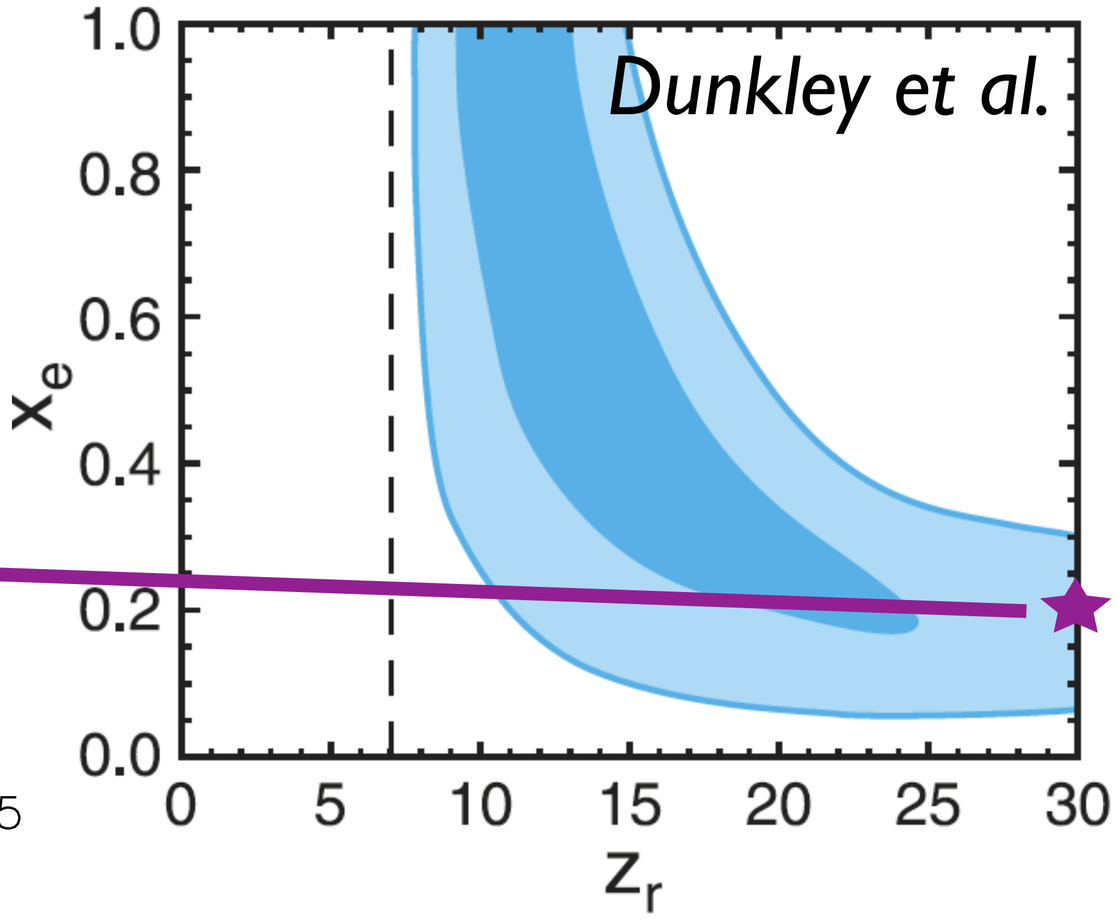
Signal vs Noise C_l (unbinned)

- Signal: instantaneous reionization with τ=0.090
- WMAP9: CV dominated at l<6
- Planck: CV dominated at l<10, if noise is white
  - 1/f noise increases the noise further



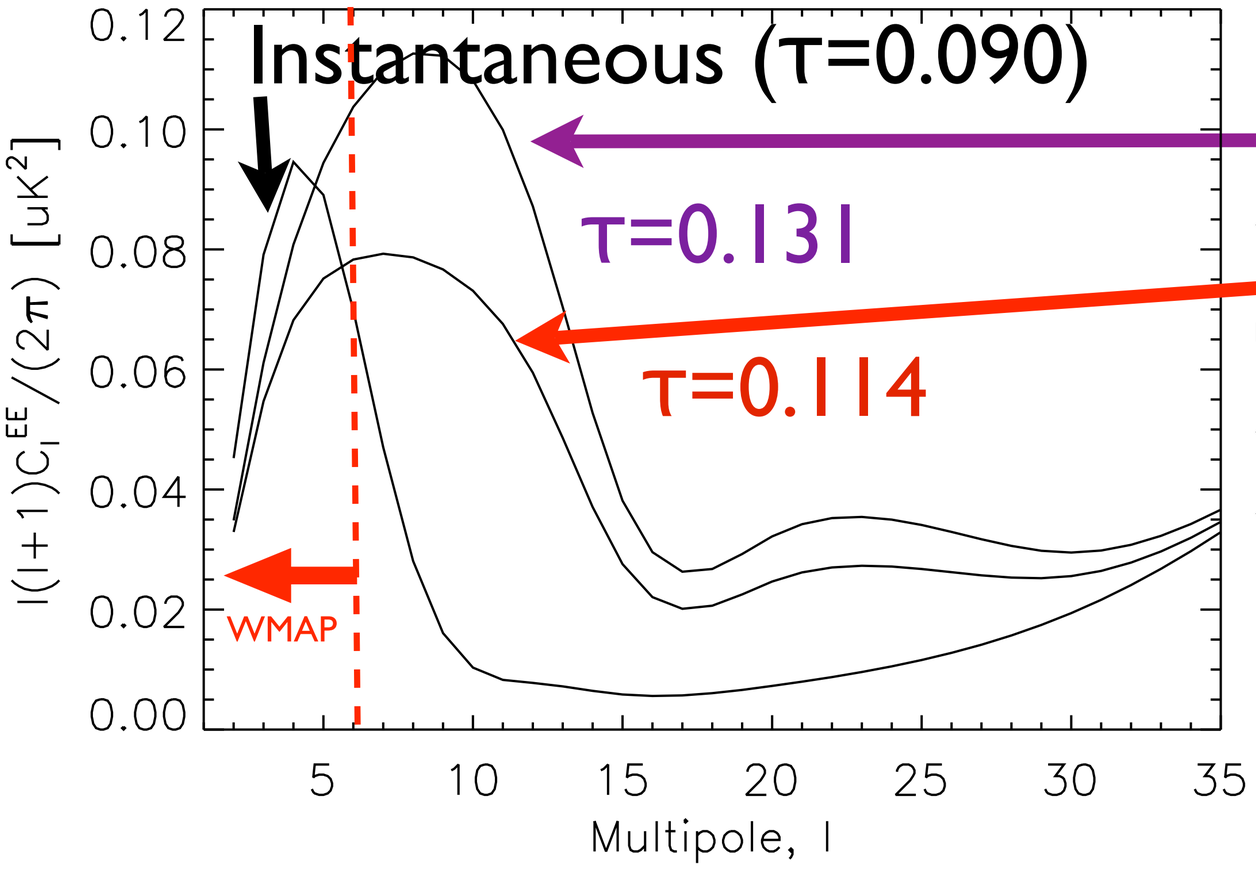
Two-step Reionization

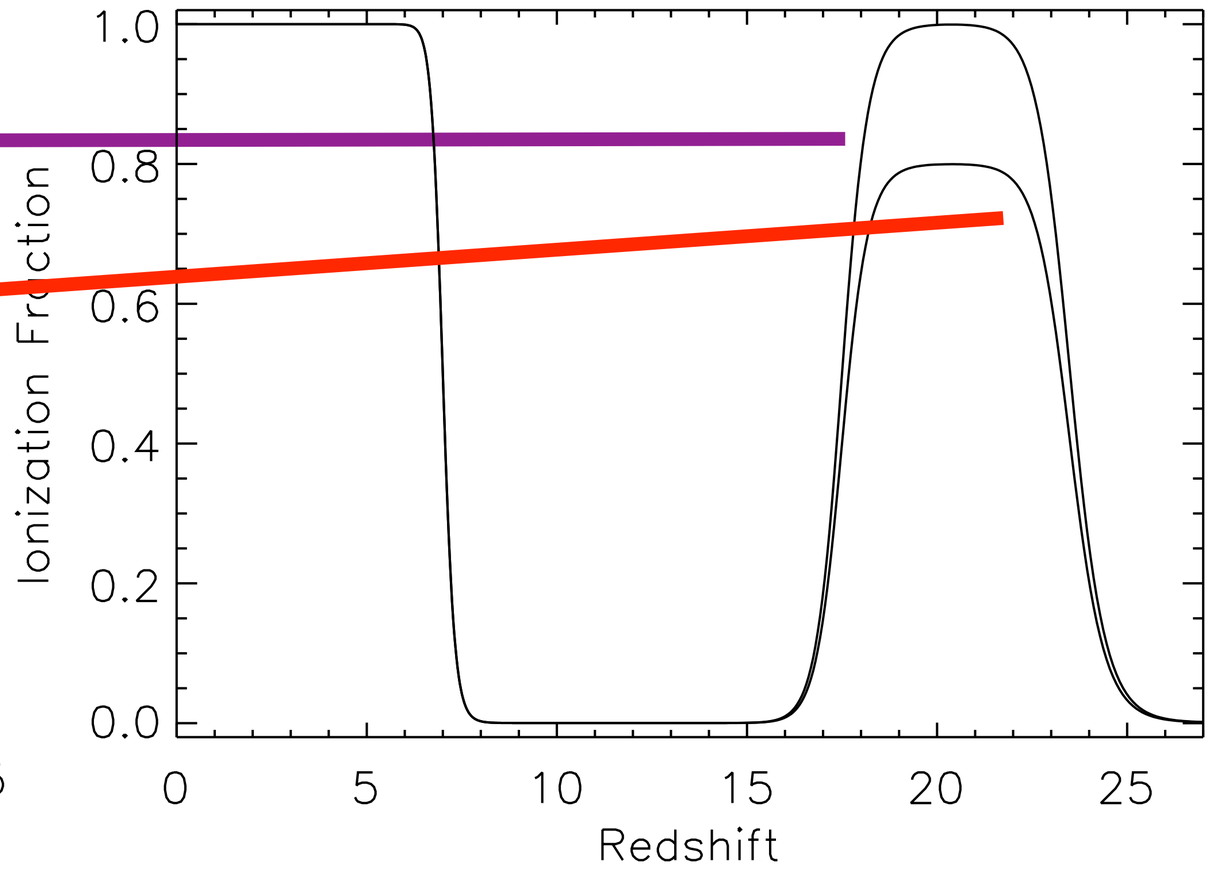




- WMAP5 cannot constrain the EE power spectrum at **l>7**.
- One has a freedom to choose reionization histories at **z>~20**.
- You can hide τ at z>~20!

Double Reionization

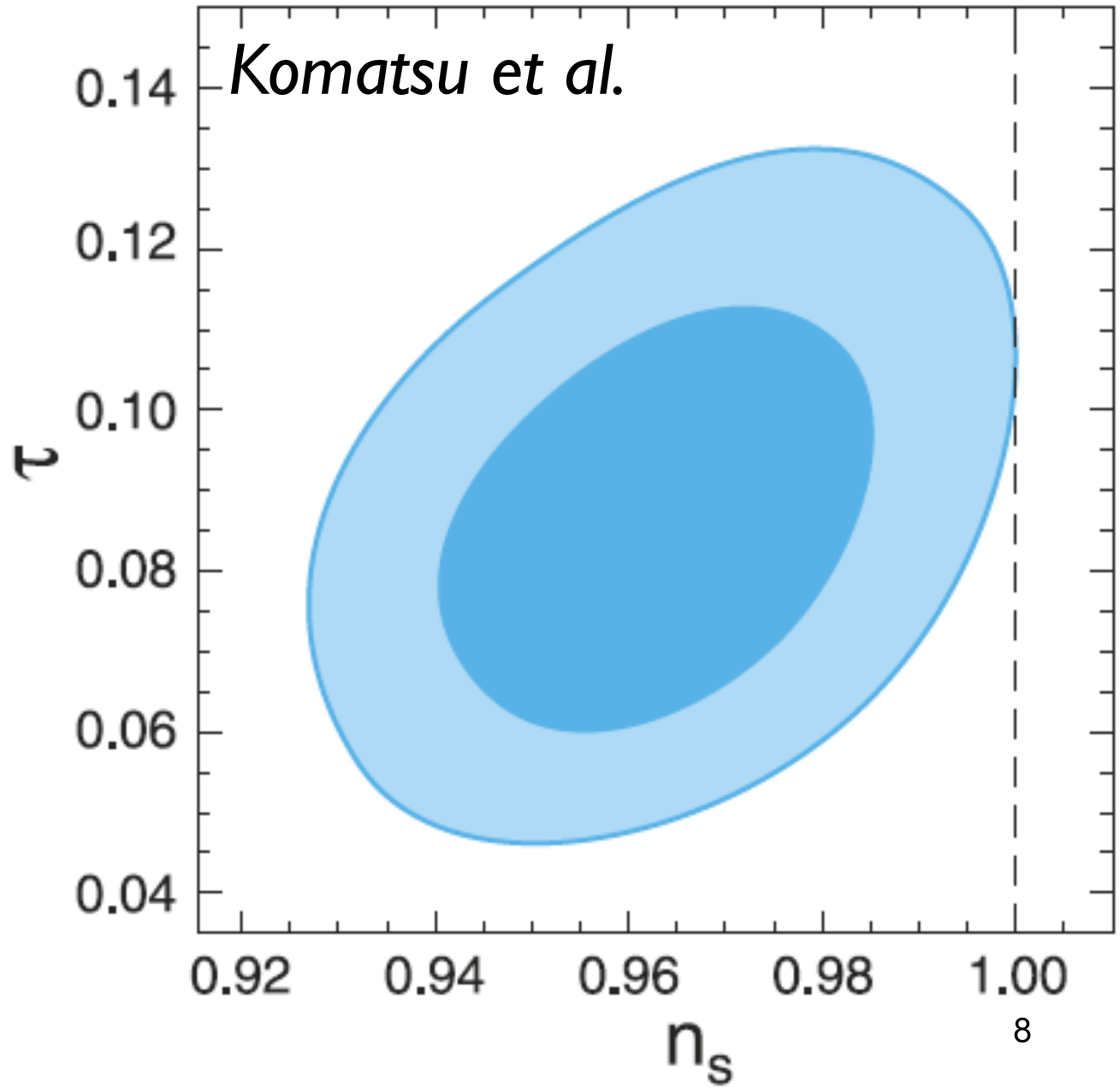




- Even more τ can be hidden in the WMAP 5-year data for double reionization (i.e., non-monotonic reionization)

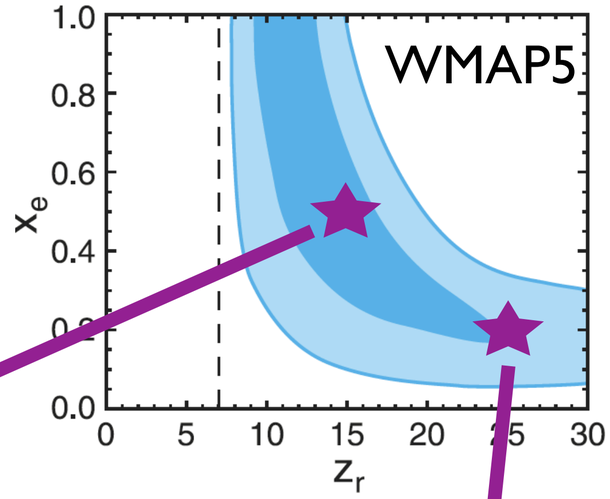
n_s - τ correlation

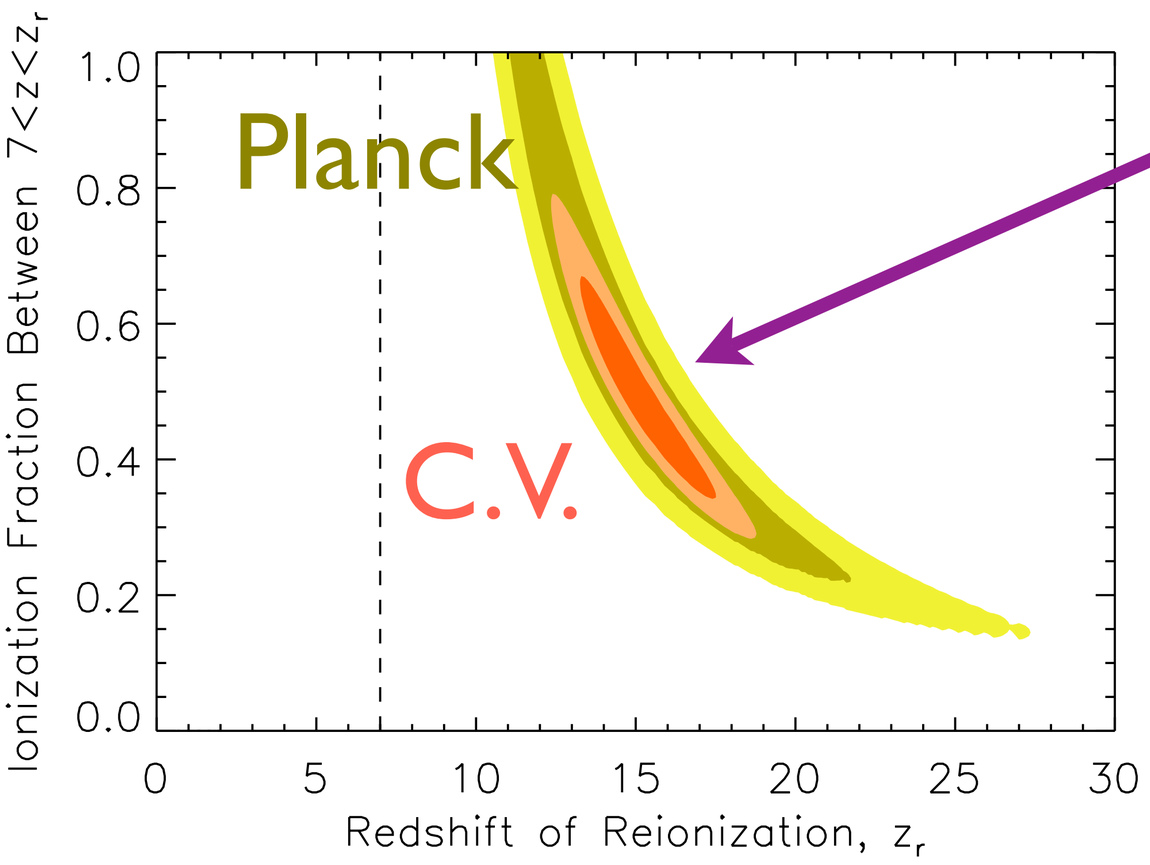
- n_s is closer to unity, if more τ is hidden in the WMAP data.
- Note that this plot assumes the instantaneous reionization.
  - The constraint would be relaxed for double reionization models (i.e., non-monotonic reionization)

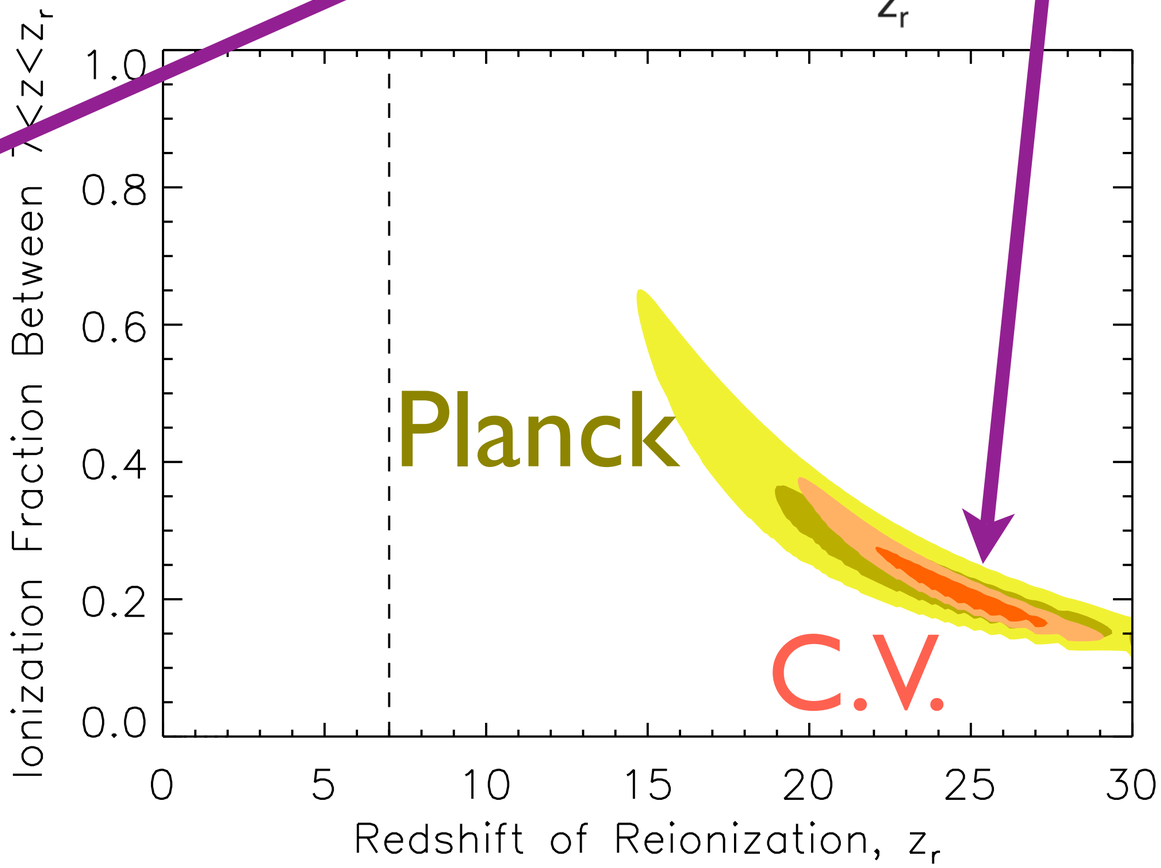


Planck vs C.V. Limited

(f_{sky}=0.8; l_{max}=30)







- The cosmic variance limited experiment constrains both x_e and z_{reion} MUCH better than Planck.

Conclusion

- Planck's EE measurement is cosmic variance limited (l-by-l) only up to l~10, assuming white noise.
  - Contribution of 1/f noise degrades the sensitivity further
  - Note that WMAP9's EE would be cosmic variance limited (l-by-l) up to l~6
- Will the cosmic variance limited experiment improve the limits on reionization histories? *Yes, significantly!*
- Implications for the cosmological parameters?
  - Accurate determination of n_s is possible only if we can find ALL of τ out there.

What I learned yesterday from Elena Pierpaoli

- n_s and τ are totally de-correlated for Planck and CMBPol
  - These experiments won't need τ for measuring n_s.
  - So, implications of Planck's and CMBPol's reionization measurement for the other cosmological parameters may be a lot less than those for WMAP.
    - In fact, there may be no implication at all.
    - Good news!