

# Variability of the proton-to-electron mass ratio on cosmological scales

## *Quasar absorption line spectroscopy*

Martin Wendt



Hamburger Sternwarte

# Overview

- Quasar absorption lines
- Methods and Physics involved
- Analysis
- Summary and Outlook

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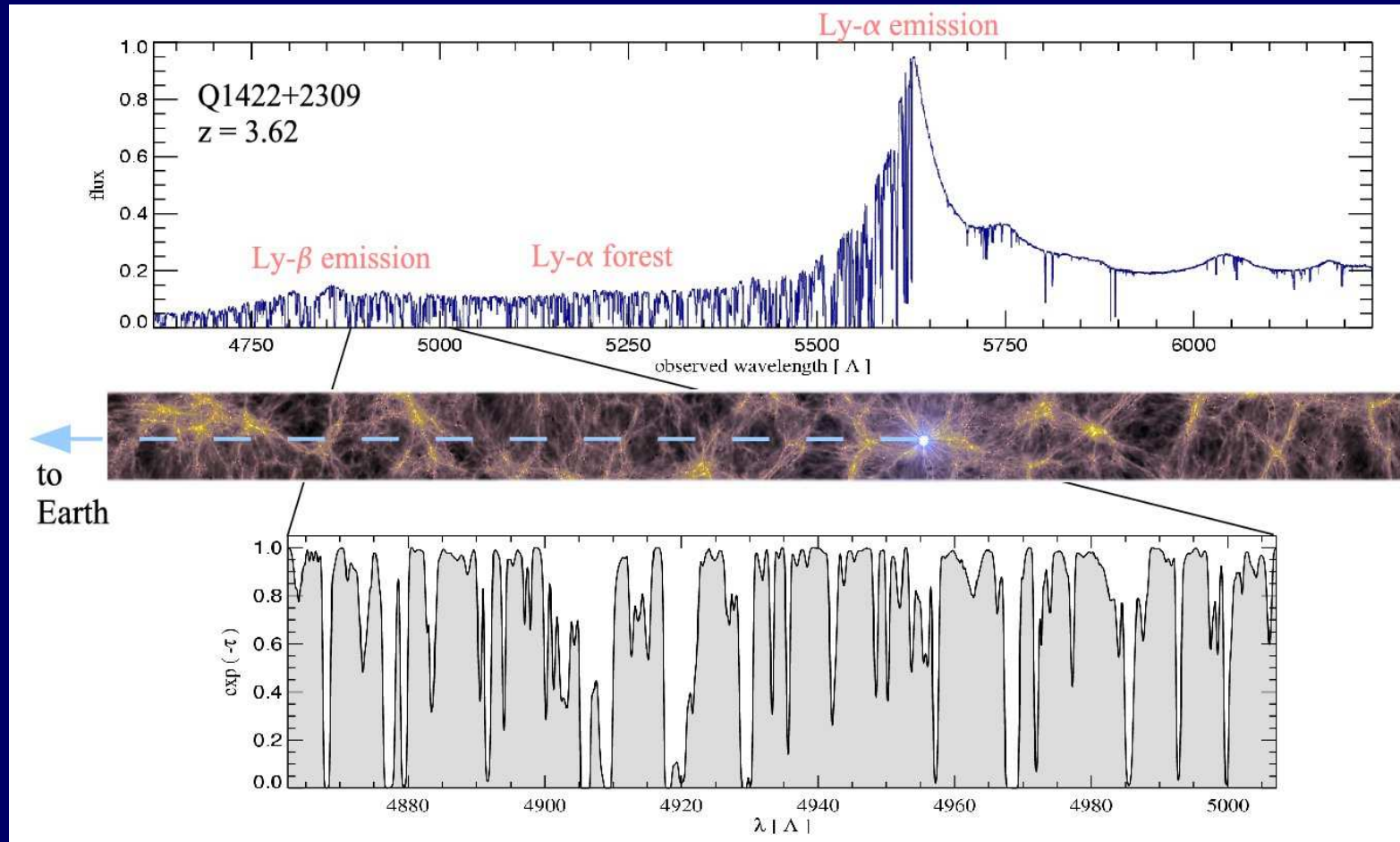
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e.g., the Ly $\alpha$  transition at  $\lambda_{\text{rest}} = 1215.67 \text{ \AA}$

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(Springel et. al 2006)



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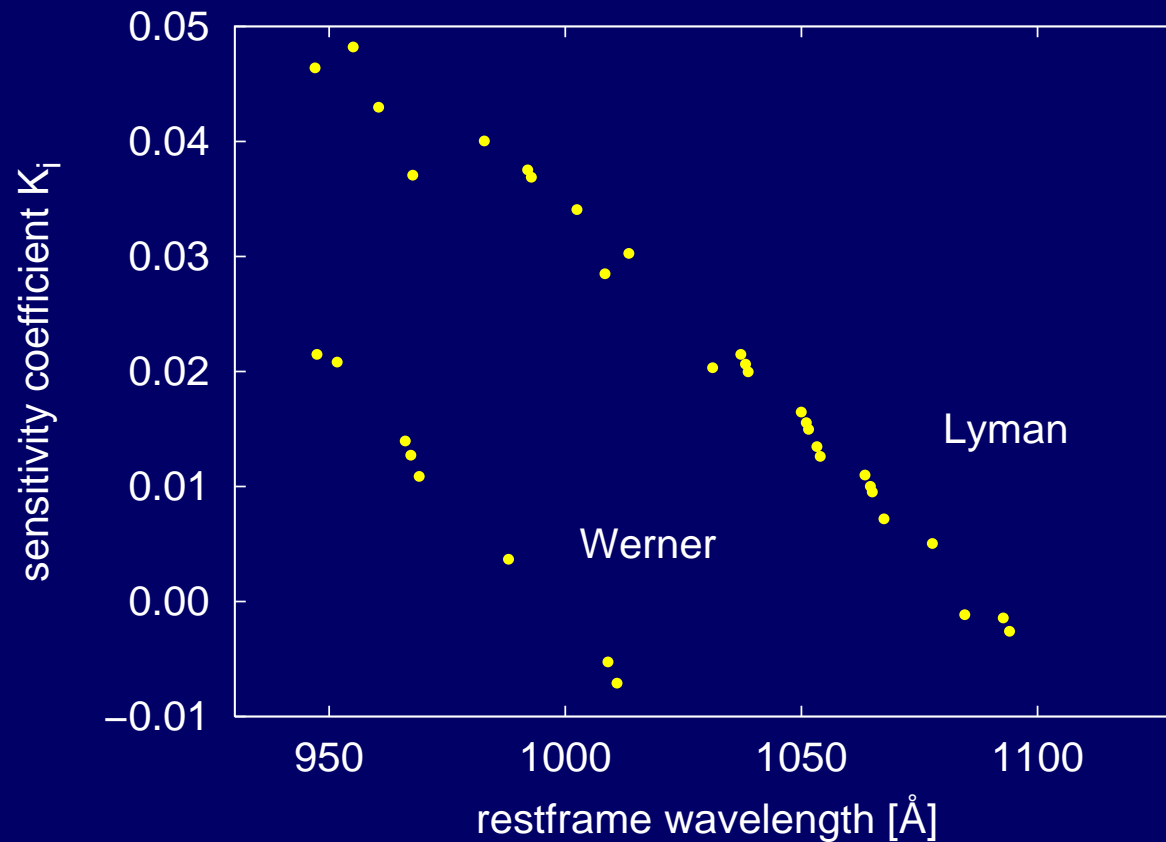
(Varshalovich & Levshakov 1993)

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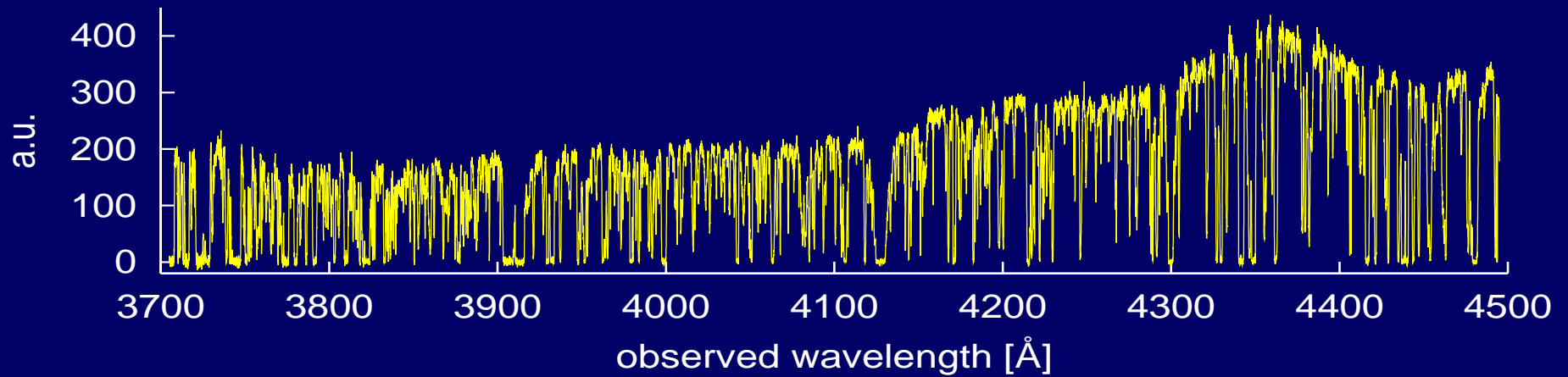


(Reinhold et al. 2006)

# Quasar absorption line spectra - probing the universe

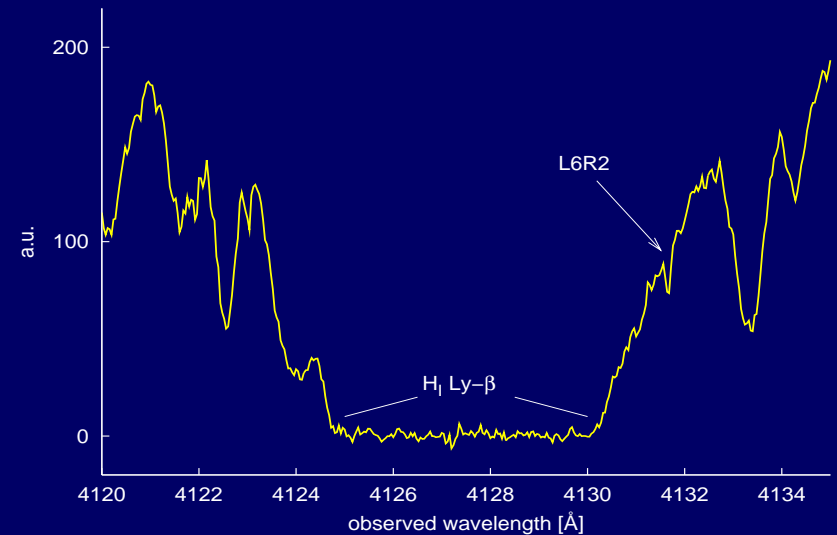
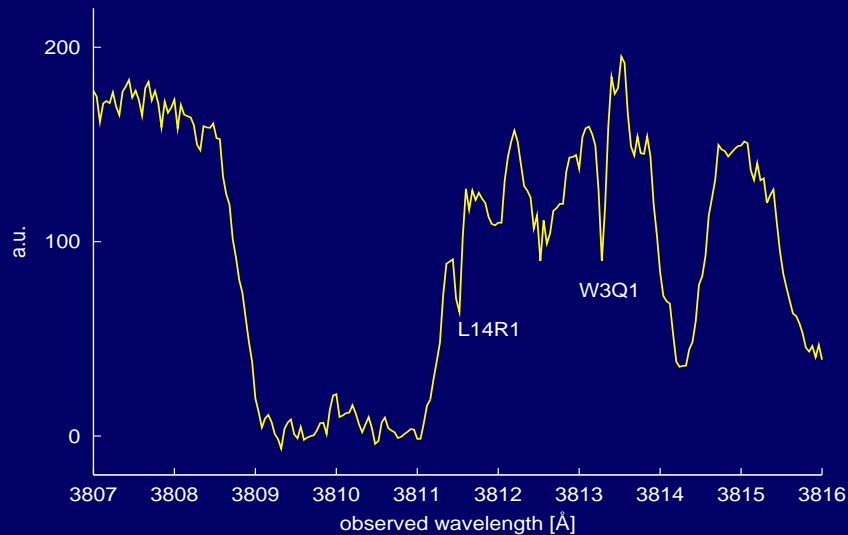
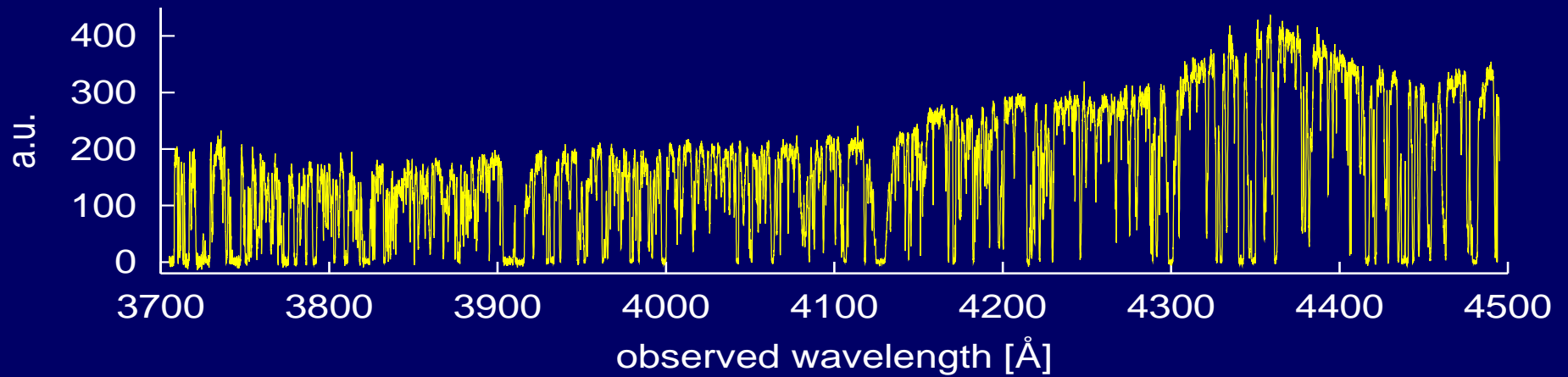
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Q 0347-383



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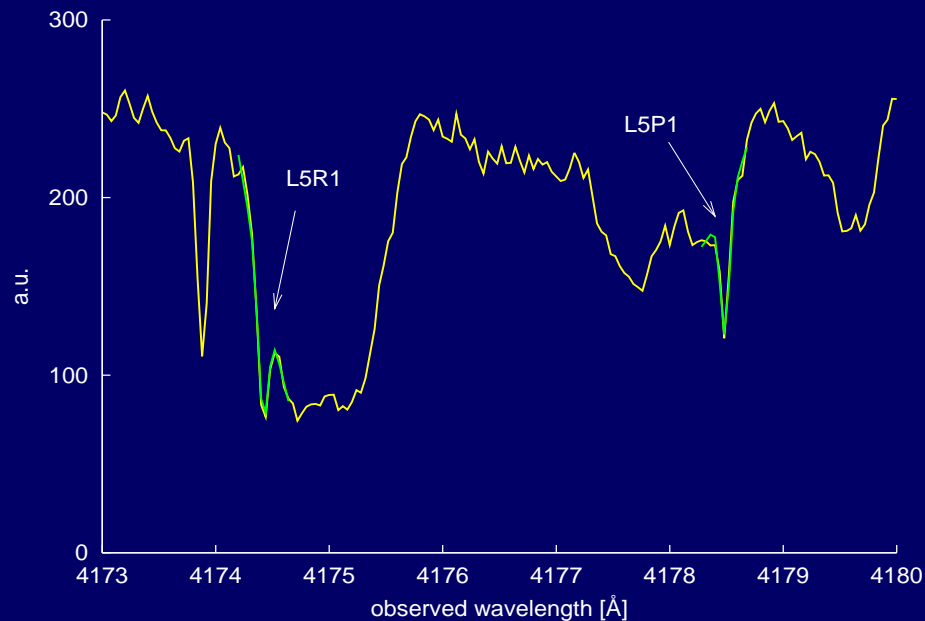


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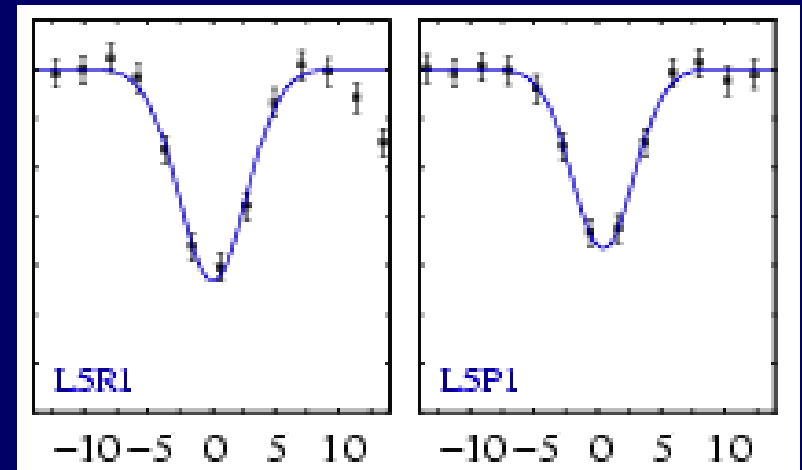
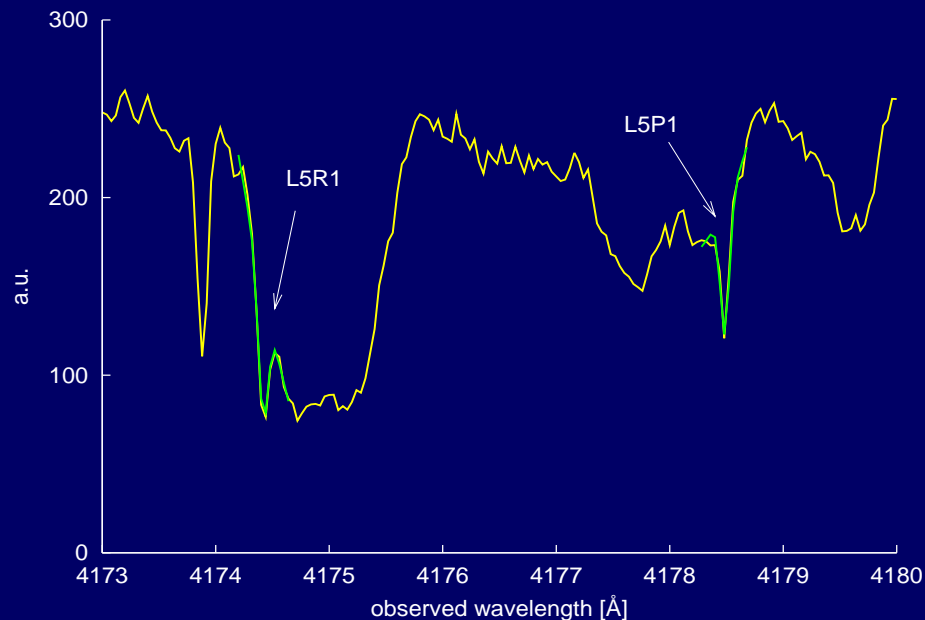
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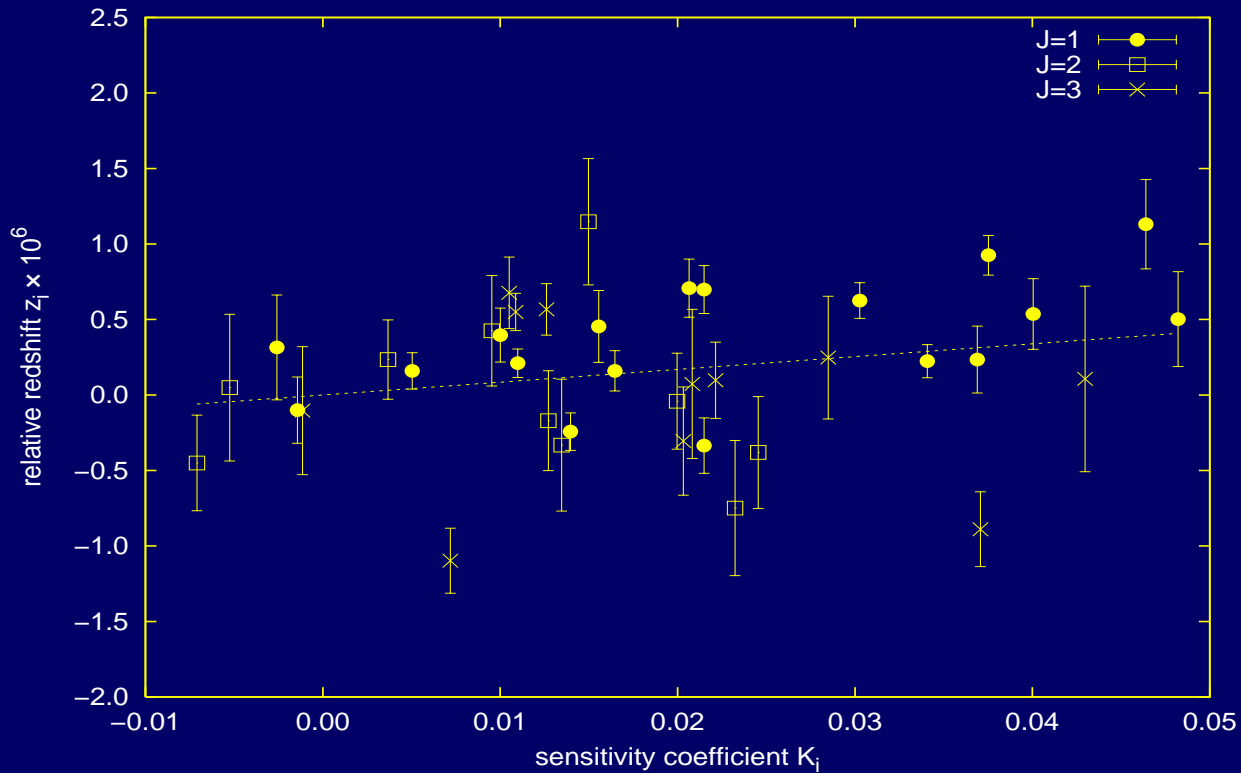
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(Ivanchik et al. 2005)

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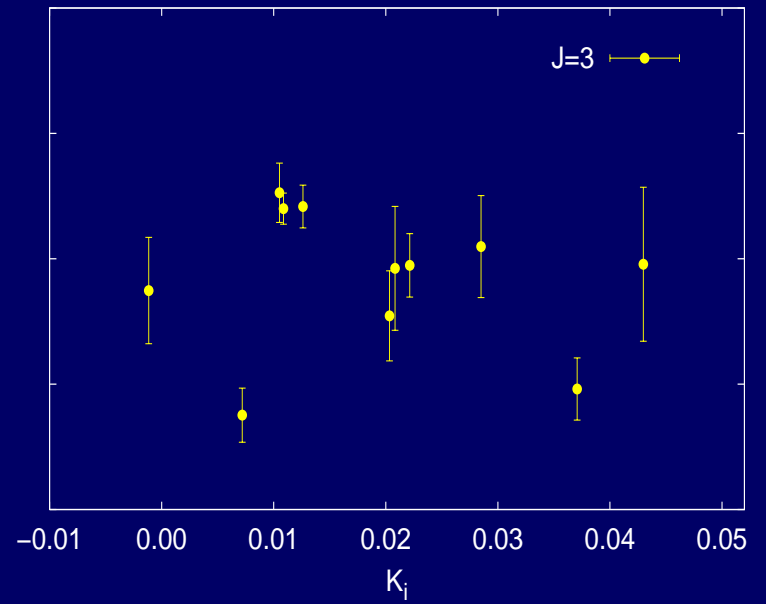
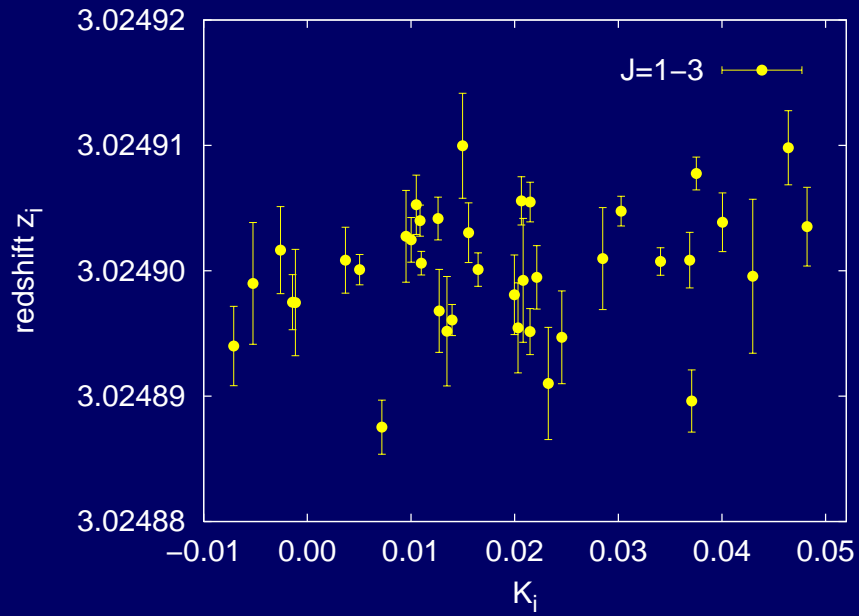
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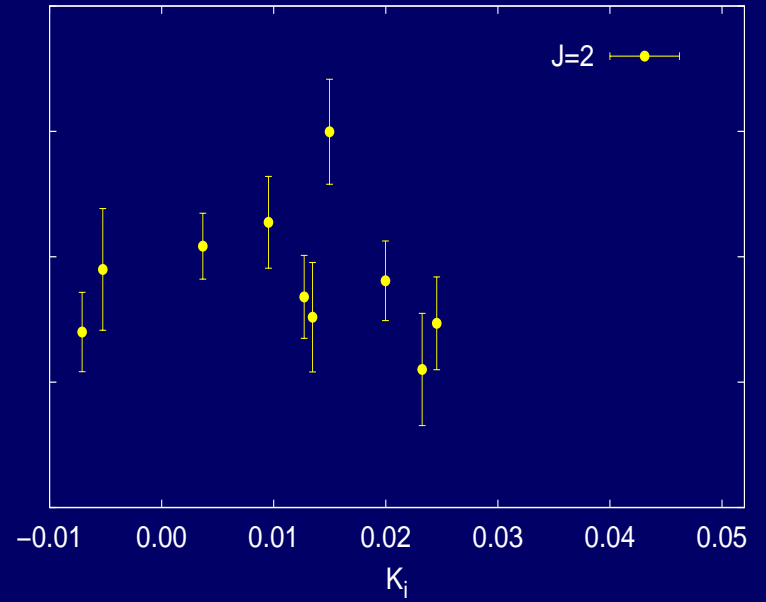
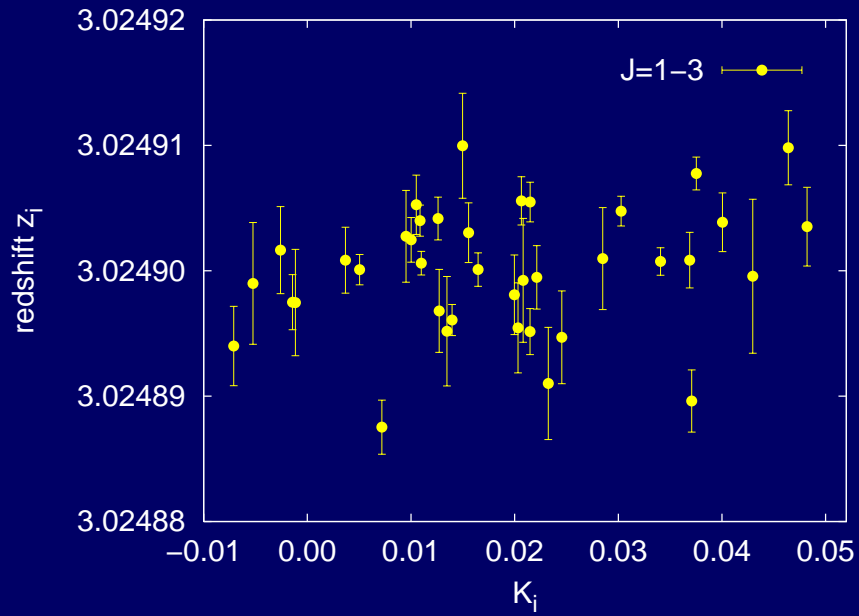
corresponding to  $\frac{\Delta\mu}{\mu} = 2.1 \pm 1.4 \times 10^{-5}$

(Reinhold et al. 2006:  $\frac{\Delta\mu}{\mu} = 2.0 \pm 0.6 \times 10^{-5}$ )

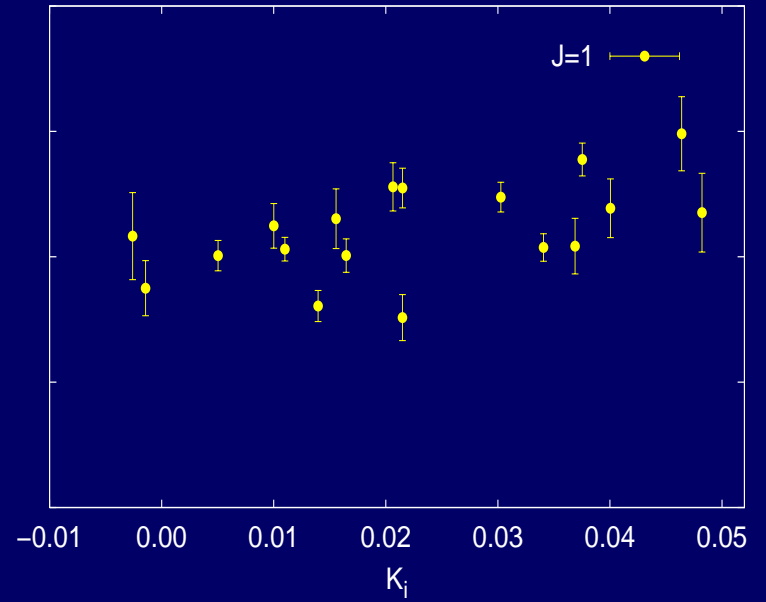
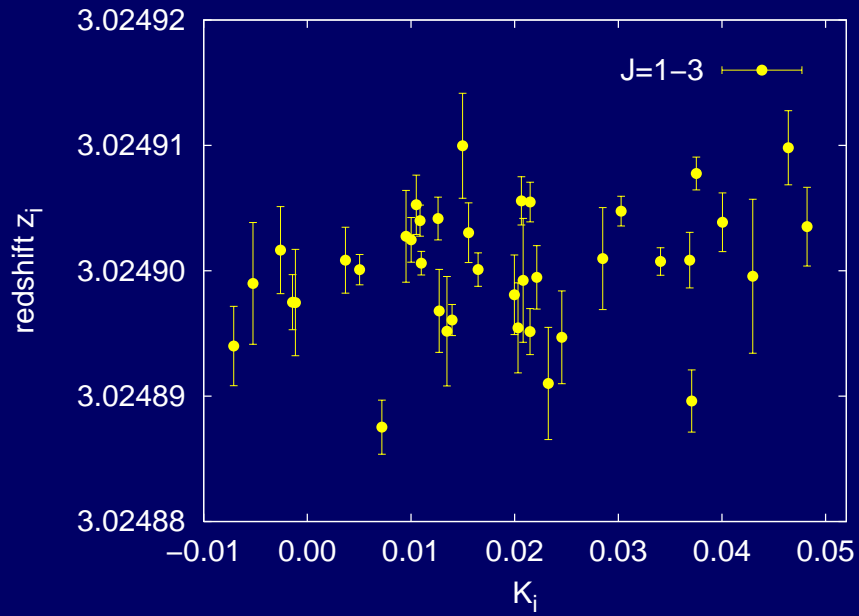
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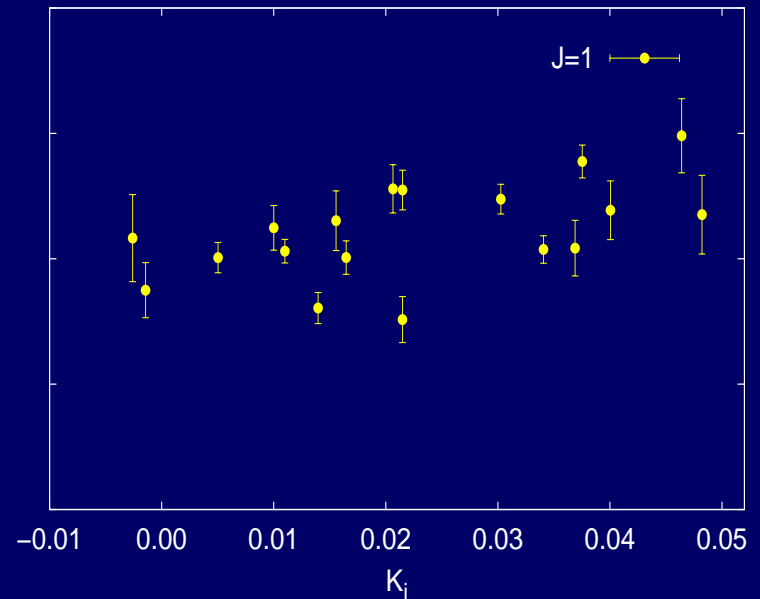
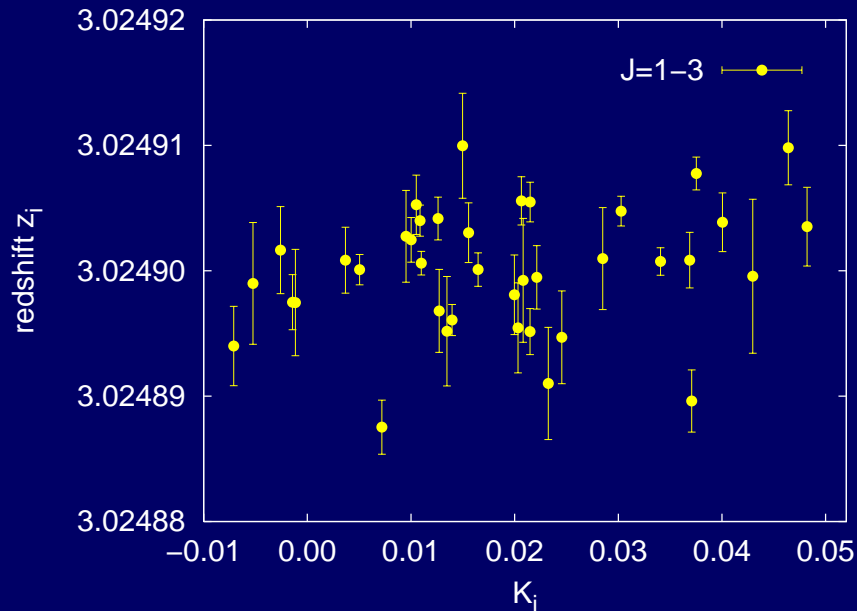


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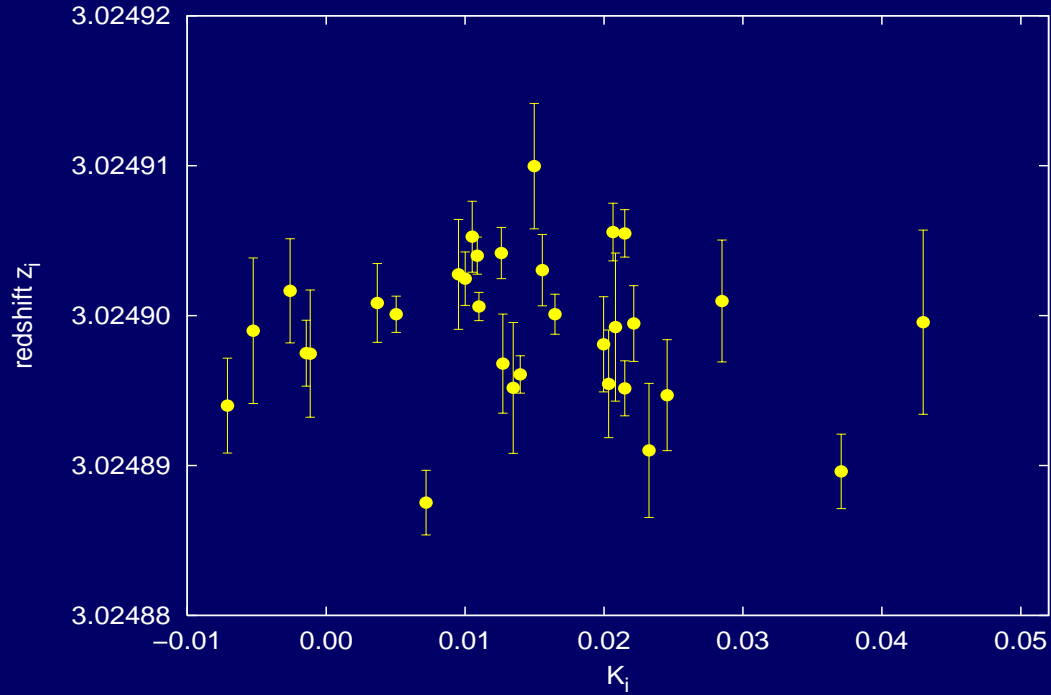


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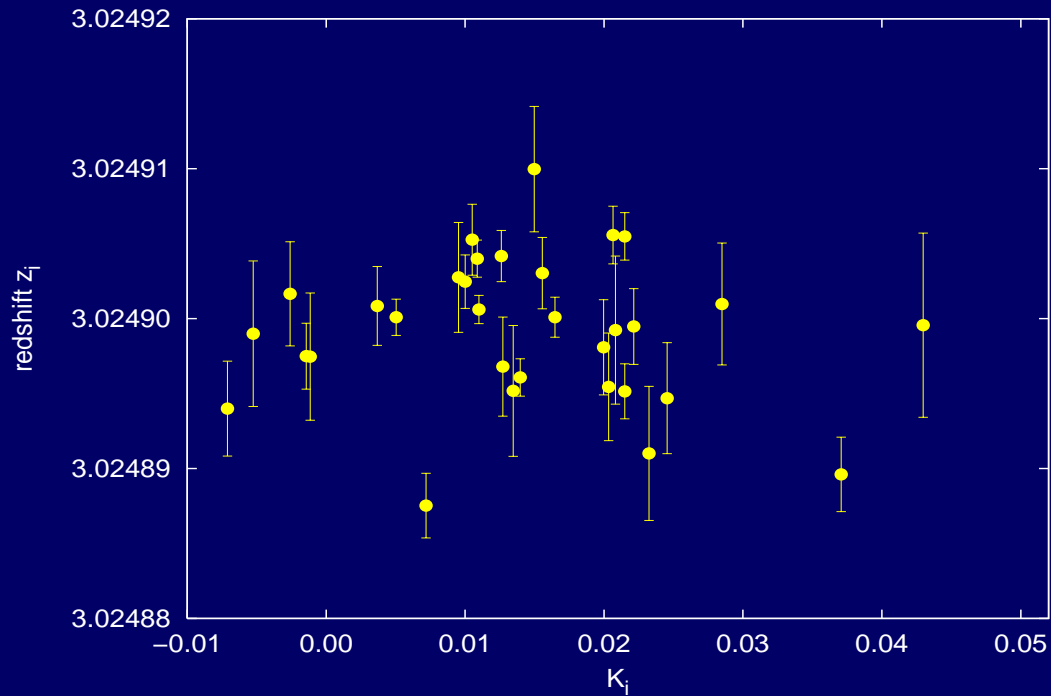


Merely transitions with high vibrational quantum numbers in the first rotational level contribute to a positive result

# News or noise?

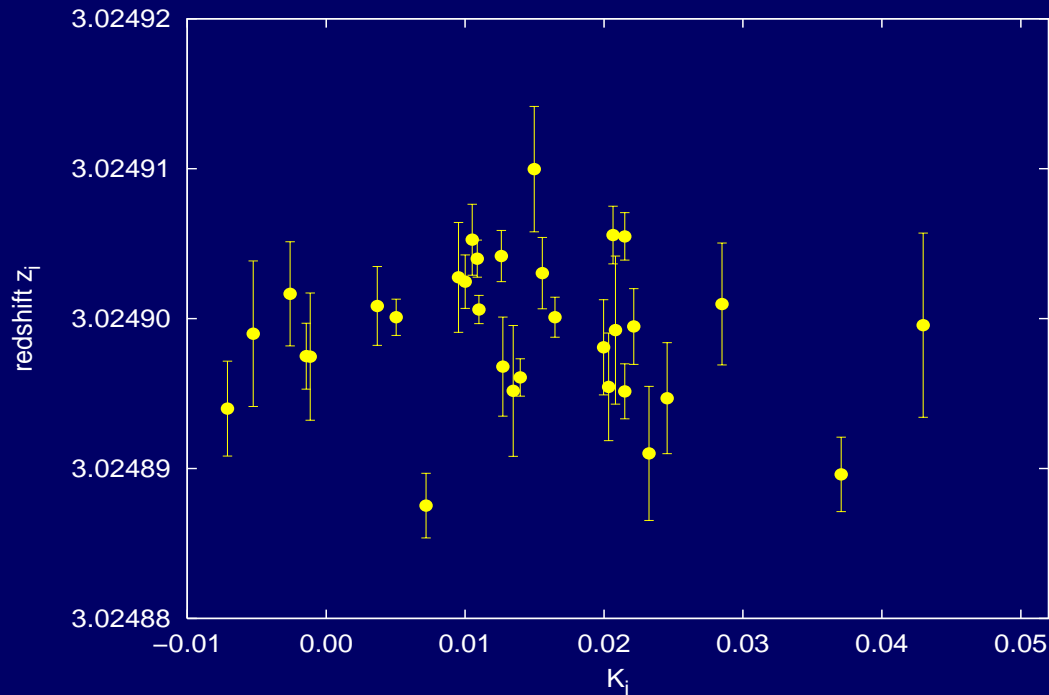


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$$|\Delta\mu/\mu| \leq 4.9 \times 10^{-5} \text{ over the period of } \approx 11.5 \text{ Gyr}$$

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⇒ increased need for high resolution
- in general attach more importance to data reduction
- search for more quasar spectra with DLA and H<sub>2</sub> signatures
- further simulations of detectability of variation
- better understanding of the nature of DLAs

# The Ratio of Proton and Electron Masses

FRIEDRICH LENZ

*Düsseldorf, Germany*

(Received April 5, 1951)

**T**HE most exact value at present<sup>1</sup> for the ratio of proton to electron mass is  $1836.12 \pm 0.05$ . It may be of interest to note that this number coincides with  $6\pi^5 = 1836.12$ .

<sup>1</sup> Sommer, Thomas, and Hipple, *Phys. Rev.* **80**, 487 (1950).