The Cosmic Flux Decrement: A Consistent Picture?

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FAR AWAY: LIGHT IN THE YOUNG UNIVERSE

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IN SHORT

GOAL To explore to which extent the observed evolution of the cosmic flux decrement, $D_{\rm A}$ (Oke & Korycansky, 1982), is recovered by different models of the evolution of intergalactic HI absorbers

METHOD Monte-Carlo simulations of the redshift evolution of $D_{\rm A}$

INPUT Empirical distribution functions of the absorbers' properties of the form

$$f\,(\mathrm{N_{HI}}, z) = \mathcal{N}_0 \cdot (1+z)^{\gamma} \cdot \mathrm{N_{HI}}^{-\beta} \qquad (1)$$

WE ...measure $D_{\rm A}$ for 25 QSOs of the SDSS DR5 at $2.71 \leq z \leq 5.41$ (continuum fit using a power-law; not corrected for metal-absorption)

...generate at each z 4000 lines-of-sight, each consisting of a random population of absorbers drawn from eq. (1) for different sets ($\mathcal{N}_0$, γ, β) corresponding to Bershady et al. (1999)'s models: *MC-NH* (here MMC) and *MC-Kim* (here BMC)

...compute $D_{\rm A}(z)$ at $0.2 < z < 6$ using the MMC and BMC models, and a recent model of the absorption of light by intergalactic HI by Meiksin (2006) (here MTC)

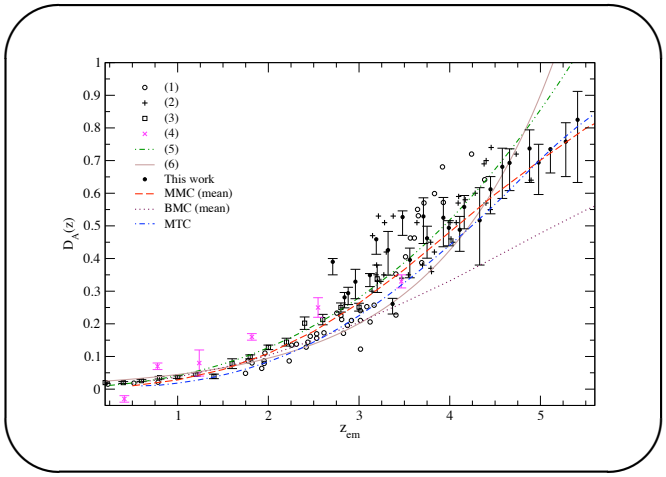

Figure 1. Evolution of the *mean* $D_{\rm A}$: MMC (dashed line), BMC (dotted line), and MTC (dot–dashed line); observations: (1) Zuo & Lu (1993), (2) Schneider et al. (1991), (3) Kirkman et al. (2007), (4) O'Brien et al. (1988); empirical fits: (5) Zhang et al. (1997), (6) Kirkman et al. (2005). All data points display 1σ error bars.

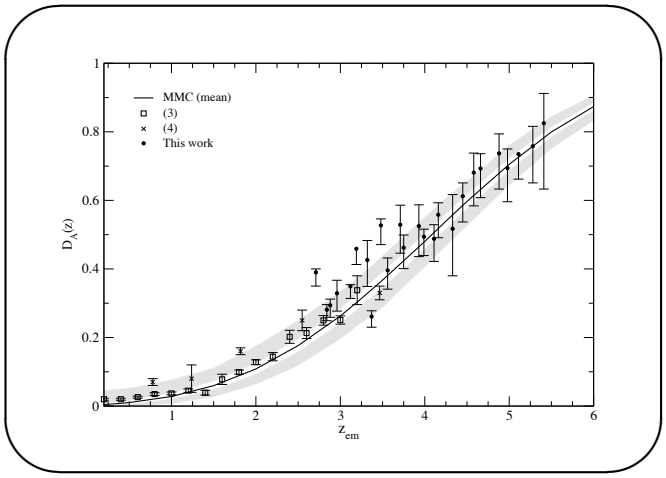

Figure 2. Evolution of $D_{\rm A}$ from the MMC model: mean (solid line), scatter at the ± 1 and $\pm 3\,\sigma$ levels (white and shaded areas around solid line, respectively). Data points constitute a more homogeneous subsample of the data sets included in Fig.1.

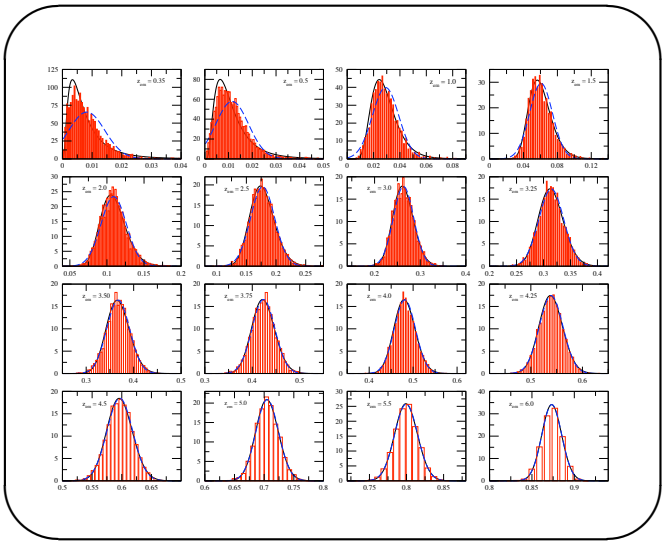

Figure 3. Probability distribution of $D_{\rm A}$ at different redshifts from the MMC model (red histogram). Bin size arbitrarily chosen to be given by $max\{D_{\rm A}(z)\}/100$, and is thus different at each redshift. Solid line: log-normal distribution function; dashed line: Gaussian distribution function. Note that the parameters (mean, standard deviation) of the probability distribution functions have been computed using the *unbinned* data.

SUMMARY & CONCLUSIONS

- Measurements of $D_{\rm A}$ (and its uncertainty due to *statistical and systematic errors*; *not corrected for metal-absorption*) extended to the redshift range $2.71 \leq z \leq 5.41$ using 25 QSOs of the SDSS DR5 catalog

- Evolution of $D_{\rm A}$ very sensitive to parameters of empirical distributions functions

  → useful tool to test any model of the absorption of light by intergalactic HI before it is used to *e.g.* correct synthetic or observed spectra for intergalactic absorption (see *e.g.* Bicker et al., 2004)

- Distribution of $D_{\rm A}(z)$ well described by a log-normal distribution at all redshifts (**in the z-range and for the particular models considered here**)

  ✓ agreement with theoretical expectation based on the fact that, *at a given wavelength*, the absorption is mathematically expressed as the product of a large number of small (*e.g.* between 0 and 1), statistically independent factors of the form $\exp[-\tau]$

  ⇒ effective optical depth normally distributed (**at redshifts where $D_{\rm A}$ is distributed log-normally**) → conflict with other studies (see *e.g.* Bernardi et al., 2003; Meiksin, 2004, but see also Inoue & Iwata 2008)

  ! caution in light of the fact that the models cannot reproduce the amplitude of the observed scatter in $D_{\rm A}$

- *Most scatter in the observed $D_{\rm A}$ introduced by combining measurements based on different methods*

  → a larger, homogeneous sample of accurate measurements of $D_{\rm A}$ (or a similar observable) over a wide z range is needed for a more faithful comparison to models, and to determine the intrinsic *shape* and *amplitude* of the distribution of $D_{\rm A}$

→ For more details please refer to Tepper-García & Fritze (2008)

ACKNOWLEDGMENTS

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