Understanding Acoustic Scale Measurements

The One Sided Fight Against Λ

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Lewis & Chamberlain, arXiv:2412.13894

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Outline

1. Background
2. Constraints
3. Results
4. Conclusions

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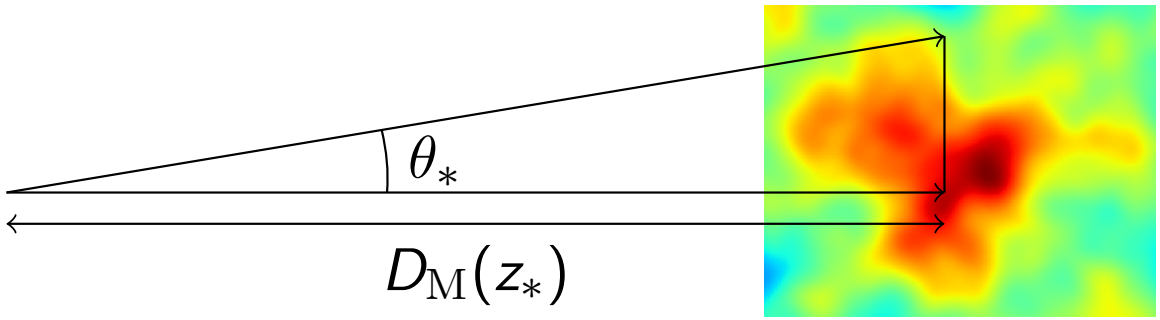
Background

- Cosmic Microwave Background (CMB) constrains the angular size of the sound horizon θ_*.



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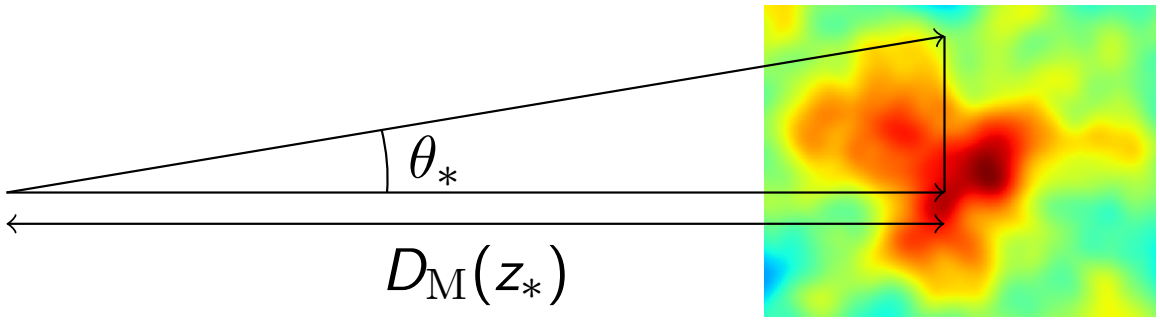
- Measured to within 0.03% by *Planck*.



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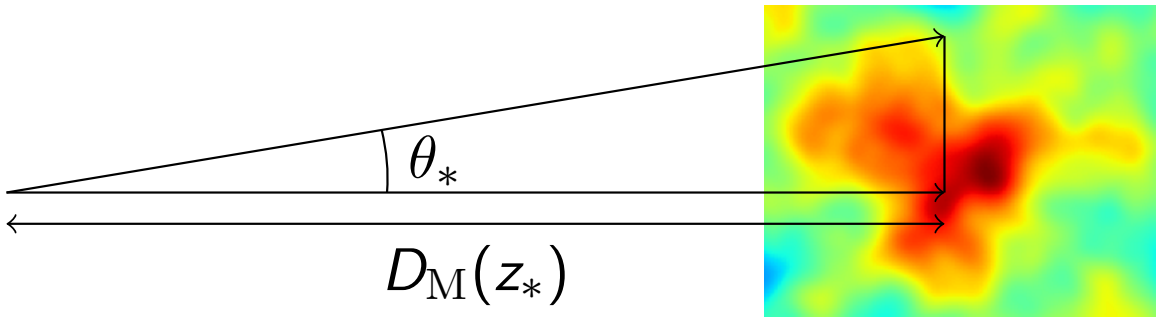
- Baryonic Acoustic Oscillation (BAO) measurements detect lower redshift imprints on galaxies.



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BAO Measurements

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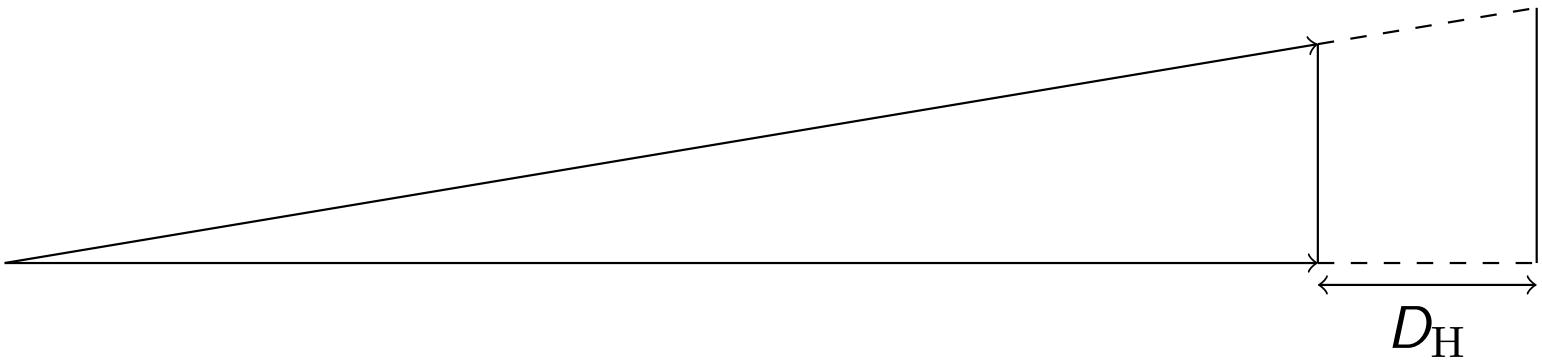

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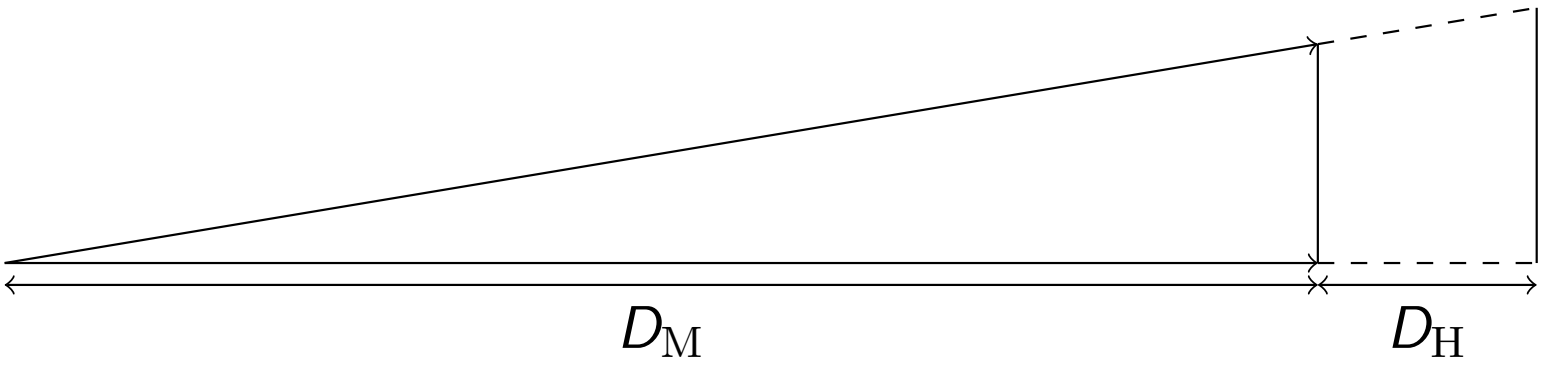

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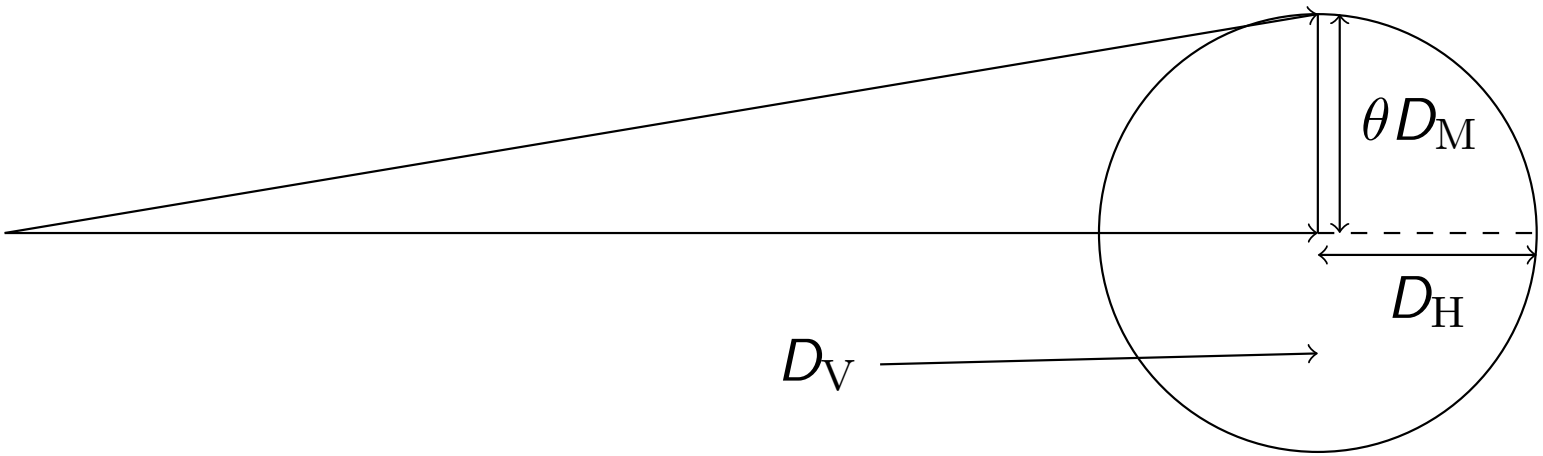

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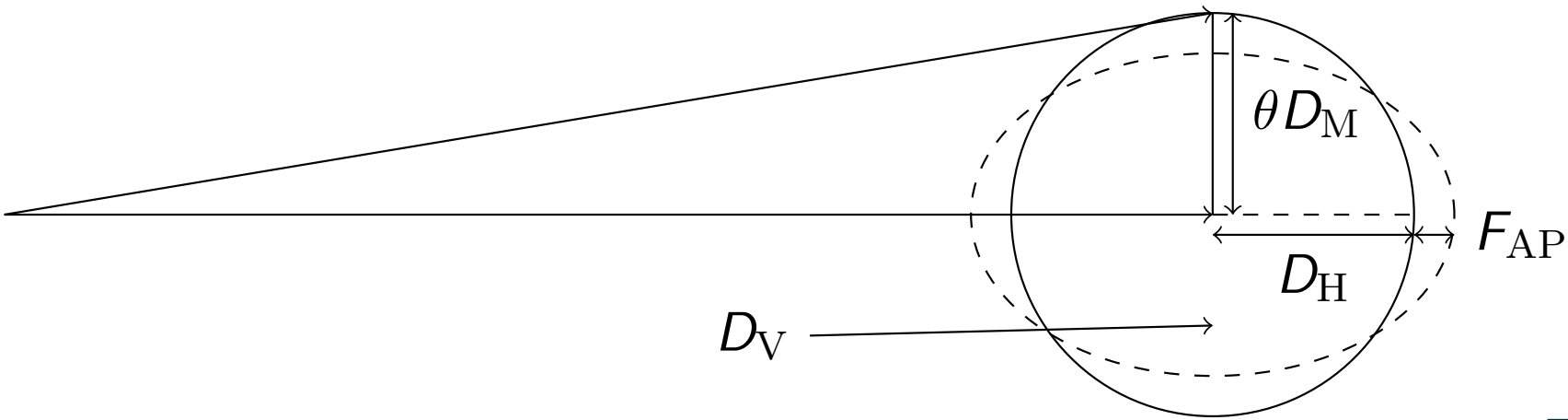
- Alcock-Paczynski parameter: $F_{\rm AP}(z) = D_{\rm M}(z)/D_{\rm H}(z)$.



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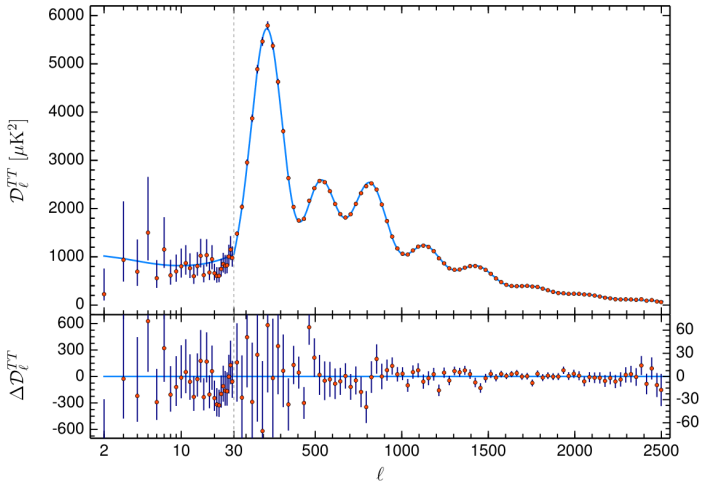
Constraints

From *Planck*:

- θ_* is fixed $\implies$ $D_{\mathrm{M}}(z_*)$ is fixed.
- $\Omega_{\mathrm{b}}h^2$ and $\Omega_{\mathrm{c}}h^2$ fixed



Planck 2018 arXiv:1807.06209

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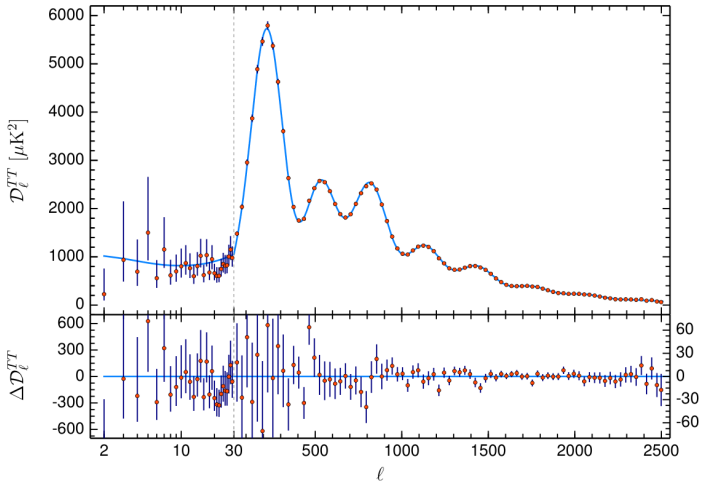

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Consider:

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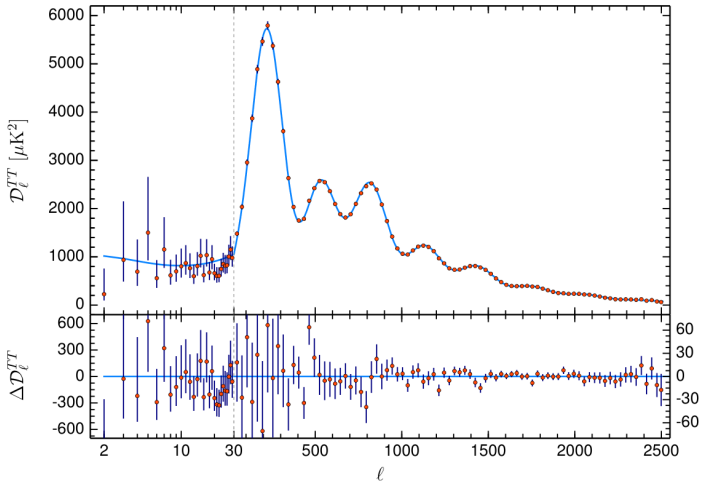

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$$\int_0^{z_*} \frac{\mathrm{d}z'}{\sqrt{\rho_{\mathrm{m}}(z') + \rho_{\mathrm{de}}(z')}} = \int_0^{z_*} \frac{\mathrm{d}z'}{\sqrt{\rho_{\mathrm{m}}(z') + \rho_{\Lambda}(z')}},$$
$$\implies \rho_{\mathrm{de}}(0) < \rho_{\Lambda}.$$

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Hubble Distance

$$D_{\mathrm{H}}(z) \propto \frac{1}{\sqrt{\rho_{\mathrm{m}}(z) + \rho_{\mathrm{de}}(z)}},$$

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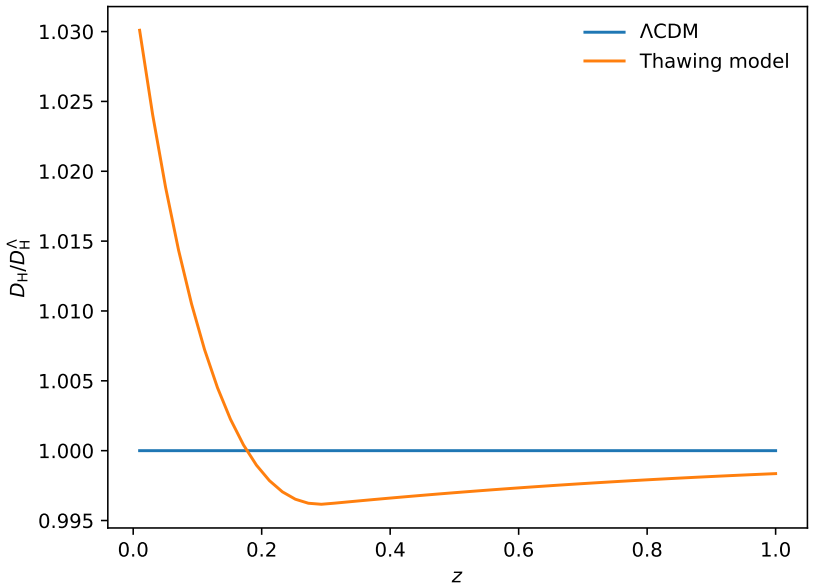

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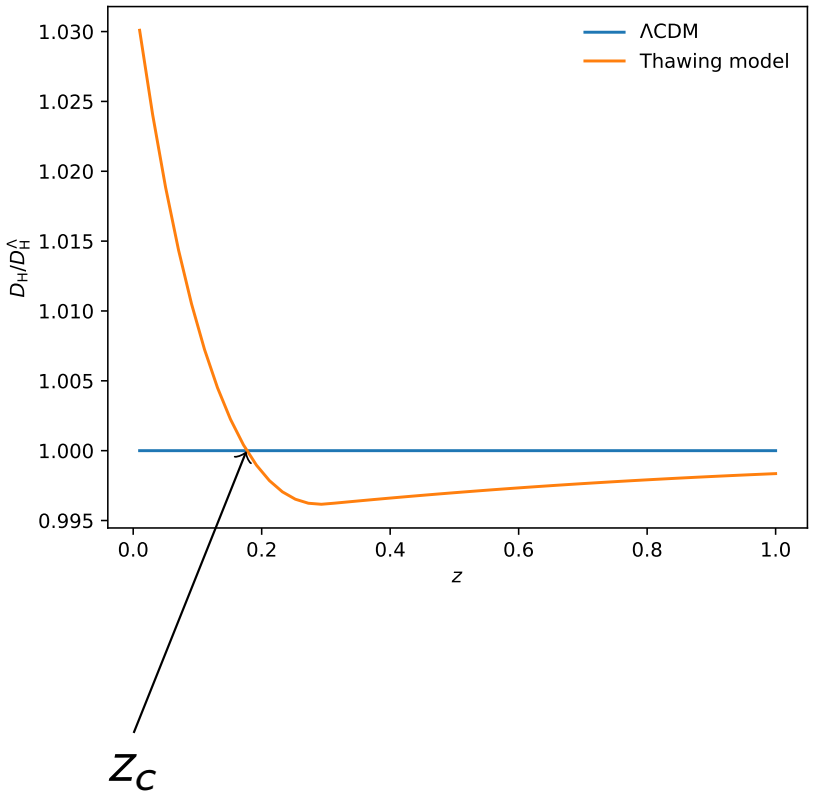

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Inequalities

Inequality	Redshift
$D_{\rm H}(0) \geq D^{\Lambda}_{\rm H}(0)$	At $z = 0$
$D_{\rm H}(z) \geq D^{\Lambda}_{\rm H}(z)$	For $0 \leq z \leq z_c$
$D_{\rm H}(z) \leq D^{\Lambda}_{\rm H}(z)$	For $z_c \leq z \leq z_*$
$D_{\rm M}(z) \geq D^{\Lambda}_{\rm M}(z)$	For all z
$\frac{D_{\rm H}}{D^{\Lambda}_{\rm H}} \leq \frac{D_{\rm M}}{D^{\Lambda}_{\rm M}}$	For all z
$F_{\rm AP} \geq F^{\Lambda}_{\rm AP}$	For all z
$D_{\rm V} \geq D^{\Lambda}_{\rm V}$	For $0 \leq z \leq z_c$
$\frac{D_{\rm V}}{D^{\Lambda}_{\rm V}} \geq \left(\frac{F_{\rm AP}}{F^{\Lambda}_{\rm AP}}\right)^{-1/3}$	For $z > z_c$

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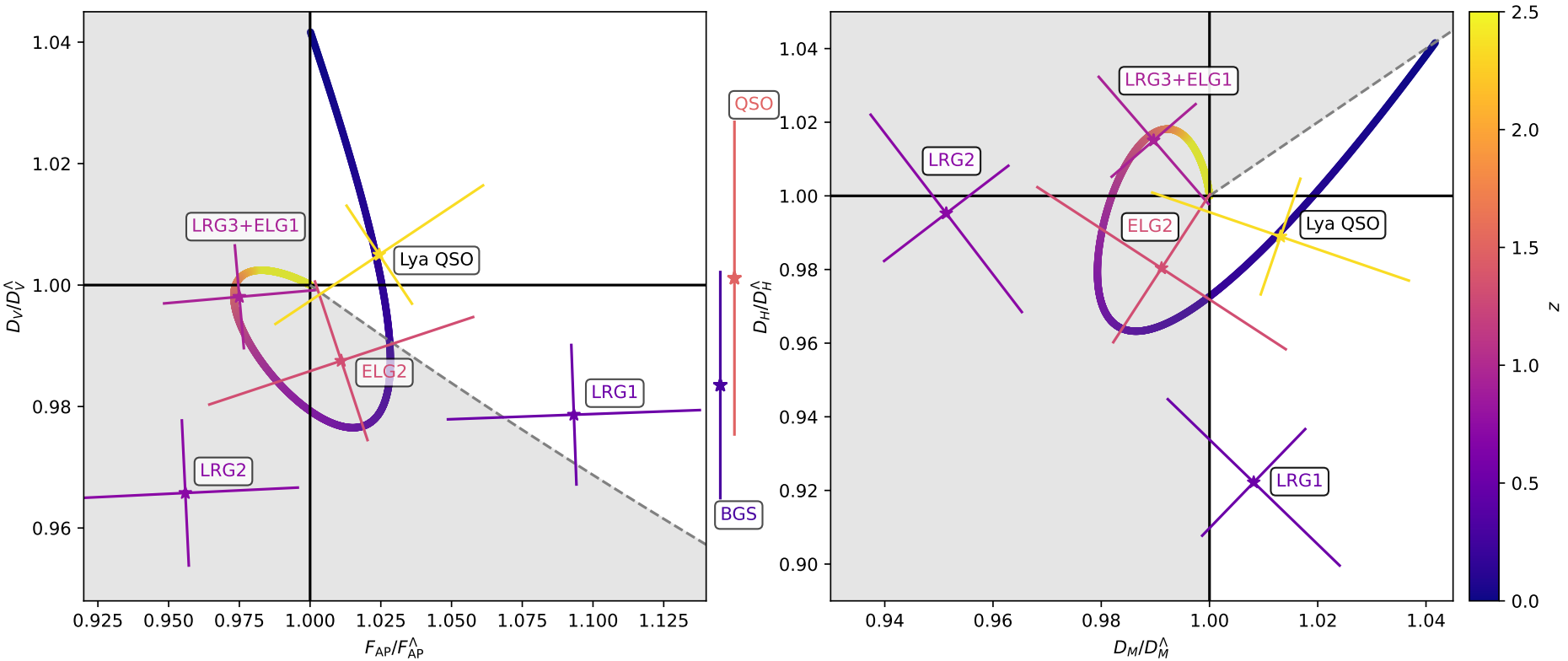
DESI BAO Measurements

$$w_0 = -0.45,\ w_a = -1.79$$



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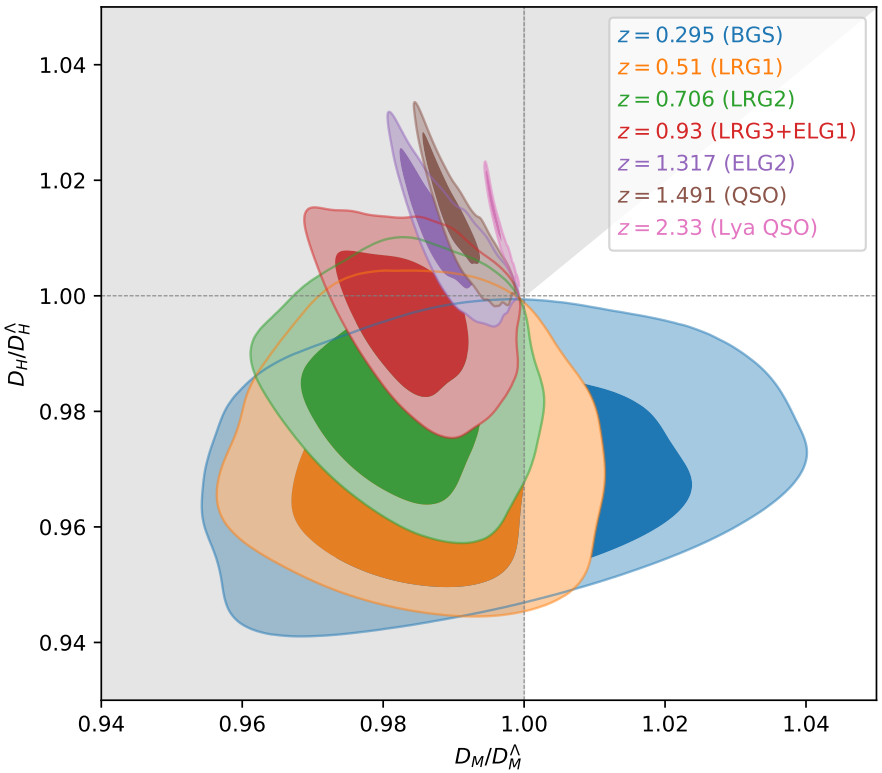

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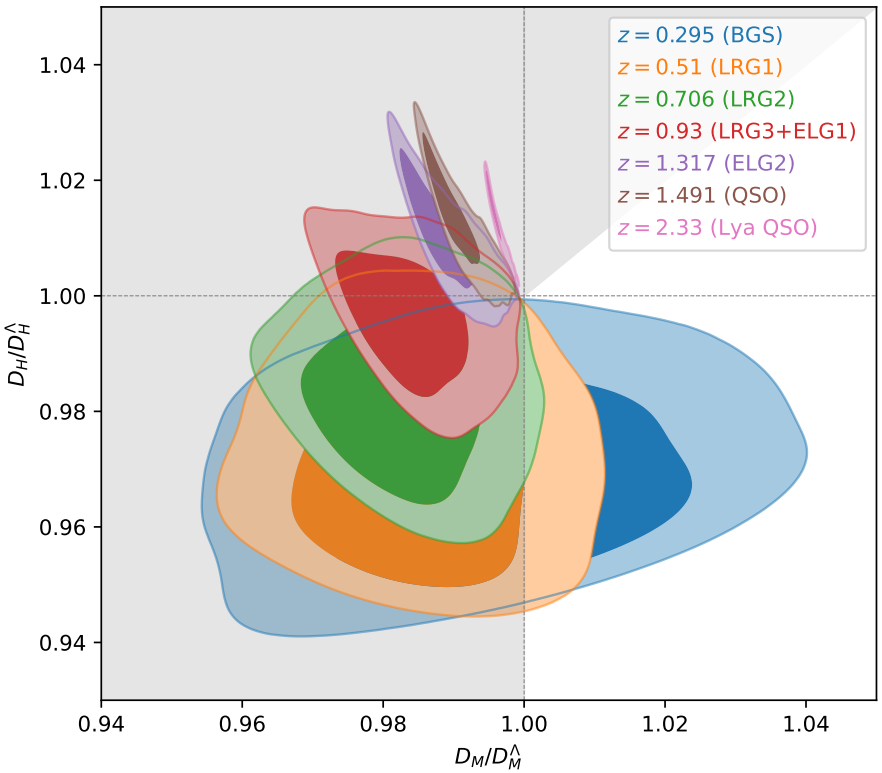

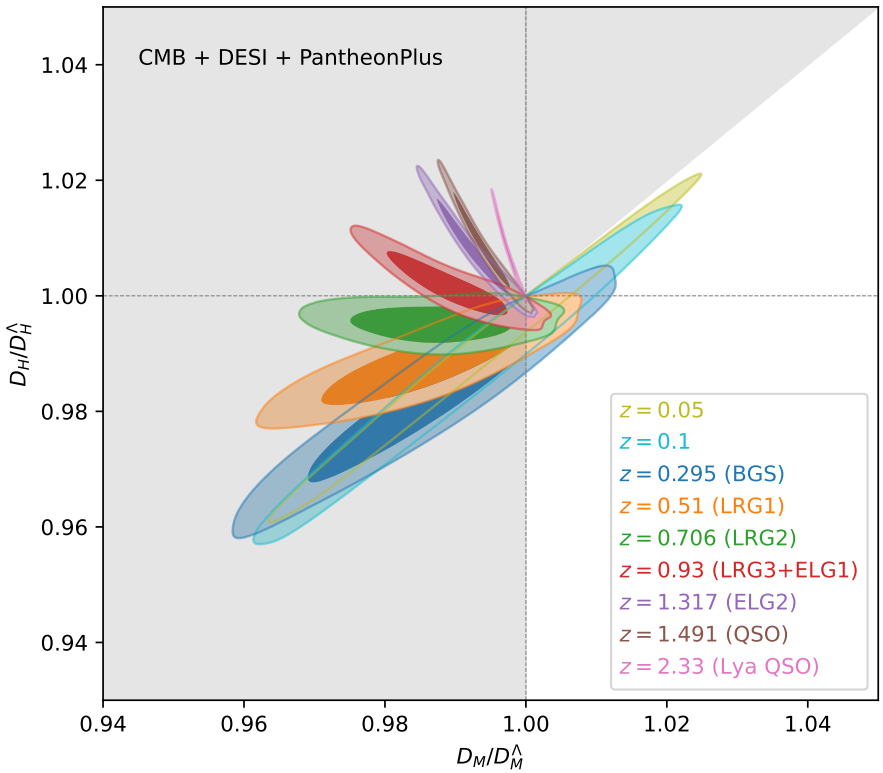

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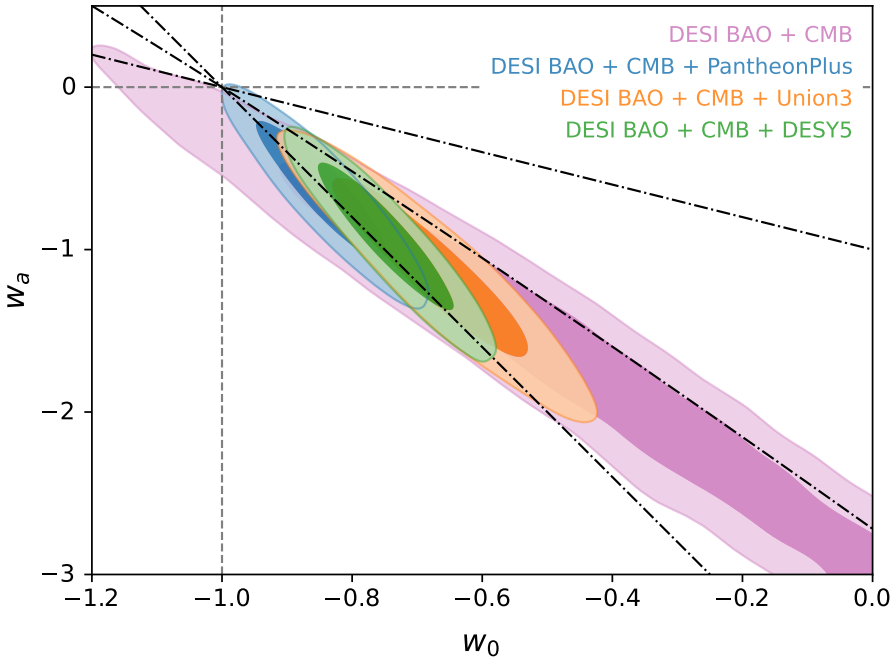

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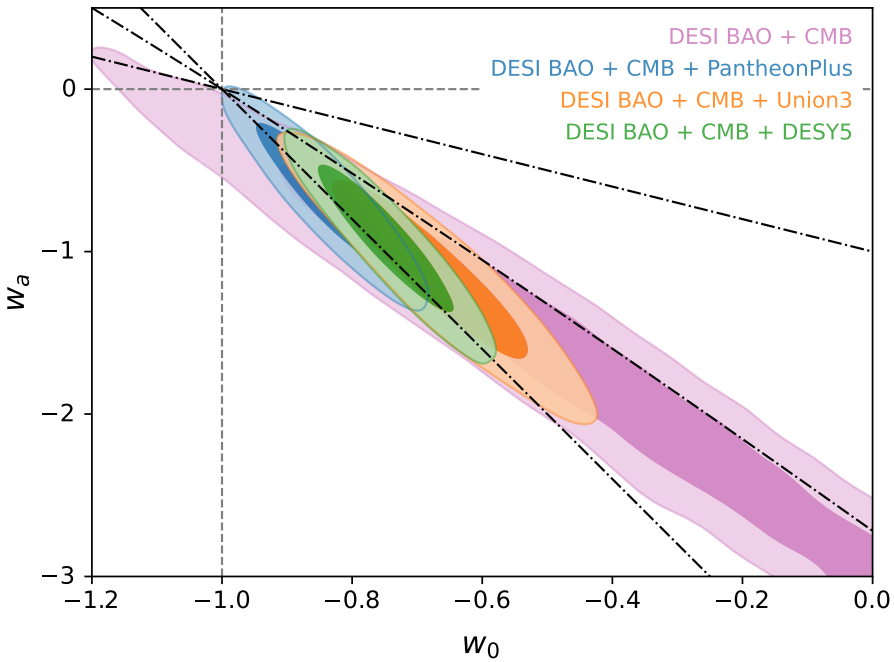

Max-$w_0 w_a$CDM

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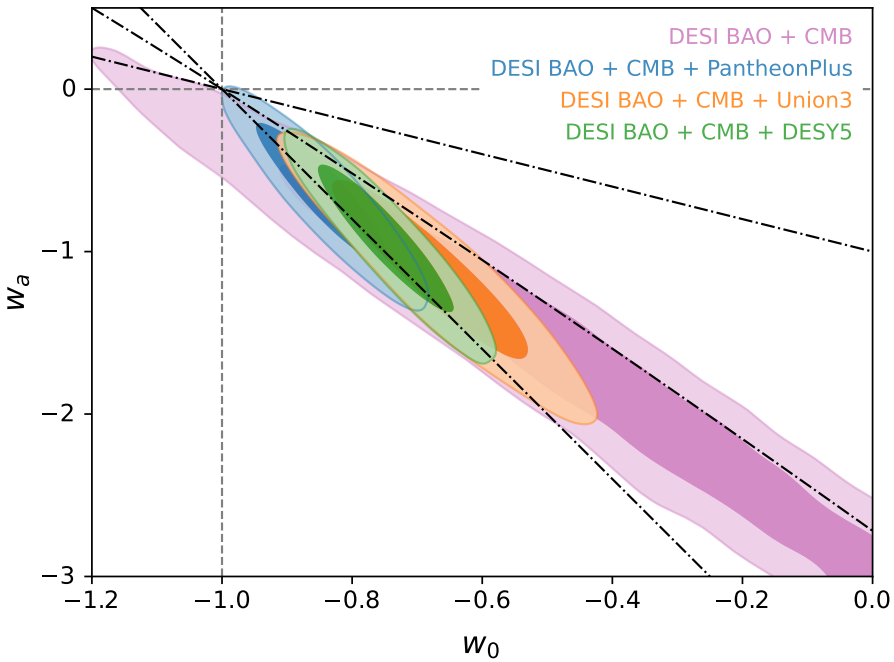

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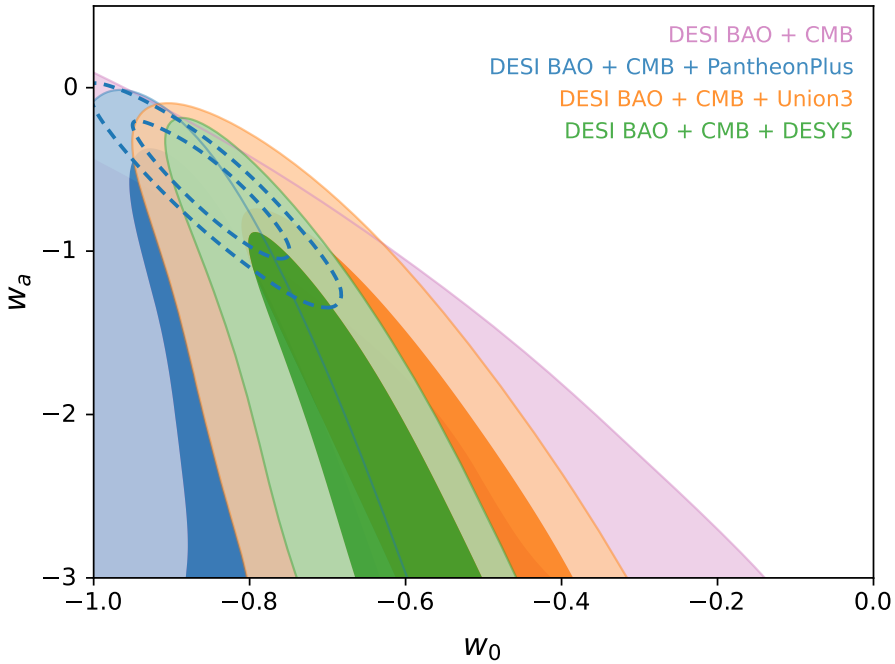

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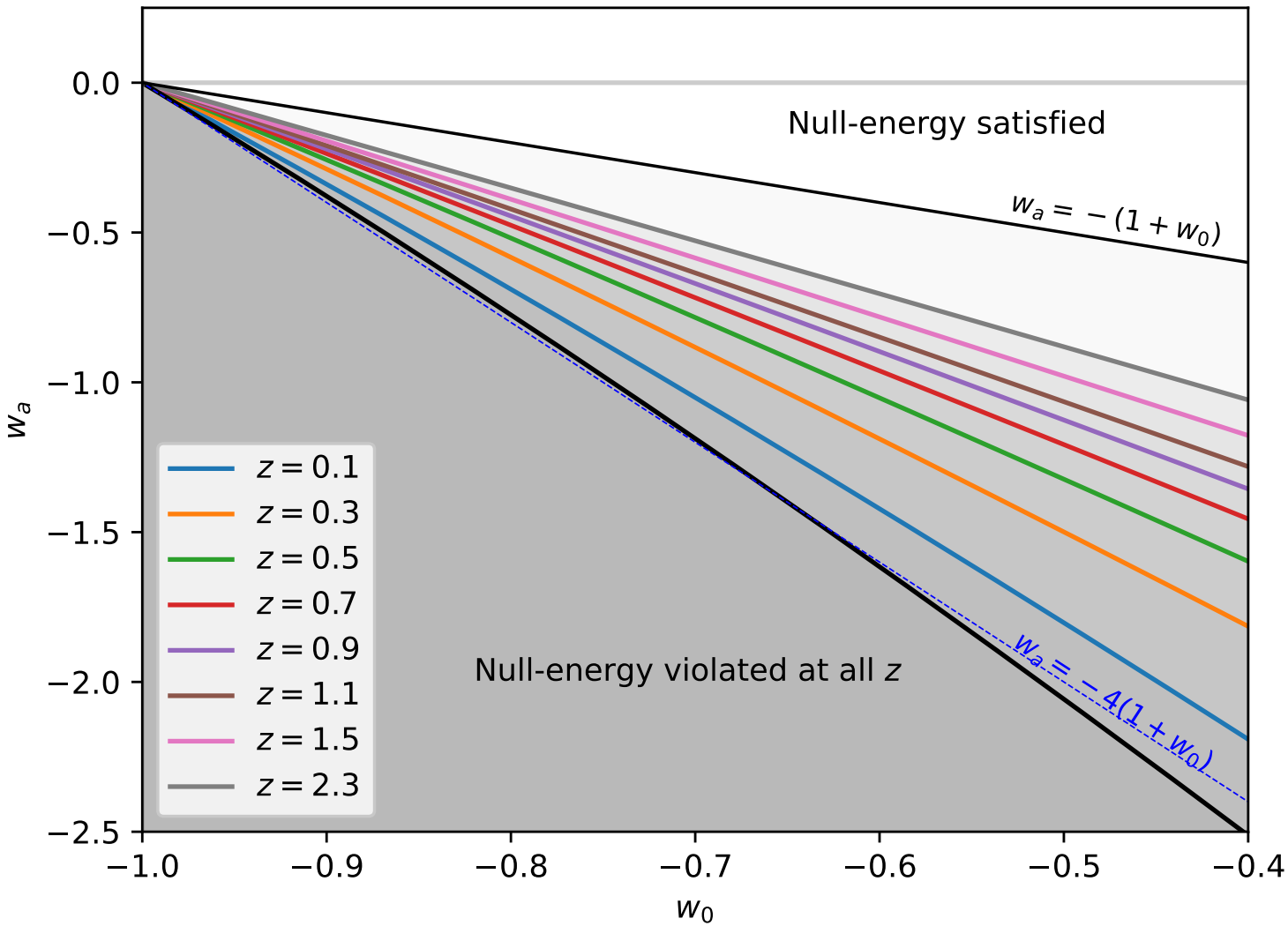
Redshift Bounds



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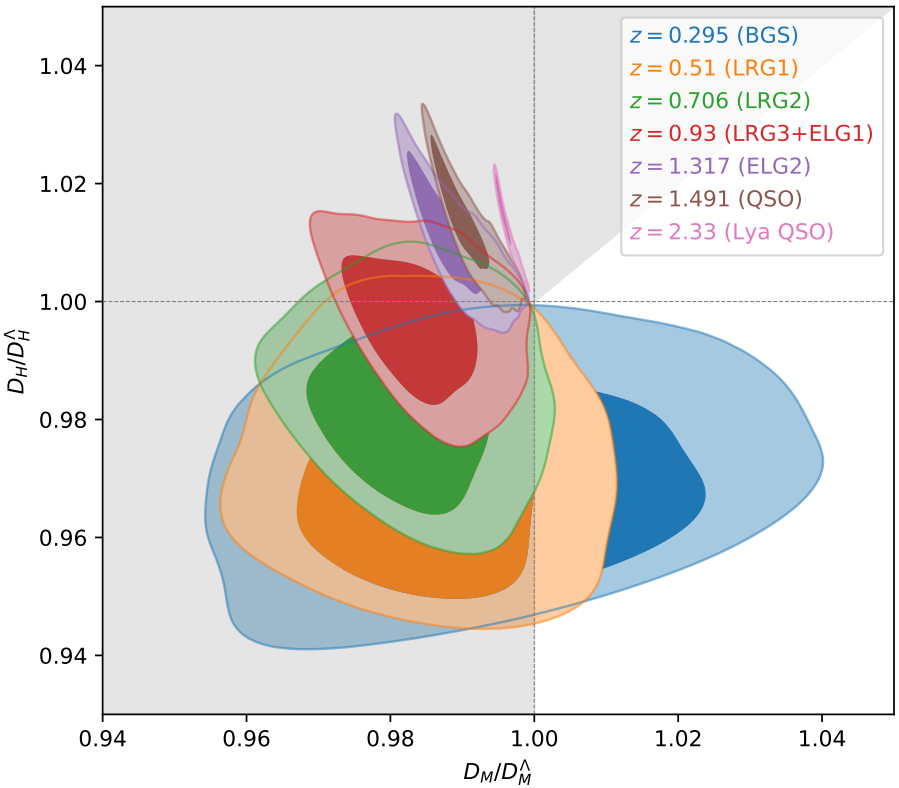
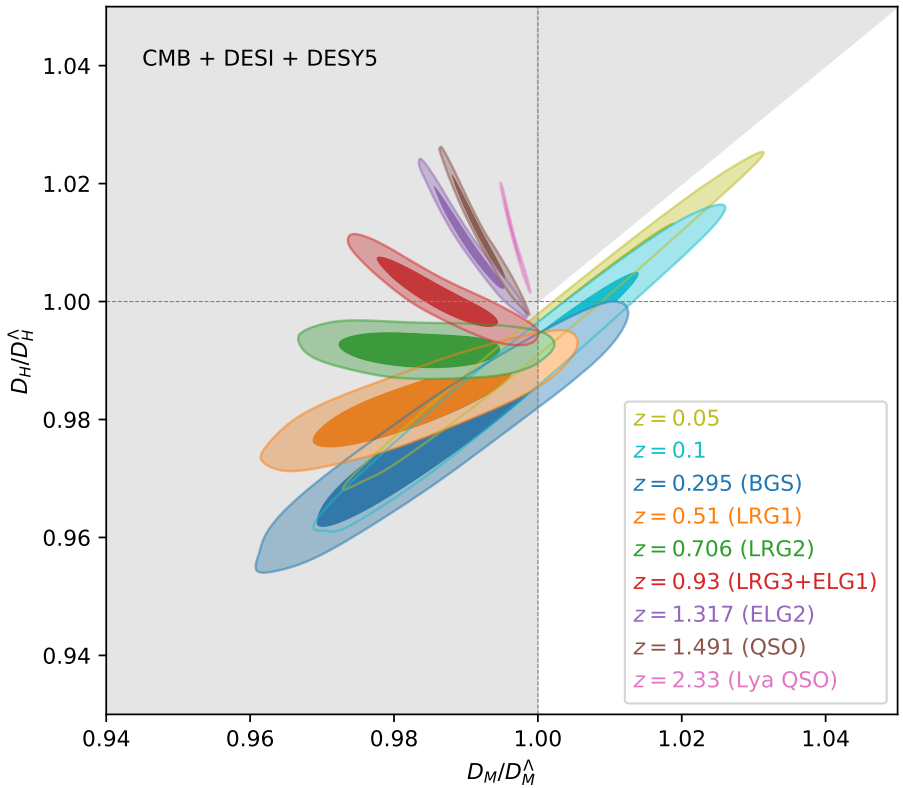
DESI+DESY5





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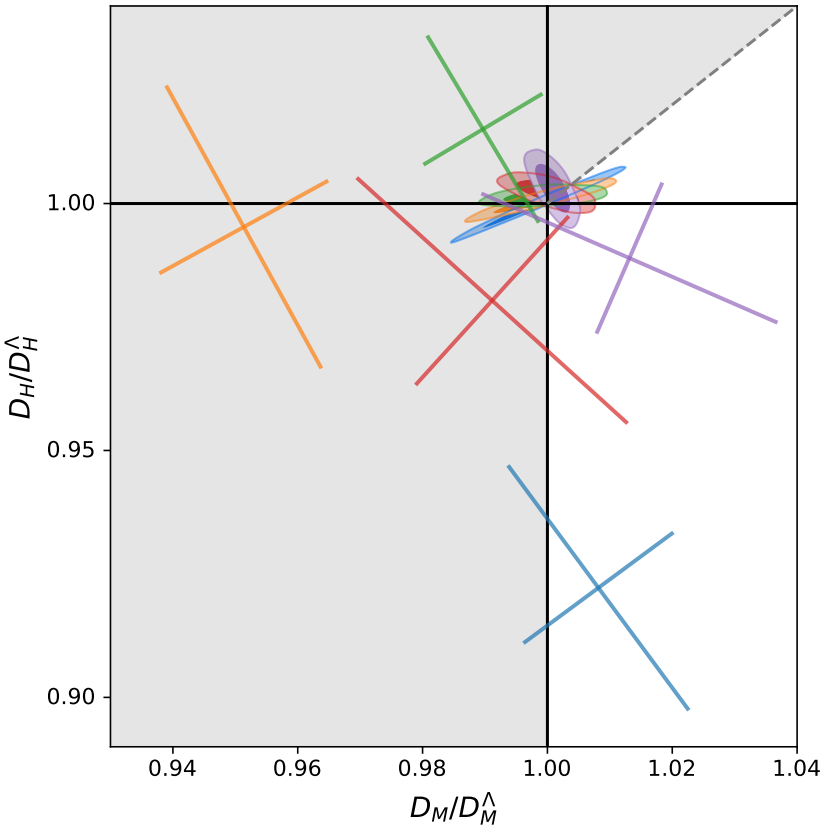
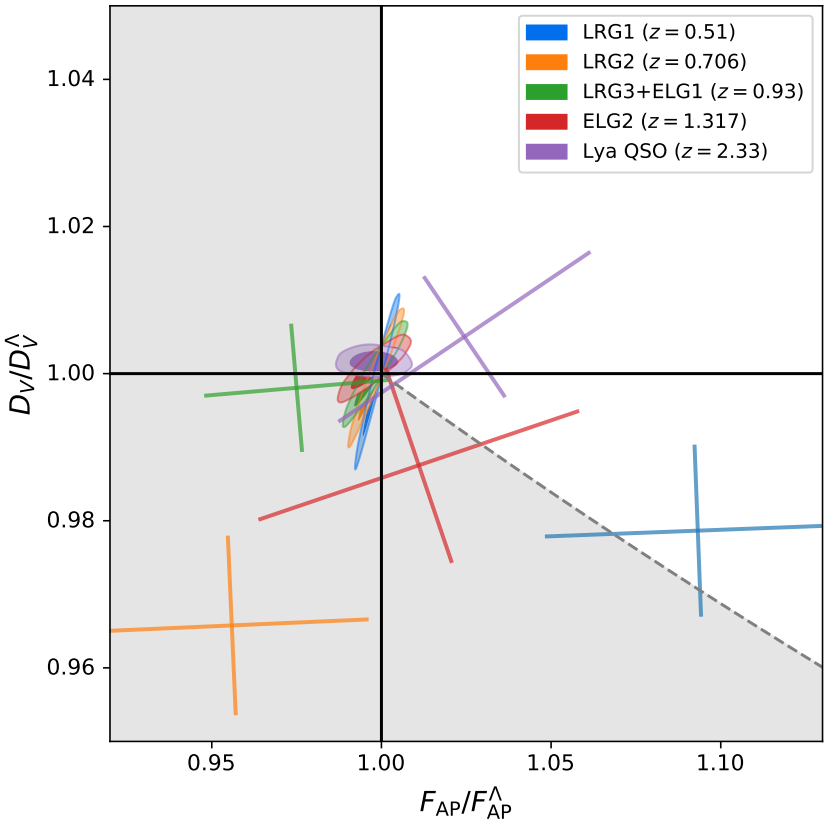
DESI ΛCDM





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Growth of Structure