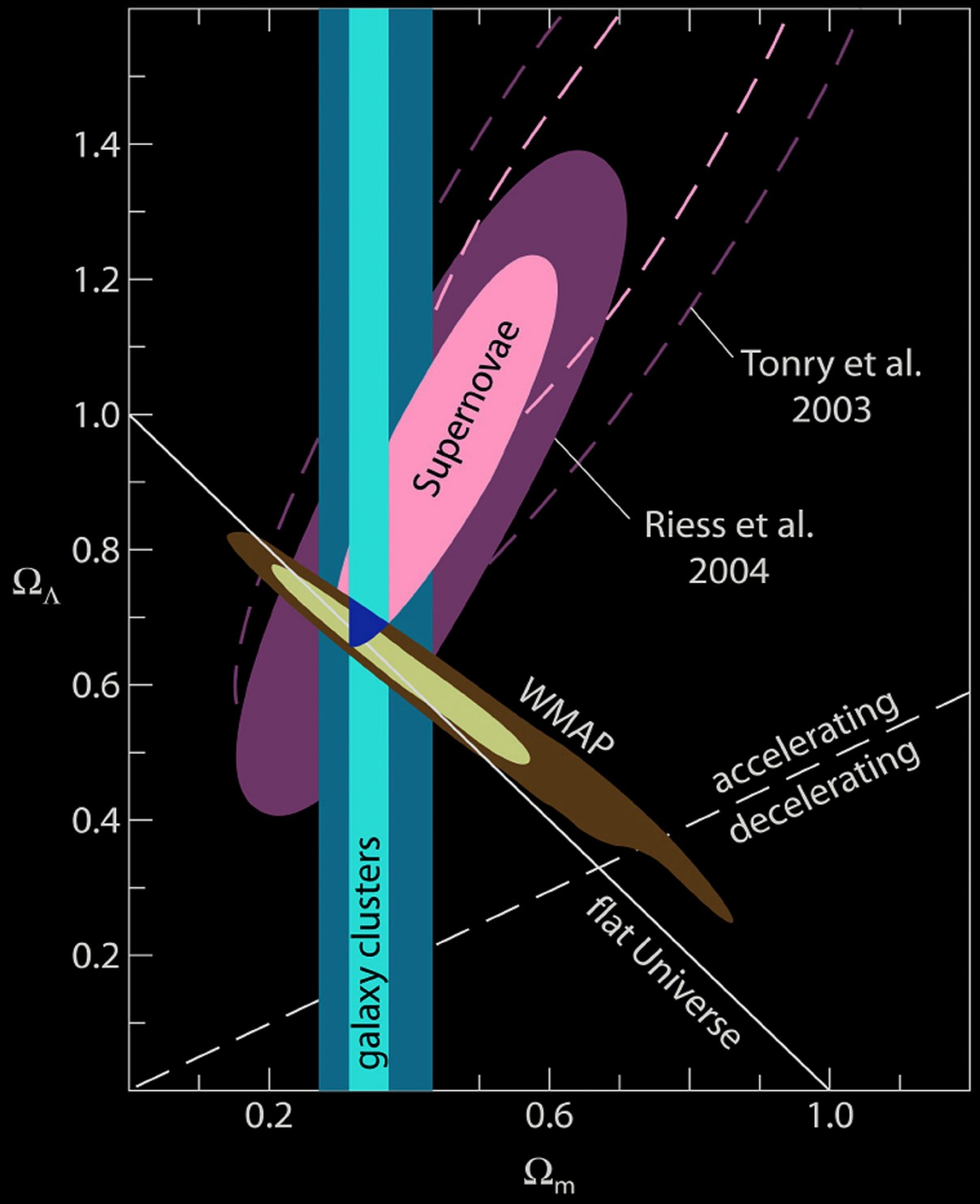
Azores School on Observational Cosmology 2011

Combining small-scale clustering with WMAP data to constrain models of dark energy dynamics

Michelle Knights
Masters student
University of Cape Town and
African Institute for Mathematical Sciences

Supervisors: Bruce Bassett and Carolina Ödman
Collaborator: Patrice Okouma

The Dark Energy Debate



Many explanations for dark energy have been suggested, including:

- Scalar fields
- Viscous fluid models
- Modified gravity
- Void models

Some models predict different behaviour on large and small scales, when compared with ΛCDM.

ESO

A General Approach

The Chevallier-Polarski-Linder (CPL) parameterisation

$$w(z) = w_0 + w_a \frac{z}{1+z}$$

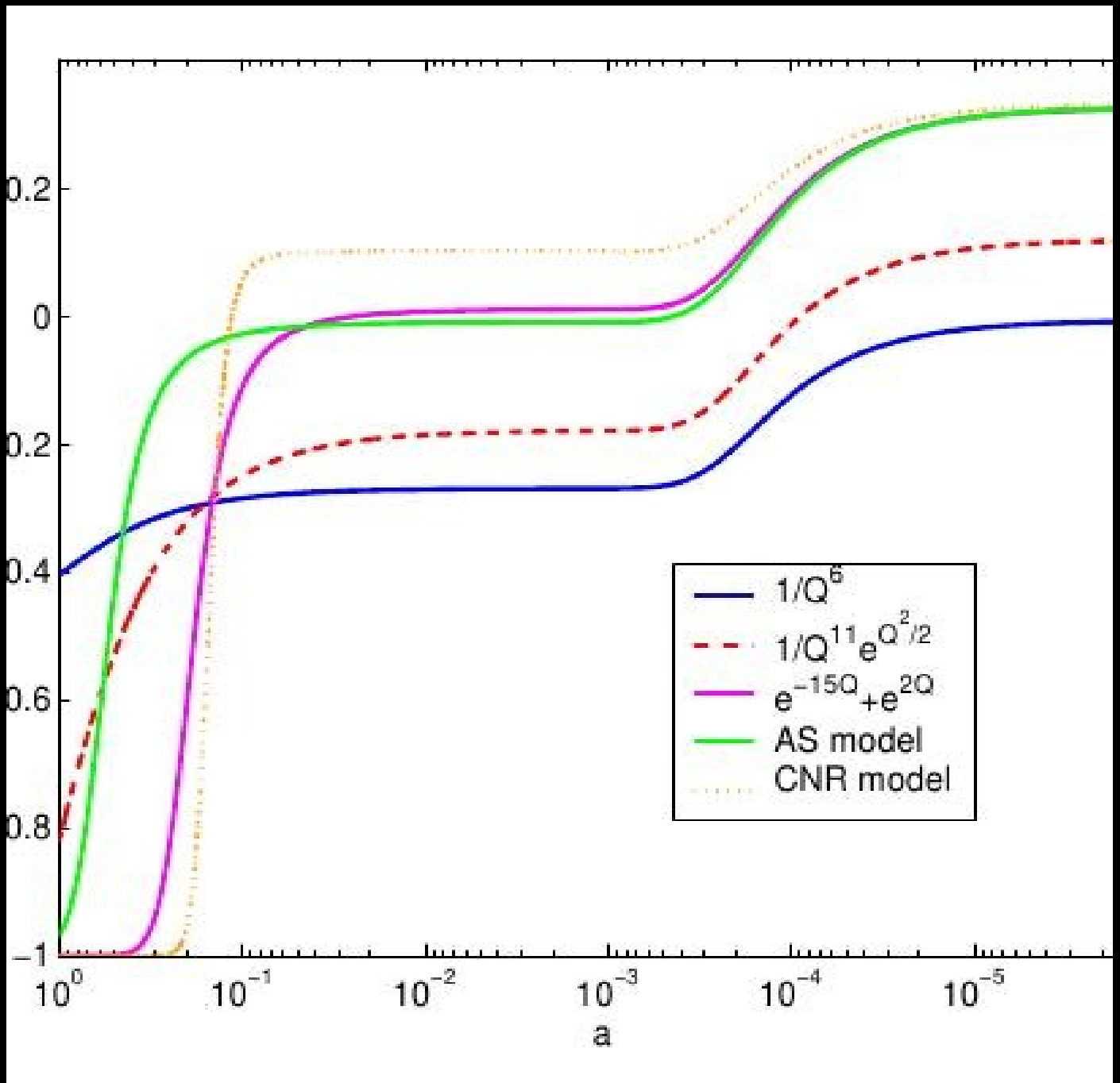
Chevallier & Polarski (2001), Linder (2003)

The kink parameterisation

$$w(a) = w_0 + (w_m - w_0) \frac{1+e^{\frac{a_c}{\Delta}}}{1+e^{-\frac{a-a_c}{\Delta}}} \times \frac{1-e^{-\frac{a-1}{\Delta}}}{1-e^{\frac{1}{\Delta}}}$$

Bassett *et al.* (2002), Corasaniti & Copeland (2003)

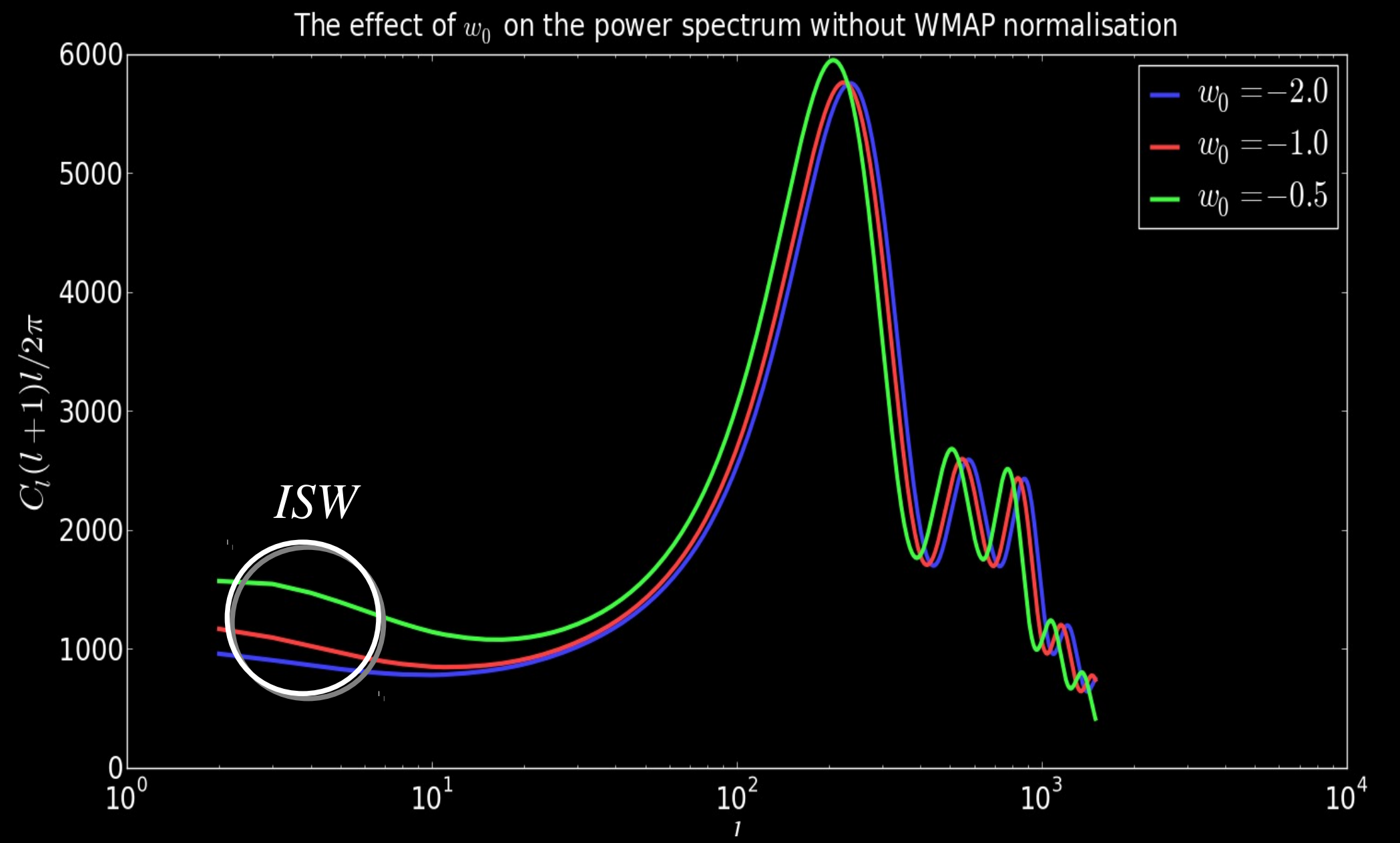
Dark Energy in Four Parameters



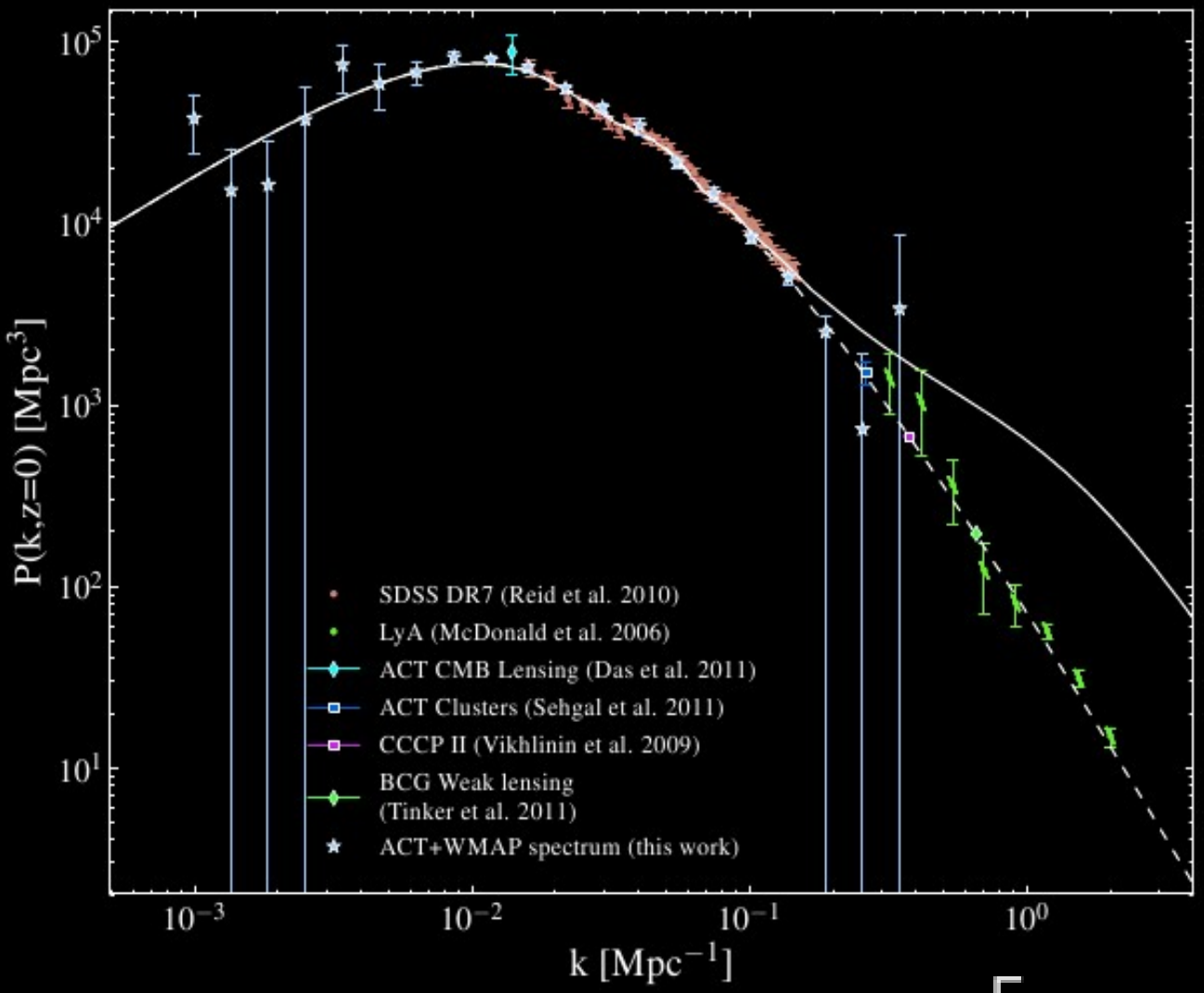
$$w_0$$
$$w_m$$
$$a_c$$
$$\Delta$$

ISW and Dark Energy

The Effect of ISW on the Power Spectrum



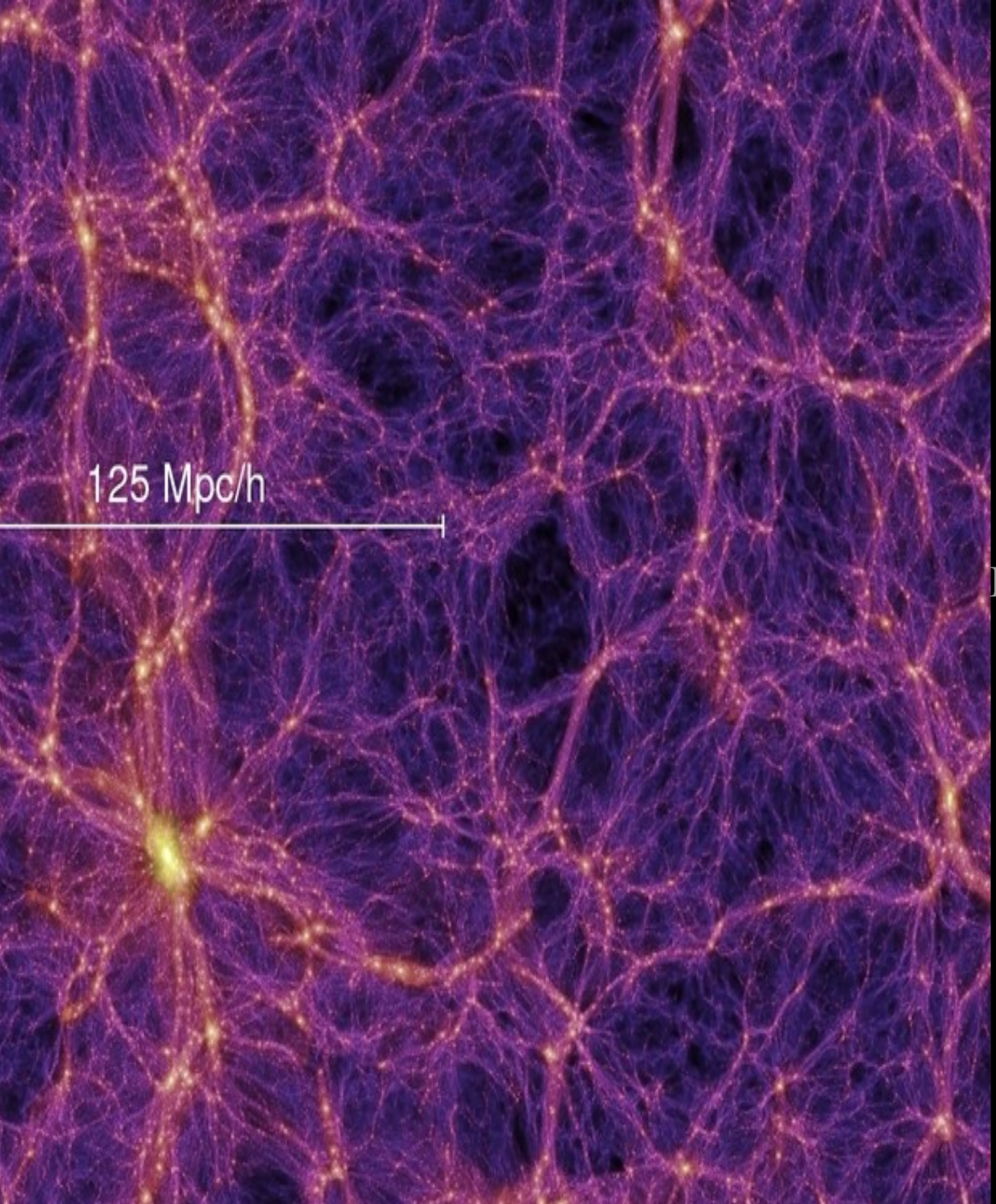
The σ_8 Parameter



σ_8 is the RMS of the mass distribution on $8h^{-1}$ Mpc scales, which is used to normalise the linear matter power spectrum.

$$\sigma_8 = \left[\int_0^\infty dk \frac{k^2}{2\pi^2} P(k) \left[\frac{3 j_1(8k)}{8k} \right]^2 \right]^{1/2}$$

Hlozek *et al.*, (2011)



Visualising σ_8

- Bruce Bassett (2011)

Variance of ***linear*** power spectrum on scales of 8 h-1 Mpc

Mass in sphere relative to Mean

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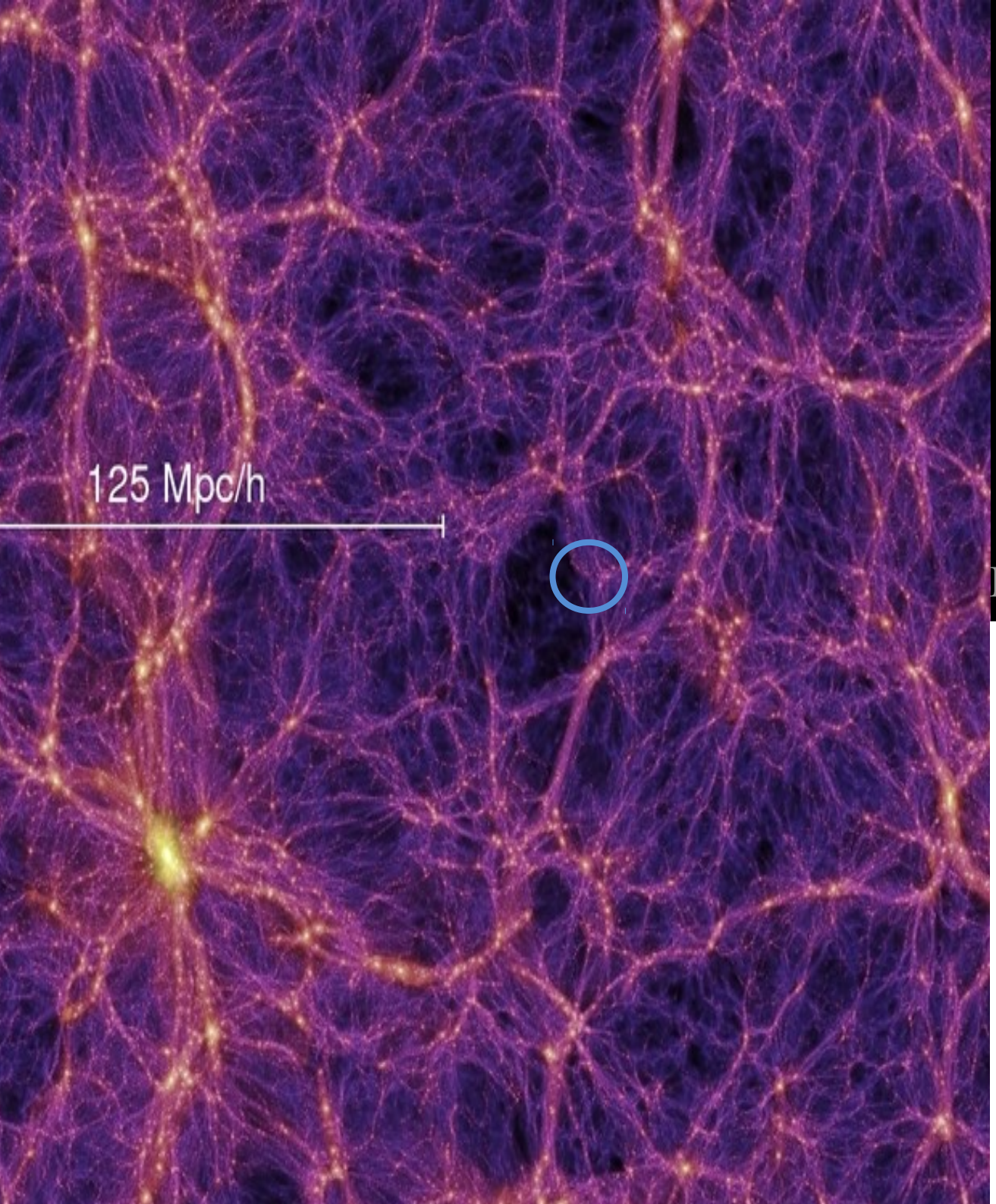

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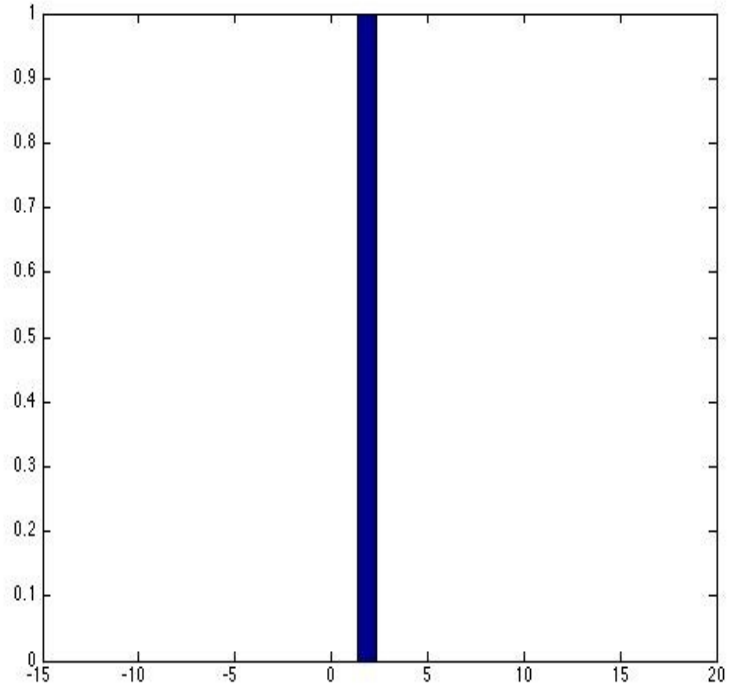

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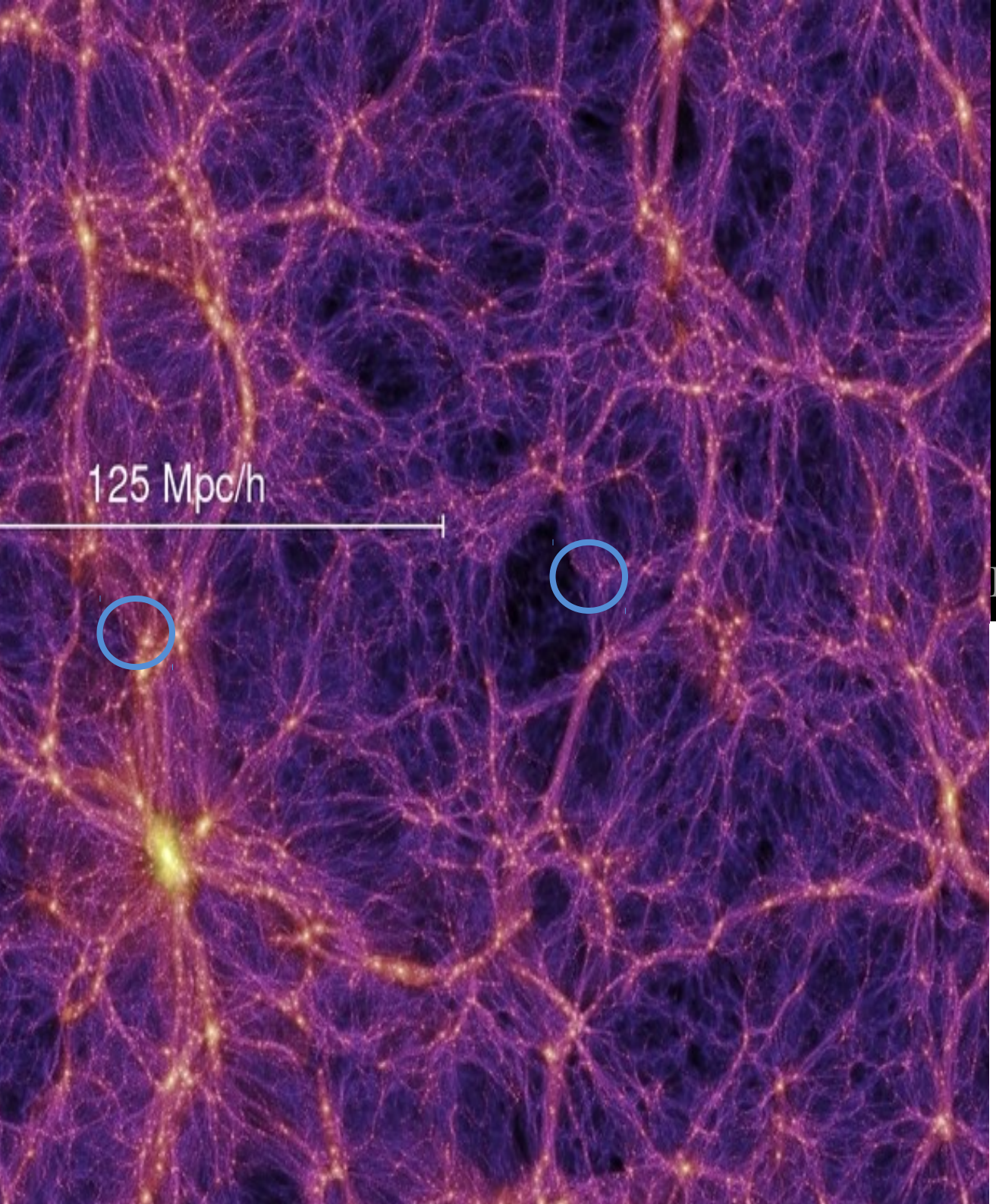

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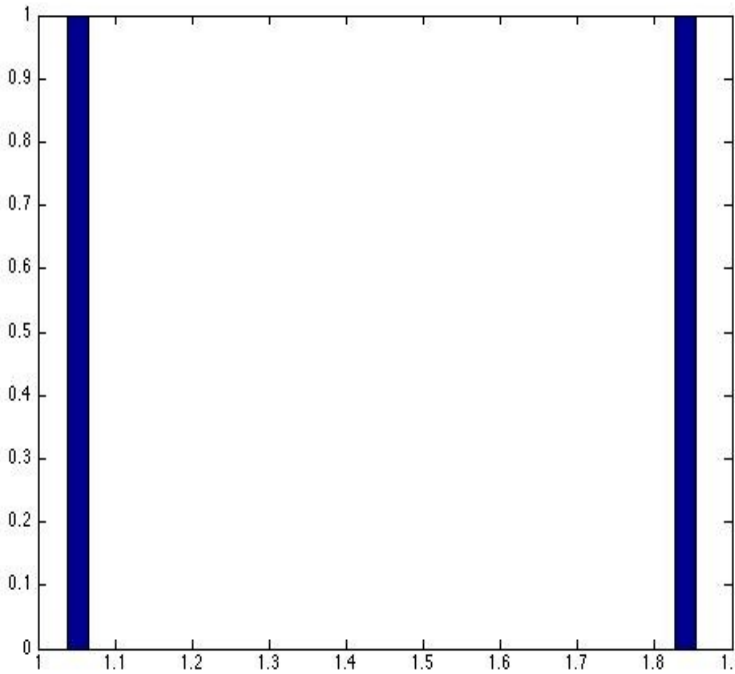

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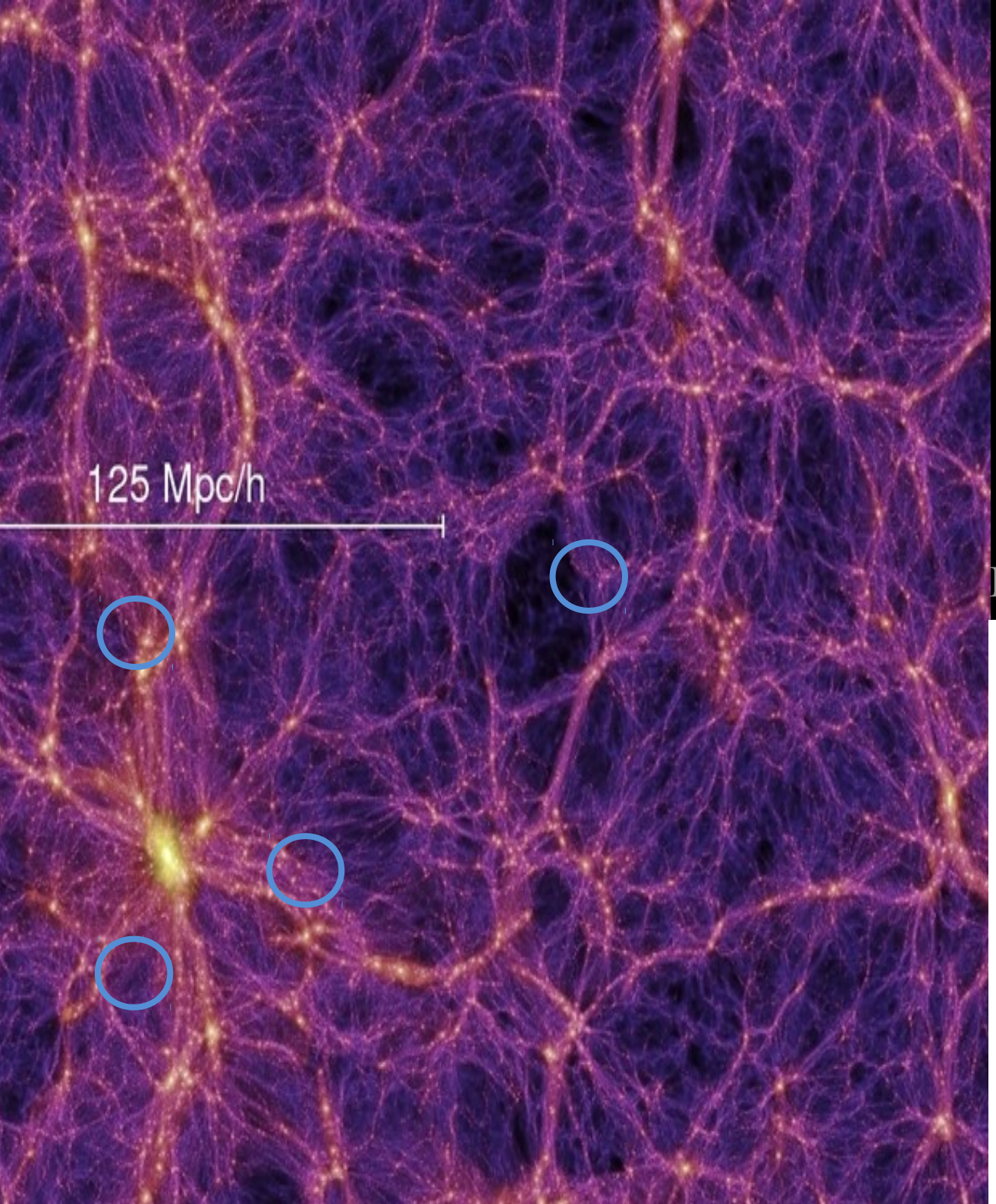

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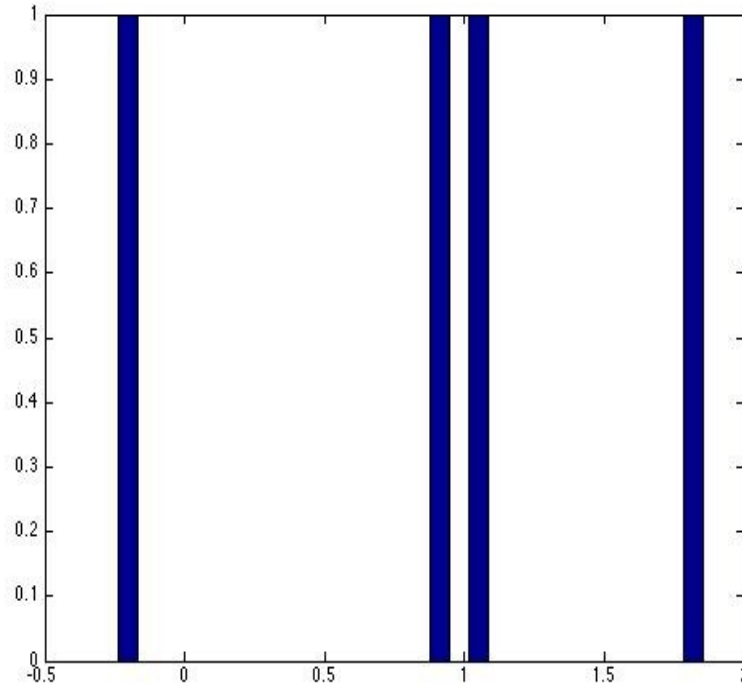

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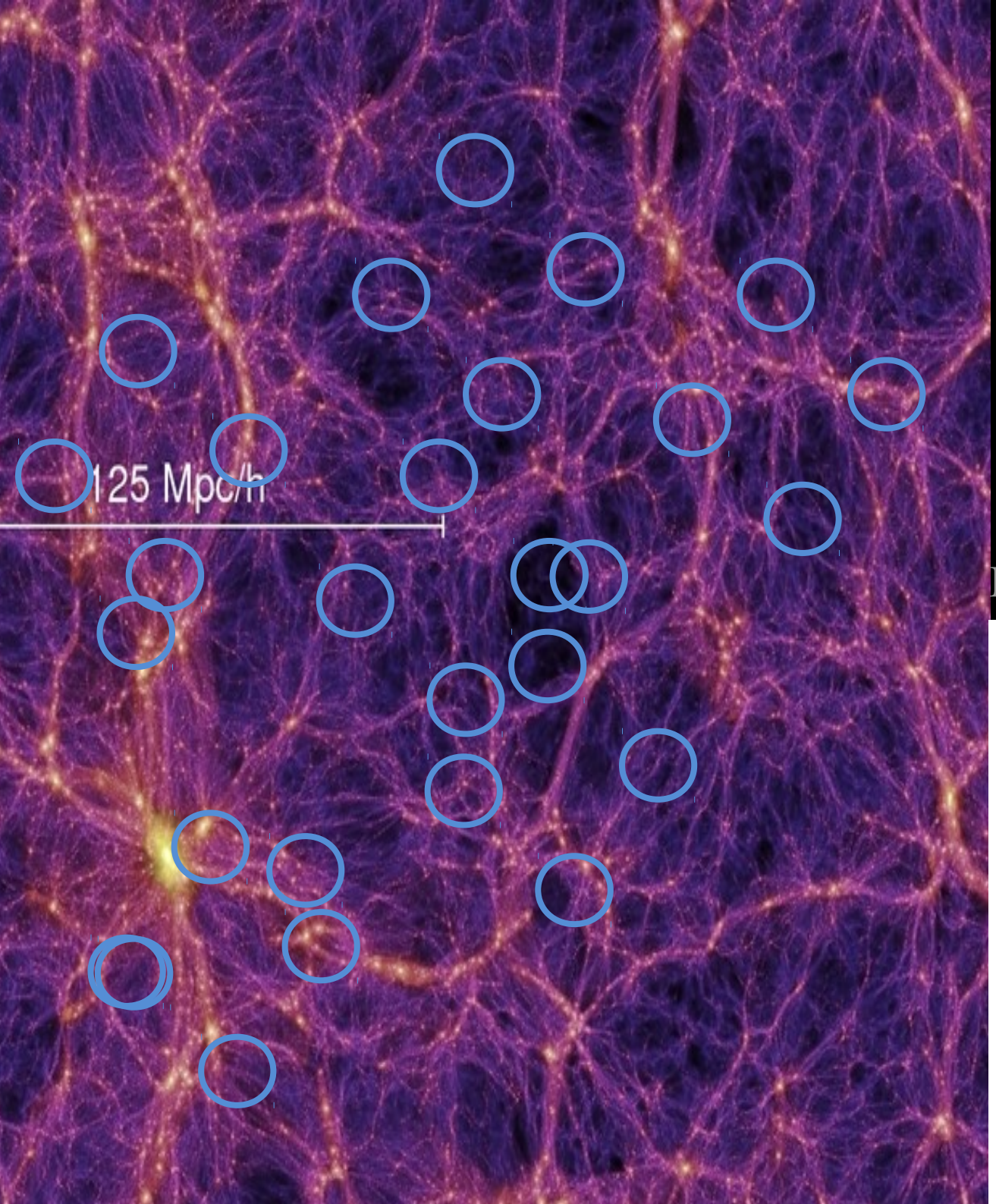

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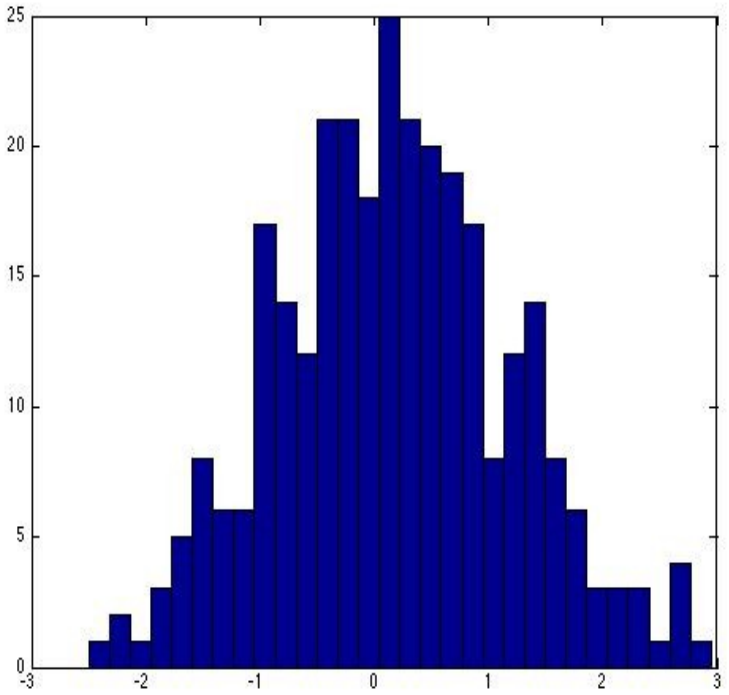

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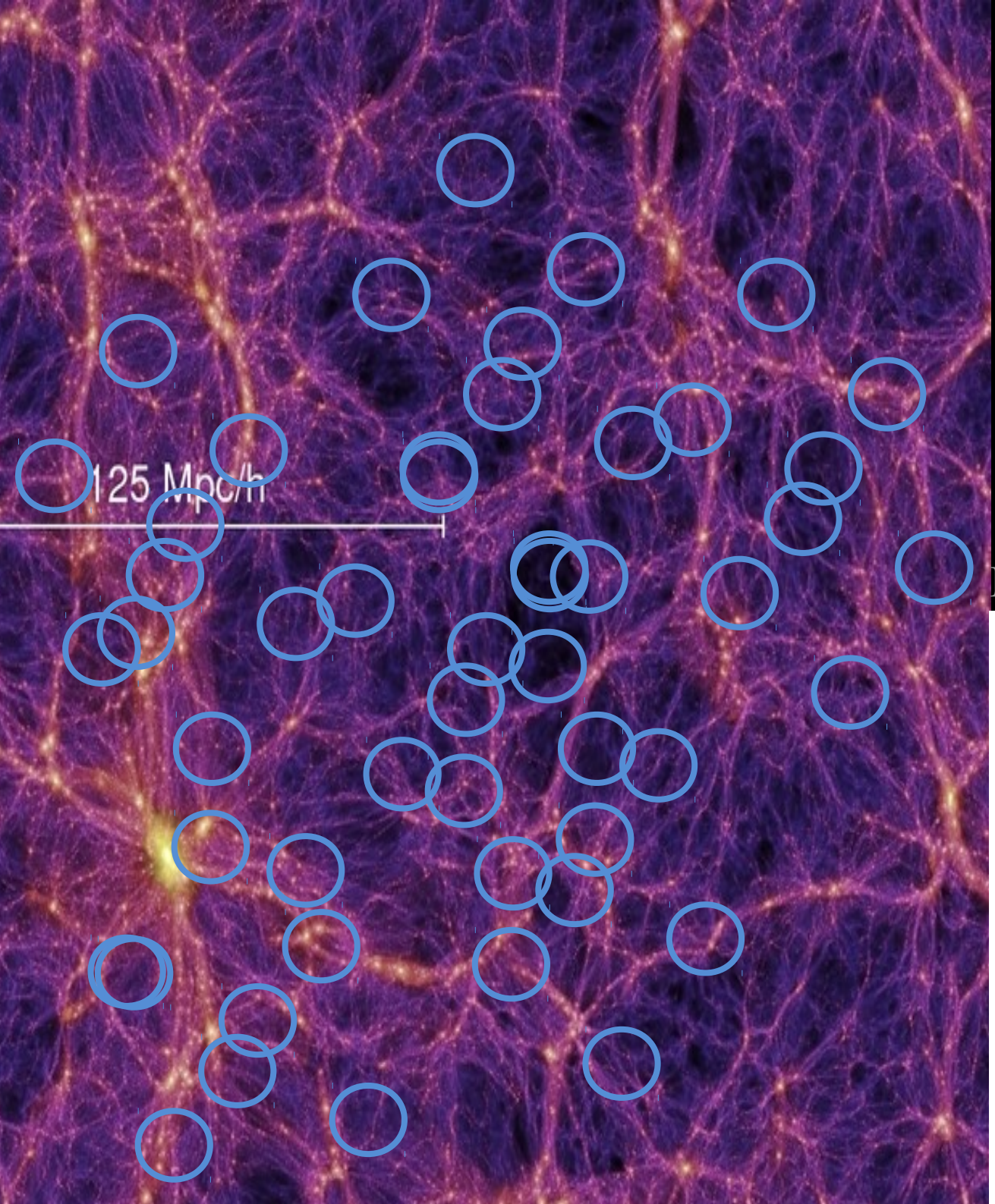

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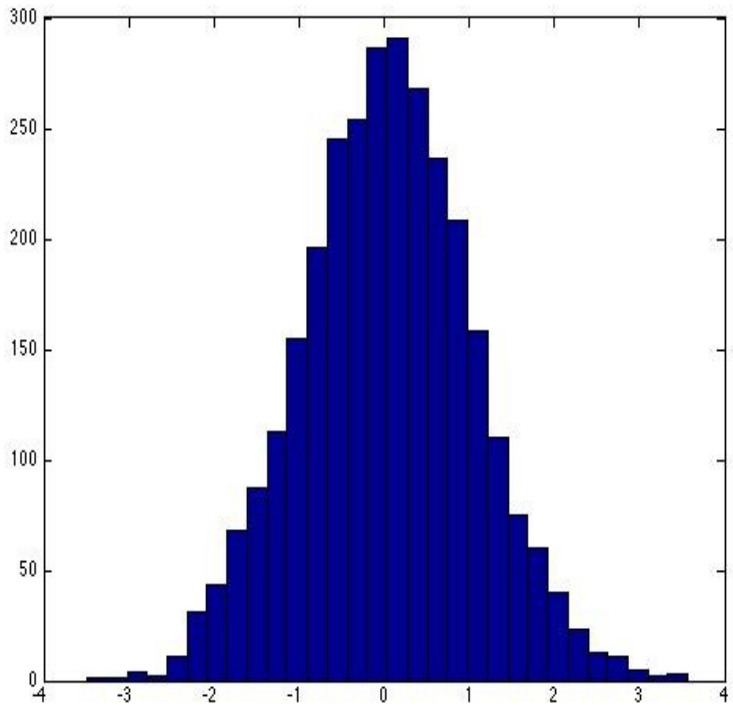
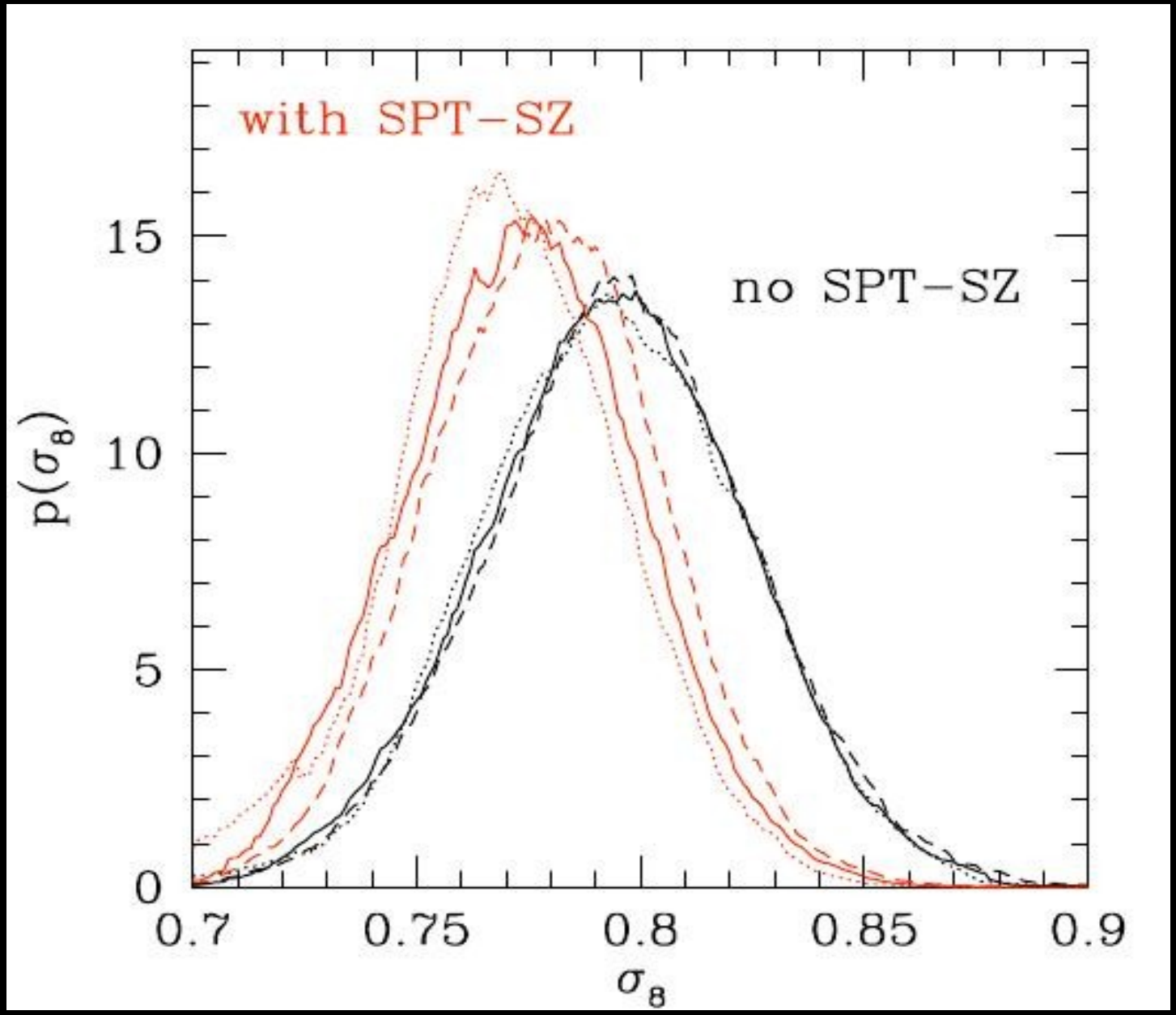


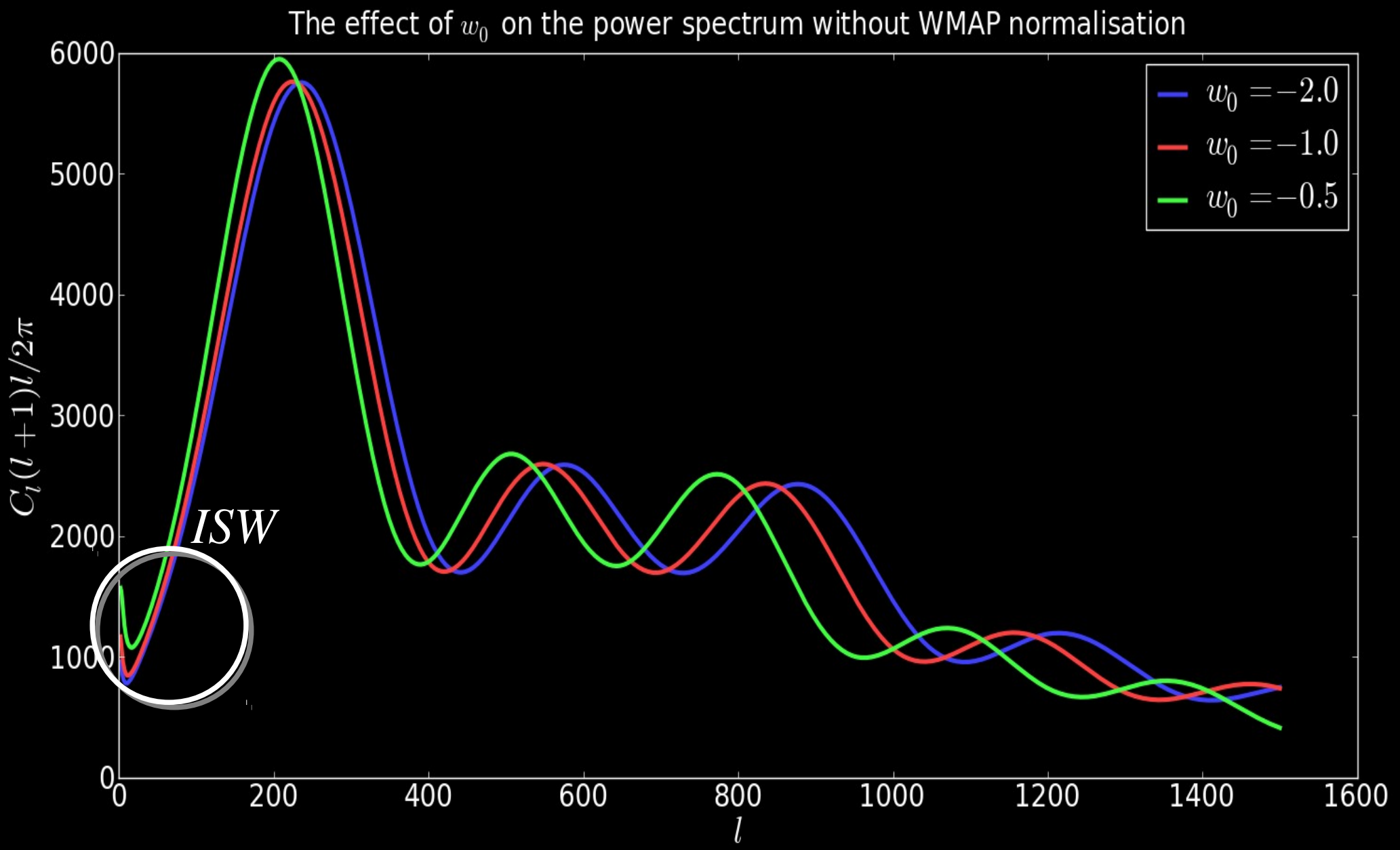
A Recent Measurement of σ_8



Lueker *et al*, 2009

The South Pole Telescope recently measured σ_8 using the Sunyaev-Zel'dovich effect and found that $\sigma_8 = 0.773 \pm 0.025$.

The Relationship between DE and σ_8



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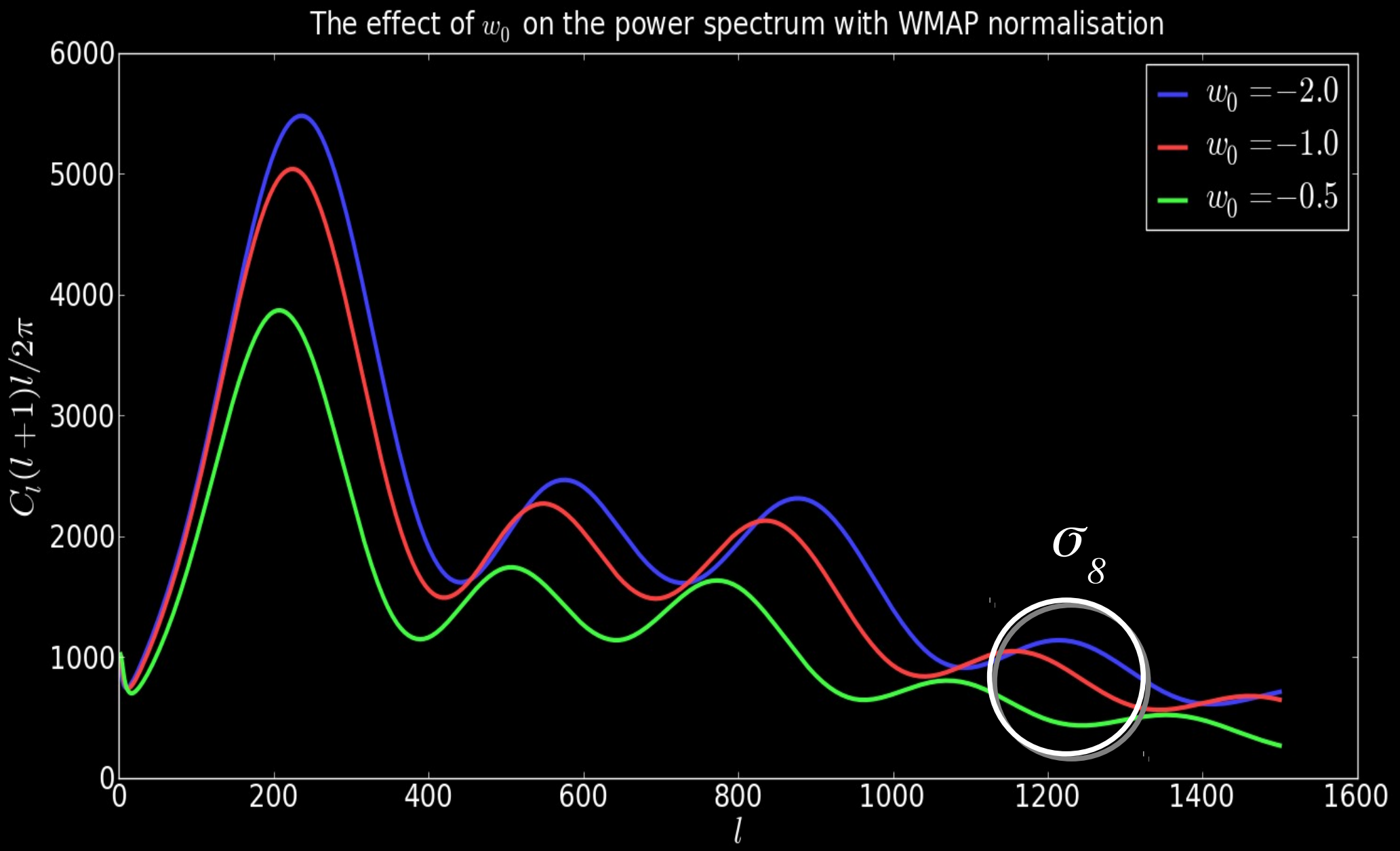

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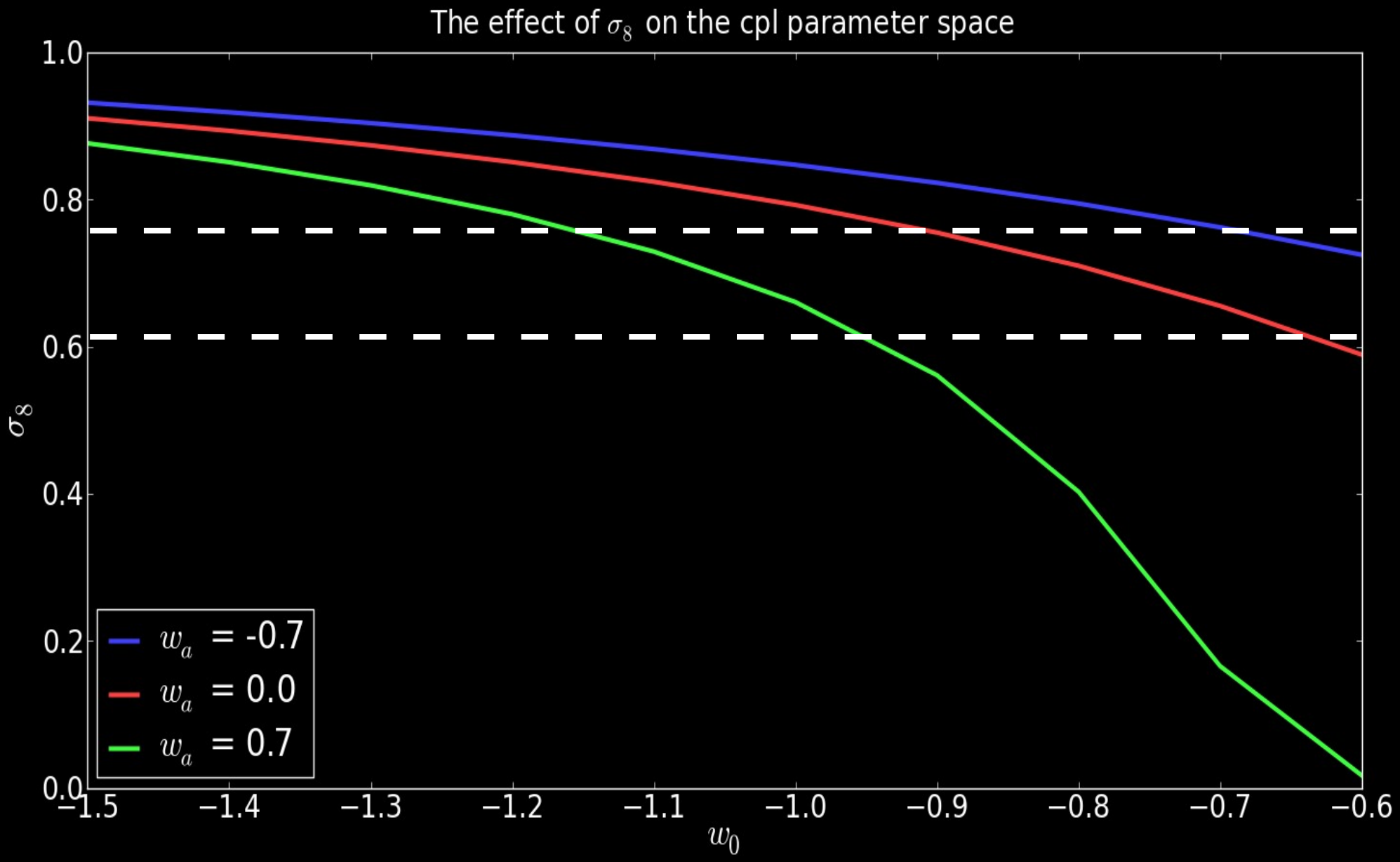

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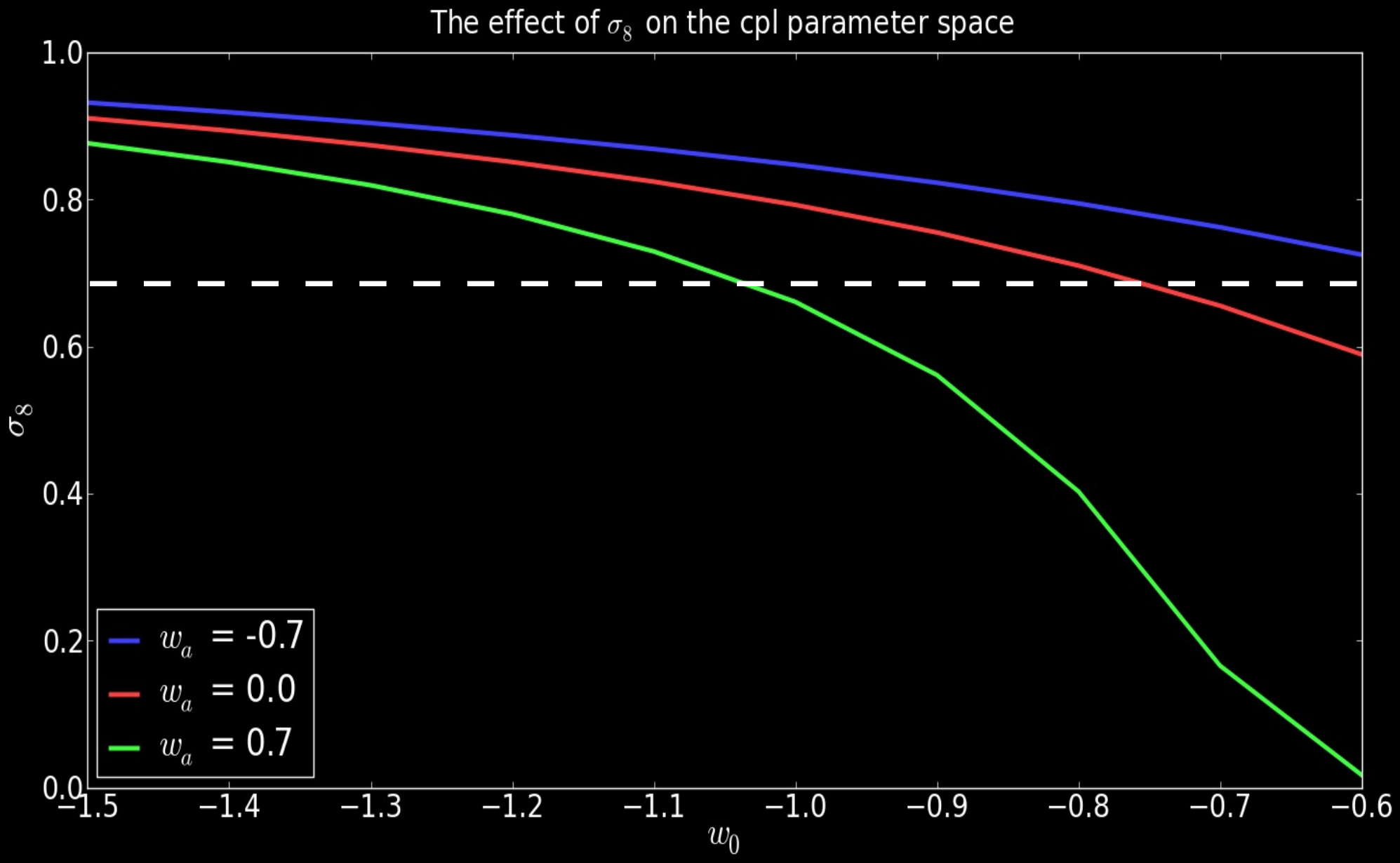
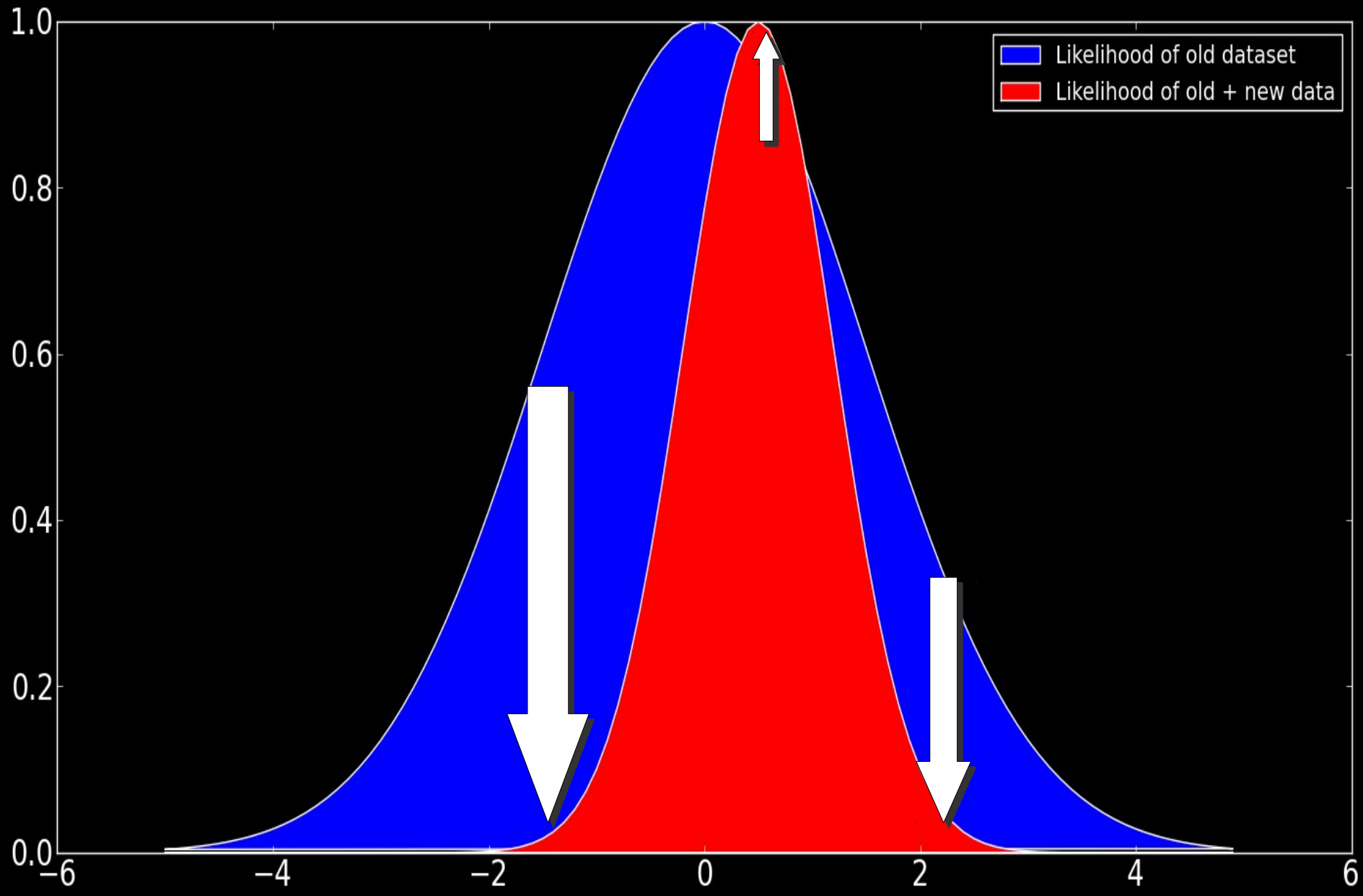
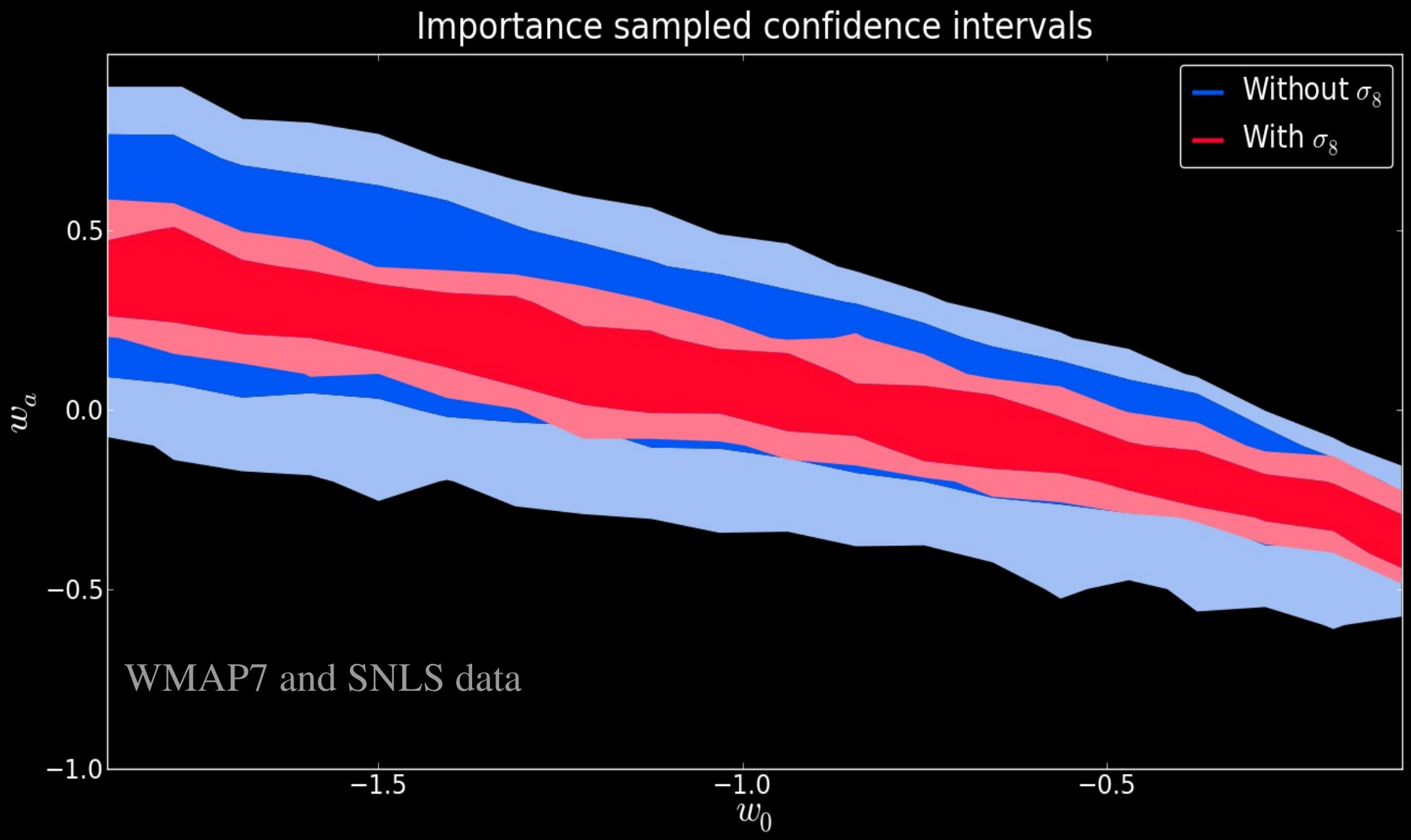


Importance Sampling

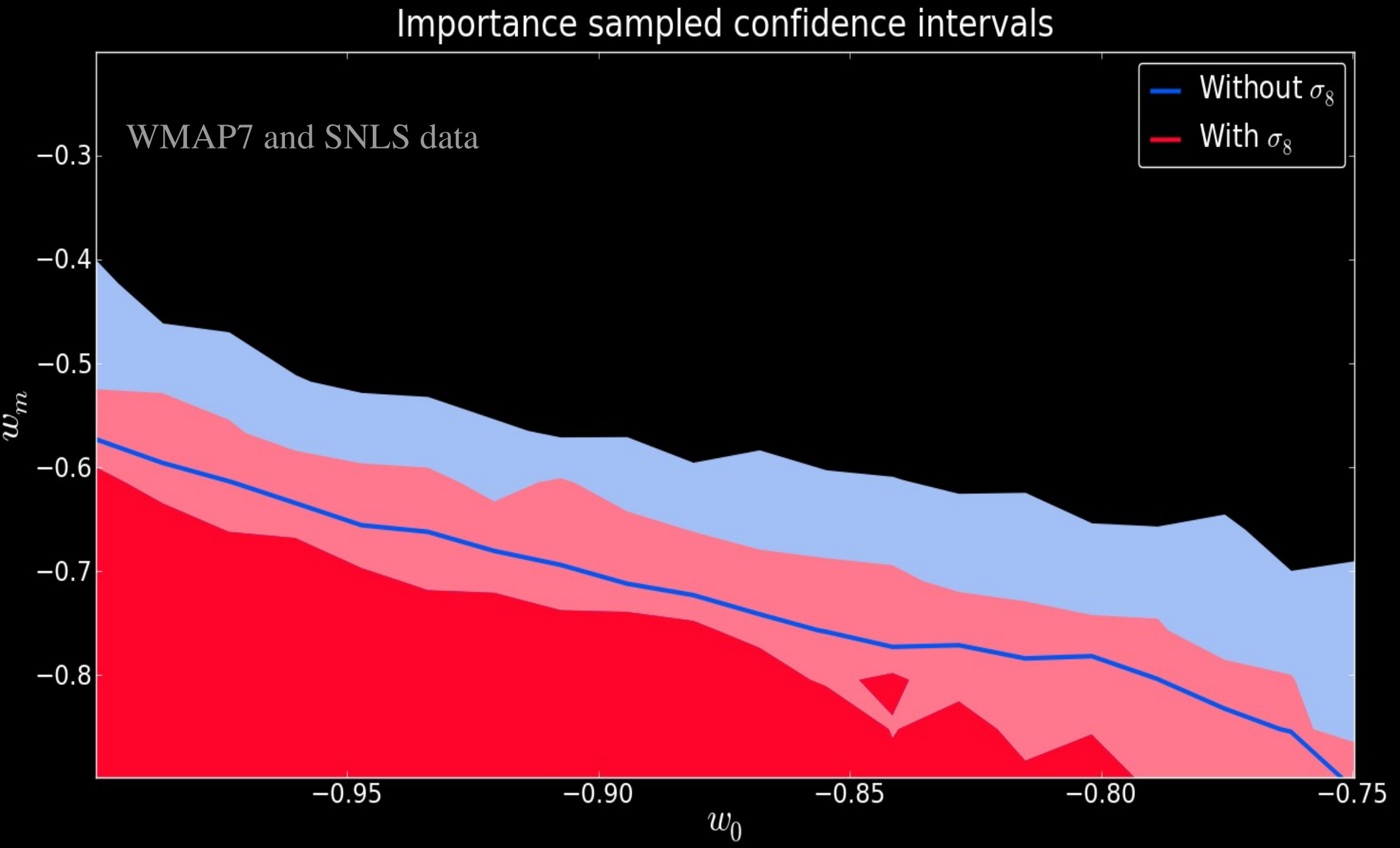


Some Results – CPL Parameterisation



The determinant of the covariance matrix reduces by a factor of 7.8.

Some Results – Kink Parameterisation



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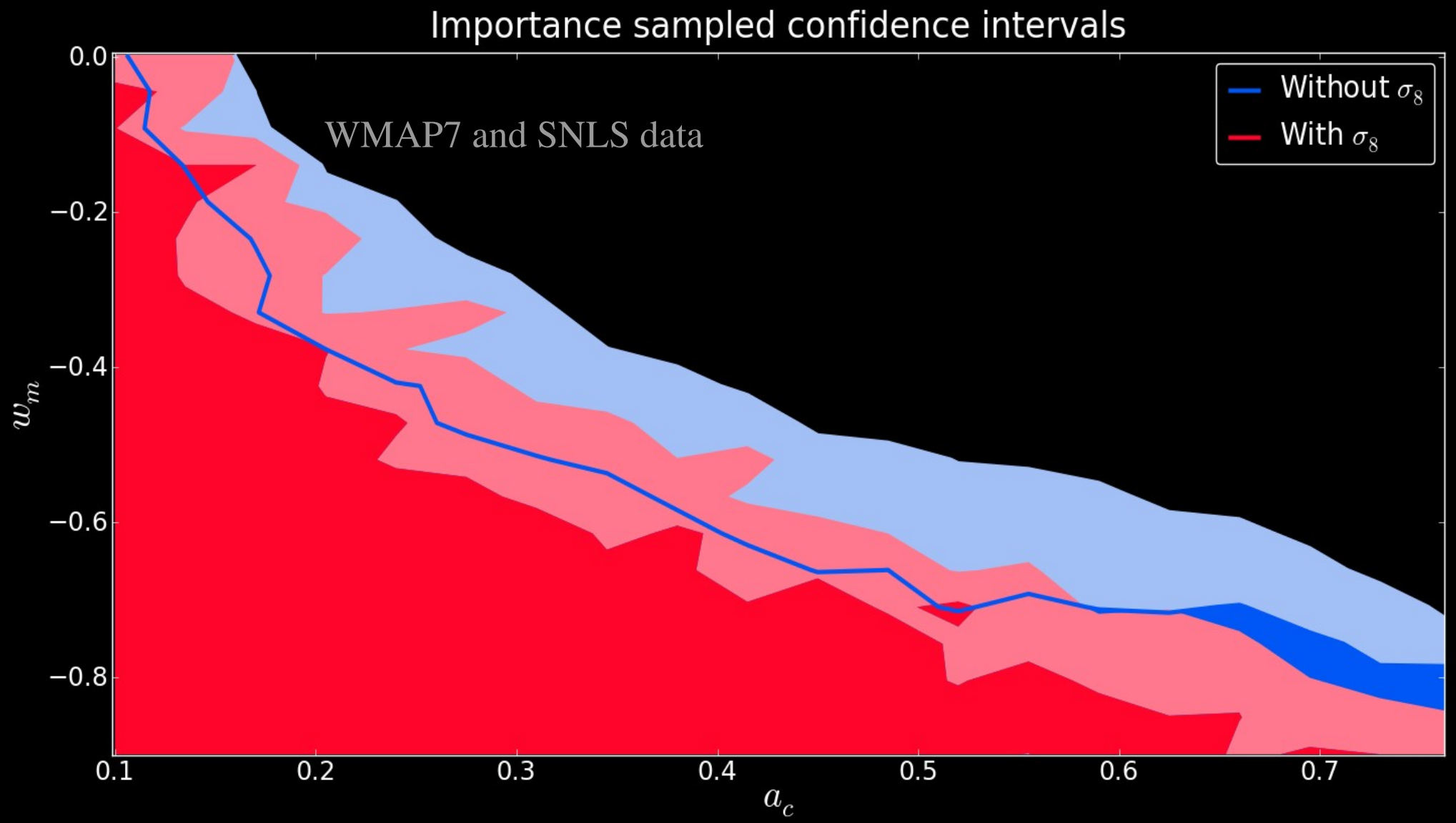


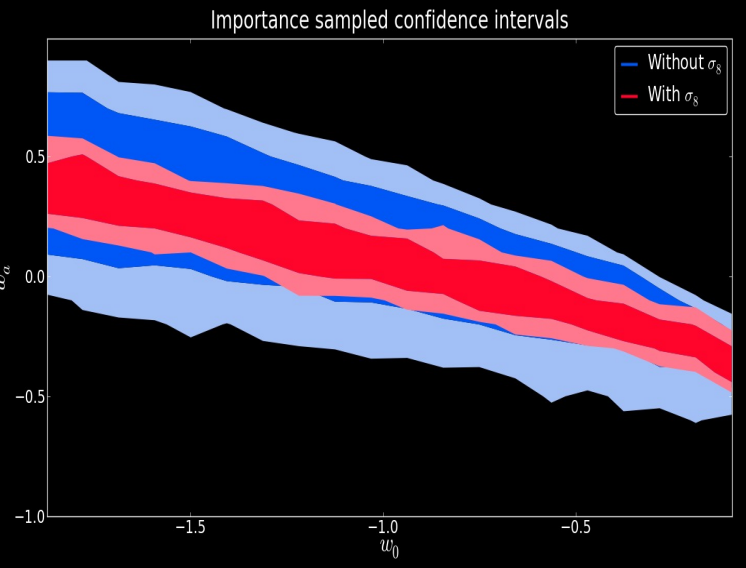
The determinant of the covariance matrix reduces by a factor of 1.7

Summary

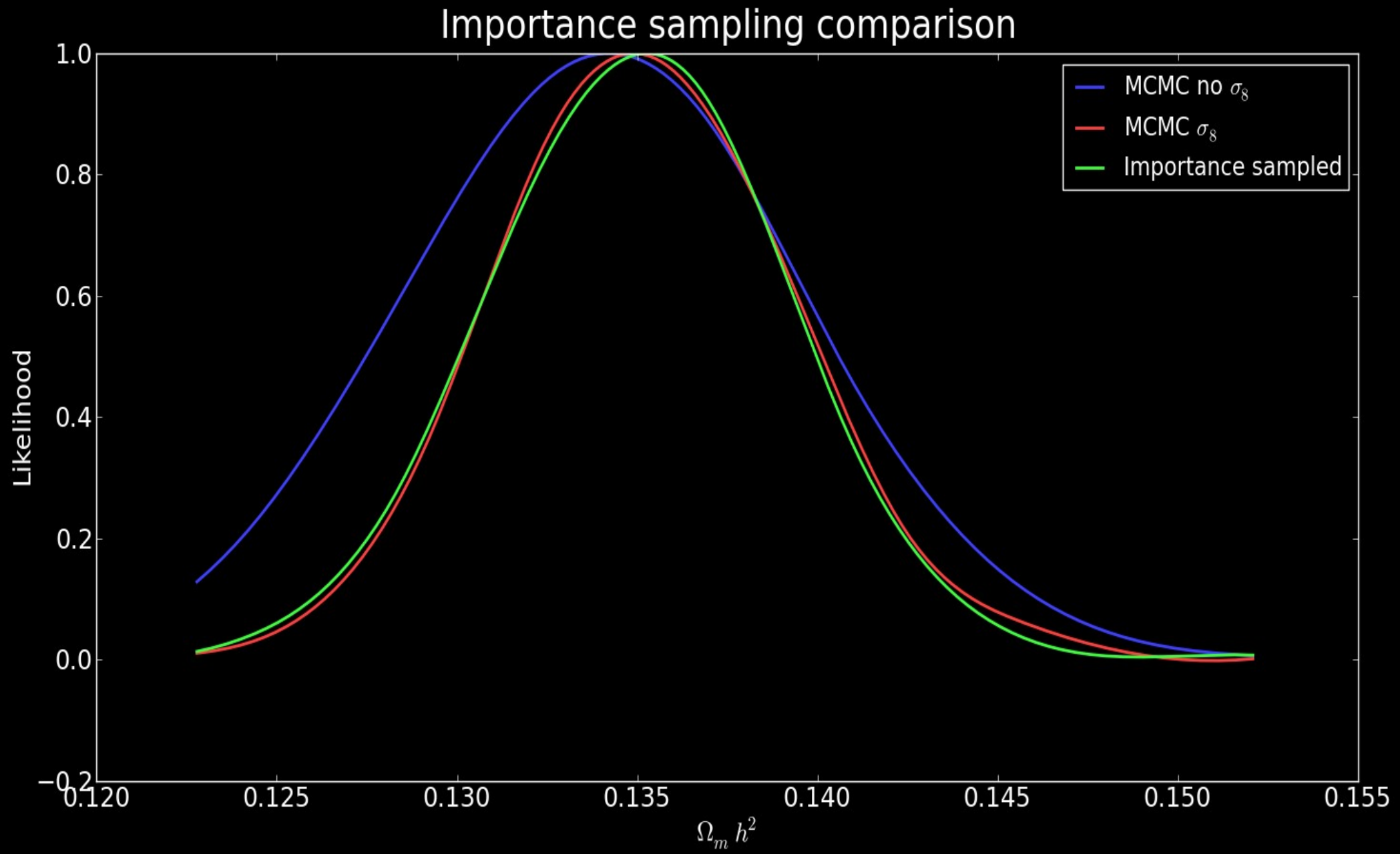
- Models of dynamical dark energy predict a lower value of σ_8, when compared with ΛCDM, due to an increased ISW effect and the normalisation of the power spectrum.

- The recent measurement of σ_8 from SPT has produced tighter contours on dynamical dark energy parameters, when included with WMAP7 and SNe data.

- This work has shown that a future, model-independent measurement of σ_8 would constrain or even rule out models of dynamical dark energy.



Importance Sampling vs. Full MCMC



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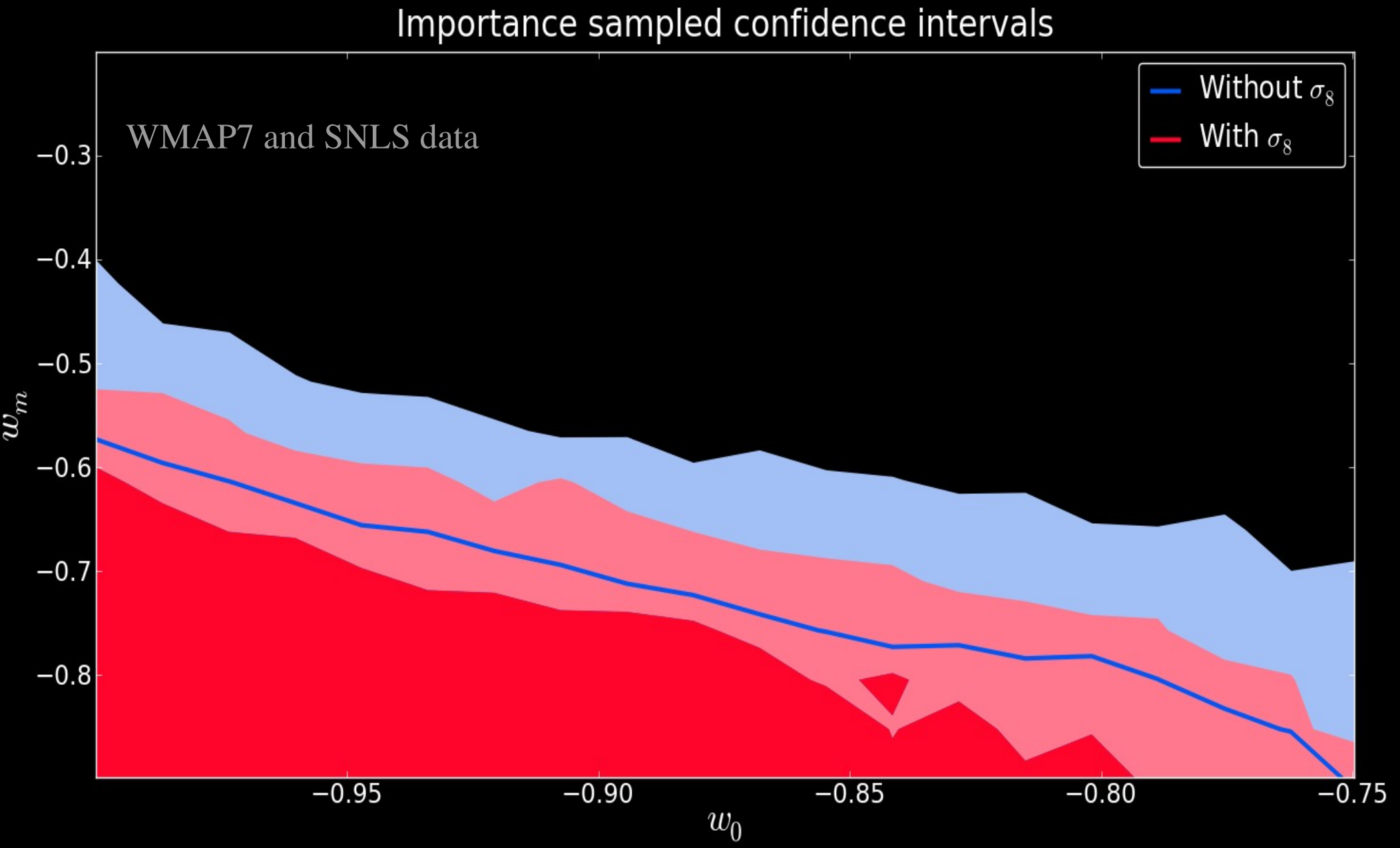

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