# Assessing the impact of baryonic feedback on dark energy constraints

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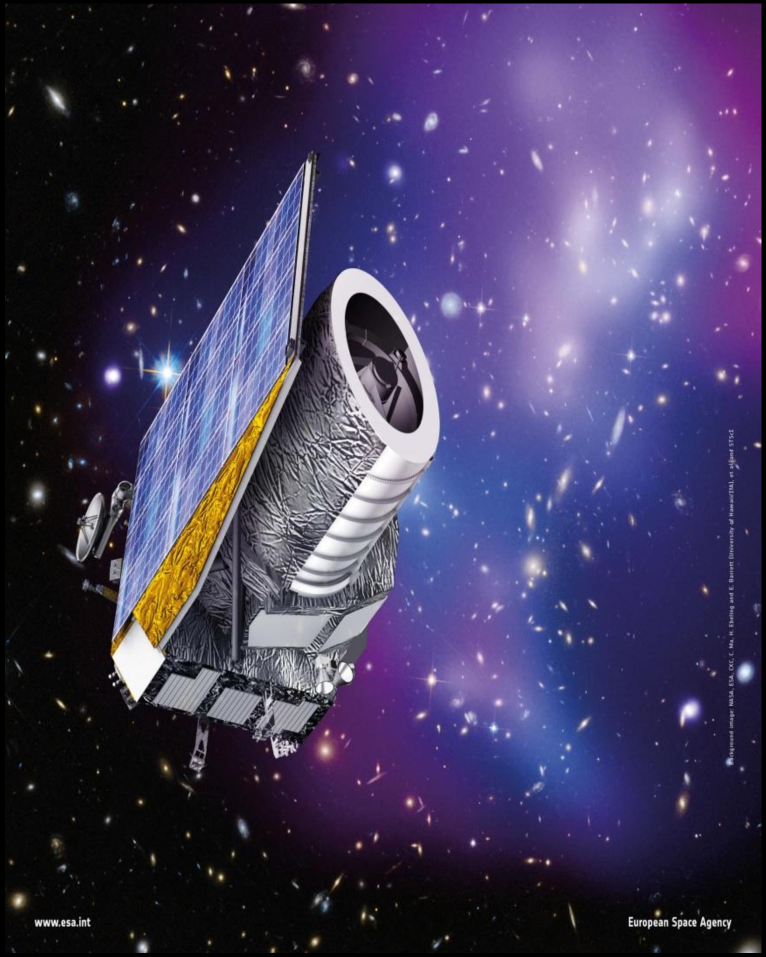
# Euclid Survey




- The Euclid mission (2020 launch) will cover 15,000 deg$^2$ of sky.

- Weak gravitational lensing and galaxy clustering measurements act as cosmological probes of dark energy signatures in large scale structure

- Percent level precision of dark energy parameters.

# Baryonic Feedback

- Baryonic astrophysical processes (e.g. star formation, supernova and AGN feedback, adiabatic cooling) have a non-negligible effect on large scale structure.

- A comprehensive theoretical understanding is very limited.

- Potentially significant degeneracies with dark energy effects.

# Baryon-Halo Model

Mead 2015 (MNRAS 2015 454(2)) halo model suggests baryon effects can be captured by two parameters:

1) $A_B$ controls the amplitude of the halo profile via the concentration factor,

$$c(M,z) = A_B\left(\frac{1+z_f}{1+z}\right)$$

# Baryon-Halo Model

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2) η encapsulates effects dependent on halo mass.

$$W\left(k,M\right) \rightarrow W\left(\nu^{\eta}k,M\right)$$

$$W\left(k,M\right) = \int_0^{r_v} r^2 \frac{\sin\left(kr\right)}{kr} \rho\left(r,M\right) dr$$

$$\nu \equiv \frac{\delta_c}{\sigma\left(M\right)}$$

# Baryon-Halo Model

A third parameter can be introduced to capture additional small scale effects.

3) $r_b$ defines a second break scale in the NFW profile:

$$\rho_{NFW} = \frac{\rho_N}{\left(\frac{r}{r_s}\right)\left(1+\frac{r}{r_s}\right)^2}$$

# Baryon-Halo Model

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3) $r_b$ defines a second break scale in the NFW profile:

$$\rho_{NFW,\mathrm{mod}} = \frac{\rho_N}{\left(\frac{r_b + r}{r_s}\right)\left(1 + \frac{r}{r_s}\right)^2}$$

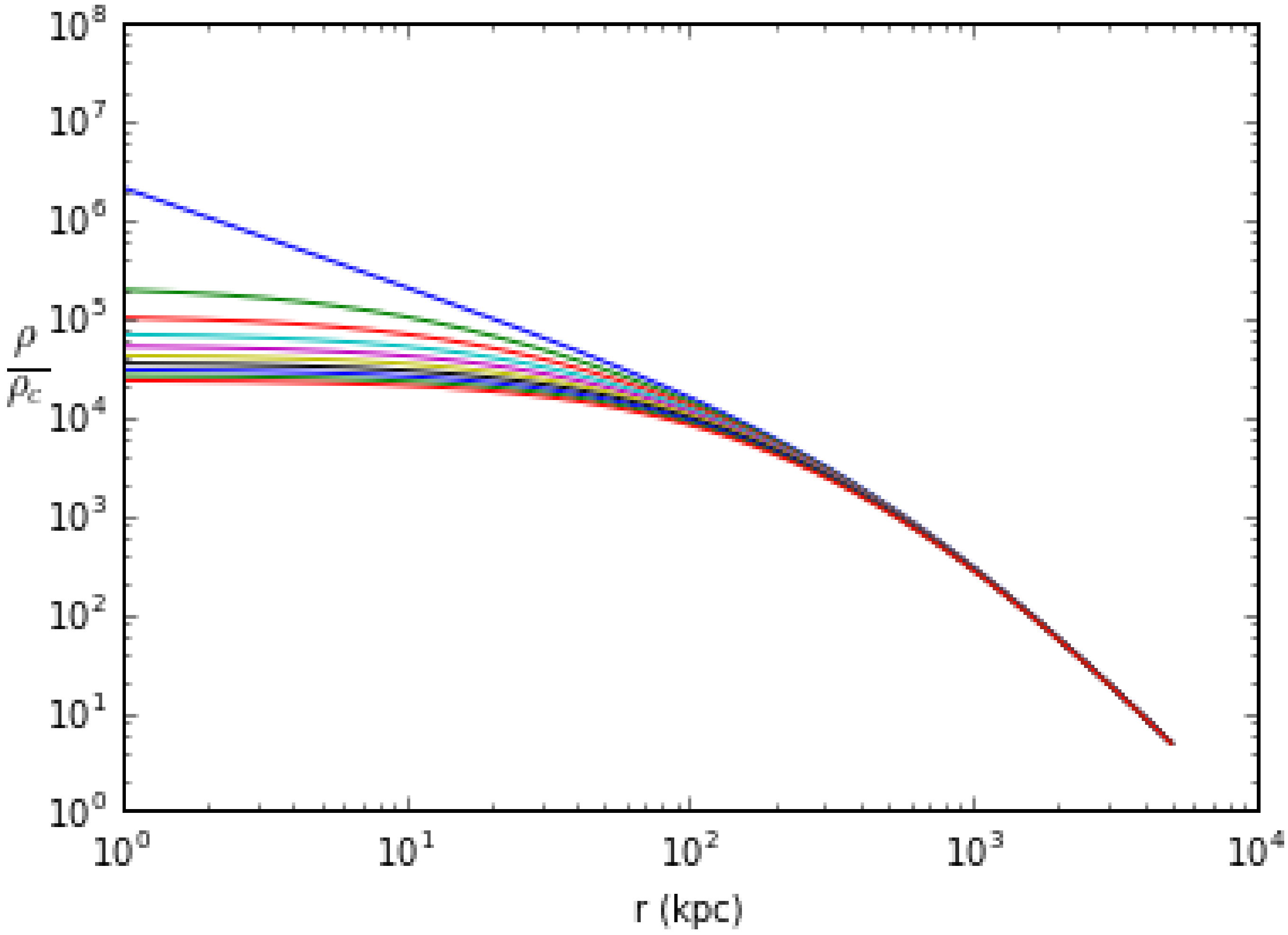
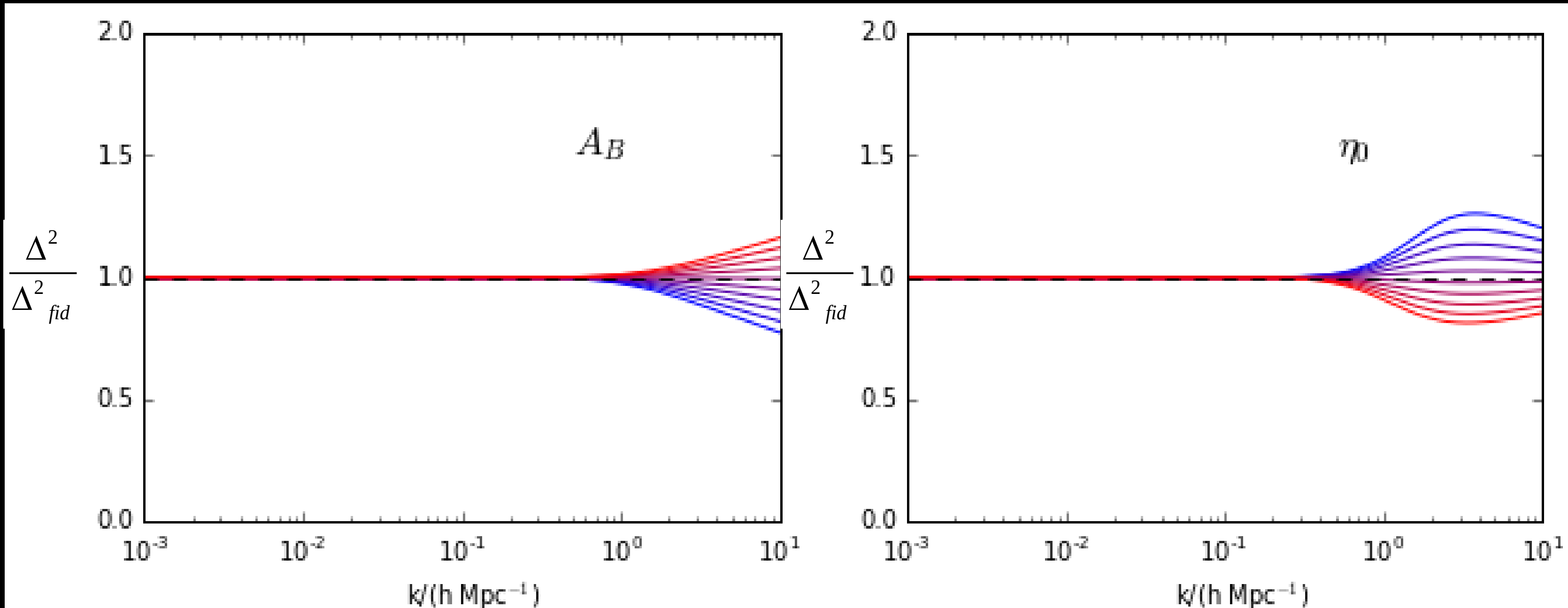



Fig. 1: Modified NFW profiles in real space, with successive $r_b$ values in the range *10-100 kpc* corresponding to increasing depressions of the core. The NFW profile (blue) is included for comparison.



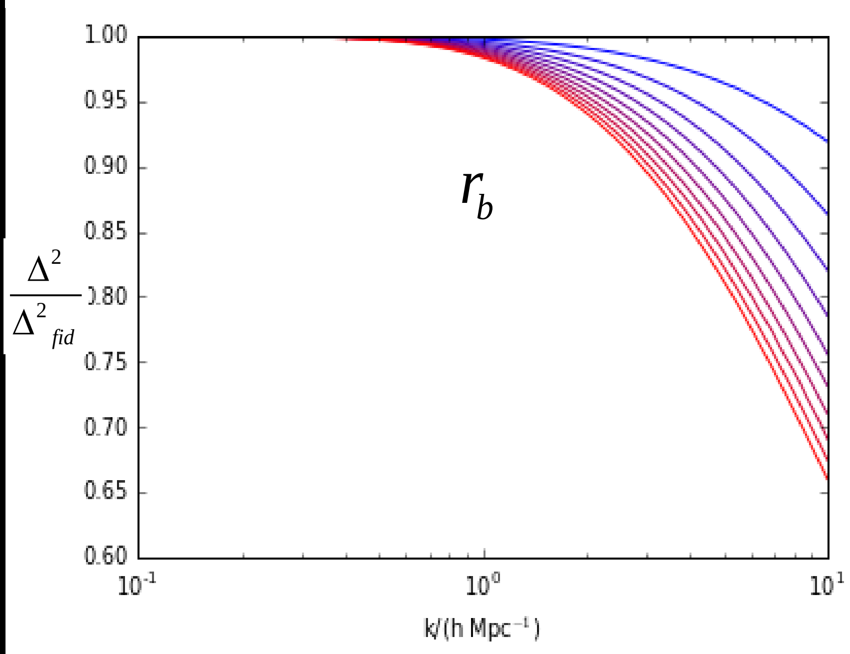




Fig. 2: The matter power spectrum response to varying the baryon parameters . Blue (red) curves represent lower (higher) values. $A_B$ and η are determined by matching to OWLS simulations. $r_b$ is varied through a range of *10-100 kpc/h*.

# Fisher Analysis

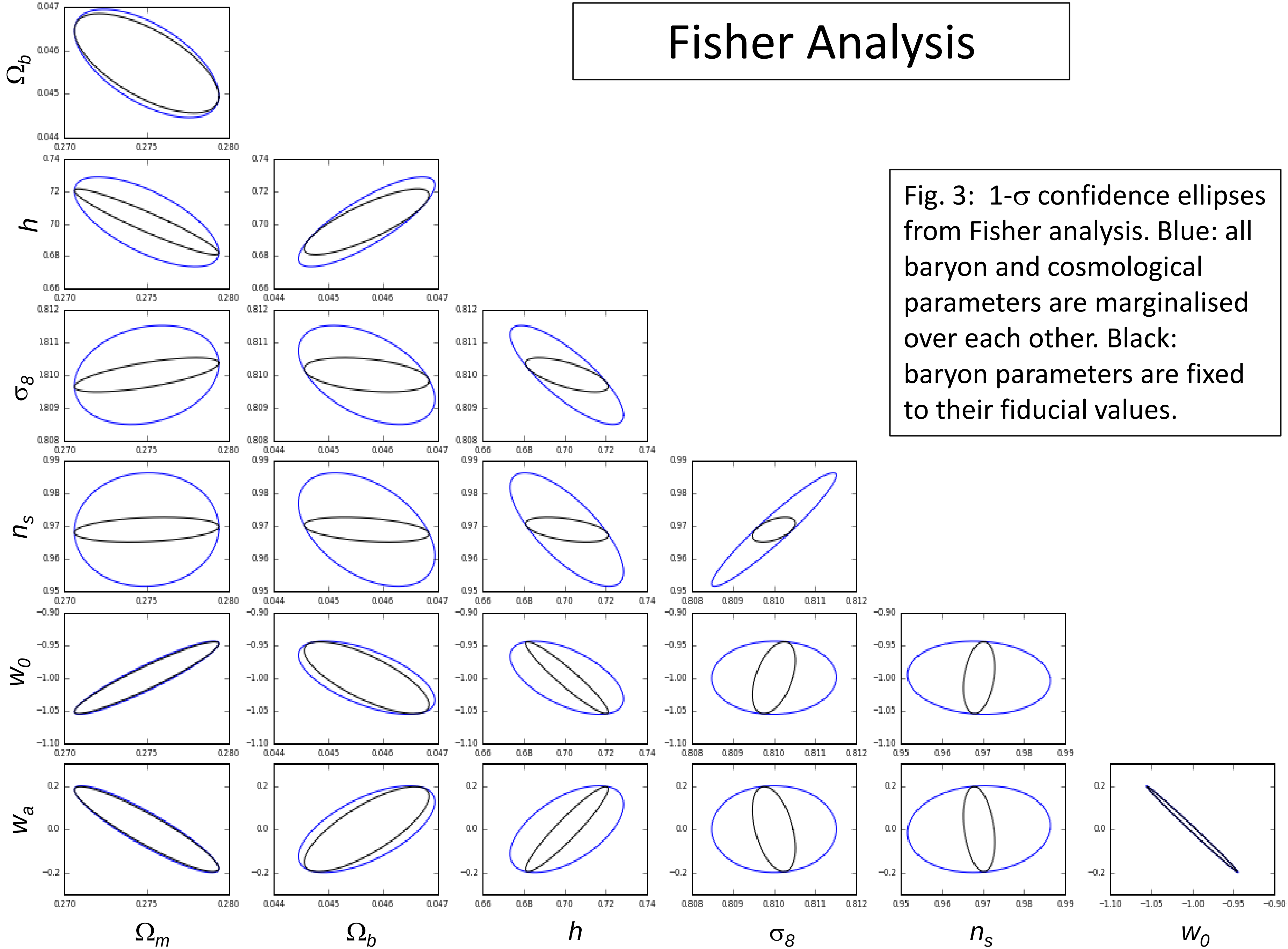



Fig. 3: 1-σ confidence ellipses from Fisher analysis. Blue: all baryon and cosmological parameters are marginalised over each other. Black: baryon parameters are fixed to their fiducial values.

# Summary

- Baryon parameterisations of the halo model can provide useful insights as to the risk of degeneracies between baryon and dark energy effects in large scale structure.
- Impact not so severe for dark energy as one might expect.
- Significant impacts for certain cosmological parameters – particularly the spectral index and $\sigma_8$.

# Future Work

- Extend analysis to include neutrinos and modified gravity effects.
- Incorporate information from observational data and simulations.
- Address the question of model bias:

  -Quantitatively how much can we trust this (or any) baryon parameterisation?

  -Possible mitigation strategy by expanding current parameters in terms of the halo mass.

Thank you

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