Cluster Observables and Mass Calibration:
An Exercise in Robustness

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Panchromatic Panoramic Studies of Galaxy Clusters
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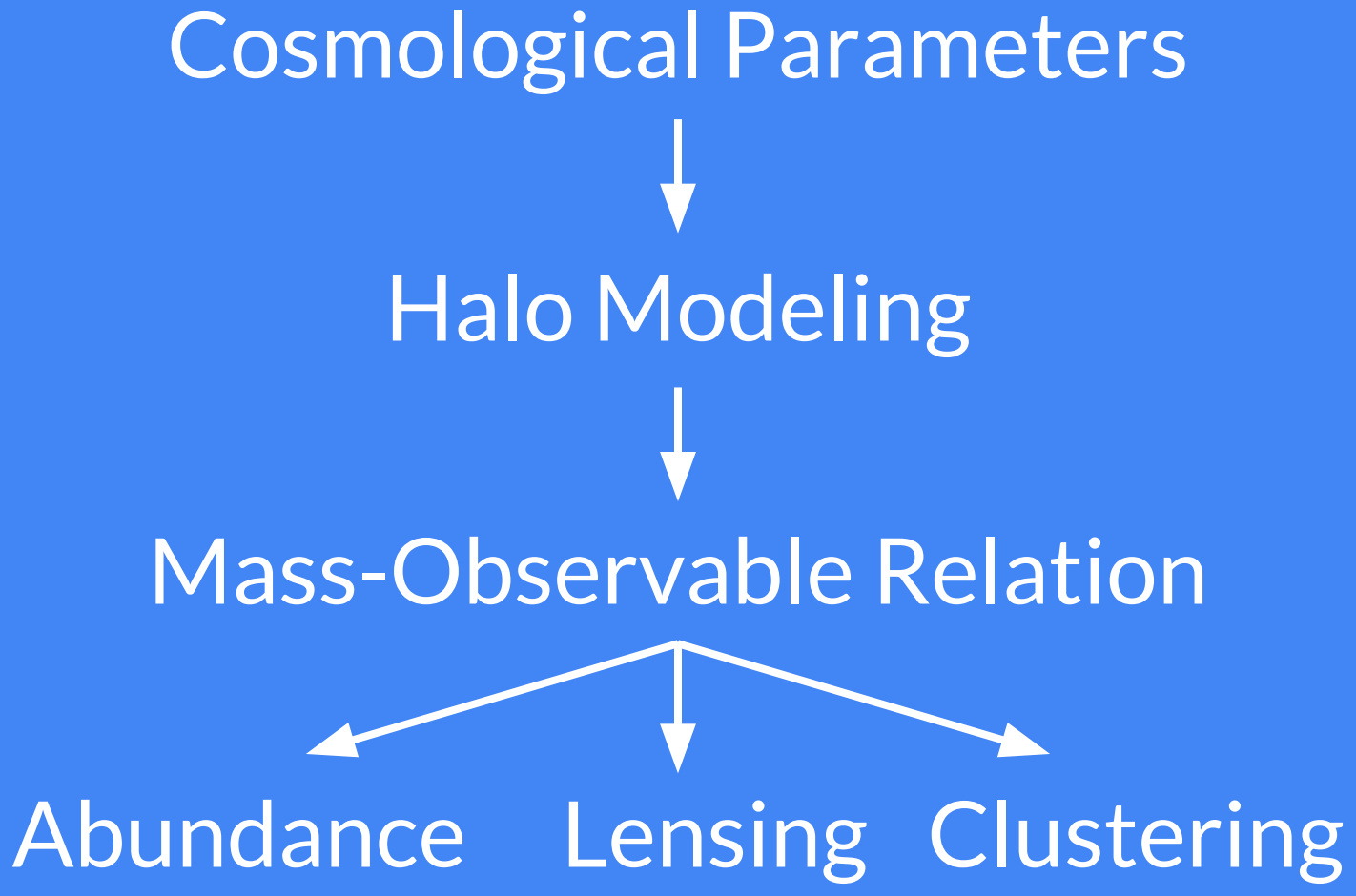
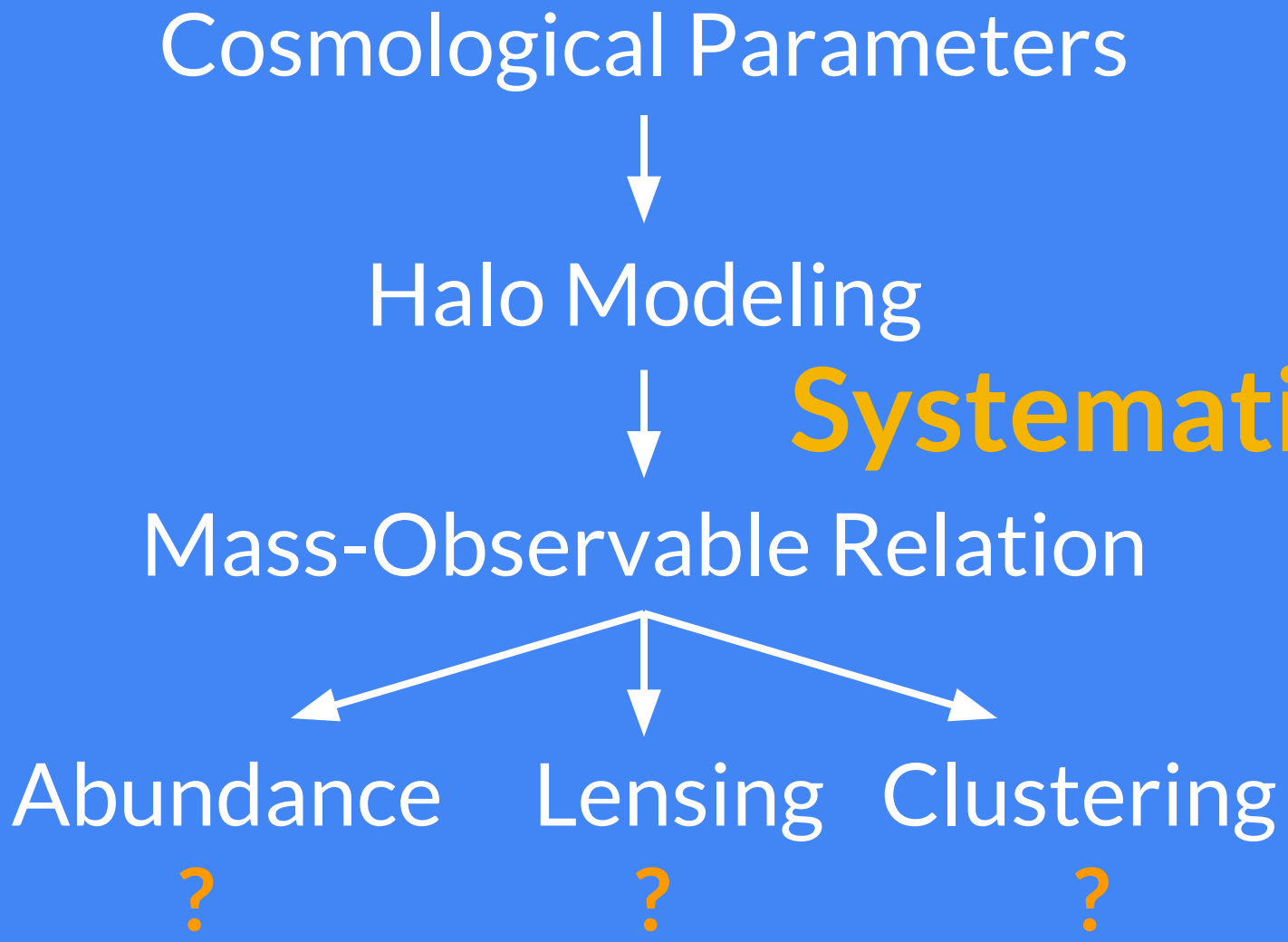
Combined Cluster Cosmology



Combined Cluster Cosmology



Combined Cluster Cosmology

Constraining Power?

Robustness?

Abundance ?

Lensing ?

Clustering ?

Forecasting

N + WL + CC

vs.

WL + CC

Forecasting

- **Fisher forecasts**

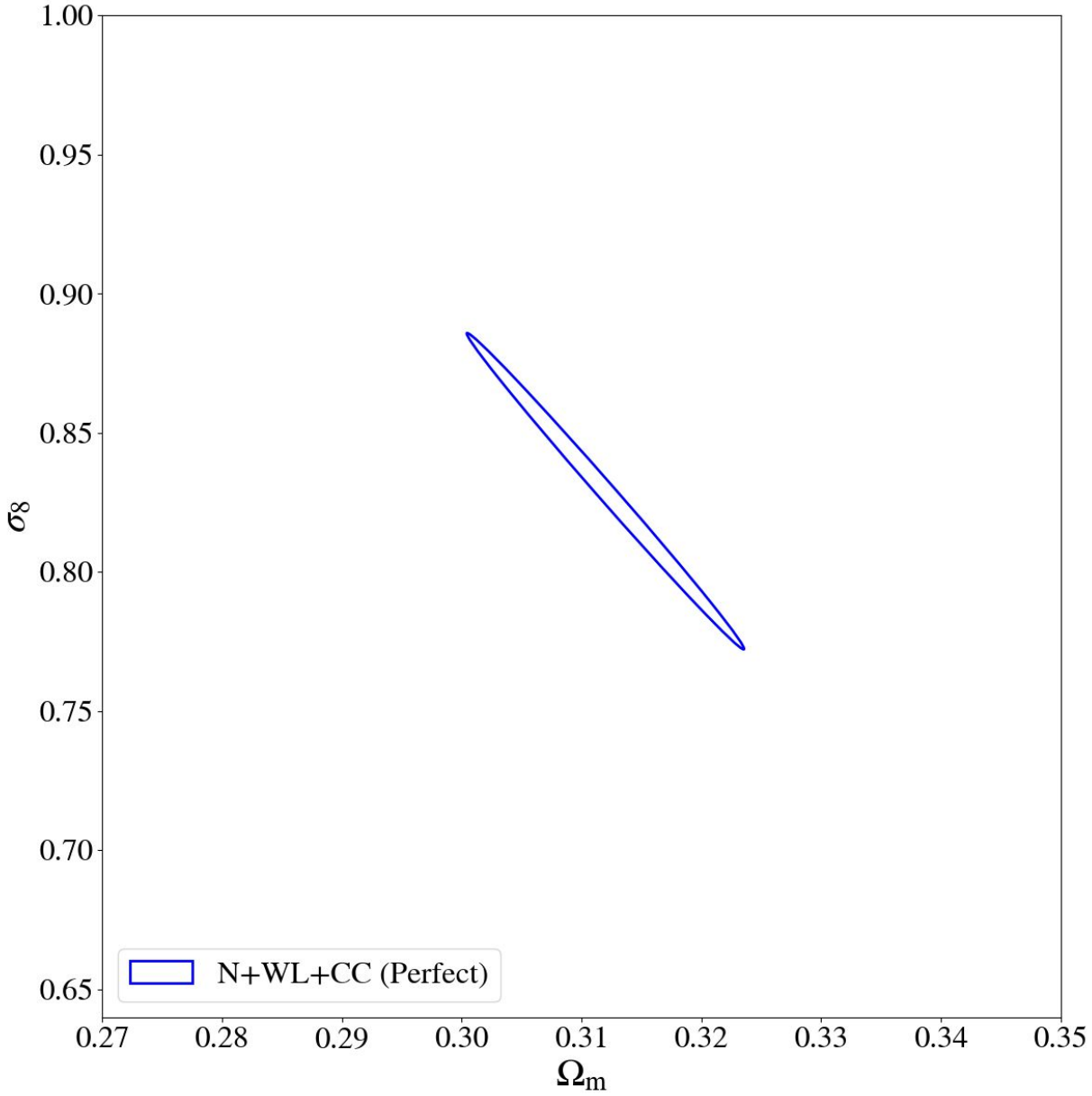
$$\mathbf{F}_{ij} = \frac{\partial \boldsymbol{\mu}^t}{\partial p_i} \mathbf{C}^{-1} \frac{\partial \boldsymbol{\mu}}{\partial p_j}$$

  - Model-based estimates for parameter constraints and shifts
  - Gaussian approximation of likelihood about the ML point

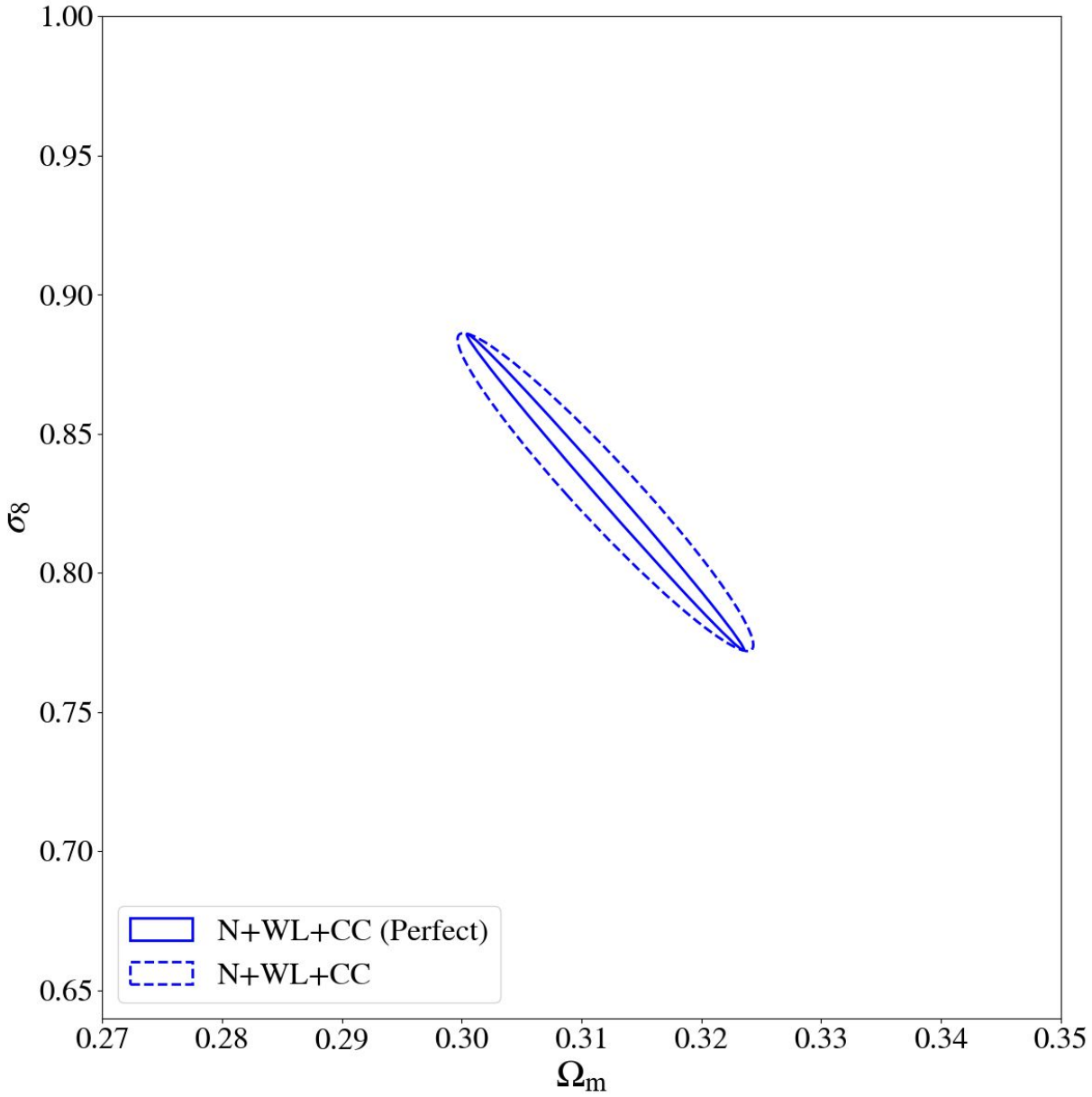
- **Fiducial "SDSS DR8 redMaPPer-like" Analysis Setup**
  - Assume log-normal mass distribution at fixed richness
  - 4 richness bins X 1 redshift bin
  - Predictions based on the Dark Emulator (Nishimichi et al.)
  - Covariances from hybrid sources (data+sim)

Constraining Power

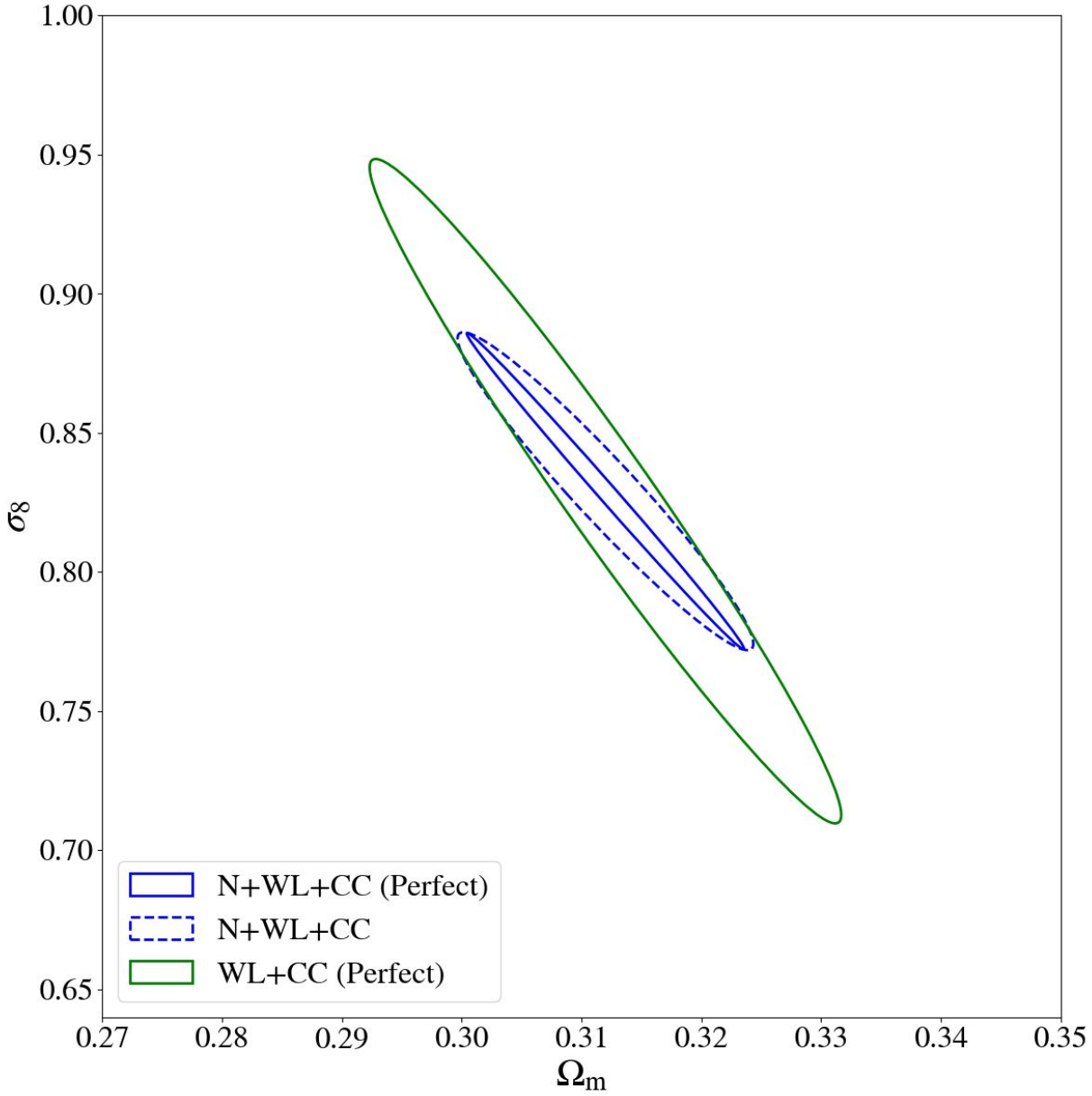
Perfect Scenario



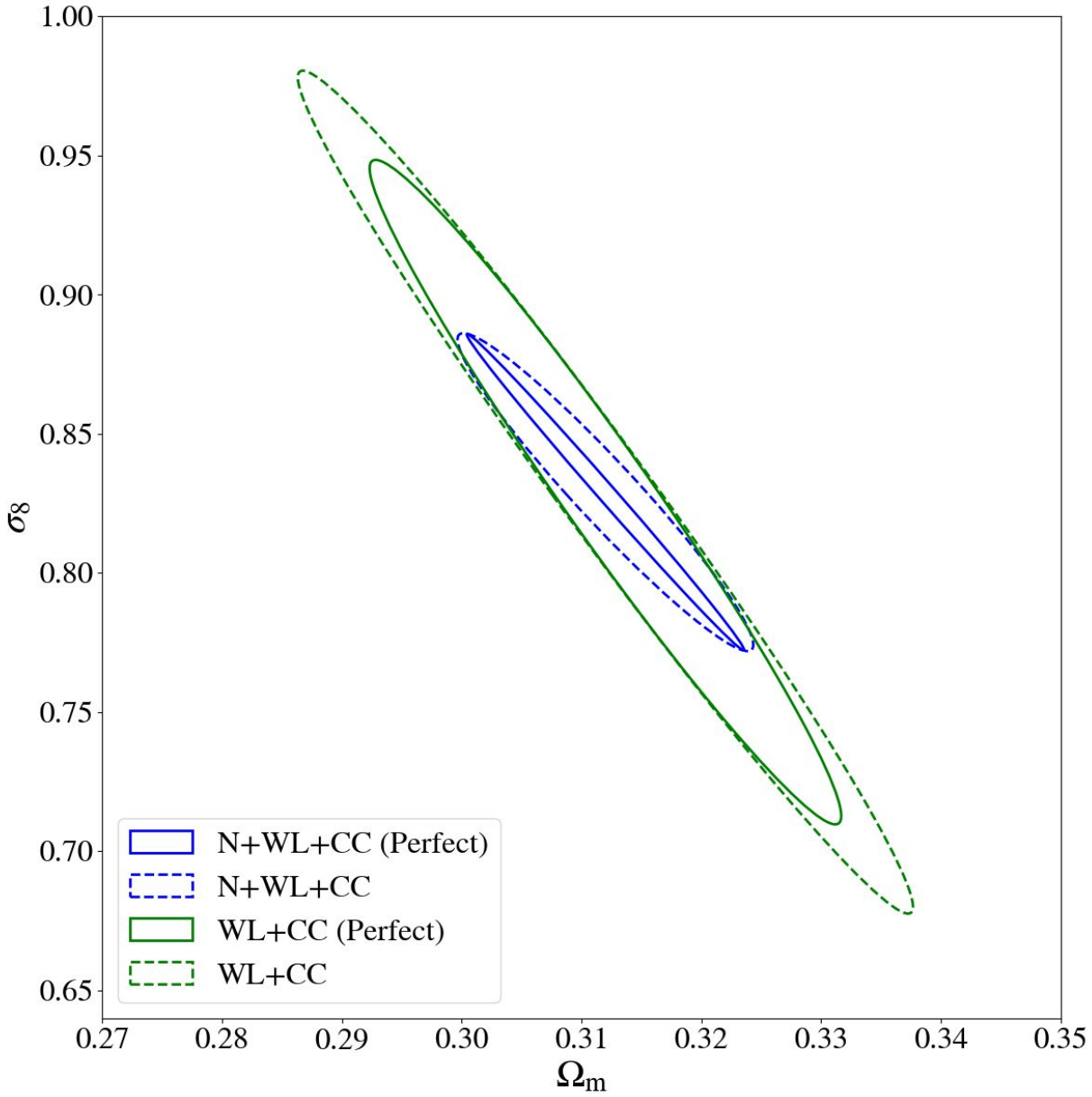
Realistic Scenario



Perfect Scenario #2



Realistic Scenario #2



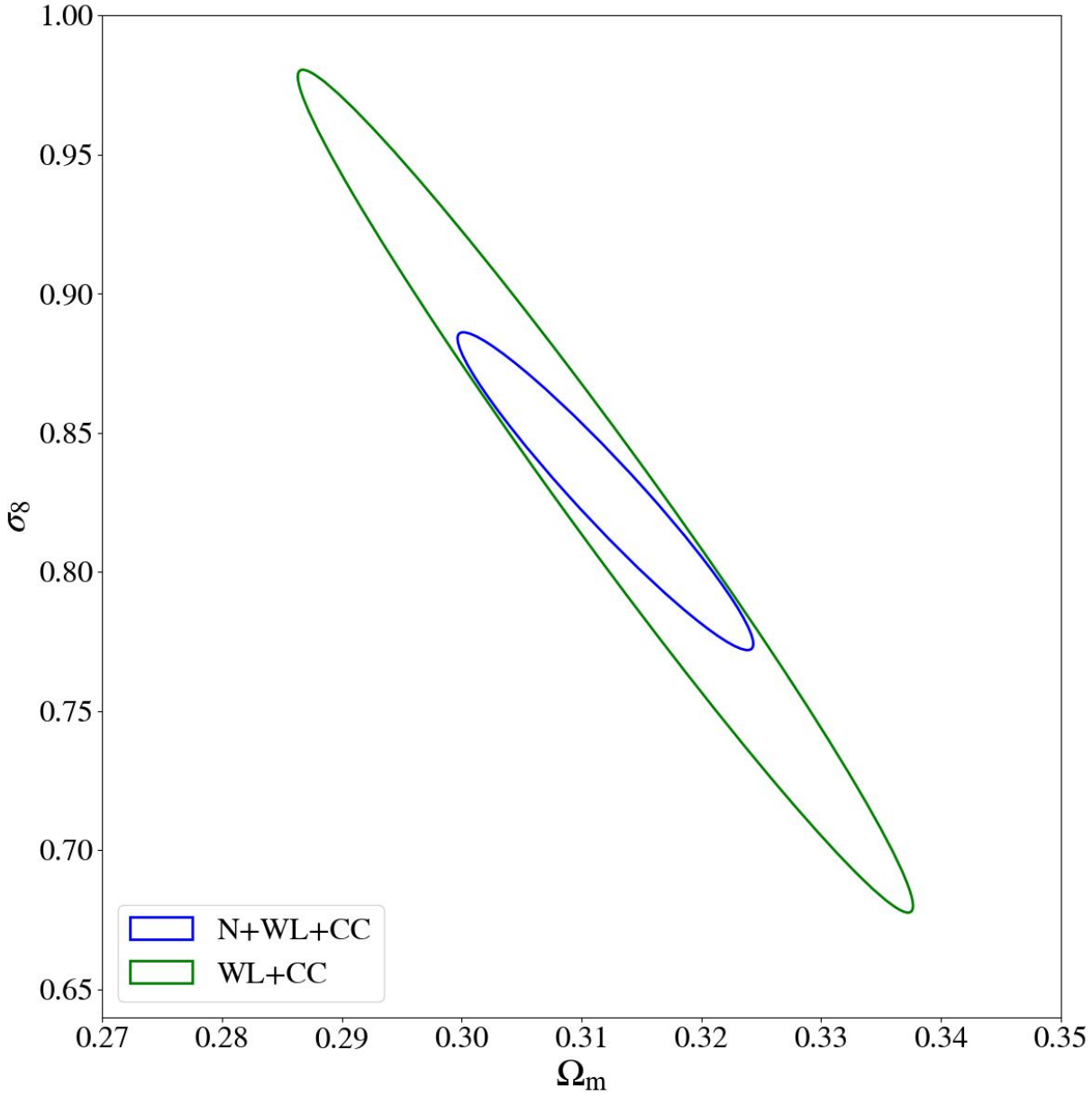
Robustness to Systematics

Robustness to Systematics

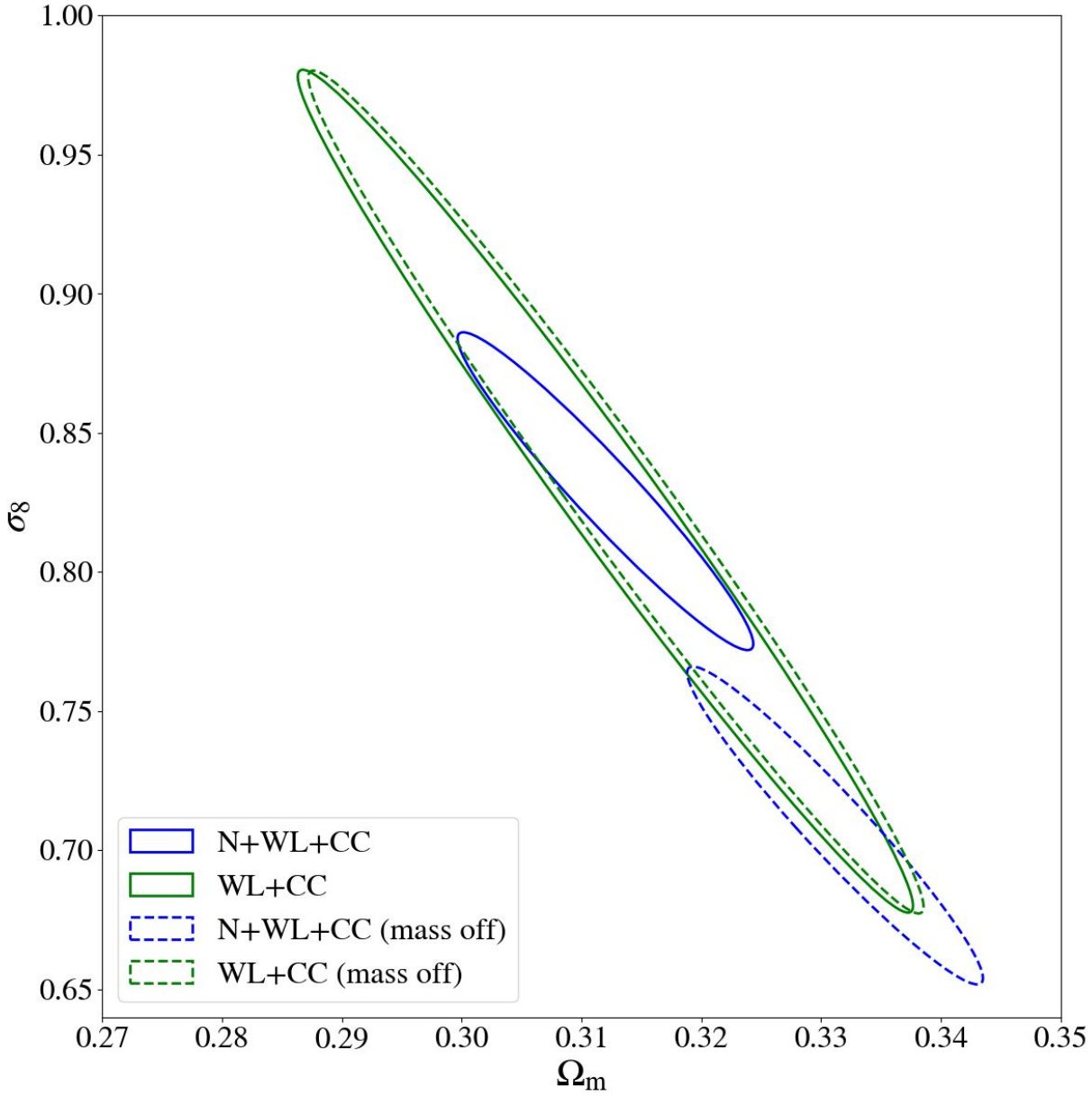
(biased mass estimates)

(off by 0.1 dex or ~25%)

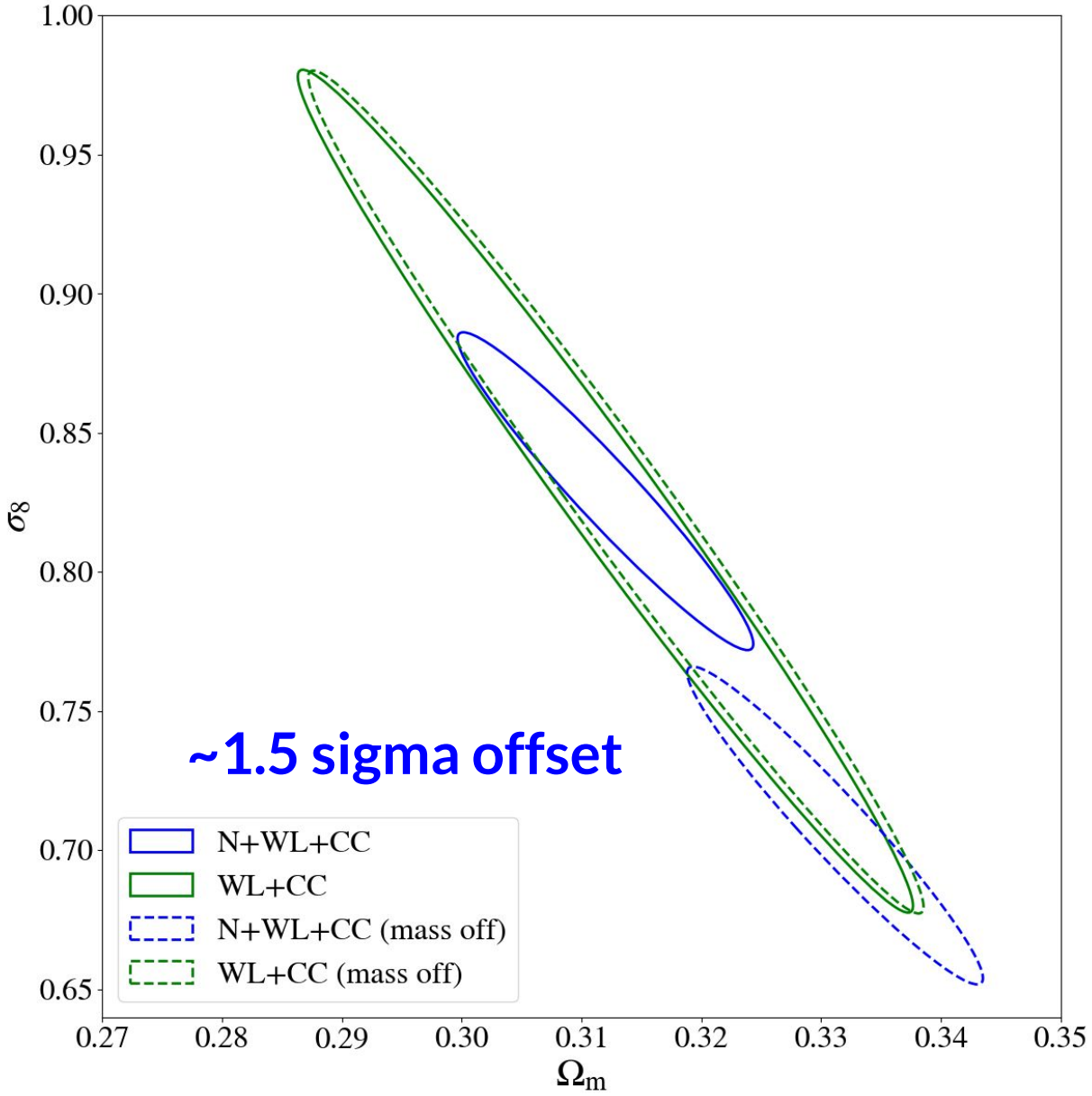
Before Mass Bias



After Mass Bias



Order-of-Magnitude Difference

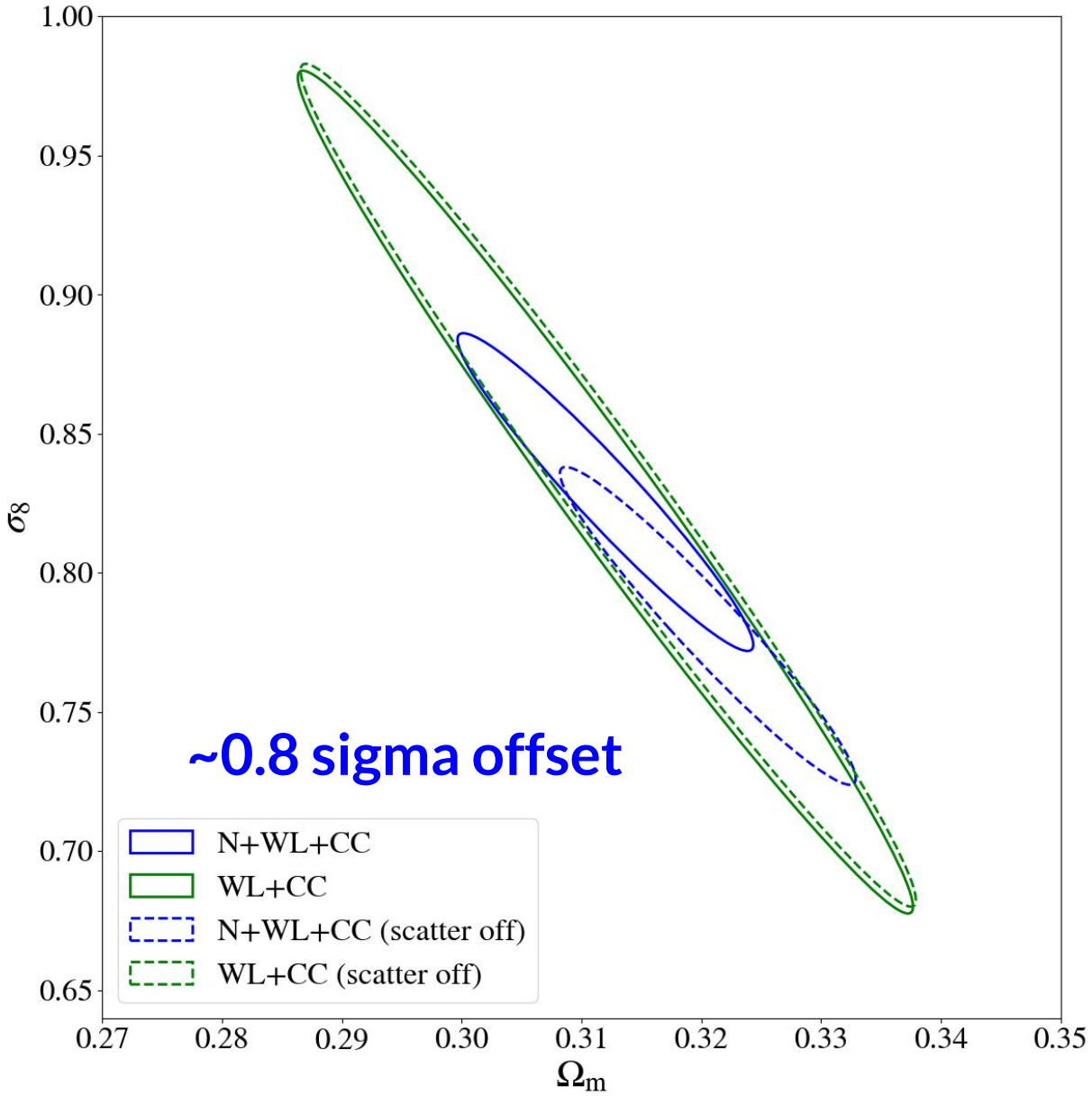


Robustness to Systematics

(wrong intrinsic scatter)

(off by 0.02 in σ_{log10M})

(almost) Order-of-Magnitude Difference



Remarks

- **Caveats**
  - Highly idealized scenario
  - Details to be updated, e.g. simulation-based full covariances

- **Cluster abundance comes at a price**
  - Under the “realistic” scenario,
  - Abundance yields 2 X greater constraining power for om and s8
  - Abundance inflates 10+ X the sensitivity of parameter constraints to systematic offsets

- **To buy the constraining power, we must pay with a lot of systematics modeling/mitigation**

Handle Abundance with Care