

Investigating Weak Lensing Effects on Supernovae Cosmology

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presenting work by Jenna Glaze and Jansyn Pihl
Shifting Landscapes in Astrophysics
July 15, 2026

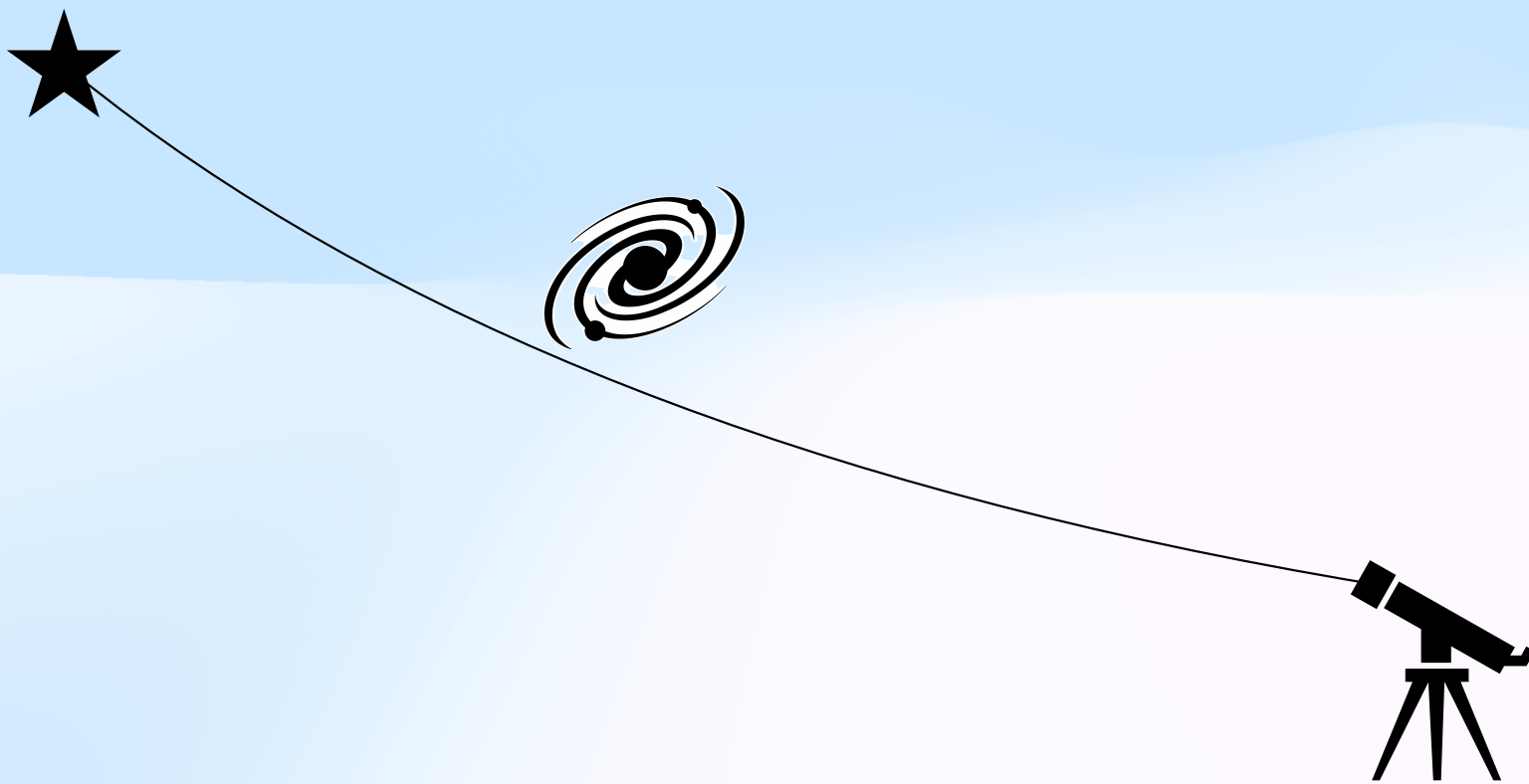


Jenna Glaze



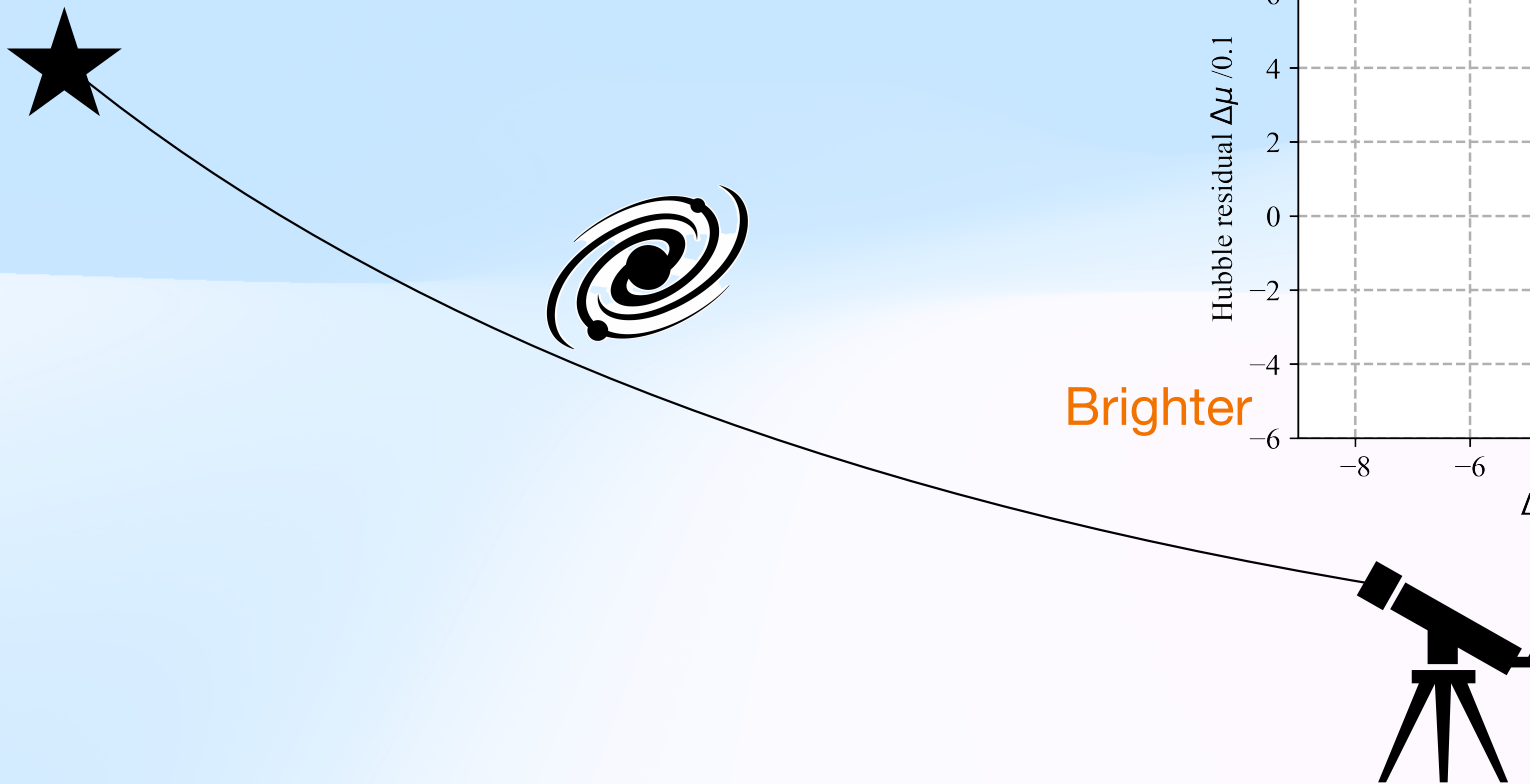
Jansyn Pihl

Gravitational Weak Lensing



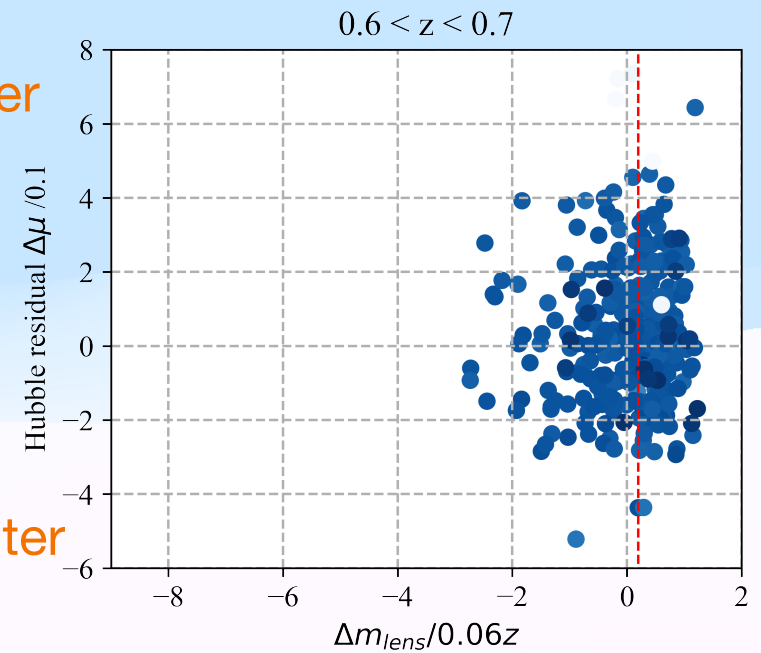
Gravitational Weak Lensing

Changed Magnitude



Fainter

Brighter



Weak Lensing and Supernova Cosmology

- Produces an “unknown” shift in apparent magnitude of the SN

Weak Lensing and Supernova Cosmology

- Produces an “unknown” shift in apparent magnitude of the supernovae

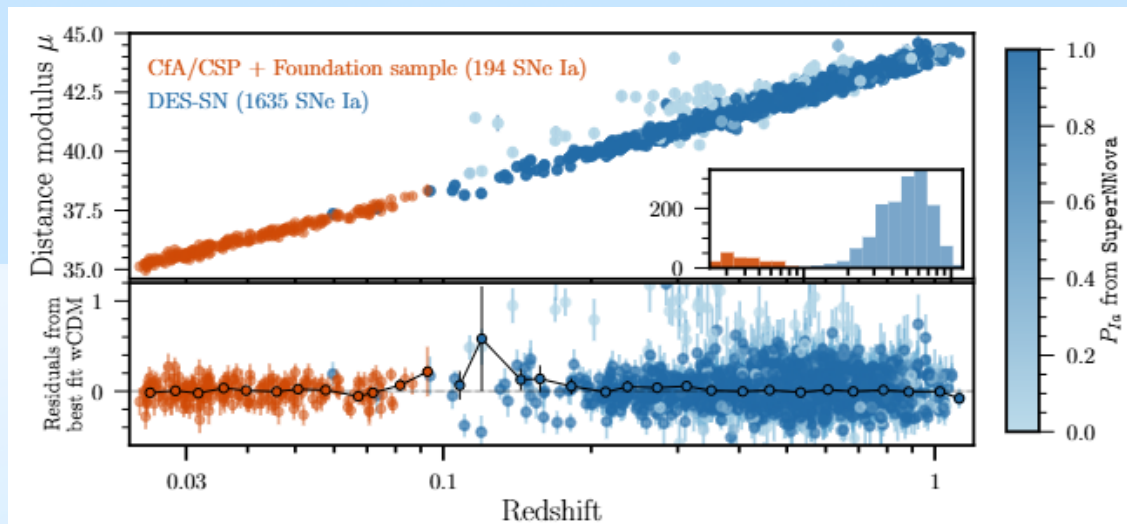
1) Increase your uncertainty

$$\sigma_{\text{tot}}^2 = \sigma_{\text{N}}^2 + \sigma_{\text{mass}}^2 + \sigma_{\mu-z}^2 + \sigma_{\text{int}}^2 + \sigma_{\text{Bias}}^2 + \sigma_{\text{lens}}^2$$

2) Fit more cosmology

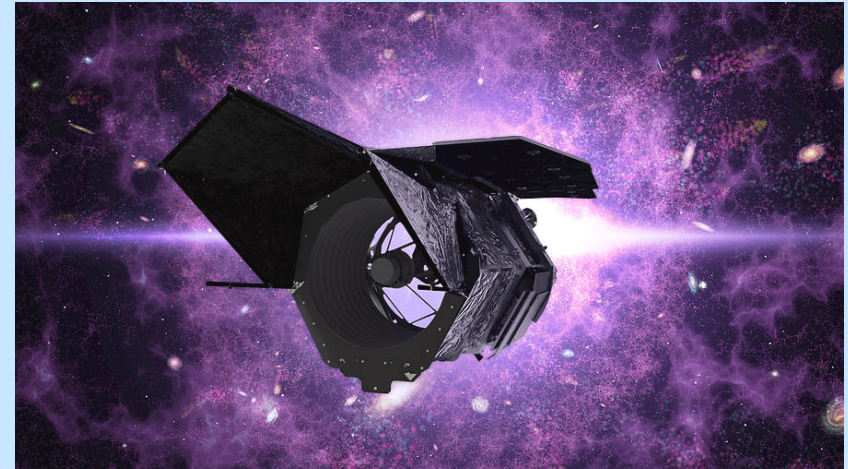
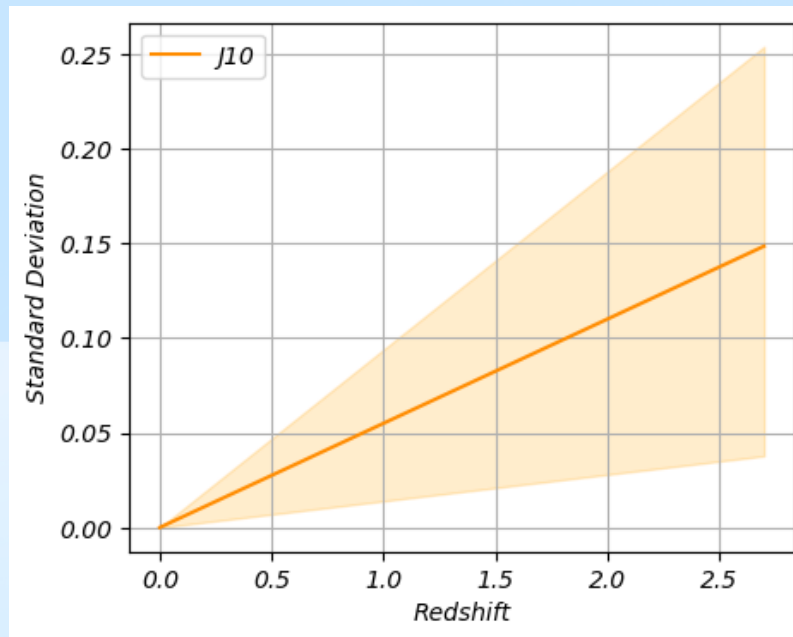
$$\sigma_8$$

Distance Uncertainty from Lensing



$$\sigma_{\text{lens}} = (0.055 \pm 0.04) \times z$$

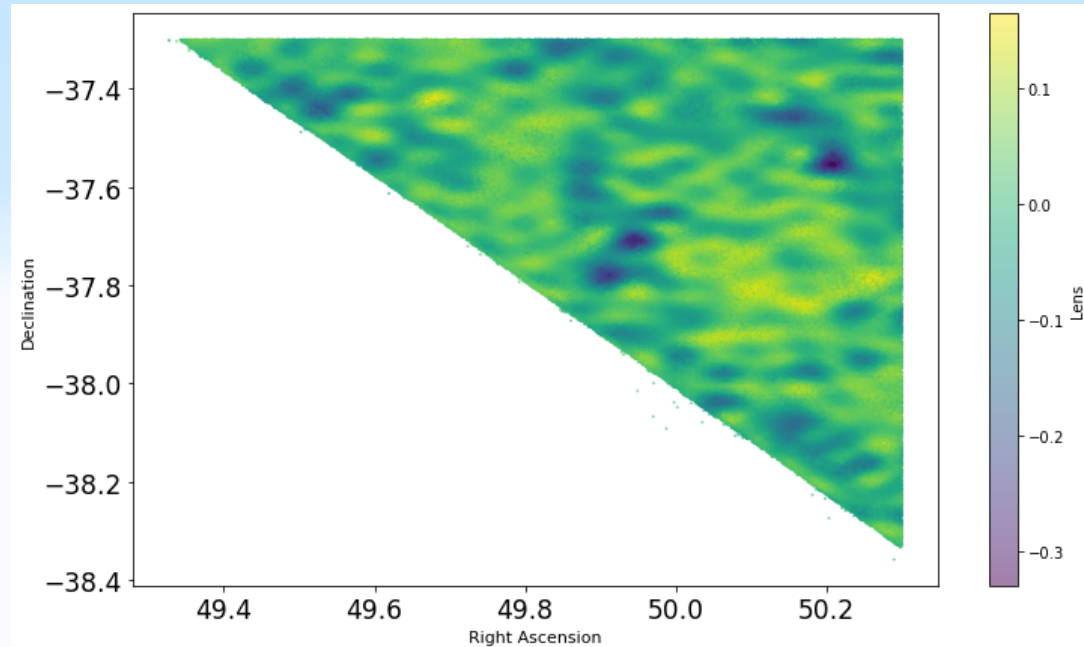
A Problem for Roman!



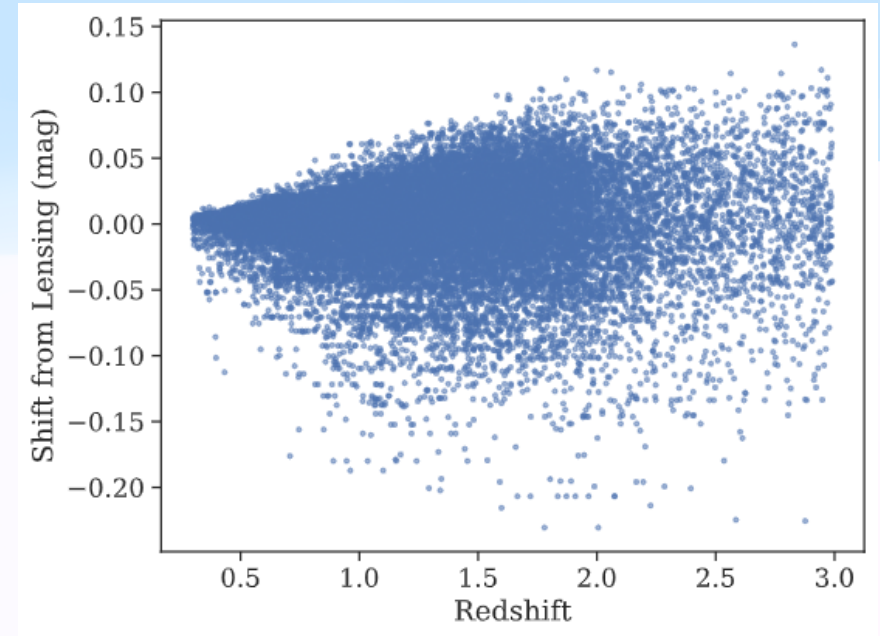
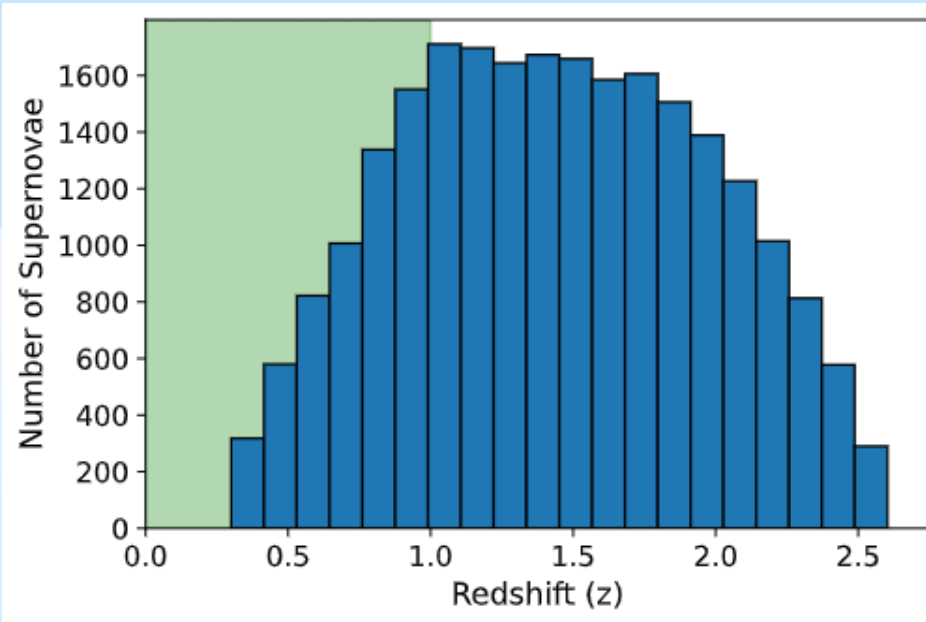
- The Nancy Grace Roman Space Telescope will measure supernova to redshifts past $z = 2.5$, or a $\sigma_{\text{lens}} = 0.14$!

Simulations

- High-Latitude Time Domain Survey
- Used Supernova Analysis (SNANA) software
- Generating the lensing map
 - Dark Energy Science Collaboration Data Challenge 2 (DC2): Provides galaxy positions, redshifts, and properties
 - Dark Energy Survey (DES): Provided the lensing magnitude values



Simulation Results

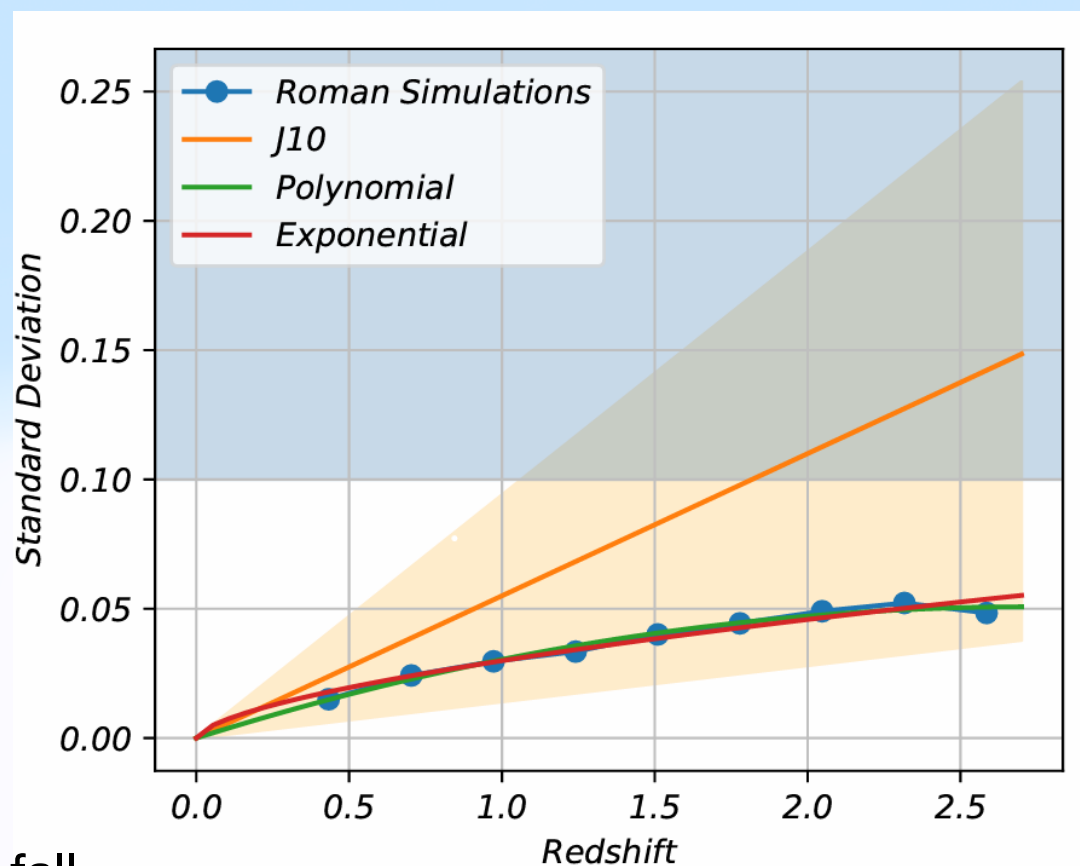


Fit the Lensing Scatter

$$\sigma_{\text{lens}} = (0.0372 \pm 0.0014)z - (0.0068 \pm 0.0007)z^2$$

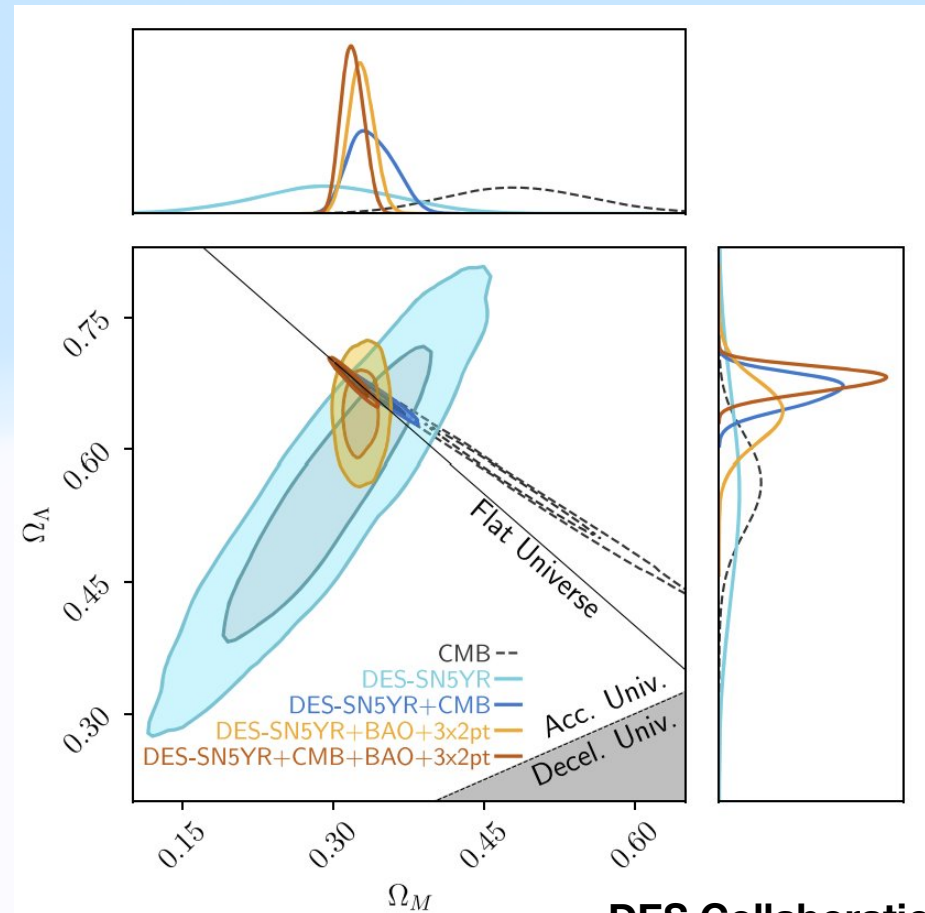
$$\sigma_{\text{lens}} = (0.0299 \pm 0.0012)z^{0.62 \pm 0.06}$$

Results coming out in Pihl+ 2026 this fall



Supernova Cosmology

- Constraining two cosmological properties
 - Ω_M - matter densities
 - Ω_Λ - dark energy density
 - σ_8 ?



DES Collaboration 2024

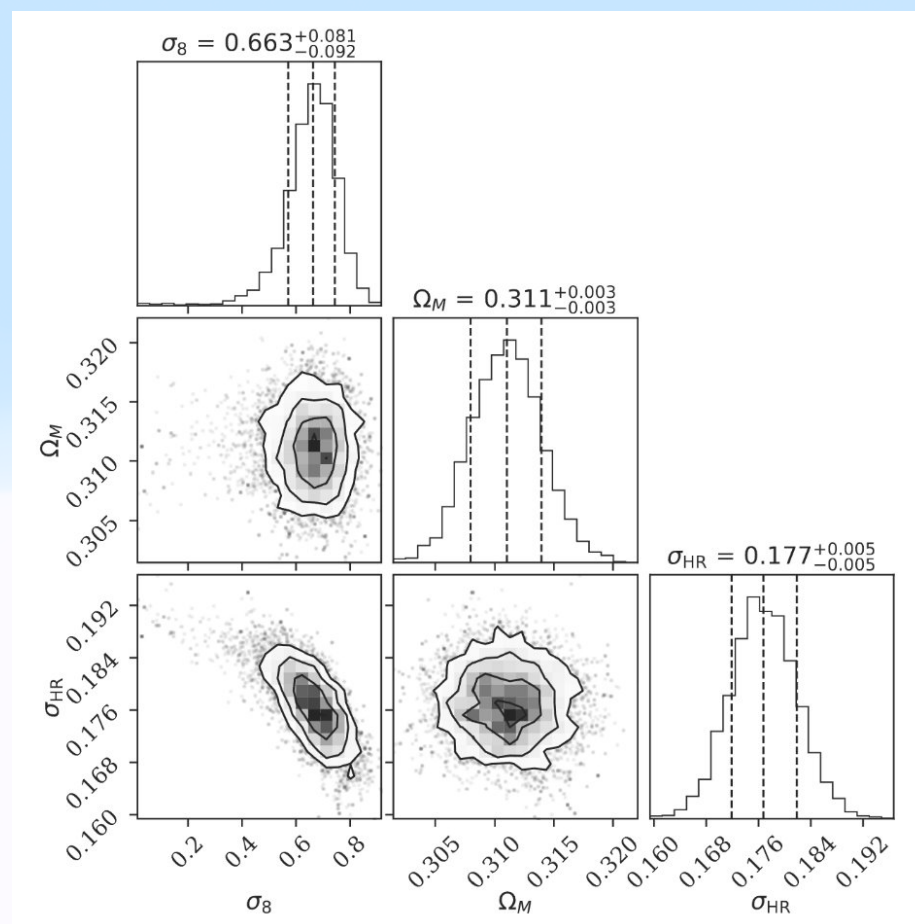
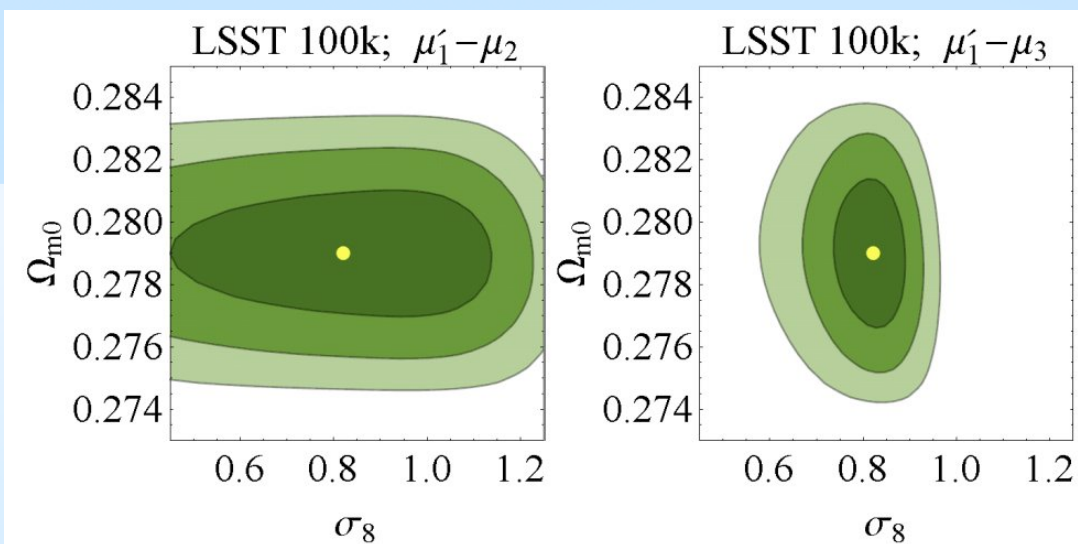
Constraining σ_8 : Method of Moments

- Method of moments for constraining σ_8
- Using 1st–4th moments

$$\sigma^2 = \sigma_{\text{SN}}^2 + \sigma_{\text{lens}}^2$$

$$\mu_3 = \mu_{\text{lens}}(\sigma_8, \Omega_{\text{M}})$$

Initial Results



Quartin+ 2014

Glaze+ in prep.

Conclusion

- Weak gravitational lensing dramatically effects SN Cosmology at high redshifts.
- Using DES lensing maps, we find that the uncertainty in distance due to lensing is non-linear with redshift.
- Roman's supernova data volume allows us to measure high order moments and make constraints on σ_8 .

