Cosmology with Cosmic Shear from the Roman Space Telescope

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Introduction

Understanding structure formation (*Figure 1*) in the universe is an active area of research in astronomy. Ongoing and upcoming surveys, such as the High Latitude Imaging Survey (HLIS) conducted with the Nancy Grace Roman Space Telescope (Roman), which will launch in 2027, will put tight constraints on the amount of clustering in the universe and on the matter energy density. Roman will image faster than other space telescopes, such as Hubble, because it is able to take a wider image of the sky (*Figure 2*).

Cosmic Shear

As light from distant galaxies travels towards Earth, it passes through the gravitational field of the mass between us. This causes the incoming light to appear bent in a process known as weak gravitational lensing. In turn, the images of these background galaxies appear stretched in an effect known as cosmic shear *(Figure 3*). **By measuring the cosmic shear across millions of galaxies, we can investigate the Universe's growth and expansion history (Kilbinger 2015).**

Measuring cosmic shear allows us to constrain the clustering and amount of matter between us and a source galaxy. Distant galaxies will exhibit higher degrees of shear, and we assign source galaxies different redshift bins to track the evolution of structure as a function of time (Amon et al. 2022).

Some challenges we currently face measuring cosmic shear include the following

- Shear signals are small, so we need to study millions of galaxies
- Mitigating systematics, which cause errors in measurements, e.g., measuring a sample's redshift distribution

To forecast the ability of Roman to measure cosmic shear, we use the CoCoA software to simulate Roman likelihood analyses.

Results and Significance

Figure 4 depicts the preliminary Roman forecasts for cosmic shear, where within the 68% confidence interval (dark red), the uncertainty of the matter density parameter Ω_m is 0.03, and 0.03 for clustering of matter σ_8. **Preliminary simulated analyses place tight constraints on amount of structure and matter density in the universe.**

Acknowledgements & References

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Killbinger, M. 2015, *IOP*, **78**, 086901
Amon, A., et al. 2022, *APS*, **105**, 023514

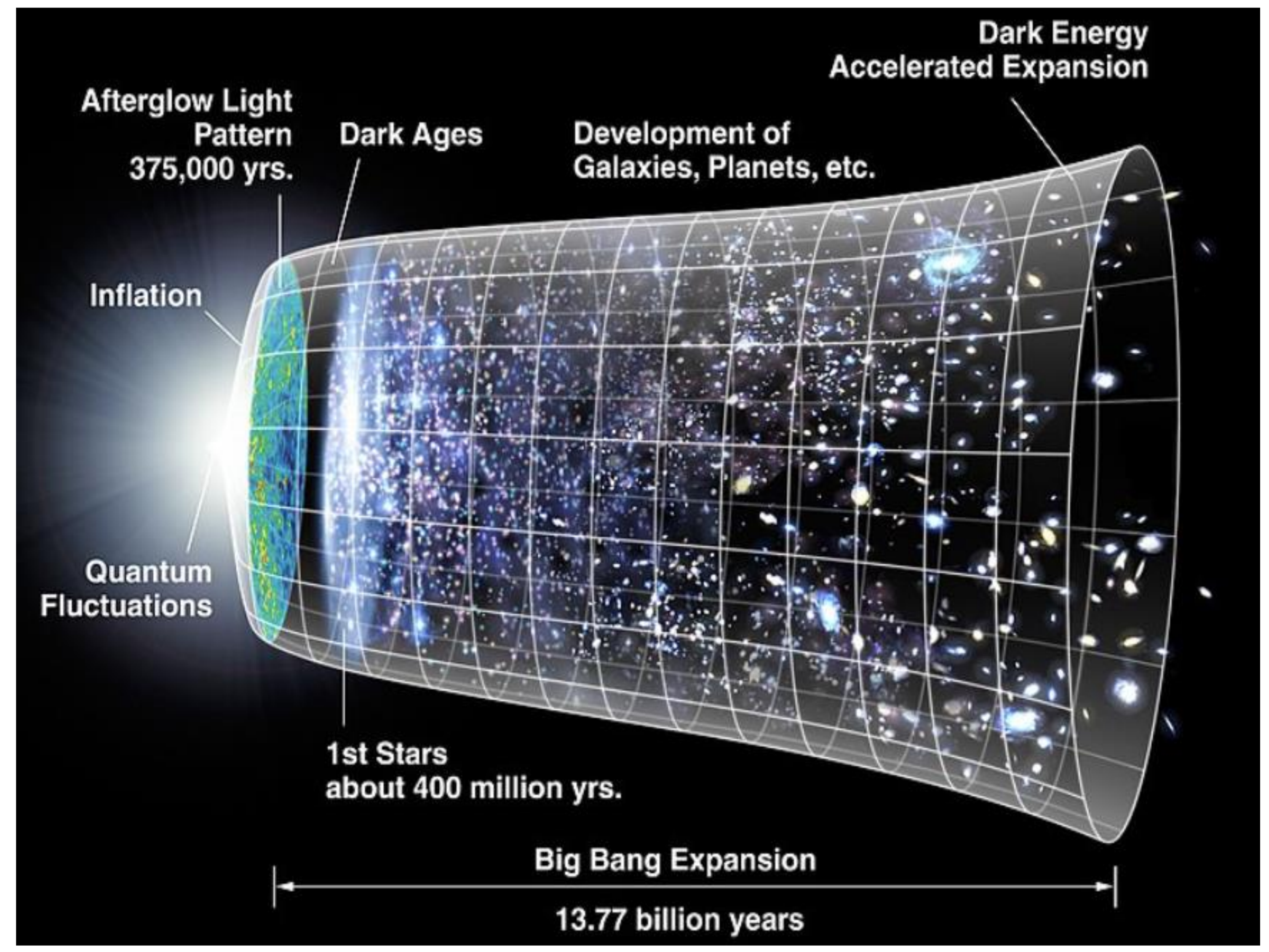
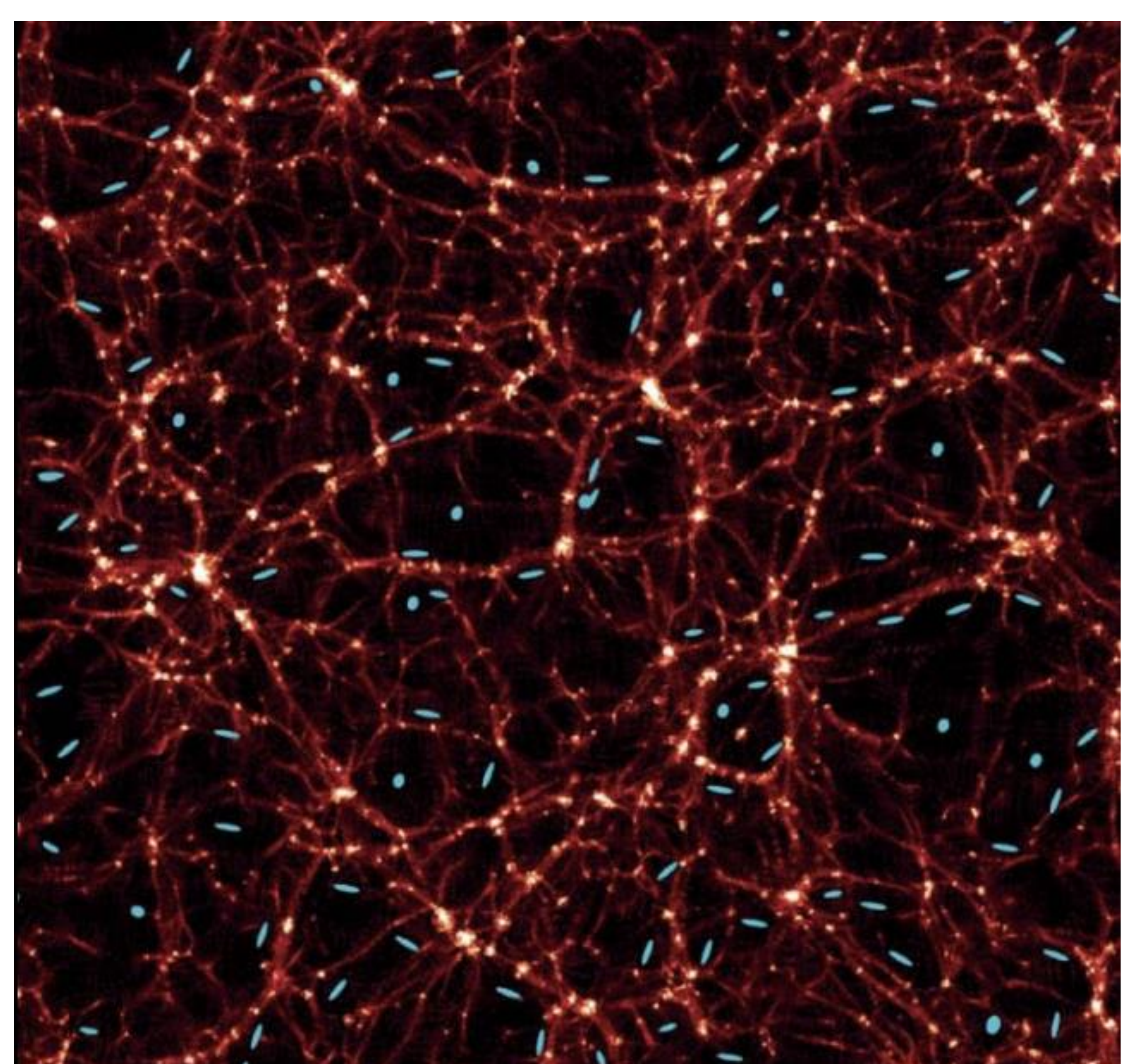


Figure 1
The Universe has continued expanding at an accelerating rate since the big bang

Figure 3
Galaxies (blue) are found in dark matter overdensities (red) and allow us to map what is known as the cosmic web.



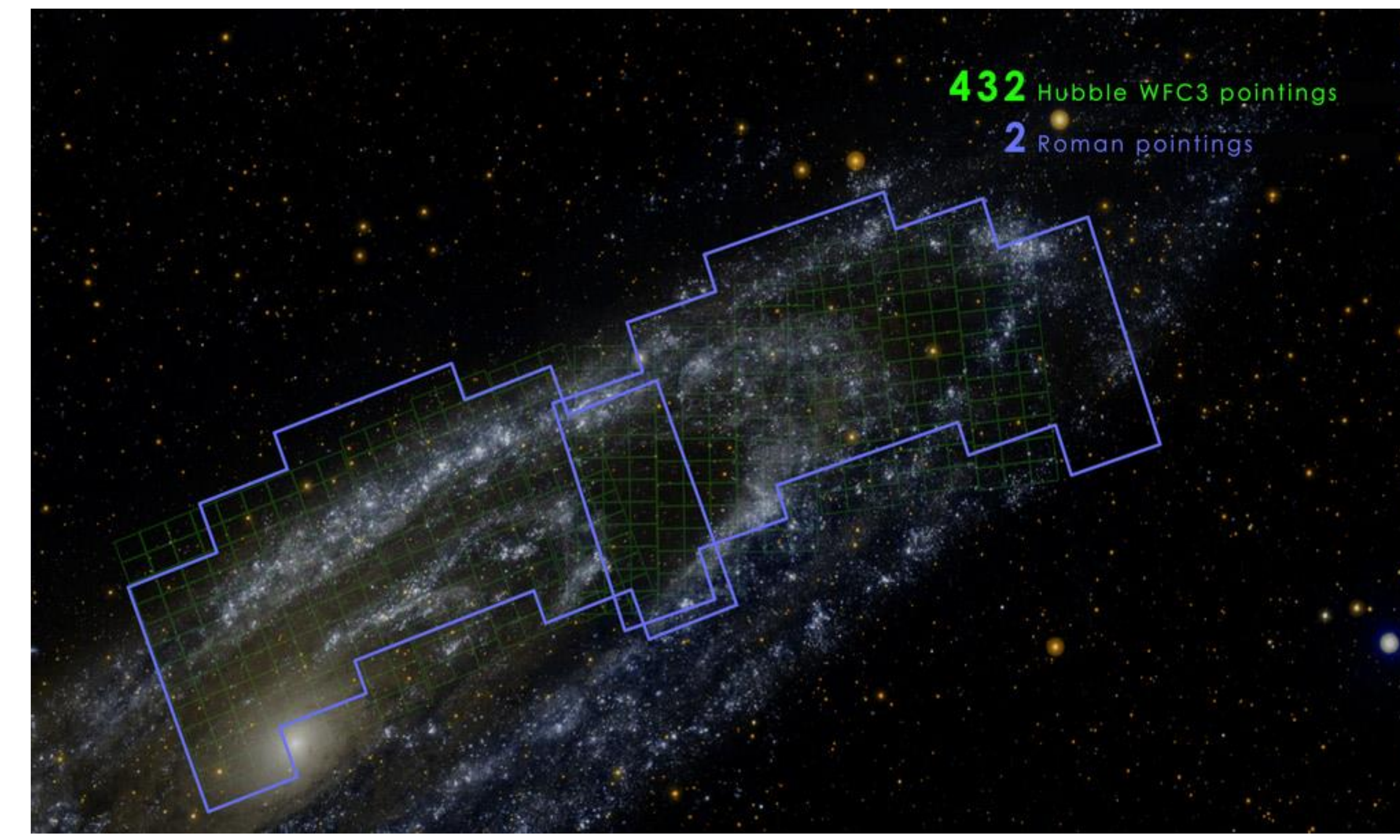
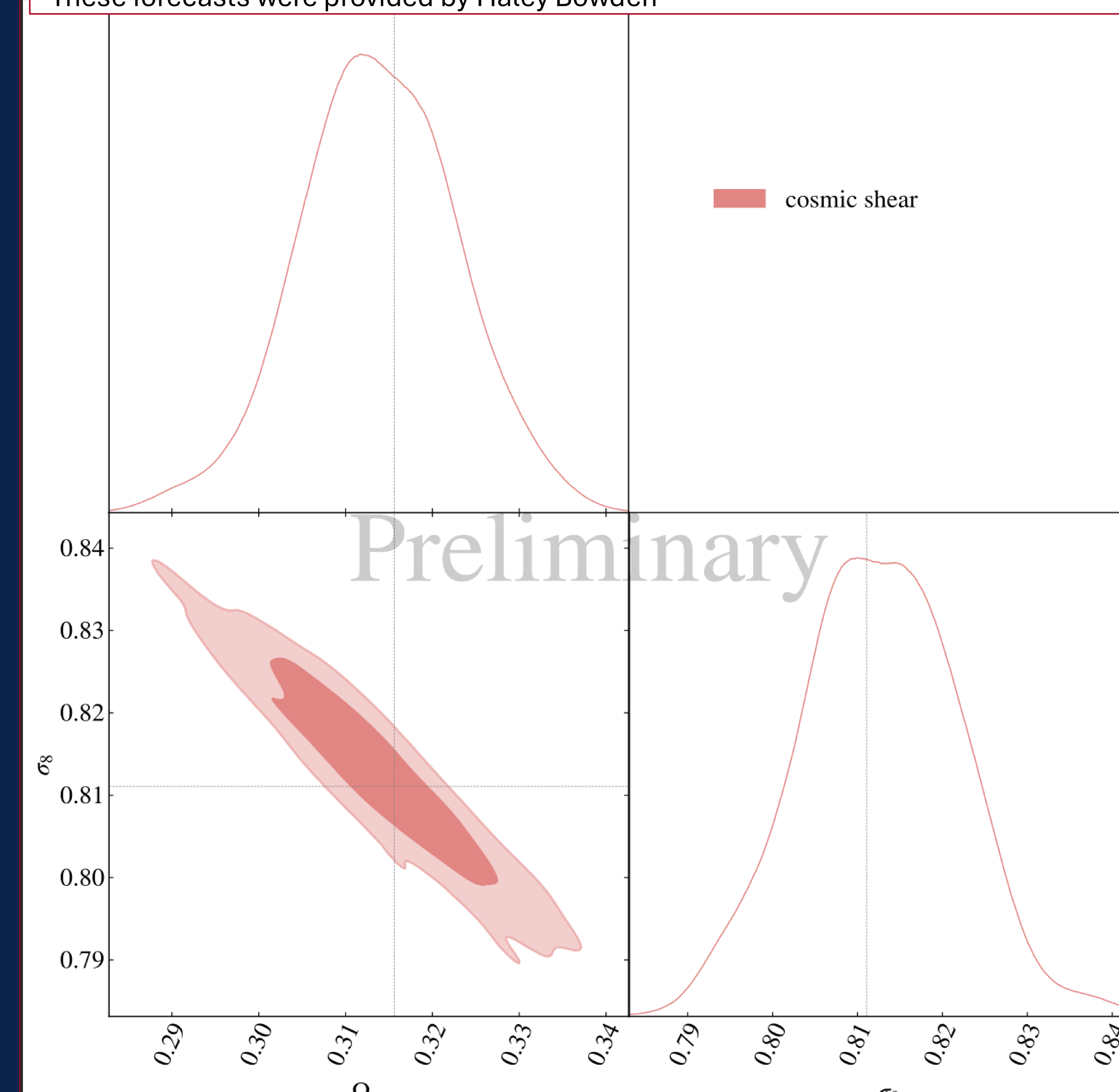


Figure 2
Two Roman images will cover the same area of sky as 432 images from Hubble, making Roman more efficient.

Figure 4
Preliminary cosmic shear forecasts constrain both Ω_m and σ_8 to an uncertainty of 0.03. These forecasts were provided by Haley Bowden



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