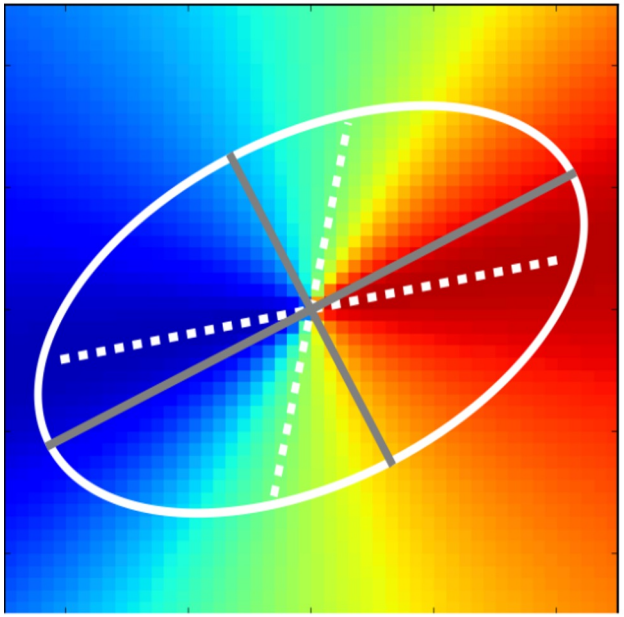
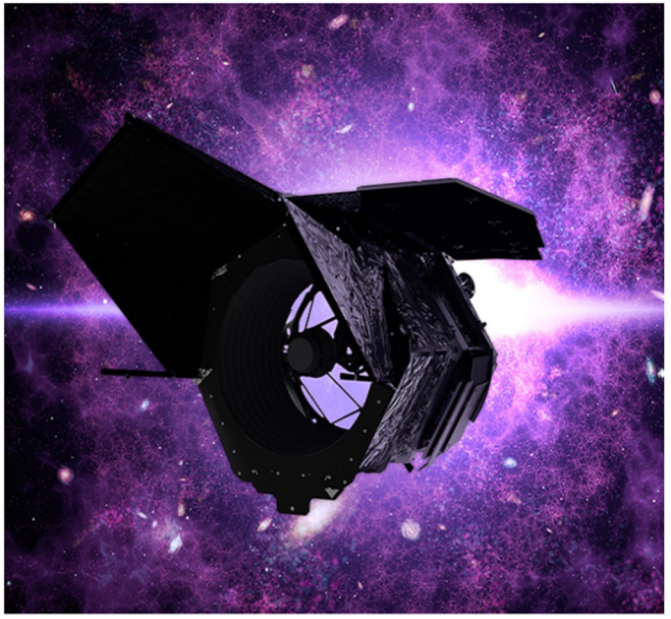


Kinematic Lensing with the Roman Space Telescope

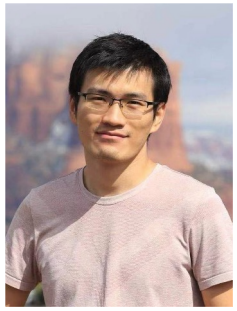
Wide Field Science Team



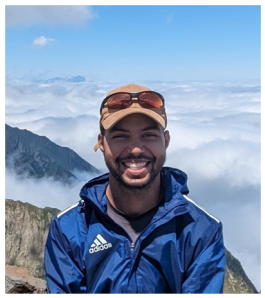
Eric Huff
Jet Propulsion Laboratory, California Institute of Technology

for the Roman WFS KL team

Roman Kinematic Lensing WFS Team



Jiachuan Xu
UA -> NE



Pranjal R. S.
UA -> JPL

Yu-Hsiu
Huang UA

Lauren
Willett UA

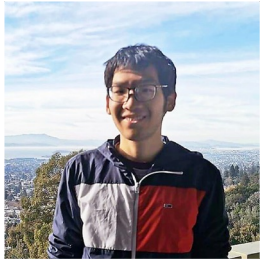
Emily
Macbeth UA

Jiyun Di UA

Eason Wang
UA -> CMU

Fabian Hervas-
Peters (UA)

Vic Lloyd, SBU



Yan Lai UA

Eiichi Egami UA

Tim Eifler UA

Elisabeth
Krause (PI) UA

Eric Huff JPL

Spencer Everett
Caltech

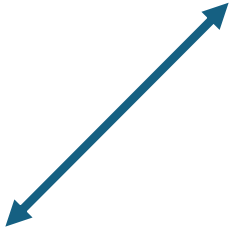
Anoma
Ganguly UA

What's hard about weak lensing

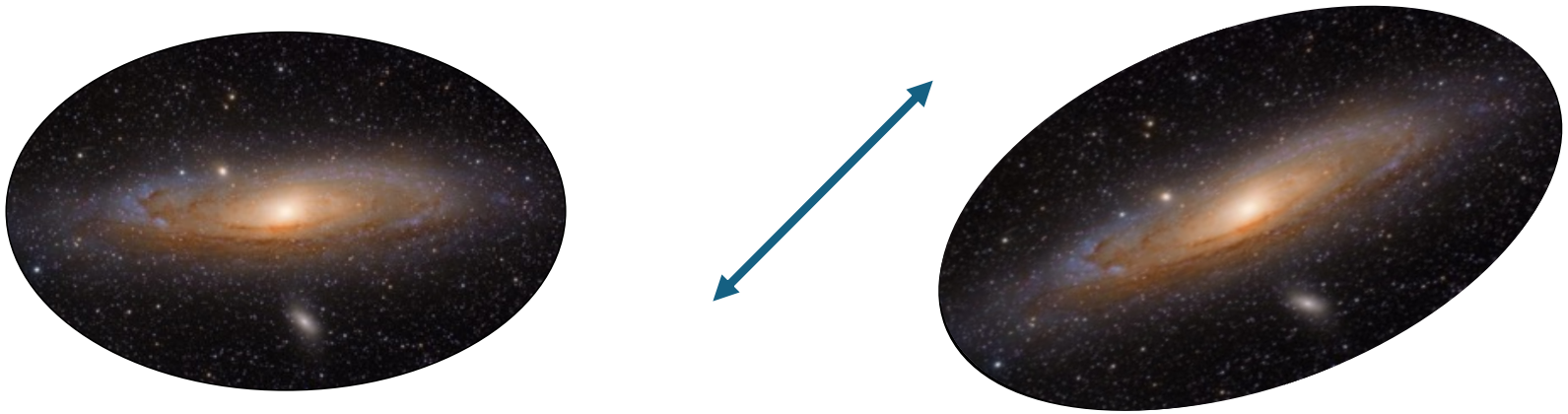
- Weak lensing is weak
- Shape and shear are degenerate
- Lots of non-lensing effects can mimic (or modulate) lensing
  - PSF distortions
  - Intrinsic alignments
  - Selection effects
  - …

Shear is degenerate with Shape

Shear is degenerate with Shape

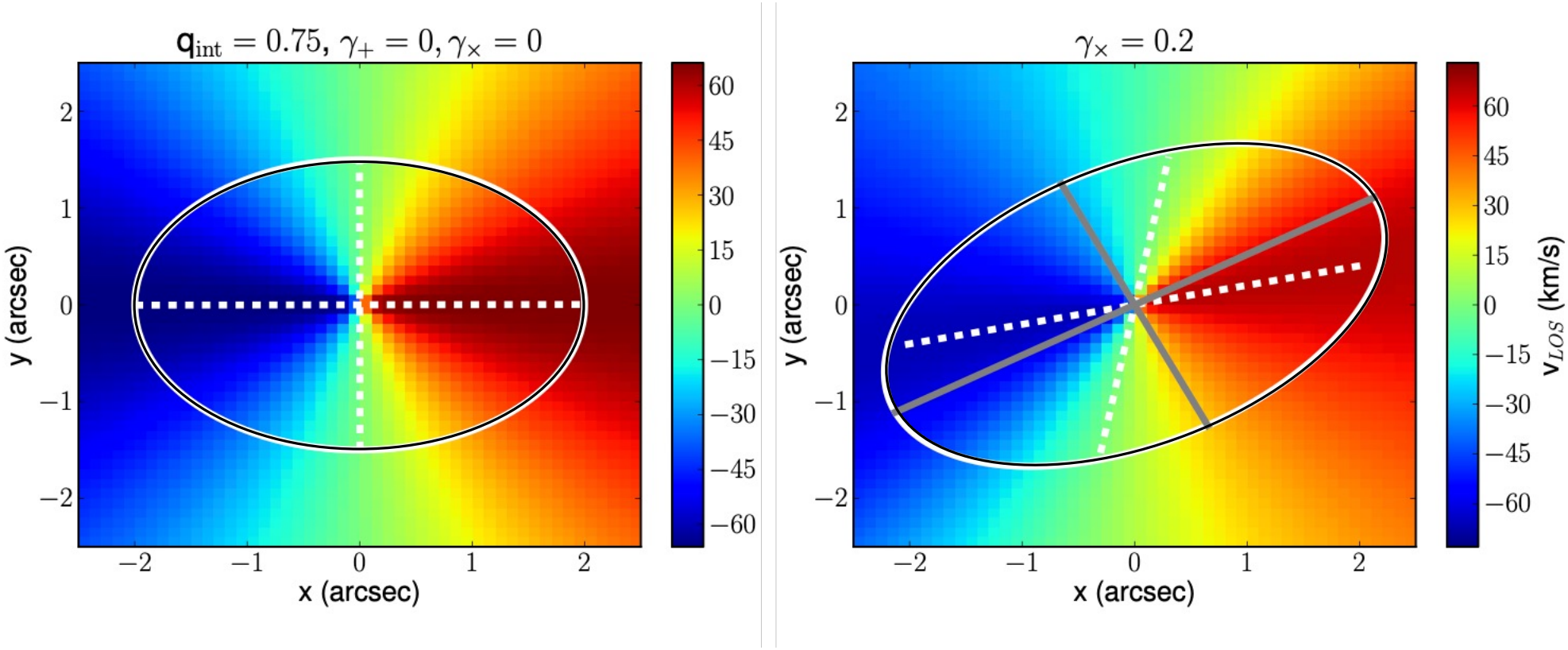


Shear is degenerate with Shape



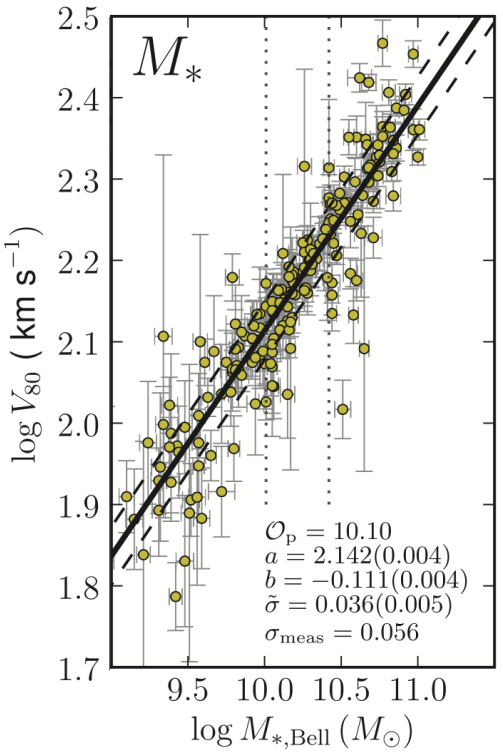
Shear is degenerate with Shape

Kinematics breaks the degeneracy between shear and shape



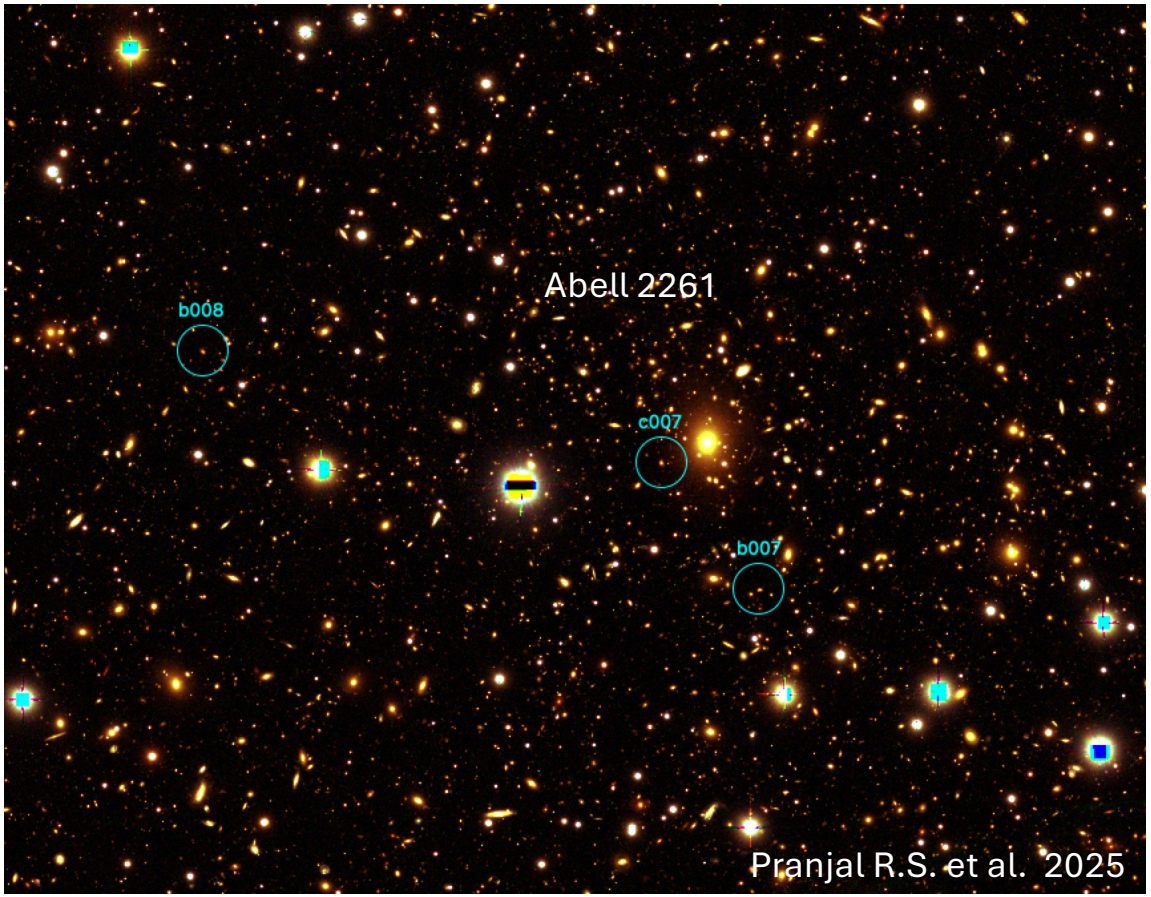
What happens when you add galaxy kinematics

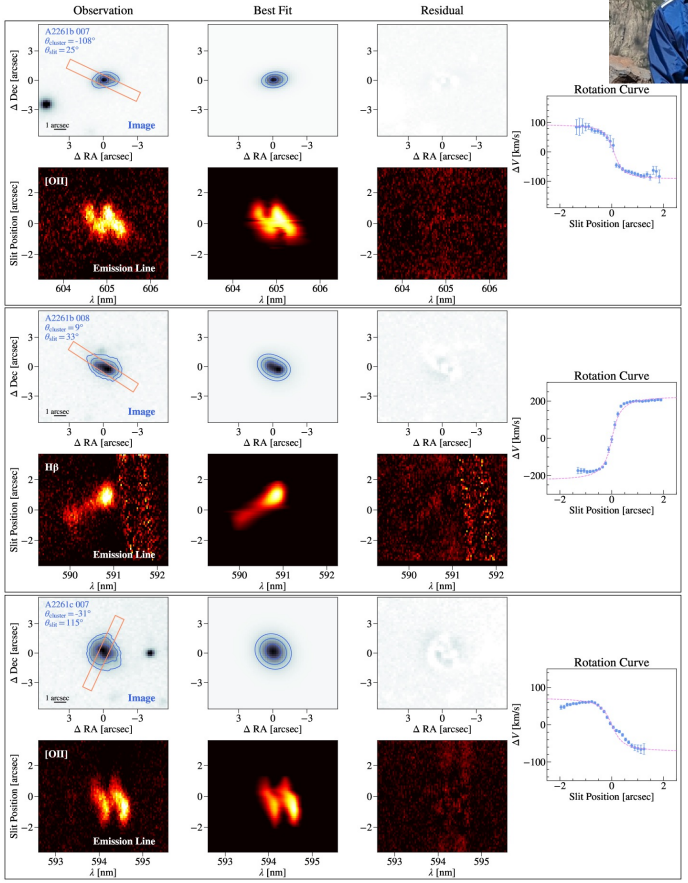
- **For disk galaxies**, most of the noise comes from random 3D orientations, rather than morphological variety.
- Controlling for the 3D orientation **eliminates ~90% of the shape noise.**
- This requires approximately **the same spectroscopic data quality**, per galaxy, as a Tully-Fisher measurement.



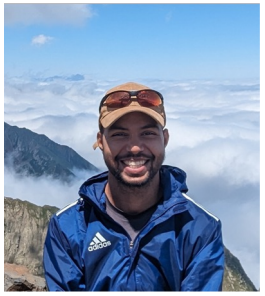
Reyes et al. 2011

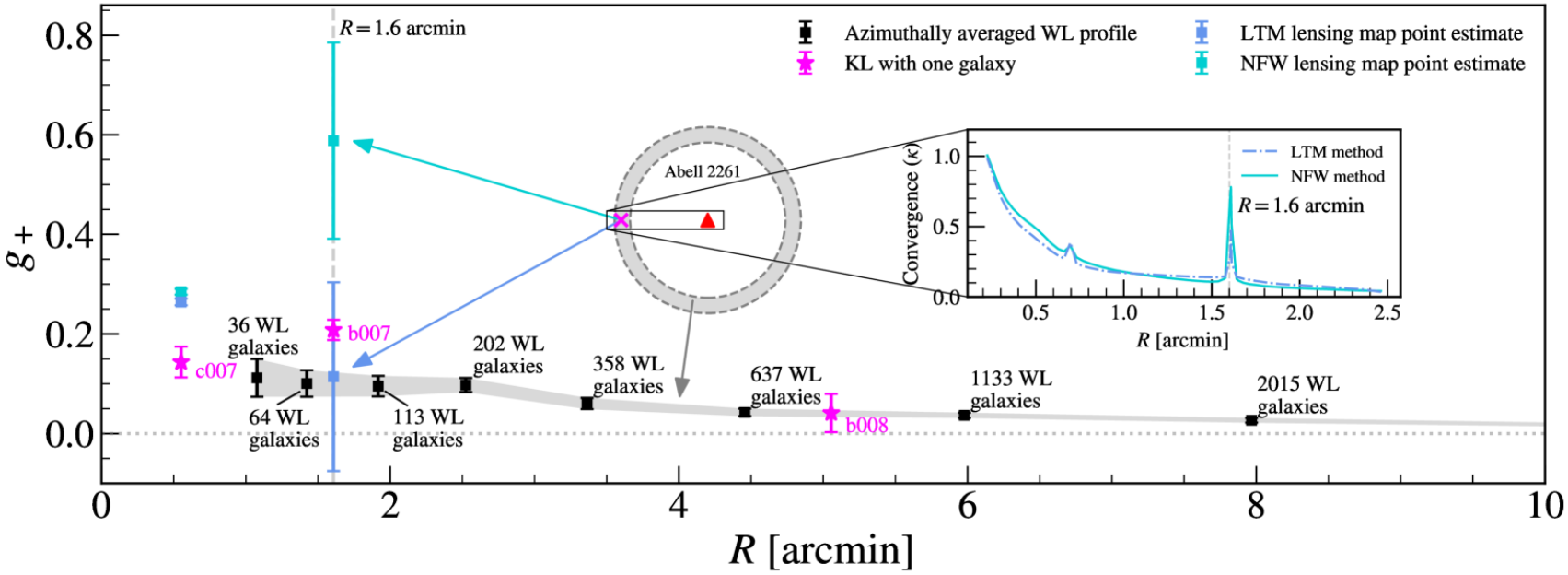
The First KL Detection



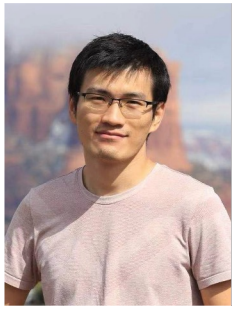


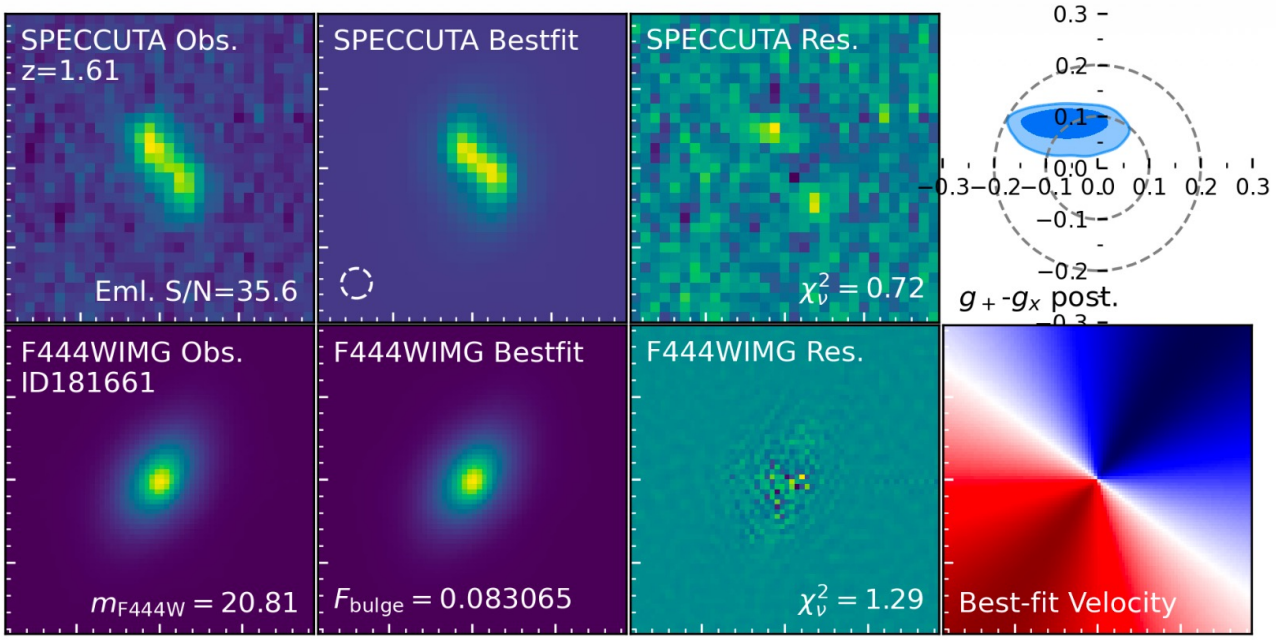
The First KL Detection





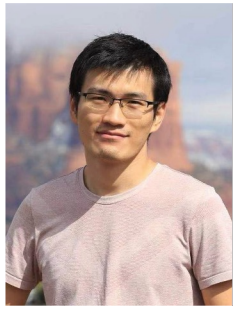
KL with the JWST Grism

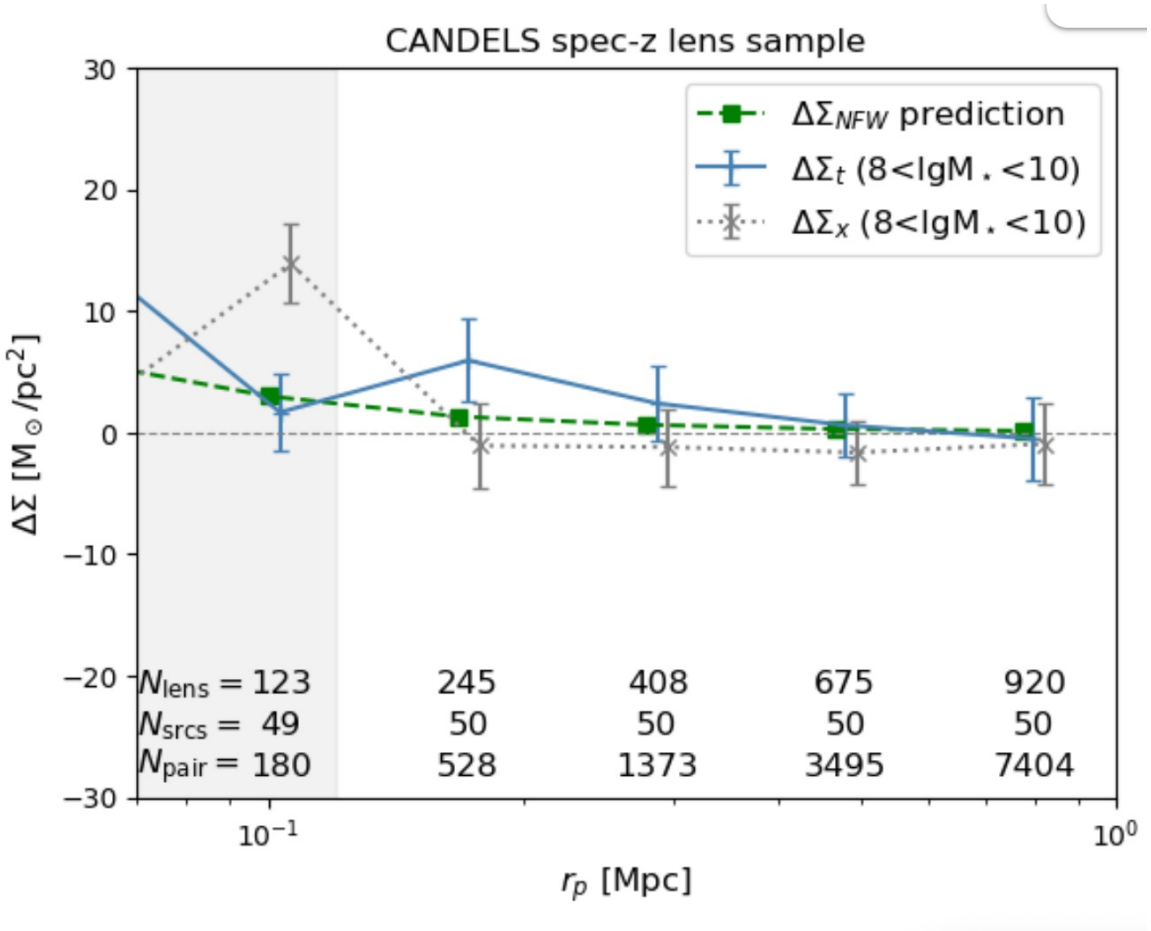




- 50 (out of 63) KL source galaxies survive quality cuts in GOODS-S field after the final KL fit
- There are more galaxies in the GOODS-N field due to extra F356W grism coverage from CONGRESS.
- We select all spectroscopically-confirmed foreground galaxies in the CANDELS catalog with constant stellar mass 8<lg(M*)<10 as the lens sample.

KL with the JWST Grism





With 50 JWST sources, each with a single slit spectrum, we have a ~1.5-sigma measurement of shear on the CANDELS field.

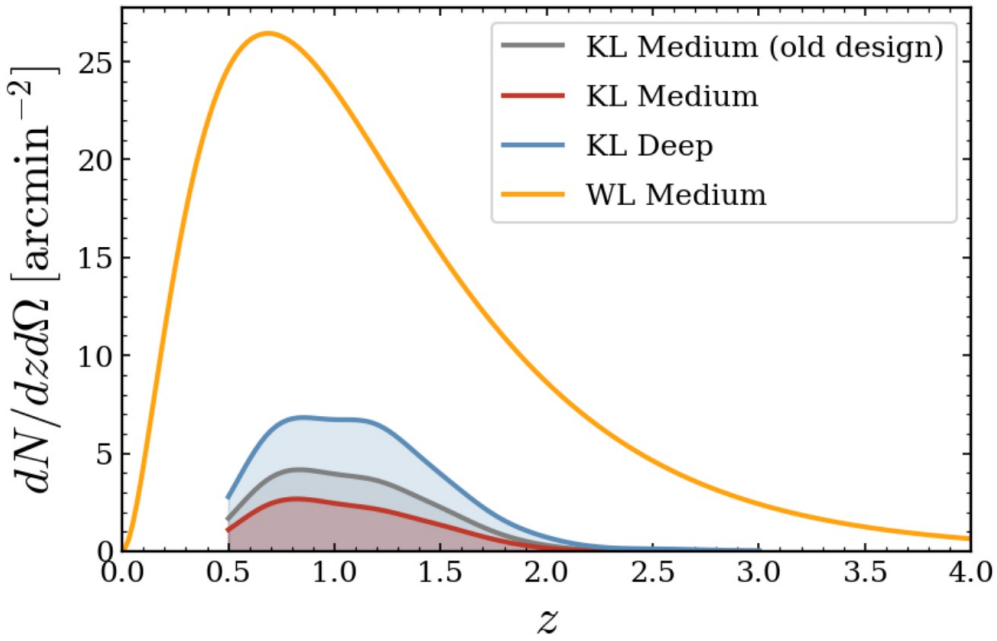
This is consistent with our forecasts for the improved shape noise.

Kinematics with Roman

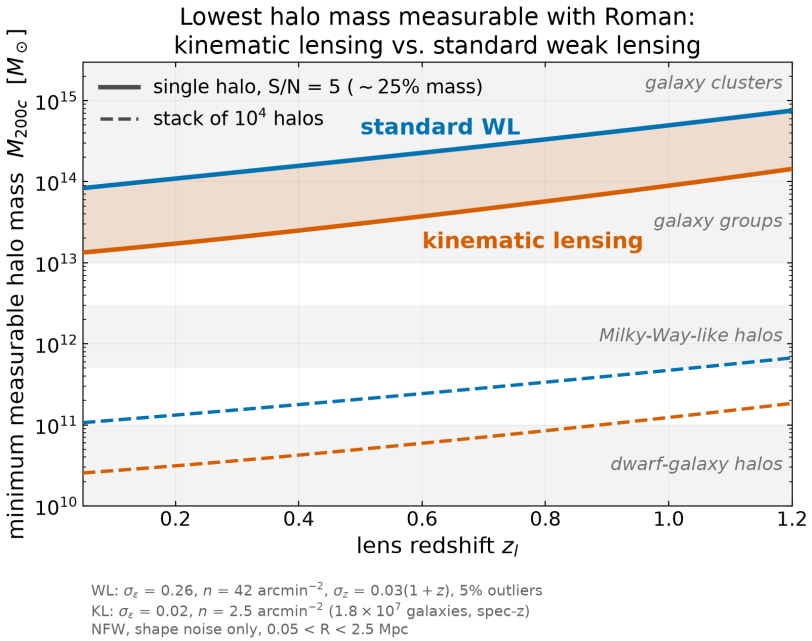
Based on simulations, we think we can get grism kinematics for *half* of galaxies with:

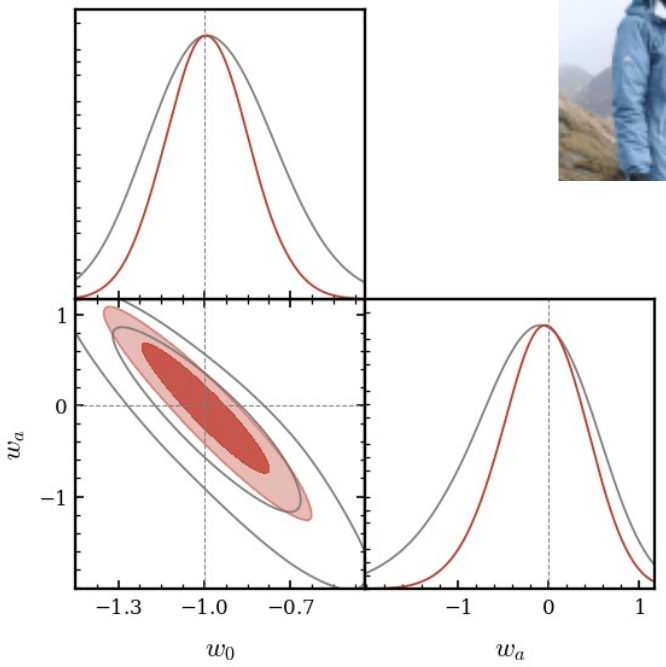
- At least one resolved emission line between 1 and 1.93 microns
- flux > 1.5×10^{16} erg/s/cm^2/s
- Half-light radius > 0.1 arcsec
- F110W < 26.5 AB

This yields 2.5 gal/arcmin^2



Kinematics with Roman



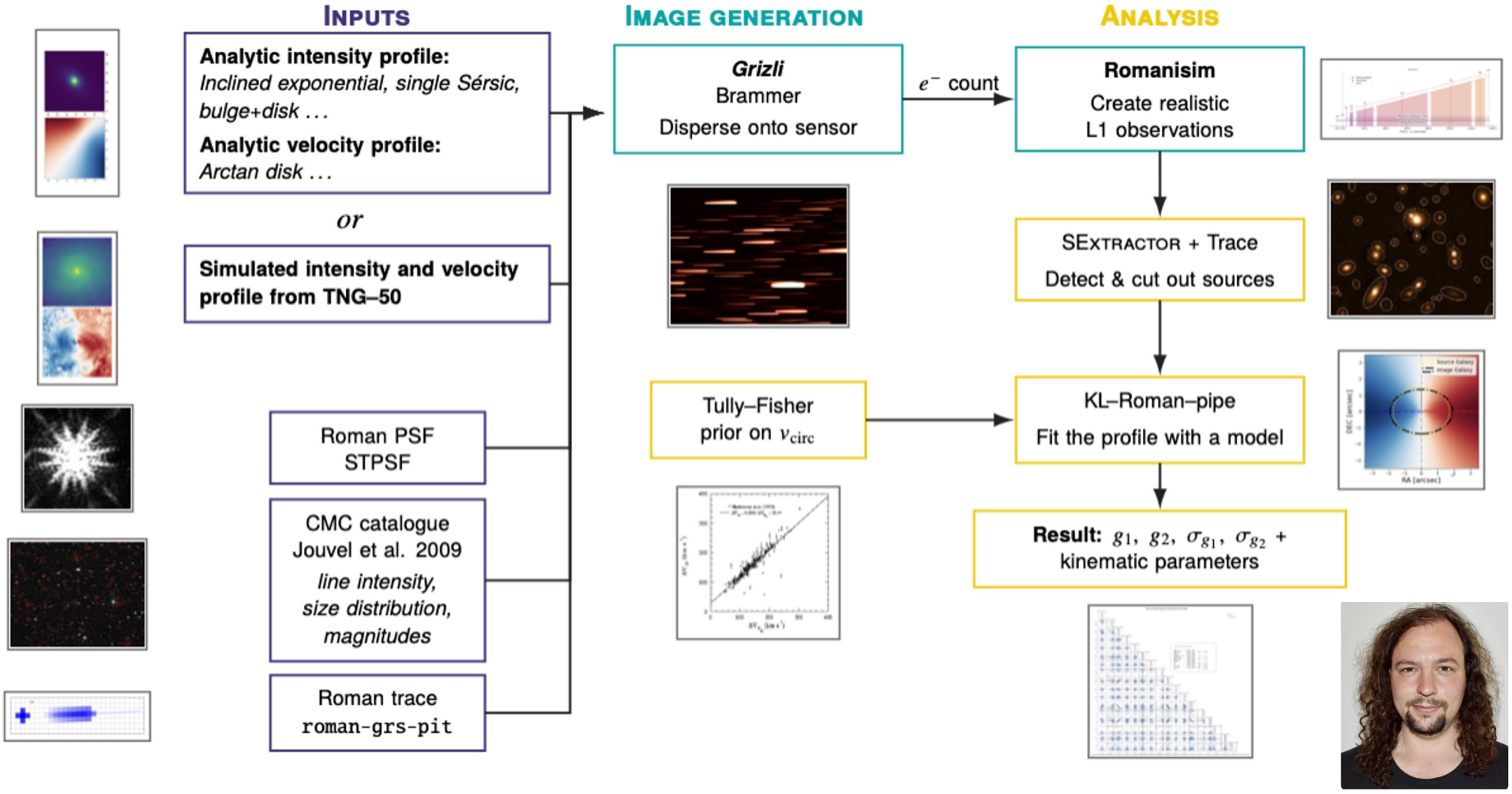


If we can get the necessary kinematics, the dark energy constraints will be competitive with the main cosmology program.

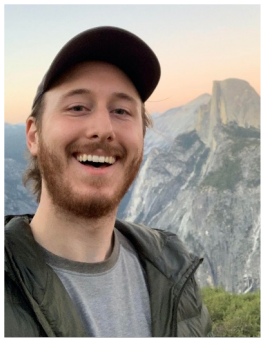
Why might this not work?

- Real galaxies are complex.
- Grisms are low resolution and mess (e.g. smearing the emission lines by the galaxy image)
- Fitting a complex 20-parameter model to10^7 rotation curves seems hard.

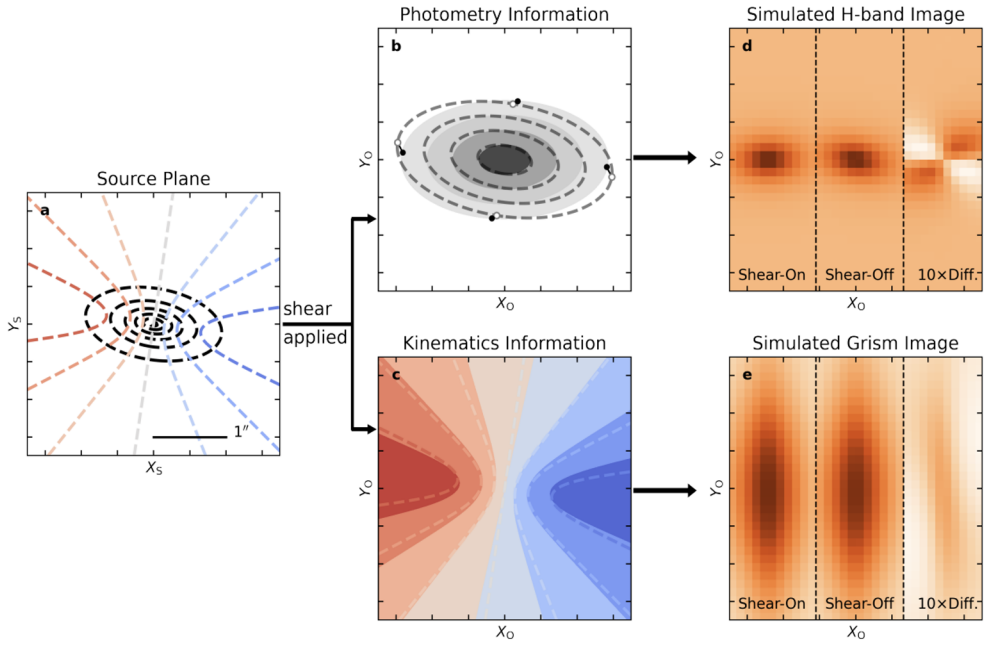
Rocking Pipeline: TNG-50 Hydro Sims → Roman data

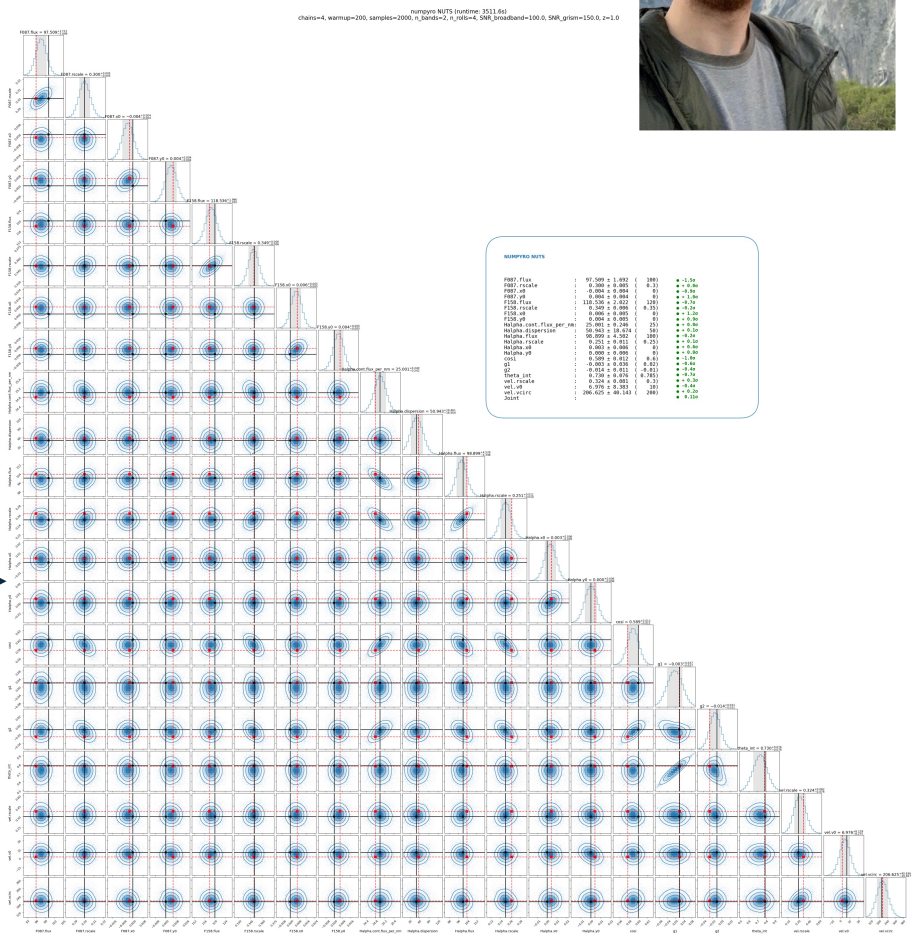


Mass production of Roman grism kinematics

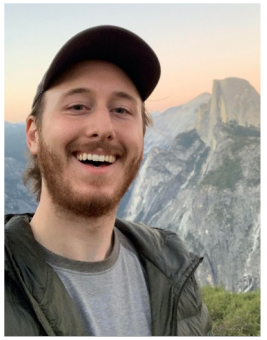


20 parameters per galaxy
2 broadband images+4 roll angles

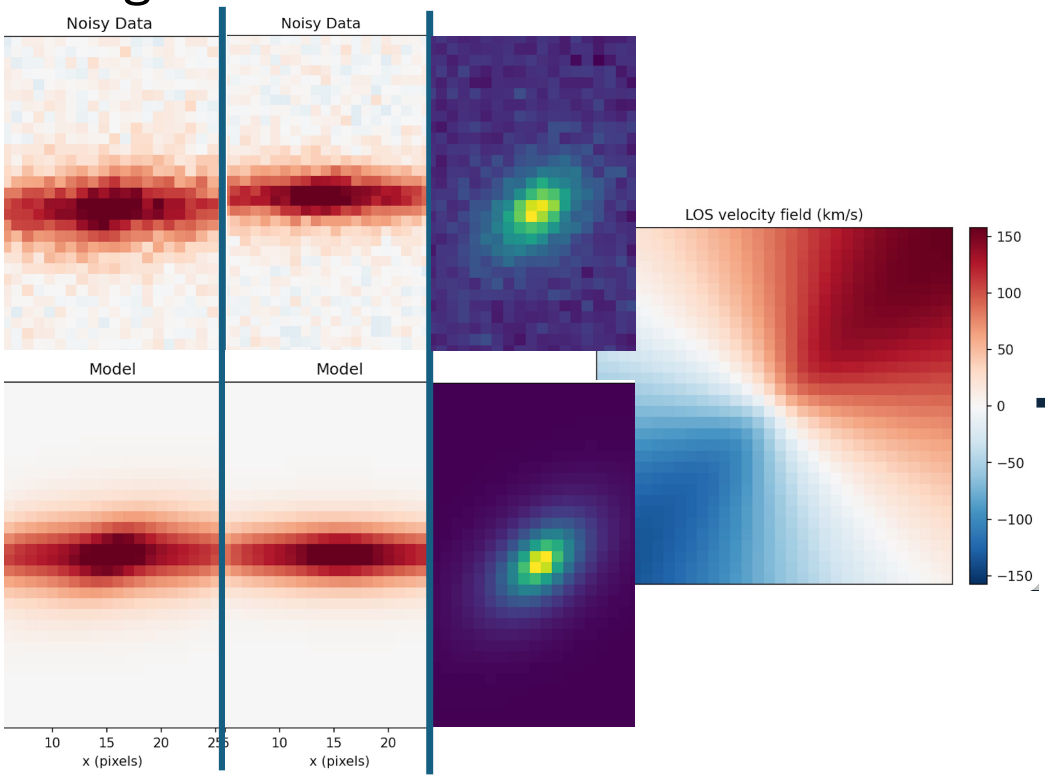


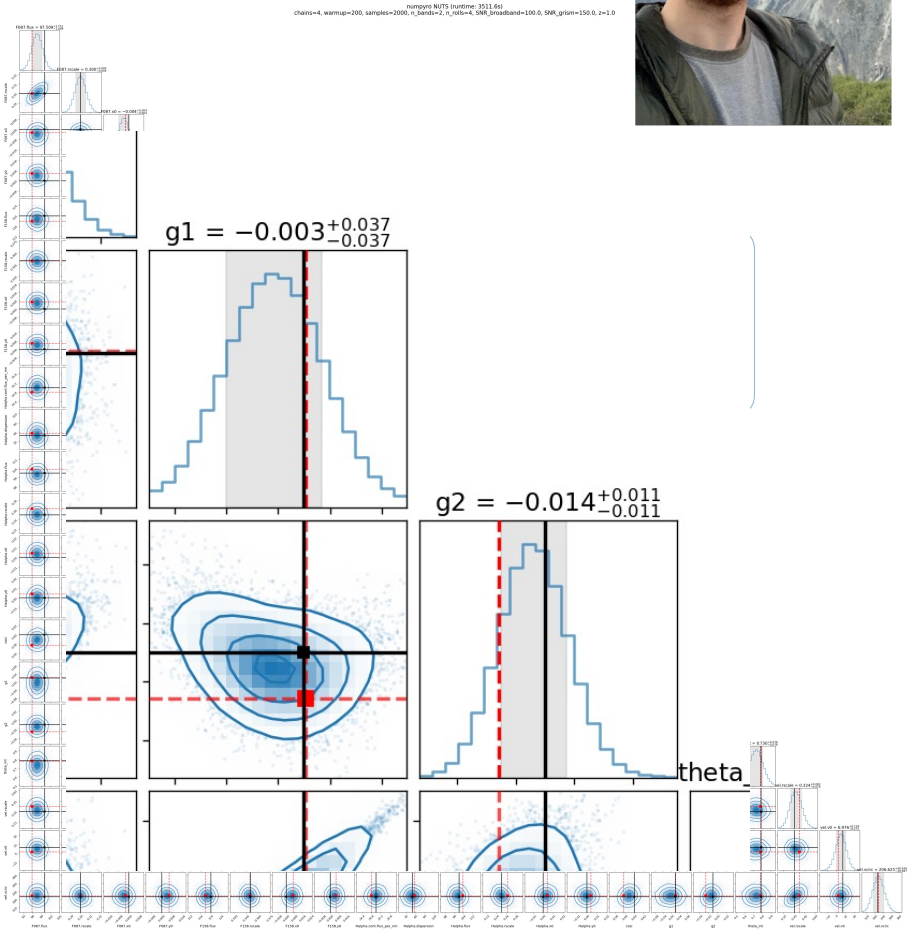


Mass production of Roman grism kinematics



20 parameters per galaxy
2 broadband images+4 roll angles
40 galaxies/node hour on an H200 GPU





- Kinematics can suppress the shape noise in weak lensing measurements by an order of magnitude
- This will let us access finer detail and much (5x) lower masses with lensing that traditional methods
- Pilot studies on existing data see find KL shape noise around 0.025, 0.03, consistent with hopes and expectations
- We are on track to produce resolved kinematics for 2 million H-α emitters in Roman.