Simulating Roman Star Catalogs

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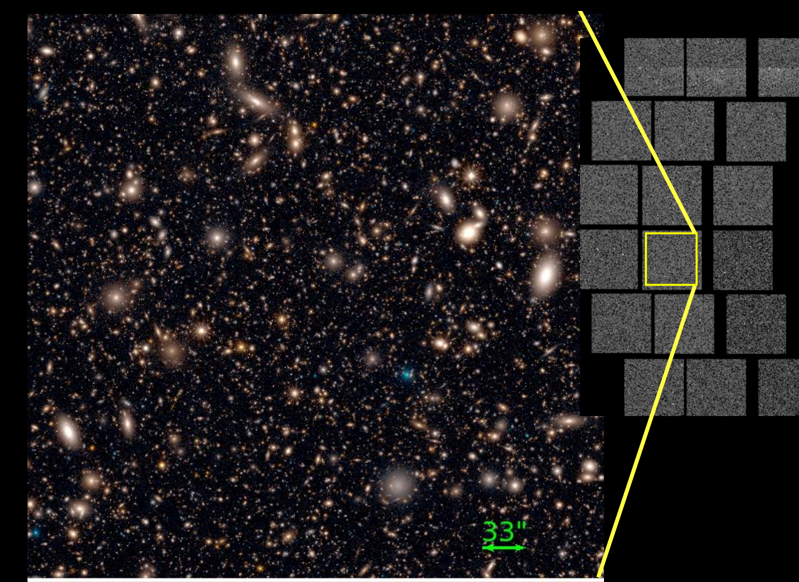
Making synthetic Roman star fields

Galaxy Simulation
(cosmology, DM model, gravity, gas physics, star formation, stellar feedback, …)

Stellar Populations

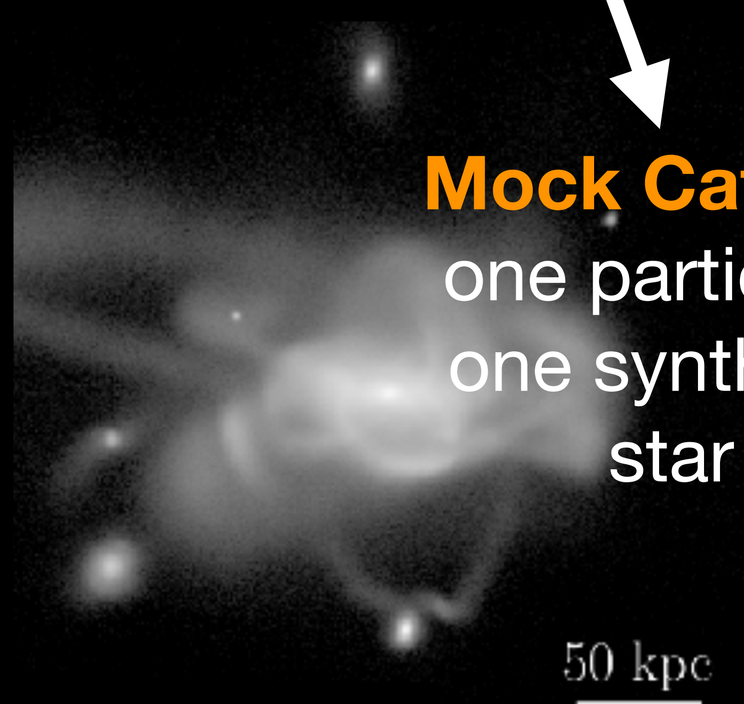
(stellar structure, stellar evolution, convection models, isochrone mapping, IMF, …)

Synthetic Survey
one particle = one "observed" star



One particle = many "stars" …with same age, chemical elements

Density estimation
(kernel dimension, smoothing scales, ages, accretion history, …)



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Survey description

(Magnitude/color limits, extinction/ reddening, selection function, error model, instrument model, …)

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Starting point: a simulated galaxy

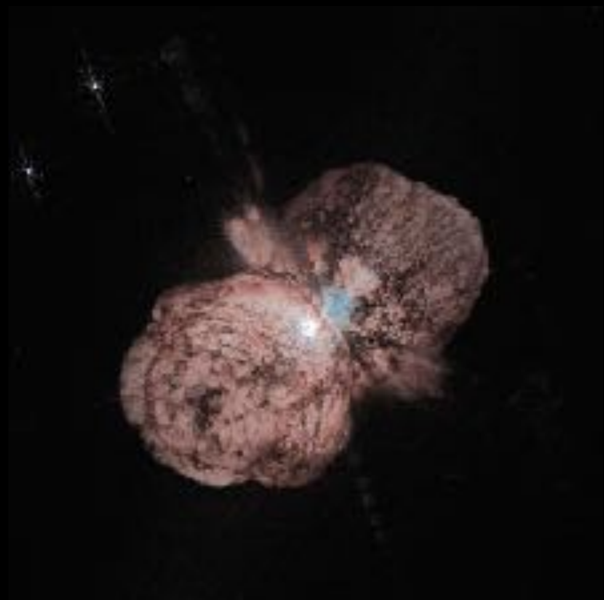
NANCY GRACE ROMAN SPACE TELESCOPE

- **Cosmological-baryonic, “zoomed” simulation from the FIRE-2/Latte Suite**

  - Pros: cosmological, includes baryonic processes, high resolution achievable -> opportunity to put more physics “on the grid” rather than subgrid. Current resolutions are sufficient to follow single-age, single-abundance stellar pops.

  - Cons: expensive -> limited sample size, little control over ICs or resulting galaxy (but we can dig out analogs to stuff), extremely nonlinear and stochastic -> identifying real effects and trends requires careful experimentation.

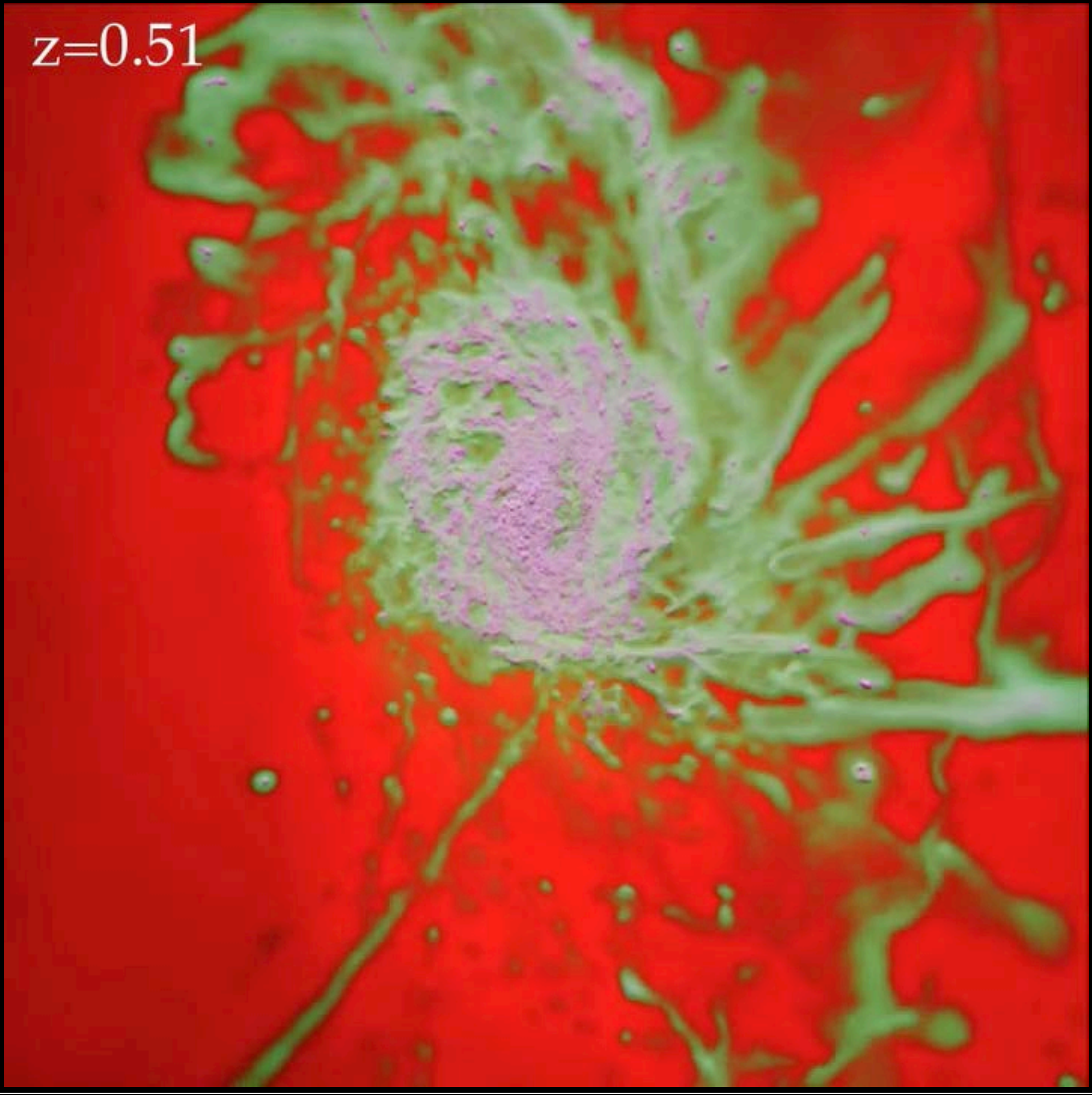
Movie by Shea Garrison-Kimmel



Cold gas dense enough to form stars (Jeans unstable)

“Warm” ionized gas (~10^4 K)

Hot gas (10^6 K)



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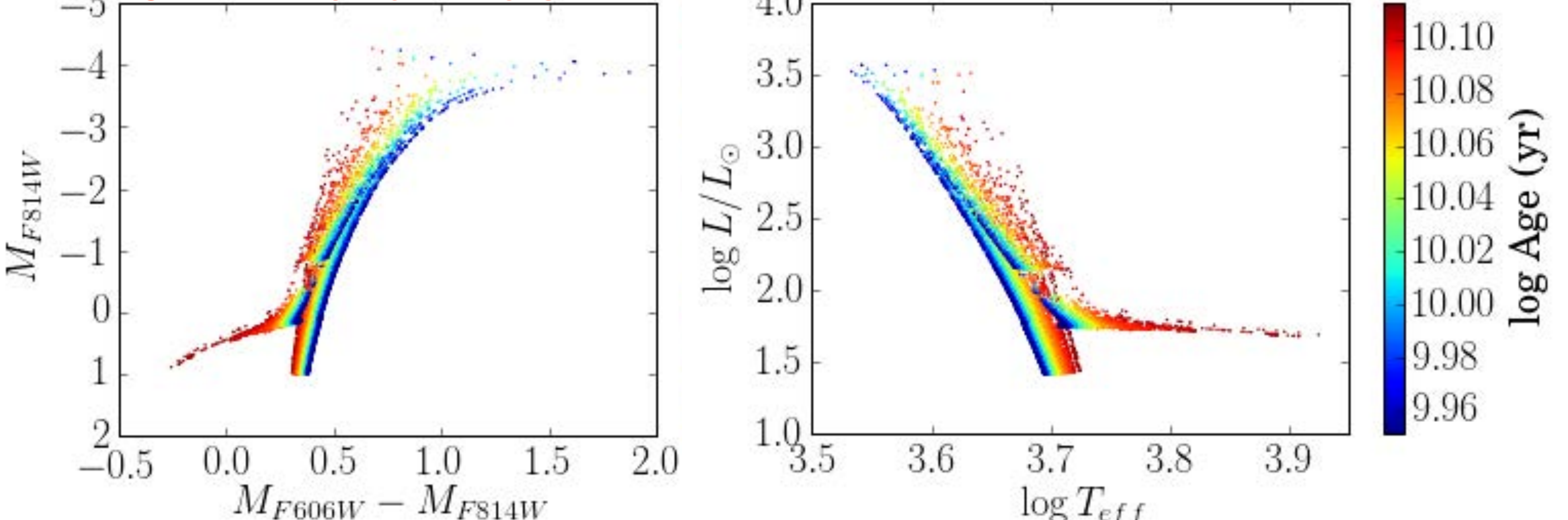
Each star particle has a:

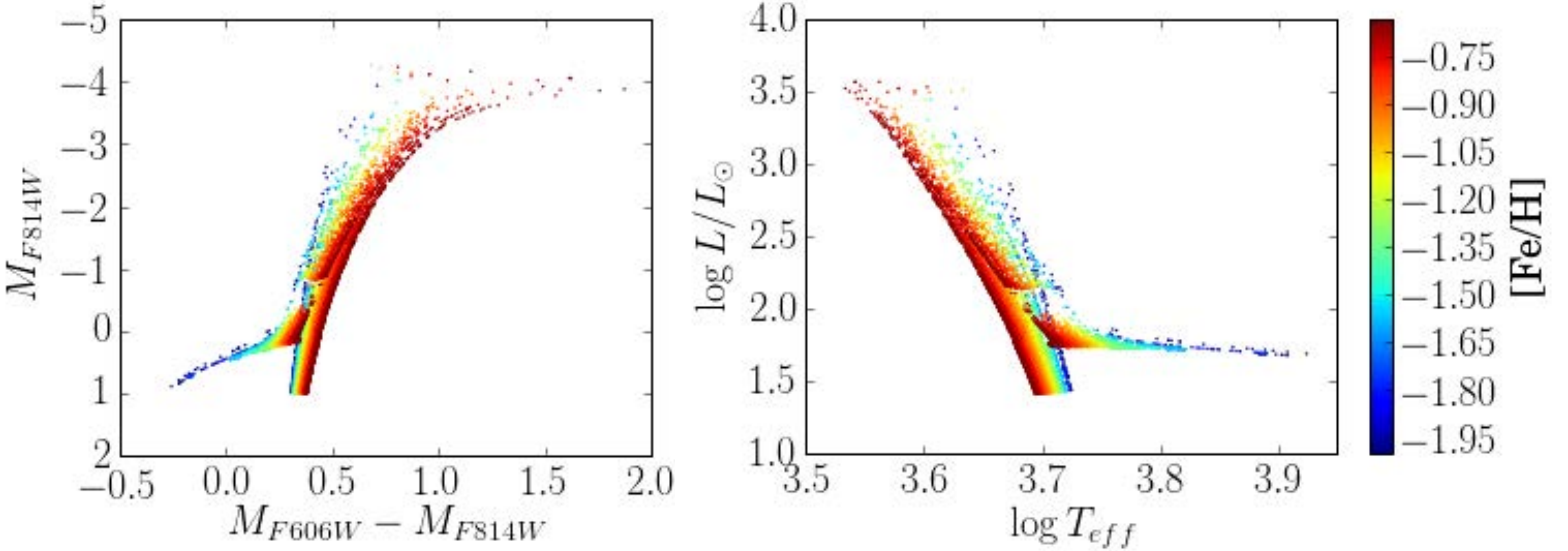
- mass -> normalization of Kroupa IMF
- age -> age of stellar pop
- [Fe/H] -> metallicity of stellar pop

Age and metallicity are mapped to the nearest isochrone in the model grid (see Léo Girardi's talk!)

CMD in Roman filters **HRD**



Example for one simulated dwarf galaxy (at 10 Mpc, DM = **30**)



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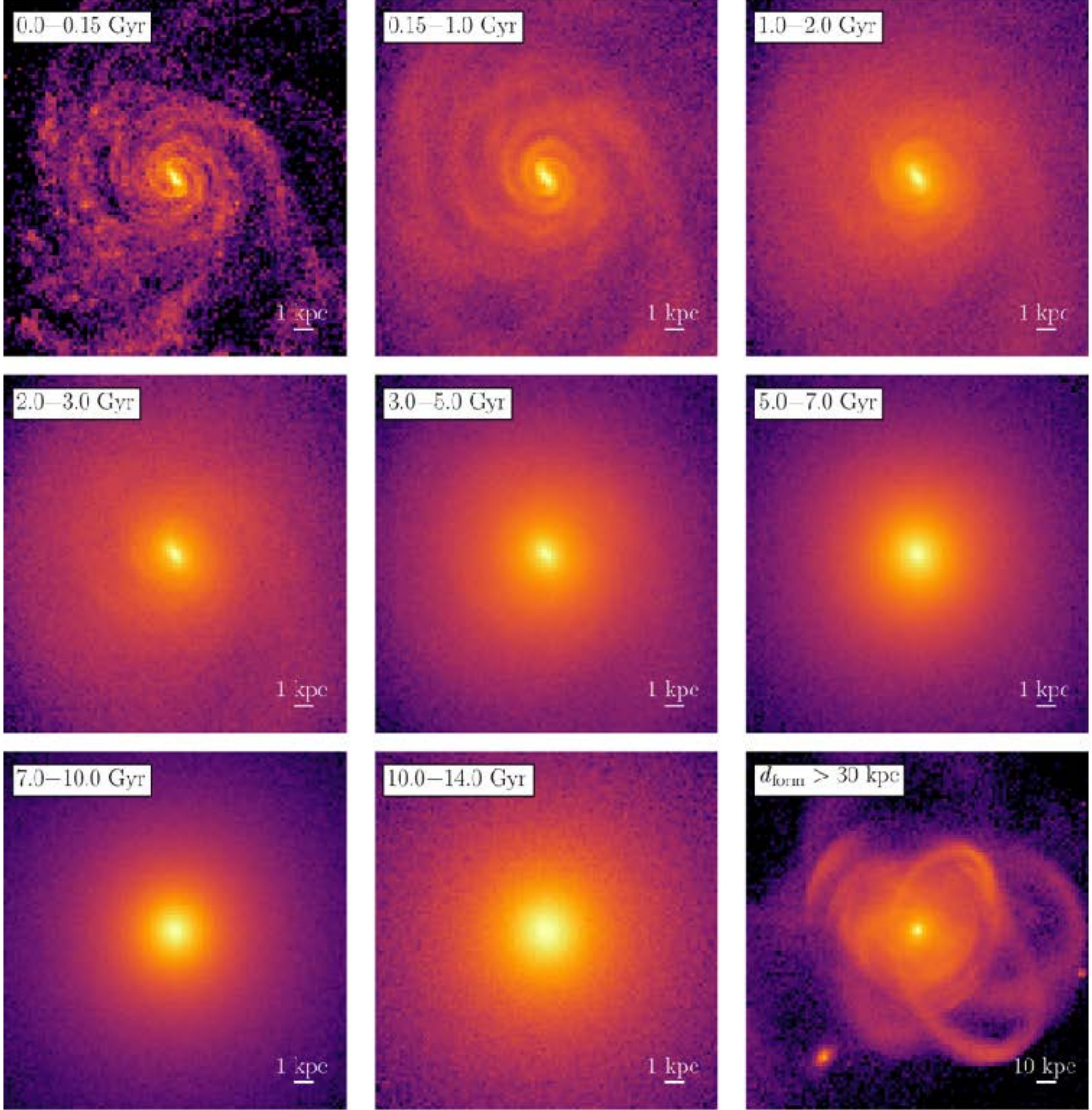

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Slicing by age and formation distance boosts resolution of fine features in the disk and halo

Sanderson et al 2020

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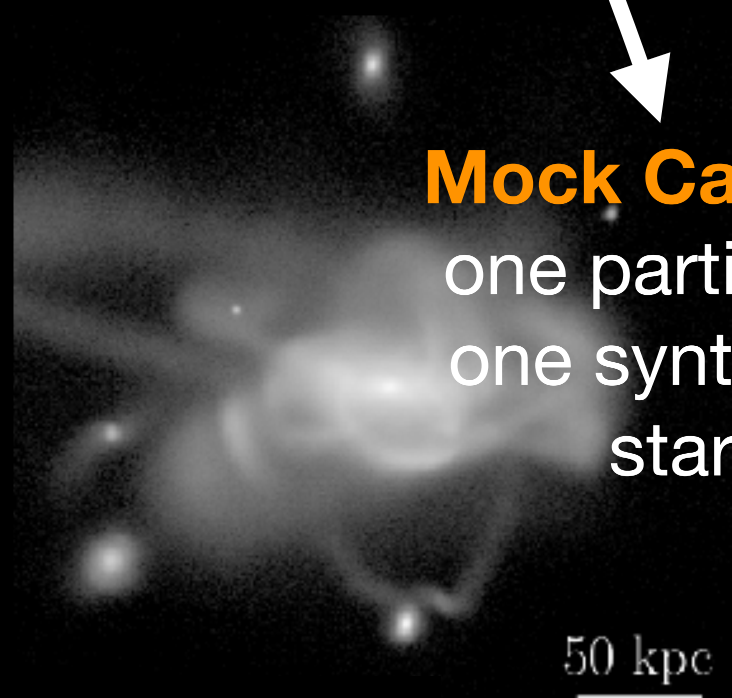

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Sky positions, absolute magnitudes, stellar parameters are written to a master list

Min absolute mag is set by sensitivity of Roman's camera and desired distances

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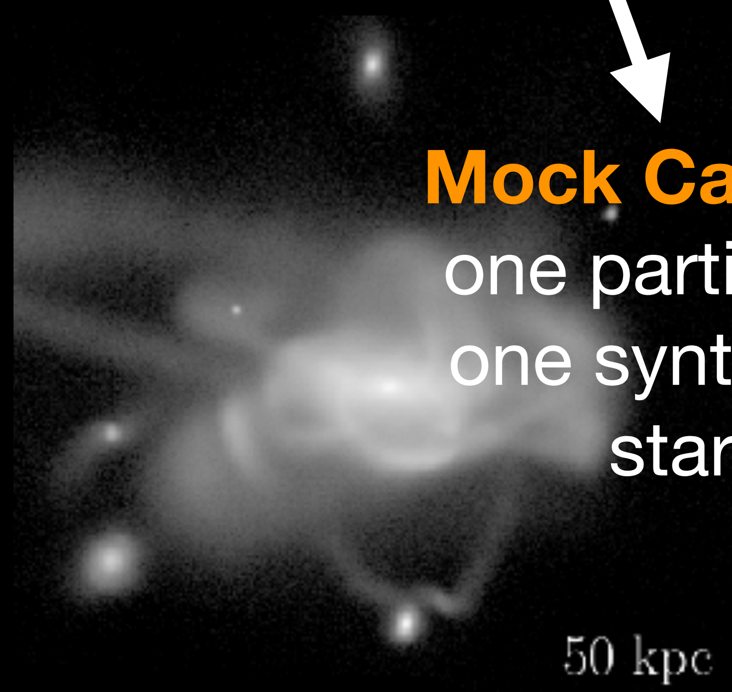

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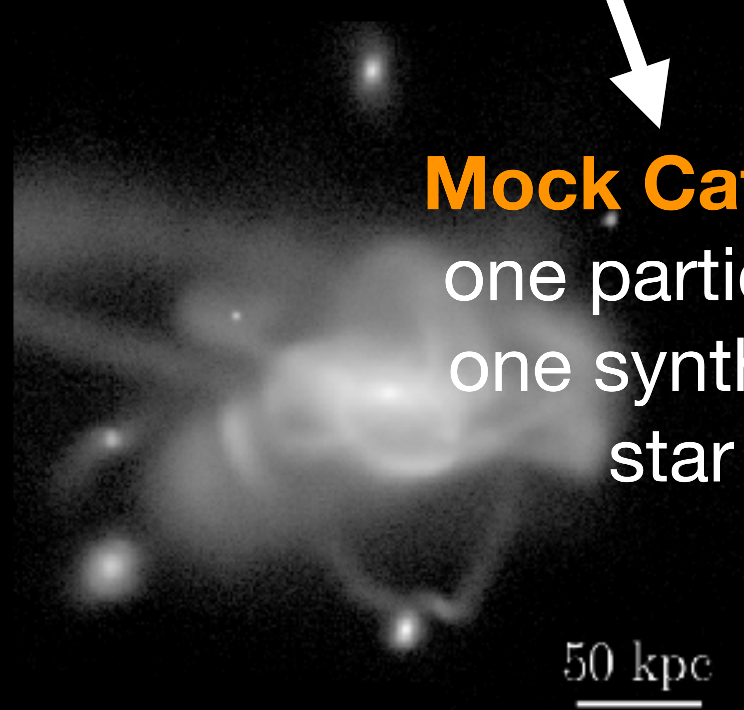

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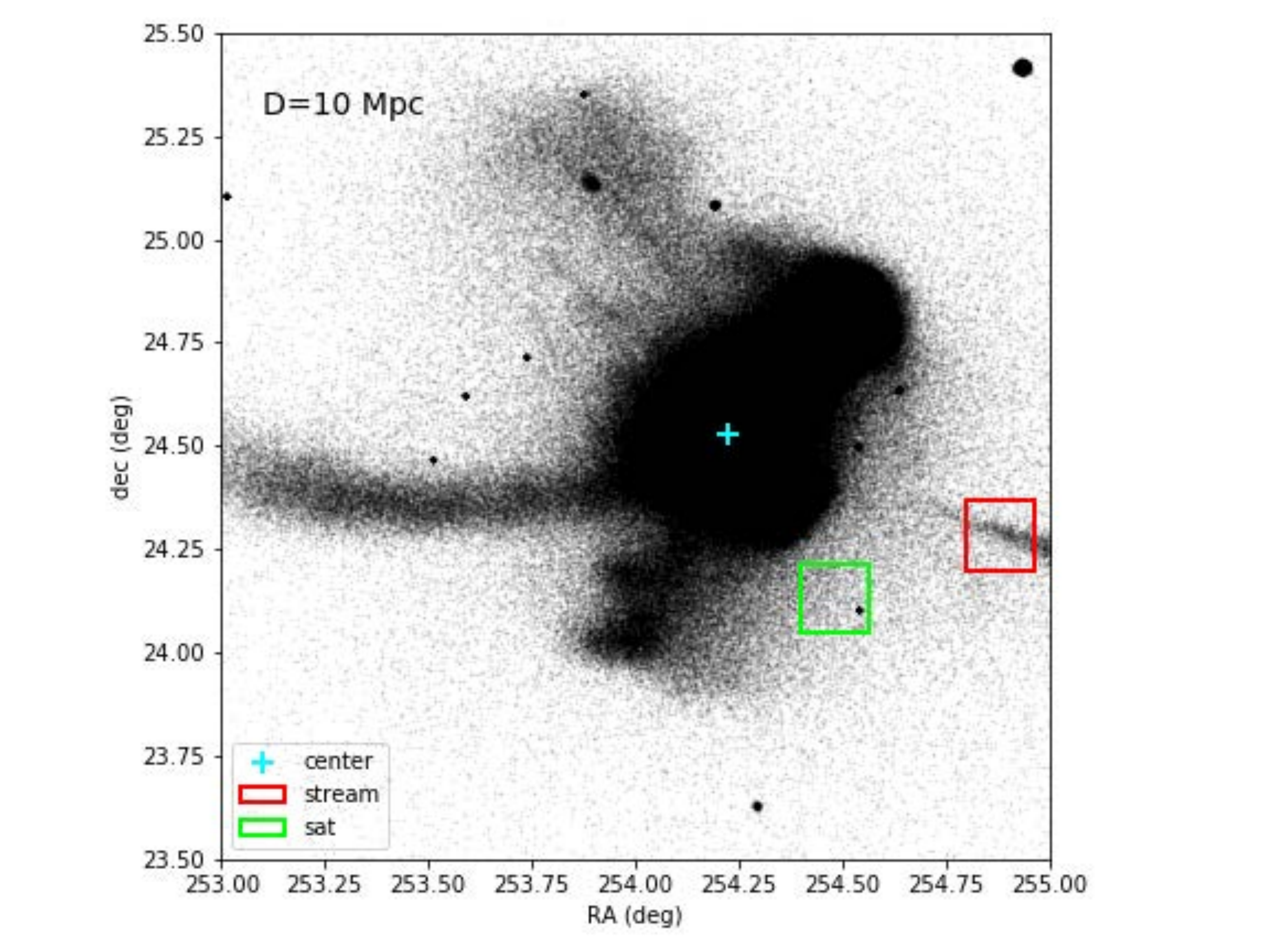
Describing the survey

The simulation is placed at the desired heliocentric distance.
Sky positions and apparent magnitudes are calculated.

Then a target field is selected (size of one CCD chip)
and a list of stars constructed for that field.

Now the star list is ready to be passed to the simulated image pipeline!



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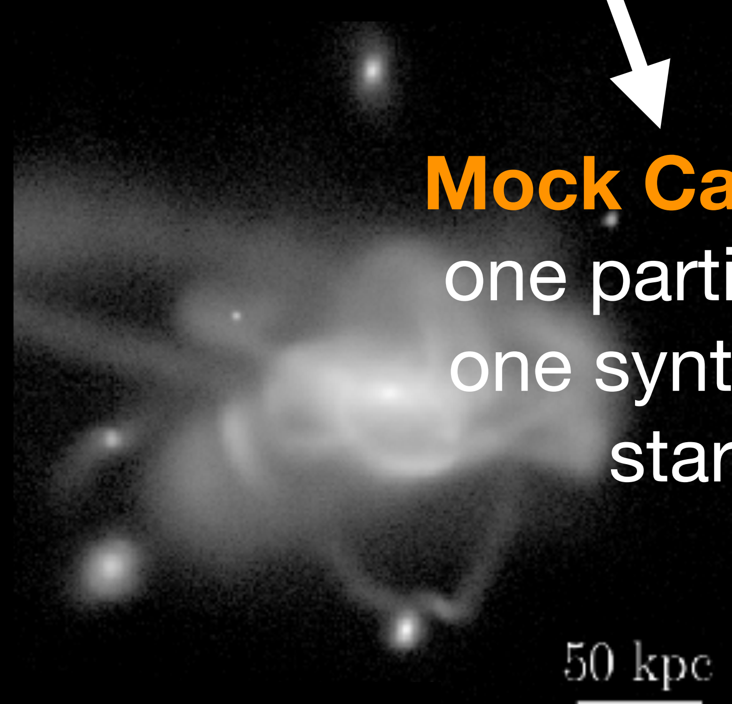

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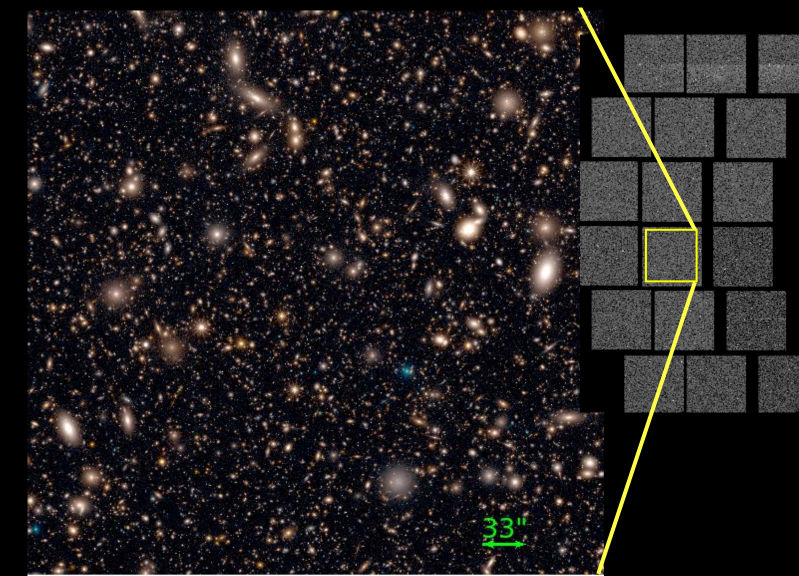

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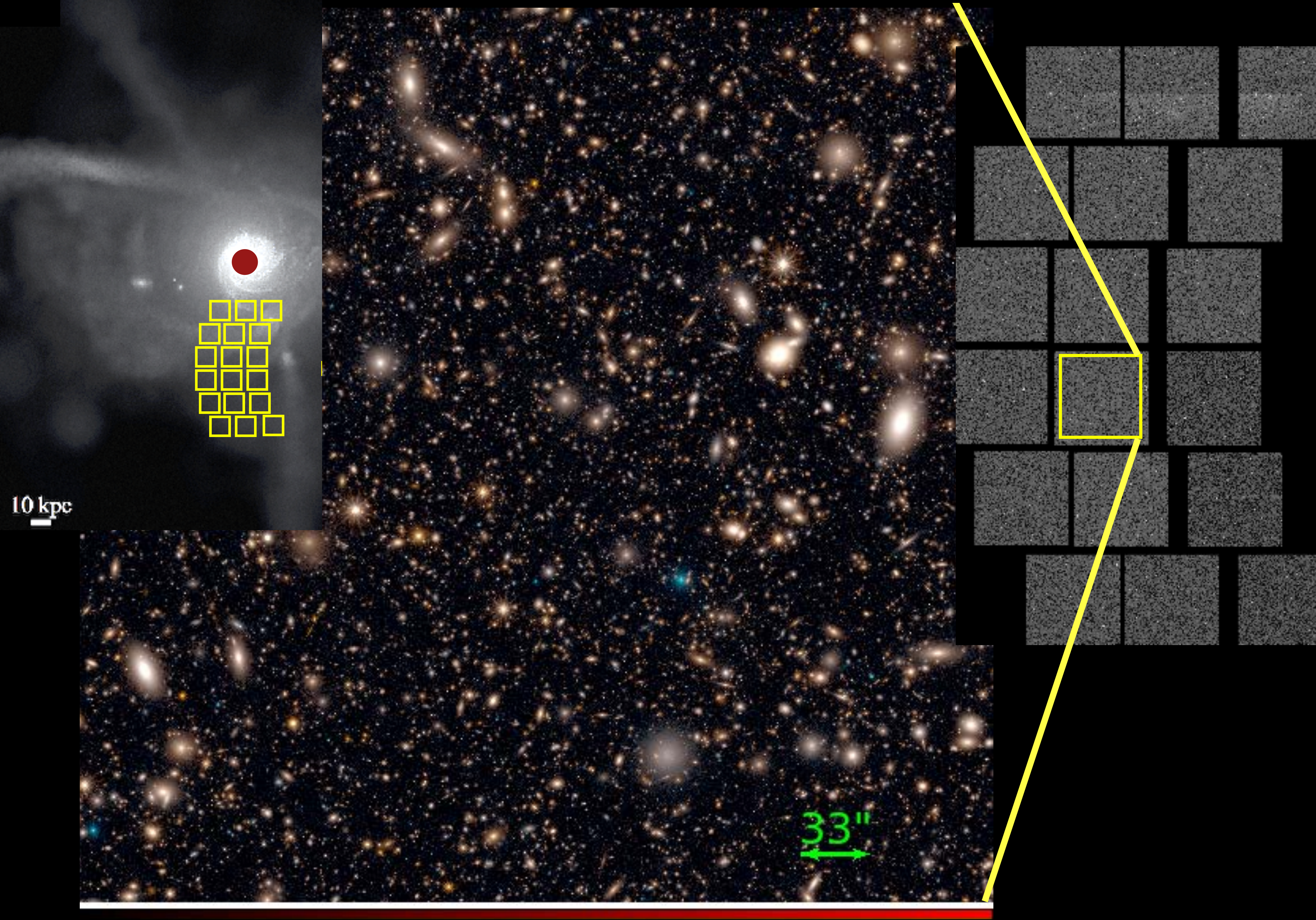
10 kpc
33"