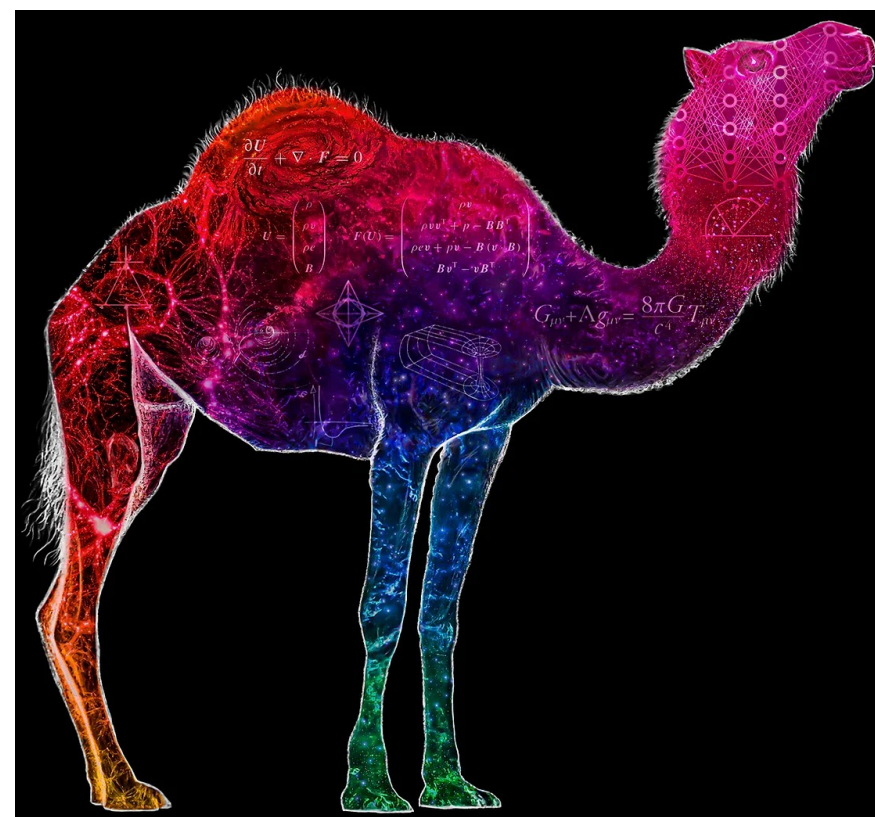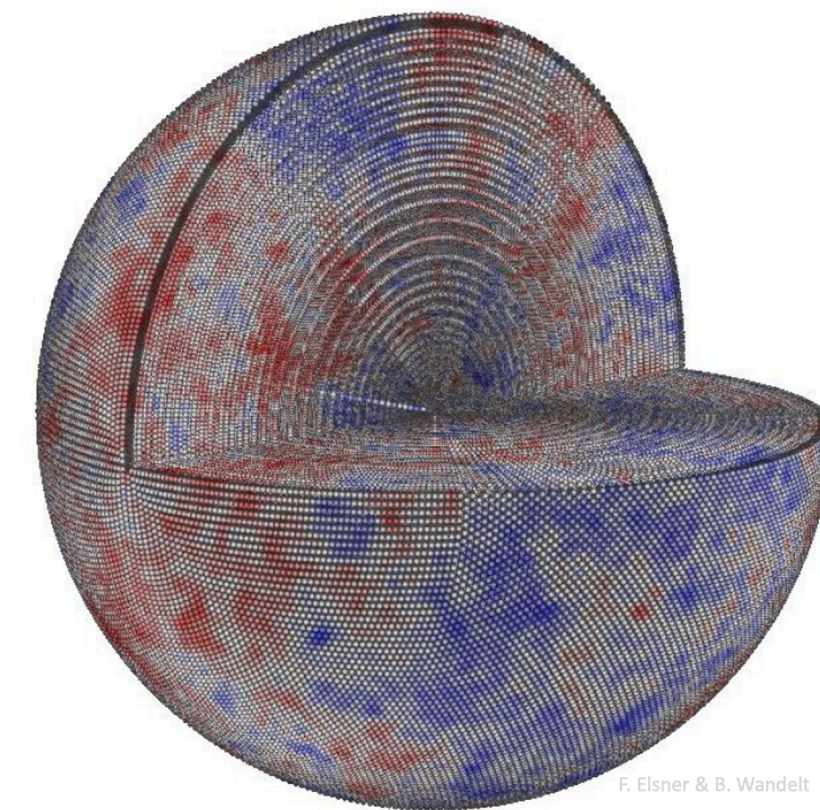*IQ-Collaboratory*

CAMELS

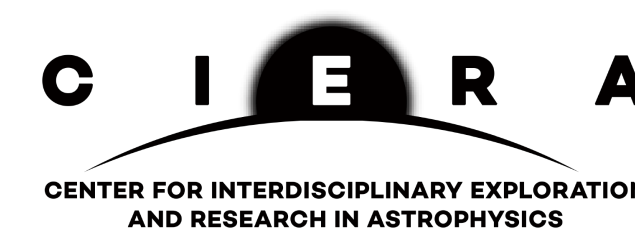*Learning the Universe*

Galaxy colors in CAMELS

Tjitske Starkenburg

Chris Lovell, Rachel Somerville, Austen Gabrielpillai

Northwestern | CIERA
CENTER FOR INTERDISCIPLINARY EXPLORATION AND RESEARCH IN ASTROPHYSICS

the Isolated and Quiescent galaxies (IQ) -Collaboratory*

Observations: SDSS volume limited sample (Tinker+2011), SDSS isolated dwarf galaxy sample (Geha+2012, Dickey+2020), CANDELS (Iyer+2018,2019)
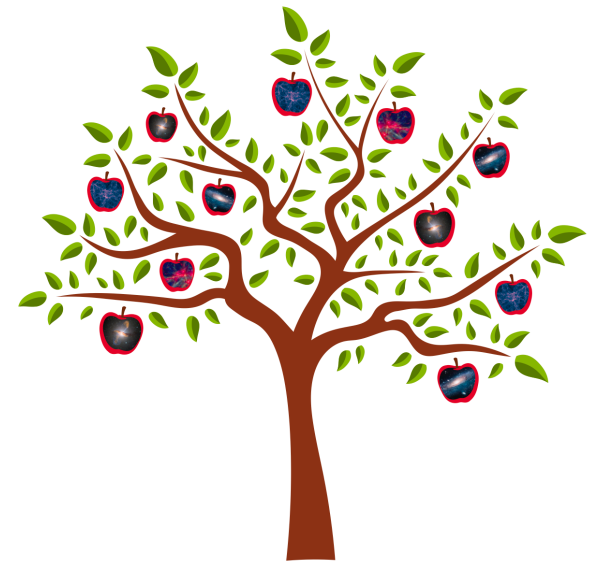
Simulations: Illustris (Vogelsberger+2014; Genel+2014), EAGLE (Schaye+2015; Crain+2015), MUFASA (Dave+2016), Santa Cruz semi-analytical model (Somerville+2015), IllustrisTNG100 (Pillepich+2018; Weinberger+2018), SIMBA (Dave+2019)

Logo credits: Claire Dickey

iqcollaboratory.github.io

*Yes, it is a real word

Build Synthetic Galaxy Spectra and Photometry

To properly compare **simulations** to **observations,** *forward modeling* the measurements is essential for an apples-to-apples comparison

forward model

theory

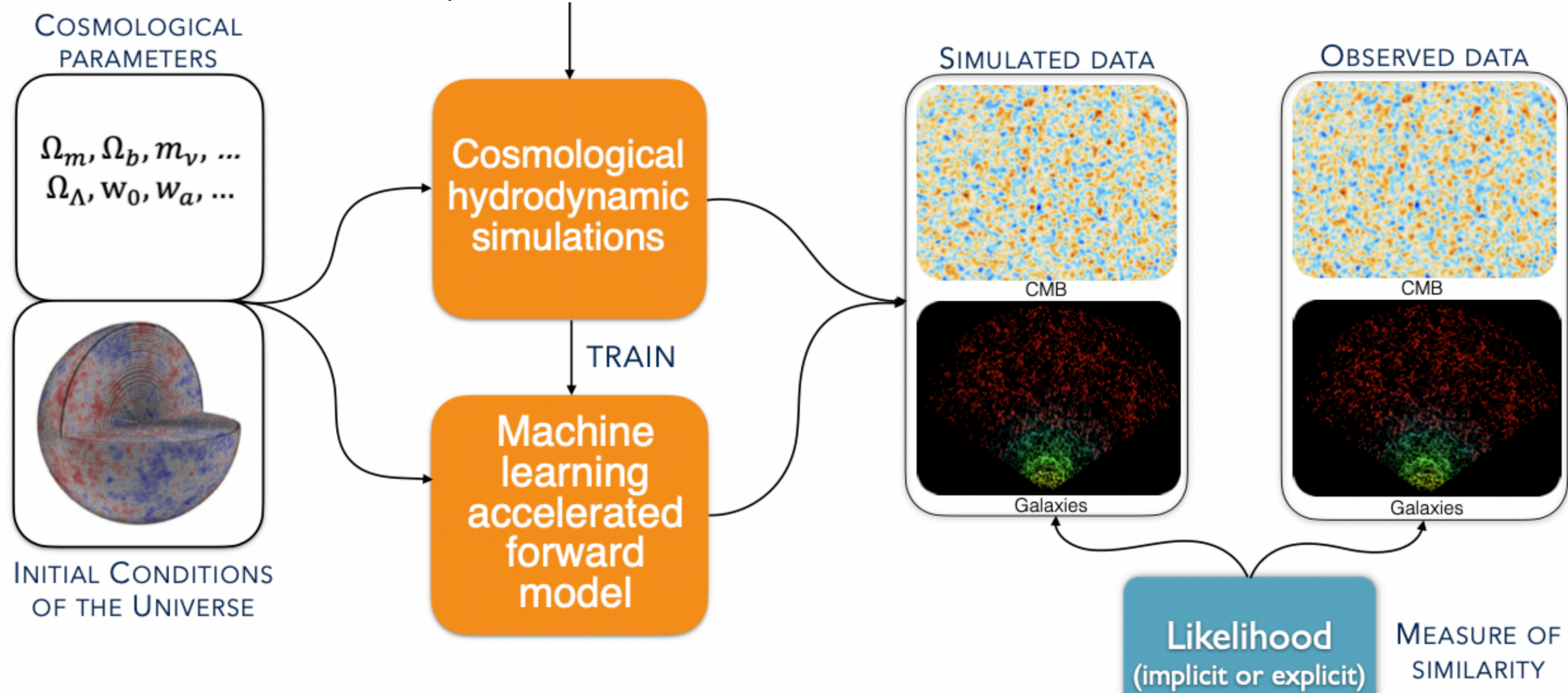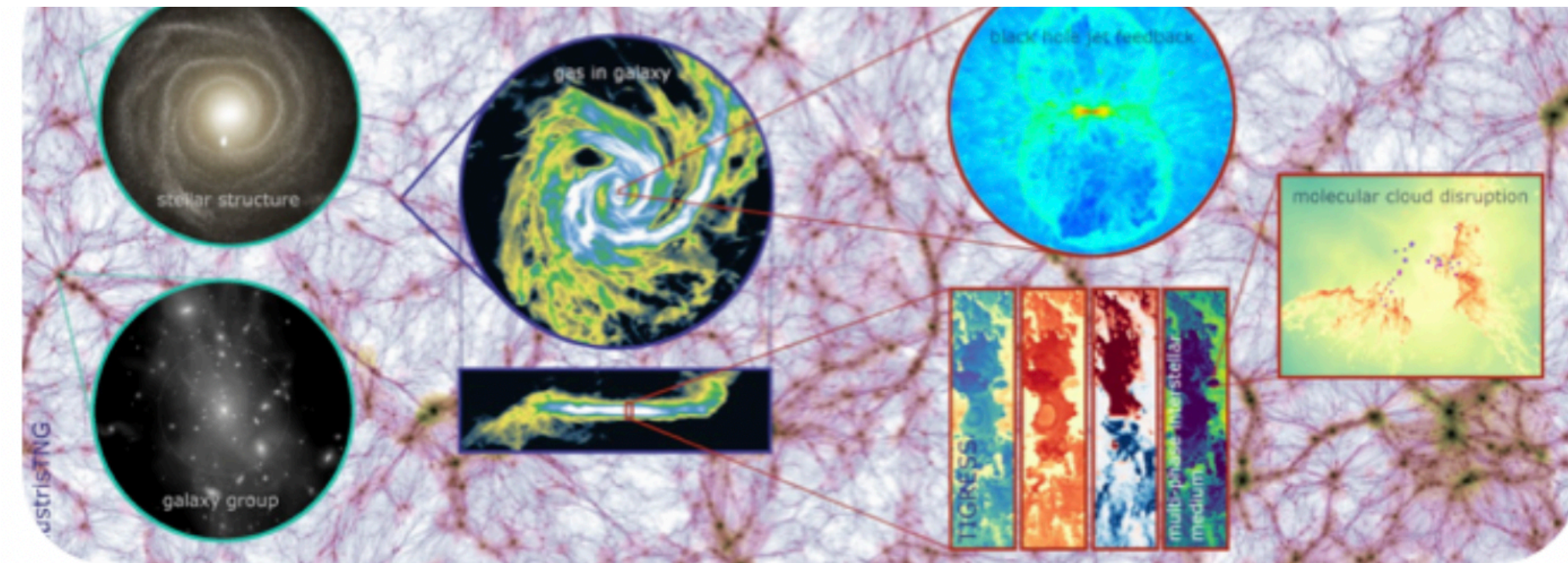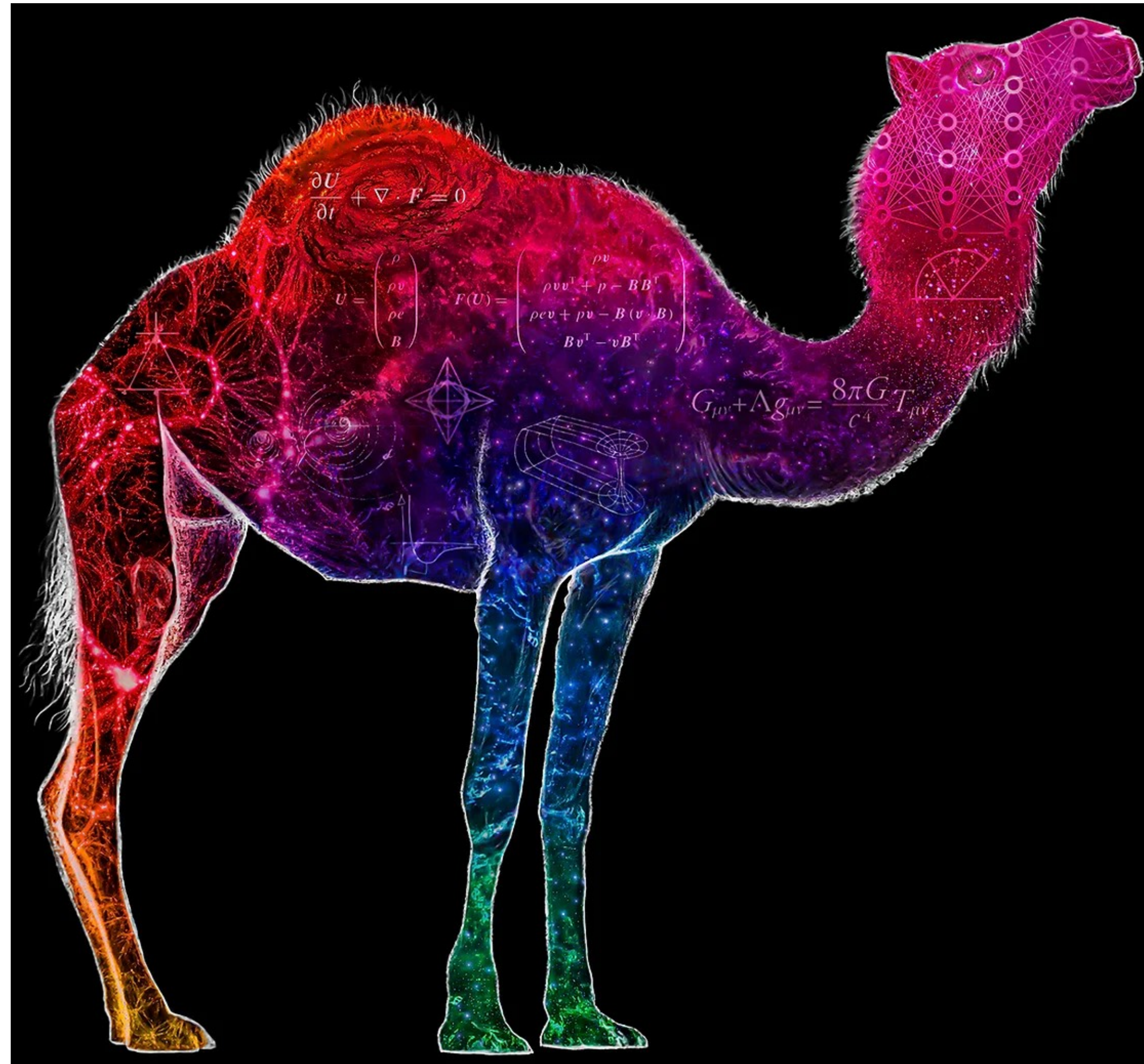M_*, SFR, *etc* from simulations

observation

$\hat{M}_*, \widehat{\mathrm{SFR}}$, *etc* derived from color, luminosity, $H\alpha$, D_n4000, *etc*

- **FSPS**: Flexible Stellar Population Synthesis (Conroy+09, Conroy&Gunn2010, Conroy+2014)
- Use identical input from all simulations, and consistent assumptions: summarize stellar ages and metallicities in a 2-d grid
- Include noise and limits consistent with observational surveys to compare to
- Explore different dust models
- Remeasure colors and spectral indices and compare one-to-one to observations

Dickey, **Starkenburg** & the IQ-collaboratory 2021
Hahn, **Starkenburg** & the IQ-collaboratory 2022
Starkenburg & the IQ-collaboratory in prep.

Simons Collaboration on Learning the Universe

See Greg Bryan's talk on Friday

COSMOLOGICAL PARAMETERS

$$\Omega_m, \Omega_b, m_\nu, ...$$
$$\Omega_\Lambda, w_0, w_a, ...$$

INITIAL CONDITIONS OF THE UNIVERSE

Cosmological hydrodynamic simulations

TRAIN

Machine learning accelerated forward model

SIMULATED DATA

CMB

Galaxies

OBSERVED DATA

CMB

Galaxies

Likelihood (implicit or explicit)

MEASURE OF SIMILARITY

*https://www.learning-the-universe.org*

https://www.camel-simulations.org

First round of forward modeling SEDs for CAMELS

- Currently run on IllustrisTNG LH-set and SB28-set, but will expand
- Use default setup from IQ-Collaboratory work, but also plan to include others (Chris Lovell)
- Mostly just stellar SEDs (no nebular lines, no dust), but also some runs with simple dust models
- Use these to test speed-up methods, and work on providing fast spatially resolved galaxy spectra/SEDs
- Remeasure colors and spectral indices and compare to fiducial simulations and observations

SDSS r-band magnitudes

selection Mr < -19

- simulated galaxies, only stellar light
- Simulated galaxies, with dust
- SDSS observed sample
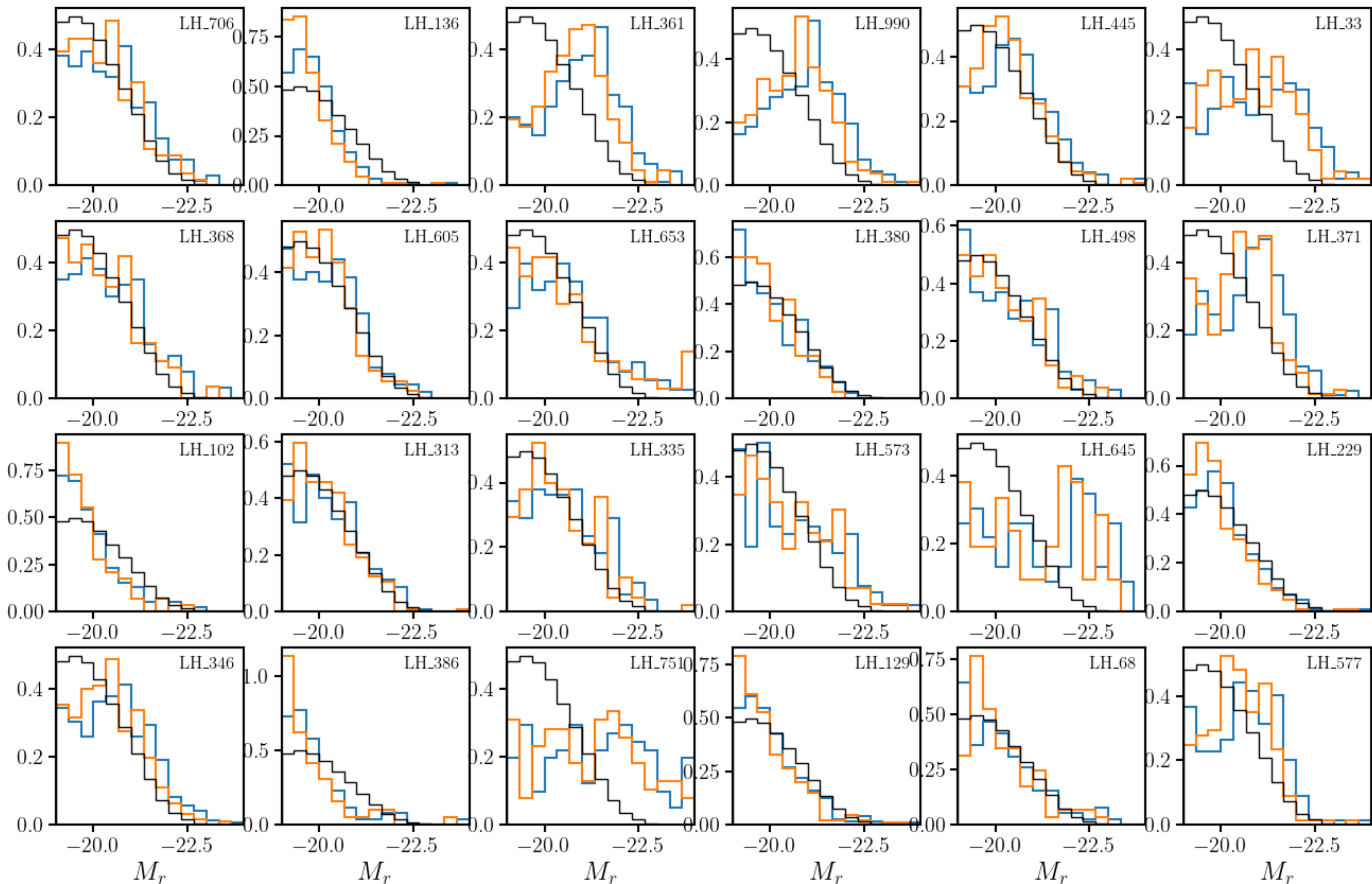
SDSS g - r colors

selection Mr < -19

- simulated galaxies, only stellar light
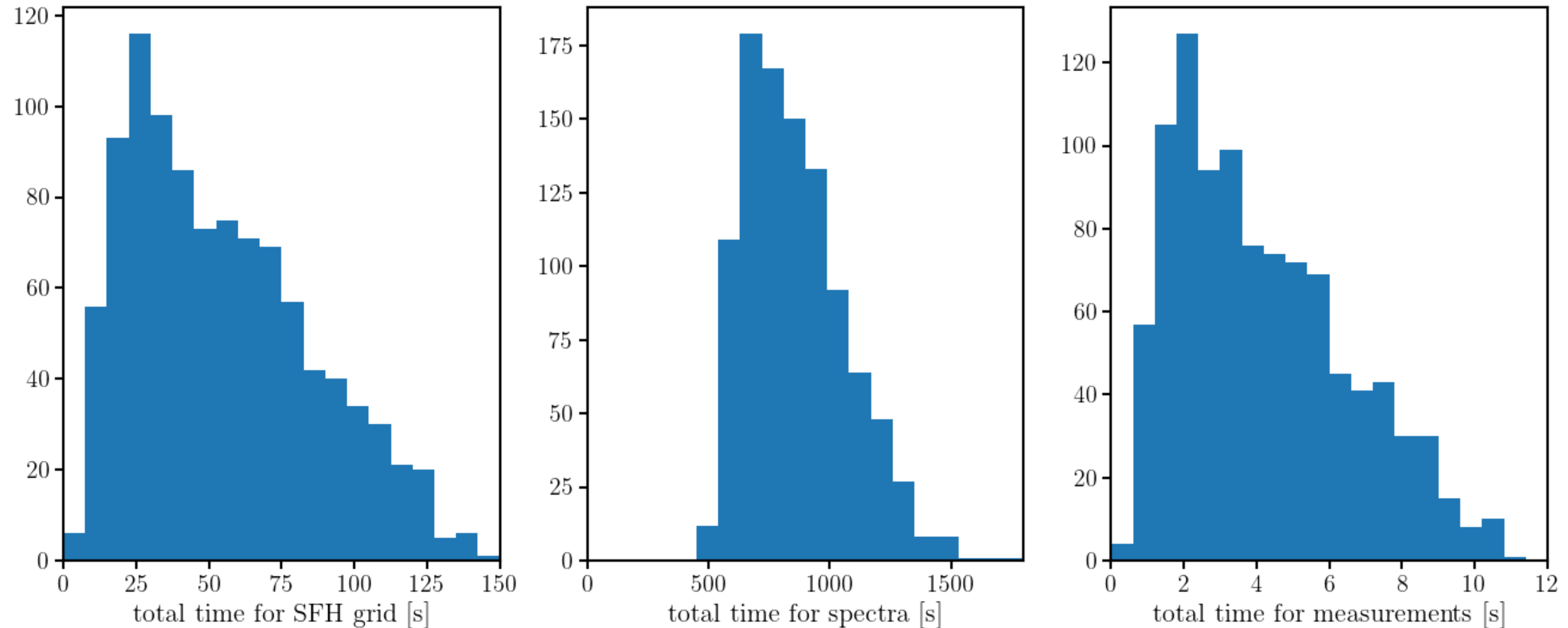- Simulated galaxies, with dust
- SDSS observed sample
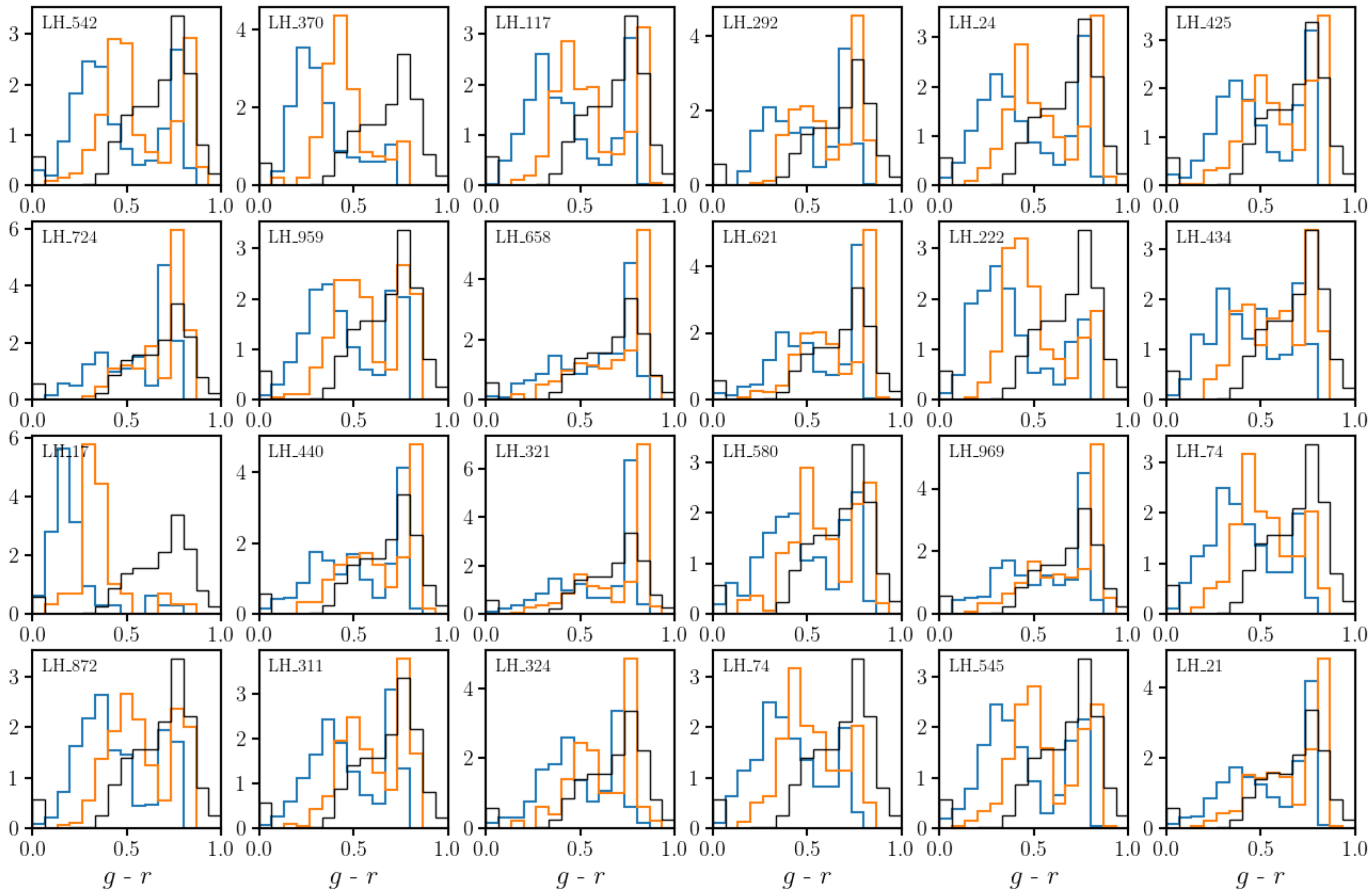
Dn4000 spectral index

selection Mr < -19

- simulated galaxies, only stellar light
- Simulated galaxies, with dust
- SDSS observed sample
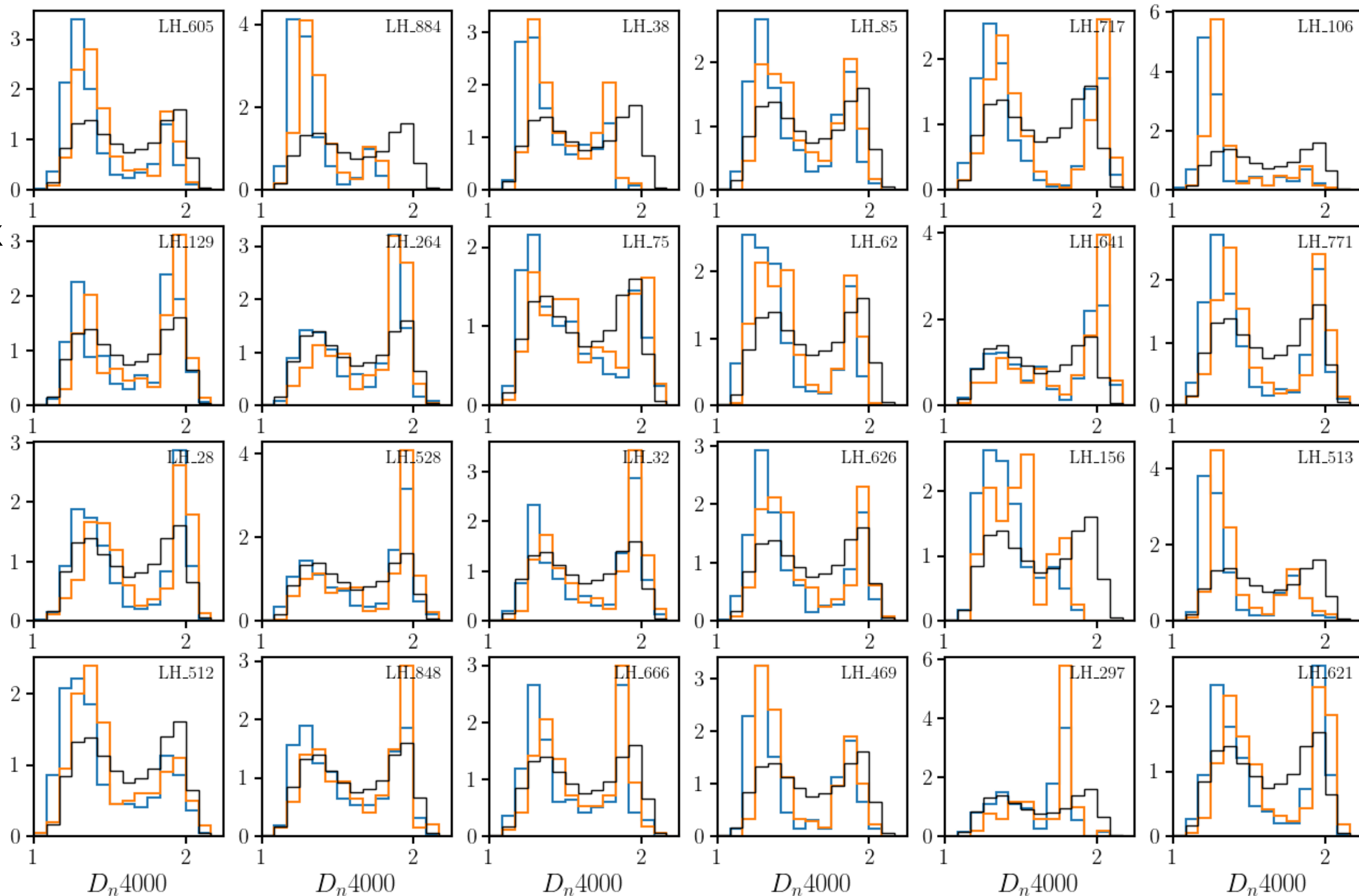
Unsurprisingly, generation of the spectra is the bottleneck, requiring ~10 minutes for boxes with few galaxies, and up to 2.5 times that for boxes with many galaxies

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HOME   **DIRECTORY**   **ACTIVITIES**   **PROPOSE ACTIVITY**   **APPLY**   **FOR VISITORS**   **ONLINE TALKS**   **OUTREACH**
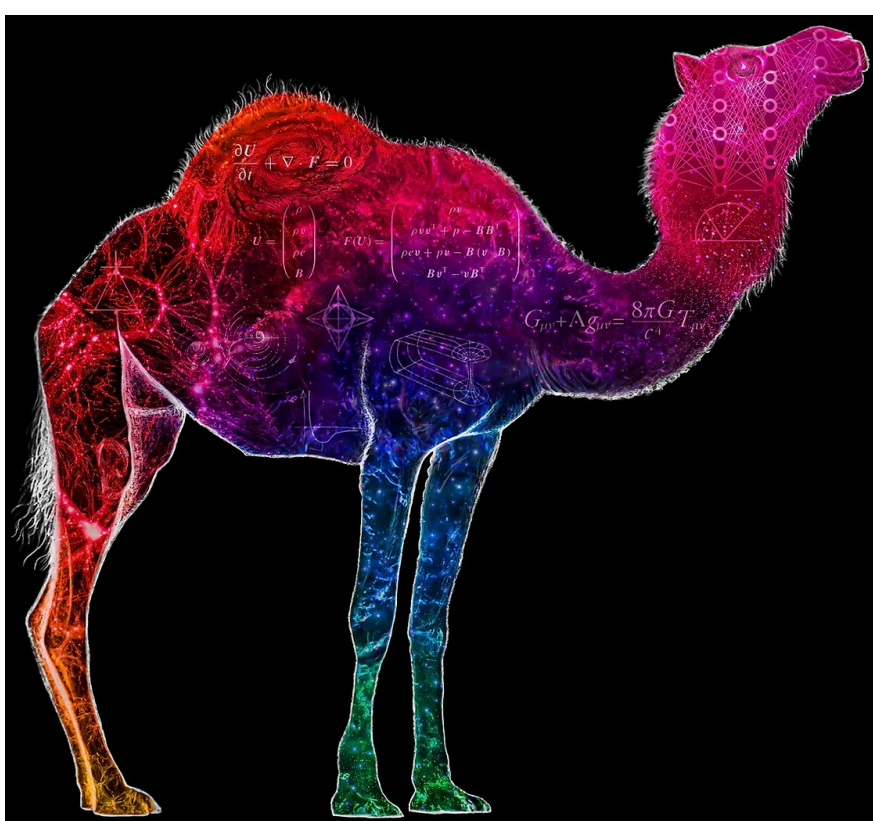
Building a Physical Understanding of Galaxy Evolution with Data-driven Astronomy

Coordinators: Peter Behroozi, Tjitske Starkenburg, Paco Villaescusa-Navarro and John Wu

Scientific Advisors: Shirley Ho, Josh Peek, and Romeel Dave

- A 10 week collaborative program January-March 2023, partly virtual, partly in-person (now full)
- Participation by a diverse group of astrophysicists with different expertise
- Including a workshop at the CCA (Jan 30 - Feb 3) and a conference at KITP (March 20-24)
- See http://datadrivengalaxyevolution.github.io for a link to register!

Thank you

F. Elsner & B. Wandelt