

Multi-survey joint analysis of galaxy formation physics across cosmic history

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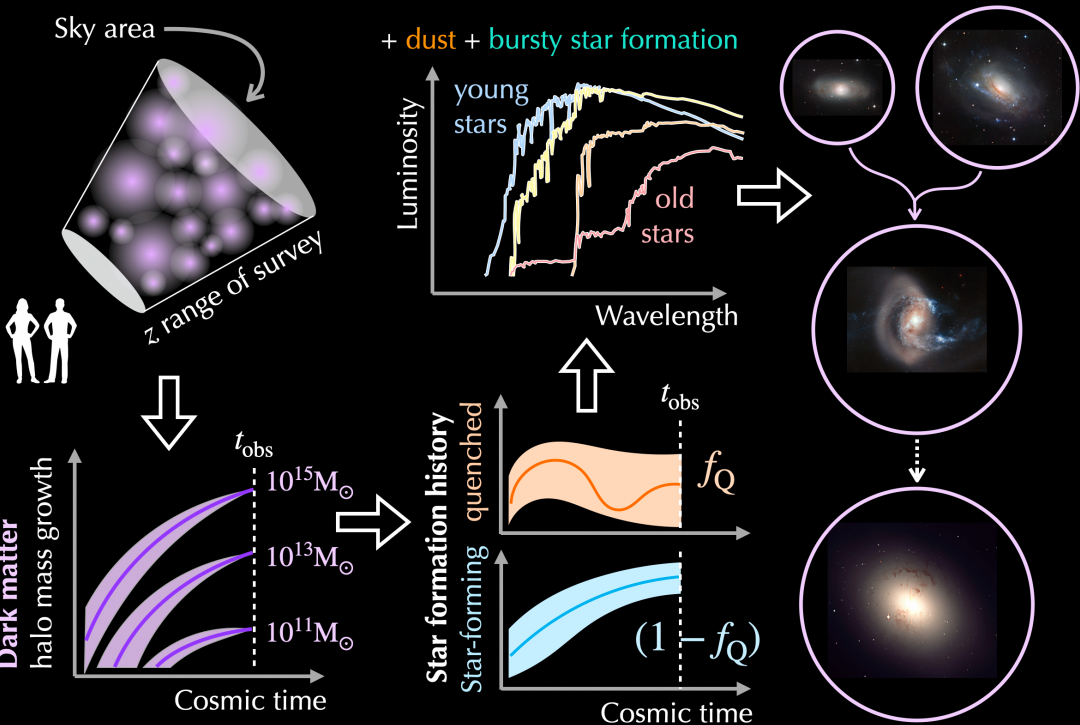


MOTIVATION

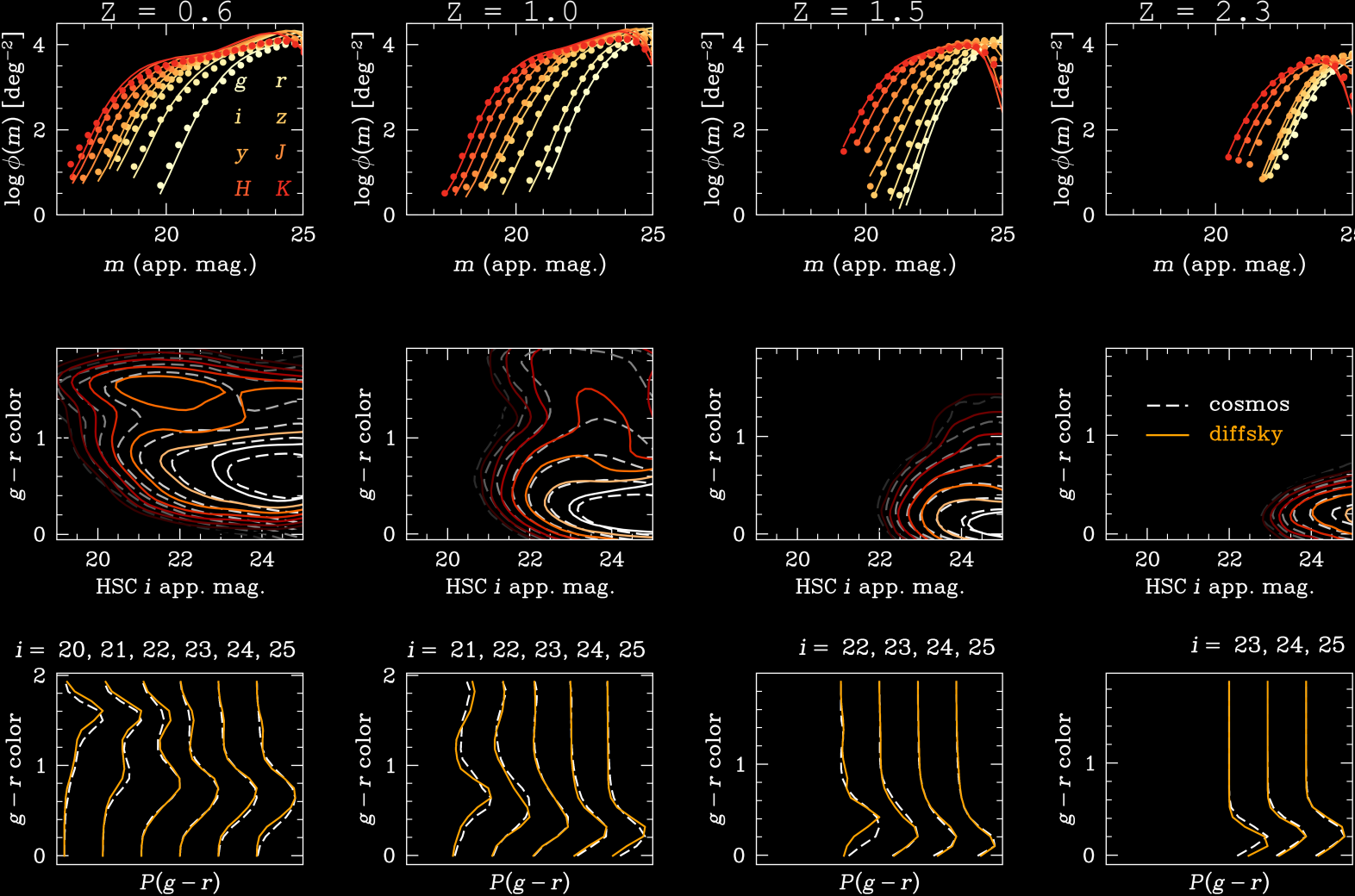
Hydrodynamical simulations are too expensive to directly apply to observational data. Halo occupation models are perhaps too simplistic and are proving to be insufficient to model the complexity of modern survey data, especially if we care about joint multi-survey analysis. So we have to rethink and revamp galaxy-halo connection.

DIFFSKY: HOW IT WORKS

Given a sky area and redshift range for any survey, Diffsky populates that lightcone with halos and subhalos, and models the halo mass growth over cosmic time with a realistic diversity of assembly histories. For each halo assembly history it paints a star formation history for a quenched or a star-forming galaxy, with f_Q and $1 - f_Q$ probabilities, respectively. Based on that star formation history it weighs the spectra of different simple stellar populations, adds dust and burstiness, to model the full SED of the final galaxy. Finally it accounts for galaxy mergers probabilistically. Doing this over the entire lightcone it generates a model galaxy catalogue, which can then be compared to the observed data by applying the right selection effects and choosing any observable statistics. **This enables the unique ability for joint multi-wavelength multi-survey analysis.**



FITTING COSMOS DATA WITH DIFFSKY



Diffsky accurately forward-models the apparent magnitude distributions for all photometric bands: g, r, i, z, y, J, H, K (top row), the color-magnitude distribution of galaxies (middle row), and the conditional color distributions: g-r color conditioned on the i- band apparent magnitude (bottom row), across a wide range of redshifts (different columns, as indicated on top).

FUTURE DIRECTIONS & CURRENT DELIVERABLES

Currently I am fitting COSMOS, COSMOS-Web and SDSS simultaneously. The goal is to do joint analysis of tomorrow's galaxy surveys like ROMAN and RUBIN, to ask what we learn about galaxy formation physics from all of that data put together. And a natural byproduct of this is to also generate ultra-realistic mock catalogues in multiple bands for multiple surveys. For example, Roman and Rubin joint mocks (images on the right) were created using an older version of Diffsky. Now we can generate even more realistic mocks with our newer calibrations — and not just for Roman or Rubin, but for DESI, Euclid, or whichever galaxy survey is your favorite one.

