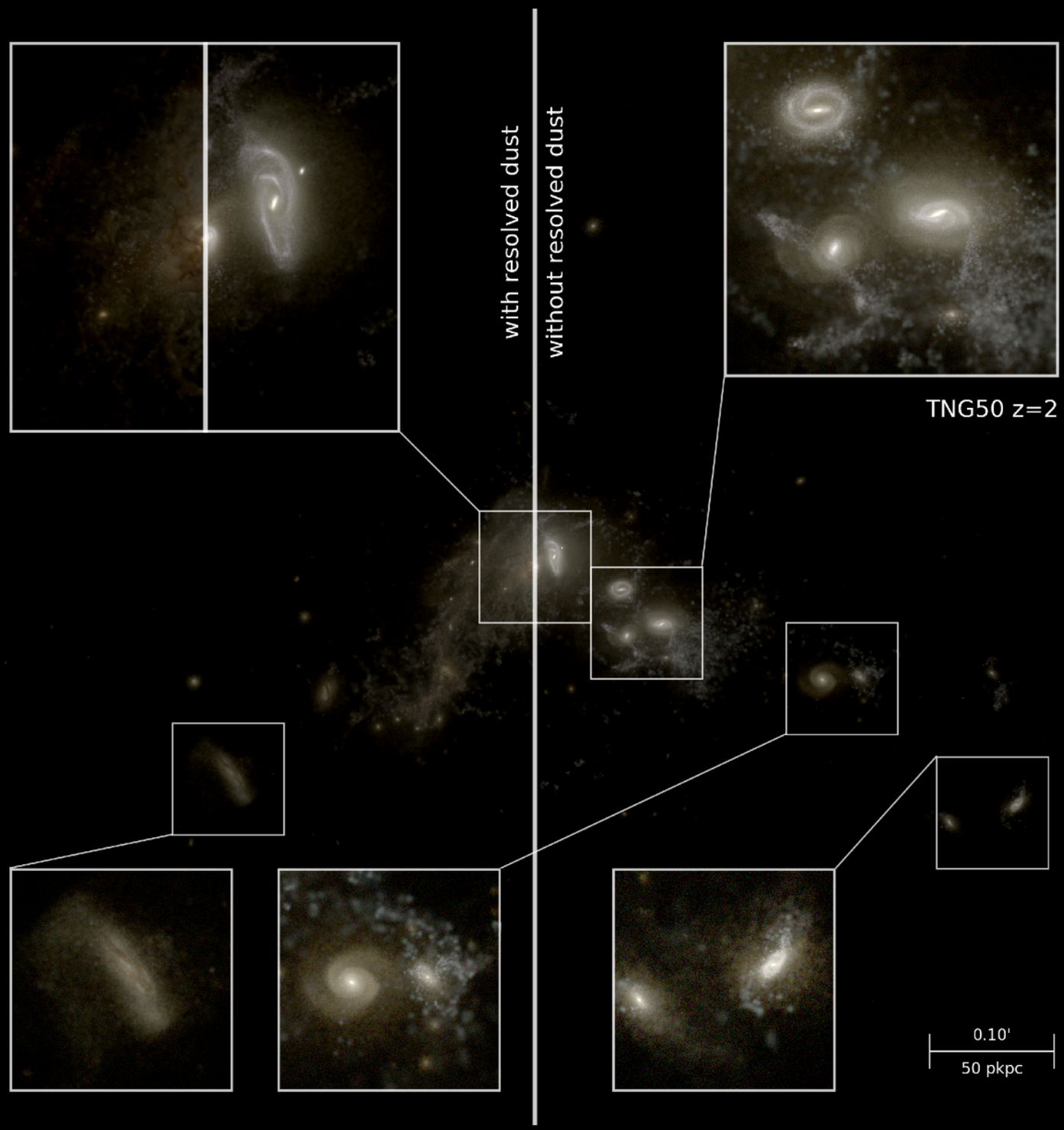
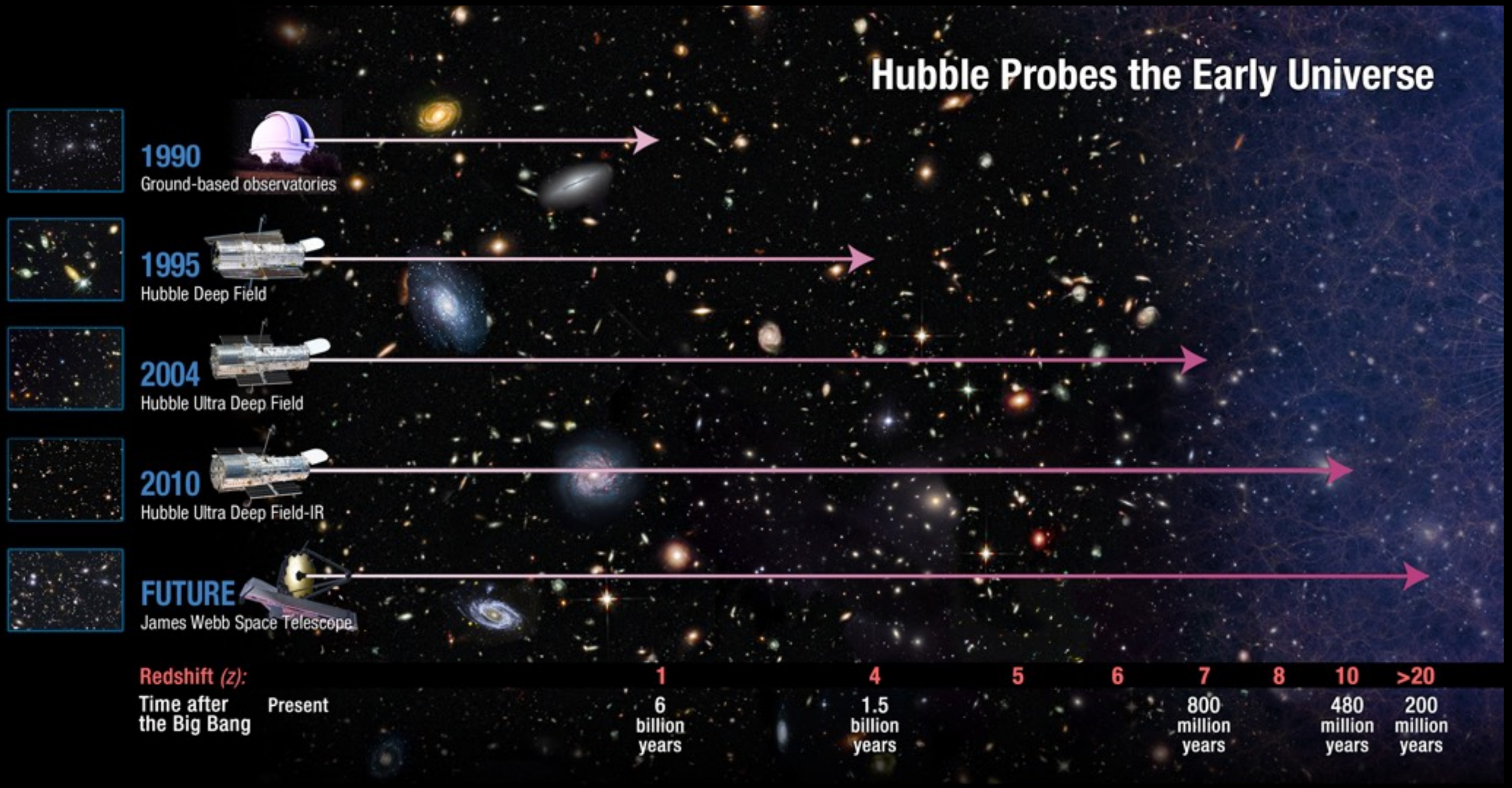
Infrared Predictions on High Redshift Galaxies from IllustrisTNG



Xuejian (Jacob) Shen

Group meeting 10/14/2020

Observations

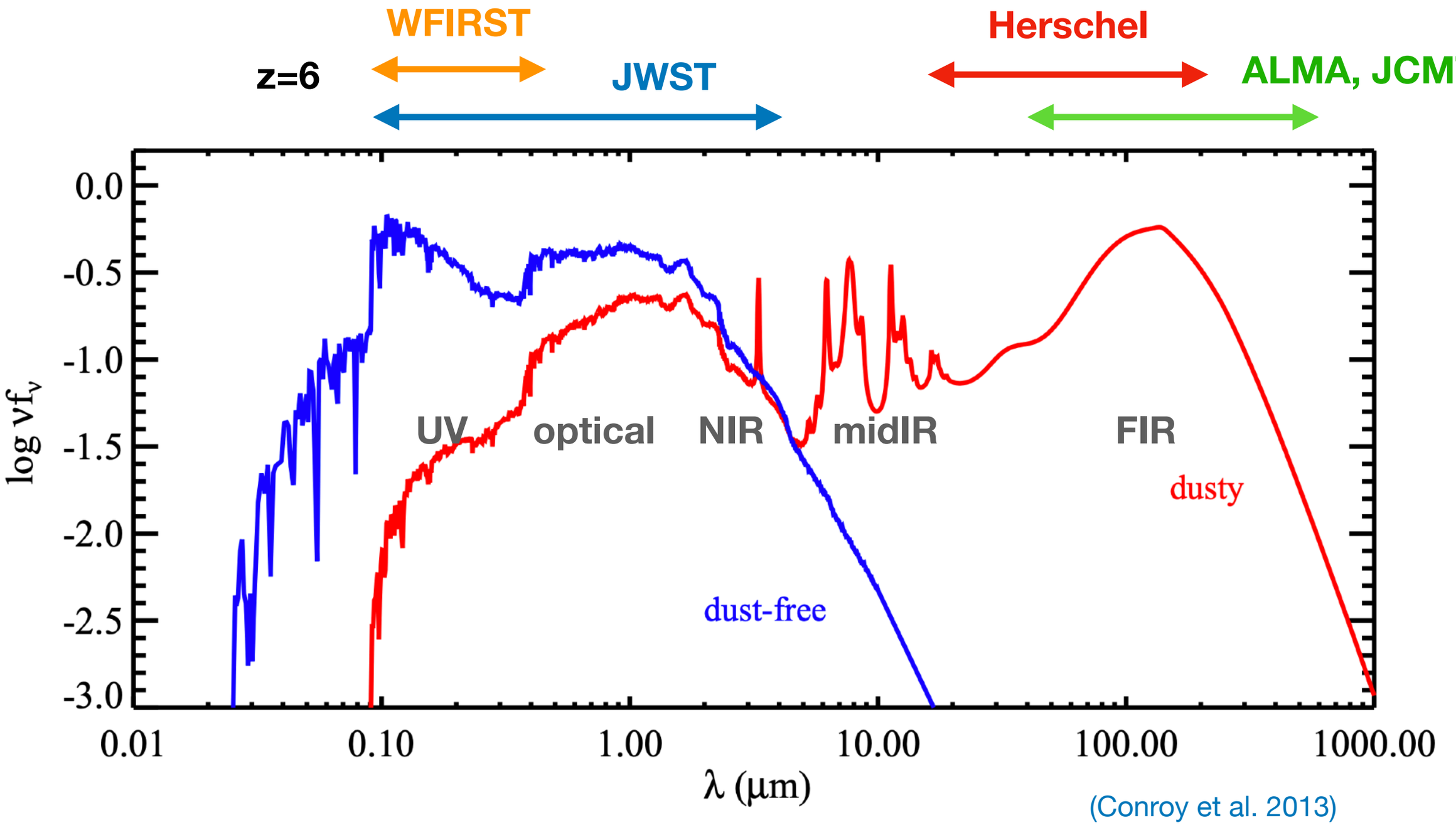


Wikipedia

- Galaxy rest-frame UV LF up to z ~ 10
- Photometric SEDs of several thousands galaxies up to z=8
- High-res spectroscopic observations up to z=3

- Limited wavelength coverage of the HST
- Sensitivity of current IR instruments

Galaxy SED and observations in near future



(Conroy et al. 2013)

Theoretical predictions

Empirical models

(e.g., Tacchella et al. 2013, 2018; Mason et al. 2015)

Semi-analytical models

(e.g., Cowley et al. 2018; Yung et al. 2018)

Hydrodynamical Simulations

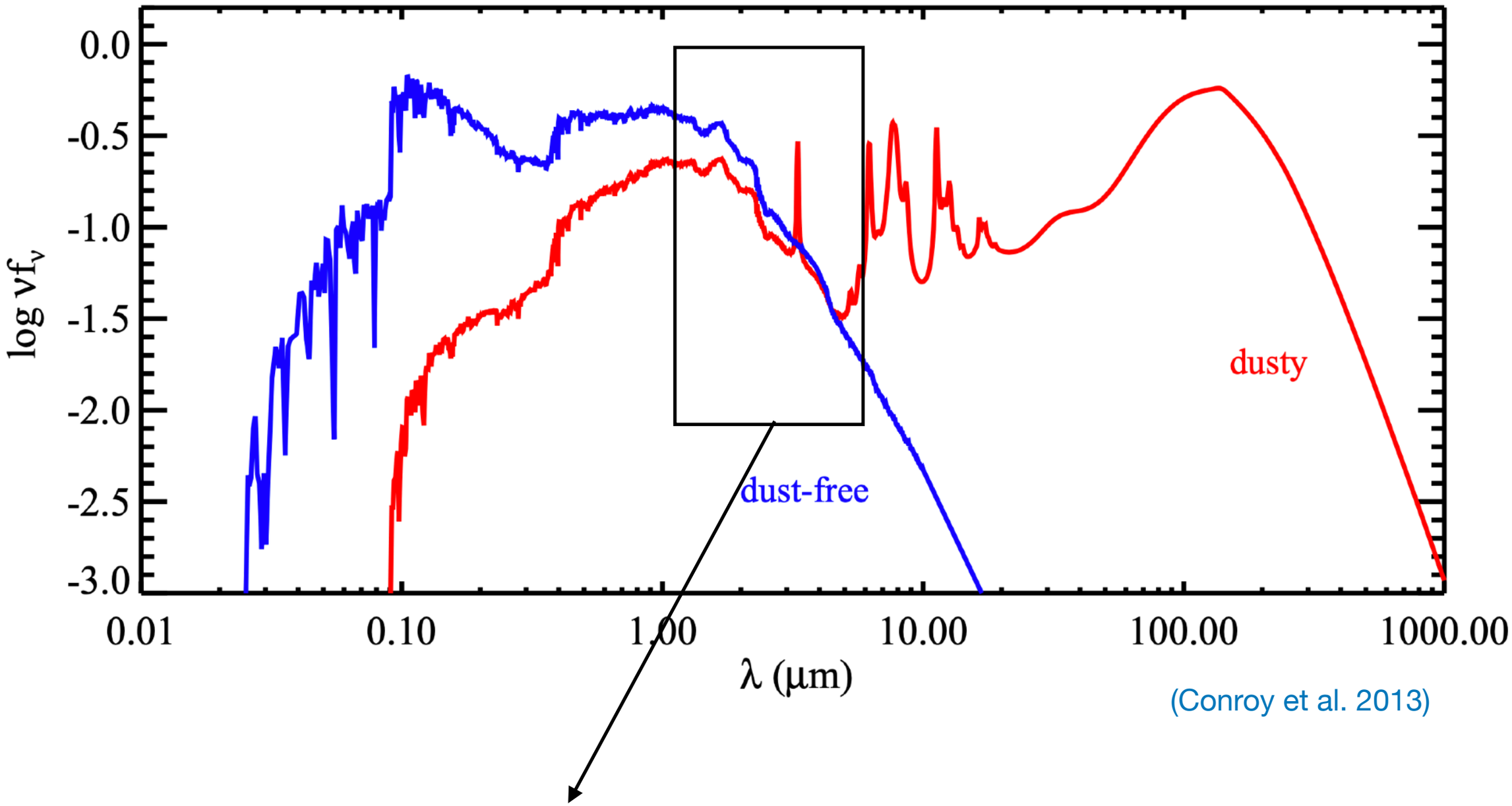
First Billion Years suites (e.g., Paardekooper et al. 2013)
BlueTides (e.g., Wilkins et al. 2016, 2017)
Renaissance (e.g., Xu et al. 2016; Barrow et al. 2017)
FIRE-2 (e.g., Ma et al. 2018, 2019)
Sphinx (e.g., Rosdahl et al. 2018)

but only evolved down to relatively high z, ~4-5
- not yet tested over numerous local observational constraints

The IllustrisTNG simulation + post-processing with radiative transfer calculations using SKIRT (Vogelsberger et al. 2020, Shen et al. 2020)

- population synthesis for old and young stars
- Monte Carlo radiative transfer calculation for dust absorption and emission
- abundance of dust calibrated based on the observed UVLF
- geometry of dust attenuation fully resolved by simulations

NIR luminosities as proxy for galaxy stellar masses

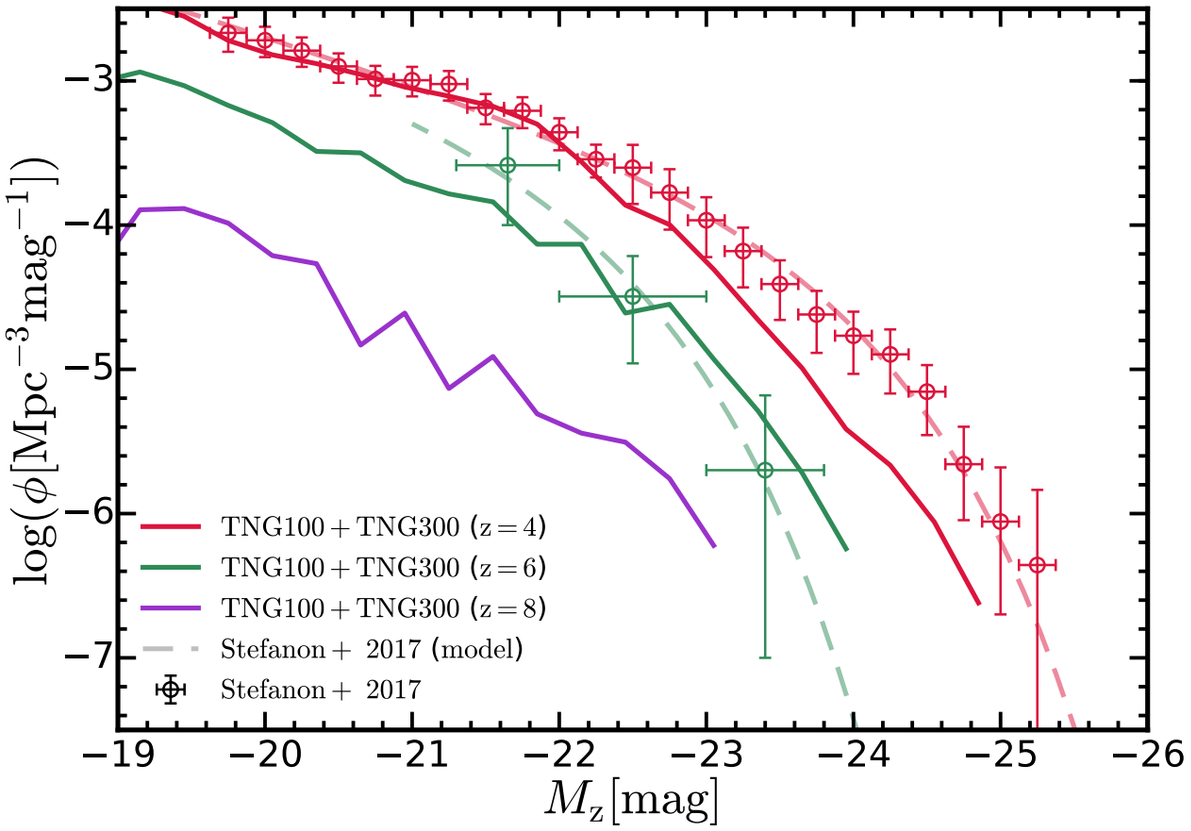


(Conroy et al. 2013)

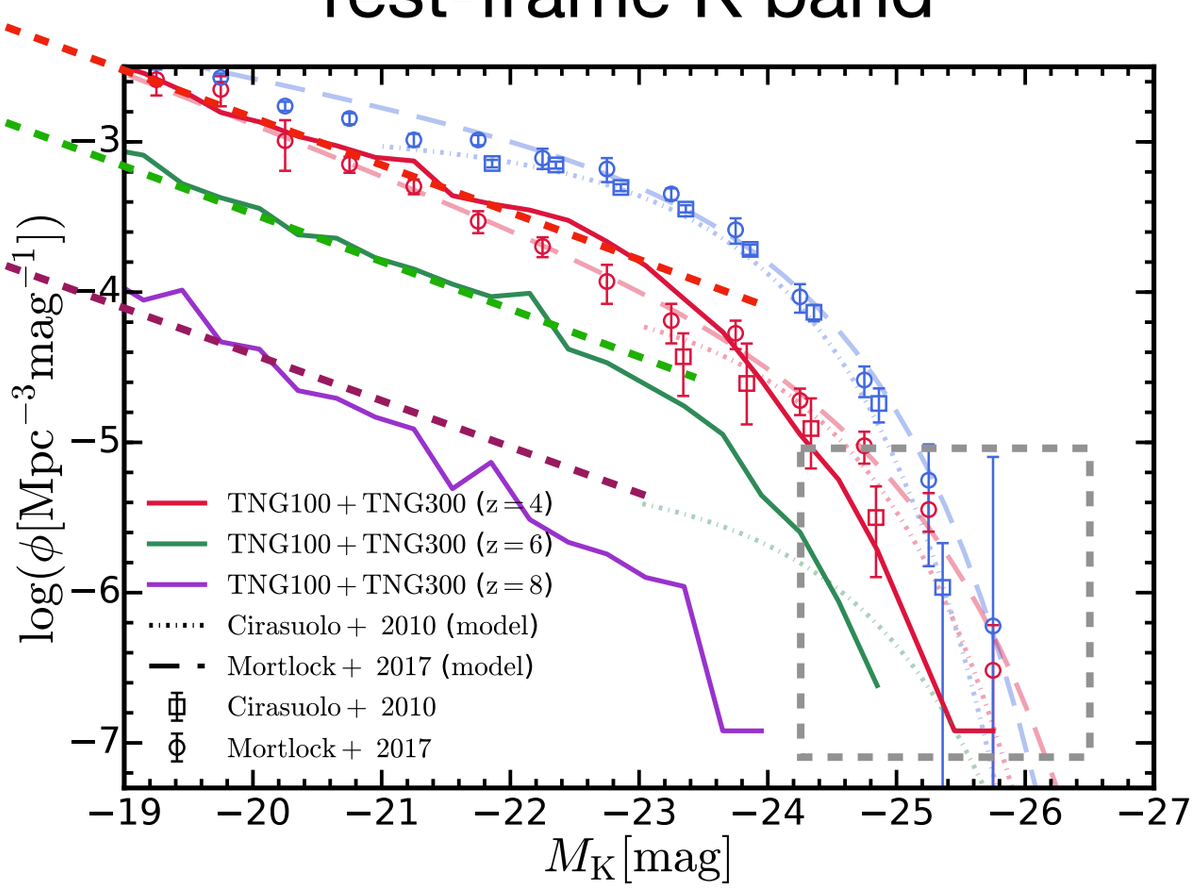
Part of the SED that is sensitive to the old stellar population and less affected by both dust attenuation and emission

NIR luminosities as proxy for galaxy stellar masses

rest-frame z band

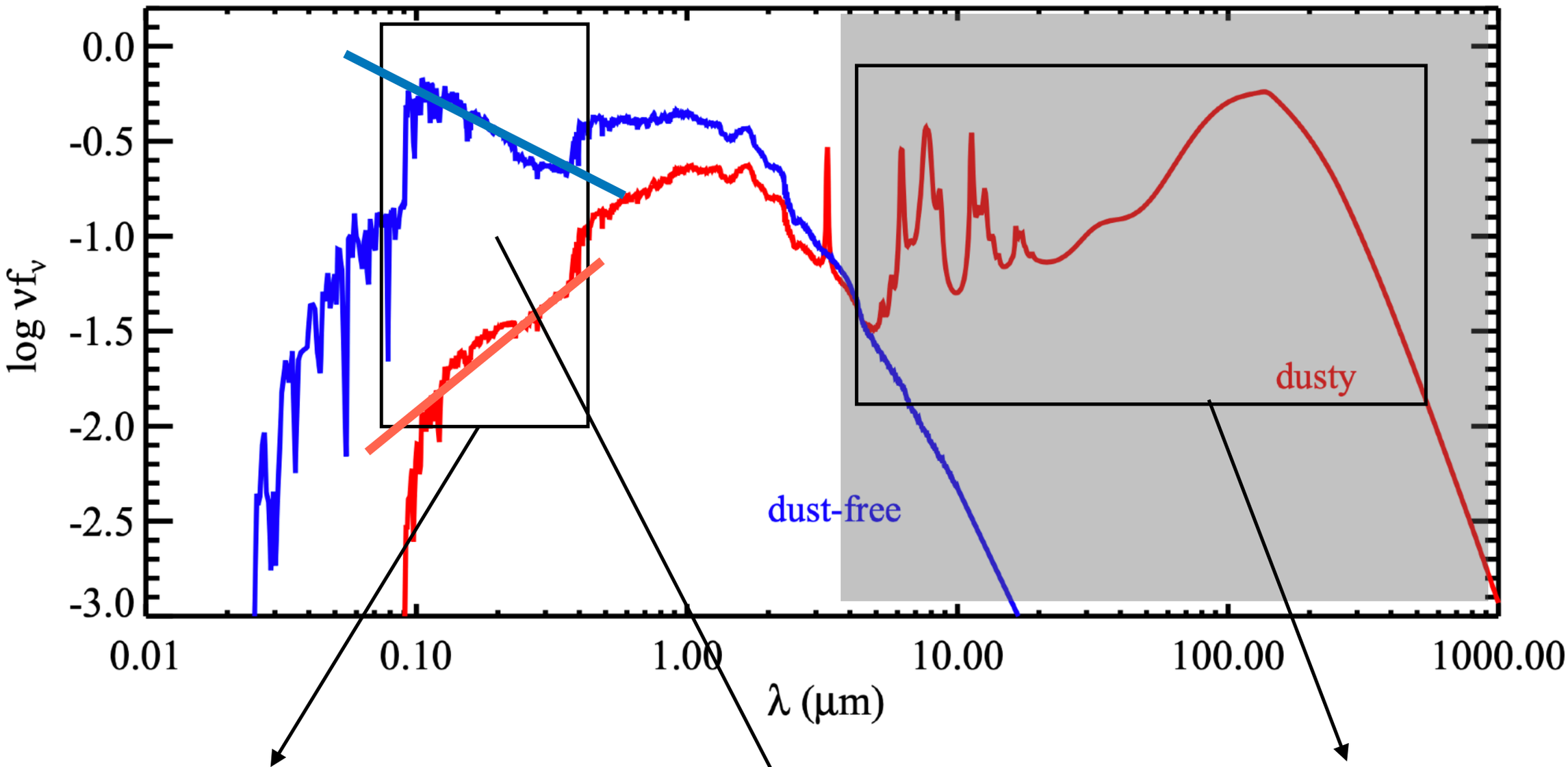


rest-frame K band



- NIR band luminosity functions reveal the mass assembly of high-z galaxies
- Low mass galaxies at high-z grow in a self-similar fashion (with almost the same mass-doubling time)
- Growth of massive galaxies gets suppressed at z~2

Obscured Star Formation

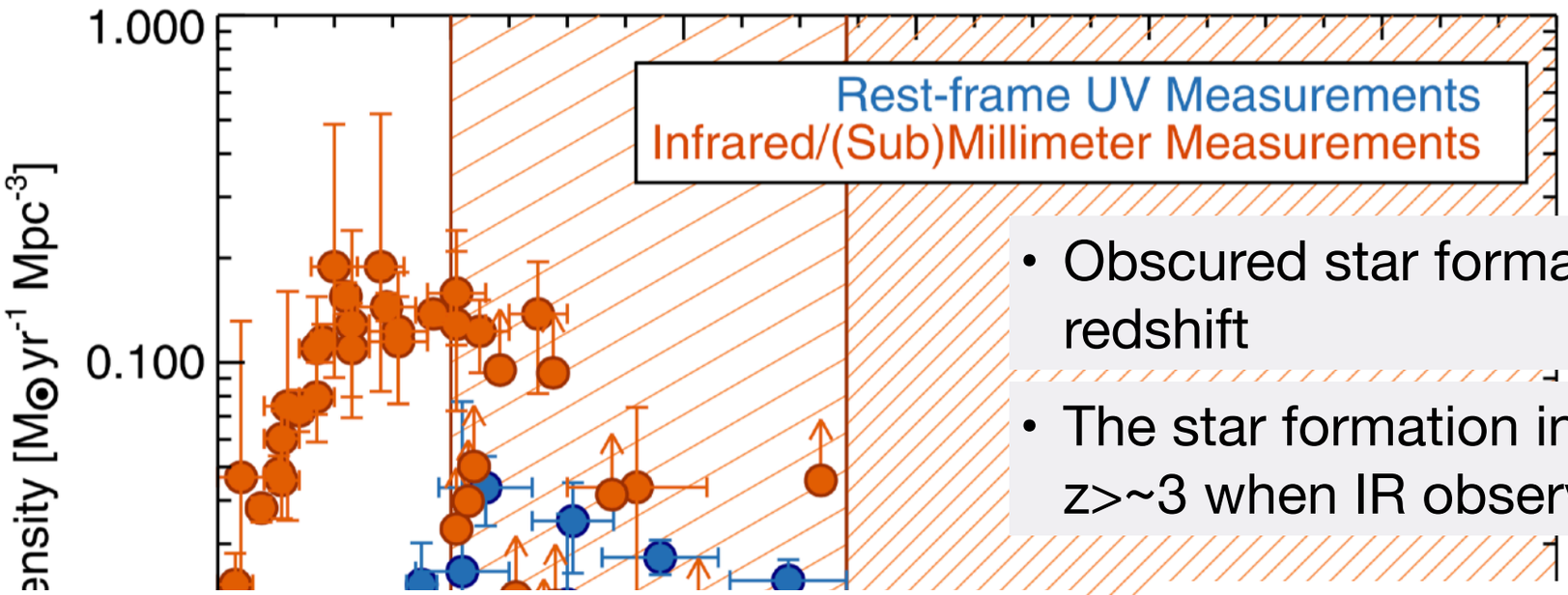


UV emission from young stars

Young stars + dust versus Old stars + no dust

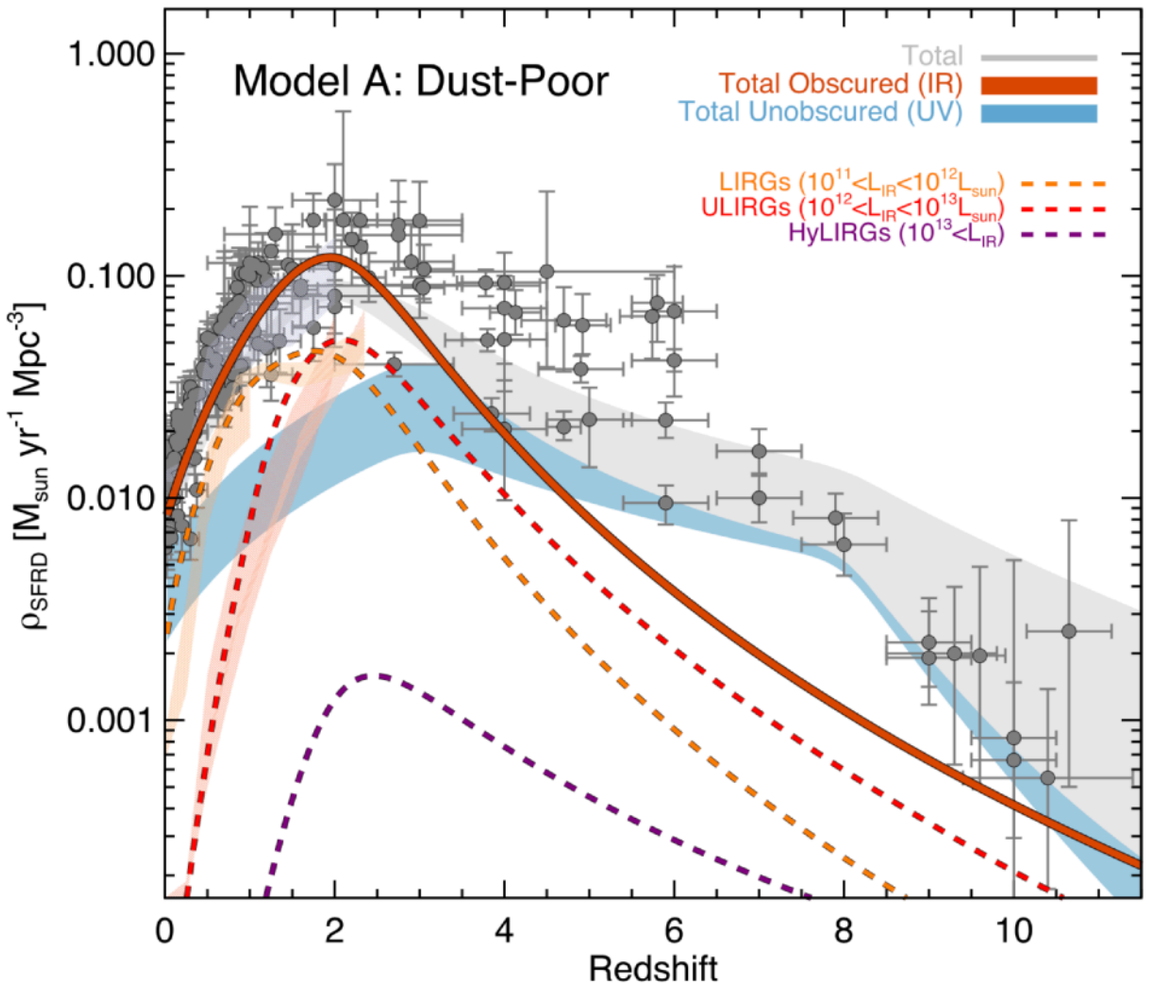
Dust reemission of the absorbed UV emission

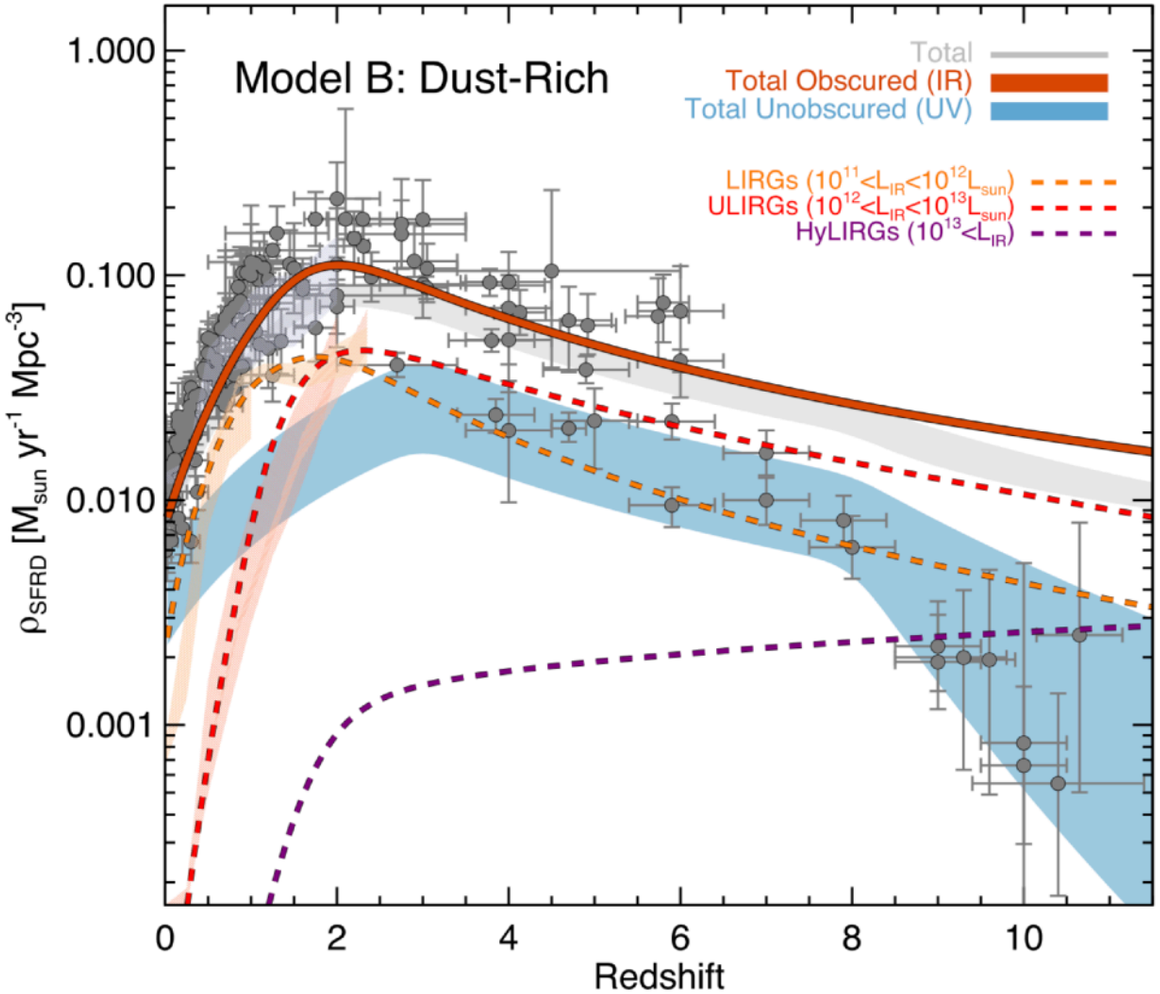
Obscured Star Formation



(Casey et al. 2018)

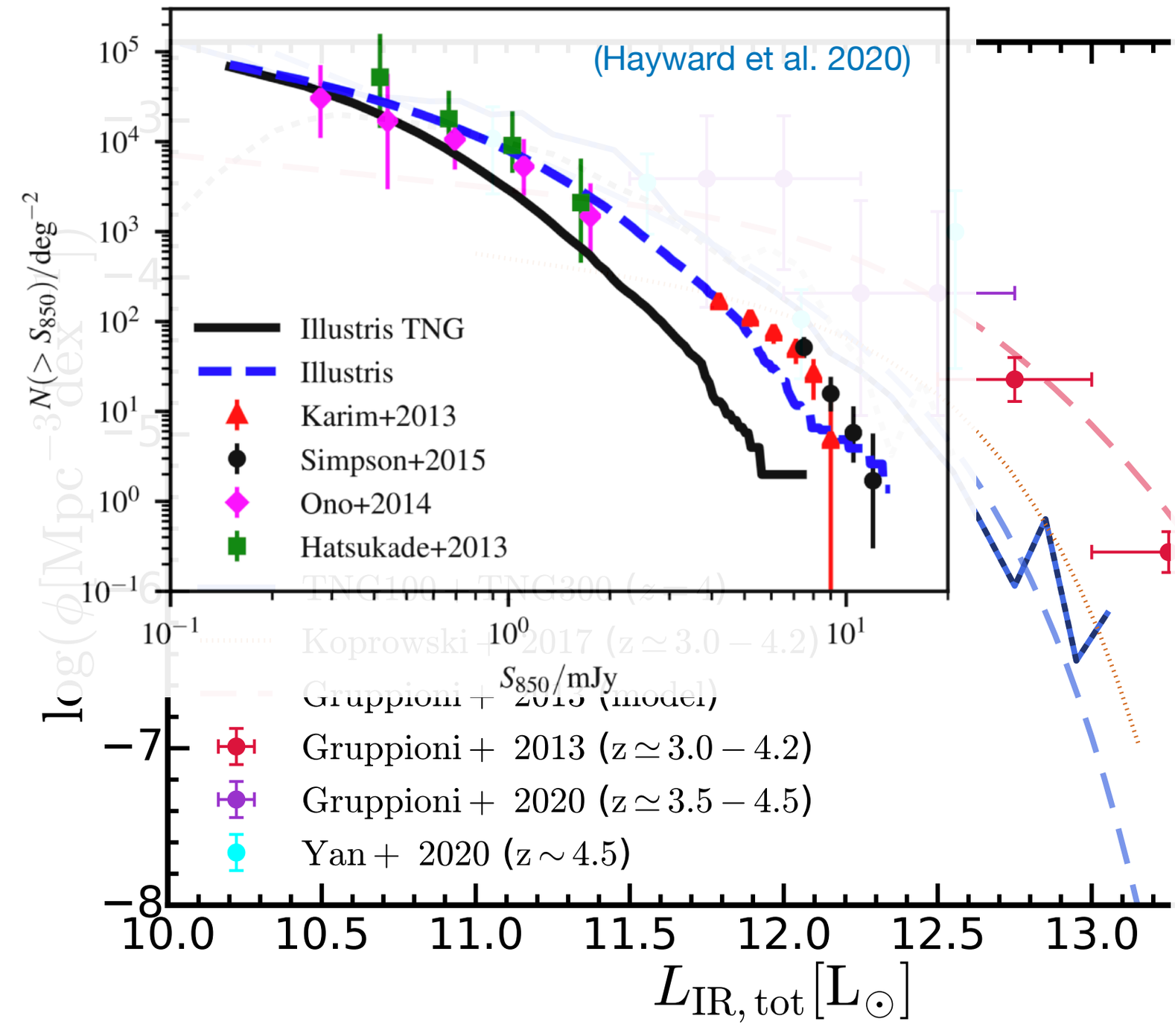
- Obscured star formation (in IR) dominates at low redshift
- The star formation in IR becomes quite uncertain at z>~3 when IR observations become incomplete

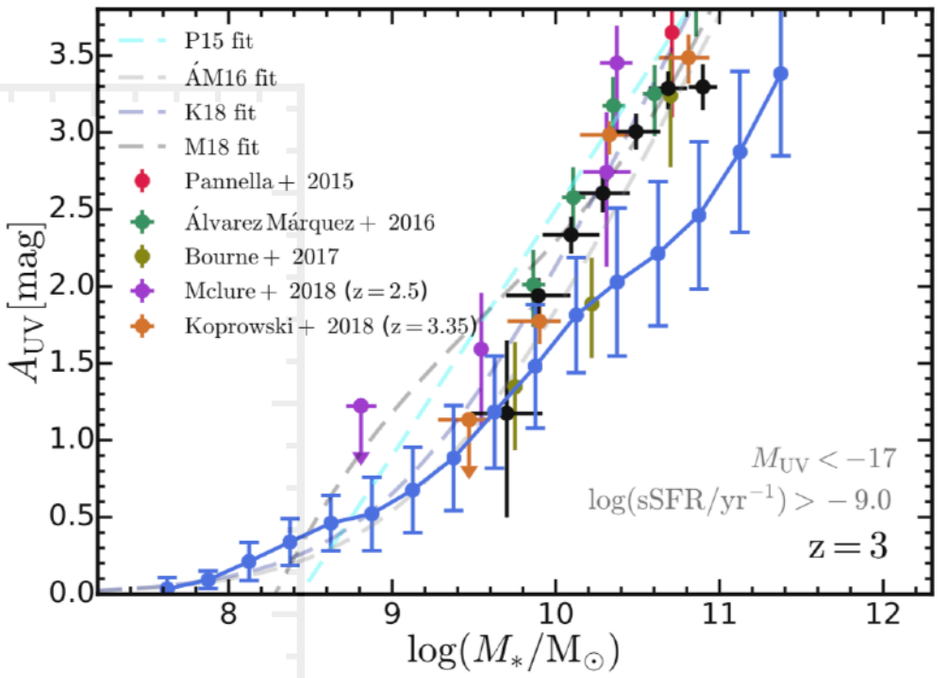


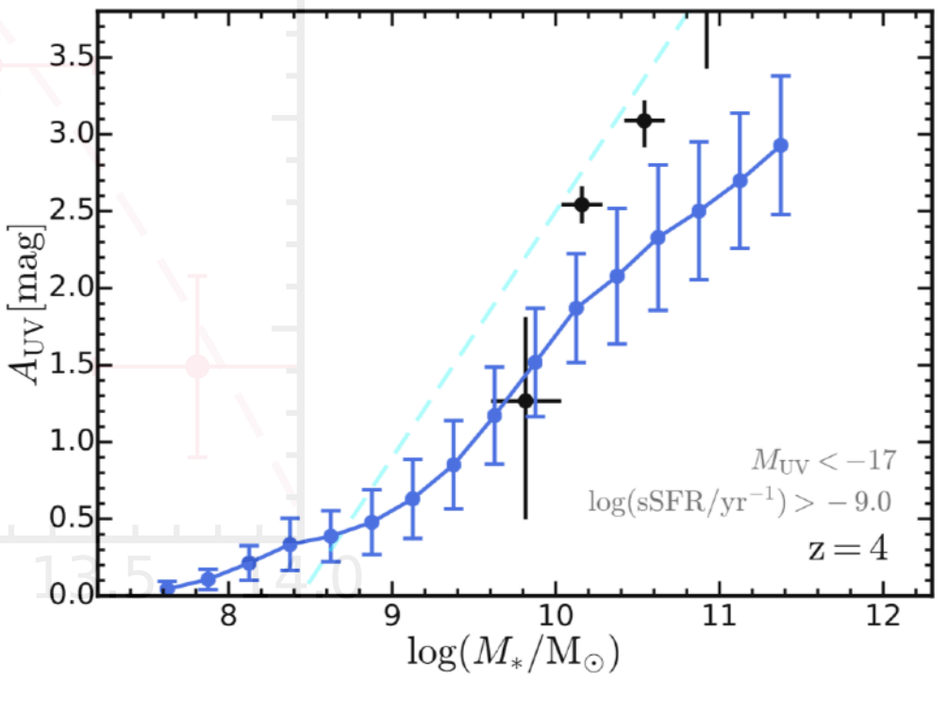


FIR luminosities as proxy for star formation

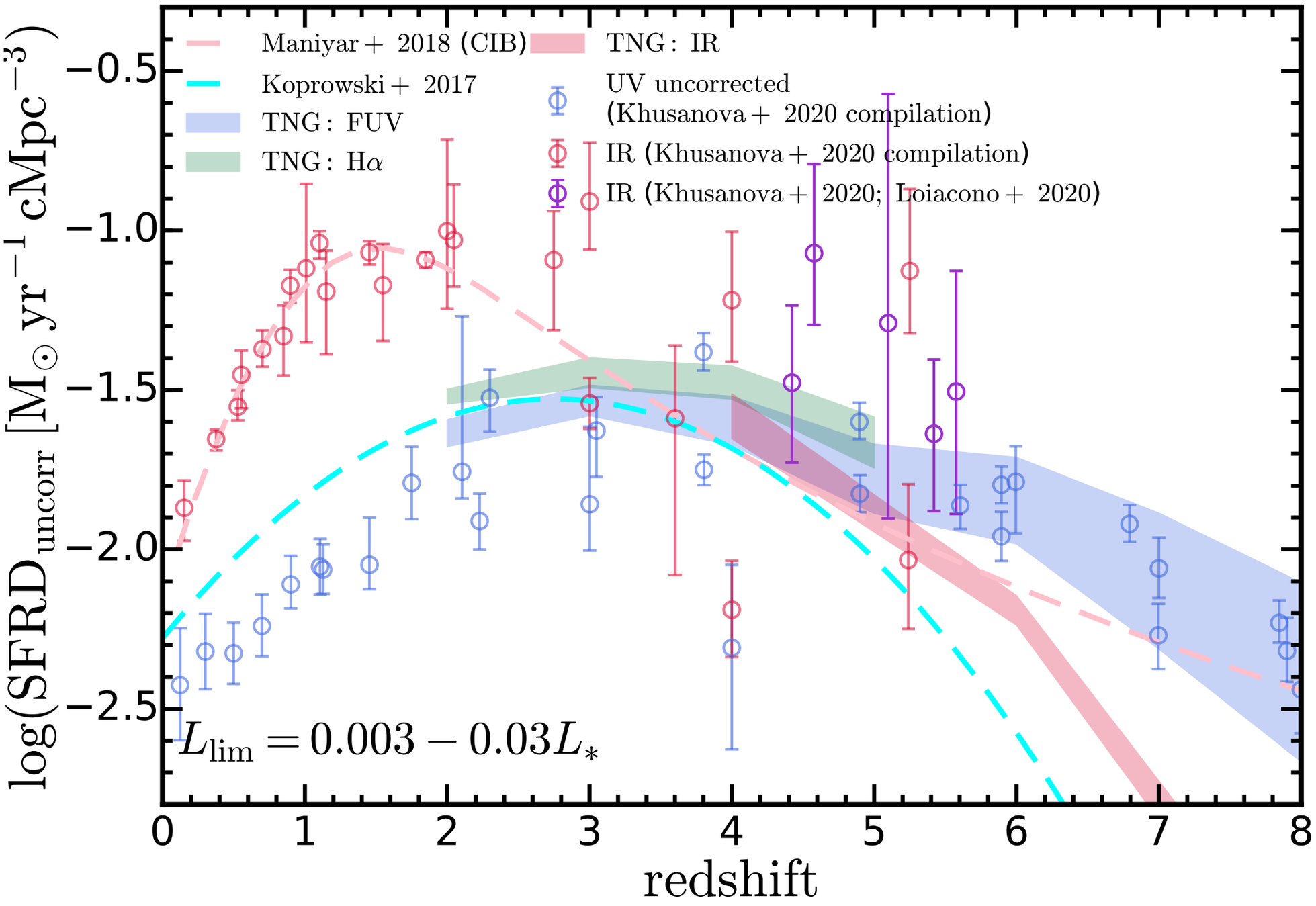
- Under-prediction of the most luminous IR galaxies (ULIRGs,HyLIRGs) at high-z
- Similar under-prediction has been reported in previous study of submillimeter galaxy counts from TNG







FIR luminosities as proxy for star formation



- SFRD(UV) consistent with observations
- Lower SFRD(IR) predicted at 4<z<6 compared to recent IR observations (related to the under-prediction of most luminous IR galaxies)

Thanks!