GAMA survey at the AAT
Exploring star formation in the local Universe

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ASTRO 3D

AAT 50th Anniversary
1st to 4th October, 2024

THE UNIVERSITY OF SYDNEY

Roadmap

- Introduction to the Galaxy And Mass Assembly (GAMA) survey
- Exploring the evolution of star-forming galaxies:
  - ★ GAMA Hα luminosity functions & their parameterisations
  - ★ Exploring the cosmic star formation history over the past 4 Gyrs
  - ★ Bivariate luminosity functions (e.g. Hα versus stellar mass)
  - ★ Enhancement of star formation in small-scales

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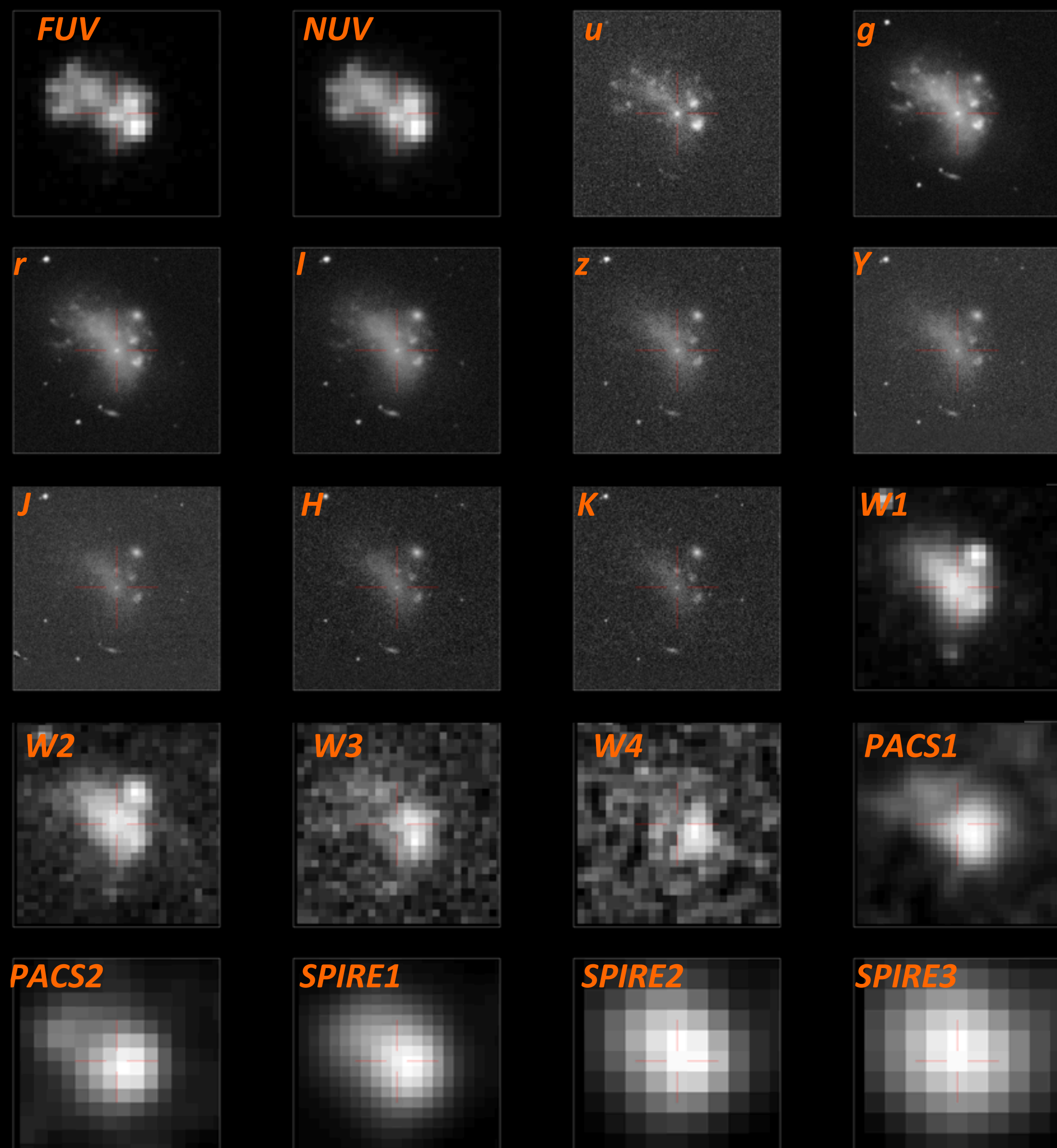
AAT (Image credit: Angel Lopez-Sanchez)

Galaxy And Mass Assembly (GAMA)

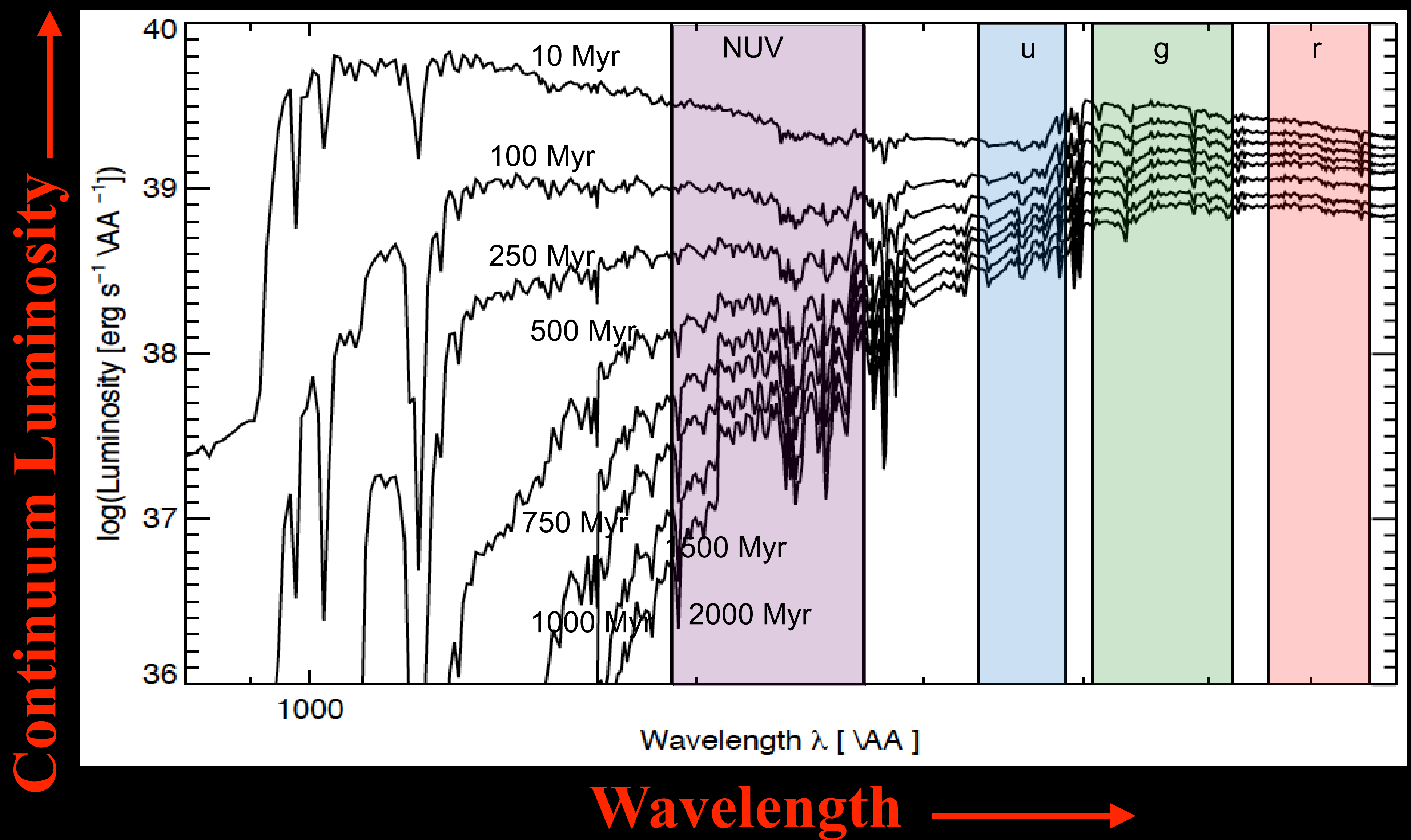


GAMA Galaxy G144491 (z=0.005, r_{AB}=14.08) [GALEX+SDSS+UKIDSS+WISE+HERSCHEL]

- High spatial and redshift completeness
- **20**-band photometry:
  FUV, NUV, ugriz, YJHK, WISE, HERSCHEL (ASKAP, GMRT)
- Data Release I - IV
  S.P. Driver et al., 2011, 2022

  See the GAMA website:
  http://www.gama-survey.org/
- Spectroscopic analysis
  - A.M. Hopkins et al., 2013, MNRAS, 430, 2047
  - M.L.P. Gunawardhana et al., 2011, 2013, 1015, MNRAS
- Stellar masses
  - E.N. Taylor et al., 2011, MNRAS, 418, 1587

Star formation timescales



- PEGASE view of the evolution of continuum luminosity for a galaxy with continuous star formation, which was truncated at ~10 Myr

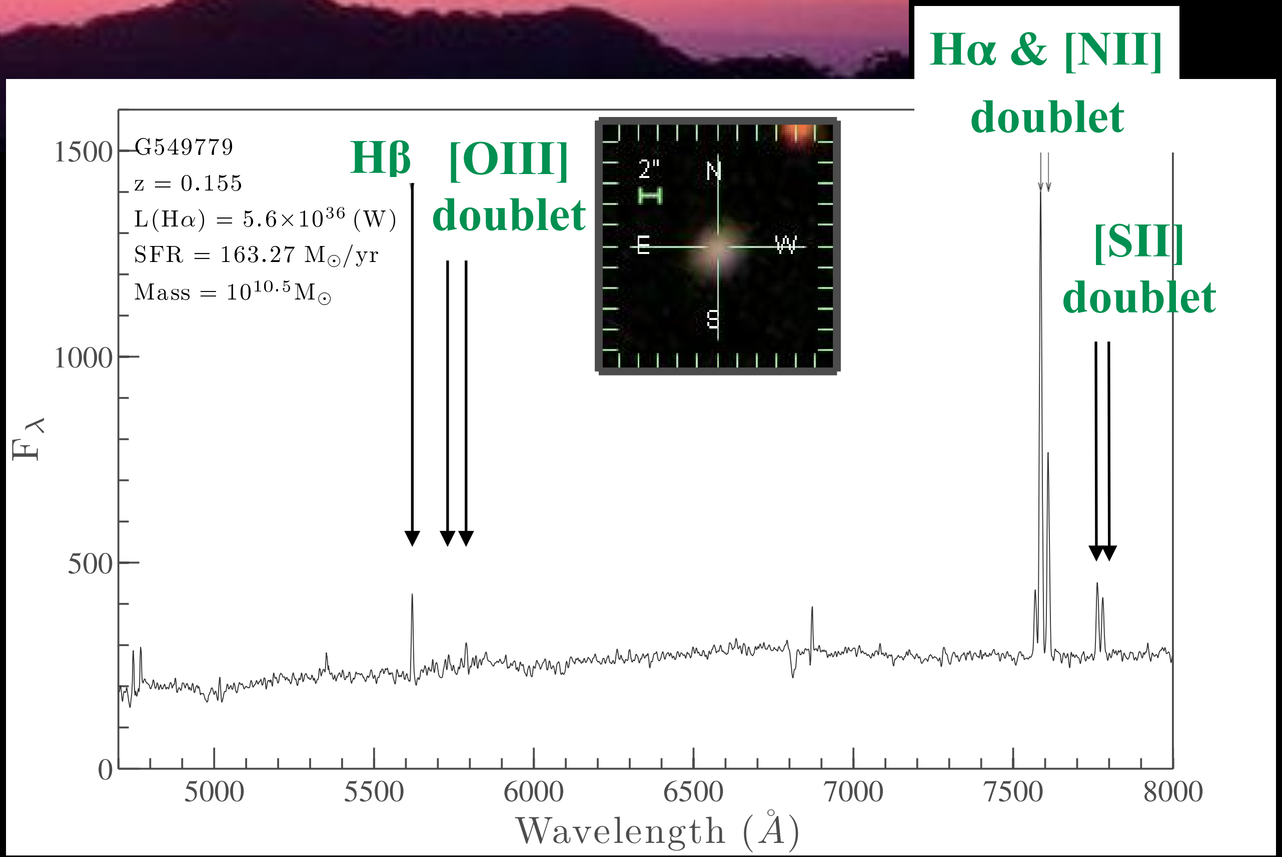
The advantages of having spectra…

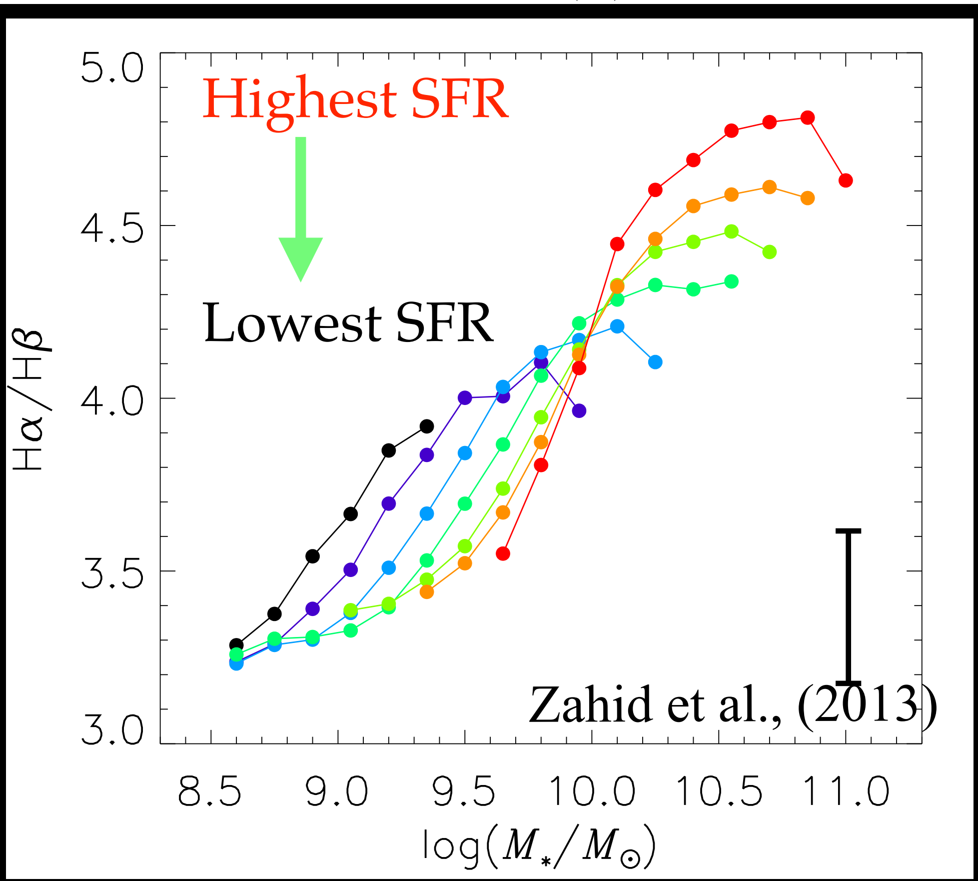
- Dust obscuration based on the ratio of Balmer lines (Hα/Hβ)
- Active Galactic Nuclei/Star-forming selection is based on emission line ratio diagnostics (i.e. BPT)
- The GAMA star-forming sample covers:

SFR → **$0.01 < SFR\ [M_\odot\ yr^{-1}] < 100$**

stellar mass → **$10^7 < M/M_\odot < 10^{12}$**

Redshift → **$z \lesssim 0.35$**



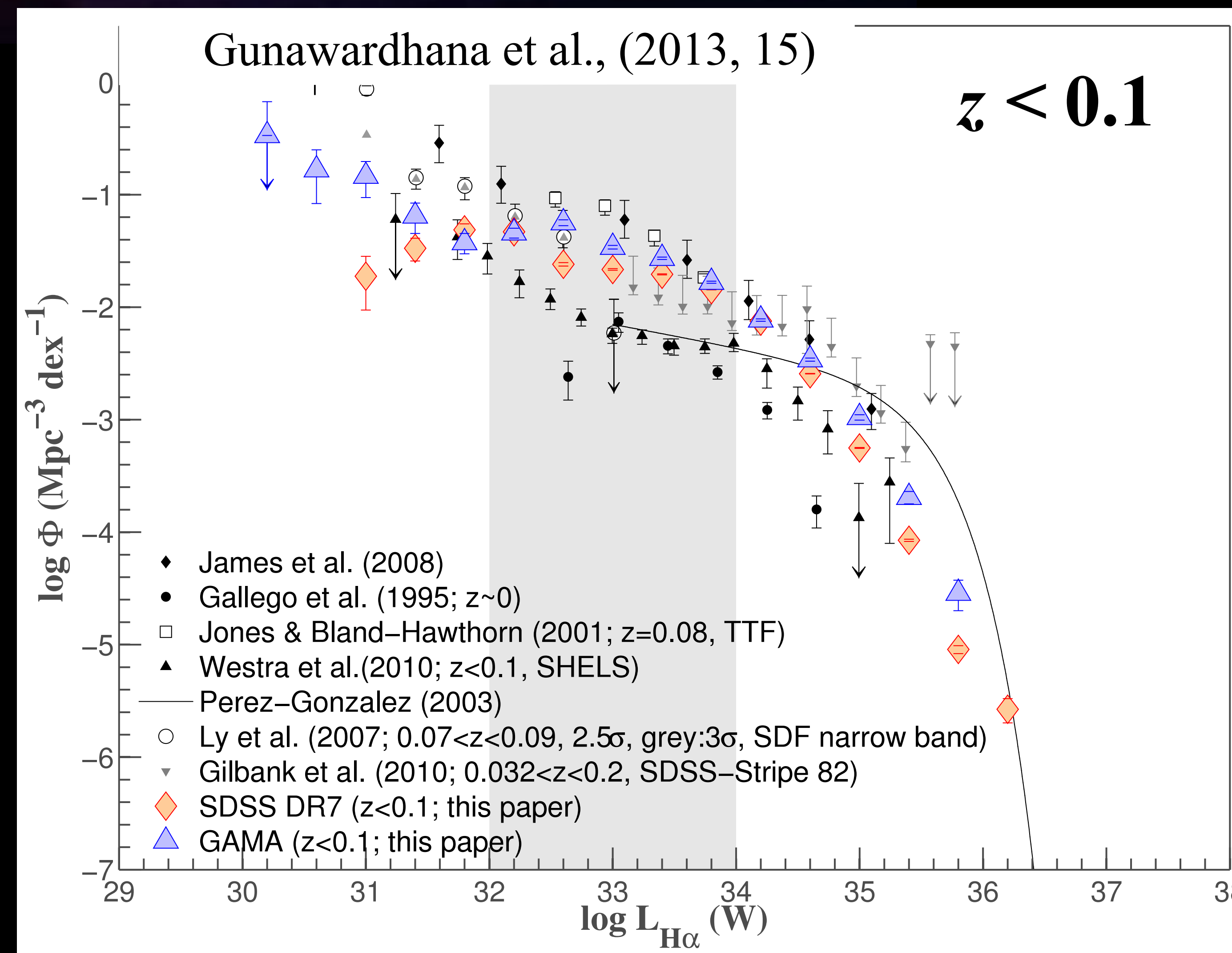


Hα Luminosity functions

- Depth, sky coverage and completeness (spectroscopic and spatial) are key in exploring the evolution of star formation through statistical studies

- The z<0.1 LF samples a wide range in luminosity and extends about one magnitude in luminosity towards both fainter and brighter luminosities

Number Density



Hα Luminosity

- For GAMA:

Depth ⟶ **19.8 in *r*-band mag.**

Coverage ⟶ **~144 sq. degrees (equatorial fields)**

Completeness ⟶ **~98.5% in redshift (equatorial fields)**

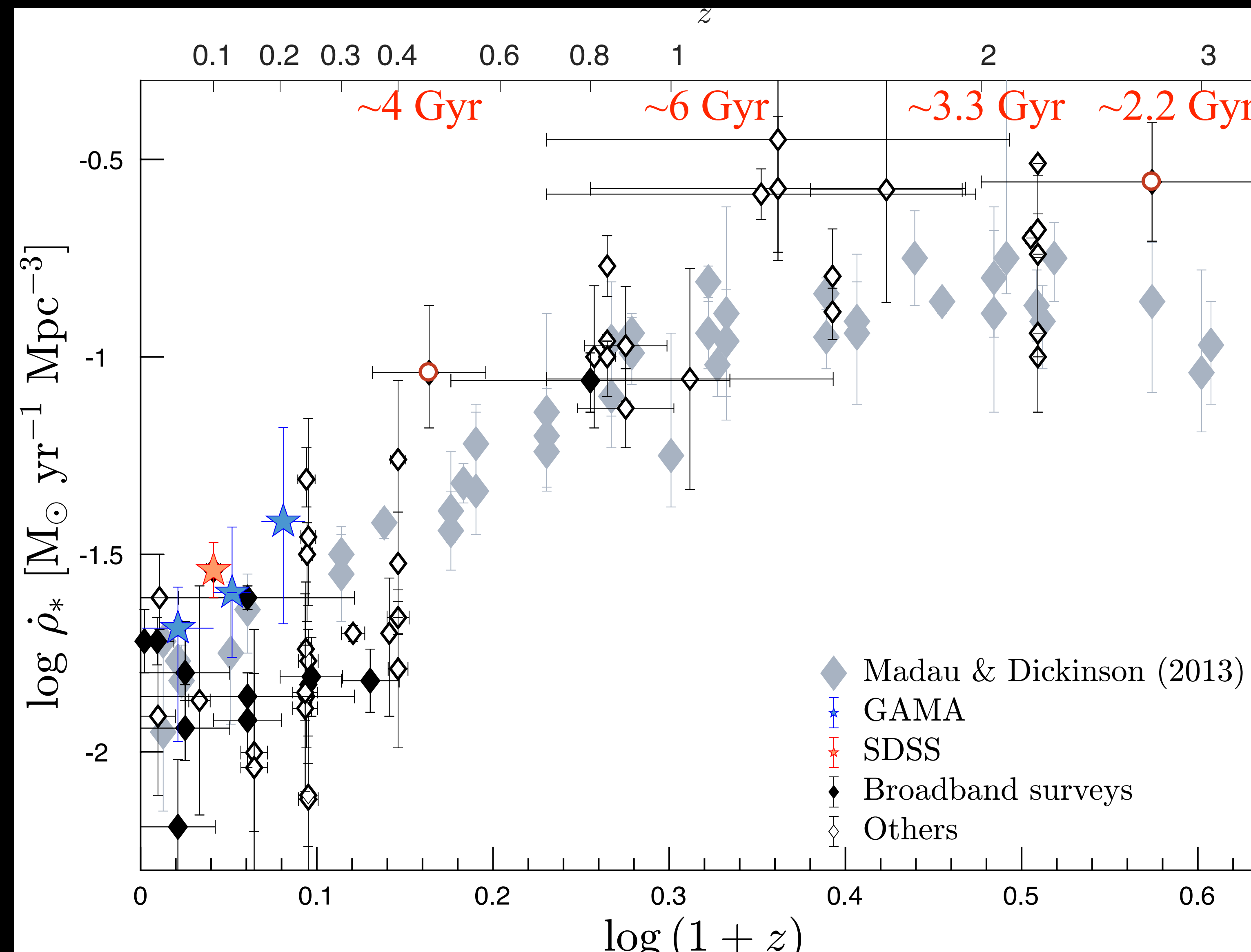
Star formation in the Local Universe

- Cosmic star formation history as probed by different star formation rate indicators
  - Nebula emission lines: [OII], [OIII], Hα, Hβ
  - Photometric measures: UV, mid-IR, far-IR, radio)

- With GAMA, we were able to constrain the star formation rate density over the last 4 Gyrs of cosmic history

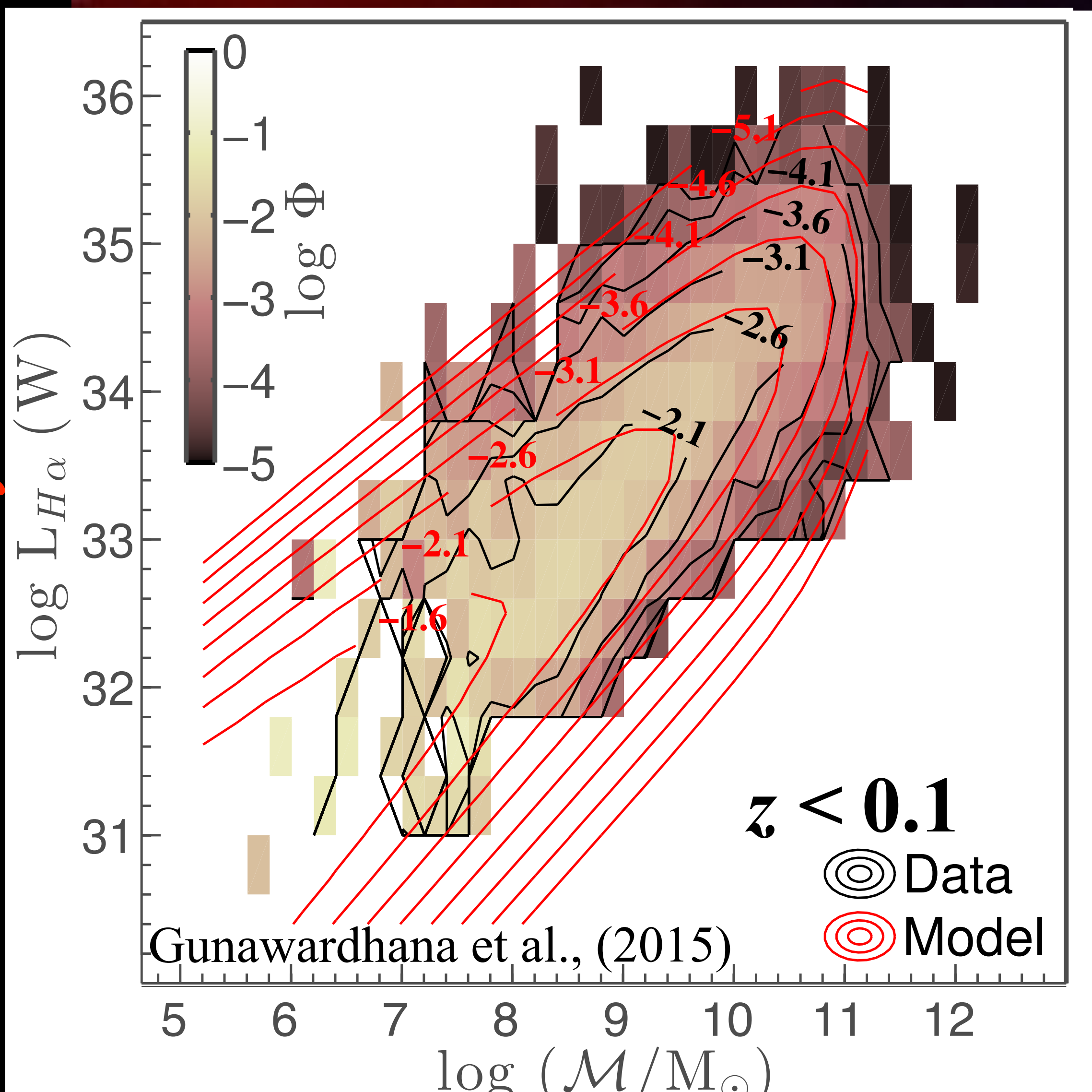
Redshift →

Star formation rate density →



Gunawardhana et al., (2013, 15)

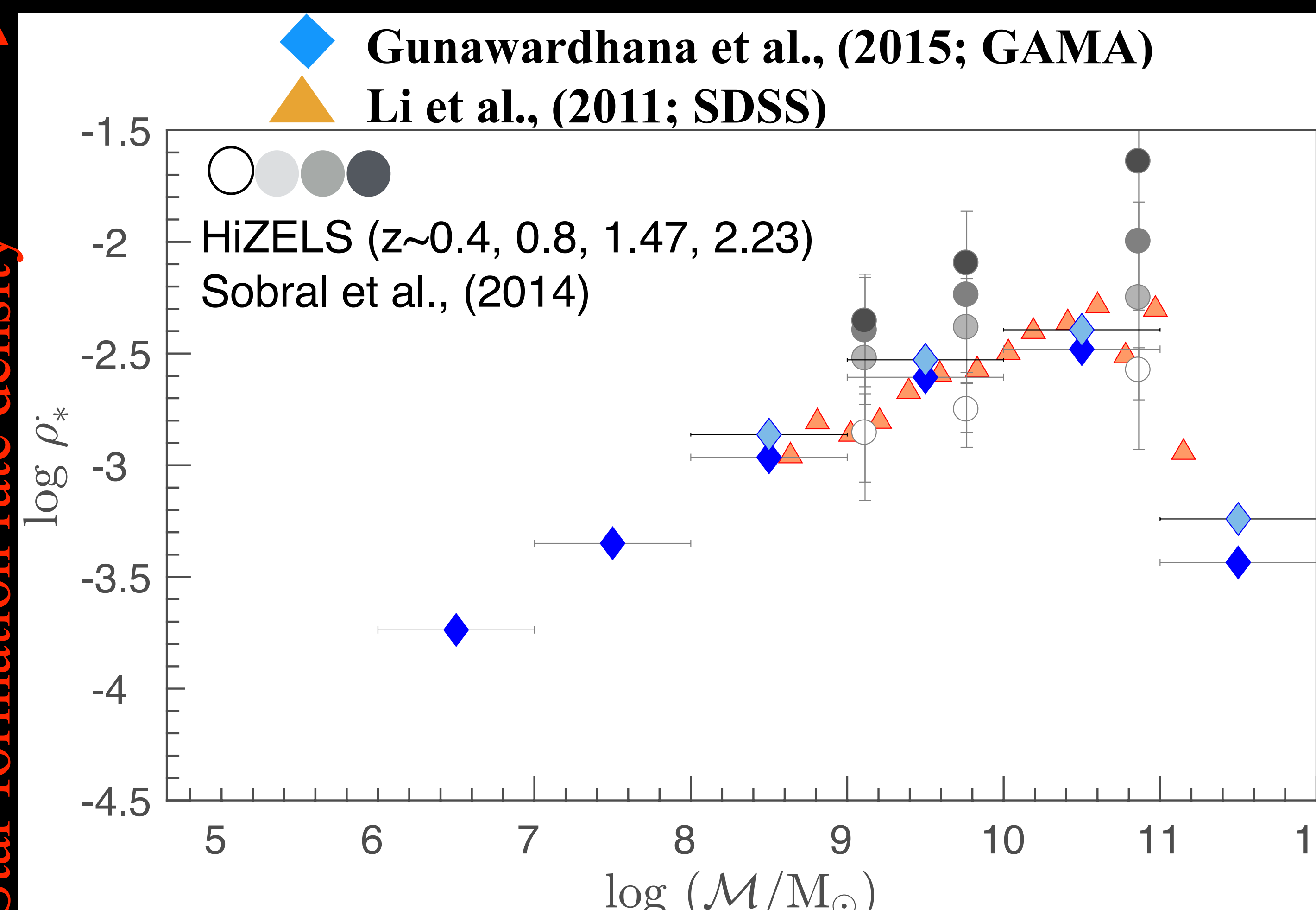
The mass dependence of star formation



Hα Luminosity

Stellar Mass

- Bivariate Hα - stellar mass function, exploring the stellar mass dependence of star formation rate density

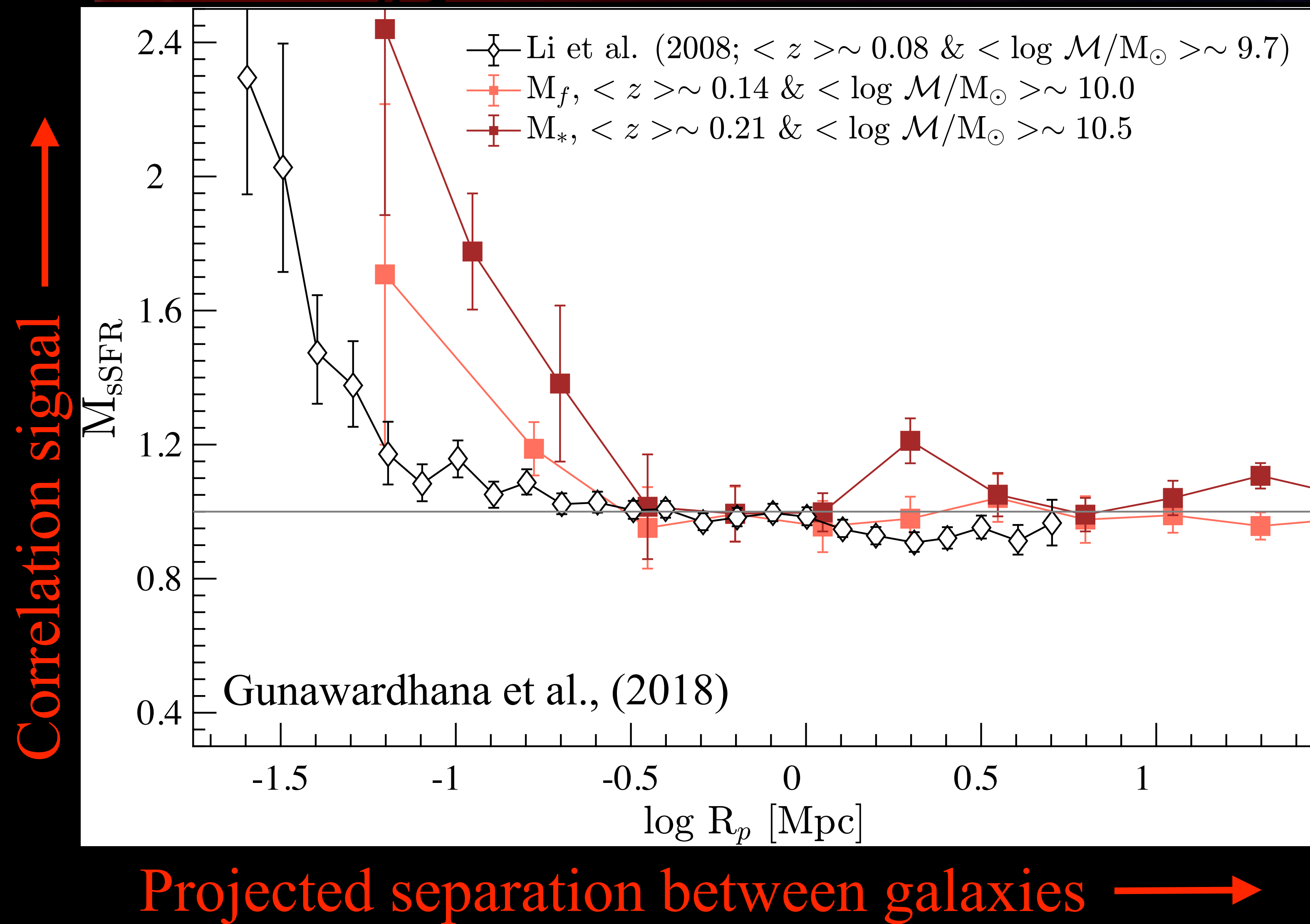


Star formation rate density

Stellar Mass

- The contribution to SFR density progressively increases with increasing stellar mass

Star formation on sub-Mpc scales



- Very close pairs can show greatly enhanced star formation, but it can be dust obscured
- In the local Universe, the enhancement in specific SFR at close separations shows a dependence on the optical brightness of galaxies

- Surveys with very high spatial completeness are needed to study the fraction of star formation taking place in mergers with redshift.

Summary

- Star formation in galaxies follows a Gaussian-like (or two-power law) distribution, **NOT** a Schechter function (i.e. an exponential decrease)

- GAMA Hα luminosity functions confirm this, making Hα consistent with other wavelength estimators of SFR, such as IR and radio.

- Bivariate selection influences **ANY** star-forming sample drawn from a magnitude-limited survey. As a consequence, the resulting SFR densities can be underestimated.

- One way to correct this is to model the bivariate distribution

(Image credit: Jesse van de Sande)