# Metallicity in context

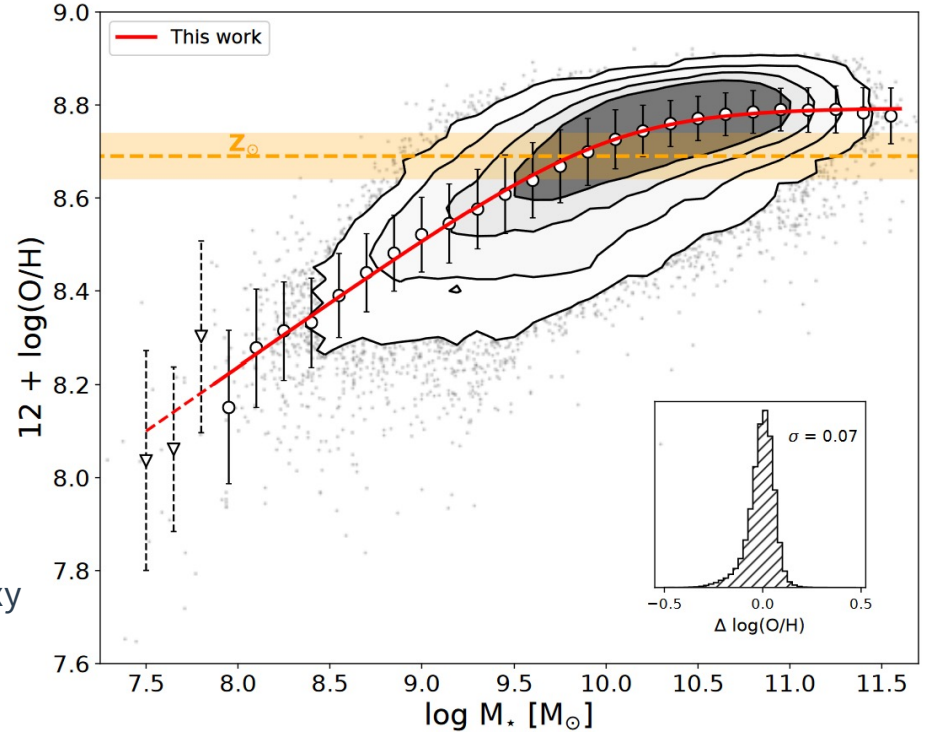
A complete view of gas metallicity in galaxies 6 Gyr ago

# Gas metallicity

We can use emission lines to measure gas metallicity.
There are many methods, with large systematic differences
(Kewley et al. 2019, Maiolino & Mannucci 2019)

All methods yield a strong correlation between stellar mass
and gas metallicity (see figure), which poses constraints to
galaxy formation models (Tremonti et al. 2004, Curti et al. 2019).

Deviations from the mass-metallicity relation help constrain
complex (and otherwise hard-to-detect/constrain) phenomena driving galaxy
evolution  such as gas accretion, outflows and efficiency of star formation
(Mannucci et al. 2010, Hwang et al. 2018)

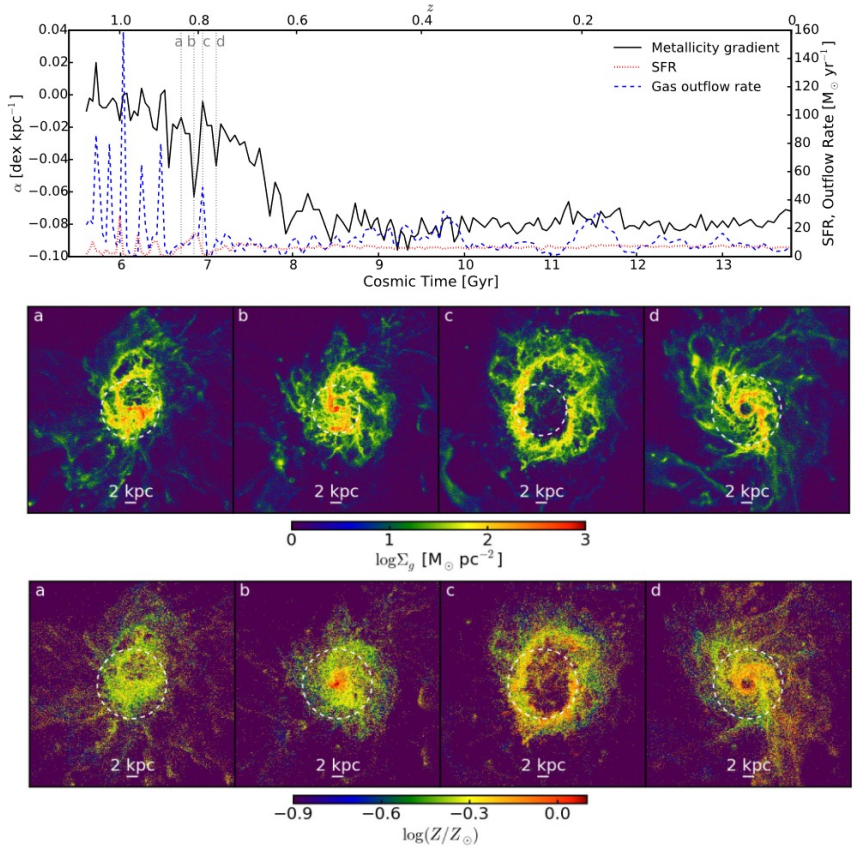



[Adapted from Curti et al. (2019)]

# Beyond the local Universe

A large number of surveys has measured metallicities beyond the local Universe (e.g. zCOSMOS, KBSS, KROSS)
This poses further constraints to galaxy formation: for example, the presence/absence of radial metallicity gradients as a function of cosmic time (see figure; Ma et al. 2017, Curti et al. 2020)

However, no high-z study has ever related the gas metallicity to the stellar population properties of galaxies,
because stellar population properties
are much harder to measure beyond the local Universe.



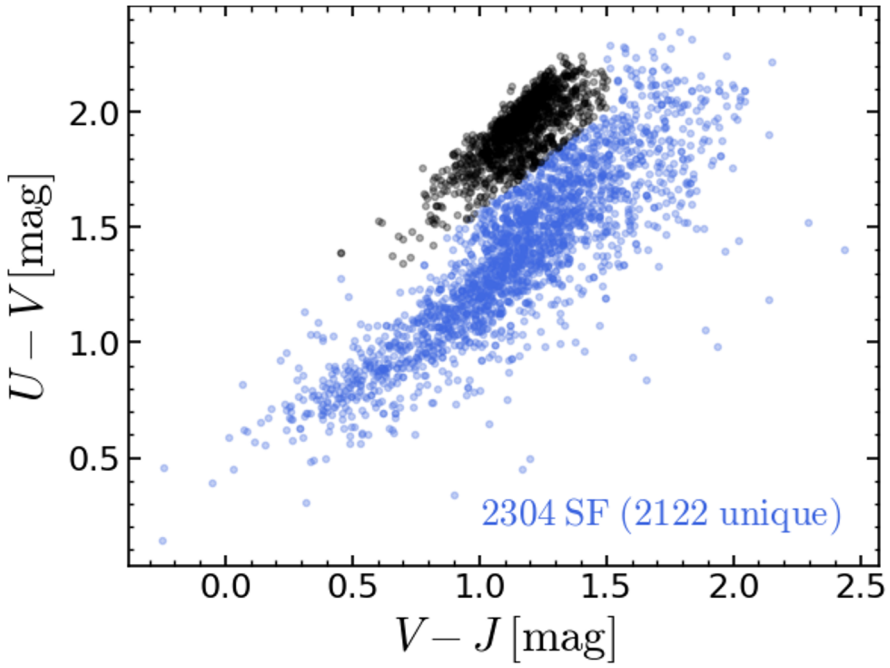

Metallicity gradient vs cosmic time from Ma et al. (2017)]

# The LEGA-C Survey – a census of z=1 galaxies

The Large Extra-Galactic Astrophysics Census (LEGA-C, van der Wel et al. 2016, 2021) provides a comprehensive view of L* galaxies in the epoch when the Universe was only half its current age.

Half of the stars in the Universe today formed between z~1 and present.

LEGA-C is the first large survey (3K+ targets, 2K+ star-forming) to provide absorption-line spectroscopy beyond the local Universe. This gives us access to information about the stellar kinematics and stellar populations of galaxies at a large look-back time.



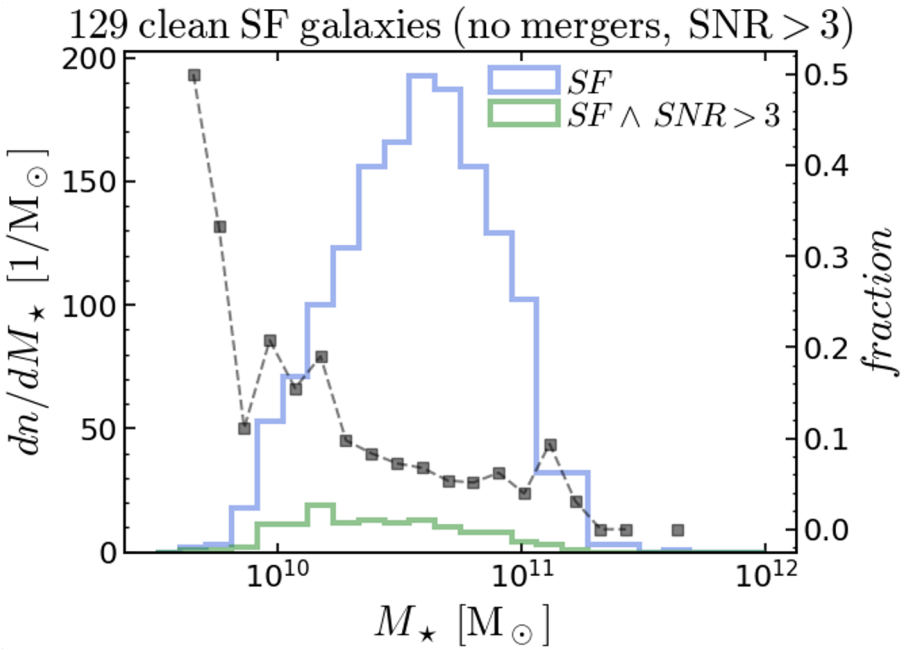

LEGA-C provides a very broad range of ancillary data: HST photometry (morphology, size, shape), broadband photometry (stellar masses, star-formation rates, colours) emission-line fluxes and kinematics, local environment, as well as stellar kinematics and absorption line indices

# Gas metallicity with LEGA-C: advantages

Unlike other surveys, LEGA-C does not survey galaxies based on their output S/N: **all** galaxies selected for the primary sample have measured stellar velocity dispersion (97% success rate)

This means the line fluxes from LEGA-C are representative of the actual galaxy population

Selecting based on the line S/N, we find only mildly varying detection fraction with mass (see figure).



# Gas metallicity with LEGA-C: challenges

These measurements come with their own challenges:

- the sample size is small compared to other surveys
- the range of emission lines available is reduced
- dust correction is particularly problematic due to the lack of Halpha
- aperture corrections may be needed

# Outline of the project

- Measure the emission line in the Lega-C spectra (these have already been measured,
  but some galaxies may require re-measuring (and this would anyhow be useful to expand
  your expertise and to have a better ideas of potential issues associated with line flux measurements)
- Determine the gas metallicity by using strong line metallicity calibrations developed by our team
- Compare with the various stellar population properties inferred by the Lega-C team and
  derive scaling relations
- Infer any evolution with redshift
- Compare with expectations of models and of cosmological simulations (e.g. Debora's team)