The metallicities of galaxies
in the Herschel Reference Survey

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Overview

In our recent work, we found strong correlations between the stellar mass, metallicity and gas content in galaxies. At fixed stellar mass, gas-deficient galaxies are typically more metal-rich than their gas-rich counterparts. However, strong metallicity gradients may bias global metallicity estimates derived from integrated spectra. We are now working on a pilot project to measure metallicity gradients for a sample of twenty nearby galaxies drawn from the Herschel Reference Survey. Our sample is representative of normal, star-forming spiral galaxies. We have obtained optical spectroscopic observations using the Very Large Telescope with the FORS2 instrument in multi-object mode, targeting individual HII and star-forming regions across the galaxy discs. From the ratios of the strong emission lines, we estimate the local gas-phase oxygen abundance and construct metallicity gradients. Combining these new data with Herschel PACS/SPIRE far-infrared photometric observations and maps of the HI 21 cm line emission, to trace the dust content and cold gas respectively, will allow the study of the relationships between stars, gas, dust and metals on sub-kiloparsec scales.

1. The Herschel Reference Survey

The Herschel Reference Survey is a magnitude- and volume-limited sample covering 323 nearby galaxies in a range of environments, from isolated systems to Virgo cluster members (Boselli et al. 2010).

Sample selection criteria:

• 15 - 25 Mpc volume limit
• 2MASS K_s < 12 mag
• Galactic latitude > ±5°
• Extinction A_V < 0.2

Ancillary data is complete for:

• H, B & V photometry ~ stellar mass
• NUV GALEX imaging ~ SFR
• HI 21cm ~ HI gas mass
• Drift-scan spectra ~ metallicity

We estimate global oxygen abundances from the ratios of the most prominent optical lines via the relations of Kewley & Ellison (2008).

2. Stellar mass, metallicity and gas relations

We study the role of gas in shaping the mass – metallicity relation, adopting a gas fraction equal to HI mass / (HI mass + stellar mass).

HI deficiency is:

the difference between the observed HI mass and that expected for an isolated galaxy of similar size and type.

Blue circles – Galaxies with normal gas content
Red circles – Gas deficient objects, i.e. galaxies missing up to 70% of their gas compared to healthy isolated systems.

3. Why do cluster galaxies have enhanced metallicities?

Metal enhancements in HI deficient galaxies may arise from a selection effect. Gas stripping by the environment will reduce number of observed HII Regions since there is less fuel for star formation.

Only HII regions within the stripping radius will contribute to the observed spectra, where gas remains as fuel for new stars to continue to be created. Galaxies with strong metallicity gradients thus appear more metal rich.

Metallicities “before” and “after” gas stripping are compared by integrating the luminosity-weighted metallicity profiles from Skillman et al. (1996).

4. VLT / FORS2 subsample

We obtained 32 hours of optical spectroscopic observations using the Very Large Telescope with the FORS2 instrument in multi-object mode (P.I.: L. Cortese), targeting individual HII and star-forming regions across the discs of twenty, face-on spiral galaxies in the HRS.

5. VLT / FORS2 MXU observations of HRS 319

For each slit position, we simultaneously cover the wavelength range between 3500Å and 7000Å, including the Hα, Hβ, [OIII], [OIII], [NII] and [SII] emission lines, with R=1000.

References:


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