The chemical evolution of gas and stars in MaNGA galaxies

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1 One metallicity to rule them all?

The levels of heavy elements in stars are the product of **enhancement by previous stellar generations**. The **distribution** of this **metallicity** among the population contains clues to the process by which a galaxy formed.

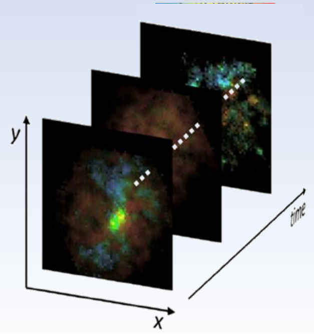
There is more to life than one single metallicity value per galaxy. We need to find the **metallicity distribution** to characterise the **stars** within galaxies, and also the **gas from which these formed**.

2 MaNGA and STARLIGHT

MaNGA is an integral field spectroscopy survey that provides **high-quality spatial and spectroscopic resolution** for over 10 000 low-redshift galaxies.

Gas-phase metallicities are determined by measuring emission lines from these spectra.

Stellar metallicities are found using the full-spectrum stellar population fitting code STARLIGHT (Cid Fernandes+05; Peterken+20).



3 The G-dwarf problem

In Greener+21, we investigate the "**G-dwarf problem**". The small number of metal-poor G-dwarfs in the Milky Way is **inconsistent with the picture of the Galaxy forming from a closed box of gas** (Fig. 1, blue line). It can be resolved by allowing the Galaxy to **accrete gas** over time (Fig. 1, red line).

4 Is our Galaxy atypical?

We make equivalent measurements for a large sample of spiral galaxies – see Fig. 2.

High-mass spirals have **few low-metallicity stars**, implying that the **Milky Way's history of gas accretion is common**. Such galaxies accrete pristine gas, adding this to material enriched by previous generations, producing a larger fraction of high-metallicity stars.

By contrast, **low-mass** spirals show **little sign of a G-dwarf problem**, presenting the metallicity distribution to be expected if such systems evolved as **closed boxes**. Their slower star formation rates thoroughly mix recycled gas between stellar generations.

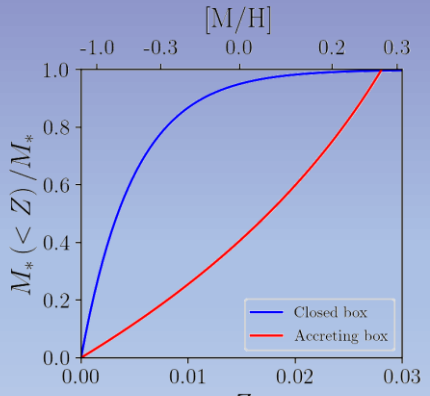


Figure 1

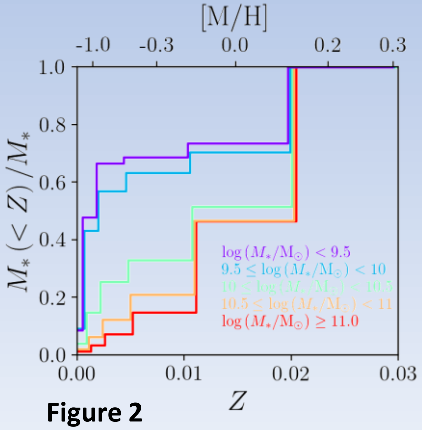


Figure 2

References:
Cid Fernandes R., et al., 2005, MNRAS, 358, 363
Greener M., et al., 2021, MNRAS, 502, 95
Mannucci F., et al., 2010, MNRAS, 408, 2115
Peterken T., et al., 2020, MNRAS, 495, 3387

5 Time evolution

The issue with looking at these distributions is that we ignore how **metallicity has evolved over time**. This is typically **easy to determine for the stars** but **less obvious for the gas**.

For our latest project, we therefore use the fundamental metallicity relation from Mannucci+10 to investigate the **time-evolution of the gas metallicity** (Fig. 3). As a sanity check, we compare the present-day value to the gas metallicity determined from emission lines.

These results confirm that **high-mass galaxies tend to accrete gas over time**, whereas **low-mass galaxies evolve as closed boxes**.

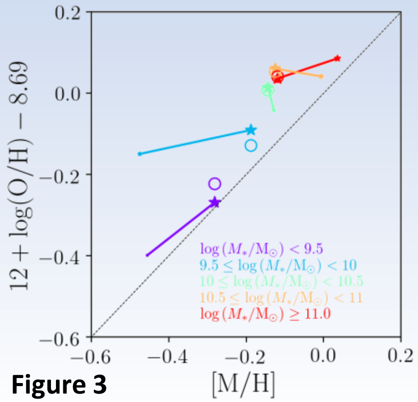


Figure 3