MINIGRANT RSN1

Francesco Belfiore – INAF Arcetri

Towards precision chemical abundances: from the local Universe to Cosmic Noon

Associated INAF projects ("Schede")

PHANGS: Physics at high angular resolution in nearby galaxies (PI: Belfiore)
MetEvol: The evolution of metallicity in the Universe (PI: Mannucci)

Abstract

The introduction of metals into the interstellar medium (ISM) via stellar feedback processes is crucial to the cycle of star formation and therefore the evolution of galaxies. However, there are large systematic uncertainties in our gas-phase metallicity measurements, which plague our understanding of the history of chemical enrichment of the Universe. I plan to address this challenge by drawing on large homogeneous samples of HII regions in the local Universe and using the James Webb Space telescope (JWST) to observe the same optical rest-frame lines in the early Universe. Combined with state-of-the-art models these unprecedented observations will provide precision chemical abundances applicable to the last 11 Gyr of cosmic history.

Key Deliverable

The aim of the proposed project is to compile a vast set of auroral line measurements from local galaxies to galaxies at Cosmic Noon. These datasets will be used to derive a coherent set of metallicity calibrations based on rest-frame optical lines applicable over the last ~10 Gyr of galaxy evolution.

Work Packages

WP1: Auroral line determinations in massive local galaxies with PHANGS.
WP2: Auroral line determination in low-metallicity dwarf galaxies
WP3: Auroral lines with JWST at Cosmic Noon (1.3< z< 3.0)
WP4: Development of new metallicity calibrations based on comparison with photoionization models.

Progress

WP1: The analysis has been carried out and represents the core of the Masters Thesis of Matilde Brazzini, who graduated from UniFI on 26/10/2023. A publication is forthcoming.
WP2: Work has not started.
WP3: Work is starting and will constitute the core of the Master Thesis project of Bianca Moreschini (UnifFI)
WP4: Work in ongoing, in collaboration with the MetEvol team at INAF - Arcetri.
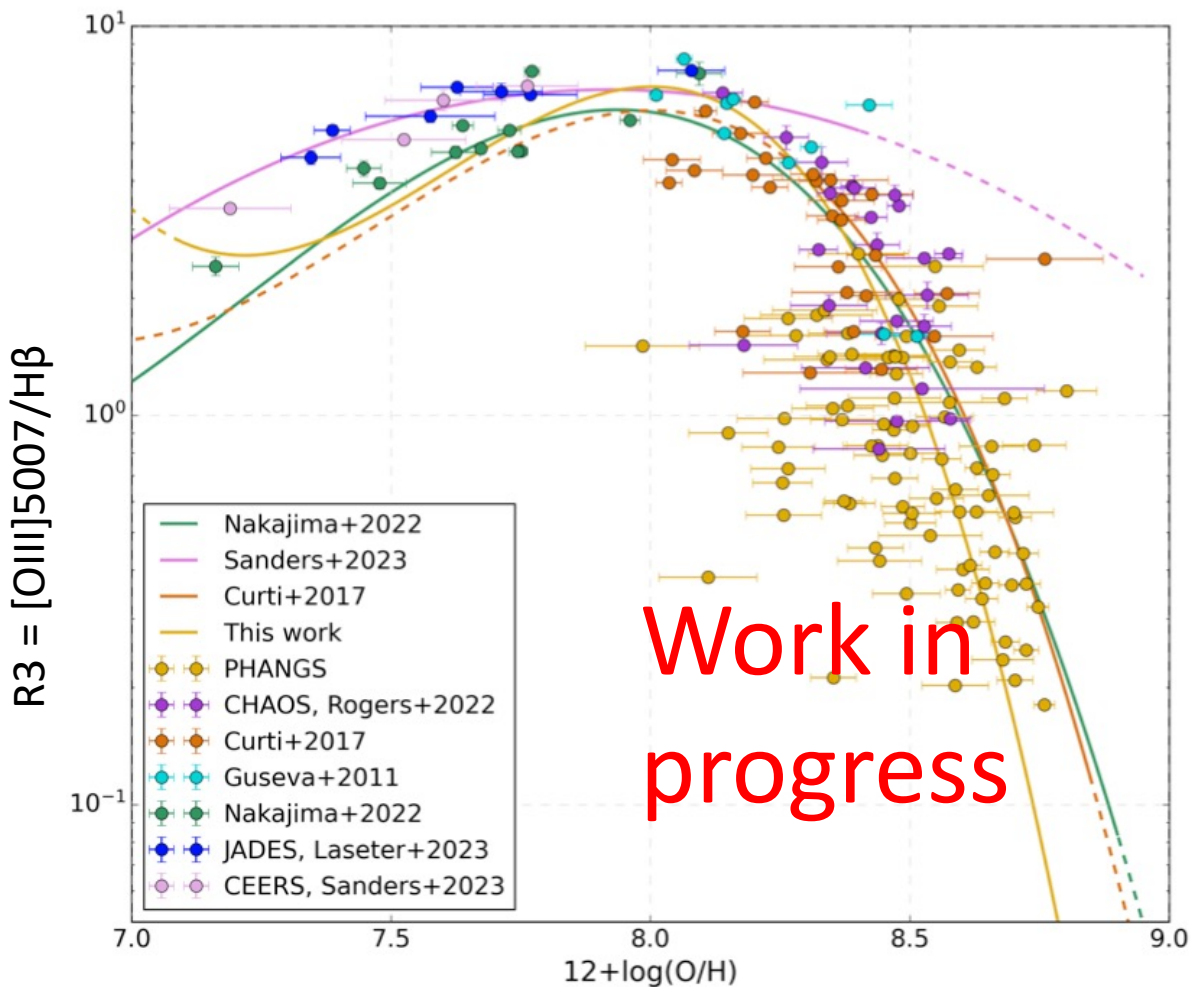
Fig. 1. Calibration of the R3 strong-line diagnostic using both low- an high-redshift data, including newly analysed data from PHANGS. Brazzini, Belfiore et al, in prep

Expenses
Funding is dedicated to participation in the PHANGS team meetings and science activities. PHANGS is a large international collaboration, and I am the only INAF participant. Additional funding is supporting the PI's travel to conference to disseminate these results. An extended visit to Heidelberg to collaborate with the PHANGS team will be scheduled in Q1 2024.

Results
We have started to recalibrate metallicity diagnostics based on the large (and expanding) catalog of auroral line detections (Fig 1).