# Exploring the Galactic Centre Planetary Nebular Populations Within the Fornax Cluster, Using VLT/MUSE Spectrograph.

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## What is a Planetary Nebulae?

$M_\odot$ = 1 Solar mass

Fig. 1

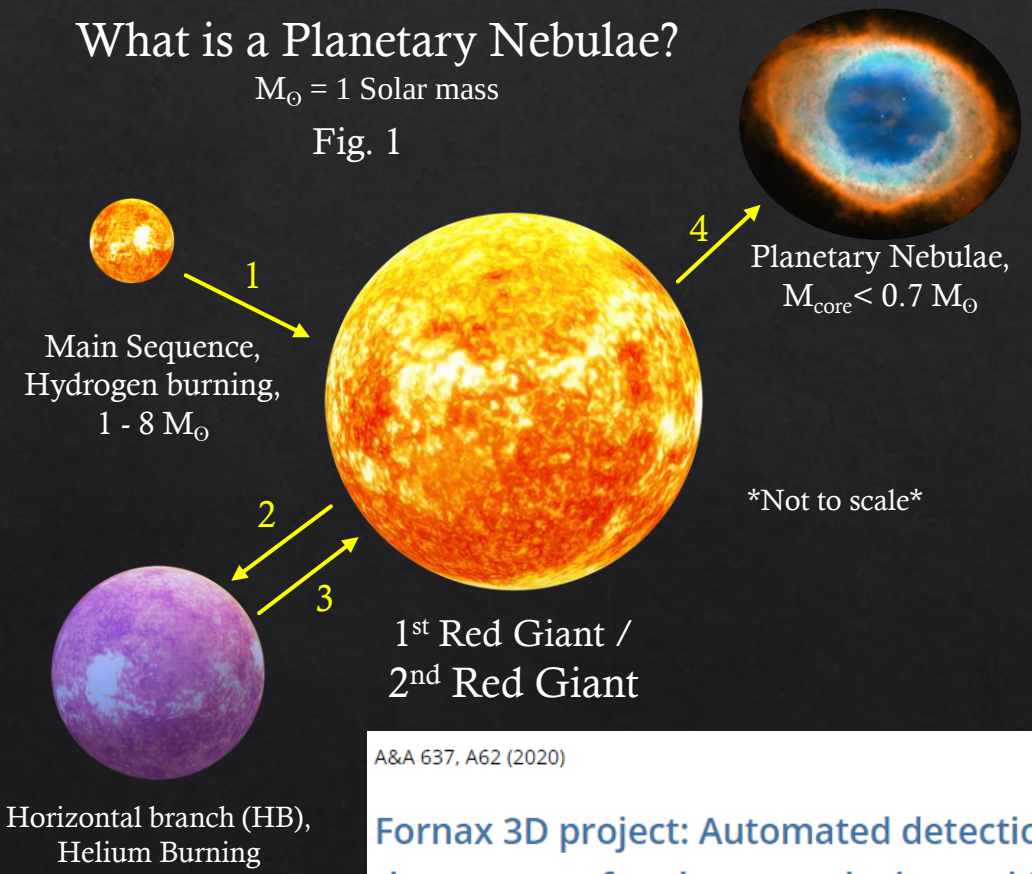
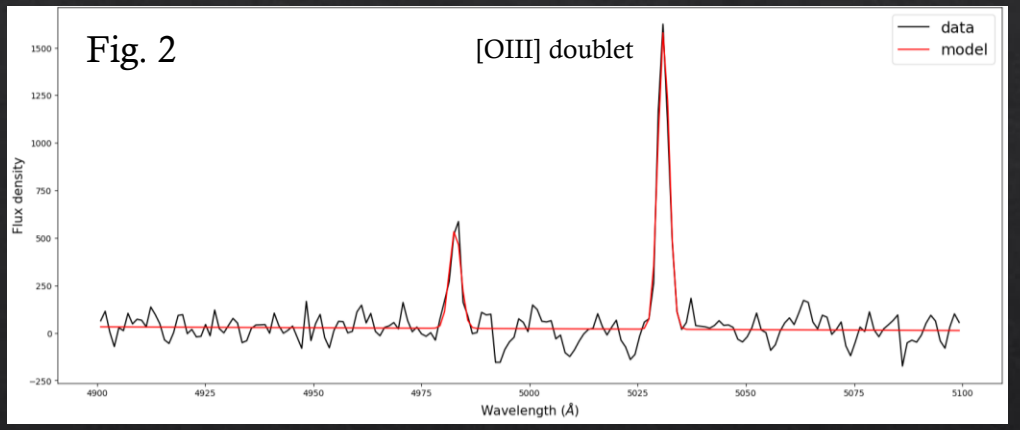



Fig. 2



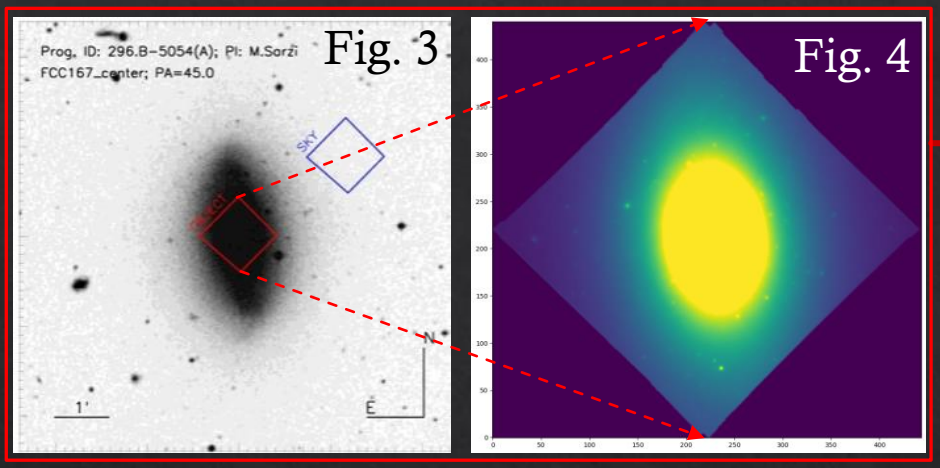

In external galaxies, Planetary Nebulae (PNe) appear as unresolved point source of nebular emission, in particular from the [OIII] 4959,5007 Å doublet from doubly ionised Oxygen.

A&A 637, A62 (2020)

Fornax 3D project: Automated detection of planetary nebulae in the centres of early-type galaxies and first results*

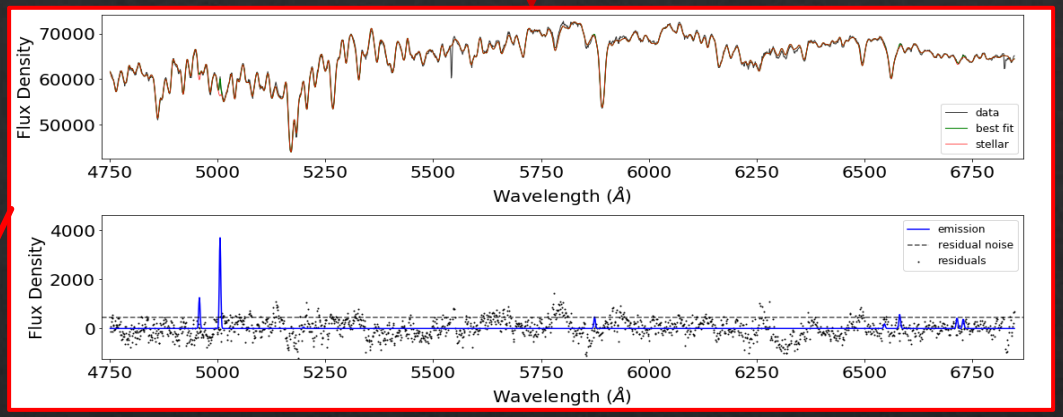
Planetary Nebulae image from: NASA, ESA, and C. Robert O'Dell

# Revealing the Planetary Nebulae Population of Galaxies



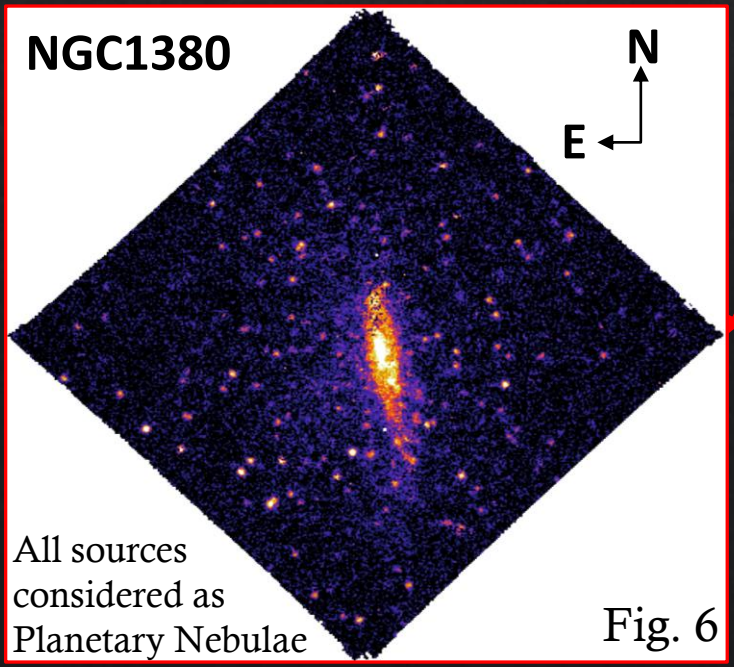

Subtracting stellar light

Fig. 5




Spectral modelling of the MUSE data (top panel) using the pPXF[1] and GandALF[2] codes, revealing the [OIII] emission (blue, lower panel).

[OIII] 5007 Å signal to noise map




PNe are easily detected in the dim outskirts of galaxies, but locating PNe in the central regions where most of them are found, necessitates a careful modelling and subtraction of the galaxy stellar light.

This is possible thanks to our deep integral-field MUSE spectroscopic observation.


1 - Cappellari, M. 2017, MNRAS, 466, 798

2 - Sarzi, M., Falcón-Barroso, J., Davies, R. L., et al. 2006, MNRAS, 366, 1151

# Distances to Other Galaxies

- The Planetary Nebulae Luminosity Function (PNLF) is used as a distance indicator due to the apparent universal nature of the bright end cut-off.
- Ciardullo et al. 1989[4] first introduced an analytical PNLF from M31 observations.
- Converting the brightest apparent magnitude to the calibrated cut-off absolute magnitude, produces a distance modulus to the galaxy:
  - $m_{5007} - M^*_{5007}(-4.5)$ = distance modulus

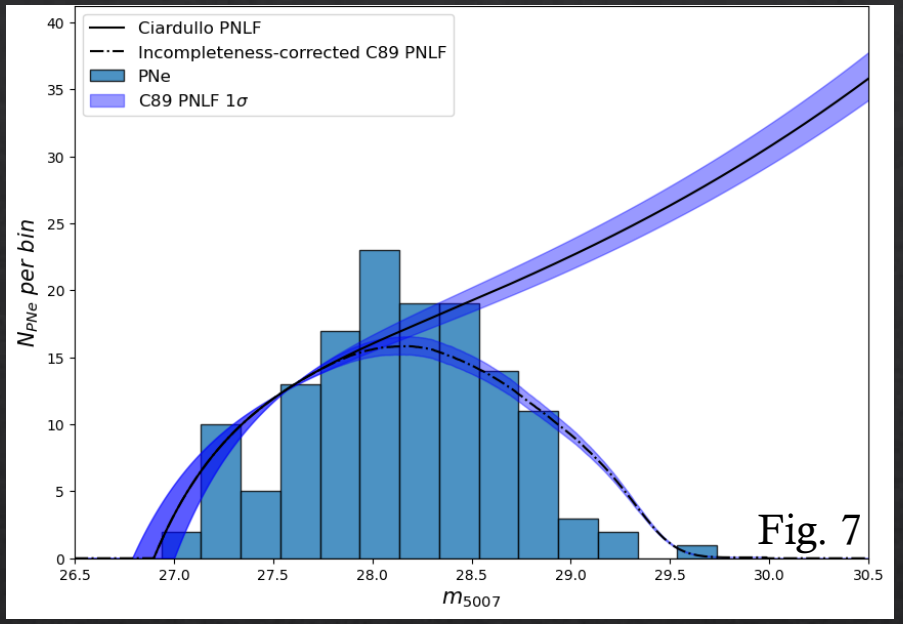


Fig. 7

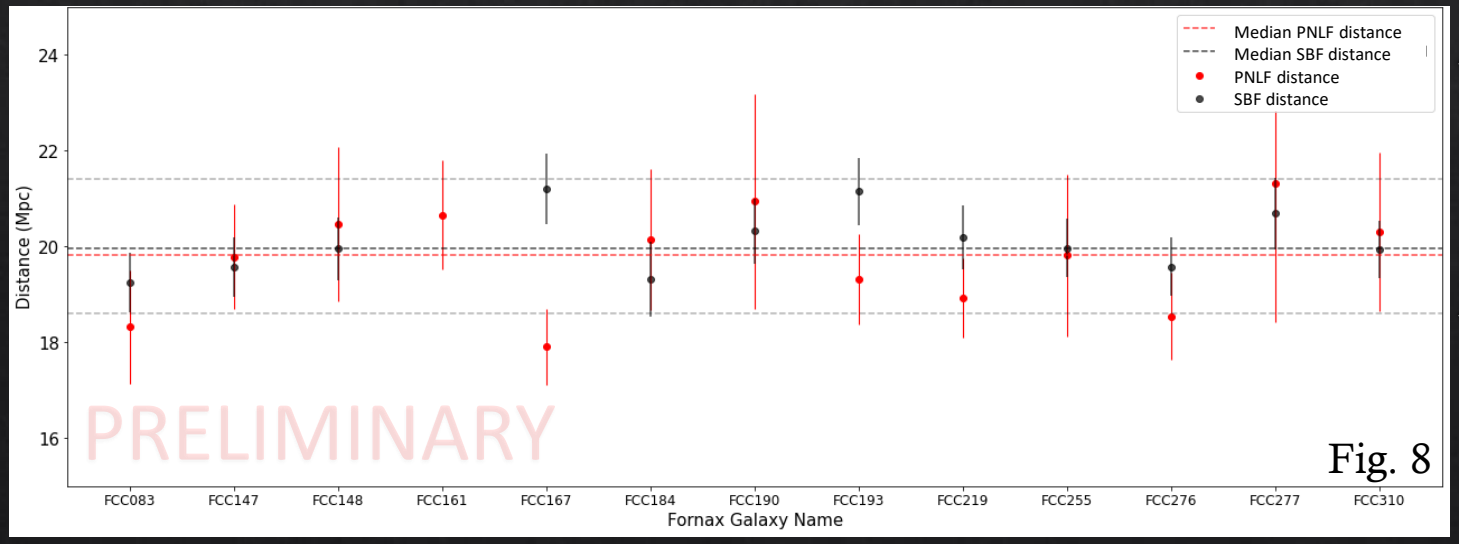


Fig. 8

- Compared to other distance indicators, including:
  - Surface Brightness Fluctuation (SBF)[5]
  - Supernovae type 1a (SNIa)
- PNe distances provide good agreement with distance to the Fornax cluster, some scatter is observed for individual galaxies.

4 - Ciardullo, R., Jacoby, G. H., Ford, H. C., & Neill, J. D. 1989, ApJ, 339, 53

5 - Blakeslee, J. P., Jordán, A., Mei, S., et al. 2009, ApJ, 694, 556

# Does stellar metallicity impact Planetary Nebulae formation rate?

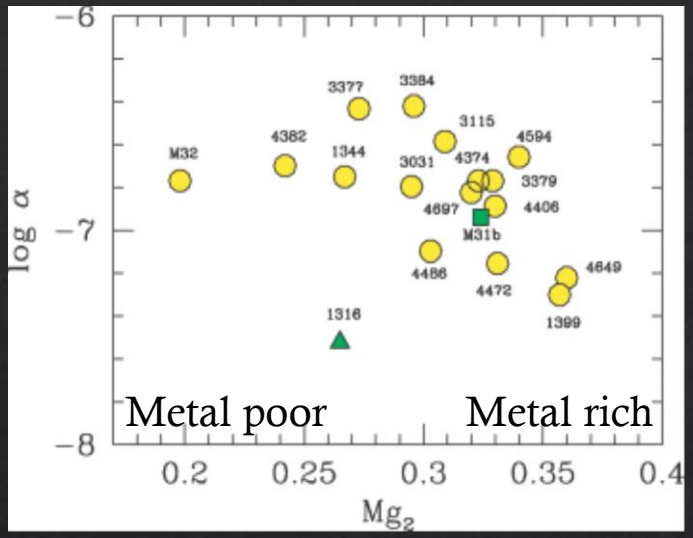



Fig. 9: Buzzoni[5]: halo α vs central metallicity, for different galaxies.

- Buzzoni et al 2006[5] presented evidence that more metal rich stellar populations (traced by the Mgb absorption line) correspond to a lower specific number of PNe per solar luminosity (alpha, left plot).
- This would be consistent with higher metallicities driving larger mass losses in the red-giant phase (right plot), leading to more Extreme Horizontal Branch (EHB) stars, than normal HB stars.
- Buzzoni et al, however, compared halo PNe populations with central stellar metallicity estimates.
- Using MUSE we can redress this spatial inconsistency and now also measure metallicity more directly. We still find a trend, albeit much weaker (lower, left plot).

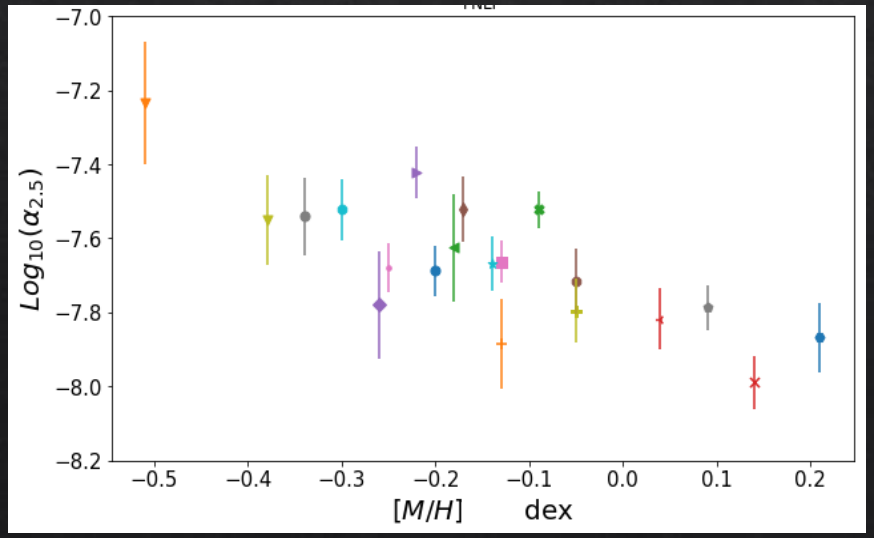
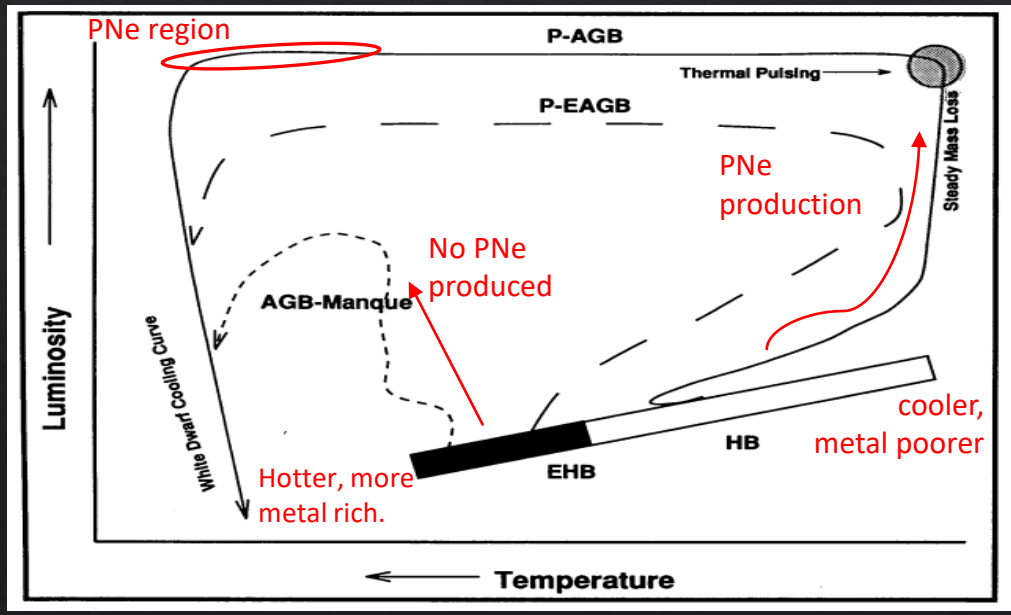



Fig. 10: Our work: central α vs central metallicity, for the Fornax Cluster galaxies.




Figure, annotated, from Dorman, B. et al 1993, 1993ApJ…419…596

Fig. 11: Stellar evolution chart; Horizontal branch (HB) stars to White Dwarfs. PNe regions marked, with arrows to highlight difference between metal poor and metal rich evolution tracks.

5 - Buzzoni, A., Arnaboldi, M., & Corradi, R. L. M. 2006, MNRAS, 368, 877