A new approach to estimate oxygen abundance
The MRC calibrator

A. Ávila-Aroche & S.F. Sánchez
aaroche@astro.unam.mx
Instituto de Astronomía. UNAM.CDMX

The cosmic feast of the elements. In honor to Grażyna Stasińska

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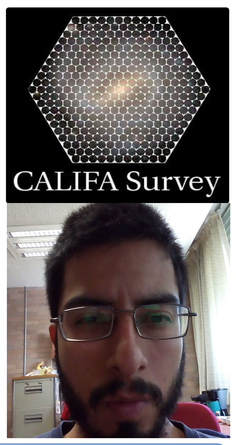


Abstract

Several studies use the emission lines fluxes of the star forming galaxies to derive the gas-phase metallicity by applying the so-called strong-line methods. These metallicity indicators are empirically calibrated using direct abundance measurements. Our main goal in this study is to present a new approach to derive oxygen abundances using all the possible combinations of strong line ratios sensitive to the metallicity, covering a wide range interval of this parameter, through a large compilation of HII regions with Te-based estimations (Marino et al. 2013). Our method called MRC (Multiple Ratio Calibrator) provides with a calibration with a systematic error of 0.13 dex. We also present a comparison between this new method and the O3N2, N2 calibrations (Marino et al. 2013), the ONS method (Pilyugin et al. 2010) and the C method (Pilyugin et al. 2012). Furthermore, we perform an analysis of the abundance gradient of the galaxy NGC628 confirming previous works.

Background

- Gas-phase oxygen abundances are the best proxy to estimate the present-day metallicities.
- Oxygen emits strong lines in the V-band and it is observed in different ionization states.
- The strong line methods rely on empirical relations between different optical emission lines ratios and metallicities anchored to the Te-method or to photoionization models, based on observations of a large samples of HII regions.

Te-based sample

- 603 HII regions from 17 different works **(Marino et al. 2013).**
- Spiral & Irregular galaxies.
- SELs ---> [OIII]λ5007, [NII]λ6584.
- Auroral lines ---> [OIII]λ4363, [NIIλ5755, [SIII]λ6312.

MRC method

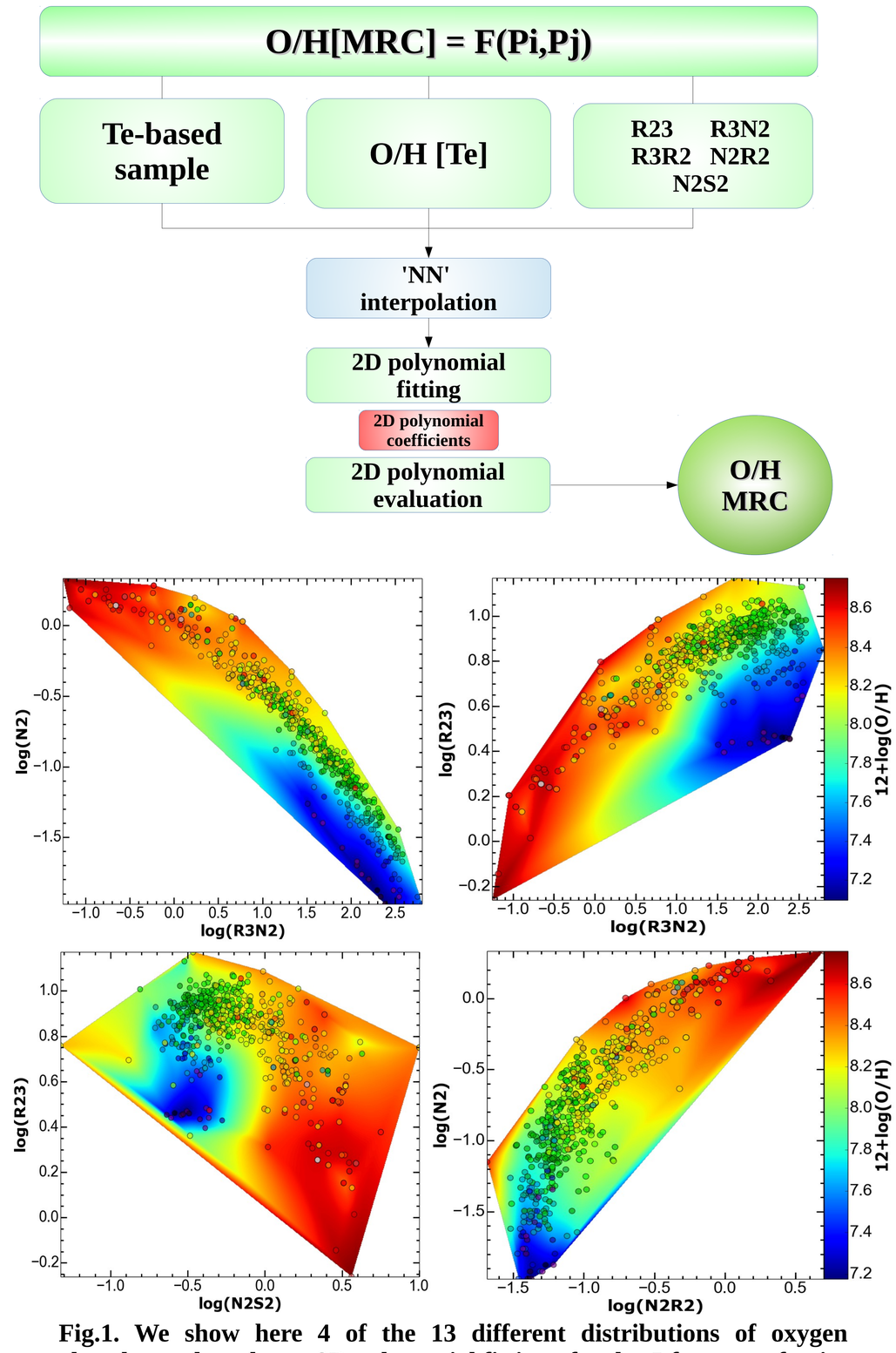


Fig.1. We show here 4 of the 13 different distributions of oxygen abundances based on a 2D polynomial fitting of order 5 for a set of pairs of line ratios sensitive to metallicity.

MRC comparisons

Results

MRC comparisons

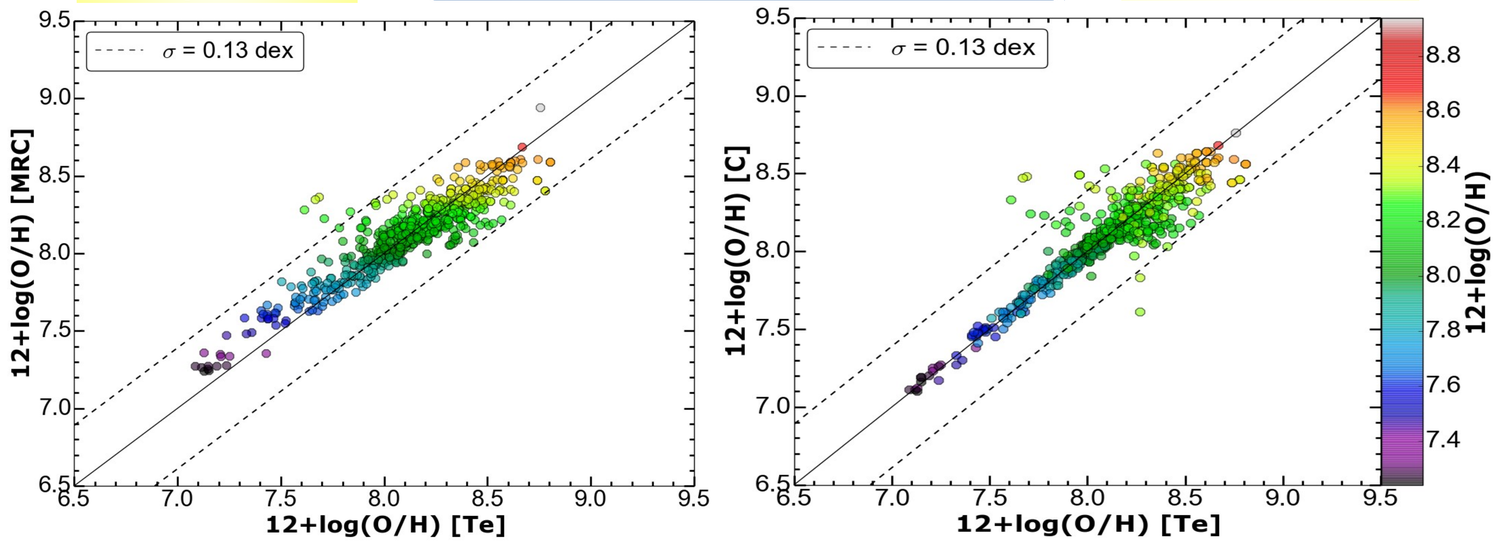


Fig.2. Comparison of the MRC and C method (Pilyugin et al. 2012) with the Te-based estimations (Marino et al. 2013). The MRC and C empirical calibrations based on Te estimations get random error of 0.13 dex, but with an offset of 0.004 and 0.007, respectively. The colorbar scale is the same for both plots.

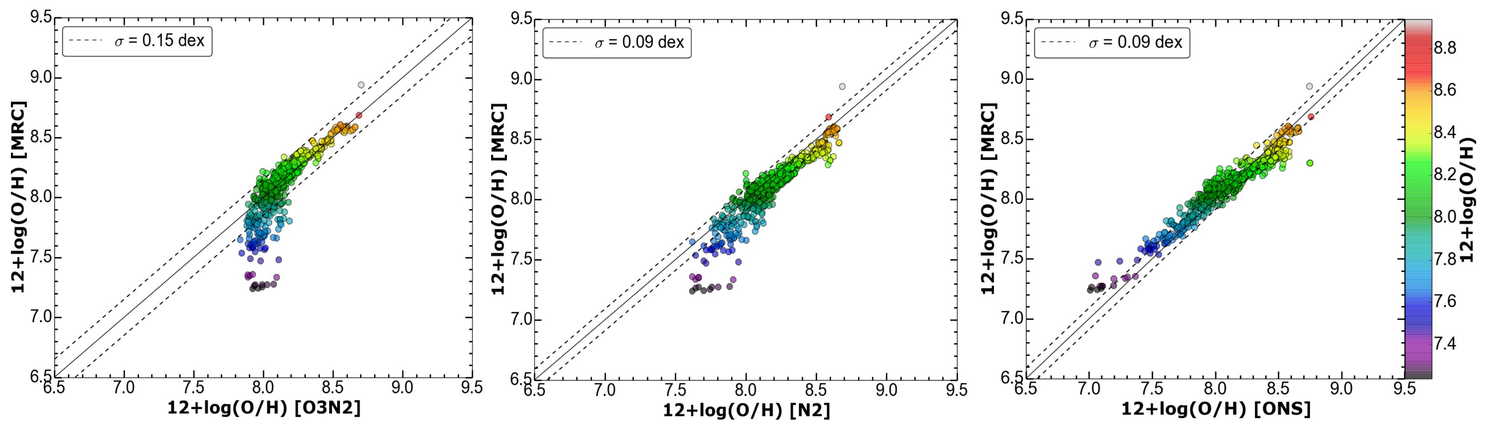
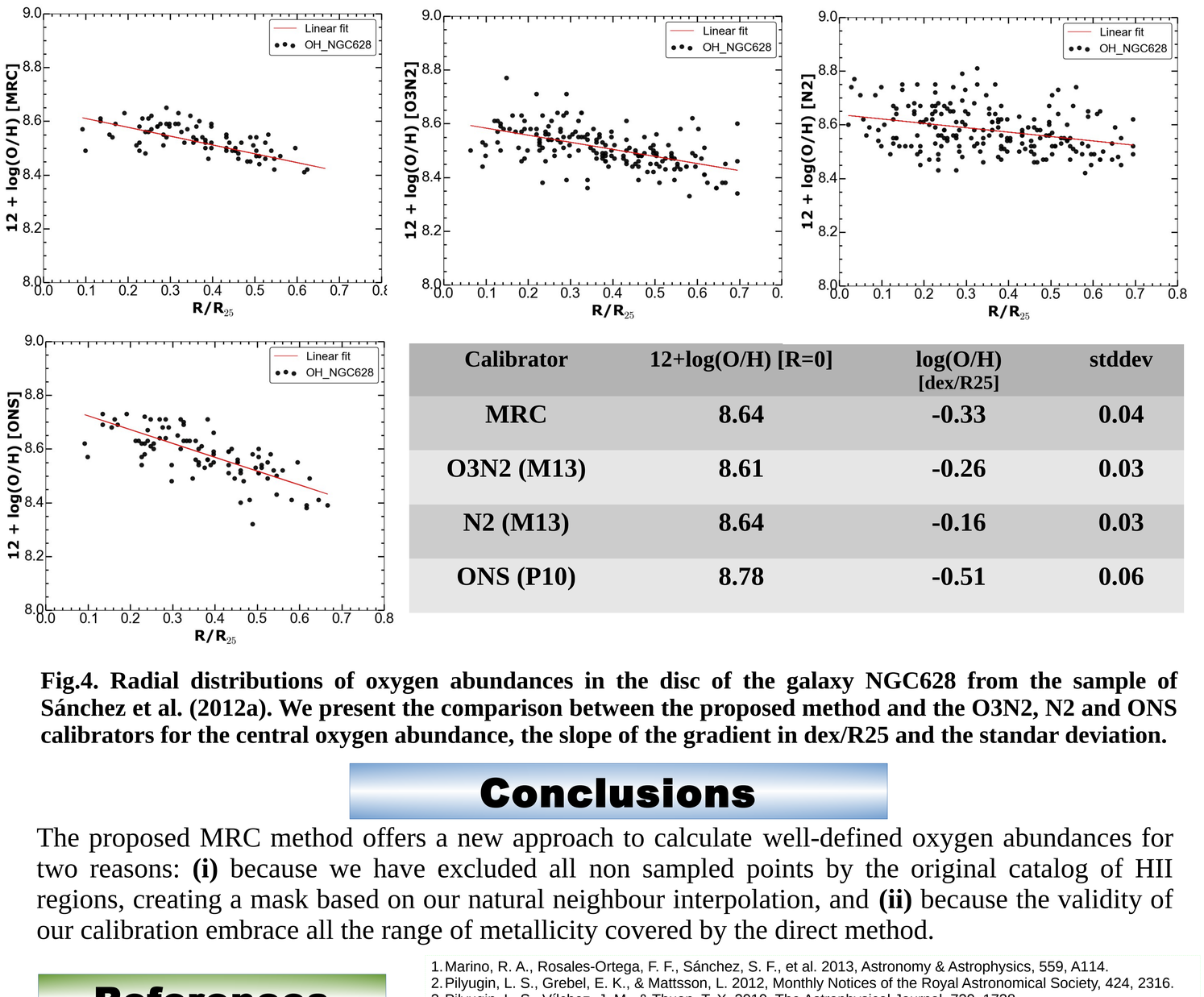


Fig.3. Comparison of the MRC method with the O3N2 and N2 recalibrated indicators from Marino et al. (2013) and the ONS method (Pilyugin et al. (2010)). The colorbar scale is the same for all three plots.

Abundance gradient in NGC628



Calibrator	12+log(O/H) [R=0]	log(O/H) [dex/R25]	stddev
MRC	8.64	-0.33	0.04
O3N2 (M13)	8.61	-0.26	0.03
N2 (M13)	8.64	-0.16	0.03
ONS (P10)	8.78	-0.51	0.06

Fig.4. Radial distributions of oxygen abundances in the disc of the galaxy NGC628 from the sample of Sánchez et al. (2012a). We present the comparison between the proposed method and the O3N2, N2 and ONS calibrators for the central oxygen abundance, the slope of the gradient in dex/R25 and the standar deviation.

Conclusions

The proposed MRC method offers a new approach to calculate well-defined oxygen abundances for two reasons: **(i)** because we have excluded all non sampled points by the original catalog of HII regions, creating a mask based on our natural neighbour interpolation, and **(ii)** because the validity of our calibration embrace all the range of metallicity covered by the direct method.

References

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For more information contact: aaroche@astro.unam.mx