Probability estimators of oxygen abundance based on pairs of strong line indicators

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INTRODUCTION

Historically, the nebular emission lines from galactic and extragalactic objects (e.g. HII regions) have been the main and a powerful tool to understand the chemical evolution of the Interestellar Medium (ISM) in galaxies.

HII regions are the zones where the stars form. We can define a HII regions as a large, low-density clouds of partially ionized gas (S.F. Sánchez et al. 2015). Since emission lines in the spectra of HII regions are easily measurable through a wide range of extragalactic distances, they are tipically considered the most powerful indicators of the chemical composition of star-forming galaxies. Indeed, the gas-phase oxygen abundances are the best means to estimate the present-day metallicites.

Oxygen is generally used as the benchmark element due its relative abundace, it emits strong lines in the visual band and it is observed in different ionization states.

Nonetheless, direct abundance measurements for the ionized gas in galaxies require the determination of the electron temperature (Te) of the gas which can it obtained from the ratio of auroral to nebular line intensities. When we have metal-rich galaxies, the process to obtain the Te it become difficult, because as the metallicity increases, the aurora lines become faint to measure, and the Te decreases. So, in this context, the calibrations based on strong emission lines are required.

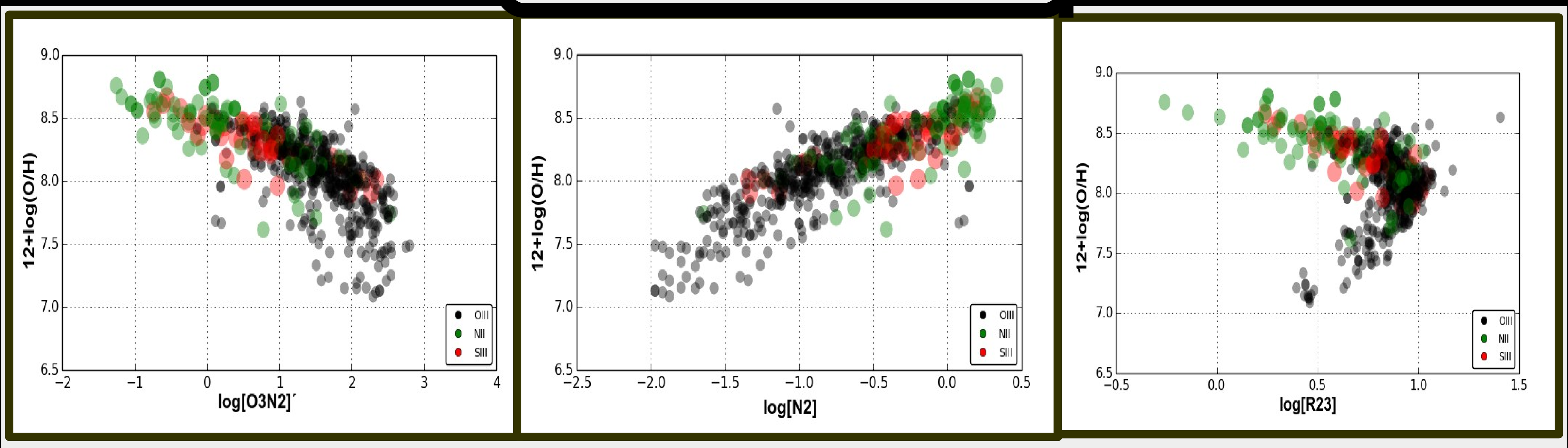
Therefore, the strong line methods rely on empirical relations between different optical emission lines ratios and metallicities determined via the Te method, based on observations of a large samples of HII regions.

MAIN GOAL

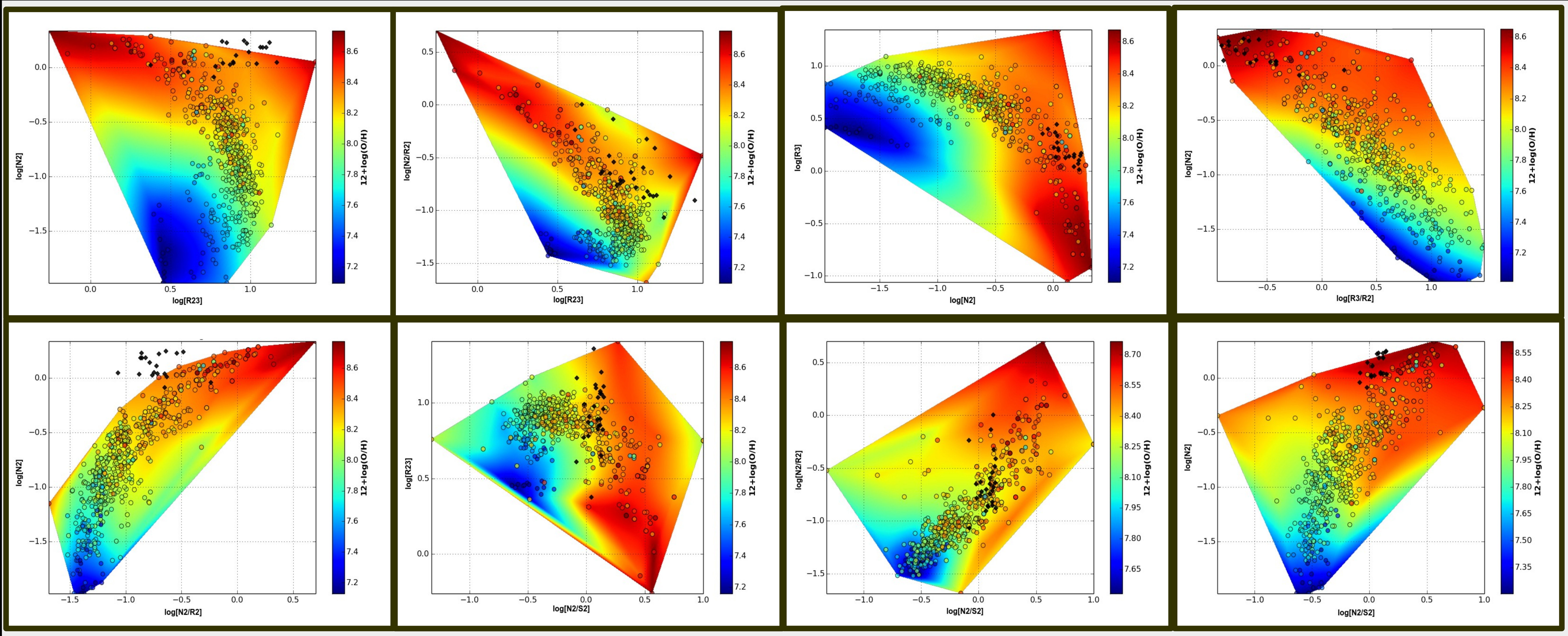
To present a new approach to derive oxigen abundances based on strong-lines indicators through a large catalog of HII regions with estimations based on the so-called direct method (Te-based on weak auroral lines).

We present here a new approach to derive oxygen abundances based on strong-lines indicators calibrated through a largue catalog of HII regions (Marino et al. 2013) with estimations based on the so-called direct method (Te-based on weak auroral lines).
The methos used consist of all the posible combinations of line ratios to provide the best estimation of oxygen abundances based on a probability distribution for a subset of pairs of lines ratios.

RESULTS
Empirical Calibrations



- The O3N2 and N2 calibrators present a monotonic behaviour with their abundance. In the case of R23, there is no monotonic behaviour, being a double valued indicator.
- To date there is not technique based on the direct method that makes use of different indicators at once.
- Data were extracted from Marino et al. 2013.



We show here different distributions of Oxygen Abundances based on a 2D polynomial fitting of order 13 for a set of pairs of line ratios sensitive to that parameter. In each panel a different pair of line ratios is analyzed. The coloured circles indicate the line ratios for a set of 594 HII regions with abundance estimated based on the direct method, with the abundance indicated by the colour. The colored image represent the best fitted 2D polynomial function. This analysis provides with 13 indepent estimations (calibrators) of the oxygen abundance, that are averaged in each derivation. The final estimation of the abundance is then the average of all those estimations. The estimated error is derived as the propagated errors of each individual estimation combined with the standard deviation of the distribution of 13 abundances derived. In this work, we only present 8 estimations.

DISCUSSION

We use empirical calibrators based on the comparison of different line ratios of strong emission lines with the corresponding abundance derived for a set of HII regions for which Te is known.
We hava followed the method known as the "closest counterpart" proposed by Pilyugin et al., 2012, which involves using different ratios of strong emission lines in the visible range.
The proposed technique for these new calibrators is based on determining the abundance using a method based on a 2D polynomial fitting of order 13.
Finally, with the current approach we provide a calibration with a systematic error of the order of ~ 0.09 dex.

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