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The Metal Abundances of Circumnuclear Star Forming Regions in Early Type Spirals

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Abstract. We present a spectrophotometric study of circumnuclear star forming regions (CNSFR) in the galaxies: NGC 2903, NGC 3351 and NGC 3504, all of them of over solar metallicity according to standard empirical calibrations. A detailed determination of their abundances is made after careful subtraction of the prominent underlying stellar absorption. It is found that most regions show the highest abundances in HII region-like objects. It is also shown that CNSFR, as a class, segregate from the disk HII region family, clustering around smaller η' values, and therefore higher ionizing temperatures.

From [SII] $\lambda\lambda$ 6717,6731 Å lines, we have derived an electron density range from 180 to 650 cm^{-3}, with average values of around 350 cm^{-3}, higher than that found in Giant Extragalactic HII Regions (GEHR). The very low intensity of the [OIII] lines ($\lambda\lambda$ 4959, 5007 Å) implies high metallicity. Measurement of line temperature of [OIII] (t[OIII]) requires detection of auroral [OIII] λ 4363 Å lines a few percent of [OIII] λ 5007 Å which is impossible.

Therefore, abundances for most of the regions require the use of empirical methods. CNSFRs show values of O_{23} (=([OII]3727+[OIII]4959, 5007)/Hβ; Pagel *et al.*, 1979. MNRAS.189.95) which indicate oversolar metallicities, but the actual values are difficult to estimate since O23 levels off. At times [OIII] lines are very difficult to measure. The combined parameter S_{23}/O_{23} (S_{23} = ([SII]6717, 6731+[SIII]9069, 9532)/Hβ; Vílchez & Esteban, 1996. MNRAS.280.720) yields values of the oxygen abundances higher than twice solar. Also the N2 parameter (log([NII]/Hβ; Denicoló, Terlevich & Terlevich, 2002. MNRAS.330.69) renders oversolar abundances. Furthermore, the CNSFRs of our sample show the highest values of the ratio N/O known for the HII region-like objects.

When we study the relation between the metallicity and the ionisation degree parametrized by the ratio [SII]6717, 6731/[SIII]9069, 9532 we find that the CNSFRs of our sample are among the HII region-like objects with the lowest ionisation parameter. Moreover, we estimate that the S_{23} parameter is, in this case, better than N2 to discriminate between different metallicities.

The temperature of the ionising stars can be parametrized by the "softness parameter" η' (=([OII]3727/[OIII]4959, 5007)/([SII]6717, 6731/[SIII]9069, 9532); Vílchez & Pagel, 1988. MNRAS.231.257). This parameter can be used as an ionising temperature indicator. Analysing N2 vs. η' we find that the CNSFR of our sample have, in general, lower values of η' than those of the GEHRs, implying higher temperatures. In an Eta Prime Plot (log([OII]3727/[OIII]4959, 5007) vs. log([SII]6717, 6731/[SIII]9069, 9532)) we can see that the CNSFRs follow the behaviour of HII galaxies rather than that of GEHR implying, again, higher temperatures.

Some general conclusions are: CNSFR spectra are difficult to analyse; they show prominent underlying stellar populations so a careful subtraction of the absorption spectrum can be critical; abundance determination mostly comes from empirical calibrations. Furthermore, some conclusions derived from line diagnostics are that CNSFR can show very high metal abundances and N/O overabundances too; they show indications of low ionization parameter; regarding the temperature of ionizing stars, CNSFRs seem to share more properties with HII galaxies than with disk GEHR, which is puzzling.