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The evolution of the oxygen radial gradients in spiral galaxies

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Abstract. We analyse the evolution with redshift of the radial gradient of oxygen abundances in spiral disks resulting from our MULCHEM chemical evolution models, computed for galaxies of different sizes or masses, studying the relationships between the gradients and galaxy characteristics as the stellar mass, the size, the gas fraction or the star formation rate for $z < 4$.

Keywords. Galaxies: Spirals; Galaxies: Abundances; Galaxies: Formation.

In Mollá *et al.* (2019) we studied the evolution of the oxygen radial gradient. Now, with our set of MULCHEM chemical evolution models, we predict how the radial gradients were in the past for other galaxy with different sizes and masses. We compute models for galaxies with dynamical masses in the range $\mathrm{M_{vir}}$ [10^{10} -10^{13}] $\mathrm{M_\odot}$, with new stellar yields and initial mass function (Mollá *et al.* 2015), updated gas accretion rates (Mollá *et al.* 2016), and new prescriptions to form molecular cloud (Mollá *et al.* 2017). We take into account the growth of the disks, measuring the radial gradients always within the optical disk corresponding to each redshift. We analyse the correlations of the radial gradients with the stellar mass, the disk size and the star formation rate at the present time and in the past. For the present time, we find that, as expected, the effective radius, R_{eff}, depends on the stellar mass $\mathrm{M_*}$. The radial gradient ∇, measured as $\mathrm{dex\,kpc^{-1}}$, shows a clear dependence on R_{eff}, in agreement with data. It also varies with the fraction of gas and with the specific SFR, showing a different behaviour between low and high star formation efficiency, ϵ_s, models. The gradient ∇ depends on $\mathrm{M_*}$ for $M_* < 4 \times 10^9\, M_\odot$ with a high dispersion. Above this mass, gradients are very similar. The normalised radial gradient is $\nabla_{\mathrm{Reff}} \sim -0.10\,\mathrm{dex\,R_{eff}^{-1}}$ for all galaxies with differences depending on ϵ_s. These correlations at $z = 0$ may change at other redshifts: R_{eff} is smaller for a similar $\mathrm{M_*}$ at higher z; In the SFR–∇ correlation, points move at higher sSFR showing steeper gradients at $z = 1$ than at $z = 0$. Correlations $\nabla - \mathrm{M_*}$ or R_{eff} appear at all redshifts, but with more dispersion at high redshift for low ϵ_s and $\mathrm{M_*}$. A light correlation of ∇_{Reff}–$\mathrm{M_*}$ and R_{eff} appears at high redshift which disappear at $z = 0$, but a similar value is obtained for high ϵ_s models at all redshifts. The evolution of $\nabla(z)$ is smooth, except when the disk begins form, when a very steep radial gradient appears. This occurs at any time depending on the dynamical mass; thus these models explain all negative ∇ for isolated spiral galaxies. (See details in Mollá *et al.* 2019).

References

Mollá M., Cavichia O., Gavilán M., Gibson B. K. 2015, *MNRAS*, 451, 3693
Mollá M., Díaz Á. I., Gibson B. K., Cavichia O., *et al.* 2016, *MNRAS*, 462, 1329
Mollá M., Díaz Á. I., Ascasibar Y., Gibson B. K. 2017, *MNRAS*, 468, 305
Mollá, M., Díaz, A. I., Cavichia, O., Gibson, B. K., *et al.* 2019, *MNRAS*, 482, 307