Formation and Evolution of Galaxy Outskirts
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Why do disk galaxies present a common gas-phase metallicity gradient?

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CALIFA data show that isolated disk galaxies present a common gas-phase metallicity gradient, with a characteristic slope of $-0.1dex/r_e$ between 0.3 and 2 disk effective radius r_e (Sanchez *et al.* 2014). Here we construct a simple model to investigate which processes regulate the formation and evolution.

Similar to our previous models (Chang *et al.* 2012), here we also adopt a Gaussian formula of the gas infall rate $f_{\rm in}(t) = \frac{A}{\sqrt{2\pi}\sigma} e^{-(t-t_{\rm p})^2/2\sigma^2}$, where the infall-peak time $t_{\rm p}$ is a free parameter, A is a normalized constant and we fixed $\sigma = 3Gyr$. We adopt the classical Schmidt star formation (SF) law as $\Psi = \nu \Sigma_{\rm gas}^n$.

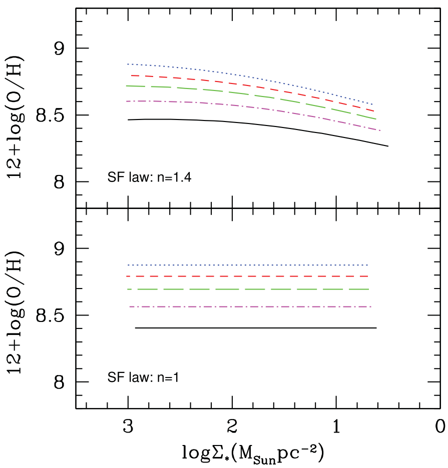

Figure 1. Model results of the gas-phase metallicity versus the stellar mass surface density. Different lines correspond to different gas-infall peak-time t_p. The upper and lower panel show the results of SF law adopting the power index as $n = 1.4$ and $n = 1$, respectively. In each panel, the curves represent the results with $t_{\rm p} = 0, 3, 5, 7, 9$Gyr from top to bottom.

Fig.1 shows that, for given $t_{\rm p}$, the SF law power index n is the main progenitor of radial gradients. Especially, when $n = 1$ is adopted, there is no radial gradient. Meantime, for given n, if $t_{\rm p}$ increases with radius, an significant gradient also appears. In other words, both the no-linear SF law and the disk inside-out formation scenario are main progenitors of metallicity gradients and further investigations are needed to explore their degeneracy.

References

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