RevMexAA (Serie de Conferencias), **40**, 115–115 (2011)

CHEMICAL EVOLUTION MODELS FOR SPIRAL DISKS: THE MILKY WAY, M31 AND M33

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We tested a chemical evolution model for spiral disks to study the influence of a threshold gas density and different efficiencies in the star formation rate (SFR) law on radial gradients of abundance, gas, and SFR. The model is applied to the Milky Way, M31 and M33. We see that most massive disks seem to have evolved faster and that threshold and efficiency play a very important role in the chemical evolution of spiral disks.

In this work we present a one-infall chemical evolution model for the Galactic disk, as well as for the disks of M31 and M33. This model can predict the evolution of the abundances of 37 chemical elements from the light to the heavy ones. It was developed assuming that the disk of each galaxy is formed by gas accretion and by varying the star formation efficiency as well as the gas accretion timescale. The similarities and the differences between the chemical evolution of these objects and the Milky Way are discussed to provide a basis for the understanding of the chemical evolution of disks.

We adopt a model where the Galactic disk forms inside-out by means of infall of a pre-enriched gas (to take into account the effect of the halo-thick disk evolution), and test different thresholds and efficiencies in the SFR. This model is described in details by Marcon-Uchida et al. (2010, and references therein).

The evolution of the disk of M31 is well reproduced by assuming a faster evolution (faster means a more intense SFR which is due both to the higher efficiency of SF and to the shorter infall timescale) than in the disks of MW and M33, and also assuming a higher star formation threshold. Since the disk of M31 is more massive than those for the other galaxies, this implies that more massive disks should form faster. Threshold and the efficiency in the star formation play a very important role in the chemical evolution of spiral disks and a variable efficiency along the radius can be used to regulate the star formation.

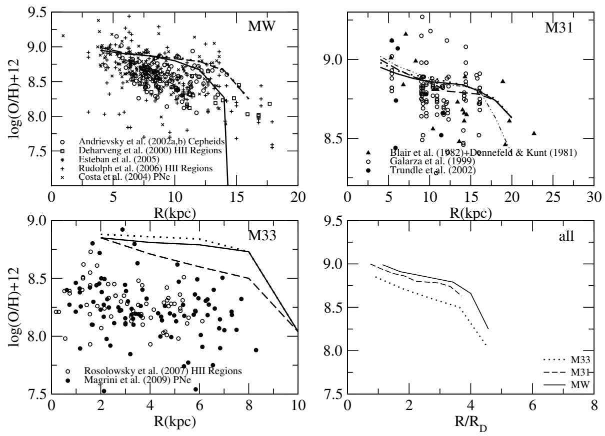

Fig. 1. Radial oxygen abundance gradient for the three galaxies in the sample. In these figures, different lines represent model outputs. See Marcon-Uchida et al. (2010) for the symbols and the origin of the data. The lower right panel shows the model prediction with variable efficiencies in the star formation process for all galaxies, using the normalized radius.

In Figure 1, we show the results for the oxygen abundance gradient for the Milky Way, M31, and M33 with a compilation of observational data and a comparative plot between the predictions for the galaxies (right lower panel). The abundance results are slightly shifted for the MW and overestimated for M33, but the predicted slopes of the gradients are in agreement with the observational data.

In conclusion, we see that most massive disks seem to have evolved faster (i.e., with more efficient star formation) than the less massive ones, thus suggesting a downsizing in star formation for spirals. The threshold and the efficiency of star formation play a very important role in the chemical evolution of spiral disks. For instance, an efficiency varying with radius can be used to regulate the star formation. The oxygen abundance gradient can steepen or flatten in time depending on the choice of this parameter

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