OXYGEN ABUNDANCES AND THE CHEMICAL EVOLUTION OF SPIRAL GALAXIES

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We have computed models of galactic chemical evolution for five nearby spirals (the Galaxy, M31, M33, M83, and M101) in order to compare the resulting oxygen abundances with those observed in the HII regions of these galaxies.

All the spirals have been assumed to have the same age (13 Gyr), the same initial mass function (IMF) as derived in the solar neighbourhood, and the same sort of stellar evolution.

The free parameters of our procedure are only two: the infall rate F of gas from outside the disk, and the law of star formation (e.g. constant or exponential in time, proportional to some power of the gas density, etc.). By dividing the disk of each galaxy into concentric rings, and knowing for each ring the observed gas and total mass density, we can compute the time evolution of its medium and therefore predict its chemical composition at any time. The resulting present abundances are then compared with the values observed in HII regions.

For the Galaxy, it turns out that a model with an exponential star formation rate (SFR) slowly decreasing with time (SFR $\propto \exp(-t/\tau$, τ =15 Gyr) and an infall rate F=3 10^{-3} $M_{\odot}$ kpc^{-2} yr^{-1} reproduces very well the observed oxygen abundances and gradient. This model also reproduces the overall metallicity gradients observed for young stars and clusters, and that observed in stars older than ~2 Gyr (this one being flatter than the previous ones). A very good agreement is also found between the model evolution with time of the metallicity in the solar ring and the age-metallicity relation observed in stars of the solar neighbourhood.

Since the assumed infall rate $F=3\ 10^{-3} M_{\odot}\ kpc^{-2}\ yr^{-1}$ corresponds to the value derived from observations of high velocity clouds and an almost constant SFR has also been suggested on the basis of several observational constraints, there are good chances that our model be quite close to the actual evolution of the Galaxy.

Similar models, with exponential SFR and infall in the range $0 \leq F \leq 4\ 10^{-3} M_{\odot}\ kpc^{-2}\ yr^{-1}$, appear to be consistent with the evolution of the other bright spirals of our sample.

In fact, the oxygen abundances and gradient observed in the HII regions of M31 are very well fitted by models with the same infall as in the Galaxy and SFR constant or slowly decreasing. The HII region gradients of M83 and M101 are also reproduced by our models ($F=0$, $\tau=\infty$ for M83; $F=4$, $\tau=5$ Gyr for M101), although there are slight differences in the abundance absolute values, which are probably due to small variations in the IMF.

Viceversa, these models do not seem to apply to low brightness, small spirals like M33, and a different sort of chemical evolution might be invoked.

The results, the model equations, the observational data and their references are described in details by Tosi(1982) and Diaz and Tosi (1983).

REFERENCES

Diaz, A.I., Tosi,M.: 1983, M.N.R.A.S. in press
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