Abundance Variations in the Galactic Disk: Planetary Nebulae, Open Clusters and Field Stars

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1 Introduction

Abundance gradients and their variations constitute one of the main constraints of chemical evolution models for the Galaxy. The time evolution of the gradients, in particular, is essential to distinguish between models involving different physical processes and time scales (see for example [6] and [8]). The gradients can be derived from different types of objects, but the study of their time variation requires the use of objects with a reasonably large age span, such as planetary nebulae (PN) and open clusters. In the present work, we compare the results obtained from PN with recent determinations from open clusters and cepheid variable stars. These objects offer some additional advantages compared with PN, such as more accurate distances and ages.

2 Planetary Nebulae

The time variation of the O/H radial gradient has been estimated by [9] from a sample of galactic PN. More recently, Lago and Maciel (in preparation) have extended these results for the elements S, Ne and Ar. From the observed abundances, the [Fe/H] ratio has been estimated, using a correlation valid for the galactic disk [7]. Adopting an age-metallicity relation which depends also on the galactocentric distance [3], the progenitor ages have been determined. Taking into account nebulae in different age groups, it was concluded that the gradients are flattening at an approximate rate of 0.005 dex kpc^{-1} Gyr^{-1}.

3 Open Clusters

Open clusters are favourite objects in the study of [Fe/H] radial gradients. Recently, new homogeneous results [4] and compilations [2] have become available. Such data allow us to estimate the time variation of the gradients, again resulting in some flattening for younger objects. In the present work, we have considered both sources and rederived the [Fe/H] gradients and their variations, taking into account samples composed of young, intermediate, and old clusters, as in [9] for planetary nebulae. We conclude that both samples [4] and [2] lead essentially to the same results. The main problem with this derivation refers to the youngest clusters, which are concentrated in the inner portions of the disk, increasing the uncertainties of their gradients.

4 Cepheids

Cepheid variables show several advantages for the determination of radial abundance gradients relative to the remaining objects. Their distances are accurately determined, as well as their ages. In a recent series of papers, Andrievsky et al. obtained accurate abundances for several elements from a spectroscopic analysis of a sample of cepheid variables (see [1] for the references). We have used this sample and rederived the O/H and [Fe/H] radial gradients. We have also determined the age distribution of the cepheids, which are concentrated in the young object group, so that the gradient at this age bracket is significantly improved.

5 Conclusions

A comparison of the gradients from PN, open cluster stars and cepheid variables shows that their temporal variations are similar, in the sense that the gradients seem to be flattening out with time for the last 8 Gyr approximately. The distribution of the youngest open clusters tends to be concentrated in the inner regions of the disk, which makes their gradient artificially flatter. For this reason, the results of the cepheids are especially important, since these objects have better determined distances and ages. The results confirm the time variation previously determined for PN and open clusters. The derived time variations of the gradient are in agreement with the predictions of theoretical models by Hou et al. [5]. These results do not allow an accurate determination of the flattening rate, but a rough estimate would be in the range $0.005 - 0.010$ dex kpc^{-1} Gyr^{-1} in the last few Gyr.

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