DISPERSSION IN MODELED ABUNDANCES

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1. Introduction

Chemical abundance data for the Galaxy shows a wide dispersion. We try to check if this dispersion may also be found with chemical evolution models as an effect of variations of an Initial Mass Function (IMF) which follows a Poisson’s distribution.

We will use two different methods: a) an analysis of the model internal error and b) a statistic study on the effects of the IMF discretization, based on montecarlo models. Both methods have been used in a chemical evolution model applied to the Solar Neighborhood. Preliminary results relative to O and N are shown.

2. The Initial Mass Function

We will try to justify the data dispersion by the possible variations in the model results which could be produced by the behavior of the IMF, whose properties are described by a probability distribution function:

If we assume that $N_{\text{tot}}$ stars are observed in a mass range $[m_0, m_{\text{max}}]$, the mass $m_i$ of the i-th star is a random variable whose probability distribution function is given by the stellar initial mass function: $\Phi(m_i)$, whose integration along the whole mass range is normalized to 1.

The number $N_i$ of stars of mass $m_i$ is another random variable whose distribution function follows a Poissonian behavior, with the value of the IMF at that mass as the only parameter of the distribution: $dn_i = dN_i/N_{\text{tot}} = \Phi(m_i)dm_i$, since the total number of stars is: $N_{\text{tot}} = \int dm_i$.

A simple test to check the Poissonian nature of the distribution of $n_i$ is simply the ratio of its variance to its average value as a function of mass. This ratio should be close to 1. Cerviño et al. (2001) illustrates in their figure 3 the results of a test with 1000 Montecarlo simulations of clusters with $10^3$ and $10^4$ stars with a Salpeter IMF slope. Despite
\( n_i \) is the ratio of a Poisson variable with a constant, it is Poissonian distributed within a 10%.

\[
\Phi(m) = 2.0865m^{-0.52}x10^{-[2.07(\log m)^2+1.92\log m+0.73]}^{\frac{1}{2}}
\]

We will use the two described above methods: a) an analysis of the model internal error and b) a statistic study on the effects of the IMF discretization, based on montecarlo models.
3.1 Error analysis

Considering the Poissonian nature for the IMF, we assume an initial variance of $\sigma^2(\Phi) = \Phi$. Then, we trail the error, following error propagation rules, within the model in every equation involved and related to our IMF. As a result we can obtain a measure of the variability of our model along the whole mass interval considered.

We may observe in Fig. 2 that the variability increases strongly in the mass interval from 4 to 8 $M_\odot$. This is exactly the interval of mass producing Fe and N. Therefore, in agreement with this result, our model must show a larger dispersion in these elements in comparison with other elements as O.

3.2 Monte Carlo Simulations

We use an uniformly distributed random numbers generator to generate from it, and using the accumulated probability distribution, a succession of numbers with our IMF as probability function. Our aim is the computation of a complete set of $Q_{i,j}$ Monte Carlo simulations, where the IMF is randomly different for each of them, with masses from 0.8 up to 100 $M_\odot$, divided in 800 intervals with linear interpolation within them. We also would like to study the effects of the discretization caused by rounding in the code. Our aim is to calculate $\sim 500 - 1000$ simulations, with $\sim 10^5 - 10^6$ stars. We will repeat our simulations for two different round down values: $10^{-3}$ and $10^{-6}$. The well calibrated model from Gavilán et al. (2002) will be our base of mean values.
4. Results

The preliminary results have been obtained by the realization of 400 montecarlo simulations for the galaxy disk zone, without having into account the rounding in the code and with non calibrated models. Despite of these facts, a dispersion of $\sim 10^{-2}$ already appears in our O and N abundances. as we may see in Fig.3. This fact seems to indicate that a good percentage of the observed dispersion could be achieved with the complete set of simulations.

![Figure 3. Preliminary results of dispersion in O and N abundances.](image)

5. Conclusions

With this kind of calculations we might estimate the variability and the errors that can be obtained by the models. Thus, we could include into the code the dispersion appearing as a consequence of the uncertainties in the IMF, and this way we could check if is possible to get the same dispersion as observed. It seems, from our preliminary results, that taking into account the sampling fluctuations from the IMF into the models can reproduce the observed dispersion.

References

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