CONFIDENCE LIMITS OF SN, KINETIC ENERGY AND CHEMICAL YIELDS IN EVOLUTIONARY SYNTHESIS MODELS

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RESUMEN

Cuando los modelos de sínthesis evolutiva tienen en cuenta la naturaleza estocástica de la IMF y la discretización del número de estrellas en cúmulos reales, los resultados típicos de los modelos pasan de líneas infinitamente delgadas a bandas de dispersión. En este trabajo presentamos un estudio cualitativo de dicha dispersión en la tasa de SN, la energía cinética y el cociente $^{14}\text{N}/^{12}\text{C}$ para cúmulos con diferente cantidad de gas transformado en estrellas.

ABSTRACT

stochastic nature of the IMF together with the discrete number of stars in real stellar clusters, typical output turns to dispersion band (where real data can be placed) instead of narrow lines. We present here a qualitative analysis of such dispersion in the SN rate, the kinetic energy and the $^{14}\text{N}/^{12}\text{C}$ ratio for different amounts of mass transformed into stars.

Key Words: GALAXIES: EVOLUTION

1. MOTIVATION

The influence of the stochasticity of the Initial Mass function (IMF) on some outputs of evolutionary synthesis models has been studied in a preliminary paper (Cerviño et al. 2000). In that paper, we showed that the resulting outputs present a dispersion which depends on the amount of gas transformed into stars.

Here we investigate such dispersion for the Supernova rate (SNr), the kinetic energy and the $^{14}\text{N}/^{12}\text{C}$ ratio resulting from the evolution of a stellar cluster. We have used the code presented in Cerviño & Mas-Hesse (1994) which performs a Montecarlo approximation to the IMF instead of the usual analytical approximation. The models have been computed for a Salpeter IMF slope, an upper mass limit equal to 120 $M_{\odot}$, and a lower mass limit of 2 $M_{\odot}$, solar metallicity with standard mass loss rates evolutionary tracks (Schaller et al. 1992) and an Instantaneous Burst of star formation. We have computed 500 Montecarlo simulations for a cluster with a mass of $10^4 M_{\odot}$, 200 simulations for a $10^5 M_{\odot}$ cluster, and 100 simulations for a $10^6 M_{\odot}$ cluster.

2. SNR

The resulting dispersion with a 90% confidence level for the SNr is shown in the Fig. 1. It can be shown that the dispersion in the SNr increases with time since the number of SN decreases and the statistics becomes lower (Cerviño et al. 2001).

3. KINETIC ENERGY AND $^{14}\text{N}/^{12}\text{C}$ RATIO

The resulting dispersion with a 90% confidence level for the kinetic energy produced by the cluster and $^{14}\text{N}/^{12}\text{C}$ ratio is shown in Fig. 2.

For the case of the kinetic energy, the dispersion comes from the integration of Poissonian distributions over time. As the cluster evolves the events become more and more numerous and the dispersion decreases.

The $^{14}\text{N}/^{12}\text{C}$ ratio have a more complicated behavior. The dispersion on the cumulative amount of individual $^{12}\text{C}$ or $^{14}\text{N}$ decreases with time. But the dispersion of the $^{14}\text{N}/^{12}\text{C}$ ratio increases with time (like the dispersion in the SNr). From an observational point of view, older clusters with the same amount of gas transformed into stars will present a higher dispersion of this ratio than younger ones.

4. DISCUSSION AND CONCLUSIONS

In general, the dispersion of synthetic observables of evolutionary synthesis models due to the stochastic nature of the IMF is reduced when the mass transformed into stars increases, but the relevance of the dispersion is heavily dependent on the studied observable.

If the kinetic energy is the origin of temperature fluctuations, or, in general, if temperature fluctuations are related with the stellar population inside...
Fig. 1. 90% confidence level for the SNr in function of the age of the stellar cluster. Different gray scale corresponds to different masses transformed into stars in the mass range $2 - 120 \, M_\odot$ with a Salpeter IMF slope.

the nebula, the dispersion in the observed $t^2$ values must increase for lower mass clusters. Such possible relation will be investigated in Luridiana et al. (2001).

The dispersion in the $^{14}\text{N}/^{12}\text{C}$ ratio becomes larger for older clusters as far as the dispersion in the SNr increases. The extension of this study to other metallicities and star formation histories remains to be done and it can be useful to find a natural explanation of the observed dispersion.

This study is included in a more general work about these observables presented in Cerviño et al. (2001) where a quantitative evaluation of the dispersion is also presented.

We want to acknowledge the Instituto de Astronomía for some facilities during this research. We also acknowledge the LOC financial support. MC is supported by an ESA postdoctoral Fellowship.

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