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

M. Cerviño[1] and V. Luridiana[2]

RESUMEN

Cuando los modelos de síntesis 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 $^{14}N/^{12}C$ para cúmulos con diferente cantidad de gas transformado en estrellas.

ABSTRACT

When evolutionary synthesis models take into account the stochastic nature of the IMF together with the discrete number of stars in real stellar clusters, typical output turns to dispersion bands (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 $^{14}N/^{12}C$ 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 (SN) rate, the kinetic energy and the $^{14}N/^{12}C$ ratio resulting from the evolution of a stellar cluster. We have used the code presented in Cerviño & Mas-Hesse (1994) which performs a Monte Carlo 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 $120M_\odot$, and a lower mass limit of $2M_\odot$, solar metallicity with standard mass loss rates evolutionary tracks (Schaller et al. 1992) and an instantaneous burst of star formation. We have computed 500 Monte Carlo simulations for a cluster with a mass of $10^4M_\odot$, 200 simulations for a $10^5M_\odot$ cluster, and 100 simulations for a $10^6M_\odot$ cluster.

2. SUPERNOVA RATE

The resulting dispersion with a 90% confidence level for the SN rate is shown in the Figure 1. It can be shown that the dispersion in the SN rate increases with time since the number of SN decreases and the statistics becomes lower (Cerviño et al. 2002).

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

The resulting dispersion with a 90% confidence level for the kinetic energy produced by the cluster and $^{14}N/^{12}C$ ratio is shown in Figure 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 $^{14}N/^{12}C$ ratio have a more complicated behavior. The dispersion on the cumulative amount of individual ^{12}C or ^{14}N decreases with time. But the dispersion of the $^{14}N/^{12}C$ ratio increases with time (like the dispersion in the SN rate). 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 the nebula, the dispersion in the observed t^2 values must increase for lower mass clusters. Such possi-

[1]Observatoire Midi-Pyrénées & CESR, Toulouse, France
[2]Instituto de Astronomía, UNAM, México D.F.

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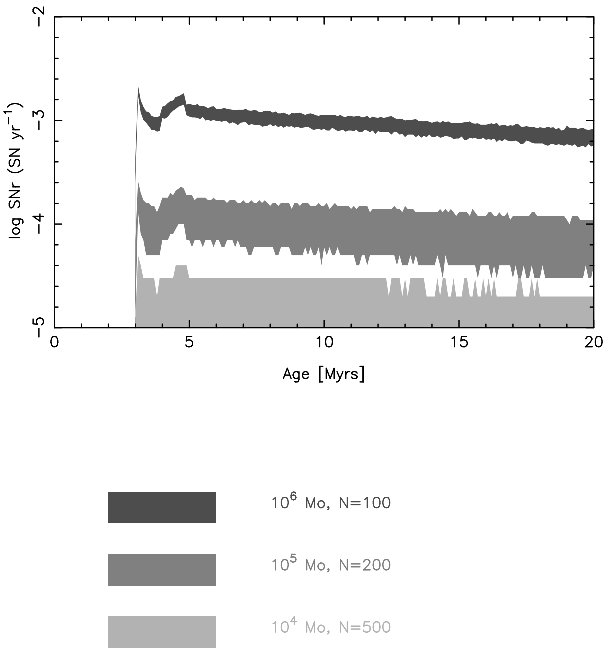

Fig. 1. 90% confidence level for the SN rate in function of the age of the stellar cluster. Different gray values corresponds to different masses transformed into stars in the mass range 2–120$M_\odot$ with a Salpeter IMF slope.

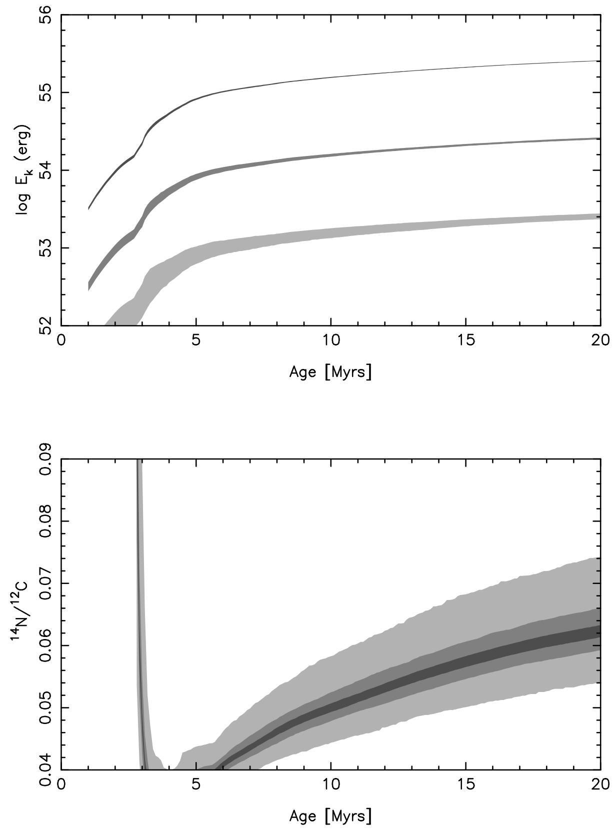

Fig. 2. 90% confidence level for the kinetic energy produced by the cluster and $^{14}N/^{12}C$ ratio in function of the age of the stellar cluster. Different gray values corresponds to different masses transformed into stars in the mass range 2–120$M_\odot$ with a Salpeter IMF slope, following the color code of Fig. 1.

ble relation will be investigated in Luridiana et al. (2002).

The dispersion in the $^{14}N/^{12}C$ ratio becomes larger for older clusters as far as the dispersion in the SN rate 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. (2002) where a quantitative evaluation of the dispersion is also presented.

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M. Cerviño: Observatoire Midi-Pyrénées, 14 av. Edouard Belin, 31400 Toulouse, France (mcervino@obs-mip.fr).
V. Luridiana: Instituto de Astronomía, UNAM, Apdo. Postal 70-264, 04510 México D. F., Mexico (vale@astroscu.unam.mx).