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PNE AS OBSERVATIONAL CONSTRAINTS IN CHEMICAL EVOLUTION MODELS FOR NGC 6822

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RESUMEN

Presentamos modelos de evolución química para la galaxia enana irregular NGC 6822, usando como restricciones observacionales las abundancias químicas de las nebulosas planetarias (PNe) y las regiones HII obtenidas a partir de ambos métodos, líneas de excitación colisional (CELs) y líneas de recombinación (RLs). Construímos dos modelos que reproducen la masa de gas y O/H derivado de los dos métodos, esto con la finalidad de discriminar entre las abundancias obtenidas por CELs y RLs. Ambos modelos están en cierto acuerdo con las observaciones, sin embargo el valor de $\Delta Y/\Delta Z$ predicho por el modelo RLs está en mejor acuerdo con los valores observados en las galaxias Irr.

ABSTRACT

We present chemical evolution models for the dwarf irregular galaxy NGC 6822, using as observational constraints chemical abundances of planetary nebulae (PNe) and HII regions derived from both, collisionally excited lines (CELs) and recombination lines (RLs) methods. We built two models that reproduce gaseous mass and the O/H derived for those two methods in order to discriminate between abundances obtained by CELs and by RLs. Both models produce a fair agreement with observations, but the predicted $\Delta Y/\Delta Z$ value for the RLs model is in better agreement with those values observed in Irr galaxies.

Key Words: galaxies: evolution — galaxies: individual (NGC 6822) — HII regions — planetary nebulae: general

1. INTRODUCTION

Planetary Nebulae constitute one of the most valuable chemical tracers of the past abundances in the interstellar medium (ISM). Therefore PNe characteristics are important as observational constraints in chemical evolution models, allowing us to improve the inferred chemical history (Hernández-Martínez et al. 2009, and references therein). The chemical evolution equations take into account many physical parameters, involving the formation and evolution of a given galaxy (e.g., infall galactic winds and the formation and evolution of stars of different masses). Due to the complexity of the problem, those equations are solved through numerical methods. We built chemical evolution models similar to that proposed by Franco & Carigi (2008) with a time-delay prescription for the chemical enrichment produced by low and intermediate mass stars (LIMS). This time-delay term considers the ejection of the nuclear processed material to the ISM at a single time after the star formation, while for the contribution of massive stars we adopt the instantaneous recycling approximation. In Hernández-Martínez, L., et al. (2011, in preparation) we present several models that explore different parameters of the chemical evolution equations in order to discriminate between the values of abundances obtained from CELs and RLs (see also Hernández-Martínez et al. 2009).

2. MODELS

We computed chemical evolution models under the following assumptions: (a) the gas infall rate and the star formation history proposed by Carigi et al. (2006), (b) the initial mass function (IMF) by Kroupa et al. (1993) between 0.1 $M_\odot$ and $M_{\rm up}$ being $M_{\rm up}$ a free parameter adjusted to reproduce the observed O/H abundance ratios derived from CELs and RLs (both corrected by dust depletion), (c) Z-dependent stellar yields for LIMS, massive stars, and SNIa (see Hernández-Martínez et al. 2009), (d) 1% of the stars with masses between 3 and 15 $M_\odot$ form binary systems and every one of those systems becomes a SNIa, and (e) a well mixed outflow that begins at t = 1.2 Gyr (that is the time when the SFR starts) up to 5.1 Gyr in order to reproduce the present-time gaseous mass of the galaxy.

Figure 1 shows two chemical evolution models for NGC 6822. The CELs and RLs models reproduce abundances obtained by collisionally excited

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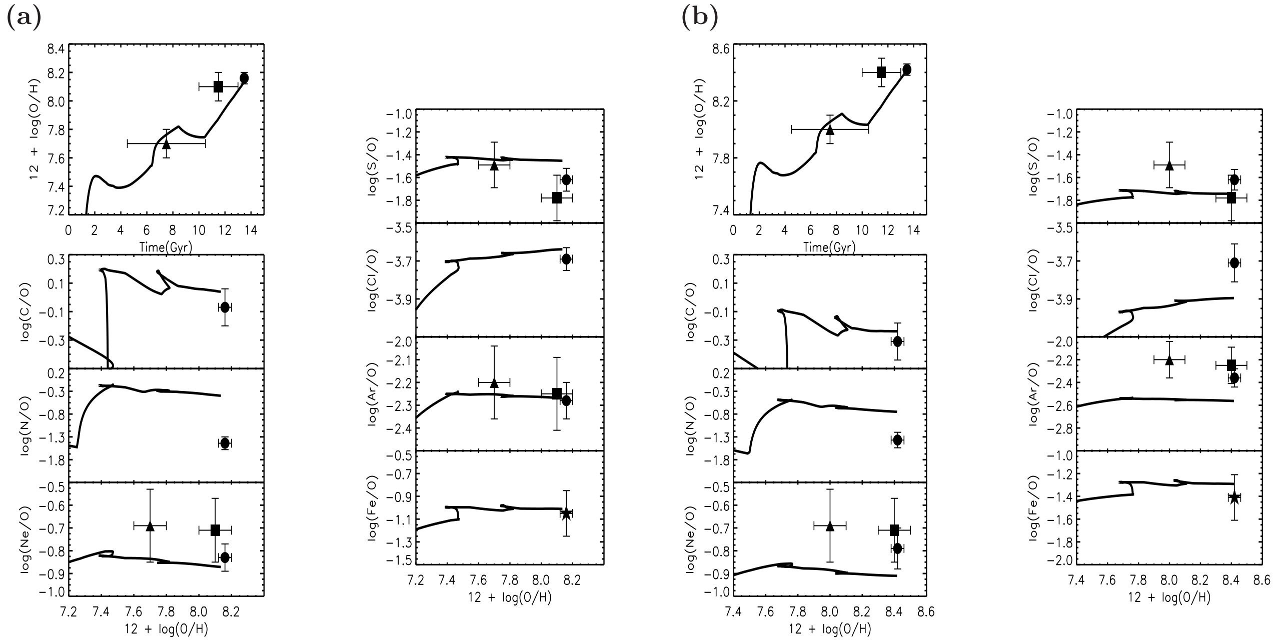

Fig. 1. Chemical evolution of NGC 6822 as predicted by the CELs model (a) and the RLs model (b). Filled circles, filled squares, and filled triangles represent the observational values for HII regions, young, and old PN populations, respectively. The filled star in the Fe/O panels show the ratio of Fe/H value from A-type stars by Venn et al. (2001) and our own O/H values.

lines (CELs) and recombination lines (left and right panels, respectively). The two models fit the same number of observational constraints, in particular both reproduce the evolution of the O/H abundance, as given by the present and past components of the ISM, HII regions, and young and old PNe and also some abundance ratios as log(C/O), log(Ne/O), log(S/O), log(Fe/O). Both models fail in reproducing the N/O ratio, the CELs model predicts 1.0 dex higher, while RLs model 0.6 dex higher than the observed values. The RLs model adopted a more traditional $M_{\rm up}$ of 80 $M_\odot$ (similar to the value derived for the solar vicinity), while the CELs model required an $M_{\rm up}$ of 40 $M_\odot$.

3. CONCLUSIONS

We present chemical evolution models for the Local Group galaxy NGC 6822 using as observational constraints chemical abundances of planetary nebulae and HII regions. These abundance were derived from collisionally excited lines and recombination lines. Our aim was to determine which set of abundances provided a better fit to the models, the set based on CELs or the set based on RLs. Both models produce a fair agreement with observations, but the predicted $\Delta Y/\Delta Z$ value for the RLs model is in better agreement with the $\Delta Y/\Delta Z$ ratios presented in the literature for irregular galaxies. The main characteristics of the models for NGC 6822 are presented in Hernández-Martínez et al. (2009) and Hernández-Martínez et al. (2011).

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