LOW RATE STAR FORMATION ACTIVITY DURING QUIESCENT PHASES IN DWARF GALAXIES

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Abstract

Observations of quiescent dwarfs and low surface brightness galaxies suggest that continuous low rate star formation is likely to occur, during the quiescent phases between bursts, in dwarf galaxies. We thus have used a spectrophotometric model to reproduce the observed abundances in IZw 18, assuming only a low constant star formation rate. We conclude that such a continuous low star formation rate cannot be neglected, especially when considering the chemical evolution of very metal poor objects.

1 Introduction

Blue compact dwarfs galaxies (BCDG) are still experiencing a strong star formation event. Their low metallicity suggests that these objects are unevolved. The nature and the age of the most underabundant ones are still controversial: are they "young" galaxies forming stars for the first time or older systems which have evolved very slowly ? Despite of extensive searches, no local galaxy with a metallicity lower than 1/50 $Z\odot$ has been found, nor massive primordial HI clouds, without optical counterpart, at low redshift. These facts could indicate that these objects are not "young" objetts experiencing their first episode of star formation.

2 Abundance profiles in BCDG

Kunth & Sargent [9], to explain why no galaxy with a metallicity lower than 1/50 $Z\odot$ has yet been found, have suggested that during the starburst phase, metals ejected by the massive stars very quickly enrich the surrounding HII region. They show that the metallicity would reach a value up to 1/50 $Z\odot$ in few Myrs. In this scenario, an abundance discontinuity, between the central starburst region (polluted) and the external regions (more pristine), is expected. However, recent abundance measurements in IZw 18 ([11], [12]) and in other starburst galaxies ([8] and references therein) have shown a remarkable homogeneity within the HII regions over scales larger than 600 pc. On the other hand, these results appear in contradiction with time-scales required to disperse and mix the newly synthesized elements, as calculated by Roy & Kunth [14]. Therefore the most likely possibility is that during a starburst, heavy elements produced by the massive stars are ejected with high velocities in a hot phase, and leave the HII region ([1], [8], [11], [15]). This implies that the observed metals do not come from the present burst, but from a previous star formation event.

3 Low rate star formation during quiescent phases

Several studies of IZw 18 have shown that the current burst was not the first star formation event in the history of that galaxy ([3], [6], [10], [4], [7]). For example, Kunth et al [10] have shown that a starburst comparable to the present one could be sufficient to account for the observed abundance. However, such a Star Formation Rate (SFR) cannot be maintained for a long time without producing excessive enrichment and consuming all the gas. Starbursts episodes must therefore be separated by quiescent phases, during which these objects are supposed to appear as quiescent dwarfs or Low Surface Brightness Galaxies (LSBG). However, studies of these later objects have revealed that their SFR was very low but not zero ([17]). Thus the metallicity increases slowly during these quiescent phases. We then have used a spectrophotometric model to investigate how this low continuous star formation rate can account for the abundances observed in IZw 18.

4 Modeling of IZw 18

4.1 Description of the model

We used the spectrophotometric model described by Devriendt et al [2]. The main features of the model are the following:

1) A normalized 1 $M_\odot$ galaxy is considered as a one zone closed system with instantaneous and complete mixing.

2) The stellar lifetimes are taken into account, *i.e.*, no instantaneous recycling approximation is used.

3) The model uses the evolutionary tracks from the Geneva group and the yields from Maeder [13].

4) The stellar output spectra are computed at each age using synthetic stellar libraries.

5) We used two typical different IMF (Salpeter and Scalo) described as a power law $\phi(m) = a.m^{-x}$ in the mass range 0.1-120 $M_\odot$.

6) The evolution of several chemical elements (C,O,Fe), the total metallicity, the mass of gas, is followed in detail.

We adopted a value of 10^8 $M_\odot$ for the initial mass of gas in IZw 18. A constant SFR was adjusted to reproduce the observed oxygen abundance in IZw 18 after 16 Gyrs. Finally, a strong star formation episode at 16 Gyrs (with a SFR of 0.04 $M_\odot/yr$ over 50 Myrs) was added to reproduce the current burst and compare the predicted colors with the observed ones.

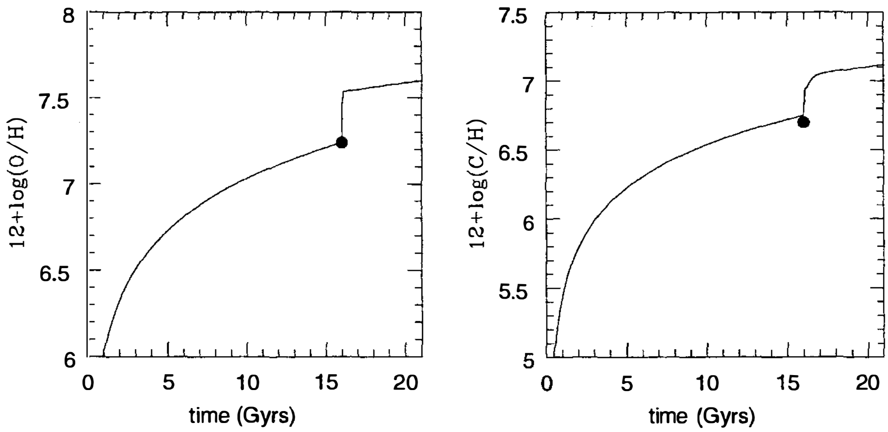

Figure 1: Evolution of abundances with time assuming a Scalo IMF. The measured abundances in IZw 18 are represented by a dot at 16 Gyrs.

4.2 Results

We found the required continuous SFR to be around 10^{-4} $M_{\odot}.yr^{-1}$ in order to reproduce the observed oxygen abundance in IZw 18. This SFR is ten times lower than what is typically observed in LSBG and 400 times lower than the present one. The carbon abundance [3] observed in IZw 18 is well reproduced as shown in fig 1.

The resulting magnitudes shown in fig 2, assuming a distance of 10 Mpc for IZw 18, are compatible with the measurements of Thuan [16] and Huchra [5].

Van Zee et al [18] reported a size for the HI envelope (at a column density of 10^{20} atom cm^{-2}) in IZw 18 of 60"x45" *i.e.,* 3x2.3 kpc. Using this value and assuming that the underlying stellar component due to the constant star formation process is uniform, we have evaluated the surface brightness produced by this old population to be 29.3 mag.arcsec^{-2} in the B band and 26.3 mag.arcsec^{-2} in K. Further observations should be performed in order to observe this faint population in region far from the central burst.

5 Conclusions

This modeling indicates that IZw 18 could undergo its first "burst" of star formation, but would not be a "young" galaxy in the sense that a mild process of star formation already started a long time ago. If these kind of objects are not "young", this would reconciliate with the negative detections of massive primordial HI clouds, without optical counterpart, at low redshift, required for their late formation, explaining why no galaxies with a metallicity lower than 1/50 $Z\odot$ have been found.

We have shown that, low rate star formation is likely to occur during the quiescent phases between bursts in dwarfs galaxies and cannot be neglected, especially when dealing with the chemical evolution of very metal poor objects. A more detailed version of this work will be presented elsewhere ([12]).

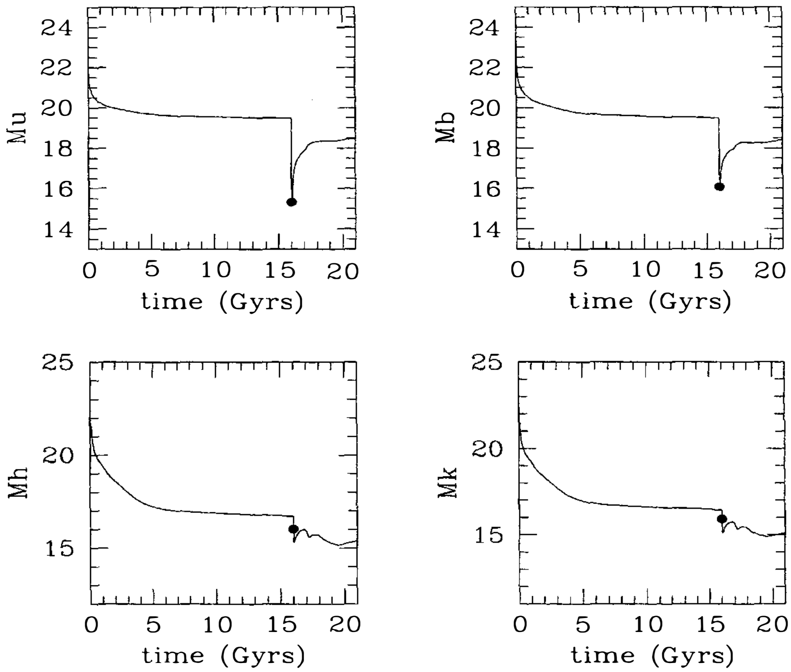

Figure 2: Evolution of colors with time assuming a Scalo IMF. The measured colors ([16] [5]) in IZw 18 are represented by a dot at 16 Gyrs.

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