HII REGIONS EVOLUTION:

BY USING POPSTAR EVOLUTIONARY SYNTHESIS MODELS

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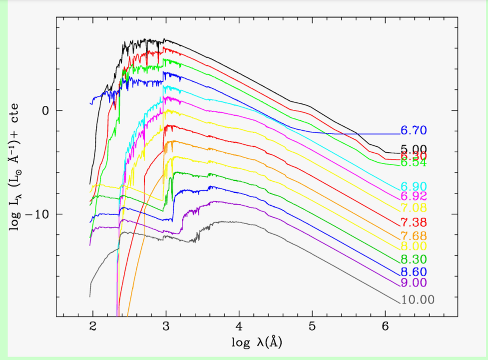
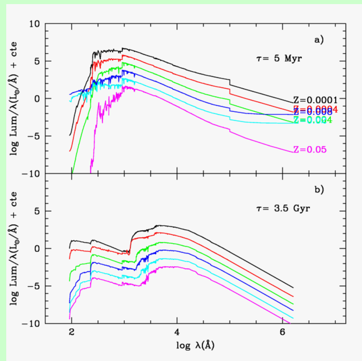
Abstract. We show the results from a series of papers where we present the POPSTAR evolutionary synthesis models. The ionizing Spectral Energy Distributions (SEDs) are those obtained by the POPSTAR code (Mollá etal. 2009) for six different metallicities, with a very low metallicity set, Z=0.0001, not included in previous similar works. We compute the synthetic emission line spectra of HII regions ionized by young star clusters by combining the cluster SEDs with the photoionization code CLOUDY, for seven values of the cluster mass and ages ranging between 0.1and 5.2 Myr (Martín-Manjón etal. 2010). We assume that the radius of each HII region is the distance at which the ionized gas is deposited by the action of the mechanical energy of massive star winds and supernovae from the central ionizing young cluster. This allows us to eliminate the ionization parameter u as a free argument, since now its value is set from the cluster physical properties (mass, age and metallicity) and from the chemical gas properties (hydrogen density and abundances). Finally we calculate the contribution of these emission lines to the broad band colors (García-Vargas etal. 2010). The color-color diagram are strongly affected, and consequently the interpretation of stellar properties from photometrical observations.

A. RESULTS FROM EVOLUTIONARY SYNTHESIS MODELS: SEDs AND COLORS

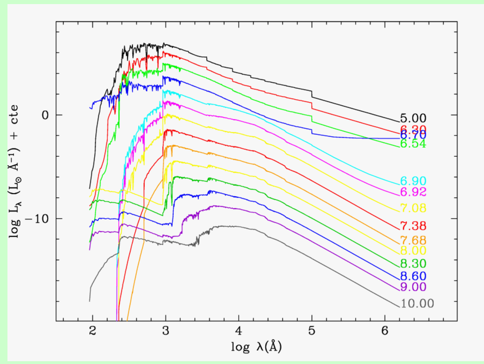
1. Spectral Energy distributions: dependence on the stellar population age



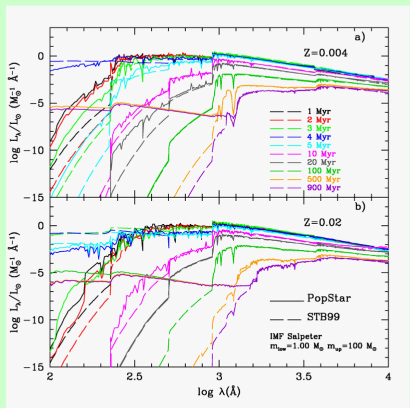
2 Spectral Energy distributions: dependence on the stellar population metallicity



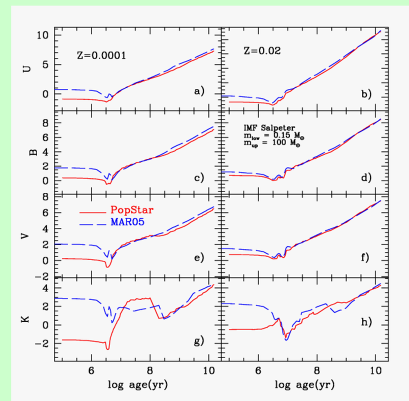
3 Spectral Energy distributions: the nebular continuum contribution



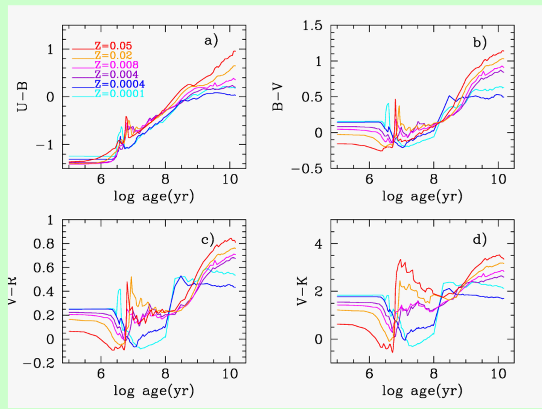
4 Influence of the nebular continuum contribution comparison with STB99



5 Influence of the nebular continuum contribution comparison with BC03

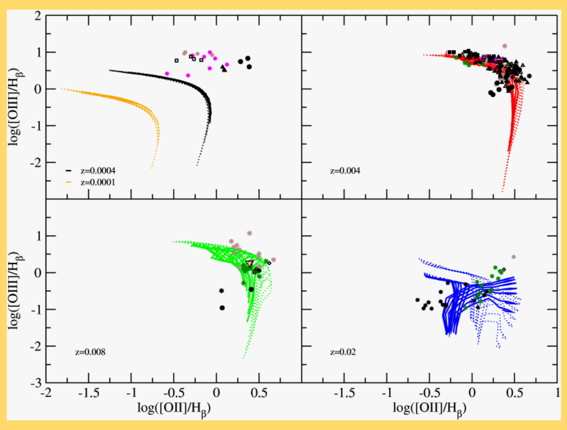


6 Color-Age Evolution for young ionizing clusters



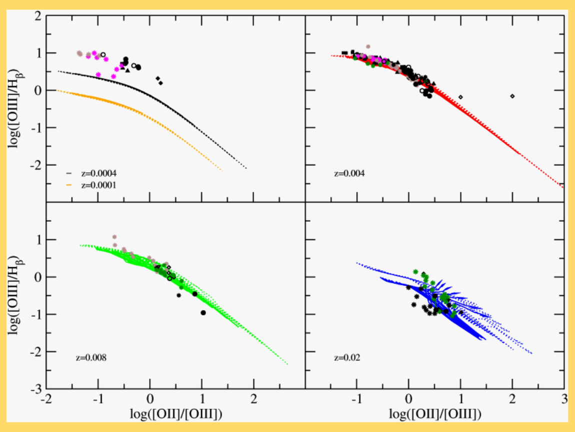
Models are based in the Padova isochrones. The atmosphere models are from Lejeune et al. (1997) complemented by the NLTE models from Smith et al.(2002) for hot stars (O, B and WR stars) and from Rausch (2003) for P-AGB and PN stars. The basic grid is composed by Single Stellar Populations (SSP) for five different IMFs: two based on Salpeter power law (Salpeter, 1955), with a mass range 0.85 - 120 $M_{\odot}$ and 0.15 - 100 $M_{\odot}$ respectively, and those of Ferrini et al. (1989), Kroupa (2002) and Chabrier (2003) functions, with masses between 0.15 and 100 $M_{\odot}$. These models do not include binaries either mass segregation. The isochrones are those from Bressan, etal. (1993), Fagotto et al (1994a,b) and Girardi (1996) for 6 different metallicities: Z = 0.0004, 0.001, 0.004, 0.008, 0.02 and 0.05. The age coverage is from log age = 5.00 to 10.30, with a variable time resolution which is Δlog age = 0.01 in the youngest stellar ages. The WC and WN stars are identified in the isochrones.

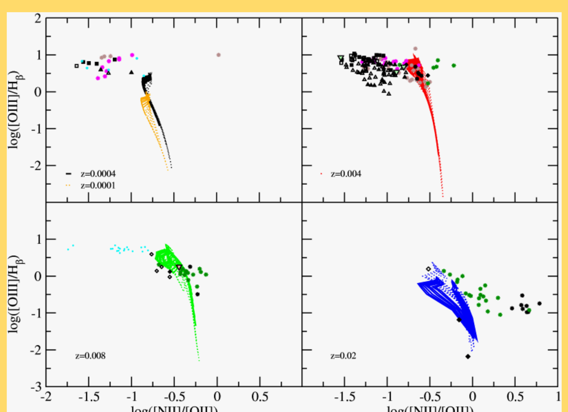
B. THE PHOTOIONIZATION MODELS: THE EMISSION LINE INTENSITIES

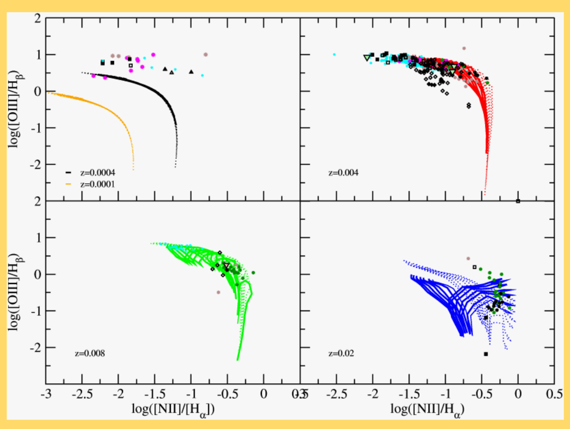


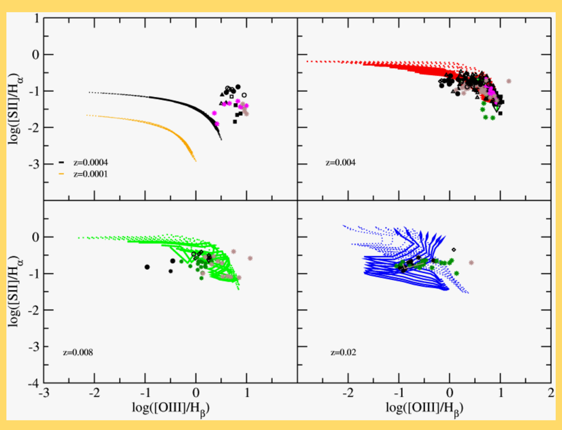
By using the CLOUDY photoionization code and the resulting spectra for different ages and metallicities, we obtain the emission lines spectra for HII regions in a mass range from 0.12 to $2\times10^{5} M_{\odot}$.

We show the diagnostic diagrams together with a set of observations for which the metallicity has been carefully calculated

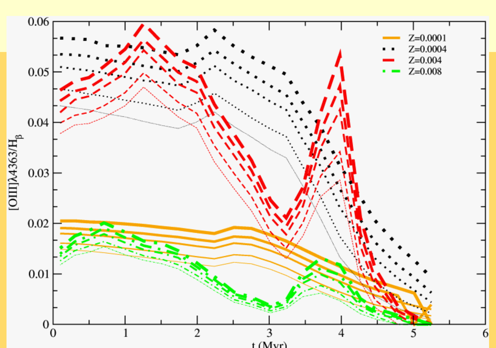


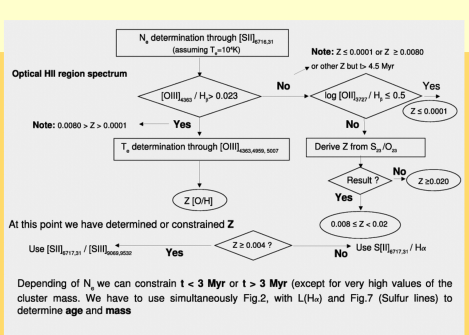


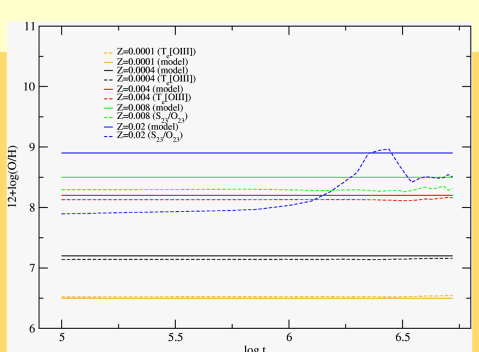




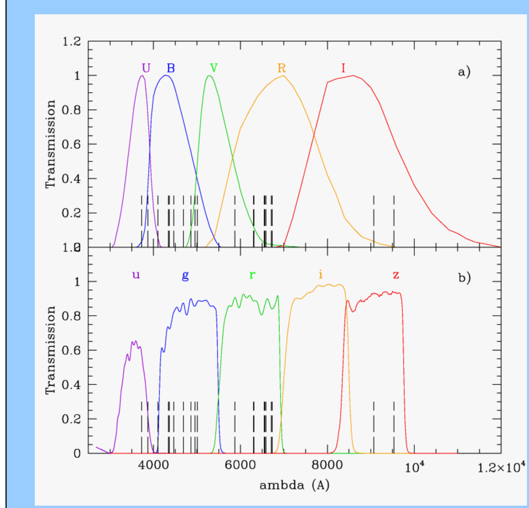
The values of the [OIII] lines (at λλ 4363, 4959, 5007A) in the lowest metallicity nebulae are found to be very weak and similar to those coming from very high metallicity regions (solar or over-solar). Thus, the sole use of the oxygen lines is not enough to distinguish between very low and very high metallicity regions. In these cases we emphasize the need of the additional support of alternative metallicity tracers, like the [SIII] lines in the near-IR.







C. CONTRIBUTION OF EMISSION LINES TO BROAD BAND FILTER COLORS



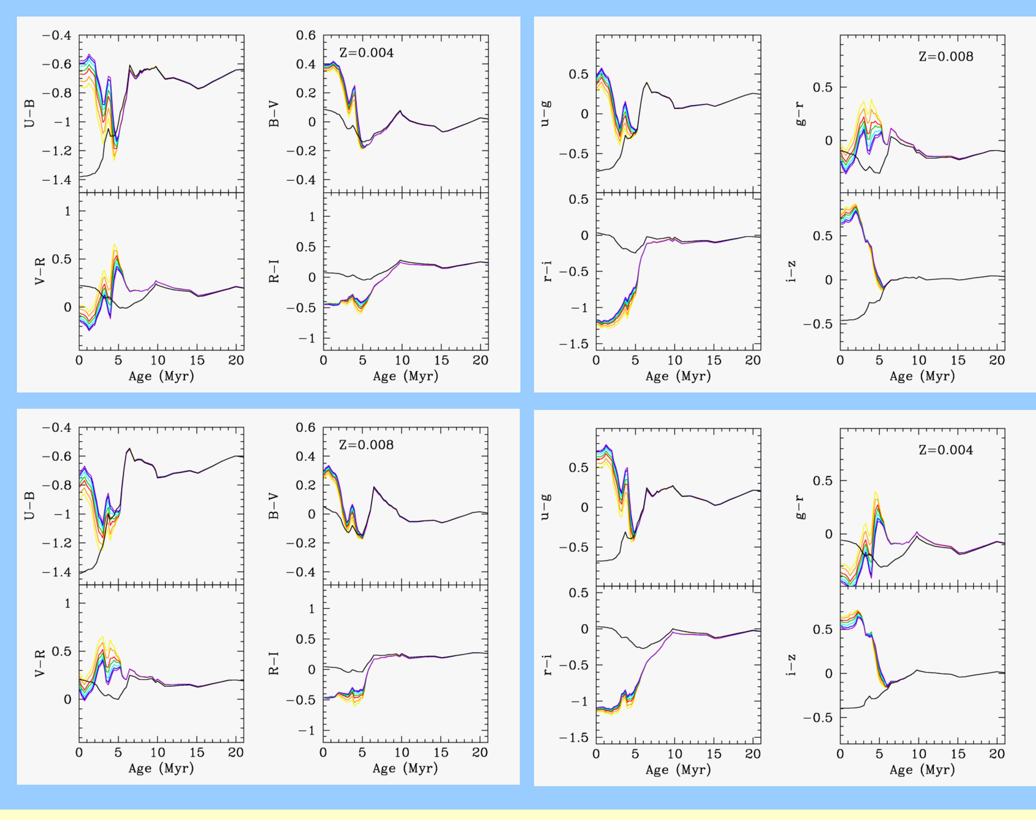
Once the photoionization models with SSP-SEDs have been computed with the use of CLOUDY, we get the intensities of the optical emission lines.

Some intense emission lines fall in the Johnson and SDSS broad band filters. The contribution depends on the filter transmission curve and the redshift, which places a given line in a different wavelength within the passband. We have calculated the contribution at z=0 in the U, B,V, R, I, and Z Johnson filters and the u, g, r and z SDSS filters.

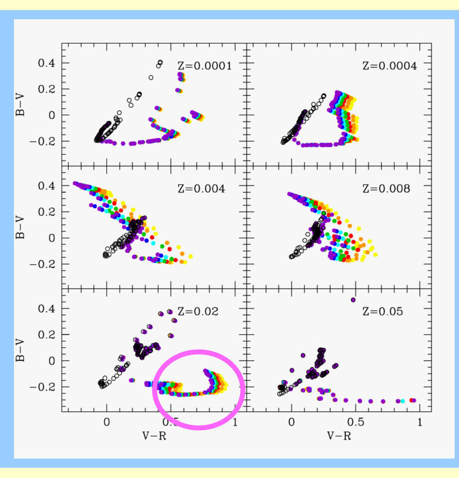
We include the contributions of the emission line to the magnitudes.

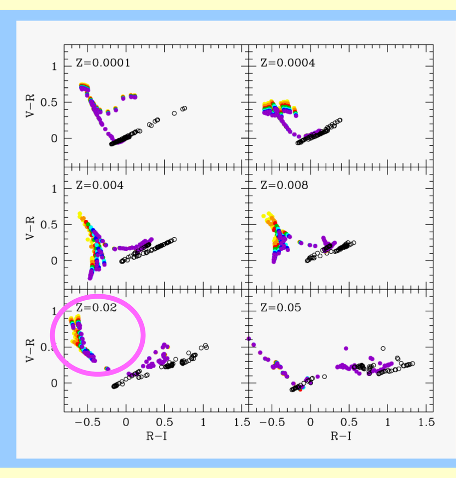
Colors for the youngest clusters (age< 10Myr) are then modified.

Hα keeps its influence over the R and r bands until almost 20 Myr for the lowest metallicities

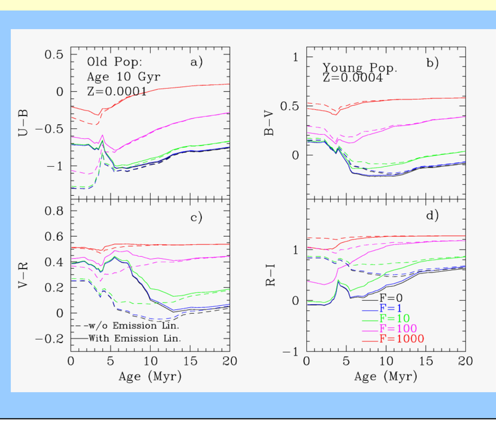


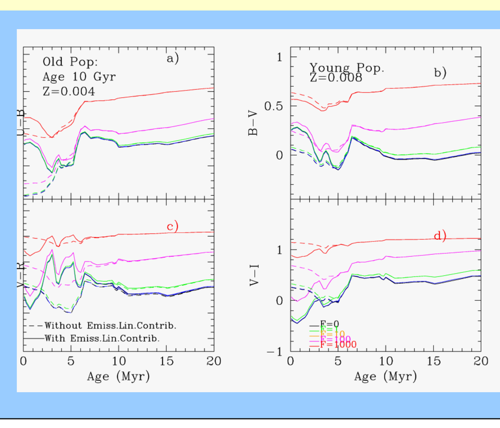
The contribution of the emission line to the color-color diagrams: points go out of the stellar population region each time that a burst of star formation takes places falling in a region impossible to reach in any other way. The position of young SSP populations in color-color diagrams changes considerably





When we mix two populations, young and old, the resulting colors are quite different than the ones synthesized without the emission lines contribution.





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