

We present new stellar population models that include the contribution of the Thermally-Pulsing Asymptotic Giant Branch (TP-AGB). The TP-AGB phase marks the spectrum with peculiar spectro-photometric features in the near-IR ($\lambda > 0.6 \mu\text{m}$) for a very short period ($0.4 < t/\text{Gyr} < 2$). Now that the Spitzer Space Telescope has access to the rest-frame near-IR at high redshifts, these models allow the use of the TP-AGB phase as age indicator also for primeval galaxies.

The determination of galaxy ages, that is accomplished by comparing observed spectra with stellar population models, is crucial to constrain galaxy formation models. However this task is very complicated since the stellar light is degenerate with respect to age and chemical composition. An exception are ages around 1 Gyr, when Thermally Pulsing Asymptotic Giant Branch (TP-AGB) stars are the dominant source of energy in the bolometric and near-infrared. In fact TP-AGB stars develop only in the narrow age range 0.4 to 2 Gyr and distinguish themselves by peculiar spectrophotometric features, like red colours (e.g. $V-K \sim 3.2$) and molecular absorption bands. If detected, these stars are a robust age indicator for the underlying stellar population. However they are usually not included in stellar population models.

Here we present stellar population models that include the TP-AGB phase.

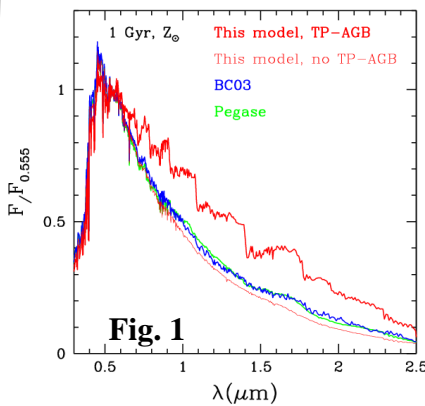


Fig. 1. Model SED of a 1 Gyr stellar population including the TP-AGB phase (thick red). Note the same model in which the phase was subtracted (thin red). Other models in the literature (blue, green) do not show the features of TP-AGB stars (Maraston 2004).

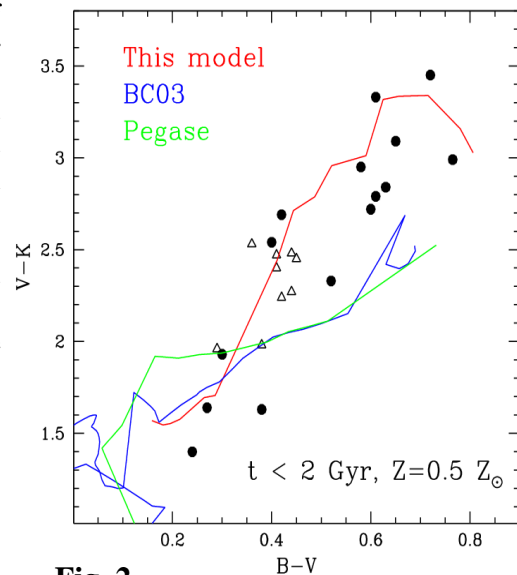


Fig. 2

Fig. 2. Model calibration with ~ 1 Gyr old globular clusters (GCs). Only our models can reproduce the GC data. (Maraston 2004).

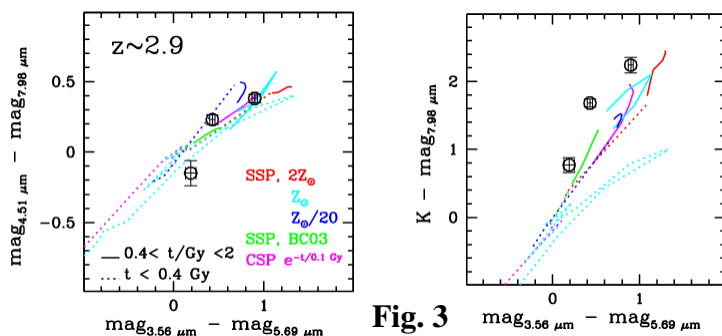


Fig. 3

Fig. 3. Galaxy observed-frame colours at redshift ~ 3 . The Spitzer data by Yan et al. 2004 (symbols) are compared with several stellar population models. AGB-ages between 0.4 and 2 Gyr are the thick lines, ages < 0.4 Gyr the dotted lines. One galaxy sticks out for having colours so red to require the inclusion of TP-AGB stars, **therefore is very likely ~ 1 Gyr old**. The galaxies have been dated to be 2.5 Gyr old by Yan et al. 2004 on the basis of models not containing the TP-AGB phase (green lines). However, this age is **larger than the age of the Universe at this redshift** (Maraston 2004)

References:

- Yan et al. 2004, ApJ, *in press*, astro-ph 0408070
- Maraston, C. 2004, MNRAS, *submitted*