How accurate are the stellar masses of massive galaxies?
Constraining the TP-AGB phase

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Introduction

Galaxy evolution studies at all epochs strongly rely on stellar population synthesis (SPS) models. These models are key in deriving stellar masses, stellar population properties, and in some cases even redshifts from spectra and broadband photometry. Nonetheless, SPS models are still poorly calibrated for certain stellar evolution stages. Of particular concern is the treatment of the thermally pulsing asymptotic giant branch (TP-AGB) phase, as different implementations lead to systematic differences in derived galaxy properties. Post-starburst galaxies are a promising calibration sample, as TP-AGB stars are thought to be most prominently visible during this phase. Here, we use post-starburst galaxies in the NEWFIRM medium-band survey (NMBS, Whitaker et al. 2010) to assess different SPS models.

Conclusions

Our composite post-starburst galaxy SED demand a very low contribution from TP-AGB stars to the near-infrared spectrum. Using the flexible SPS models by Conroy et al. (2009), we find that the bolometric luminosity of TP-AGB stars is a factor of ~3 lower than predicted by the latest Padova TP-AGB models (when assuming Z⊙). The significant reduction in the bolometric luminosity of TP-AGB stars that is required to fit the observed post-starburst SED reflects one or more failures of the current generation of SPS models. This reduction can be physically achieved in the models by reducing TP-AGB lifetimes, reducing bolometric luminosities of stars in the TP-AGB phase, and/or embedding a significant fraction of TP-AGB stars within optically thick circumstellar dust shells.

Downloads

• Composite post-starburst galaxy spectrum: www.cfa.harvard.edu/~mkriek
• NMBS images: www.astro.yale.edu/nmbs
• Flexible SPS models: www.cfa.harvard.edu/~conroy

References


Figure 1: Comparison of a 1 Gyr Z⊙ spectral energy distribution (SED) of the Maraston (2005) [M05] models, with and without TP-AGB phase to the Bruzual & Charlot (2003) [BC03], Pegase and SB99 models (Fig. from Maraston 2005).

Figure 2: Medium-bandwidth filters designed for the NMBS. The filters unambiguously pinpoint the location of the redshifted Balmer break for galaxies at 1.5<z<3.0 enabling very accurate redshift measurements. The NMBS covers 0.2 square degrees in the COSMOS and AEGIS fields (Fig. from van Dokkum et al. 2009).

Figure 3: The post-starburst galaxies in our sample are selected by their red rest-frame U_m-B_m colors (strong Balmer breaks) and relatively blue B_m-V_m colors, as indicated by the black box (Fig. from Kriek et al. 2010).

Figure 4: Composite post-starburst SED (black dots), derived from the individual SEDs (gray dots) of 62 post-starburst galaxies in the NMBS. The best-fit BC03 and M05 SPS models to the full spectrum, with the same resolution as the data, are shown by the orange (overlaps with the red curve) and purple curves, respectively. The red and blue curves show the respective best fits when excluding λ > 6000 Angstrom in the fit. The inset represents the χ² value per degree of freedom vs. the mean stellar age for both SPS models. The BC03 models more accurately reproduce the SED shape of post-starburst galaxies than the M05 models, implying that the latter give too much weight to TP-AGB stars (Fig. from Kriek et al. 2010).