A JavaScript Passive Evolution Calculator

When there is no new star formation, galaxies evolve "passively", i.e., they redden and fade as stars turn off of the main sequence. In principle, this evolution can be measured by comparing the mass-to-light ratios and colors of distant passively evolving galaxies to those of nearby ones. The measured evolution can then be compared to predictions from stellar population syntesis models, to determine ages and other parameters.

This technique has been applied successfully to determine the ages of early-type galaxies in the field and clusters, out to redshifts $z \sim 1.25$ (e.g., van Dokkum & Franx 1996; Treu et al. 2002; van der Wel et al. 2004). However, there is growing evidence that the number of early-type galaxies is not stable with time, but decreases with redshift (e.g., Dressler et al. 1997; van Dokkum et al. 2000; Bell et al. 2004). The implication of such complex evolution is that the sample of early-type galaxies at high redshift is a biased subset of the sample at $z = 0$, containing only the oldest progenitors of today's early-types. This "progenitor bias" leads us to overestimate the ages of today's early-type galaxies.

In van Dokkum & Franx (2001), we quantified the effects of progenitor bias on the observed luminosity and color evolution of early-type galaxies, and developed a simple model which can provide the bias-corrected ages of early-type galaxies for an assumed rate of morphological evolution. Here we present a JavaScript calculator for predicting the luminosity and color evolution of passively evolving galaxies, based on the van Dokkum & Franx (2001) parameterization.

Simple evolution

In its simplest form, the calculator provides the evolution of a stellar population with a given luminosity-weighted formation redshift ("Default 1"). Figure 1 shows examples of the output, for a stellar population formed at $z = 6$.

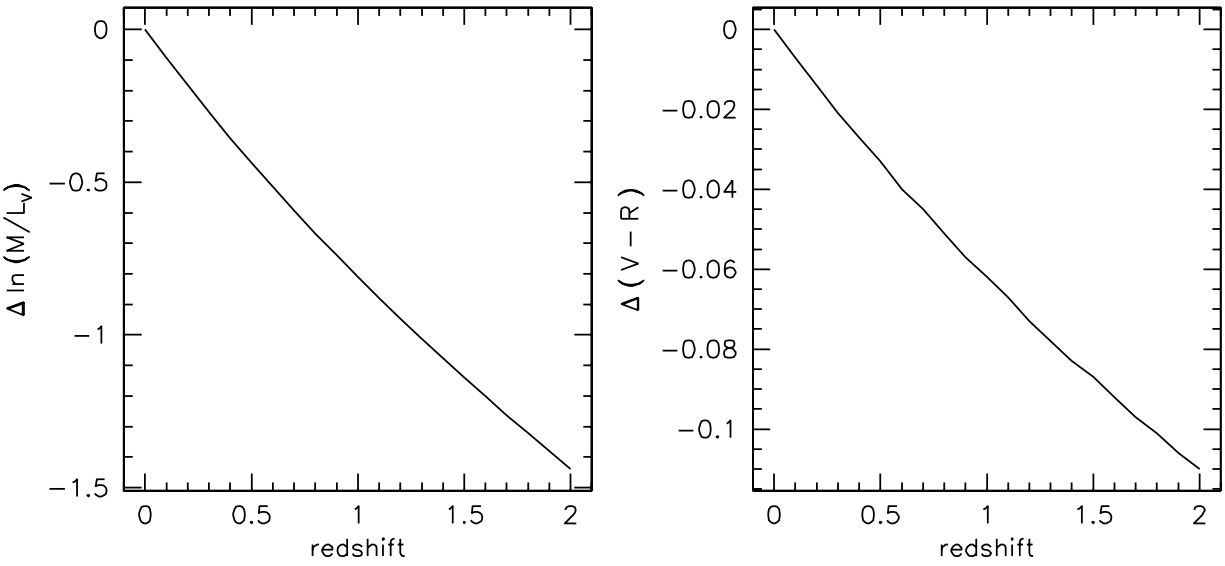

Figure 1: Example output for a single stellar population formed at $z = 6$.

Complex evolution

The calculator can also incorporate morphological evolution (i.e., progenitor bias) and complex star formation histories of individual galaxies. The calculator provides the luminosity evolution, scatter in luminosity, color evolution, scatter in color, the fraction of today's early-type galaxies formed at a given redshift, and the luminosity-weighted stellar formation redshift of the early-types at that redshift. The example below shows some of the output for "Default 3", a model with strong morphological evolution.

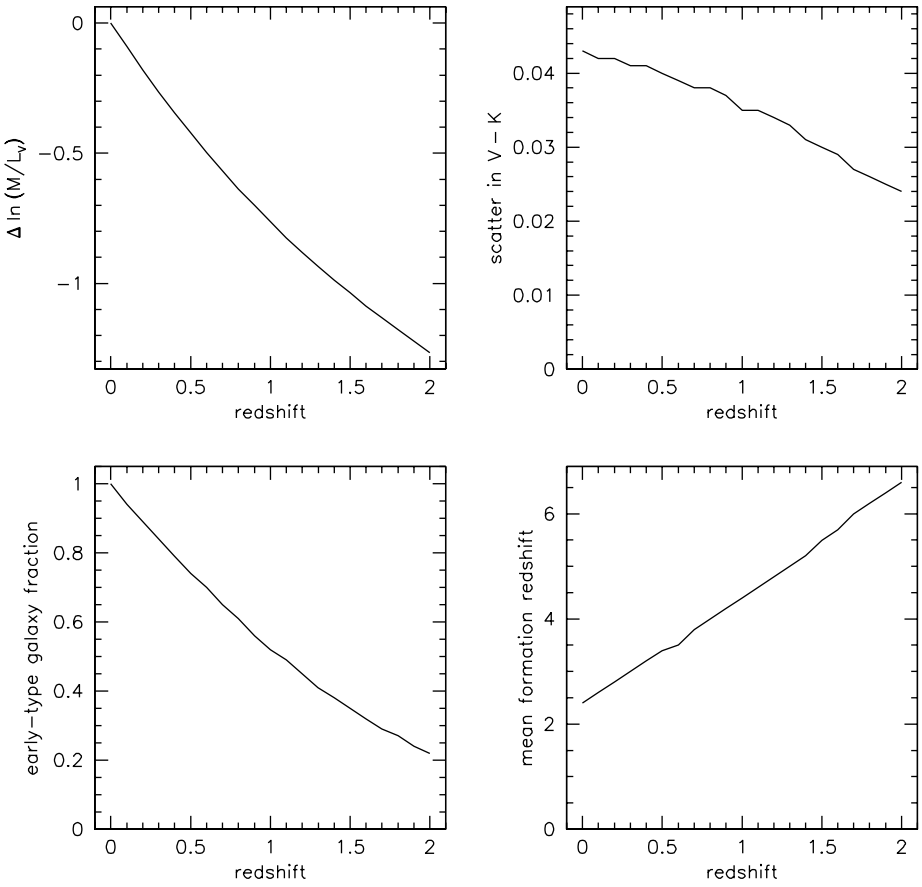

Figure 2: Model with strong morphological evolution. Although only $\sim 20\,\%$ of present-day early-types were in place by $z = 2$, the luminosity evolution is very similar to that in Fig. 1, and the scatter in $V-K$ color is small at all redshifts. These counter-intuitive trends are explained in van Dokkum & Franx (2001).

Web location: **www.astro.yale.edu/dokkum/evocalc/**
Please refer to van Dokkum & Franx (2001) if you use this calculator.

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van der Wel, A., Franx, M., van Dokkum, P. G., Rix, H.-W. 2004, ApJ, 601, L5
van Dokkum, P. G., & Franx, M. 1996, MNRAS, 281, 985
van Dokkum, P. G., Franx, M., Fabricant, D., Illingworth, G. D., & Kelson, D. D. 2000, ApJ, 541, 95
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