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GalevNB: GALEV for *N*-body simulations

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Abstract. We report on GalevNB (Galev for *N*-body simulations), an integrated software solution that provides *N*-body users direct access to the software package GALEV (GALaxy EVolutionary synthesis models). GalevNB is developed for the purpose of a direct comparison between *N*-body simulations and observations. It converts the fundamental stellar properties of *N*-body simulations, i.e., stellar mass, temperature, stellar luminosity and metallicity, into observational magnitudes for a variety of filters of widely used instruments/telescopes (HST, ESO, SDSS, 2MASS), and into spectra that span from far-UV (90 Å) to near-IR (160 μm).

Keywords. *N*-body, magnitude, spectra

1. Introduction

The output parameters of `NBODY6++` (Aarseth 1999) simulations are mostly theoretical values. To make a direct comparison between *N*-body simulation data and observations, we combine GALEV (GALaxy EVolutionary synthesis models; Kotulla *et al.* 2009), a flexible algorithm to combine astrophysical colors in many filters and spectra of stars (Lejeune, Cuisinier & Buser 1997, 1998) or sets of stars, with `NBODY6++` simulations. In this paper, we present the structure of this new code: GalevNB (Galev for *N*-body simulations). Adapting subroutines from GALEV, GalevNB can produce spectra spanning the range from far-UV at 90 Å to far IR at 160 μm, with a spectral resolution of 20 Å in the UV-optical and 50-100 Å in the near IR range. Given a list of requested filters in HST, ESO, SDSS, 2MASS etc., GalevNB convolves the spectra with the filter response functions and applies the chosen zero-points (Vegamag, ABmag, and STmag) to yield absolute magnitudes. GalevNB bridges theoretical parameters and their observed values, thus allows us to understand the color and spectra evolution of star clusters, and to determine the initial conditions and parameters of star cluster simulations with a direct comparison to observations.

2. GalevNB structure and execution

The main program of GalevNB is `GalevNB.f90`, which parses single snapshot files (stellar evolution only) generated by `NBODY6(++)`. It uses seven subroutines (`startomaginit`, `specint_initialize`, `reset_weights`, `startomag`, `add_star`, `spec2mag`, `spec_output`) of GALEV package to convert effective temperature, stellar luminosity, metallicity, and mass into observational magnitudes and spectra. The functions of these routines are presented in Table 1. The GalevNB package contains four folders: 1) `spectral_templates`, in which locate all the spectral template files from the BaSeL library of model atmospheres (Lejeune, Cuisinier & Buser 1997, 1998); 2) `standard_filters`, contains a large set of filter response functions (FUV, NUV, U, B, V, R, I, J, H, K) that are used as

Table 1. Functions of subroutines computing magnitudes and spectra

Subroutine	Function
`specint_initialize`	initialize the stellar spectra
`reset_weights`	reset the weight of stellar spectra
`add_star`	integrate the flux of all stars in the cluster
`spec_output`	output spectra
`startomaginit`	initialize the stellar magnitude
`spec2mag`	convolve the stellar spectra with the filter response function
`startomag`	compute magnitudes for stars

Table 2. Column contents for the filter information file: `filterlist.dat`

Column	Content	ID of zero point
1	Filter name	
2	Corresponding path of the filter response function	
3	ID of selected zero point (default value is 1)	
4	Standard zero point in the Vega magnitude system	1
5	Standard zero point in the AB magnitude system	2
6	Standard zero point in the ST magnitude system	3
7	Optional user-defined zero point	4

standard reference filters; 3) `filter_response_curves`, includes filter response functions from magnitude systems of HST, ESO instruments, 2MASS, SDSS, Johnson, and Cousins in separate subfolders. We also provide a choice of user-specify filter response functions. Information about the entire set of available filters is included in the file `filterlist.dat`. Please be aware that `filterlist.dat`, in which the user specify their own choice of magnitude system by uncommenting the line of chosen filter, MUST be presented in the same directory as the `NBODY6(++)` snapshot files. The content of the file, `filterlist.dat`, is presented in Table 2.

To compile GalevNB, the user should have C++ and Fortran compilers installed. The input file of GalevNB should be a single snapshot output from `NBODY6(++)` simulations. In case of a file containing all snapshots (called `sev.83` in `NBODY6++` and `fort.83` in `NBODY6`), we provide the user with a shell script `generate_snapshots.sh` in the folder, `scripts`, for retrieving single snapshot data out of `sev.83` and `fort.83`. The user can select his/her preferred filters (maximum 20) by uncommenting the row of the corresponding filter in `filterlist.dat`, and choose his/her desired magnitude system (Table 2). Magnitudes of individual stars and the whole cluster, and spectra of the cluster or chosen stellar types are produced, respectively.

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