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Blue Stragglers from Primordial Binary Evolution

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Abstract. Binaries exist in all clusters and much evidence suggests that close-binary evolution makes an important contribution to the blue straggler population, at least in some clusters as well as in the field. Here we present different channels to blue stragglers from primordial binary evolution and examine their contributions to the integrated spectral energy distribution of the host clusters in theory via binary population synthesis.

Keywords. binary:close, stars: blue stragglers, stars: evolution

1. Introduction

Blue stragglers (BSs) were first found by Sandage in 1953, and many mechanisms have been provided to explain them ever since. These stars exist in all populations and their existence shows an incomplete understanding of stellar evolution and perhaps also of star formation within clusters. These strange objects lie above the main-sequence turnoff region in color-magnitude diagrams, and may significantly affect the integrated spectral energy distributions (ISEDs) of their host clusters by contributing excess spectral energy in the blue and ultraviolet (Xin & Deng 2005). It is becoming clearer that several mechanisms are responsible for the blue-straggler phenomenon. Generally the mechanisms may be divided into two types: one is from single stars and the other is from binaries. Both of them have advantages and limitations (see the review by Stryker 1993). It is likely that more than one mechanism occurs even within the same cluster to produce BSs, and primordial binaries are important contributors in some clusters as well as in the field.

There are three different channels leading to BS formation from primordial binary evolution. Channel A: mass transfer. During stable Roche lobe overflow (RLOF), the accretor goes upward along the main sequence, if it is a main sequence star, and becomes a BS when it is more massive than the turnoff of the host cluster. Channel B: contact binary. Also during stable RLOF, the accretor is also likely to fill its Roche lobe and the system becomes a contact binary. The contact binary eventually coalesces as a single main-sequence star, if both of the two components are on the main sequence. So the remnant may be a BS if it is more massive than the turnoff. Channel C: dynamically unstable RLOF between two main-sequence components. In this case, a common envelope (CE) is formed and the binary merges into a single star if CE cannot be ejected. The merger is a BS if its mass is beyond the turn-off mass of the host cluster. All binary evolutionary cases (i.e. cases A, B and C) can produce BSs from mass transfer but in various period range. Binary coalescence from case A evolution is a popular hypothesis for single BSs.

2. Binary Population Synthesis

We employ the binary population synthesis code originally developed by Han in 1994, which has been updated regularly ever since. The main input of the code is a grid

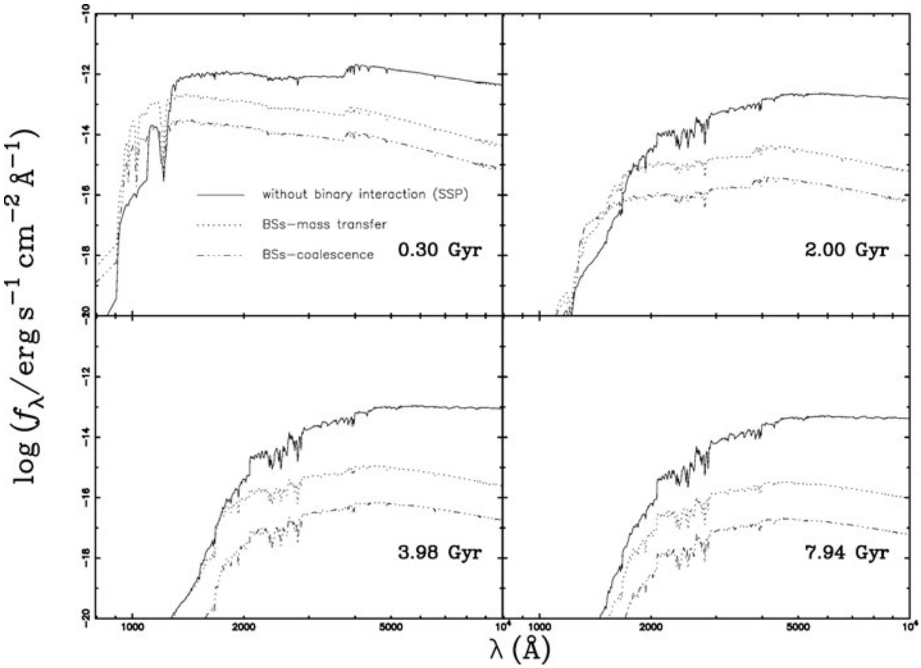

Figure 1. Integrated rest-frame intrinsic SEDs for a stellar population (including binaries) with a mass of $10^{10} M_\odot$ at a distance of 10Mpc. We see that BSs resulting from primordial binary evolution are dominant contributors to the ISED in UV and blue bands between 0.3 and 2.0 Gyr. The BSs and SSP have comparable energy in UV and blue bands between 2 and 4 Gyr.

of stellar evolution, which is calculated from Eggleton's stellar evolution code. Here a Population I grid ($Z = 0.02$) is adopted, and single stars are evolved via interpolations in the model grid. We adopt the critical mass ratio for stable RLOF $q_c = 3.2$ when the primary is on the main sequence or during Hertzsprung gap. If the mass donor is on the FGB or AGB, we use $q_c = 1.5$. For case A, we assume that RLOF is always conservative while various values of mass transfer efficiency are adopted for other cases. The mass lost from the system takes away a specific angular momentum in units of the specific angular momentum of the system. In order to obtain the colours and the ISED of the populations produced in our simulations, we use the latest version of the comprehensive BaSeL library of theoretical stellar spectra (Lejeune *et al.* 1997, 1998), which gives the colours and ISEDs of stars with a wide range of Z, log$g$ and $T_{\rm eff}$. Figure 1 shows the preliminary results from binary population synthesis.

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