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Massive close binaries and evolutionary synthesis of young starbursts

Dany Dionne

Département de physique and Observatoire du mont Mégantic
Université Laval, Québec, PQ, G1K 7P4, Canada

Abstract. With an evolutionary synthesis code, I follow the evolution of a starburst composed of massive close binaries (MCBs) and of single stars at various metallicities. Evolutionary tracks for MCBs have been developed in collaboration with D. Vanbeveren and C. de Loore. The models reproduce the observed WR/O ratio in the Magellanic Clouds.

1. Evolutionary synthesis

The evolutionary synthesis code is an updated version of the one developed by Leitherer *et al.* (1992). The single-star (SS) evolutionary tracks are the standard mass-loss tracks produced by the Geneva group (Schaller *et al.* 1992; Charbonnel *et al.* 1993; Schaerer *et al.* 1993a,b). The MCB evolutionary tracks are based on the work of de Loore & Vanbeveren (1994) for the primary stars and de Loore & Vanbeveren (1997, private communication) for the secondary stars. These tracks were re-normalized to avoid systematic differences with the Geneva tracks. The stellar population includes 30% MCB and 70% SS. Based on observations, 30% MCB seems a minimal value among O stars (Mason *et al.* 1998). As suggested by Vanbeveren *et al.* (1998), only the Case Br is considered for the MCB evolution in the models.

2. Results

The continuous star formation model predicts a WR/O ratio (see Fig. 1) of 0.020, 0.034, and 0.065 at a metallicity of 0.1 (*i.e.*, SMC), 0.25 (*i.e.*, $\sim$ LMC) and $1\,Z_\odot$. The observed ratios in the SMC, LMC, and solar environment are 0.015, 0.039, and 0.1, respectively (Azzopardi *et al.* 1988). There is excellent agreement between the observed and predicted WR/O ratio at low metallicities only when the MCBs are included. At low metallicity, we find that the WR population comes mainly from the MCBs. At higher metallicity, the model ratio deviates from the observation. An explanation involves the SS tracks used, as we find more WR stars when the stellar mass-loss rate is doubled (more WR are also expected when stellar evolution will include stellar rotation, which may be closer to reality than increasing the mass-loss rates; Maeder 1999). Population synthesis with MCB also predicts, for example, a stronger $H\beta$ around 5 Myr as massive stars are rejuvenated through the binary channel, especially at low metallicity. Colors are found to be bluer.

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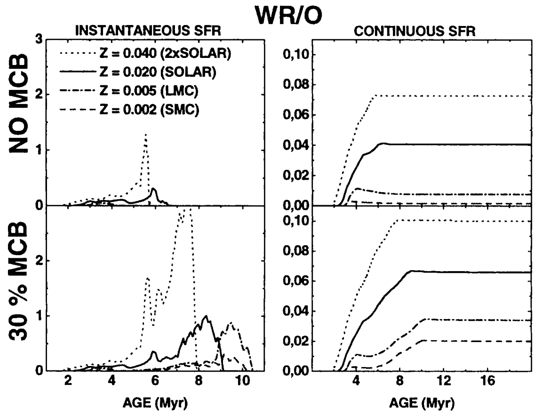

Figure 1. WR/O ratio as a function of burst age. A Salpeter IMF with stars from 1 to 120 $M_{\odot}$ was used.

3. Conclusion

MCBs exist. MCB evolution differs from SS evolution. At low metallicity, MCB evolution seems to reproduce better the observed WR/O ratio. Thus, MCB evolution seems to be a necessary ingredient in young stellar population models. Other quantities like the ionizing flux, equivalent widths, spectral continuum, UV lines, colors, number of stars, mechanical energy and yields, and supernova rates are computed by the models and are available upon request.

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