Grids of stellar models with rotation
II. WR populations and supernovae/GRB progenitors at Z = 0.014

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Context: In recent years, many very interesting observations have appeared concerning the positions of Wolf-Rayet (WR) stars in the Hertzsprung-Russell diagram (HRD), the number ratios of WR stars, the nature of type Ibc supernova (SN) progenitors, long and soft gamma ray bursts (LGRB), and the frequency of these various types of explosive events. These observations represent key constraints on massive star evolution.
Aims: We study, in the framework of the single-star evolutionary scenario, how rotation modifies the evolution of a given initial mass star towards the WR phase and how it impacts the rates of type Ibc SNe. We also discuss the initial conditions required to obtain collapsars and LGRB.
Methods: We used a recent grid of stellar models computed with and without rotation to make predictions concerning the WR populations and the frequency of different types of core-collapse SNe. Current rotating models were checked to provide good fits to the following features: solar luminosity and radius at the solar age, main-sequence width, red-giant and red-supergiant (RSG) positions in the HRD, surface abundances, and rotational velocities.
Results: Rotating stellar models predict that about half of the observed WR stars and at least half of the type Ibc SNe may be produced through the single-star evolution channel. Rotation increases the duration of the WNL and WNC phases, while reducing those of the WNE and WC phases, as was already shown in previous works. Rotation increases the frequency of type Ic SNe. The upper mass limit for type II-P SNe is âˆ¼ 24.9 MâŠ™ for the non rotating models and âˆ¼ 1 for the rotating ones. This last value agrees better with observations. Moreover, present rotating models provide a very good fit to the progenitor of SN 2008ax. We discuss future directions of research for further improving the agreement between the models and the observations. We conclude that the mass-loss rates in the WNL and RSG phases are probably underestimated at present. We show that up to an initial mass of 40 MâŠ™, a surface magnetic field inferior to about 2 G may be sufficient to produce some braking. Much lower values are needed at the red supergiant stage. We suggest that the presence/absence of any magnetic braking effect may play a key role in questions regarding rotation rates of young pulsars and the evolution leading to LGRBs.

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