Grids of stellar models with rotation
I. Models from 0.8 to 120 Msun at solar metallicity (Z = 0.014)

S. EkstrÃ¶m (1), C. Georgy (2), P. Eggenberger (1), G. Meynet (1), N. Mowlavi (1), A. Wyttenbach (1), A. Granada (1,3), T. Decressin (1), R. Hirschi (4,5), U. Frischknecht (4,6), C. Charbonnel (1,7), and A. Maeder (1)

1- Geneva Observatory, University of Geneva, Maillettes 51, CH-1290 Sauverny, Switzerland
2- Centre de recherche astrophysique, Ecole Normale SupÃ©rieure de Lyon, 46, allÃ©e dâ€™Italie, F-69384 Lyon cedex 07, France
3- Instituto de AstrofÃ-sica La Plata, CCT La Plata, CONICET-UNLP, Paseo del Bosque S/N, La Plata, Buenos Aires, Argentina
4- Astrophysics group, EPSAM, Keele University, Lennard-Jones Labs, Keele, ST5 5BG, UK
5- Institute for the Physics and Mathematics of the Universe, University of Tokyo, 5-1-5 Kashiwanoha, Kashiwa, 277-8583, Japan
6- Dept. of Physics, University of Basel, Klingelbergstr. 82, CH-4056, Basel, Switzerland
7- IRAP, UMR 5277 CNRS and UniversitÃ© de Toulouse, 14, Av. E.Belin, 31400 Toulouse, France

Many topical astrophysical research areas, such as the properties of planet host stars, the nature of the progenitors of different types of supernovae and gamma ray bursts, and the evolution of galaxies, require complete and homogeneous sets of stellar models at different metallicities in order to be studied during the whole of cosmic history. We present here a first set of models for solar metallicity, where the effects of rotation are accounted for in a homogeneous way.

We computed a grid of 48 different stellar evolutionary tracks, both rotating and non-rotating, at Z = 0.014, spanning a wide mass range from 0.8 to 120 Msun. For each of the stellar masses considered, electronic tables provide data for 400 stages along the evolutionary track and at each stage, a set of 43 physical data are given. These grids thus provide an extensive and detailed data basis for comparisons with the observations. The rotating models start on the ZAMS with a rotation rate v_ini/v_crit = 0.4. The evolution is computed until the end of the central carbon-burning phase, the early AGB phase, or the core helium-flash for, respectively, the massive, intermediate, and both low and very low mass stars. The initial abundances are those deduced by Asplund and collaborators, which best fit the observed abundances of massive stars in the solar neighbourhood. We update both the opacities and nuclear reaction rates, and introduce new prescriptions for the mass-loss rates as stars approach the Eddington and/or the critical velocity. We account for both atomic diffusion and magnetic braking in our low-mass star models.

The present rotating models provide a good description of the average evolution of non-interacting stars. In particular, they reproduce the observed main-sequence width, the positions of the red giant and supergiant stars in the HR diagram, the observed surface compositions and rotational velocities. Very interestingly, the enhancement of the mass loss during the red-supergiant stage, when the luminosity becomes supra-Eddington in some outer layers, help models above 15-20 Msun to lose a significant part of their hydrogen envelope and evolve back into the blue part of the HR diagram. This result has interesting consequences for the blue to red supergiant ratio, the minimum mass for stars to become Wolf-Rayet stars, and the maximum initial mass of stars that explode as type II-P supernovae.

Reference: A&A, in press
arXiv:1110.5049
Status: Manuscript has been accepted

Weblink: http://arxiv.org/abs/1110.5049

Comments: 19 pages, 15 figures
Electronic tables on CDS

Email: sylvia.ekstrom@unige.ch