

# Title: Rotating Massive Main-Sequence Stars II: Simulating a Population of LMC early B-type Stars as a Test of Rotational Mixing

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Rotational mixing in massive stars is a widely applied concept, with far reaching consequences for stellar evolution. Nitrogen surface abundances for a large and homogeneous sample of massive B-type stars in the LMC were obtained by the VLT-FLAMES Survey of Massive Stars. This sample is the first covering a broad range of projected stellar rotational velocities, with a large enough sample of high quality data to allow for a statistically significant analysis. We use the sample to provide the first rigorous test of the theory of rotational mixing in massive stars. We calculated a grid of stellar evolution models, using the FLAMES sample to calibrate some of the uncertain mixing processes. We developed a new population-synthesis code, which uses this grid to simulate a large population of stars with masses, ages and rotational velocity distributions consistent with those from the FLAMES sample. The synthesized population is then filtered by the selection effects in the observed sample, to enable a direct comparison between the empirical results and theoretical predictions. Our simulations reproduce the fraction of stars without significant nitrogen enrichment. The predicted number of rapid rotators with enhanced nitrogen is about twice as large as found observationally. Furthermore, a group of stars consisting of slowly rotating, nitrogen-enriched objects and another consisting of rapidly rotating un-enriched objects can not be reproduced by our single-star population synthesis. Additional physical processes appear to be required to understand the population of massive main-sequence stars from the FLAMES sample. We discuss the possible role of binary stars and magnetic fields in the interpretation of our results. We find that the population of slowly rotating nitrogen-enriched stars is unlikely produced via mass transfer and subsequent tidal spin-down in close binary systems

Reference: Accepted for publication in A&A

Status: Manuscript has been accepted

Weblink: <http://arxiv.org/abs/1102.0766>

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