Massive Stars and Emission-line Stars with Gaia

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MASSIVE STARS

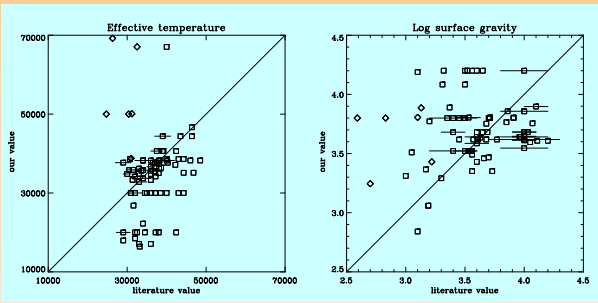
- The major interest in massive stars is in their role as important contributors to galactic evolution.
- Thanks to Gaia, highly accurate parallaxes will become available for a large sample of massive stars (i.e. O and, mainly, B type stars). According to the Besançon Universe model (Jordi 2007, ASPCS 364, 215), about 900,000 OB stars should be observed. About one sixth of these stars (Briot & Robichon 2004, ESA SP-576, 561) are expected to have parallaxes with a relative precision better than 3%.
- This large number will enable us, for the very first time, to perform unbiased statistical analyses and high-accuracy luminosity determinations based on a homogeneous dataset. It will also allow us to study the dynamics of the open clusters in which these stars are formed.
- In preparation for the Gaia mission, we are developing algorithms to determine the stellar parameters of massive stars. Due to the high number of objects involved, the automation of the classification procedure is an important issue for making the data rapidly usable and advantageously available to the whole astronomical community after completion of the mission.
- We validate our techniques on ground-based spectrophotometry and spectroscopy, collected - among others - from data of the GBOG (Ground-Based Observations for Gaia).

STELLAR PARAMETER DETERMINATION

- Different approaches to derive stellar astrophysical parameters are being developed and tested. All these methods have in common that they compare observed and synthetic data.
- One of the methods is the "Extended Stellar Parametrizer" (ESP), which uses a simplex least squares technique to find the best fitting theoretical model.
- The ESP simplex technique can be applied to any combination of BP, RP and/or RVS data.

VALIDATION TESTS

- One way of validating our techniques is by comparing our results to those from the literature.
- The figure below shows the effective temperature and surface gravity for a set of massive stars observed at OHP and ESO (Nazé et al.). On the x-axis we plot the literature values, on the y-axis our own values.
- Squares indicate O-type stars, diamonds Wolf-Rayet stars.
- From this test, we conclude that a reasonable number of stars give acceptable results, but further refinement of the algorithms and the grids of synthetic spectra is obviously needed.



EMISSION-LINE STARS

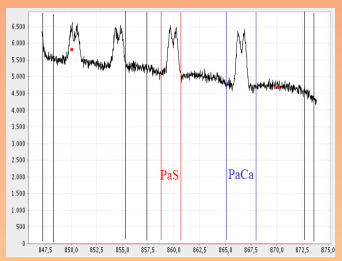
- Emission-line stars can be found across the whole HR diagram. The presence of emission lines signifies that interesting physical processes are occurring in a star, such as stellar winds (Wolf-Rayet stars), discs (Be stars), magnetic fields (M stars), etc.
- Gaia will provide accurate parallaxes, spectrophotometry and spectroscopy for hundreds of thousands of emission-line stars. This will lead to a better understanding of the physical mechanisms responsible for the emission.
- In preparation for the Gaia mission, we are developing algorithms to recognize and classify emission-line stars.

DATA

- For both the massive stars and the emission-line stars, we will have spectroscopic data available (RVS) as well as spectrophotometry (BP, RP).
- Because of sensitivity and saturation limits, not all of these data will be available for all Gaia detected stars.
- The spectroscopy and spectrophotometry are useful for stellar parameter determination (hot stars) and classification of emission-line stars.
- Astrometry will be useful for the determination of the luminosity, identifying runaways and for cluster studies.

RECOGNIZING EMISSION-LINE STARS

- To detect emission-line stars, we use software filters targeted for specific spectral lines we expect to be in emission. By comparing the integrated flux over such a filter to that of a nearby "continuum" filter, we can detect the presence of emission.
- Below is an example of two filters introduced to look for emission in the Pa14 line (PaS) and the Pa13+Ca II line (PaCa).



(Martayan et al. 2008, Gaia internal report GAIA-C8-TN-ROB-CDM-002-01)

- On the right is an example of a colour/colour diagram with PaCa filter. The solid line indicates the expected limit between emission-line stars (ELS) and normal stars (ABS for absorption). The dotted line is the safety interval defined with ABS spectra with noise.
- Such colour/colour diagrams can be used to detect and distinguish different types of emission-line stars.