Emission-line Stars and Early-type Stars with Gaia

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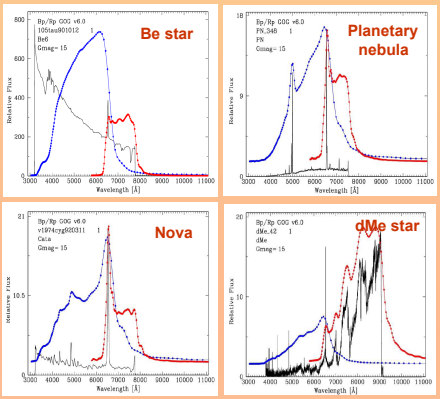
EMISSION-LINE STARS

- 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. These algorithms can be based on either RVS data or BP/RP data.
- Here we present work we did on BP/RP spectra.

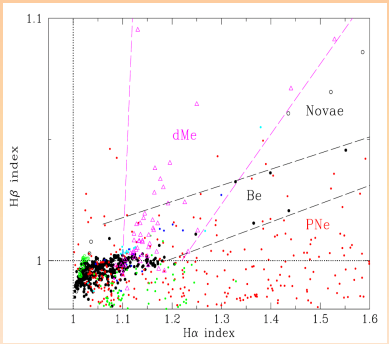
DATA MINING FOR EMISSION-LINE STARS

- To tests our classification algorithms, we use ground-based observations of various classes of emission-line stars.
- We collected 1620 spectra from various telescope archives, covering a large part of the BP/RP wavelength range.
- We pass these spectra through the GOG simulator, to obtain the BP/RP spectra. Some examples are shown below.



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 define an "index" for this line.
  - This is an Hβ vs. Hα index diagram. The various classes of emission-line stars are indicated with different symbols and colours.
  - This diagram can be used to partially distinguish dwarf Me stars, Be stars, novae and planetary nebulae.
  - Diagrams with other indices are needed to fully distinguish all subclasses.



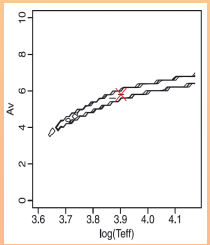
- For more details, see Lobel et al. 2010, *Data Mining and Processing of Ground-based Observations for Extended Stellar Parametrizer Algorithms*, GAIA-C8-TN-ROB-AL-001-1 (Gaia Livelink)

EARLY-TYPE STARS

- Early-type stars are major contributors to galactic evolution.
- Gaia will provide highly accurate parallaxes for a large sample of O and B type stars. According to the Besançon Universe model (Jordi & Carrasco, 2007, ASPCS 364, 215), about 900,000 B 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 early-type stars. As part of this, we also explore with what accuracy these parameters can be determined.

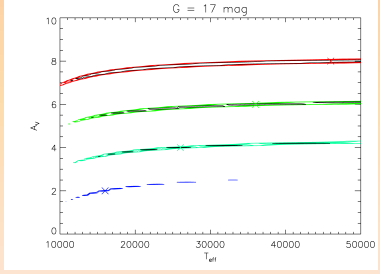
THE A_V – T_{EFF} DEGENERACY

- Bailer-Jones (2010, MNRAS, 403, 96) pointed out the A_V – T_{eff} degeneracy that will be present in the Gaia data.
- As can be expected, a unique determination of interstellar extinction (A_V) and effective temperature (T_{eff}) is not possible, due to the noise in the data.
- However, the 90 % confidence region around the best-bit solution is not a nice error-ellipse, but it is an extended "ridge" in the T_{eff}, A_V plane.
- There is a considerable range of T_{eff} values (and corresponding A_V) that can explain the observed BP/RP fluxes, within their error bars.
- This is shown in this figure from Bailer-Jones (2010). The true solution is given by the red cross, the 90, 99, 99.9 and 99.99 % confidence regions by the black curves.
- Considerable errors will therefore result in the T_{eff} determination, unless additional information can be used.



THE A_V – T_{EFF} DEGENERACY FOR EARLY-TYPE STARS

- We explore the implications of the Bailer-Jones work for hotter stars.
- We generate theoretical spectra by superimposing interstellar extinction on Planck functions.
- We pass these spectra through the GOG simulator and we simulate BP/RP spectra for a G=17 star, without noise.
- We select 4 of the resulting BP/RP spectra and add Poisson noise to them.
- We then measure the χ^2 distances between these 4 simulated "observations" and all the noise-less "theoretical" models In our grid.
- Finally, we plot the 90 (black curve), 99, 99.9 and 99.99 % confidence regions for these 4 "observed" spectra (solid lines). True values are indicated with a cross.



- Considerable uncertainty exists on the T_{eff} determination for the hotter stars. The uncertainty becomes larger for higher T_{eff} and for fainter stars.