Herbig Ae/Be stars with TGAS parallaxes in the HR diagram

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Introduction
The intermediate mass Herbig Ae/Be stars are young stars approaching the Main Sequence and are key to understanding the differences in formation mechanisms between magnetic low mass stars and the non-magnetic high mass stars. A large fraction of known Herbig Ae/Be stars have TGAS parallaxes, which are used to derive luminosities and place 108 of these objects in the HR diagram. The number of Herbig Ae/Be stars that could be placed in the HR diagram using directly determined distances has increased by more than a factor of 5 with this study. By means of the HR diagram, we studied the characteristics of the infrared excesses of this set of Herbig Ae/Be stars and we linked our results to an evolutionary analysis.

Methodology
1. First, we selected 254 Herbig Ae/Be stars candidates (see [1]) and cross-matched them with TGAS, reducing the set to 108 sources.
2. T_eff, log(g) and metallicity for these stars were taken from the works of [2], [3] and [4]. When no information was available for a certain Herbig Ae/Be star indirect estimations were made.
3. We used multi epoch and simultaneous photometry when possible. Photometry was dereddened using a R_V = 3.1 when applicable and the reddening law of [5].
4. An atmosphere model from [6] of the appropriate T_eff, log(g) and metallicity was scaled to the dereddened Johnson V band point for each star. A total flux was obtained by integrating below the atmosphere model.
5. By means of the parallax the total flux was converted to luminosity (in a similar way to what was done by [7]).
6. Finally, as a control sample, a similar procedure was done for 73240 TGAS sources whose parallaxes resulted in better than 3σ detection.

Infrared Excesses
Figure 1: 141 Herbig Ae/Be stars in the HR diagram. Together with the 108 sources with luminosities determined in this study (blue dots), 33 additional Herbig Ae/Be stars whose luminosities are known from spectra (from [2] and [3]) are also plotted (red dots). Vertical error bars are dominated by parallax uncertainties. The mass of each Pre-Main Sequence track (from [8]) is indicated at right.

Evolutionary Analysis
Another approach for studying the evolution of Herbig Ae/Be stars towards the Main Sequence is through the SEDs. Fixing a mass value and picking several stars on the corresponding Pre-Main Sequence track provides an evolutionary movie of a Herbig Ae/Be star of that mass. Doing this for several masses will lead to a general understanding of the evolution of dust and gas around these objects.

Conclusions
• Largest to date homogeneous analysis of Herbig Ae/Be stars using directly determined distances.
• An example of how useful the HR diagram can be in order to study general properties of these stars with different approaches.

References

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Forthcoming Research
This work serves as an illustration for our longer term Gaia based project to search, identify and analyse new Herbig Ae/Be stars; for which the study of already catalogued ones constitutes the first logical step.