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

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Abstract. 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 non-magnetic high mass stars. A large fraction of known Herbig Ae/Be stars have TGAS parallaxes, which were used to derive luminosities and place 107 of these objects in the HR diagram, increasing the number of objects using directly determined parallaxes by a factor of 5. We also studied the characteristics of the infrared excesses of this set of Herbig Ae/Be stars and we linked our results to an evolutionary analysis.

Keywords. stars: formation, stars: fundamental parameters, Hertzsprung-Russell diagram, stars: pre–main-sequence, infrared: stars.

1. Methodology, Infrared Excesses and Evolutionary Analysis

We selected 254 Herbig Ae/Be star candidates (see Chen *et al.* 2016) and cross-matched them with TGAS, reducing the set to 107 sources. An atmosphere model from Castelli & Kurucz (2004) of the appropriate Teff, 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 and by means of the parallax it was converted to luminosity (in a similar way to what was done by van den Ancker *et al.* 1998). Finally, as a control sample, a similar procedure was done for 73240 TGAS sources (selected from McDonald *et al.* 2012) whose parallaxes resulted in better than 3σ detections (see Fig. 1). We can study the infrared properties of this set of Herbig Ae/Be stars by grouping similar sources in colour-colour diagrams, colour-excess or even excess-excess diagrams and then observing how they are placed in the HR diagram. For example, in Fig. 1 we can appreciate how the majority of A type stars are mostly only present at high J-K_s and W1-W4 whilst many B type stars have little excess. This may indicate that they are more evolved and have already cleared most of their dust. Some may be misclassified Be stars. Another approach for studying the evolution of Herbig Ae/Be stars is through the SEDs. Fixing a mass value and picking several stars on the corresponding Pre-Main Sequence track (see Fig. 1) provides an evolutionary movie of a Herbig Ae/Be star of that mass.

2. Conclusions and Forthcoming Research

This work constitutes the largest to date homogeneous analysis of Herbig Ae/Be stars using directly determined distances. It is also an example of how useful the HR diagram can be for studying general properties of these stars. This work serves as an illustration for our Gaia based project to search, identify and analyse new Herbig Ae/Be stars.

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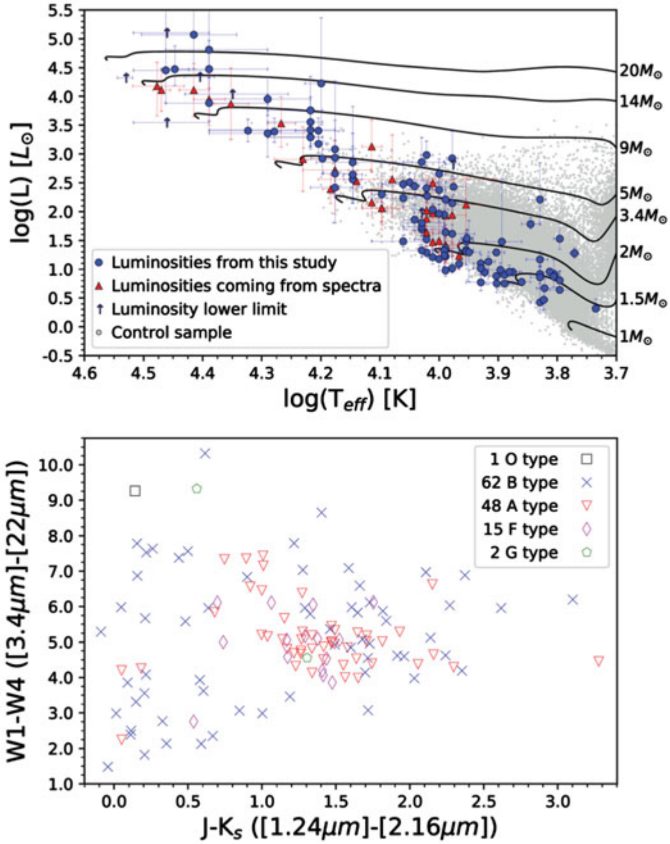

Figure 1. *Top:* 107 Herbig Ae/Be stars in the HR diagram. 33 additional Herbig Ae/Be stars whose luminosities are known from spectra are shown (from Fairlamb *et al.* 2015 and Montesinos *et al.* 2009). Vertical error bars are dominated by parallax uncertainties. The Pre-Main Sequence tracks are from Bressan *et al.* (2012). We can study SED evolution by picking sources on same Pre-Main Sequence tracks. *Bottom:* Colour-colour diagram of infrared excess. Note that most A stars have a very cool infrared excess.

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