Spectro-astrometry of Herbig Ae/Be binary systems

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(brandner et al. 2000)
Herbig Ae/Be stars

Young stars of intermediate mass (M \sim 2-10 M_\odot) - still contracting to the ZAMS \cite{(Herbig, 1960)}. Most massive objects that experience an optically visible PMS evolutionary phase.

Known to have a relatively high binary fraction, e.g. \cite{(Pirzkal et al. 1997)}.

From \cite{van den Ancker et al. (1997)}.
High binary fraction: 68 +/- 11% (Baines et al. 2006).
Binary properties can constrain binary formation mechanisms: e.g.

- distribution of mass ratio (Woitas et al. 2001)
- orientation of circumstellar disks and binary orbit (Wolf et al. 2001).

**Aims:** Obtain mass ratio of Herbig Ae/Be binary systems.

**Method:** Use spectro-astrometry to split unresolved spectrum into constituent spectra.

The difference between the circum-primary disk and binary position angle, from Baines et al. (2006).
Spectro-astrometry

Schematic representation of spectro-astrometry.
Results: binary detections

Sample: 47 Herbig Ae/Be stars.

Detect all but 1 known close binaries.

12 new close binary detections.

High binary fraction, 0.68.

Spectro-astrometric example: MWC 120.
Splitting binary spectra

Use the spectro-astrometric signatures over photospheric lines to separate binary spectra.

Two methods, see: Bailey (1998a), Porter et al. (2004).

Use the separated constituent spectra to spectrally type binary components, and hence determine the mass ratio.

GU CMa: spectro-astrometric signatures over different lines.
Splitting binary spectra: example

HD 245906:
Separation ~ 0.1”

Separated spectra of the close HD 245906 binary system.
Splitting binary spectra: example

GU CMa:
Separation ~ 0.6"

Separated spectra of the close GU CMa binary system.
Results: binary mass ratio

Estimated mass ratio of 14 close binary systems.


Mass ratio distribution skewed towards equal mass systems.

This is not consistent with random pairing from the IMF.

Mass ratio distributions

Observed + undetectable systems

Predicted

Observed

Number of systems (cumulative)
Conclusions

Binary mass ratio inconsistent with random selection of secondary from IMF.

Either:

- Fragmentation process results in two components of comparable mass.

- Post-fragmentation processes alter system, e.g. hardening by dynamical decay of a tertiary system (Goodwin et al. 2007), or binary system interactions may destroy low mass ratio systems preferentially (Hubber & Whitworth 2005).

Future work:

Put correlation between circum-primary disks and binary orbital plane on firmer statistical footing: on-going.
### References


Brandner W. et al, AAS 195th Meeting, January 2000,

Goodwin, S. P. et al., 2007, PPV, 133

Herbig G. H., 1960, AJS, 4, 337


