Why are brown dwarf binaries different?

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IMF R.I.P?

IMFs are always the same…

But, almost all young stars >0.5$M_{\odot}$ are in multiples.

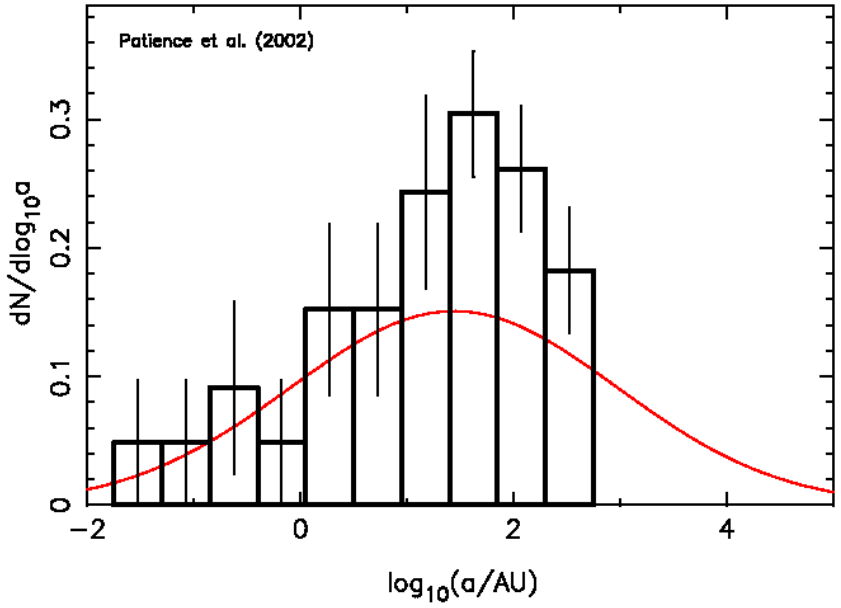
Different binary properties = different star formation

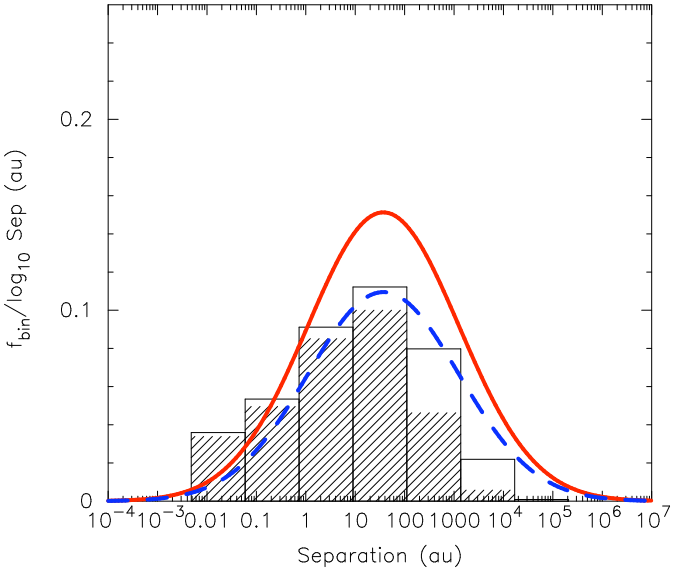
Different binary properties by mass would also suggest some differences in how stars of different masses form.

(Bastian et al. 2010; Goodwin 2010)

Dynamical processing

The primordial binary population is modified by dynamical interactions: the extent of which is mainly set by the densest phase of the cluster's evolution.

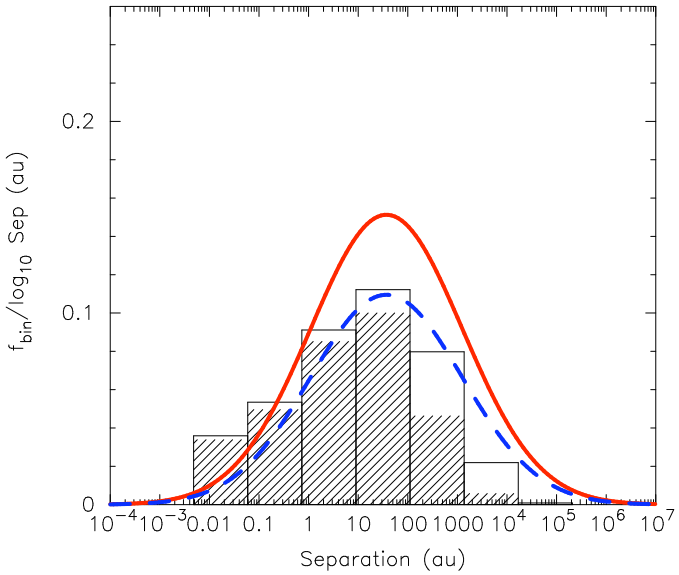


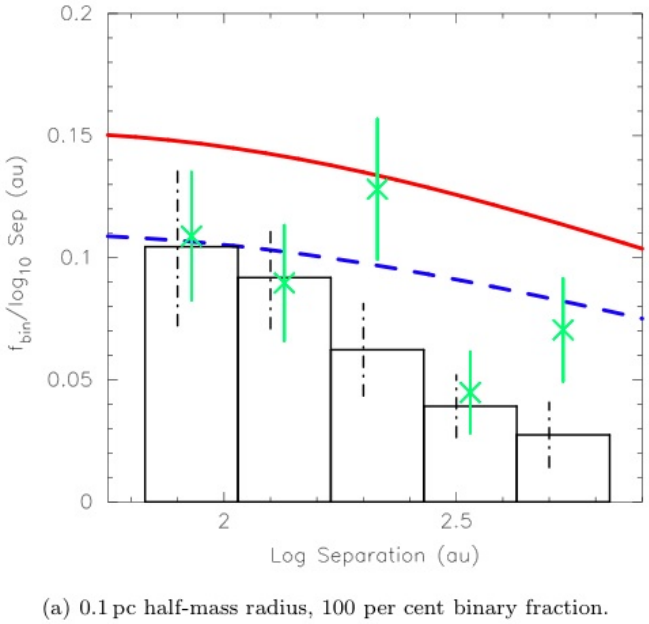


(Patience et al. 2002; lots of papers by Kroupa; Parker et al. 2009,2010)

Dynamical processing

The best way to explain the binary population in the ONC is that it was a lot denser in the past with r_h = 0.1-0.2 pc (now 0.8pc) with many more binaries.





(a) 0.1 pc half-mass radius, 100 per cent binary fraction.

(Reipurth et al. 2007; Parker et al. 2009,2010; also Scalley et al. 2005; Moraux et al. 2007)

Dynamical processing

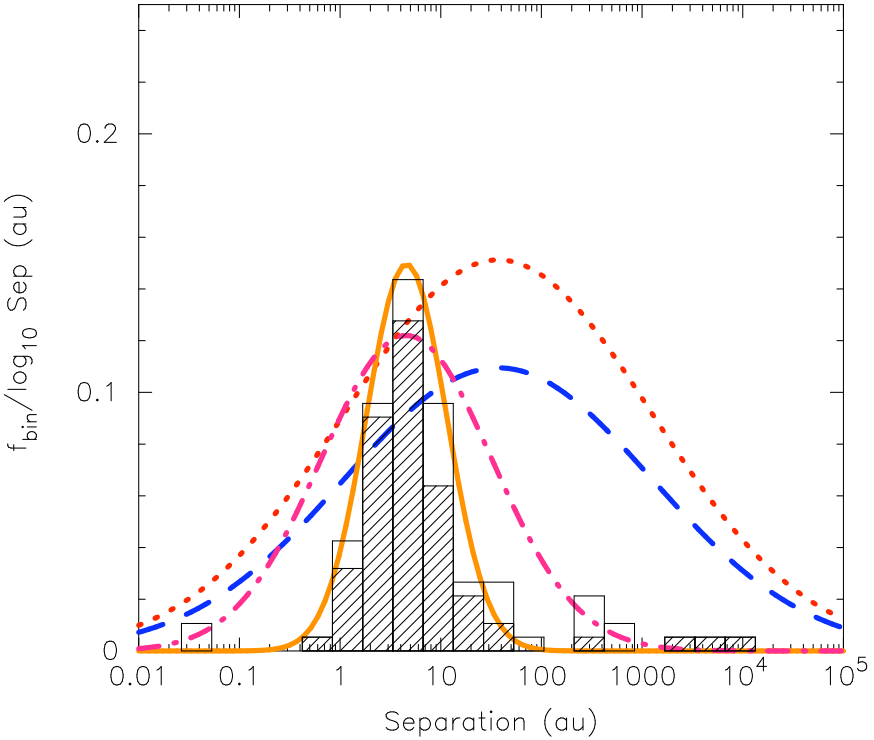
Dense environments process binaries.

The (universal) primordial population cannot be the same as the field.

More binaries must form than we see later, especially wide binaries.

Very low-mass binaries

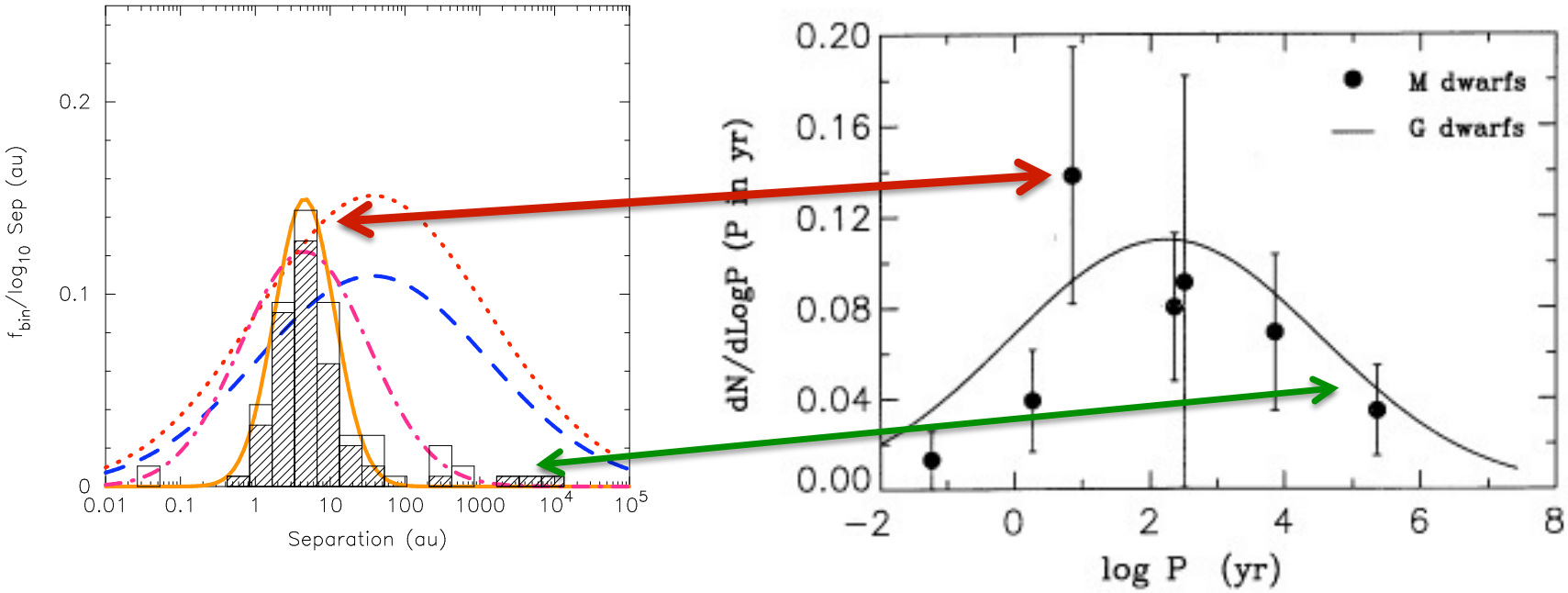
They look very different to higher-mass binaries *in the field*



(Burgasser et al. 2007; Basri & Reiners 2006; Theis & Kroupa 2007; Duquennoy & Mayor 1991; Fischer & Marcey 1992)

Very low-mass binaries

Compare with M-dwarfs…



Is there a smooth transition through the M-dwarfs or not?

Very low-mass binaries

Brown dwarf binaries must be different from stars because M-dwarf binaries are modified in exactly the same way.

Different now = different at birth

But far more wide systems must have formed than are now seen as they are easy to destroy in almost any environment.

Maybe these could be made later???

(Parker & Goodwin 2010; Kouwenhoven et al. 2010; Moekel & Bate 2010)

Why are they different?

An obvious possibility is that they form in some different way (ejection, liberation, discs, filaments????). But this involves introducing another mode of star formation…

Or is it a smooth transition????

How do binaries form anyway????

(Theis & Kroupa 2007; Reipurth & Clarke 2001; Bate 2009; Stamatellos & Whitworth 2007; Goodwin & Whitworth 2007)

Why are they different?

Or binary properties could change fairly suddenly even if they form in the same way…

Brown dwarfs probably can't form binaries in the same way as stars.

For a disc to fragment it must have >> mass than the fragment (>>5 M_{jup}) a BOE calculation suggests >0.2-0.3$M_{\odot}$ this disc material will then be accreted onto one/both objects.

Minimum *system* mass for disc fragmentation ~0.2-0.3$M_{\odot}$.

We ❤ M-dwarfs

Plea to observers – please tell us about M-dwarf binaries as well… they are crucial – 90% of stars are M-dwarfs

Star formation = M-dwarf formation

(Goodwin 2010)

Summary

✪ Brown dwarfs form with different binary properties to higher-mass stars.

✪ They must also form with a higher binary fraction than is currently observed (as do most stars).

✪ Disc fragmentation can't work at system masses below 0.2-0.3 $M_{\odot}$ could it give us a sharp change?

✪ M-dwarf binary properties are a crucial test of star formation models, please tell us what they are…