

# Ultracool dwarf binaries

(SpT > M6)

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# Ultracool dwarf binaries

**Introduction:** Multiple systems as testimonies

- 1./ Multiplicity of Ultracool Dwarfs in the Field (1 ~5 Gyrs)
- 2./ Multiplicity of Ultracool Dwarfs in the Pleiades (~120 Myrs)
- 3./ Multiplicity of Ultracool Dwarfs in the Upper Sco OB association (~5 Myrs)
- 4./ Ultracool dwarfs as members of other types of multiple systems

**Conclusion:** an overview of multiplicity properties over the age

# Ultracool dwarf binaries

## **Introduction: Binaries as testimonies**

How do ultracool dwarfs (SpT > M7) form ?

The properties of multiplicity are directly related to:

- the mechanisms involved:
  - e.g. contraction/collapse of MC, photo-evaporation, ejection
- the environment:
  - e.g. dense proto-stellar clusters, or loose SFR

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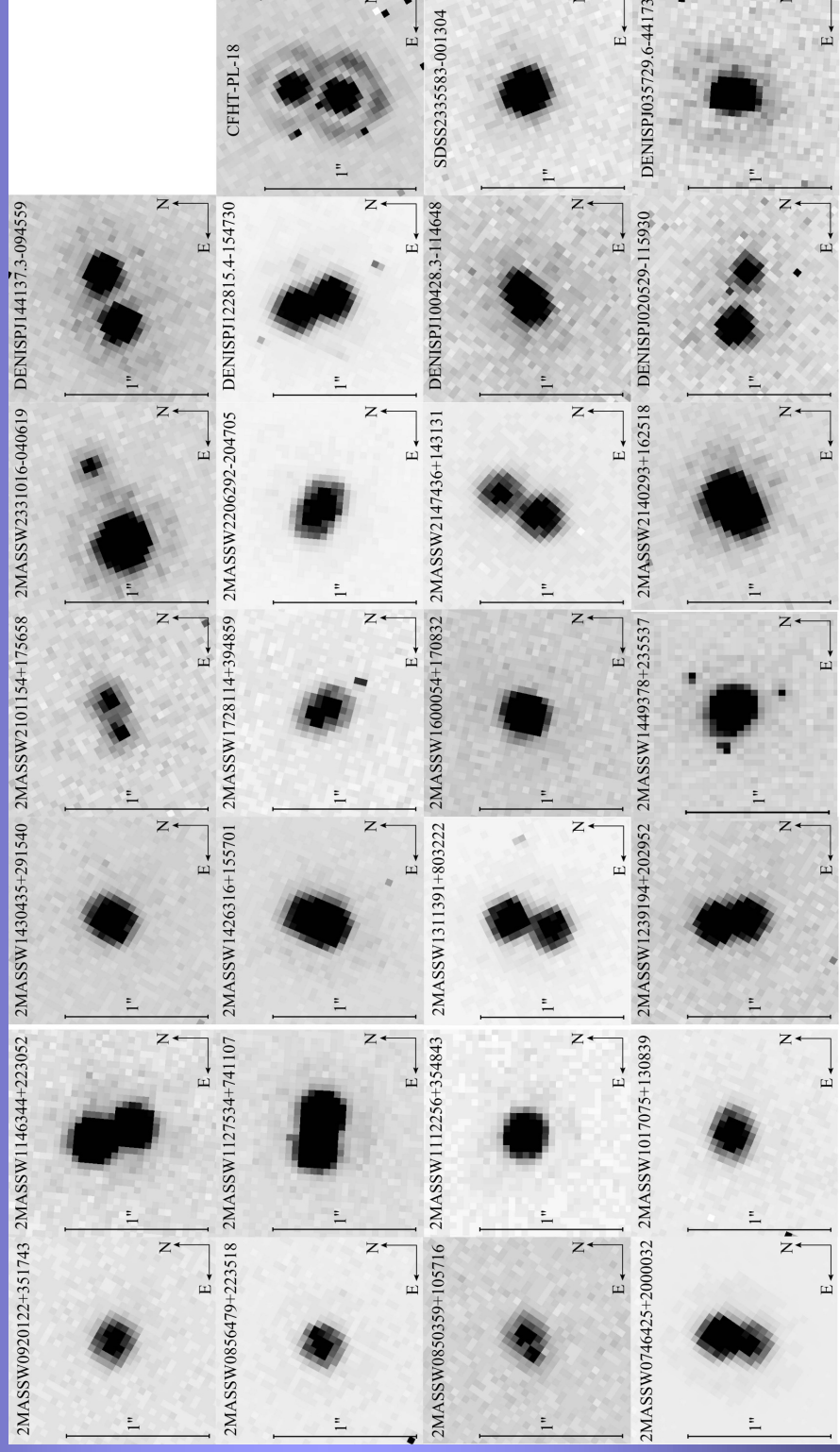
**3./** Multiplicity of Ultracool Dwarfs in the Upper Sco OB association (~5 Myrs)

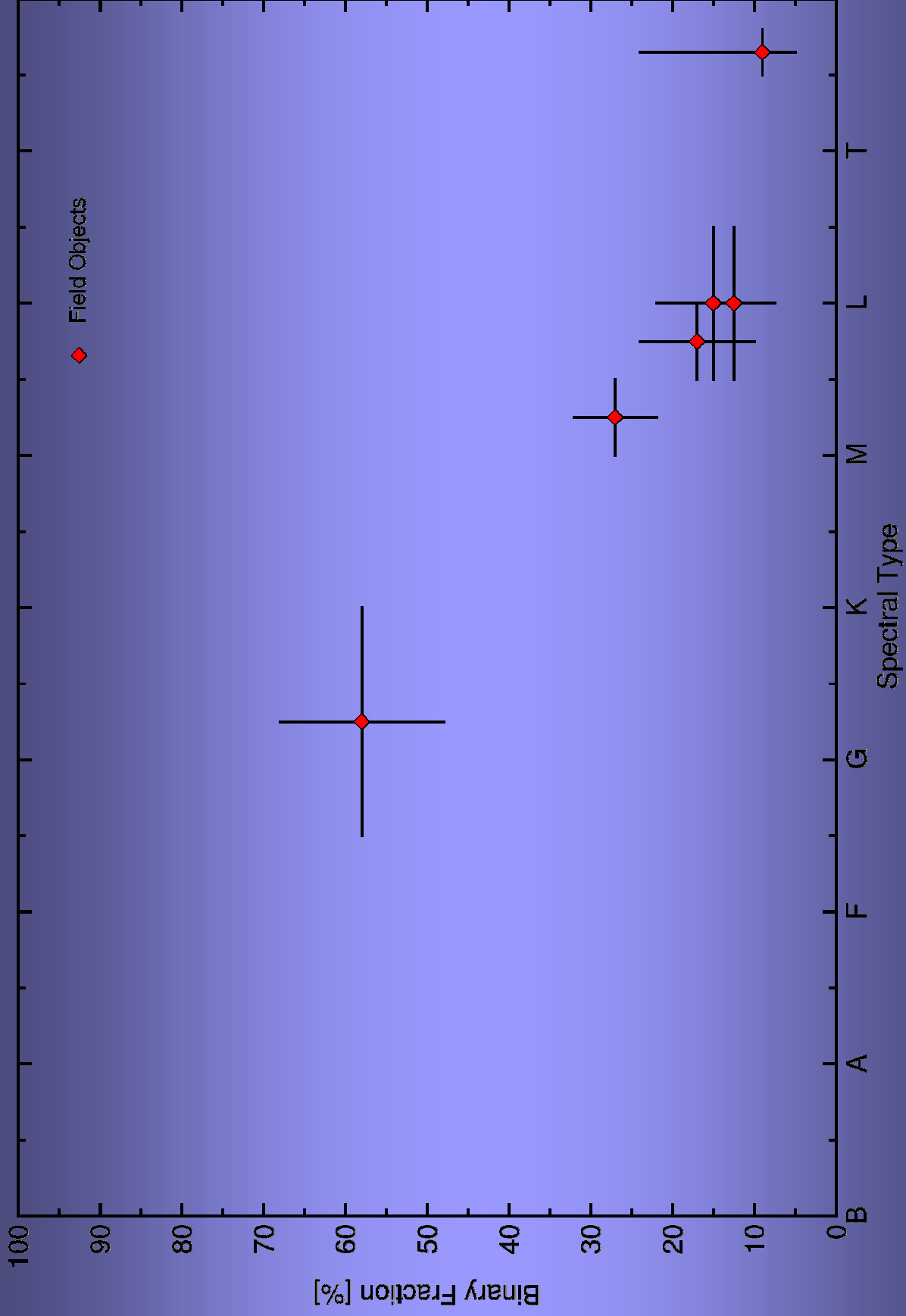
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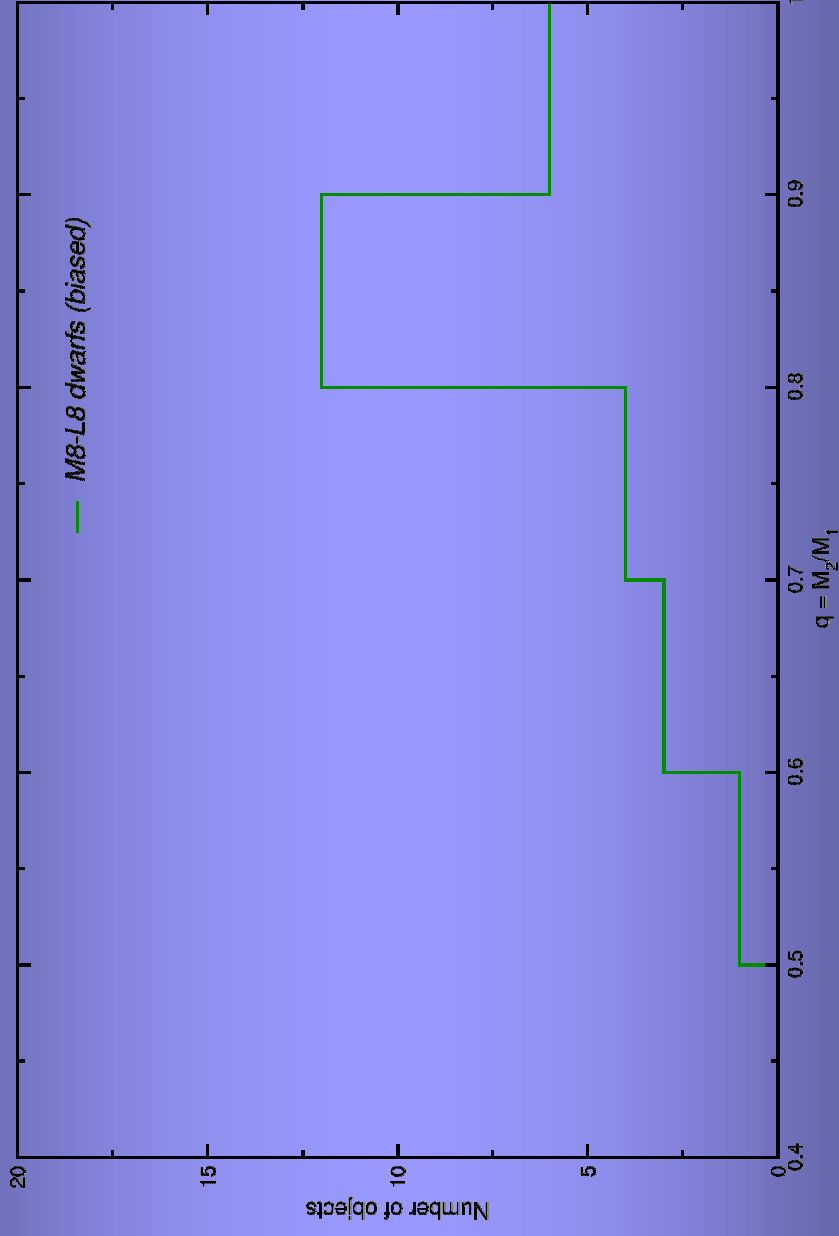
# Ultracool dwarf binaries in the field

## 1./ Multiplicity of Ultracool Dwarfs in the Field (1~5 Gyrs)

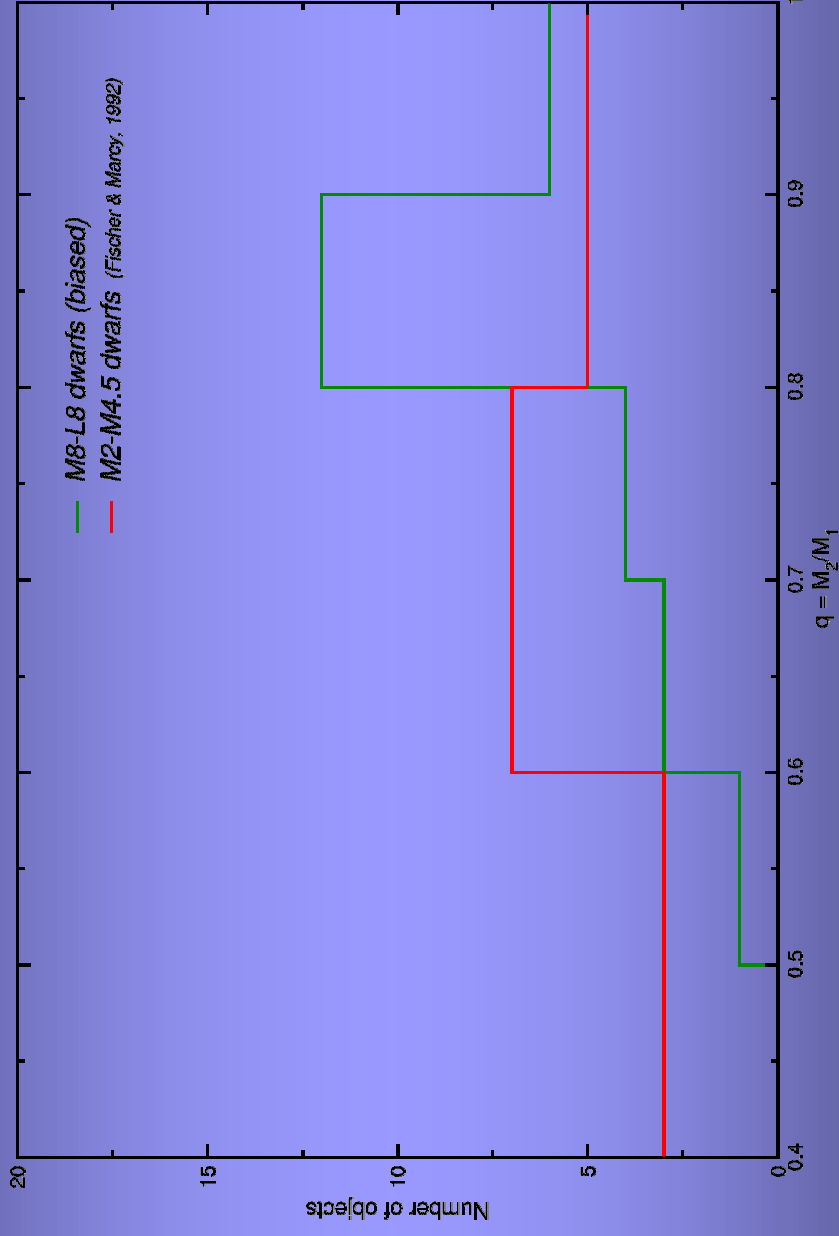




# Ultracool dwarf binaries in the field

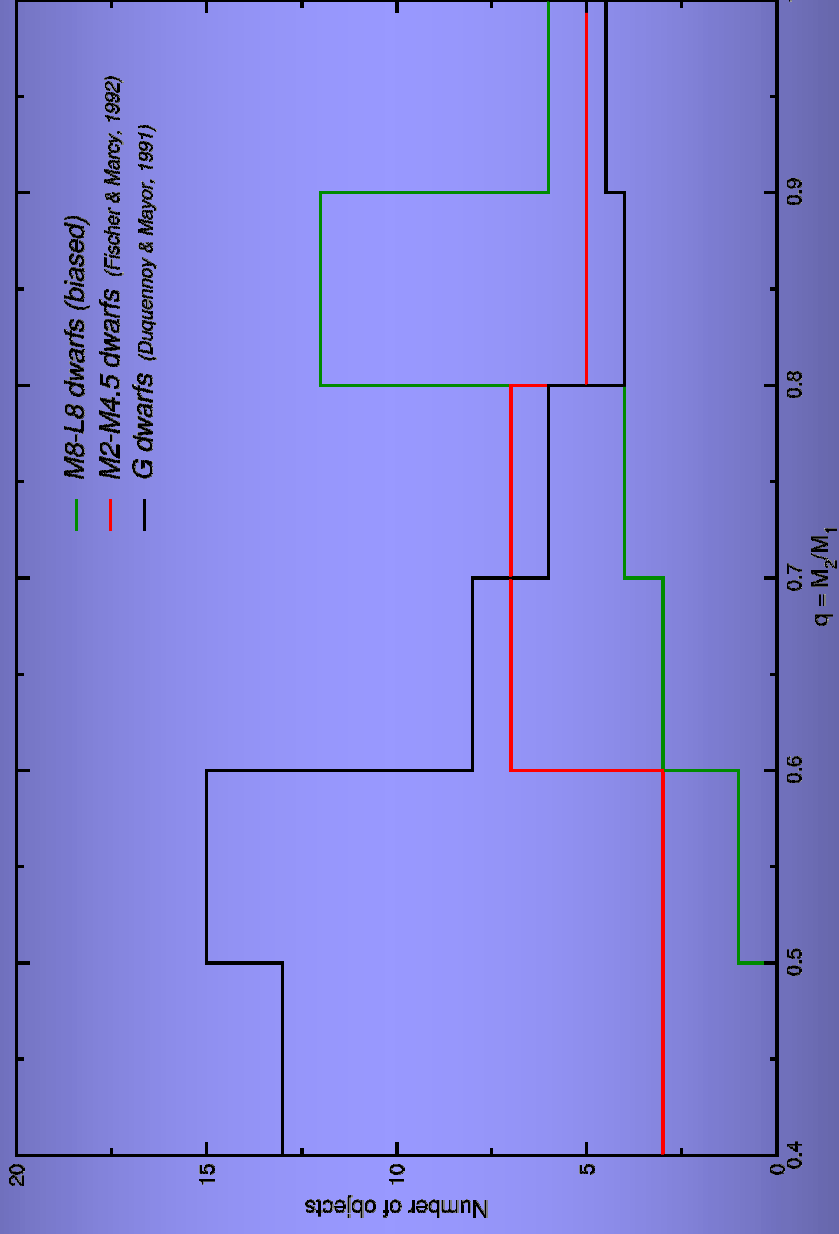


# Ultracool dwarf binaries in the field

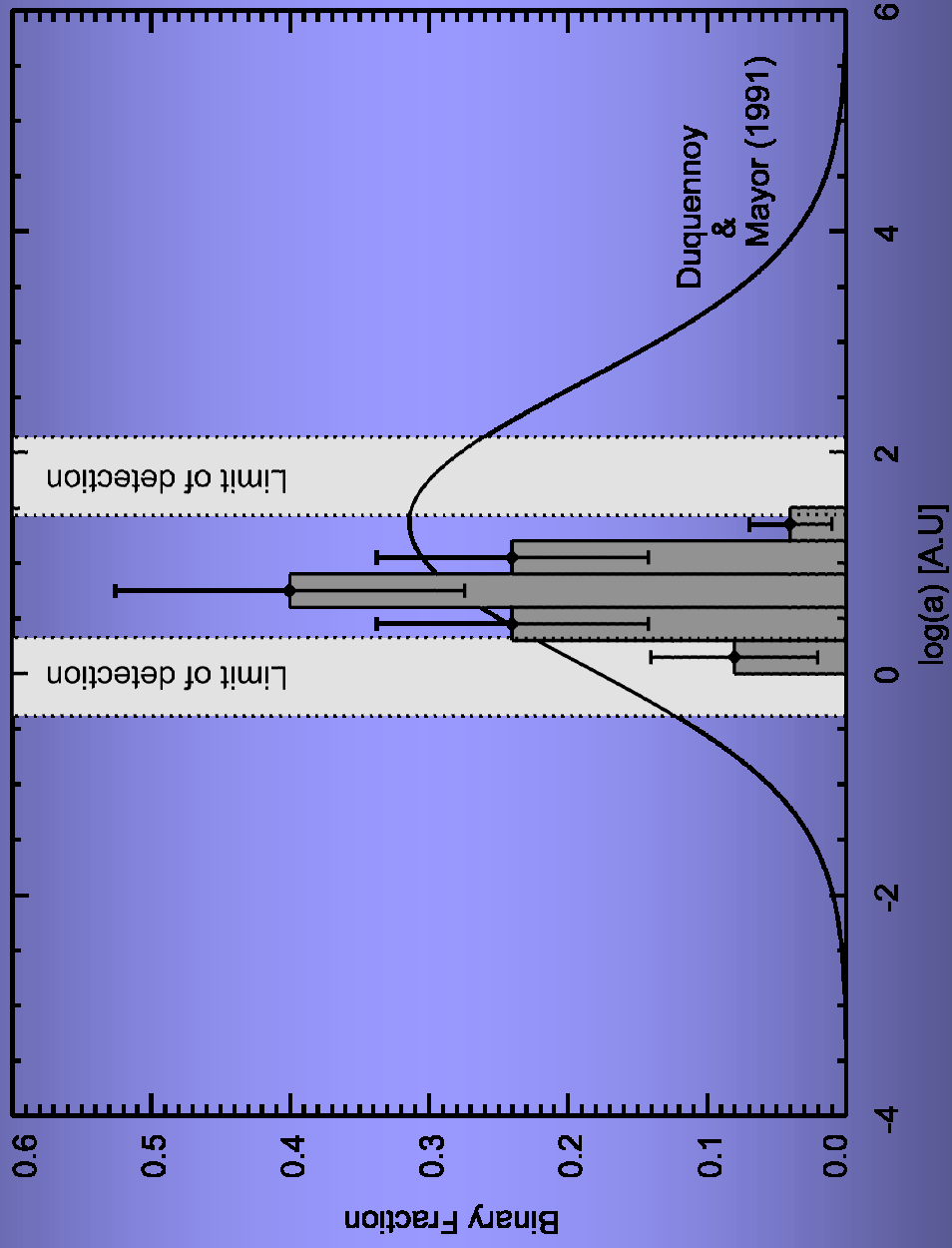




# Ultracool dwarf binaries in the field

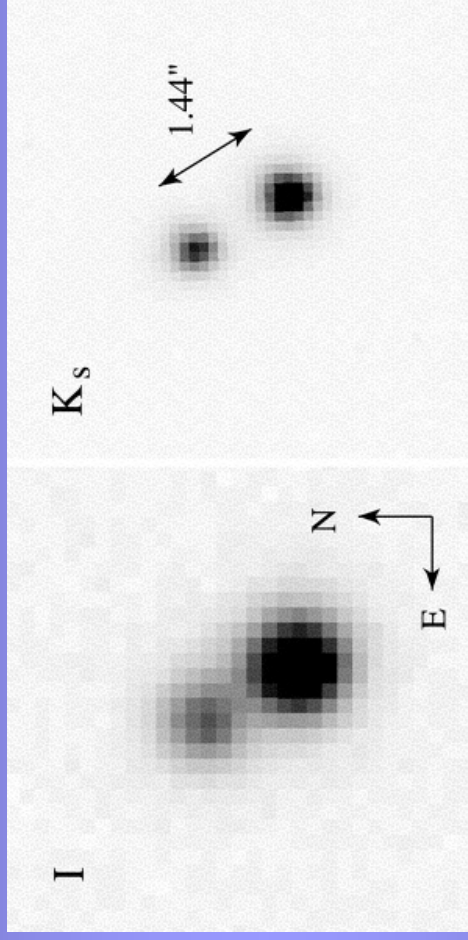
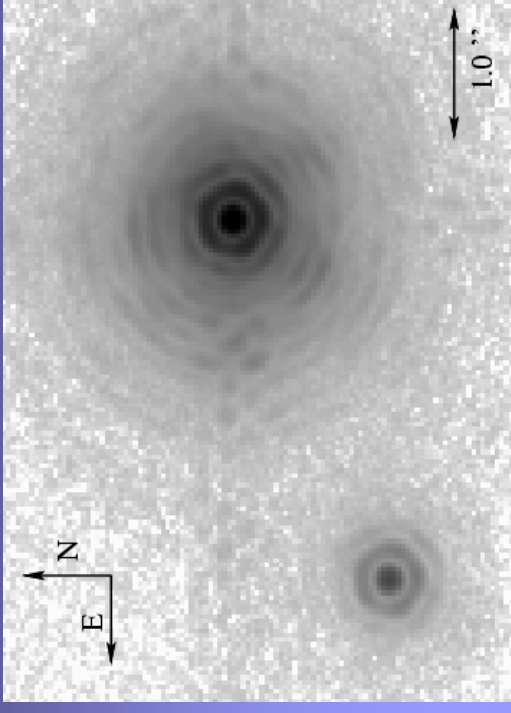


# Ultracool dwarf binaries in the field



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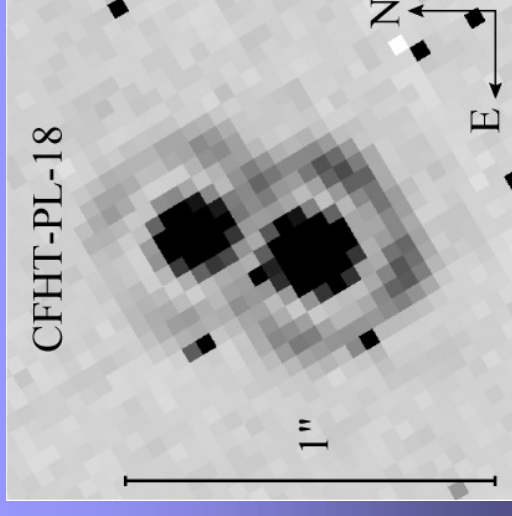
Forveille et al. 2004  
 Golimowski et al., 2004  
 30 A.U



Luhman et al. 2004, 240 A.U

Poster by Phan Bao  
 1 object at ~30 A.U

Martín et al. 1998  
 30 A.U



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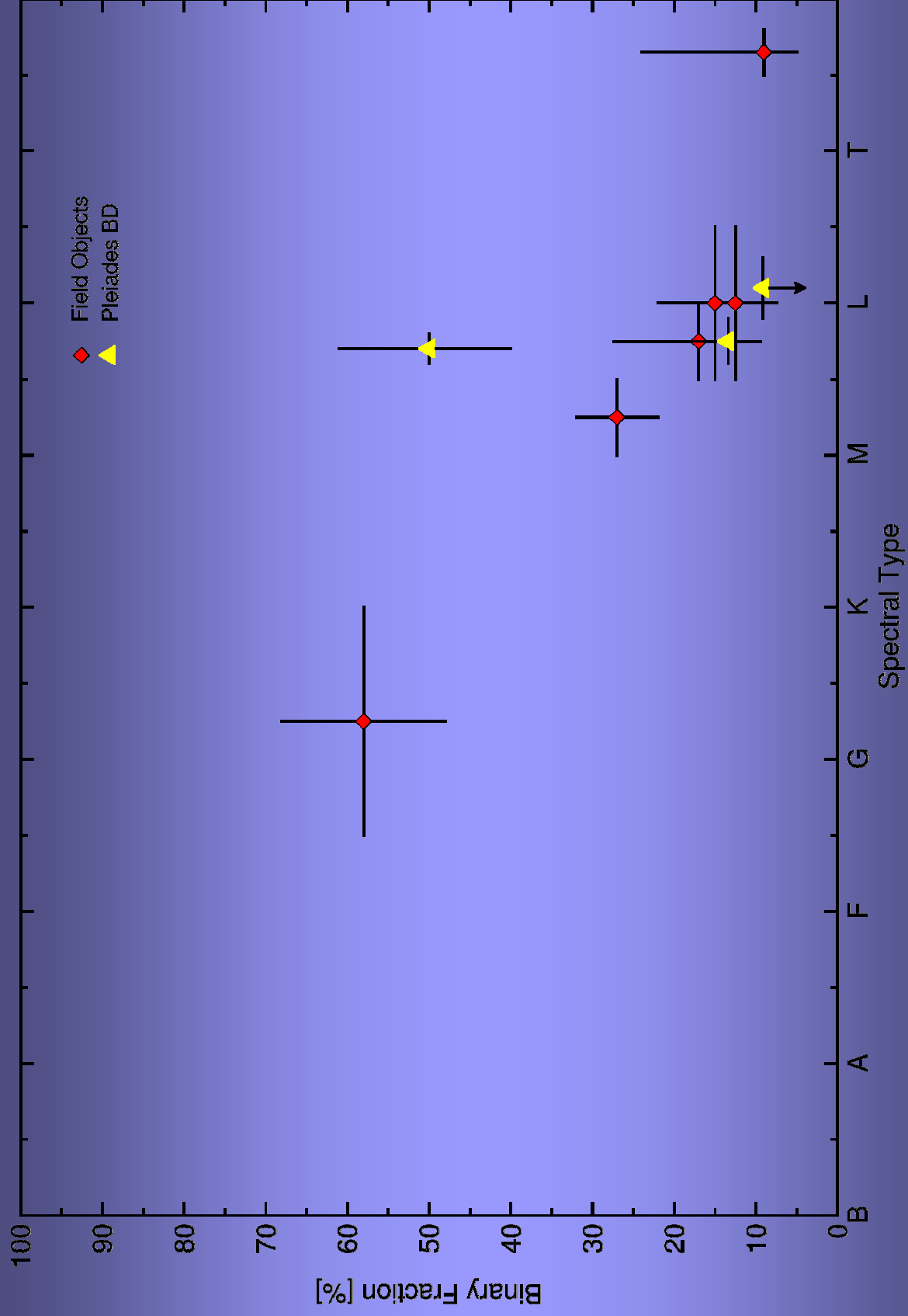
**Conclusion:** an overview of multiplicity properties over the age

# Ultracool dwarf binaries in the Pleiades

## 2./ Multiplicity of Ultracool Dwarfs in the Pleiades (120 Myrs)

Also an intense field of research:

Authors	SpT	Binary Fraction
Martín et al. (2000)	M5-L0	<3% for a>27 A.U
Martín et al. (2003)	M6-M9.5	15% ± 5% for a>7 A.U
Pinfield et al. (2004)	M6-M8	50% ± 10% photom.
Bouy et al. (2005)	M6-M9 M9-L3	13.3% <sup>+14%</sup> <sub>-4%</sub> <9.1% for a>7 AU for a>7 AU



# Ultracool dwarf binaries in the Pleiades

## 2./ Multiplicity of Ultracool Dwarfs in the Pleiades (120 Myrs)

Sample of binaries in the Pleiades is too small (only ~4 objects)

But:

- No wide binaries (all sep. less <12 A.U)
- All have mass ratio ~1.

Are all Pleiades BD binaries spectroscopic ?

On-going studies (Ansgar & Gibor) looking for SB in a sample of field UCD do not find such a high rate of spectroscopic binaries...

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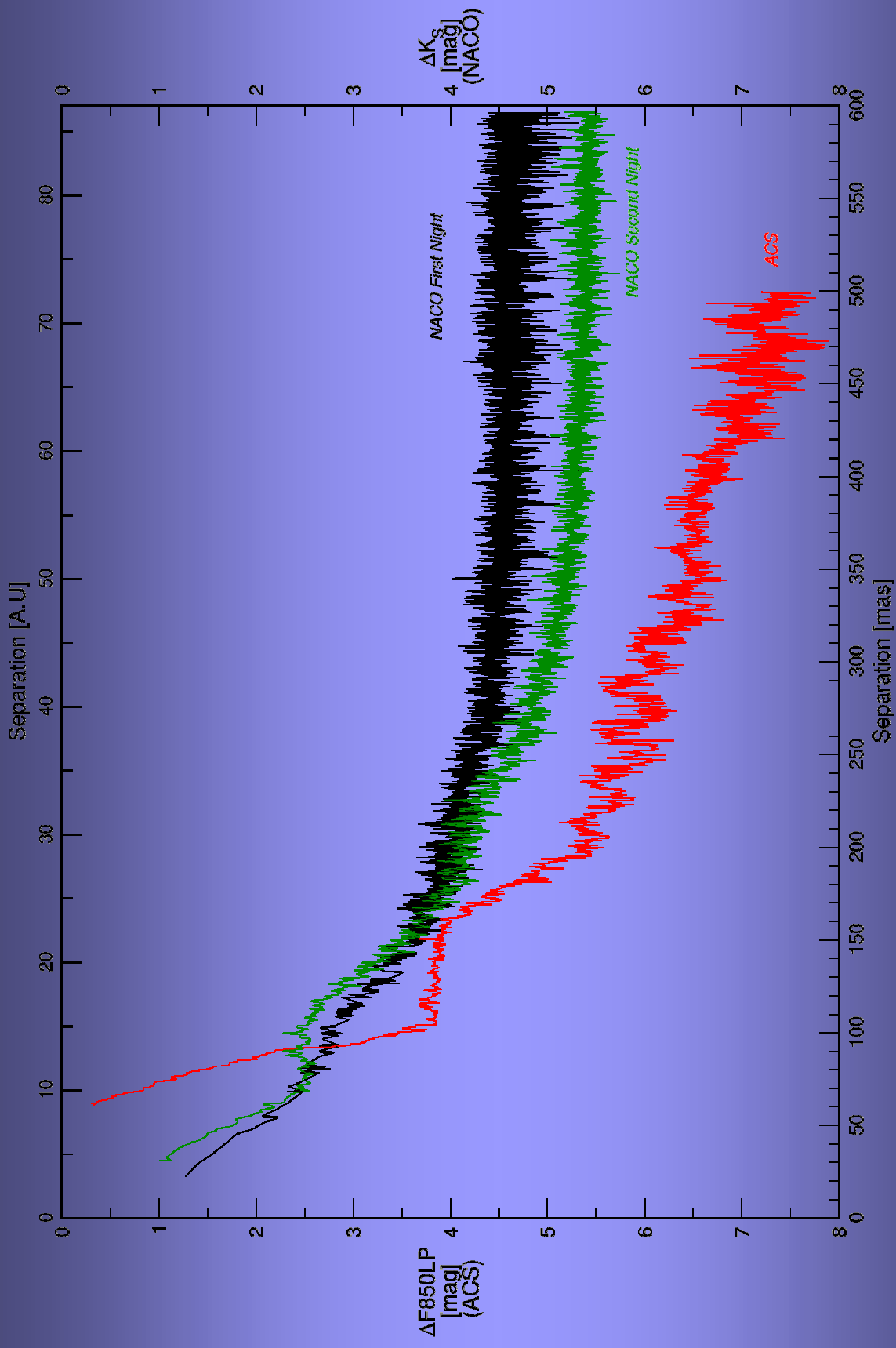


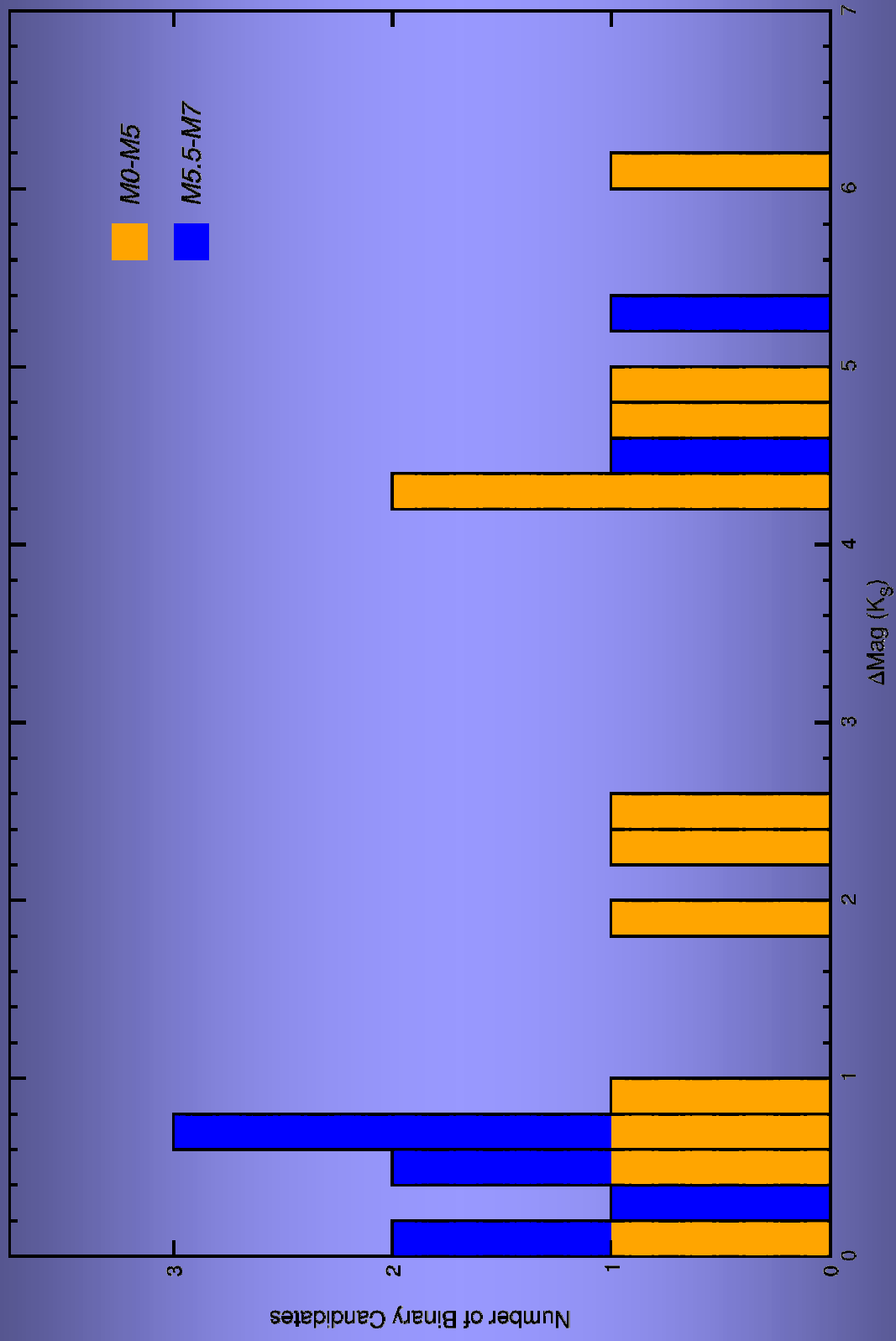
# Ultracool dwarf binaries in USco

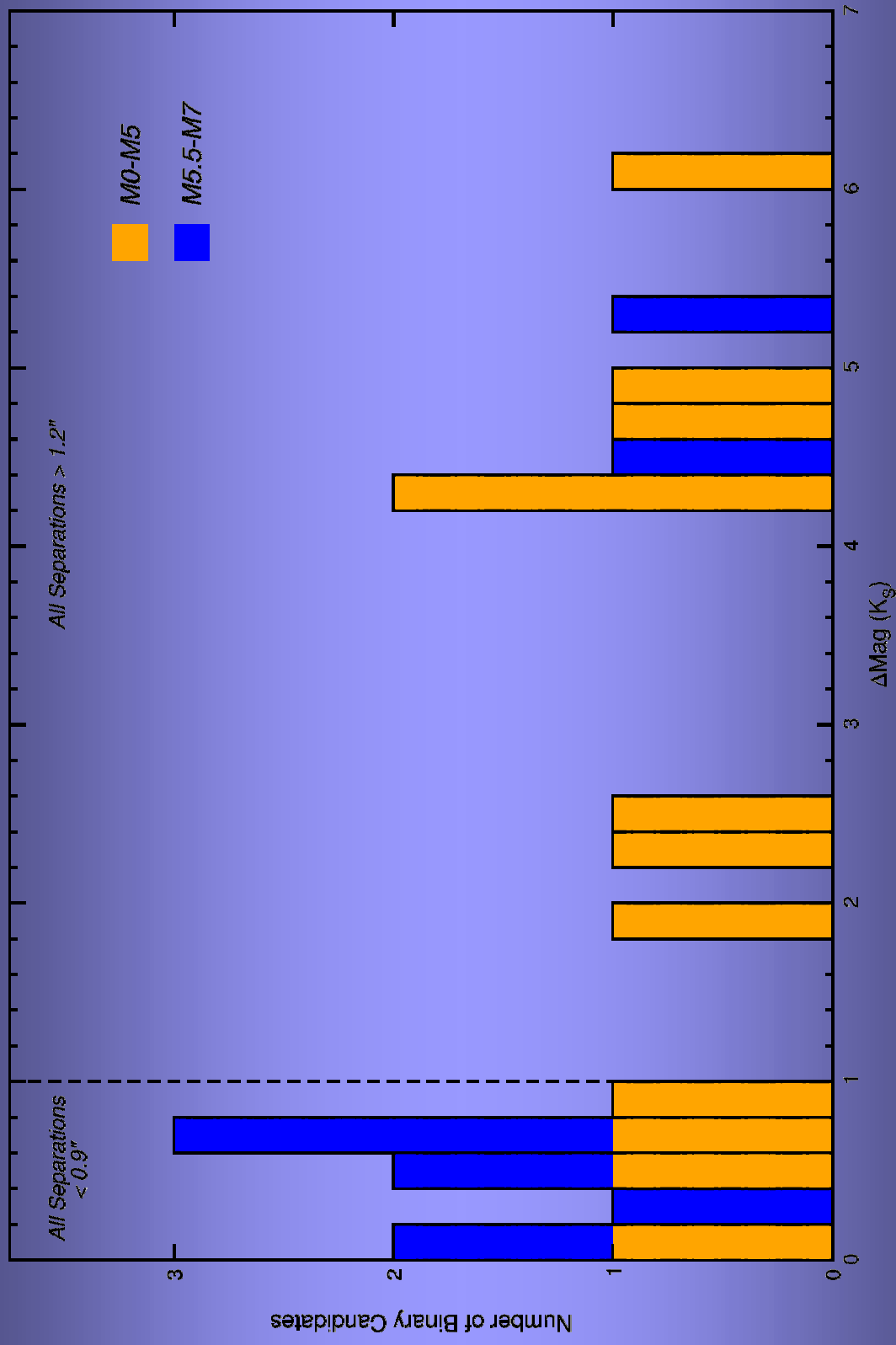
## 3./ Multiplicity of VLMS and BD in Upper Scorpius (5 Myrs)

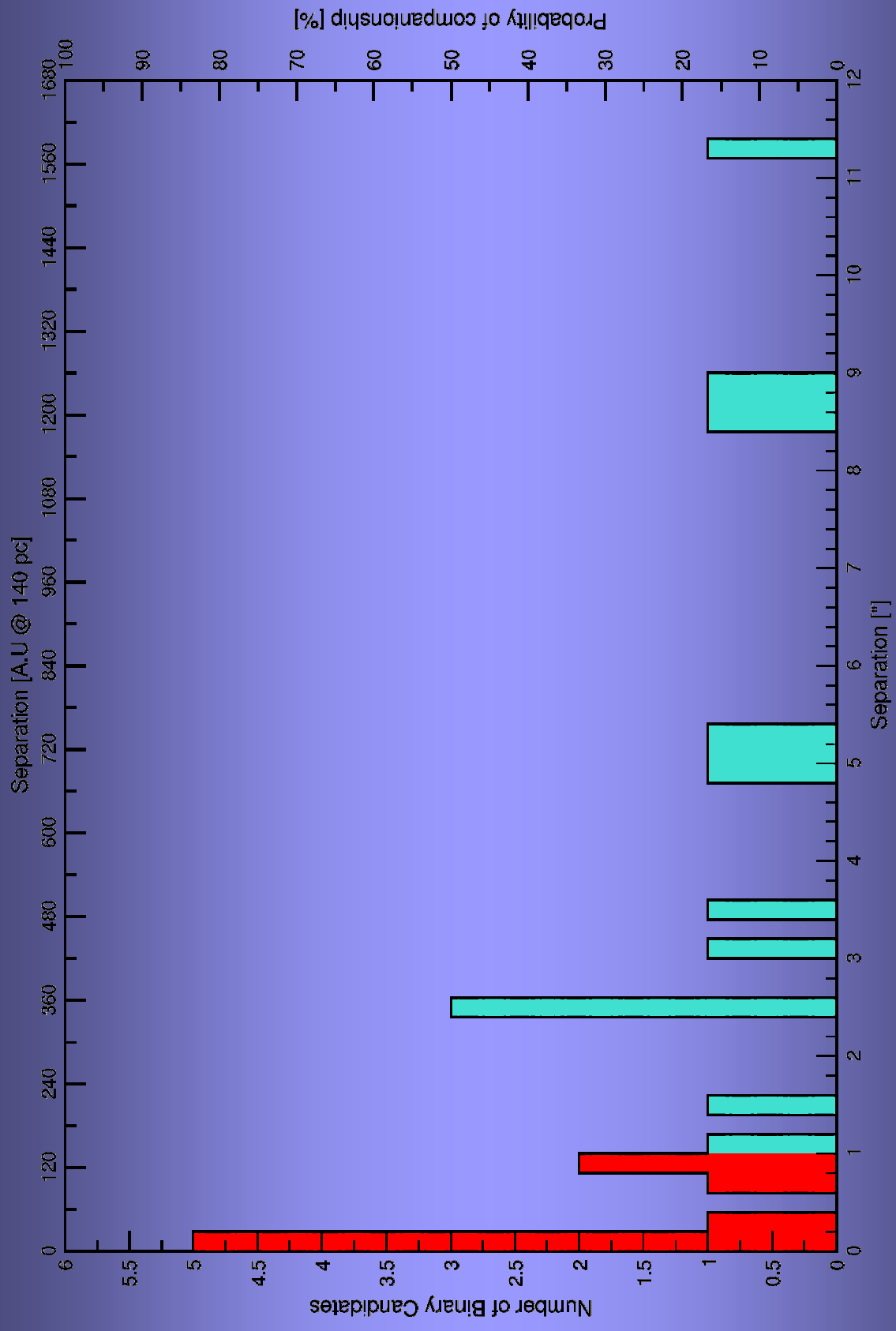
Multiplicity of M5-M6.5 BD (12 objects) with HST-ACS  
(Kraus et al., submitted)

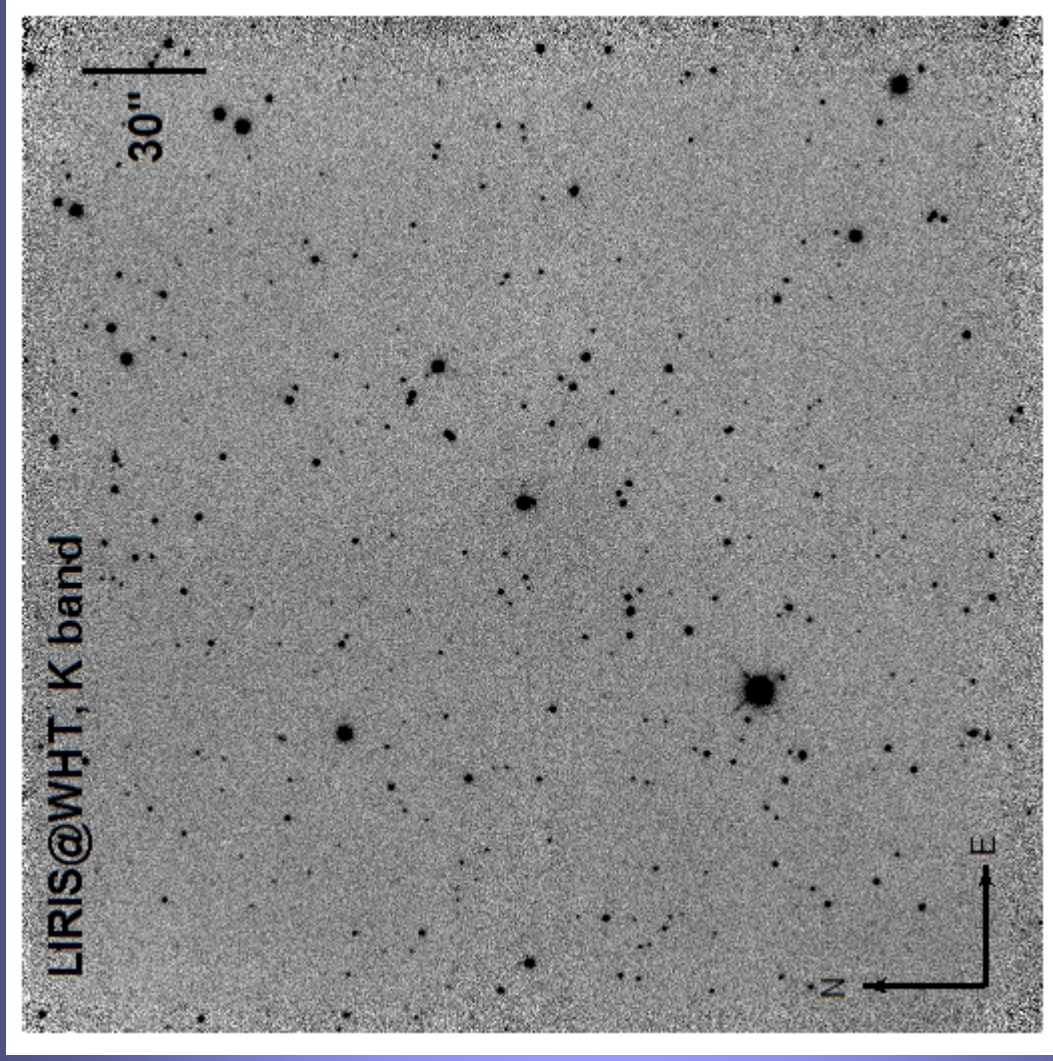
Multiplicity of M0-M8 dwarfs (60 objects) with NACO @ VLT

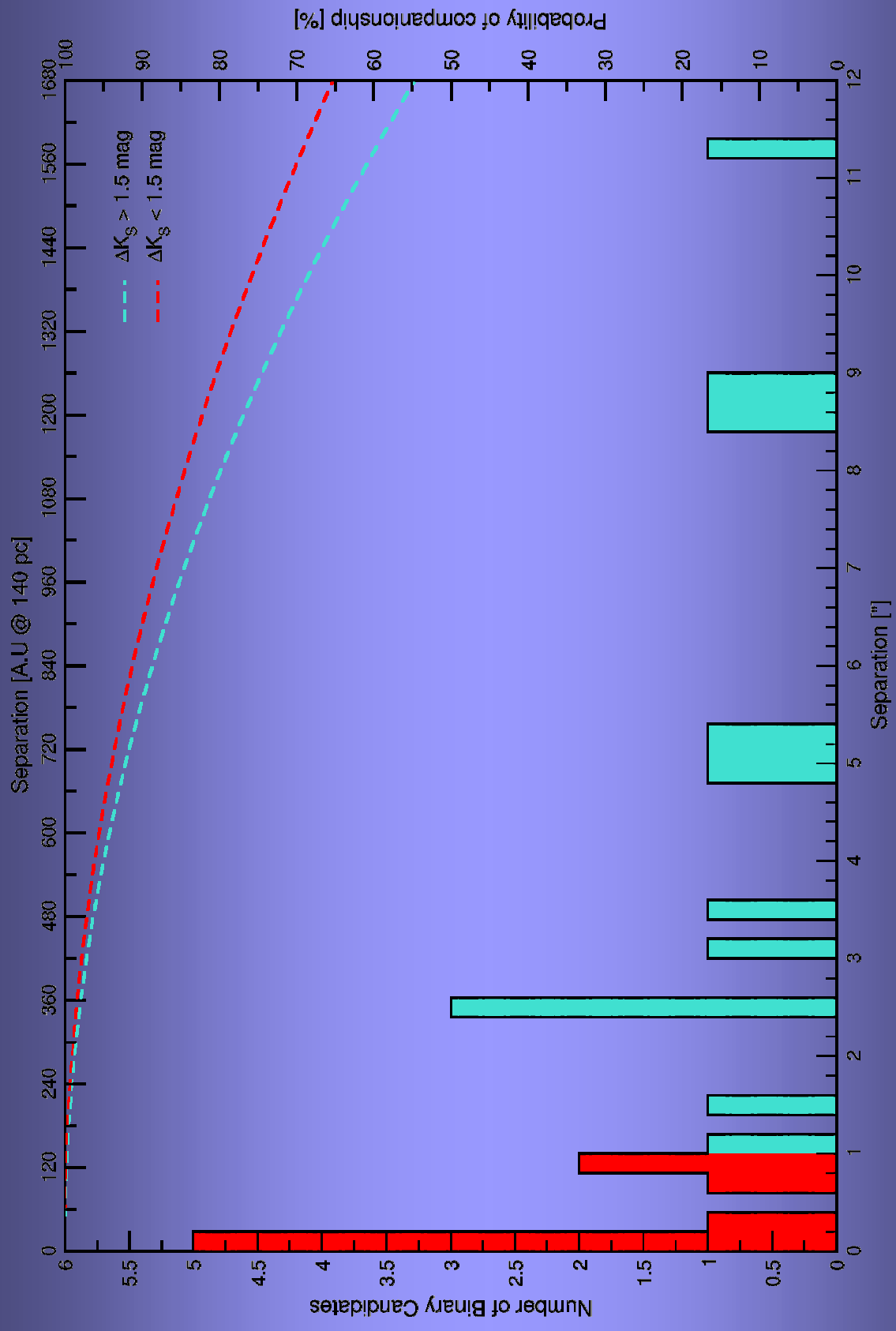


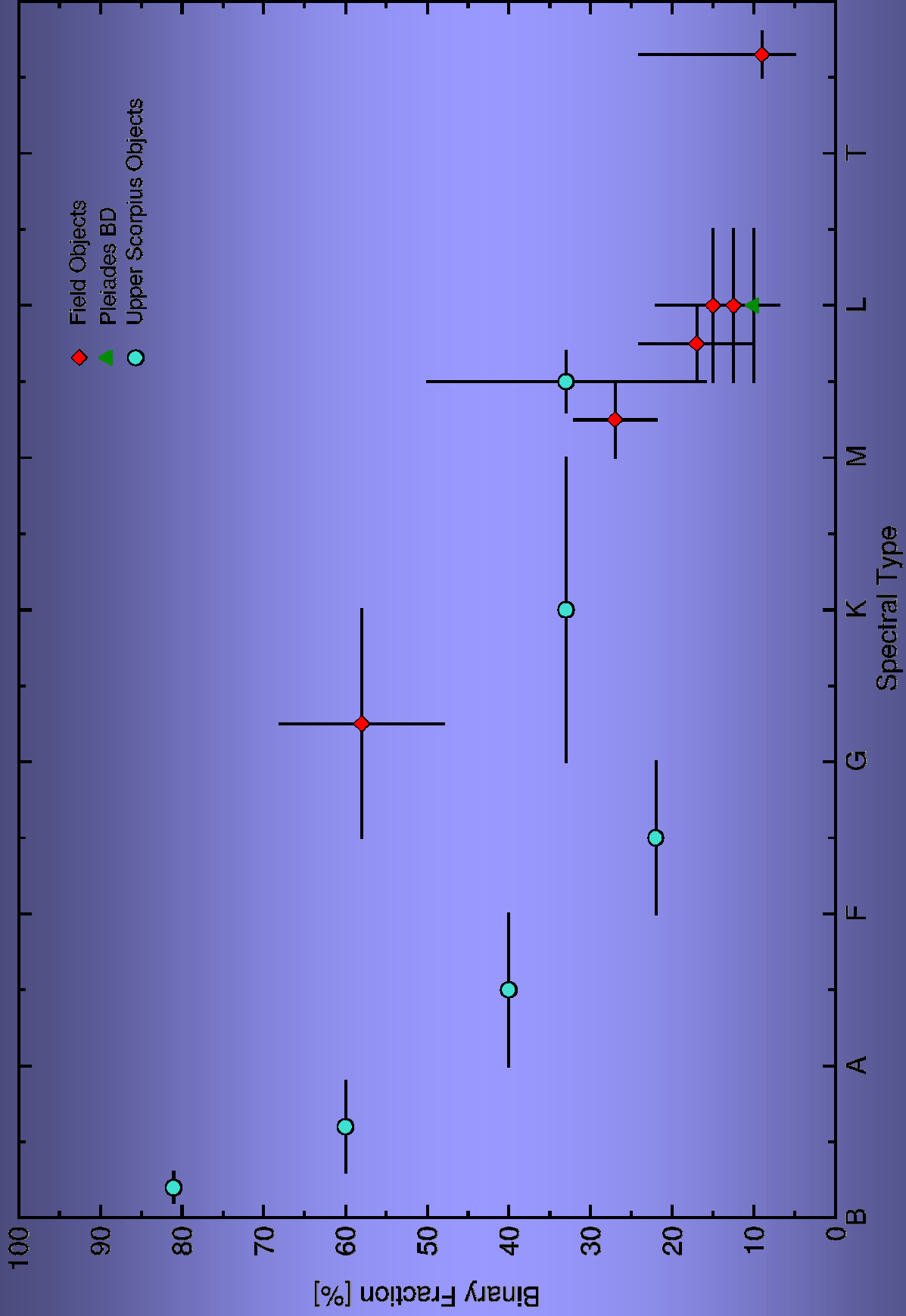














# Summary

	USco (~5 Myrs)	Pleiades (~120 Myrs)	Field (1~5Gyrs)
Binary Fraction	~30%	~15% M6-M9 <10% M9-L3	10%~15%
Distribution of separations	Bi(+)modal ? a<30 & a>30 AU	All objects < 20 AU	<ul style="list-style-type: none"> <li>• Most objects &lt;20 AU</li> <li>• Few objects &gt; 30AU</li> </ul>
Distribution of mass ratios	q~1	q~1	q~1 (biased)

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# Ultracool dwarfs in other types of systems

Ultracool and Brown dwarfs have been found as companions to many other kind of objects, such as:

- white dwarfs (see presentation by Jay just after)
- A stars (a couple of exemple)
- G stars: very few: less than ~1%
- as primary star of planetary systems (see e.g Chauvin et al., 2005, Neuhauser et al., 2005)

These must also be explained by the models !!

*They are probably the most obvious proofs that ultracool and brown dwarfs form not only in one way but in several competing/complementary ways*

# Conclusions & Future prospects:

- There seems to be significant differences in the properties of multiplicity of ultracool objects at young and evolved ages !
- Need to refine the currently available statistics
- Need to extend these surveys to:
  1. Larger range of mass ratios
  2. Larger range of separations (Reiners et al., in prep)
  3. Fainter (less massive) objects
  4. More environments
    - IC348 (K. Luhman et al., 2005, No binary BD)
    - Taurus (A. Kraus, on-going)
    - Praesepe (Chapelle et al. 2005, ~30% of photom. binaries)
    - ...