



VERY LOW-MASS SPECTROSCOPIC COMPANION AROUND THE BROWN DWARF CHAHA8

AND OTHER RESULTS FROM RV SURVEY OF BDS/VLMS IN CHAI

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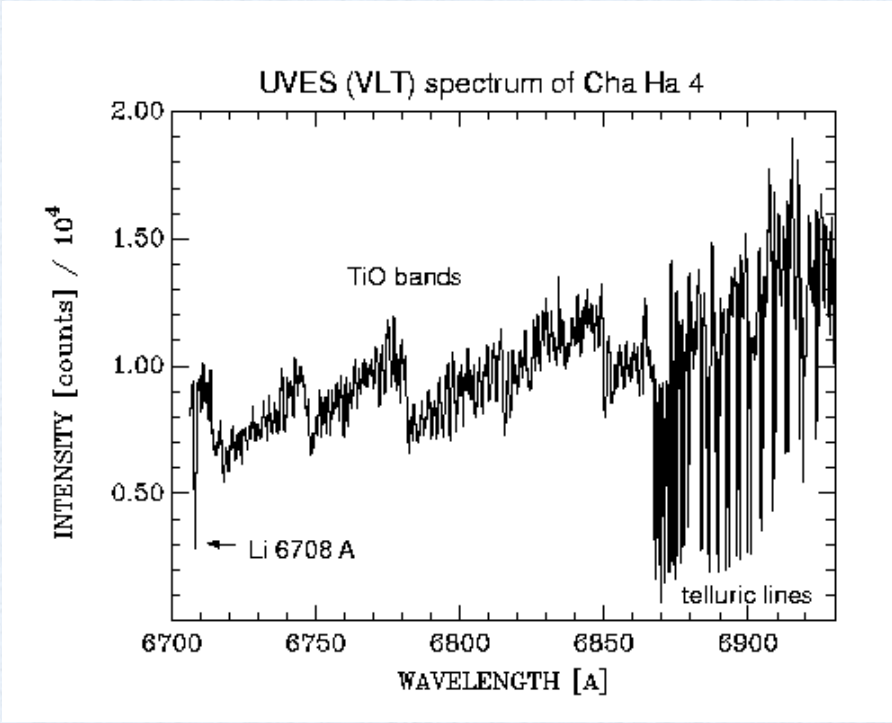


RADIAL VELOCITY SURVEY OF BROWN DWARFS IN CHAI WITH UVES / VLT



VLT Kuyén 8m telescope

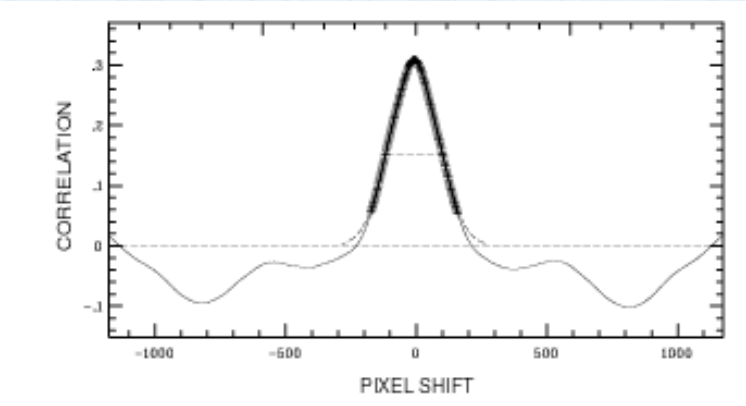
time resolved
high-resolution
UVES Echelle
spectra



spectral resolving power
40 000

wavelength range:
6700 – 10 000 Å

Cross correlation with a template



stellar lines

telluric lines --> wavelength reference

==> RV determination
RV precision 40 – 670 m/s
(depending on S/N)

(Joergens & Guenther 2001, A&A379, L9
Joergens 2006, A&A 446,1165; Joergens 2006, A&A 448, 655)
Joergens 2007a ApJ in prep; Joergens 2007b A&A in prep)

Brown dwarfs and very low-mass stars in the Cha I cloud

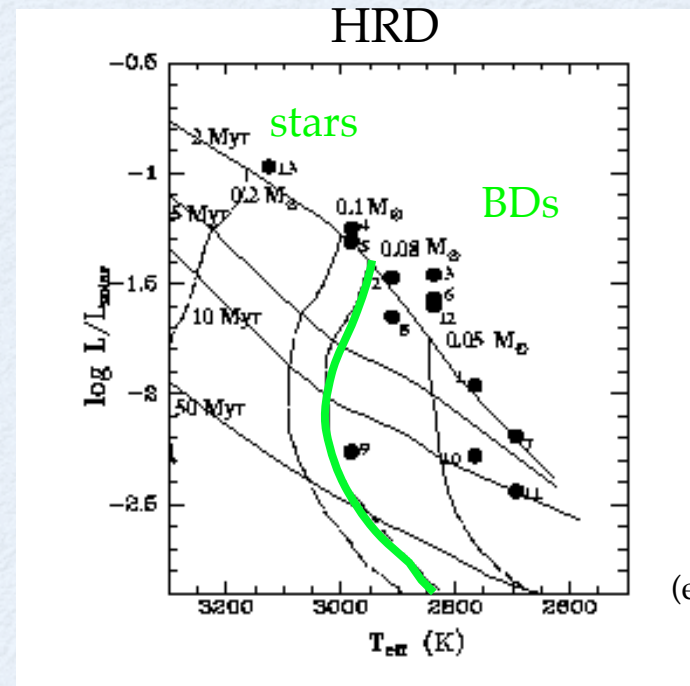


The Chamaeleon I complex
(VLT UT1 + FORS1 credit: ESO)
160 pc

very young BDs and VLMS detected by Ha survey

(Comeron et al. 1999, 2000;

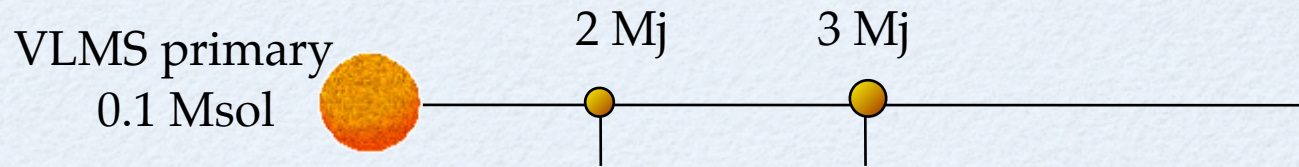
Neuhäuser & Comeron 1998, 1999)



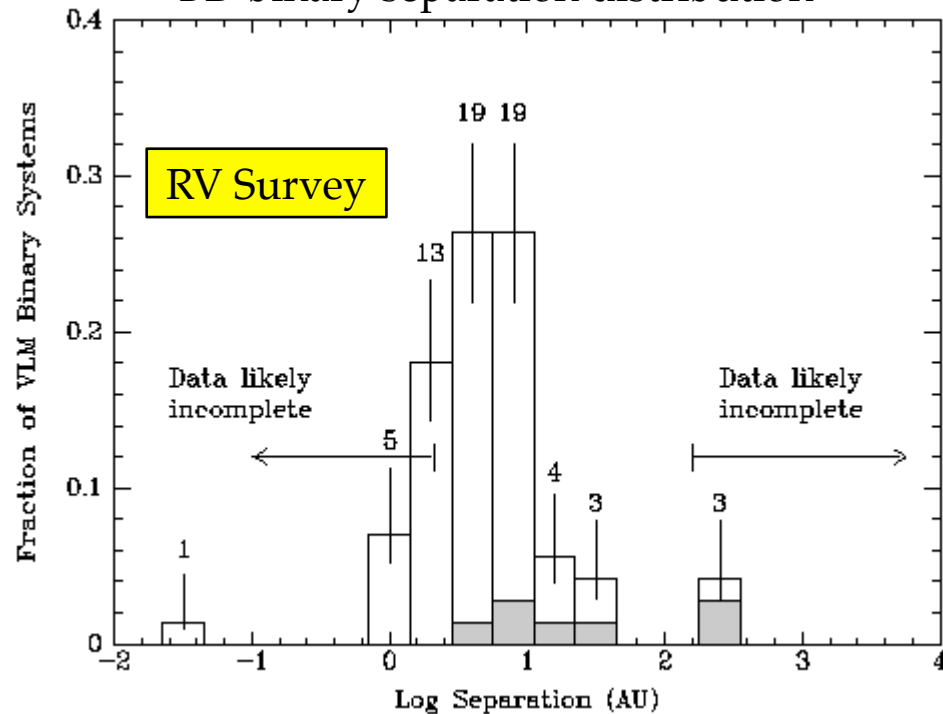
(evolutionary tracks by
Baraffe et al. 1998)

well established cluster membership
(low-res. Spectra, Li, Ha, RVs)

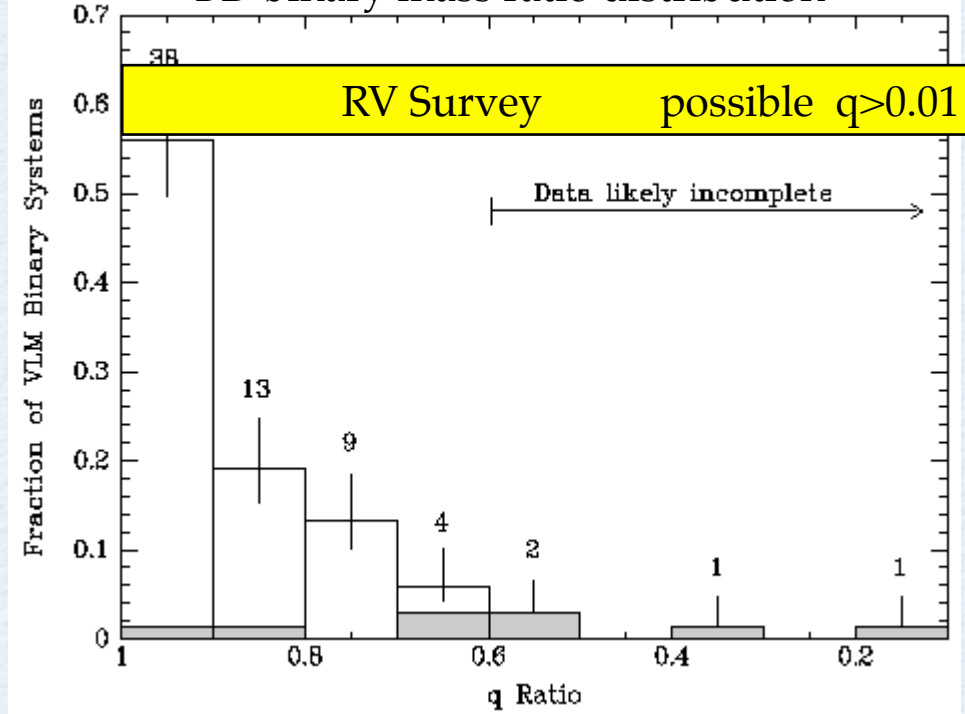
Covered parameter range: masses, orbital separations, mass ratios



BD binary separation distribution



BD binary mass ratio distribution

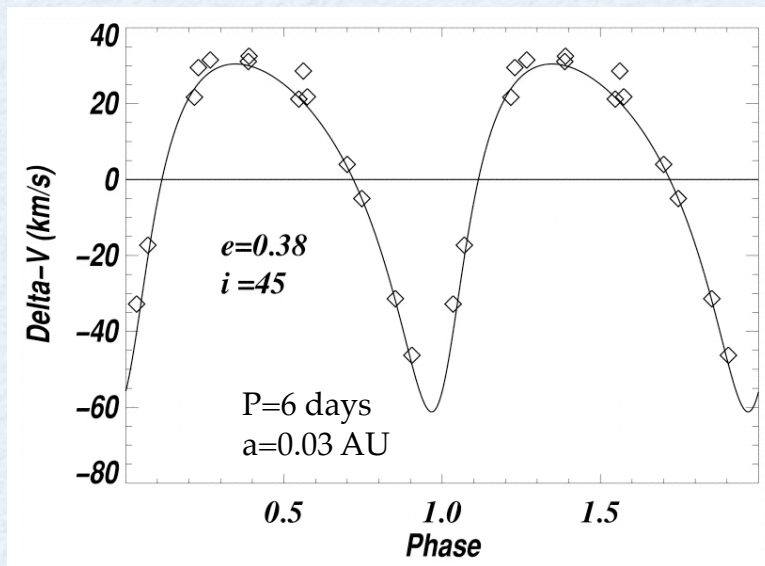


(Burgasser et al. 2007, PPV)

Known spectroscopic companions to Brown dwarfs

PPl 15: 1st BD binary (Basri & Martin 1999)

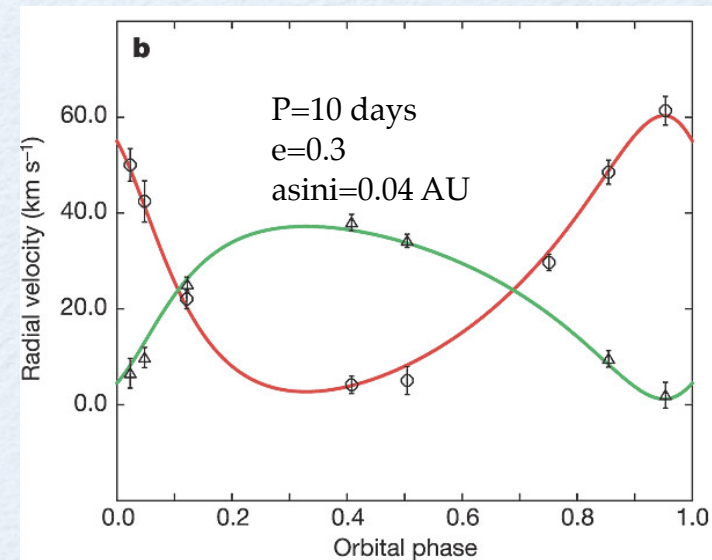
SB2, $M_2/M_1=0.85$ $M_1=0.07M_{\text{sol}}$ $M_2=0.06M_{\text{sol}}$



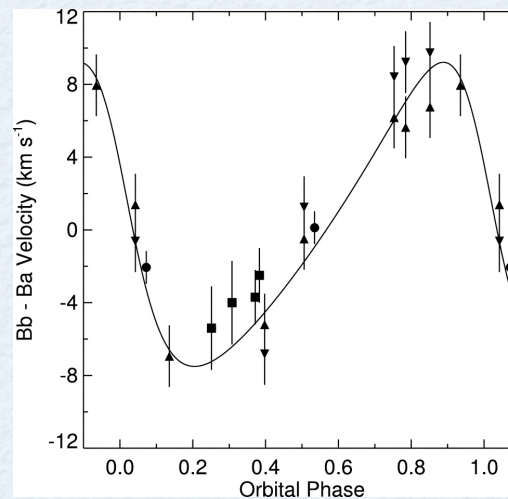
1st BD eclipsing SB2 (Stassun et al. 2006)

$M_1=0.05M_{\text{sol}}$ $M_2=0.03M_{\text{sol}}$ $q=M_2/M_1=0.6$

$R_1=0.7R_{\text{sol}}$ $R_2=0.5R_{\text{sol}}$ age=1-3Myr

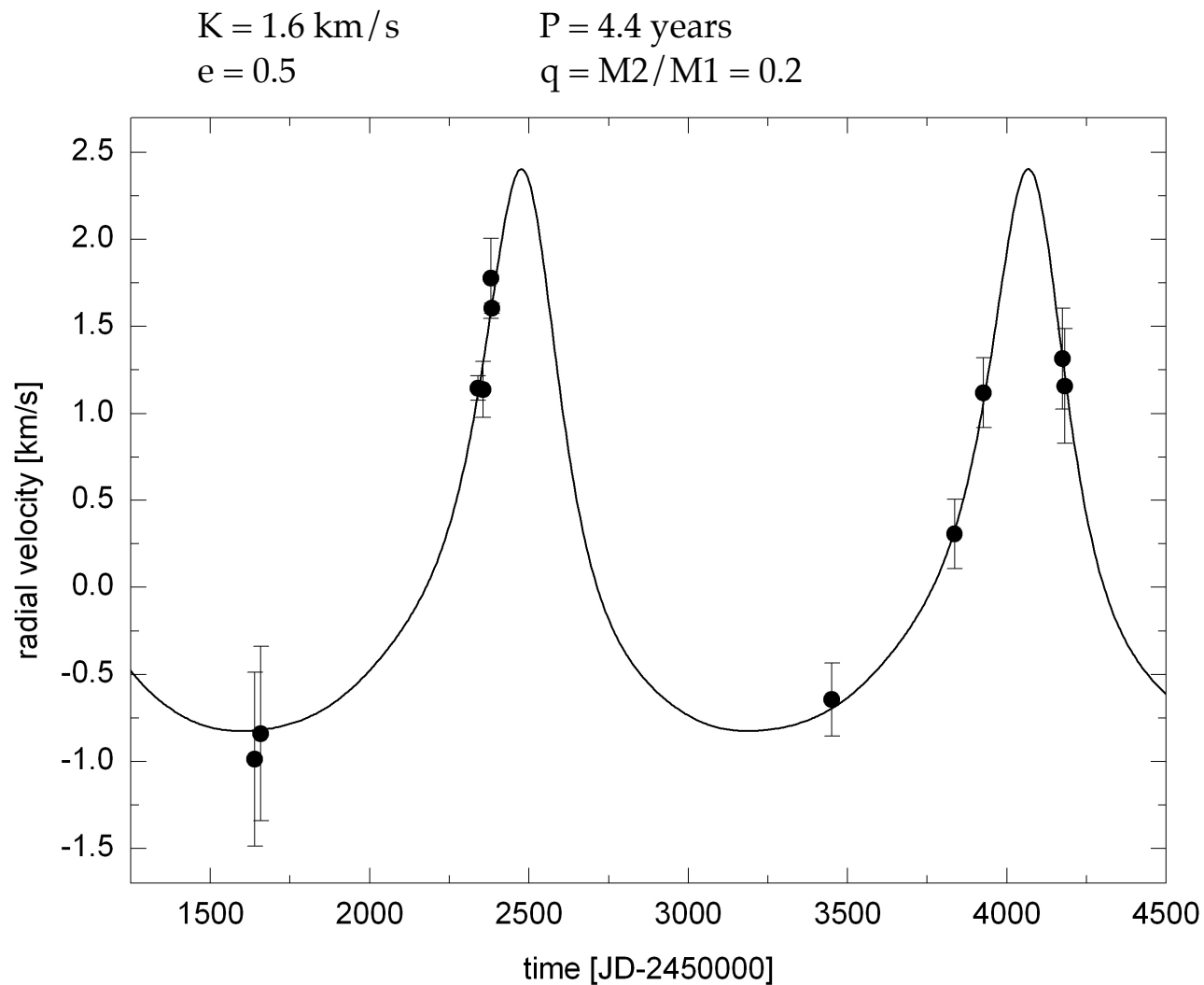


GJ 569: quadrupel w/ triple BD w/ BD SB (Simon et al. 2006)



further BD / VLMS SB candidates:
Reid et al 2002; Guenther & Wuchterl 2003;
Kenyon et al. 2005; Kurosawa et al. 2006;
Prato 2007 and maybe more

ChaHa8 : BD with very low-mass companion



The Kepler orbit of ChaHa8

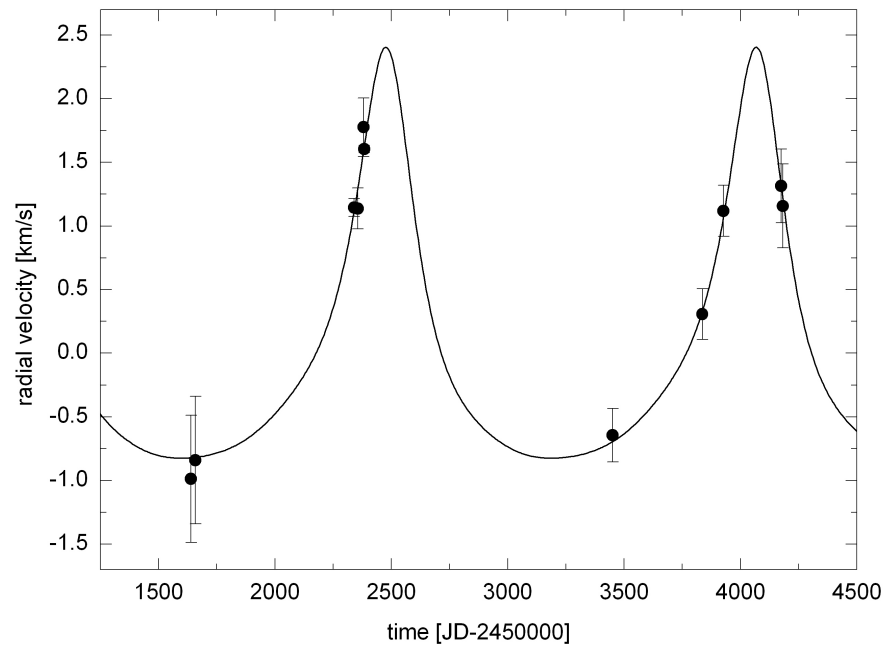


Table 3. Orbital and physical parameters derived for the best-fit Keplerian model of Cha H α 8.

Parameter		Cha H α 8	
		Value	Error
P	[days]	1590.9	21.1
T	[HJD-2450000]	2487.5	87.3
e		0.49	0.19
V	[km s ⁻¹]	15.774	0.212
ω	[deg]	8.20	^{+40.2} _{-8.20}
K	[km s ⁻¹]	1.615	0.366
$a_1 \sin(i)$	[AU]	0.21	0.10
$f(m)$	[10 ⁻⁴ $M_{\odot}$]	4.599	
$m_2 \sin(i)$	[M_{Jup}]	15.6–20.7	0.6–0.8
a_2	[AU]	0.97–1.14	0.10–0.13
N_{meas}		11	
span	[days]	2542	
σ (O-C)	[m/s]	96.7	
χ^2_{red}		0.424	

(courtesy to A. Mueller, MPIA)

The host ChaHa8

ChaHa8:

M6.5, 0.07 Msol (Comeron et al. 2000)

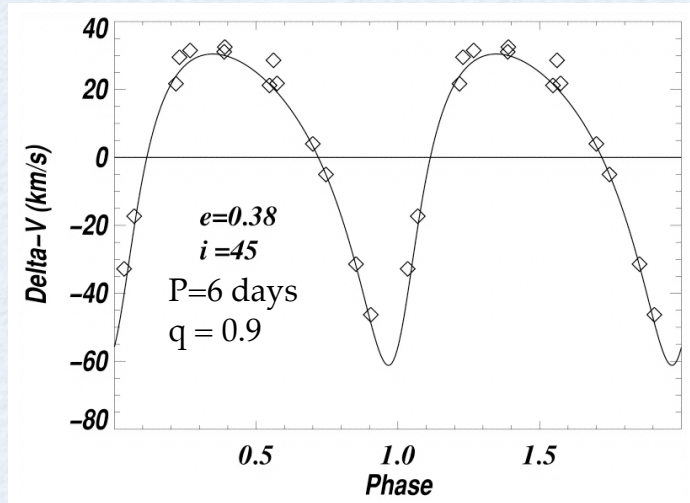
M5.75, 0.11 Msol (Luhman 2004)

Table 1. Physical parameters for Cha H α 8. References: (1) Comerón et al. 2000, (2) Joergens & Guenther 2001, (3) Joergens et al. 2003, (4) Luhman 2004, (5) this work.

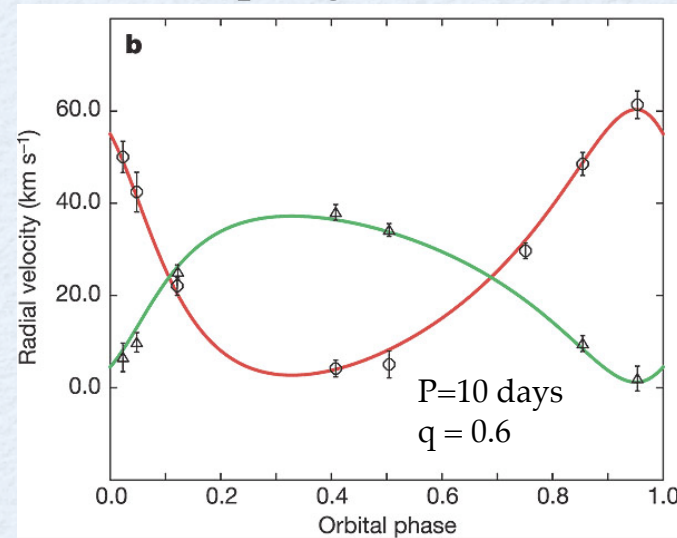
Parameter		Cha H α 8	reference
SpT		M6.5, M5.75	1,4
V	[mag]	20.1	1
T_{eff}	[K]	2910, 3024	1,4
$\log(L)$	[$L_{\odot}$]	-1.65, -1.35	1,4
M_*	[$M_{\odot}$]	0.07, 0.11	1,4,5
$v \sin(i)$	[km s $^{-1}$]	15.5 $\pm$ 2.6	2
$P_{v \sin(i)}$	[days]	1.9	2
R_*	[$R_{\odot}$]	0.59	2
ΔR	[mag]	<0.02	3
Δi	[mag]	<0.04	3

ChaHa8: Fourth BD / VLMS spectroscopic system

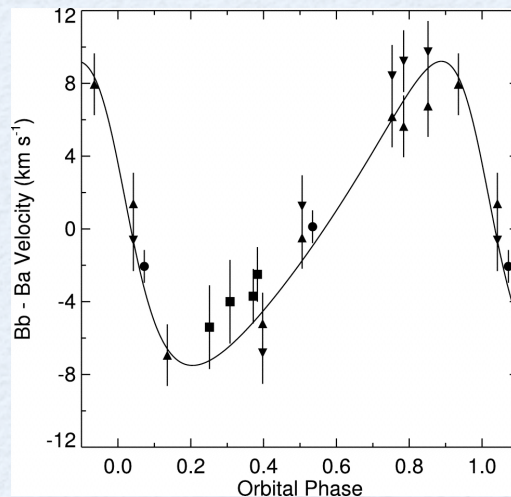
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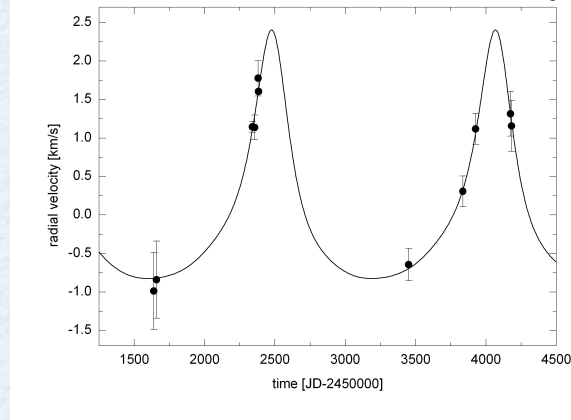
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GJ 569: quadrupel
w/ triple BD w/ BD SB
(Simon et al. 2006)

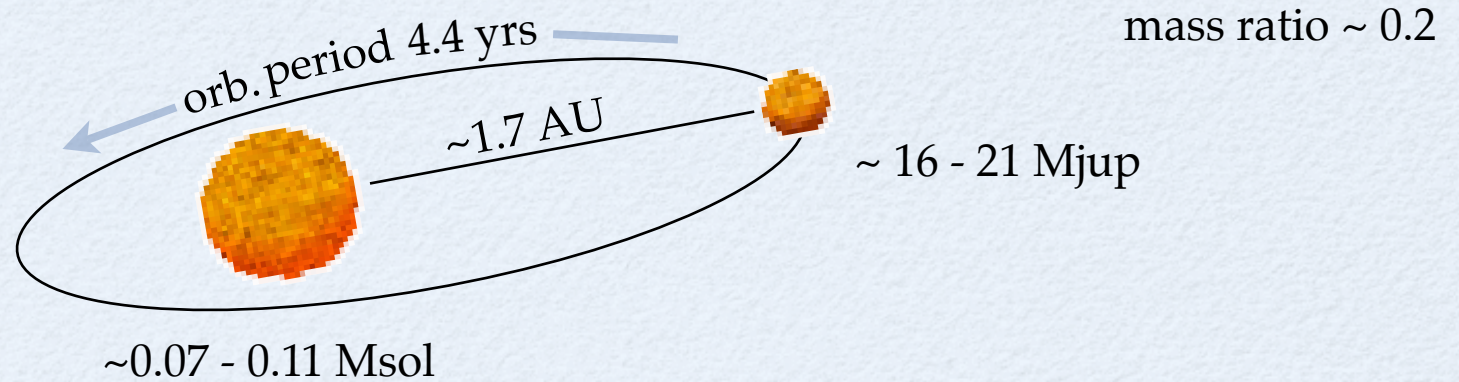


ChaHa8: 4th BD / VLM binary, very low q system



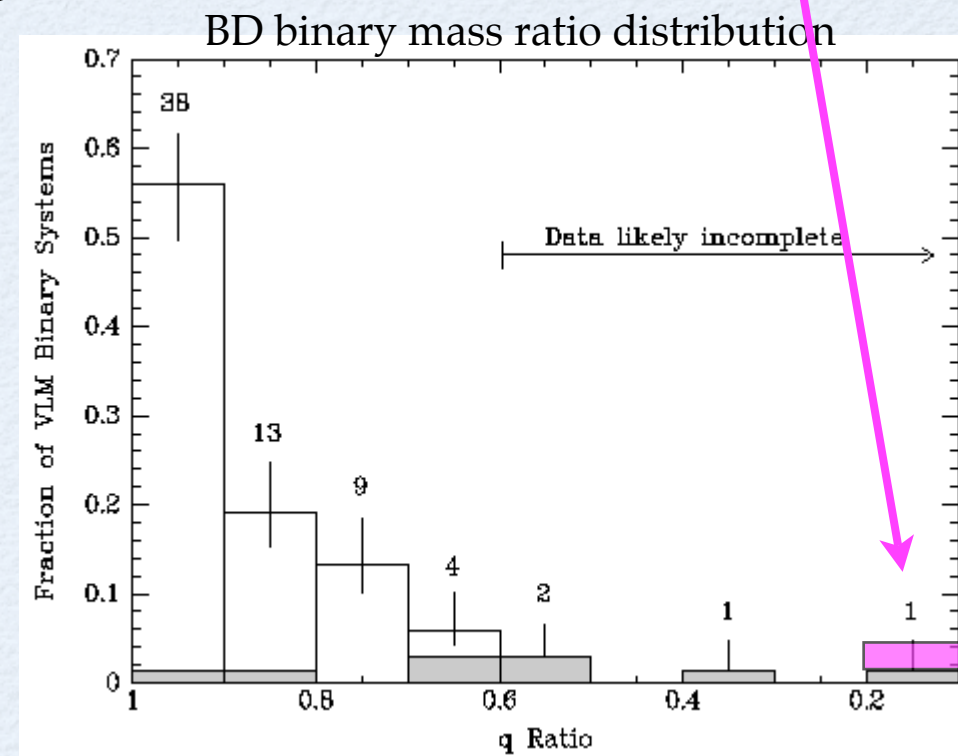
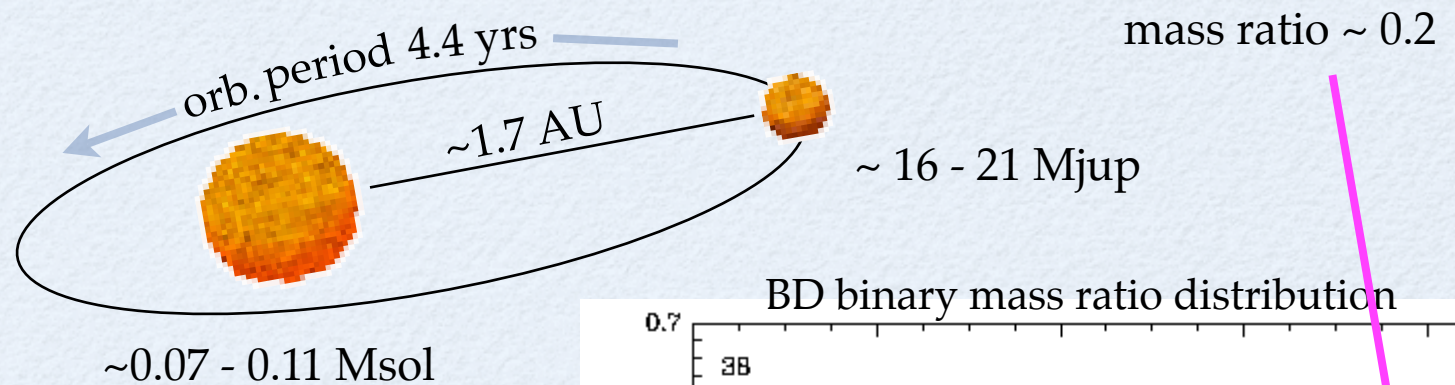
The system ChaHa8

age: ~ 3 Myrs



The system ChaHa8

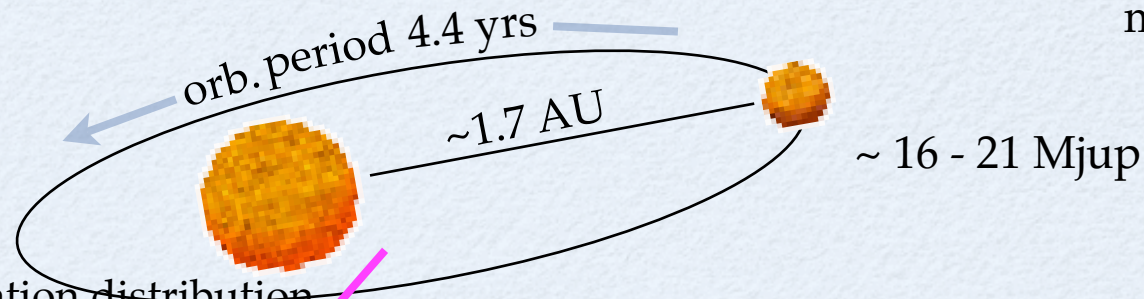
age: ~ 3 Myrs



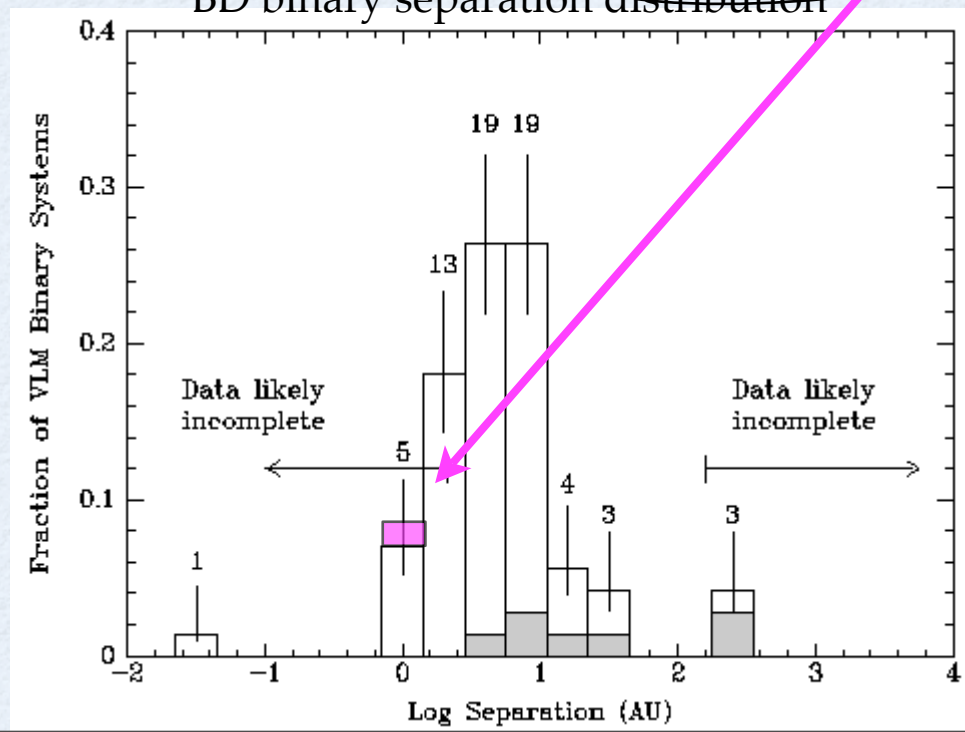
The system ChaHa8

age: ~ 3 Myrs

mass ratio ~ 0.2



BD binary separation distribution



Activity ?

chromospheric activity

H alpha emission (Comeron et al 2000, Mohanty et al 2005, Luhman 2004)
X-ray emission (Stelzer et al 2004)

no sign. accretion

$W(\text{H}\alpha) < 10 \text{ \AA}$, no CaII 8662Å emission (Mohanty et al 2005)

surface activity can cause photometric and RV variability on time scale of rotation rate

rotation period: a few days

$v \sin i = 15.5 \text{ km/s}$ (Joergens & Guenther 2001)
 $P(v \sin i) = 1.9 \text{ days}$

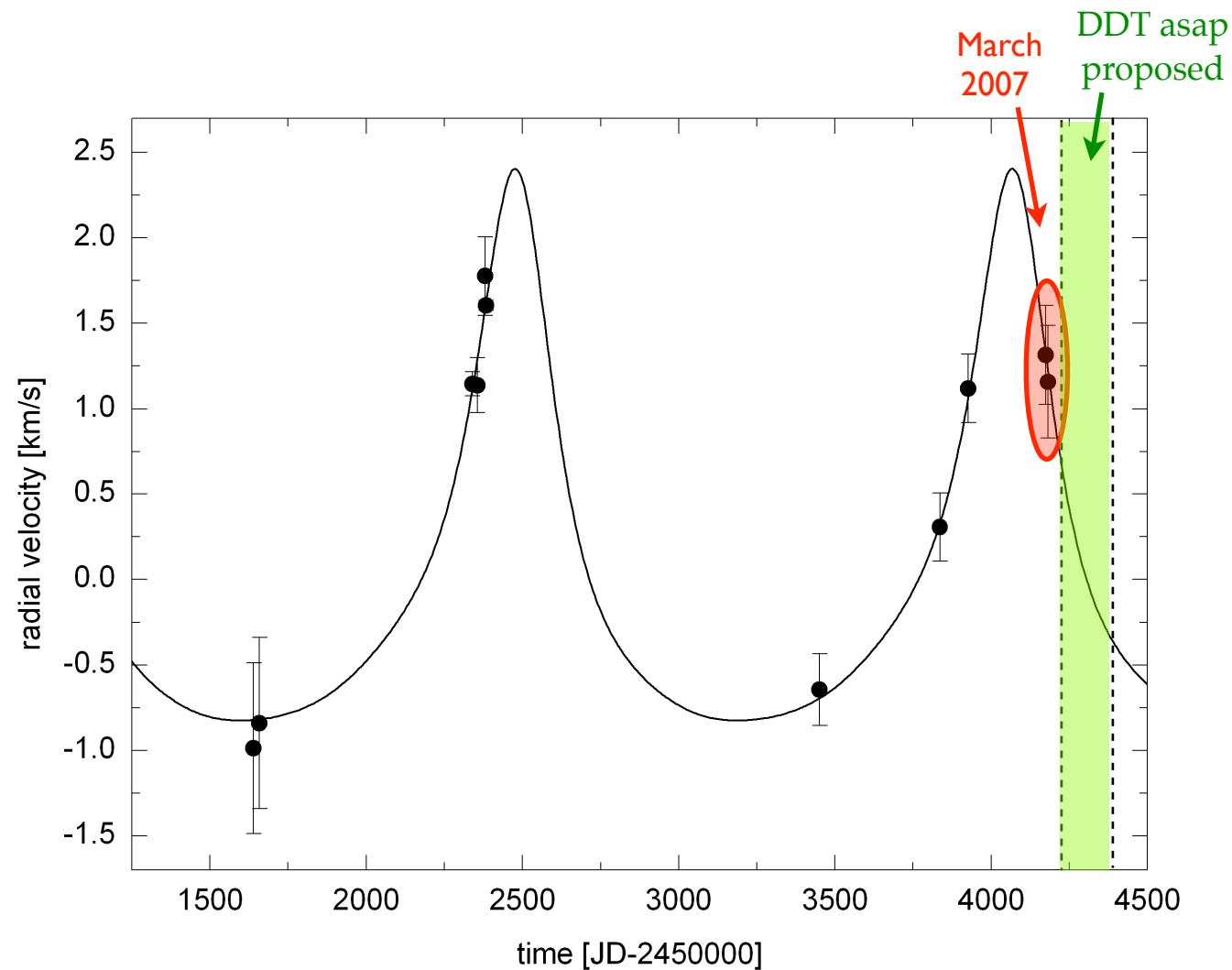
small photometric variability

phot. amplitude in I and R filter $< 0.04 \text{ mag}$ (Joergens et al. 2003)

small RV variability amplitude on times scales of a few days

$\Delta \text{RV (peak-to-peak)} < 0.17 \text{ km/s}$

Future: RV follow-up of ChaHa8



Future: astrometric orbit of ChaHa8

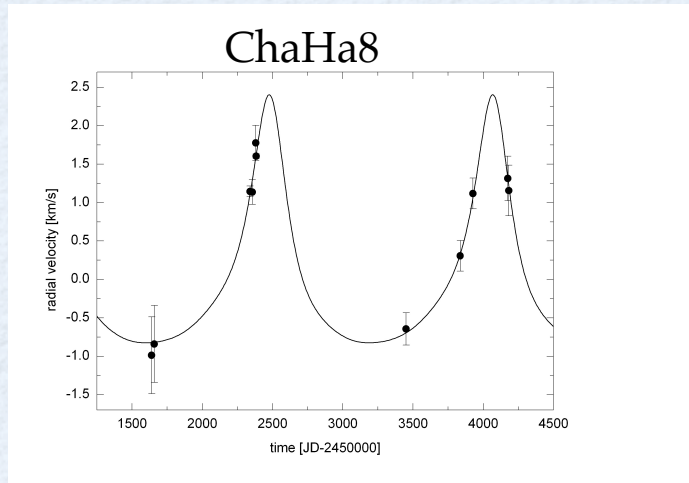
astrometric signal of ChaHa8:

$$\text{Theta ["}] = (M2 / M1) * (\text{sep[AU]} / D[\text{pc}])$$

$$\text{Theta ["}] \sim 3 \text{ milli arcsec}$$

PRIMA/VLTI observations: target faint (K=11.6mag) but
suitable brighter reference star (K=8.3mag at 29")
for fringe tracking
> astrometric precision ~30 micro arcsec

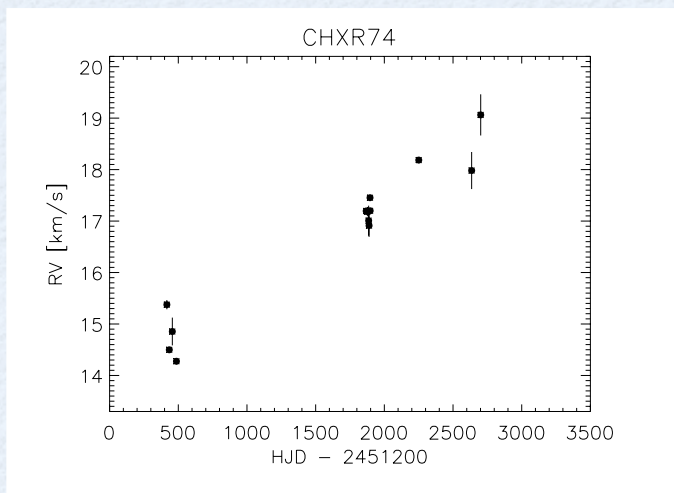
Summary / conclusions



4th known brown dwarf (or VLM) spectroscopic binary
extremely young (3 Myr) --> 2nd known very young BD / VLM SB

BD / VLM SB with the smallest mass ratio (0.2)

Joergens 2006 A&A 446, 1165; Joergens 2007a ApJ in prep



spectroscopic BD around 0.2 Msol star ?

3rd epoch data of whole sample:
probing larger separation

Joergens 2007b A&A in prep