BD discs sizes as a clue to their formation model

Jean-Louis MONIN, Université de Grenoble, France

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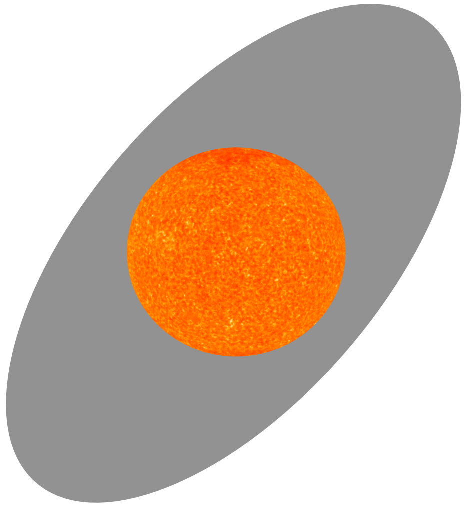


(V)LMS discs sizes
as a clue of their formation model

BD formation in a nutshell:

• If Brown Dwarfs form like stars, they have discs and accrete mass from them.

• If Brown Dwarfs are ejected embryos, their possible discs are stripped off, hence have smaller outer radii.

→ SIZE MATTERS! What about discs' size around Brown Dwarfs ?

Research note : discs sizes around (V)LMS...

LAOG FOST constellation Université Joseph Fourier cnrs dépasser les frontières

The original idea came from a theoretical perspective !

Hydrodynamical simulations of star cluster formation, Bate 2009 MNRAS, 392, 590

Ejections -> typical truncation radius decreases with increasing stellar mass (more massive stars have had closer encounters).

Difficult to directly associate the closest encounter with the radii of protostellar discs because many stars accrete new discs after suffering a close encounter. Particularly for the more massive stars.

For VLM objects, dynamical encounters usually occur soon after their formation and terminate their accretion -> truncation radii may more closely reflect their disc radii.

At least 10 per cent of the VLM objects should have disc radii > 40 AU.

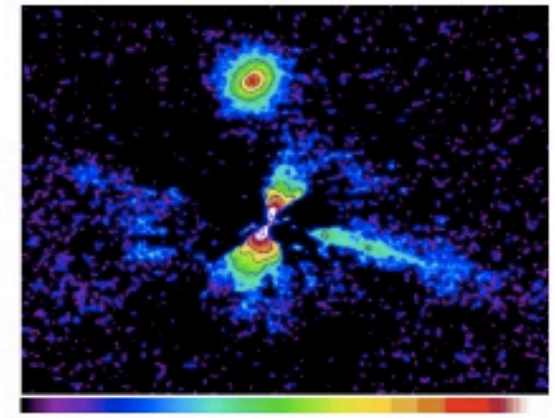
Fraction may be expected to be larger in lower density star-forming environments

(Taurus ?)

http://www.circumstellardisks.org/

Catalog of Resolved Circumstellar Disks

Last updated: August 13 2009; maintained by Caer McCabe & Carlotta Pham



- The catalog
- What's new...
- Description of Catalog
- Contributing to the database
- List of spatially resolved disks that have been withdrawn or refuted

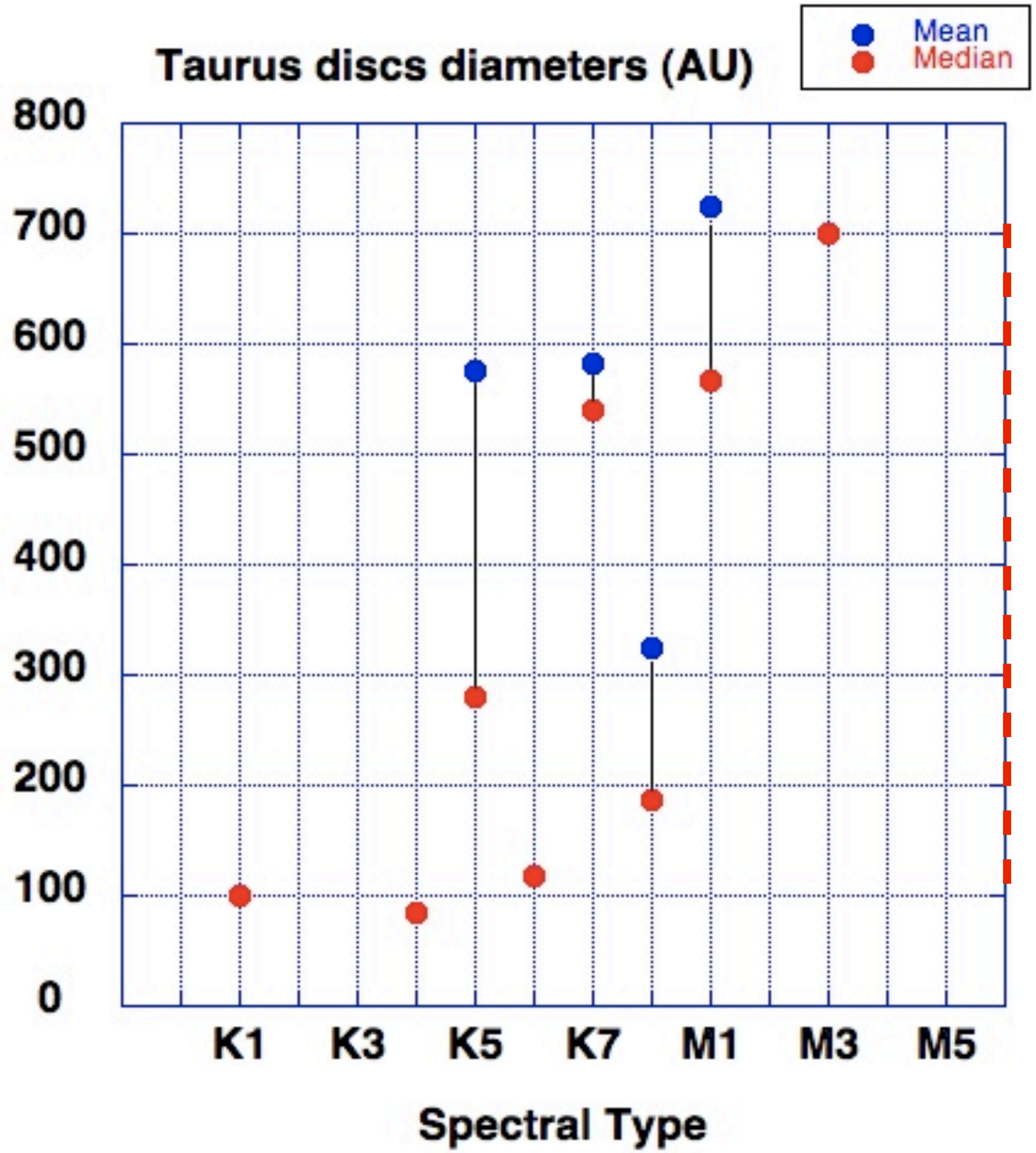
ASR 41		TT	316		20	6320	80	97.0	2.2
AU Mic	M1	MS	9.94	8.9	29.25	290	90	567.2	0.6
Beta Pic	A5	MS	19.28	3.9	26	501	90	504.2	0.6
BP Psc New		TT	100	12.2	1.2	120	75	36.4	1.6
BP Tau	K7	TT	140	11.1	1.5	210	30	1.5	1300.39
CB 26		YSO	140		5.5	770	88	42.4	2.2
CI Tau	K7	TT	140	12.3	1.7	238	46	1.0	880

Taurus discs sizes in the **mm** (and later vis-ir) range

- "homogeneous sample"
- One SFR (physical conditions, ~ age) at a time …
- Use Spectral type as a proxy for mass

Object	Sp Type	Diam. (AU)	λ (μm)	Ref.
AA Tau	M0	187	2000	Kitamura et al. 2002, ApJ 581
BP Tau	K7	210	1300	Simon et al, 2000, ApJ 545
CI Tau	K7	238	880	Andrews & Williams, 2007, ApJ 659
CY Tau	M1	532	1300	Simon et al, 2000, ApJ 545
DG Tau	K6	85	2700	Looney et al. 2000, ApJ 529
DL Tau	K7	1040	1300	Simon et al, 2000, ApJ 545
DM Tau	M1	1600	1300	Simon et al, 2000, ApJ 545
DN Tau	M0	70	2000	Kitamura et al. 2002, ApJ 581
DO Tau	M0	714	1300	
DR Tau	K5	200	2000	Andrews & Williams, 2007, ApJ 659
Elias 2-24	K6	152	1300	
GG Tau	K7	800	1360	
GO Tau	M0	280	1300	Andrews & Williams, 2007, ApJ 659
HL Tau	K5	145	2000	
IQ Tau	M1	215	2000	
IRAS 04158...	M3-M5	1400	880	Andrews & Williams, 2007, ApJ 659
Lk Ca 15	K5	500	1300	Isella et al., 2009, ApJ 701
RY Tau	K1	200	2000	Isella et al., 2009, ApJ 701
UZ Tau E	M1	500	1300	Isella et al., 2009, ApJ 701

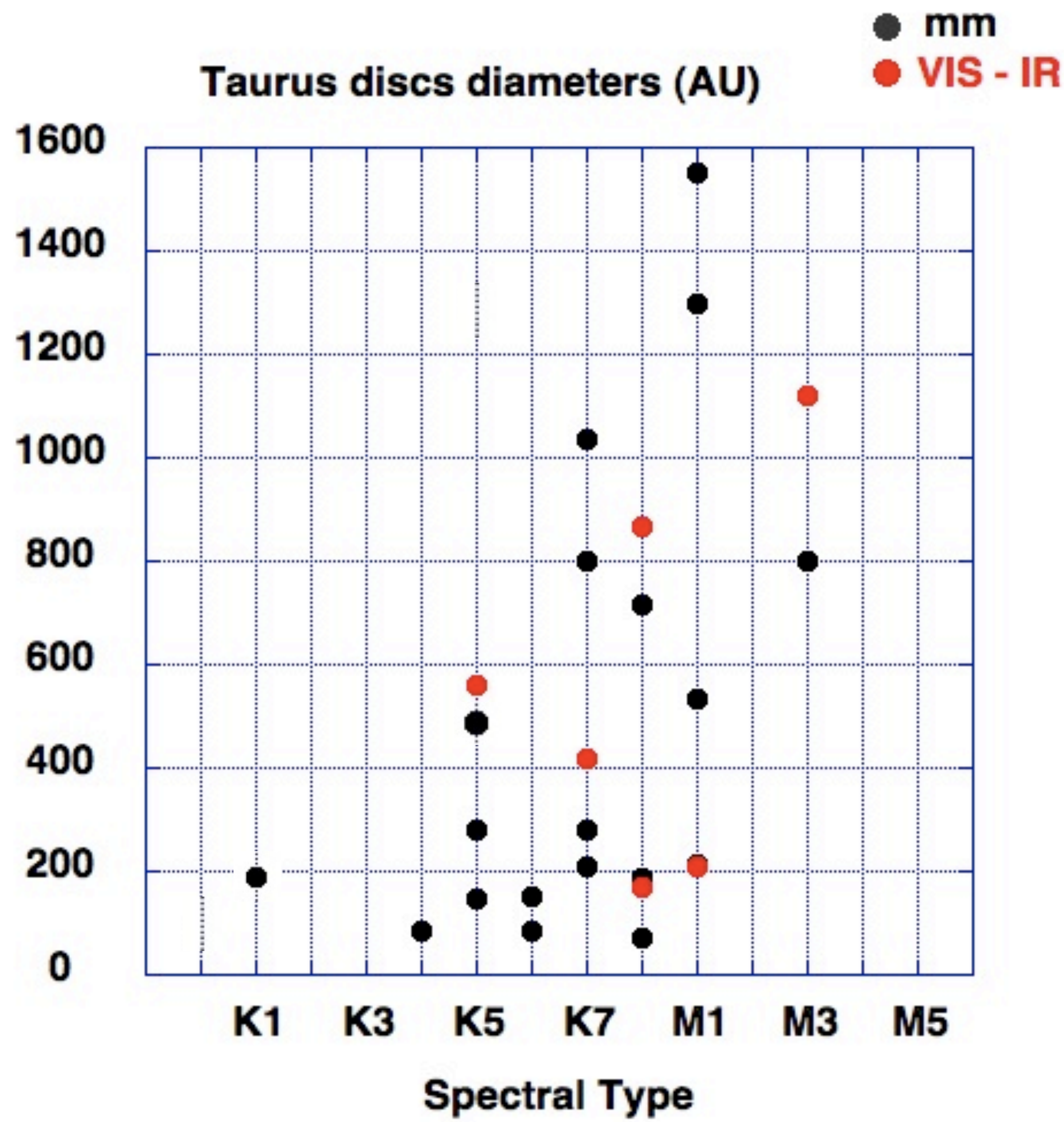
Mean and Median (mm) sizes vs. Spectral Type over the CSD database



sorry, no BD
… yet

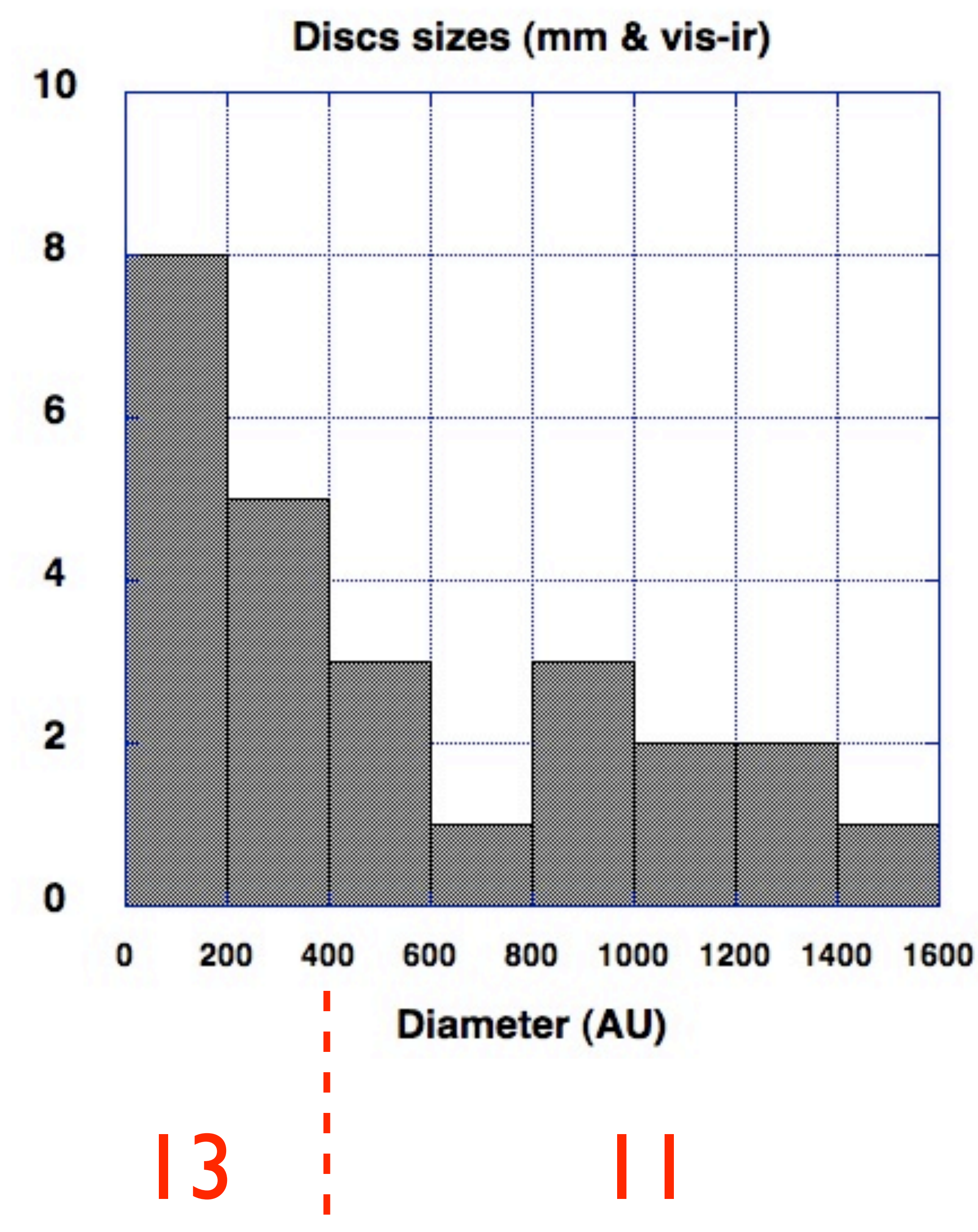
Monin, 2009, 2nd Subaru Conf

All measurements in the CSD database

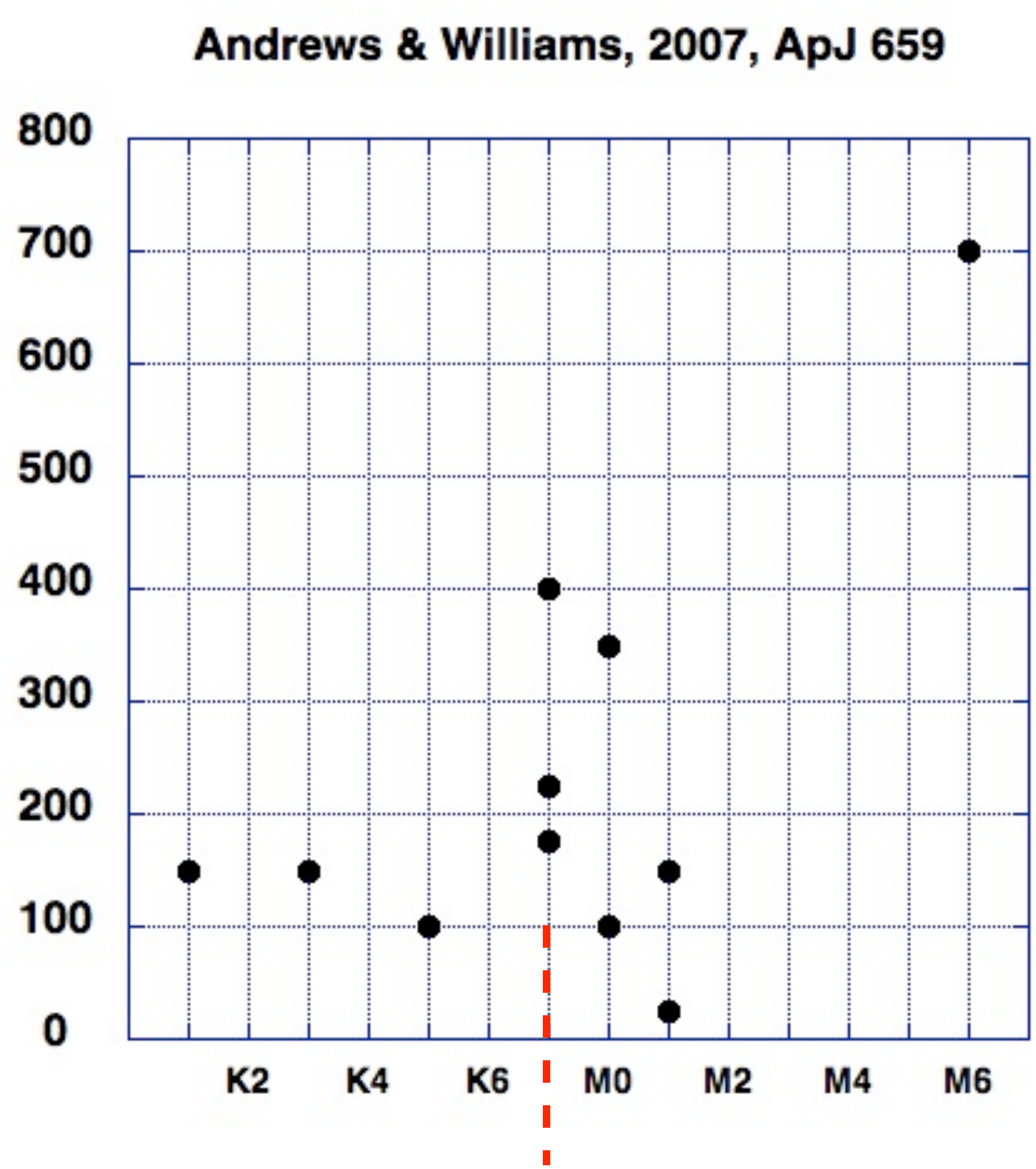


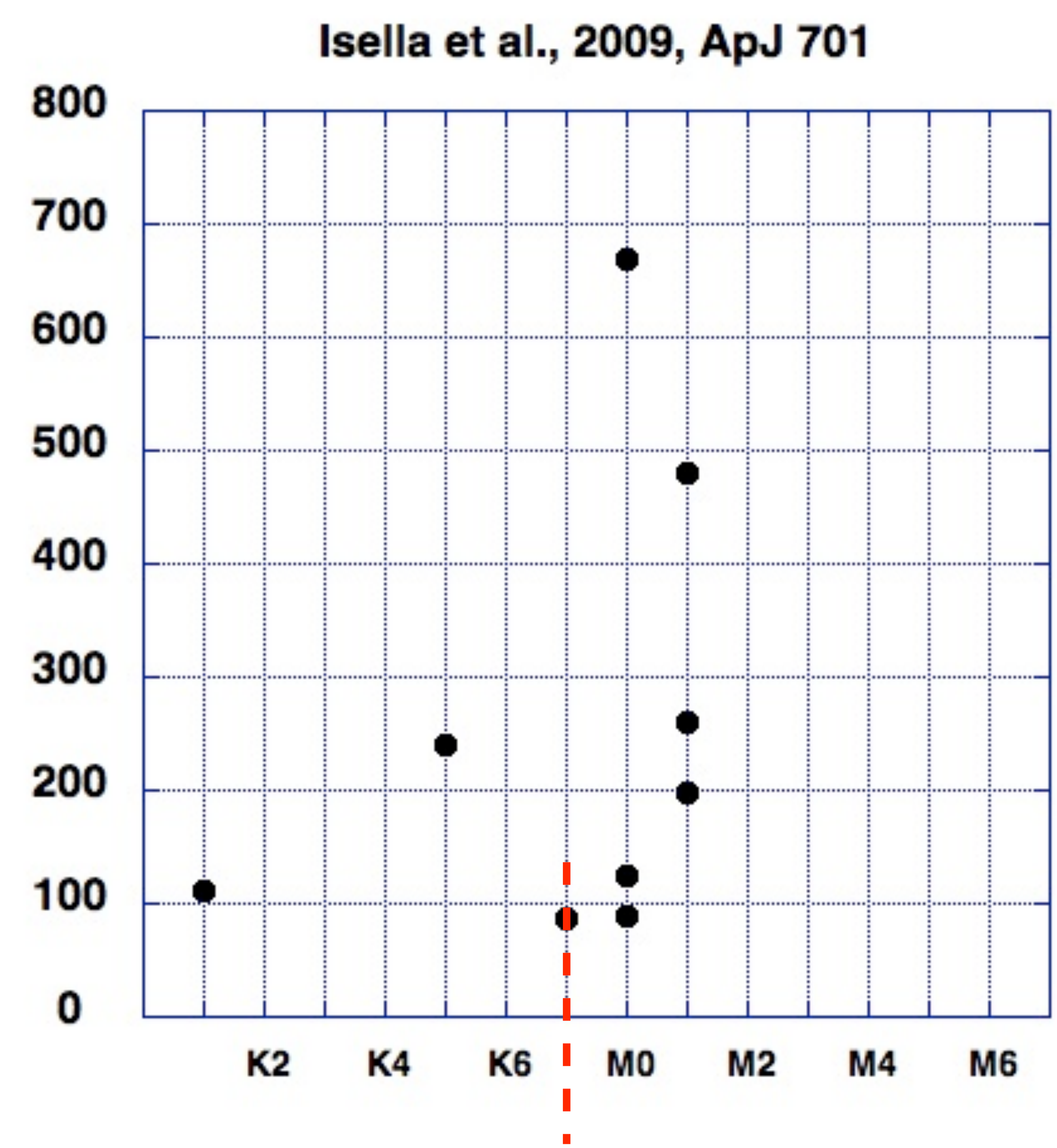
(24 objects)

A population of large discs, around lower mass objects



Two similar studies (with consistent results) in the recent literature

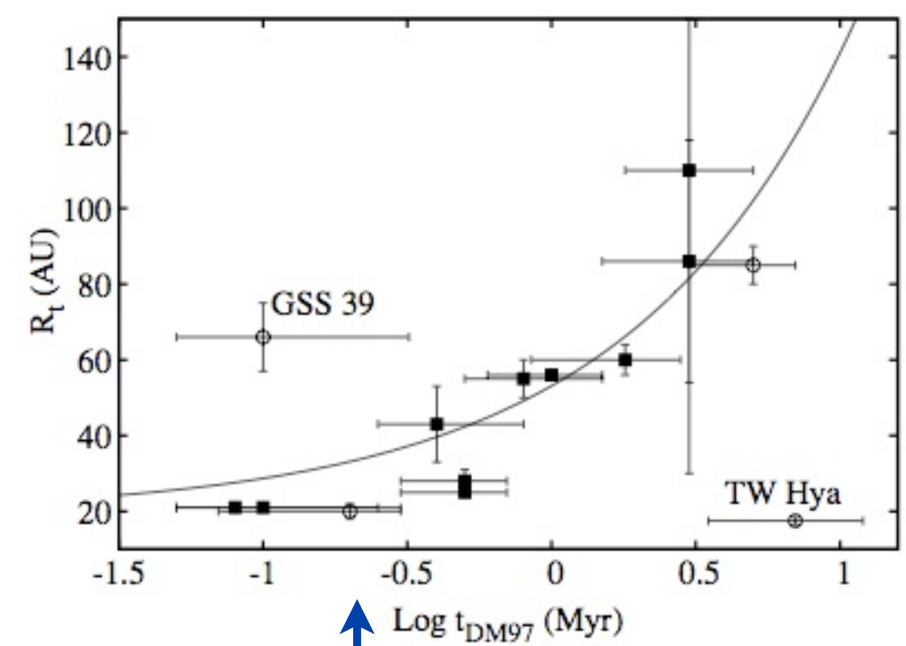




Caveats & questions

- No brown dwarf in the sample !
- small number statistics ?
- The mass range is quite small (K1-M3)
- What is the outer radius of a disc *anyway* ?
  - dust vs. CO ? (should be comparable)
    - power law model ?
    - exponential troncation ?
    - radius where $\tau(L_*)$ gets < 1 ?

Isella et al, 2009



(opposite)

- Age sequence ? Then why related to Spectral type ?
  - discs around low mass objects evolve and dissipate more slowly

$\tau \, \alpha \, M^{-1/2}$

- Some objects have various size determination
  - some consistent : BP Tau (K7), 110 AU (Simon et al, 2000)
    120 AU (Dutrey et al, 2003)
  - some questionable : DM Tau (M1), 800 AU (Simon et al, 2000)
    400 AU (Isella et al., 2009)
  - Some disks have upper limits in mm interferometry
  - Combination of disk proportion and M / K dwarfs ration in Taurus ?

Summary and future work

• Double check CSD database vs. literature and check mass / age distribution (WIP) ; + include upper limits

• No actual direct variation of disc size with spectral type, but existence of a large disc population, apparently preferentially at later spectral type.

• Dominated by disc evolution timescale ?

• Result against "the" ejection model ?

• Or could this be a result of dynamical interactions vs mass in low density Taurus aggregates ?

➙ Observing: need actual brown dwarf disc imaging.

➙ Simulations: need to follow disc fate (after ejection) in low density regions even more precisely.