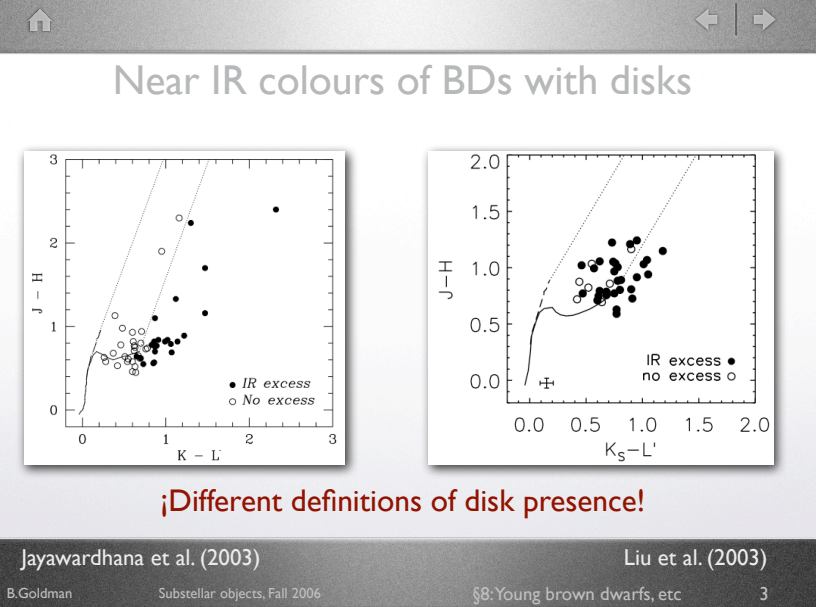


Brown dwarfs in their infancy and some other remaining bits

December 11, 2006

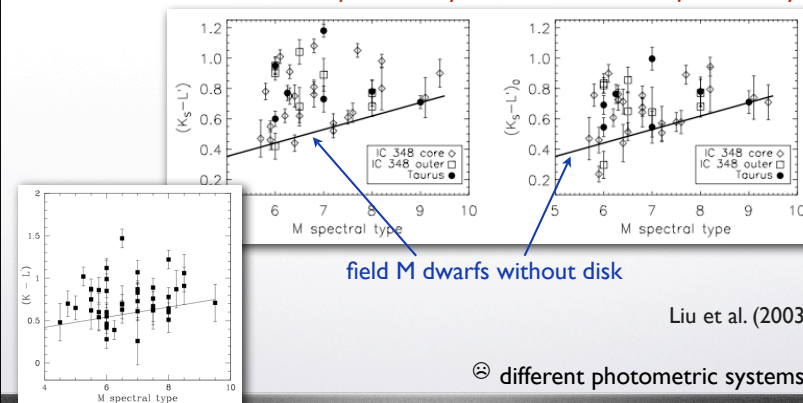


! Different definitions of disk presence!

Brown dwarf disks

Observed photometry

Dereddened photometry



Jayawardhana et al. (2003)

B.Goldman

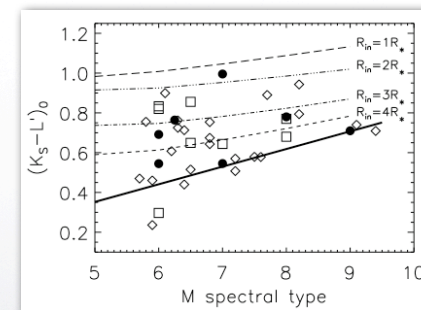
Substellar objects, Fall 2006

§8: Young brown dwarfs, etc

2

Inner holes in BD disks

- Typical hole size $2R_*$.
Larger if large accretion
and/or flaring



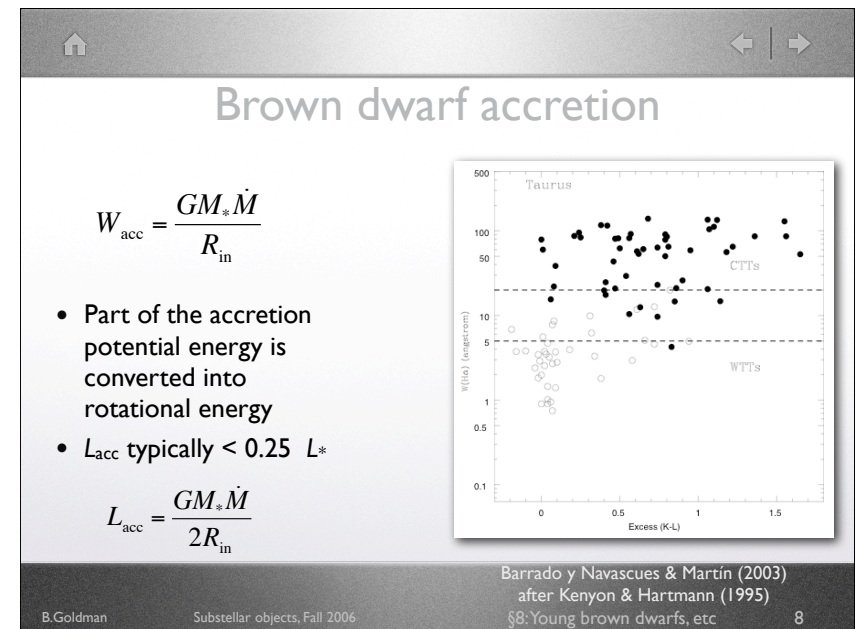
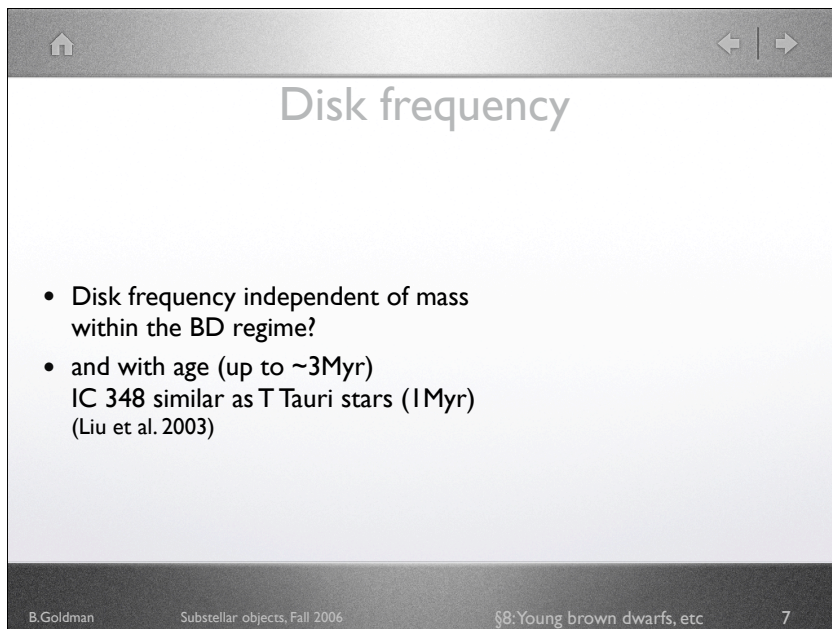
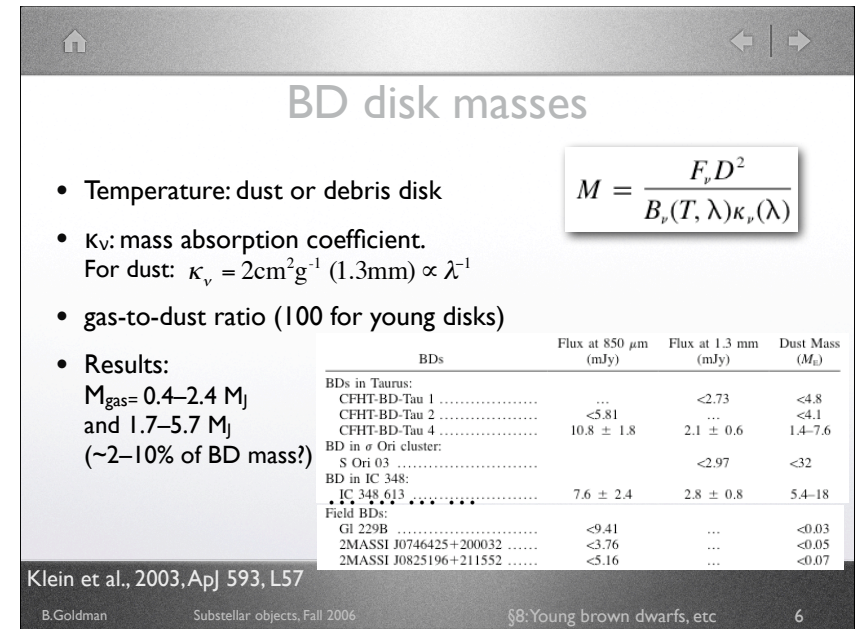
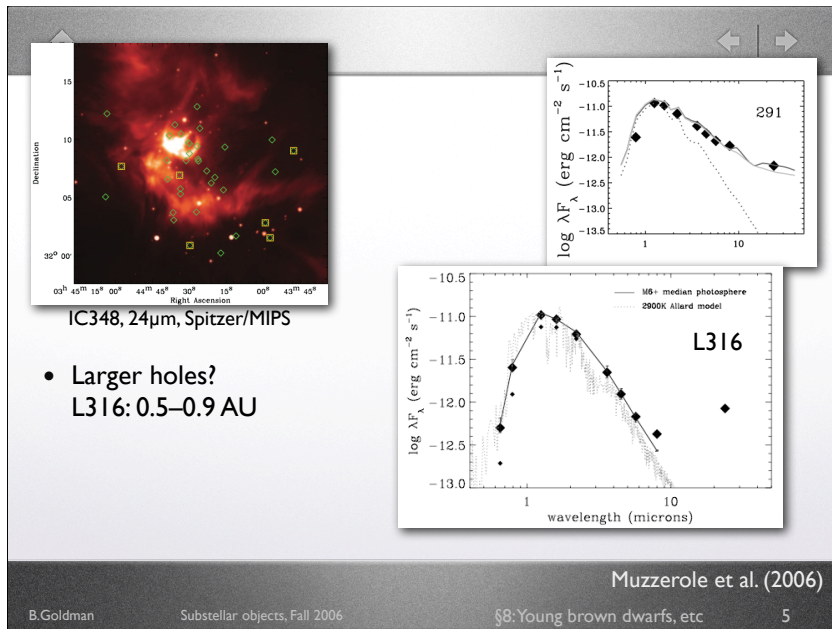
Liu et al. (2003)

B.Goldman

Substellar objects, Fall 2006

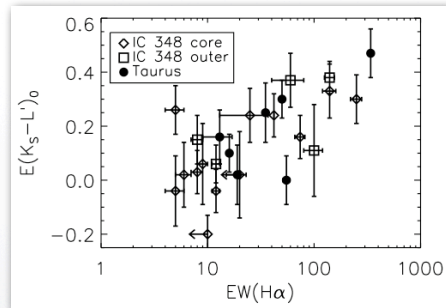
§8: Young brown dwarfs, etc

4



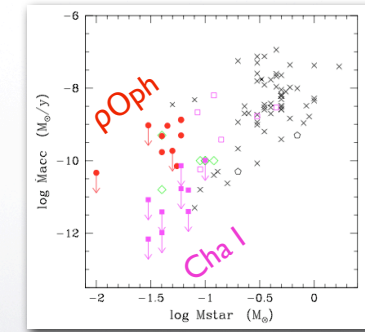
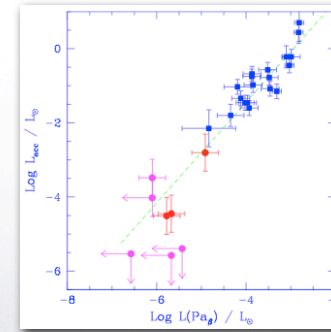
Disk and accretion

- Caution: Importance of disk inclination
- Correlation at $3\text{-}\sigma$ (Spearman rank test) (same as T Tauri stars, back in 1995)



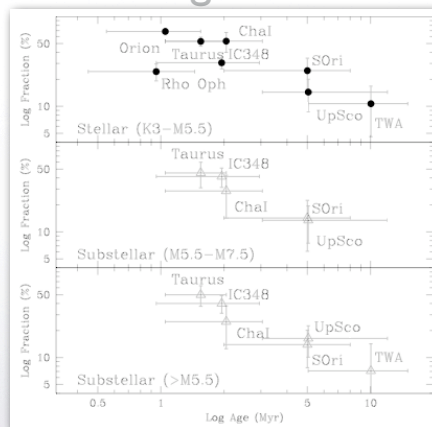
Liu et al. (2003)

Mass accretion rates



Natta et al. (2004)

Accretion and age



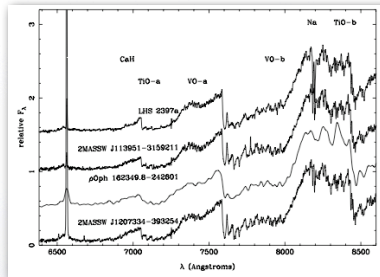
Barrado y Navascues & Martín (2003)

Summary

- Many (most?) young BDs have disks
- They have small disks, and small accretion
- BD disk life time possibly similar to stellar disk
- Many details in the disk structure and evolution remain to be understood (including, what happens during the ejection, if any?)

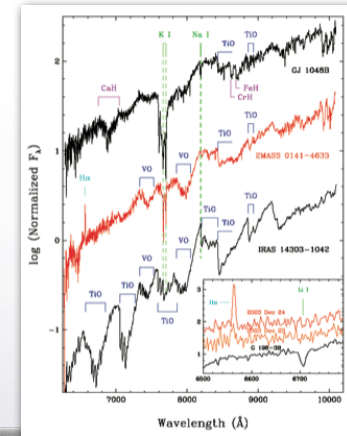
Some nearby young BDs

- 2MASS J1207334 – 393254 (M8)
 - TW Hydra, 8 Myr
 - A: Gizis (2002)
 - B: Chauvin et al. 2004, A&A 425, L29
- TWA 5B: Lowrance et al. (1999)
- 2MASSW J1139511 – 315921 (M8)
- 2MASS J1315309 – 264951 (L5)



Gizis (2002)

A low gravity field L dwarf ?



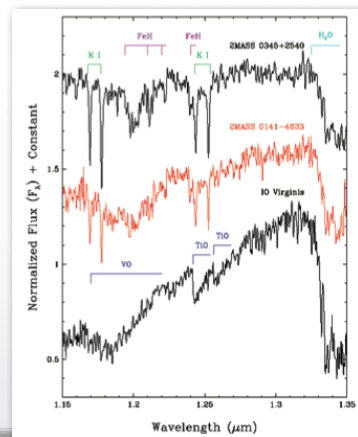
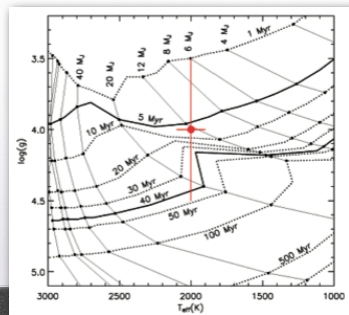
dwarf

giant

dwarf

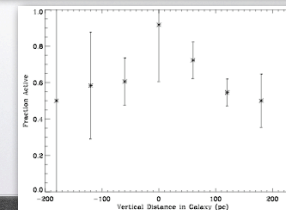
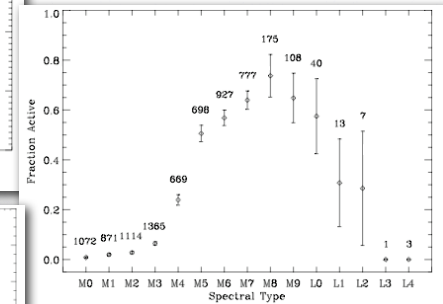
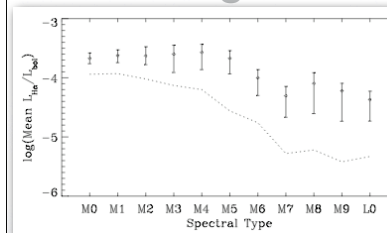
Kirkpatrick et al. (2006)

2MASS J01415823–4633574

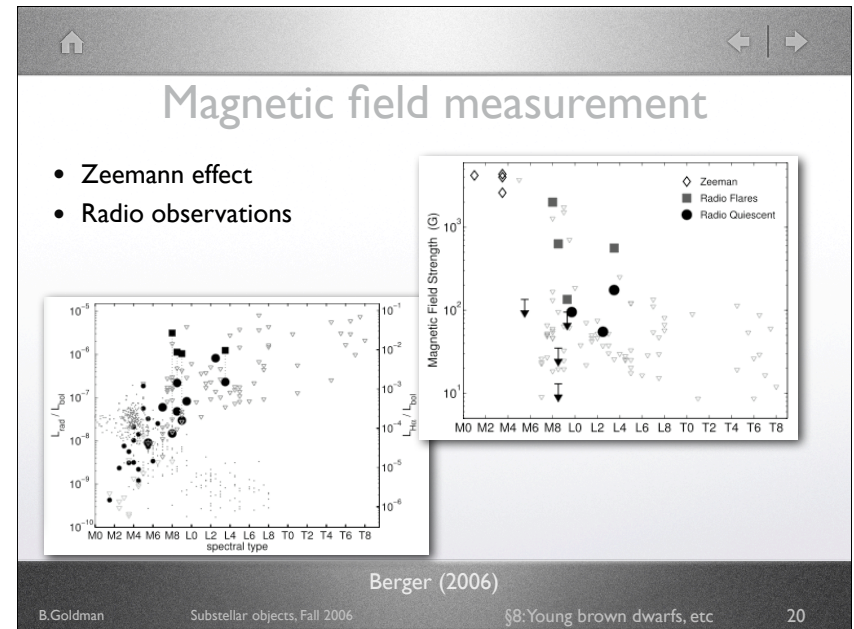
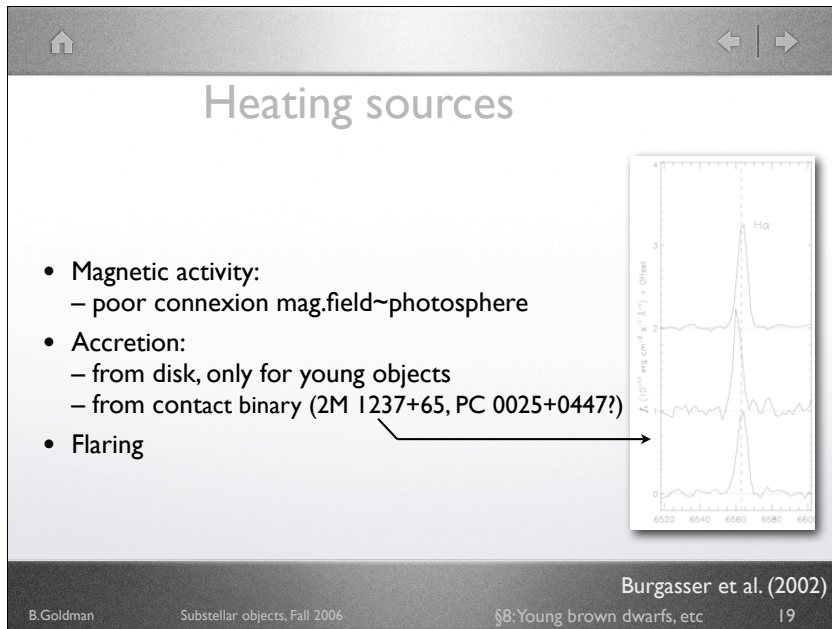
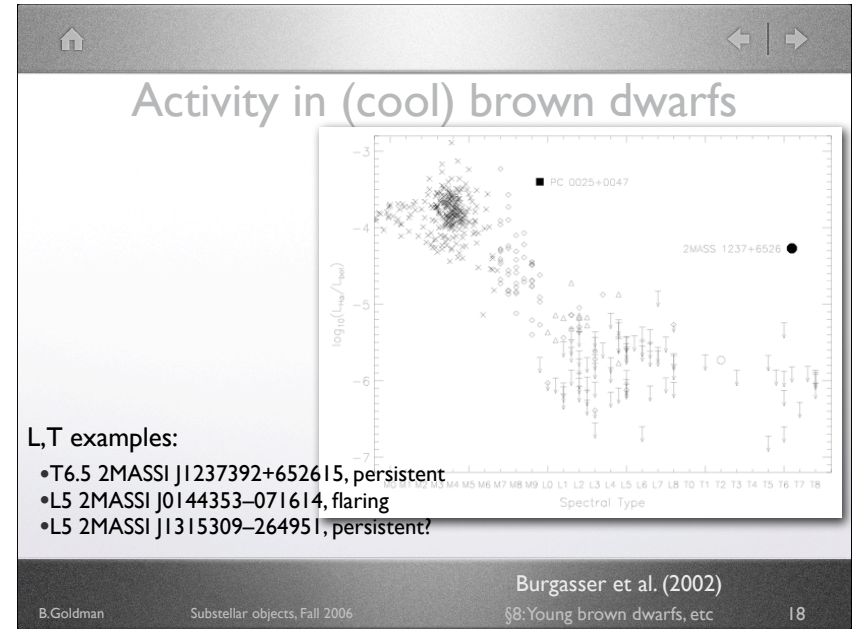
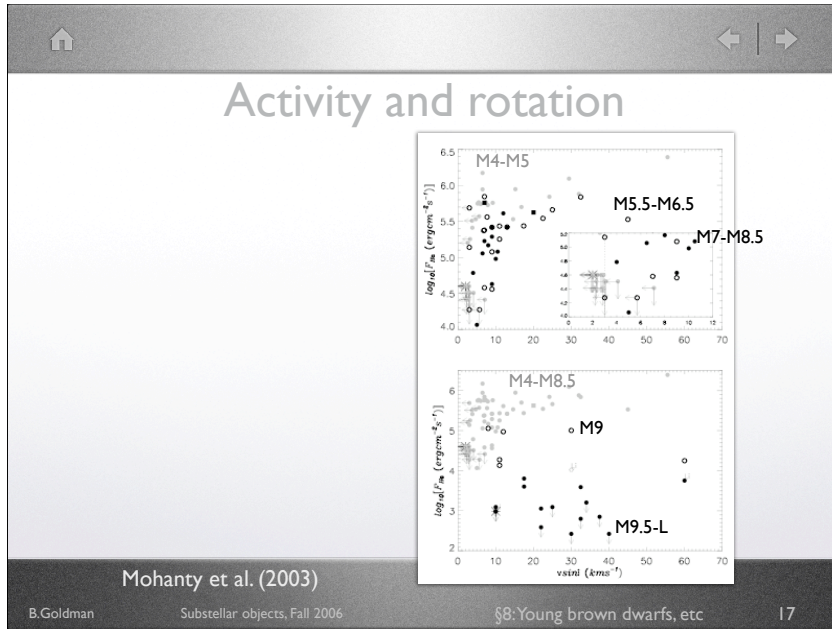


Kirkpatrick et al. (2006)

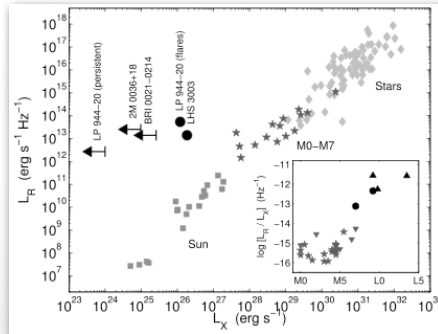
Magnetic activity: M dwarfs



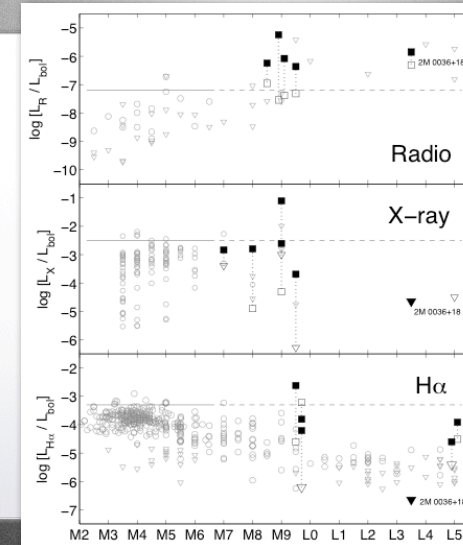
West et al. (2004)



X rays in cool brown dwarfs



Berger (2006)



Berger et al. (2005)

The short-term future of BD research

- New, deeper large-field surveys:
 - UKIDSS, 2006+: near IR: ZYJHK [J] proper motion]
 - VISTA, 2007+: near IR: ZYJHK
 - Pan-STARRS, ~2007+: optical/red: grizy [i parallax, PM, variability]
 - mm observations (very young embedded BDs, disks)
- Deeper narrow-field surveys:
 - towards Jupiter-mass young free floating objects
- Increased statistics:
 - disks, spatial distribution, variability
- Cooler objects:
 - water ice clouds
- New Technology: near IR high resolution spectroscopy

Next lectures: exo-planets

Monday, January 15

Thursday, January 18, 2:45

Monday, January 22 (Henning)

Monday, January 29

Monday, February 5

Introduction to the
extra-solar planet research

• Bibliography:

- *New light on dark stars*: §11
- *Planet formation*, Klahr & Brandner ed., §1