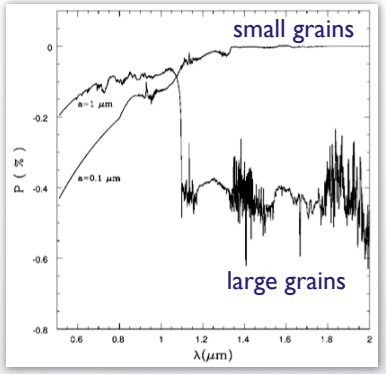
Observational properties of brown dwarfs (end)

Polarimetry–expectations

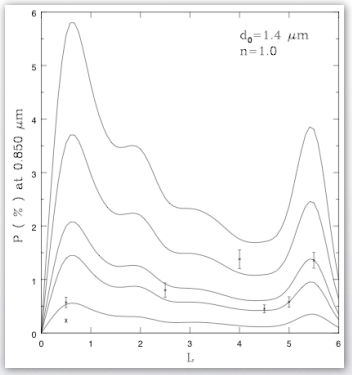
- Dust in the photosphere
  - produces scattering
- Non-spherical:
  Relation eccentricity e–angular velocity ω:
  - uniform density ρ
  - uniform rotation
  - Chandrasekhar (1933)



Sengupta & Krishan (2001)

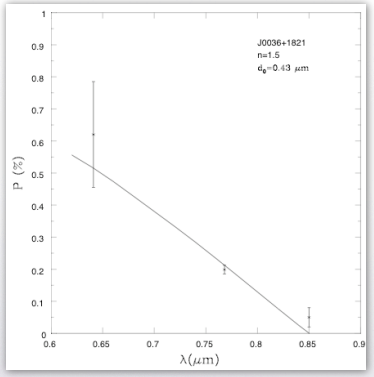
Polarimetry–expectations

- A lot of assumptions:
  - rotational velocities
  - density profile
  - cloud location
  - particle size distribution
  - single/multiple scattering



Sengupta et al. (2005)

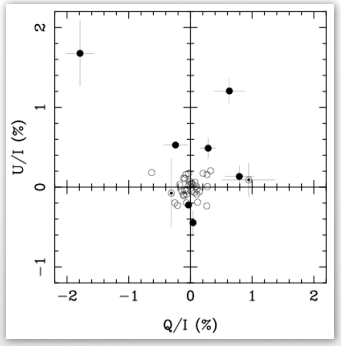
Polarimetry–example

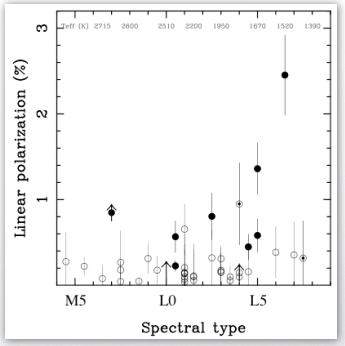


2MASS J0036+1821 (L3.5)

Sengupta et al. (2005)

Polarimetry–results





Zapatero Osorio et al. (2005)

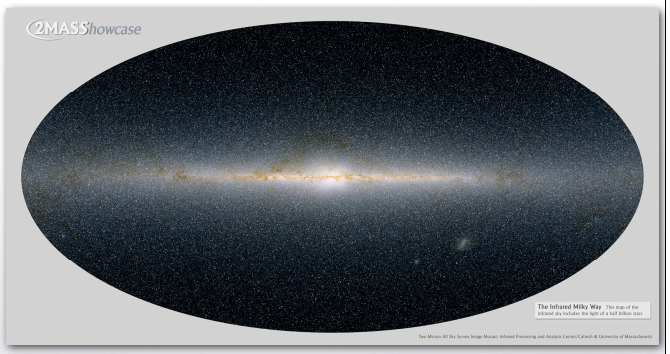
How to search for brown dwarfs

Methods

- Wide-field surveys:
  - colour selection
  - proper motion selection
- Brown dwarfs as companions to nearby stars (and brown dwarfs)
  - Imaging
  - Doppler shift and astrometric wobbling
- Microlensing (gravitational effects)

Colour searches for nearby BDs

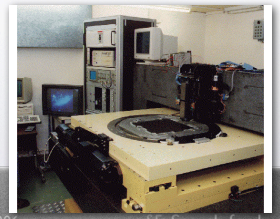
- Near IR:
  - 2MASS
  - DENIS
- Optical:
  - SDSS
  - POSS



Technical advances

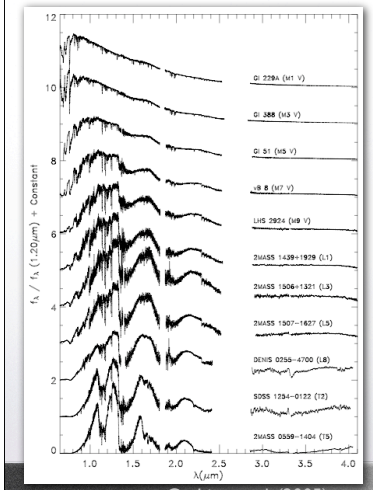
- Larger detectors
  - SDSS: 142 Mpixel CCD mosaic
  - larger IR arrays
- Simultaneous observations through dichroic beam splitter
  - 2MASS, DENIS
- Schmidt plate scanners

SDSS camera



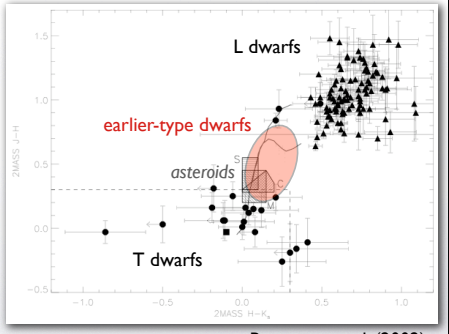
MAMA, Paris

Colour searches



Cushing et al. (2005)

Near infrared (2MASS)

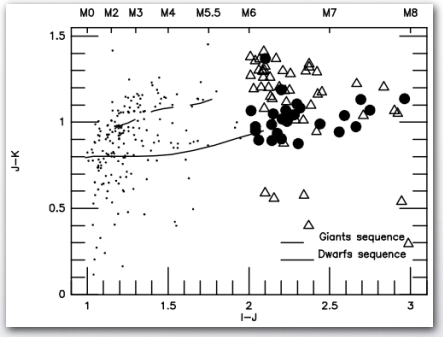


Burgasser et al. (2002)

Colour searches

Optical/near infrared (DENIS)

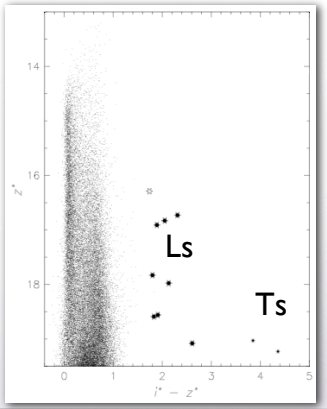
- Very red colours
- Needs to identify giants



Phan-Bao et al. (2002)

Colour searches

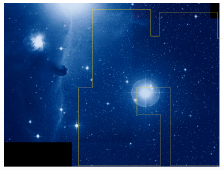
Optical (SDSS)

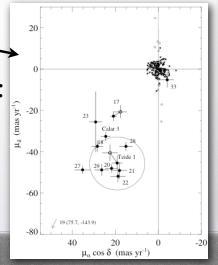


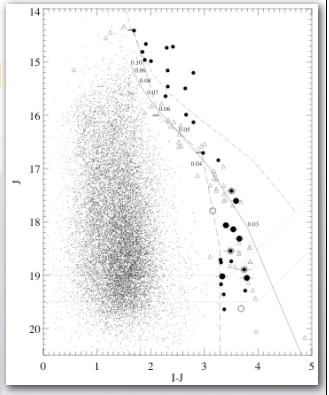
Fan et al. (2000)

The case of young clusters

- Example: Pleiades
- Search for young M, L dwarfs
- [Proper motion confirmation]
- Deeper observations: → more extragal. contamination







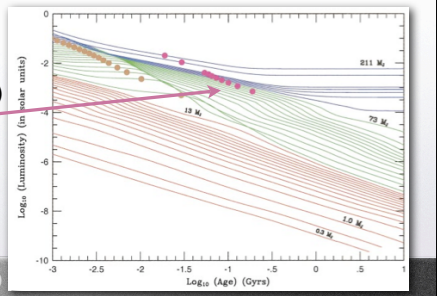
Bihain et al. (2006)

Issues: contamination

- Survey dependent:
  - simultaneous vs. multi-epoch observations
  - single-band detections
- Astrophysical contaminants:
  - very red extragalactic objects (EROs, QSOs)
  - cool giant stars
  - asteroids
- Artefacts:
  - bright star illumination
  - detector (bad pixels, memory effects,...)
  - cosmic rays

Confirmation

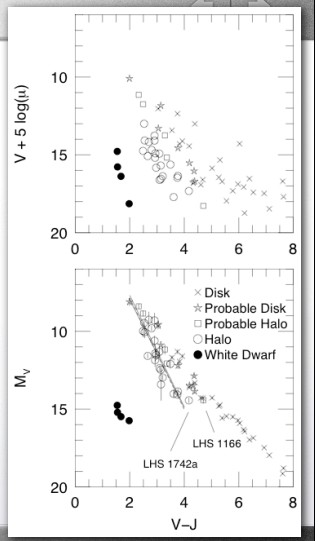
- Photometry:
  - second epoch observations
  - methane band imaging for T dwarfs
- Spectroscopy (low resolution):
  - spectral classification
  - effective temperature (through atmospheric models)
  - Lithium test (for old objects)



Burrows et al. (2001)

Proper motion surveys

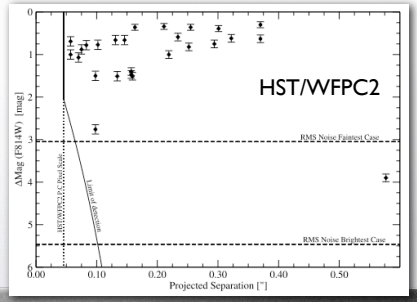
- Identify high angular velocity objects:
  - nearby, and/or
  - have high transverse velocity (thick disk, halo)
- Requires 2+ epochs
  - additional contamination: mismatches, galaxies (faint end)
  - second life of photographic plate surveys



Gould (2003)

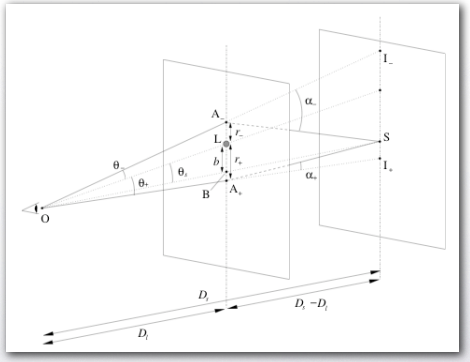
Companions

- Observe nearby stars at high angular resolution
  - HST/Adaptive optics
  - distance and age known from primary
- Also: radial velocity search for close binaries; astrometric monitoring; spectroscopic binaries; infrared excess

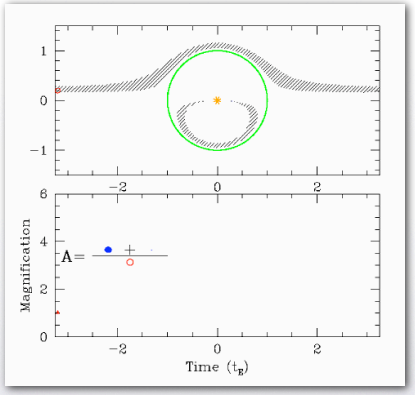


Bouy et al. (2003)

Microlensing



Microlensing



Gaudi: http://cfa-www.harvard.edu/~sgaudi/movies.html

Announcements:

Astronomisches Kolloquium

Gilles Chabrier (CRA Lyon)

Birth and Evolution of Protostars, Brown Dwarfs and Giant (Exo-)Planets

Tomorrow, 17:15 Uhr, im Grossen Physik-Hoersaal
Physikalisches Institut, Philosophenweg 12

Next lecture

- ARI, Monday, November 20th, 15:15
- Initial mass function(s?) of brown dwarfs (observations):
  - in the field
  - in young clusters
  - in the Dark Halo: brown dwarfs and dark matter
- Readings:
  - *New light on dark stars:* §9
  - Chabrier, 2003 *PASP* **115** 763 (link on the web)