Accretion disks around BDs: the variability perspective

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T Tauri stars are variable

T Tauri VARIABLE STARS*

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ABSTRACT

Eleven irregular variable stars have been observed whose physical characteristics seem much alike and yet are sufficiently different from other known classes of variables to warrant the recognition of a new type of variable stars whose prototype is T Tauri. The distinctive characteristics are: (1) irregular light-variations of about 3 mag., (2) spectral type F5–G5 with emission lines resembling the solar chromosphere, (3) low luminosity, and (4) association with dark or bright nebulosity. The stars included are RW Aur, UY Aur, R CrA, S CrA, RU Lup, R Mon, T Tau, RY Tau, UX Tau, UZ Tau, and XZ Tau.

T Tauri has a magnitude range of from 9.4 to 13.5 or 14, but no regular period has as yet been detected. I have had it under observation (...) for the past 27 years (...) and can only describe its changes as “irregular”. (George Knott from Cuckfield, 1891, The Observatory, 3 citations)
Origin

accretion shock (hot spots)

accretion rate

disk-wind

mass accretion

open field lines

disk inhomogenities (clumps, walls, spiral arms, gaps, planets?)

stellar activity (cool spots, flares)
The first T Tauri BDs

- 12 highly variable VLMS and BDs in σOri and εOri (3-5 Myr) from monitoring in 2001/2
- T Tauri lightcurves: high amplitude, irregular
- accretion+disks confirmed with IR excess and emission lines

Scholz & Eislöffel 2004, 2005
Origin: hot spots

- hot spots with temperature of 6000-7000K (similar to 2M1207, Koen et al.)

- no clear period yet found, but P=35-45 h seen in 4 seasons

- accretion flow is funnelled, variable, and asymmetric

Scholz, Xu, Jayawardhana, et al., 2009
Variability and HR diagram

- ~20% of all accreting VLMOs show strong variability; affected are I- and J-band
- for such objects, higher uncertainties are expected when deriving L, Teff, M, age
- disentangling the origin of the variation helps

Luhman 1999, HR diagram in IC348 and BCAH98
The case of 2M1207

- red-shifted absorption features strongly variable on 1d timescale
- accretion column + edge-on view + rotation (a mini AA Tau)
- structured flow, magnetic funneling

Scholz, Jayawardhana, Brandeker 2005
The 1st brown dwarf stamp
The case of 2M1207

- follow-up confirms broad, asymmetric profiles, but not the strong changes
- absorption feature is always visible
- changes in the flow (wind?) structure on timescales of months and years

Stelzer, Scholz, Jayawardhana 2007
see Herczeg & Hillenbrand 2007
Mdota variability?

Mdot variability? Not much.

- in a large sample of stars typical Mdot changes are 0.35dex, with 32% exceeding 0.5dex
- not enough to explain spread in Mdot-M diagram
- timescales: days to weeks, longer timespans not tested yet

Nguyen, Scholz, van Kerkwijk, et al., 2009
Four conclusions

- T Tauri like variability extends down into the substellar regime.
- Brown dwarfs have asymmetric accretion flows, as expected for magnetospheric accretion.
- Variability information relevant for constraining fundamental parameters of accretors.
- Accreting stars/BDs are variable, but accretion itself is mostly stable within 0.5dex.