When does accretion cease?

T Tauri stars in general and IM Lup in particular

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• Introduction to star formation
• Accretion onto young stars
  - Hα
  - Soft excess
  - He-like triplets
  - Model
• IM Lup as a transitional object
• Summary
Introduction

Taurus molecular cloud in CO emission
Five College Radio Astronomy Observatory/Gopal Narayanan/Mark Heyer
Planet formation

a) Dark cloud cores
b) Gravitational collapse
c) Proto star, embedded in 8000 AU envelope; disk; outflow

d) T Tauri star, disk, outflow
e) Pre-main-sequence star, remnant disk
f) Main-sequence star, planetary system (?)
T Tauri Stars (TTS)

Classical TTS (CTTS)
- Hα EW > 10 Å
- Opt. thick disks
- accretion

Weak-line TTS (WTTS)
- Hα EW < 10 Å
- Little or no disk
- No accretion

Collection of He-like triplets

HD 98800 (WTTS)
TW Hya (CTTS)

Archival data

Soft excess

Classical T Tauri stars are special.

- Broad H\(\alpha\) lines
- Low f/i ratio in He-like triplets
- Soft excess
A combination of dense accretion shock and thin corona can explain the X-ray emission from CTTS.
T Tauri stars

Classical T Tauri stars
Weak-lined T Tauri stars


CTTS have accretion, WTTS do not.
When does accretion cease?

150 ks Chandra HETGS spectrum of IM Lup

- Has a disk
- Hα EW < 10 Å

→ CTTS or WTTS?
IM Lup: X-ray spectrum

150 ks Chandra MEG spectrum
IM Lup: soft excess
IM Lup: Hα line

ANU Simultaneous to Chanda

ESO/HARPS

Intensity

line shift [km/s]
IM Lup is truly a transitional object with characteristics of both CTTS and WTTS.