

# Accretion to Outflow Status Report

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Subaru Telescope/NAOJ

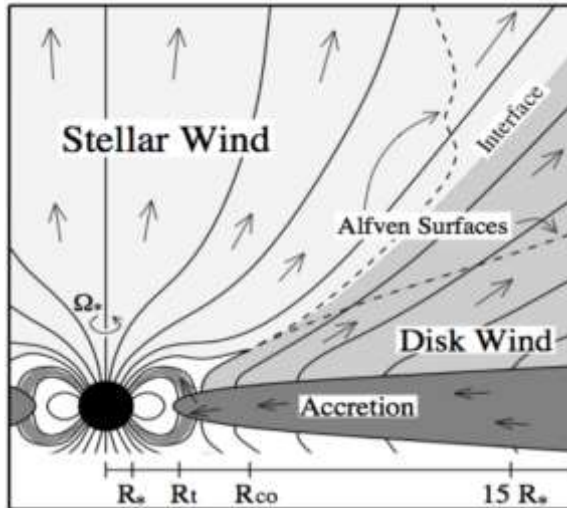
# Accretion to Outflow

Mass  
Accretion

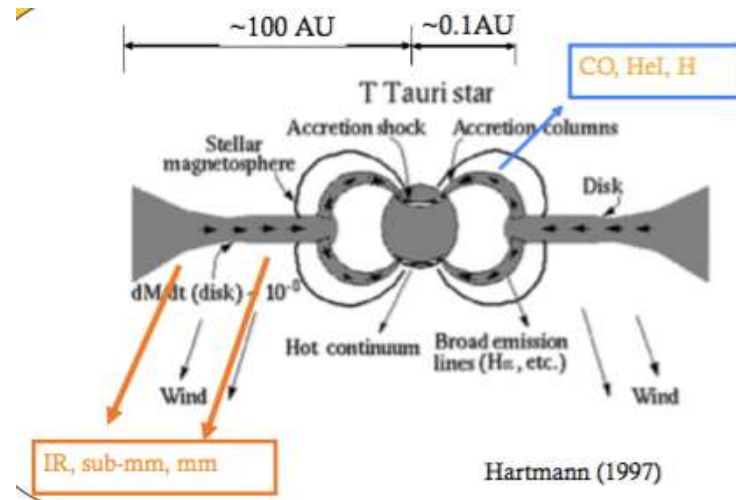


Jet/Outflow  
w

Magneto-Centrifugal Force



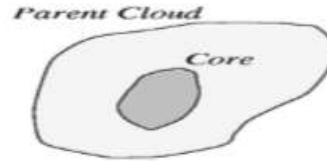
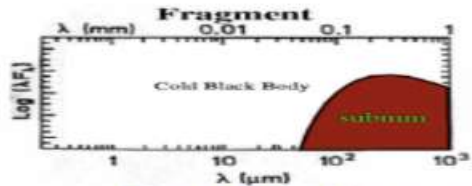
Matt & Pudritz (2008)



Hartmann (1997)

# Class I,II,III: Evolution Phases

Pre-Stellar Phase

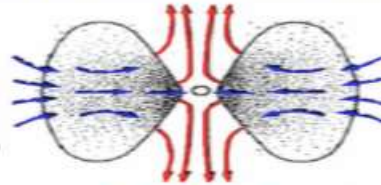
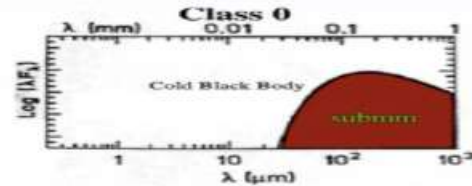


Pre-Stellar Dense Core  
 $T_{\text{bol}} \sim 10\text{-}20\text{ K}$ ,  $M_{*} = 0$   
 - 1 000 000 yr

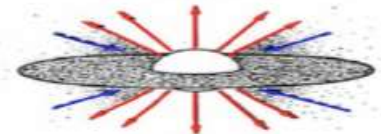
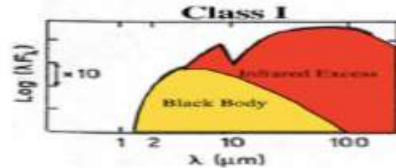
Formation of the central protostellar object

$t \sim 0$  yr

Protostellar Phase



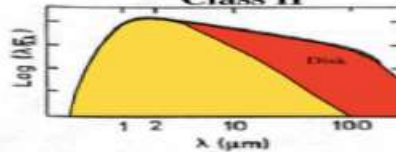
Young Accreting Protostar  
 $T_{\text{bol}} < 70\text{ K}$ ,  $M_{*} \ll M_{\text{env}}$   
 < 30 000 yr



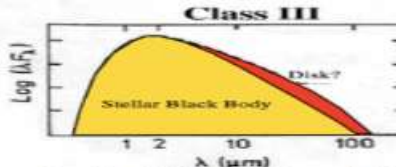
Evolved Accreting Protostar  
 $T_{\text{bol}} \sim 70\text{-}650\text{ K}$ ,  $M_{*} > M_{\text{env}}$   
 - 200 000 yr

Birthline for Pre-main sequence stars

Pre-Main Sequence Phase



Classical T Tauri Star  
 $T_{\text{bol}} \sim 650\text{-}2880\text{ K}$ ,  $M_{\text{Disk}} \sim 0.01 M_{\odot}$   
 - 1 000 000 yr



Weak T Tauri Star  
 $T_{\text{bol}} > 2880\text{ K}$ ,  $M_{\text{Disk}} < M_{\text{Jupiter}}$   
 - 10 000 000 yr

Time

Lada (1984); Shu, Adams, & Lizano (1987); Andre (2000)

# Measurements

## Time variation

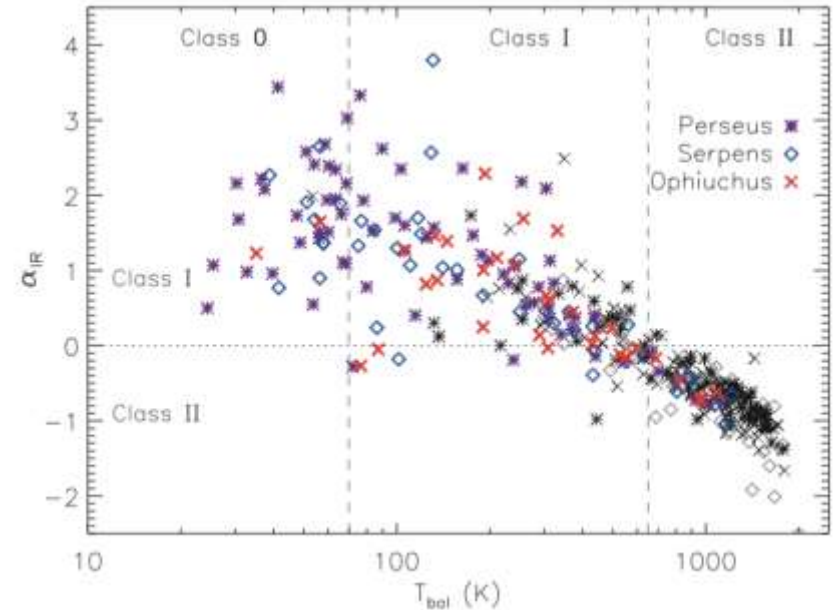
- Simultaneous observation of outflow and accretion signature (H<sub>2</sub>, [Fe II], Br $\gamma$ )

## Teff, log g, veiling

- Line ratio of photospheric absorption
- Teff: Na interval (2.2-2.21 $\mu$ m), Na I, Sc I, Si I
  - T decrease: Na I (broaden), Sc I (deeper), Si I (strong)
- Log\_g : W (Na I) / W(12CO 2.3  $\mu$ m)
- Lbol

## Evolutional phase

- H & K veiling
- Lacc (Class I >> Class II)



Enoch et al. (2009)

# Plan of Projects

- Current:
  - 16 objects ( $H < 14$ ,  $K < 12$  w/ strong [FeII], H<sub>2</sub>, and Br $\gamma$ ) are observed and now investigating the spectra.
  - Many objects shows flat or featureless continuum with emissions.
- At first we will concentrate emission features (Kinematics, line profile, line ratios)
- Photospheric spectrum Model to measure  $T_{\text{eff}}$ ,  $\log g$ , veiling.

# Featureless continuum of Class I

Weak and broad absorption features

Veiling by high accretion rate ( $\sim 100$  higher than Class II)

Fast rotation : break up velocity in outflow ( $V > \sim 500$  km/s)

Magnetic field : a few KG (Zeeman Effect)

# Outflow Study w/ IGRINS+Gemini

- Slit Scanning + High spectral resolution → Data cube.
  - High contrast monochromatic images.
  - Channel map with narrow velocity bin. ( $\sim 7$  km/s)
  - Cf. No IFU instruments providing  $R > 10$  K.