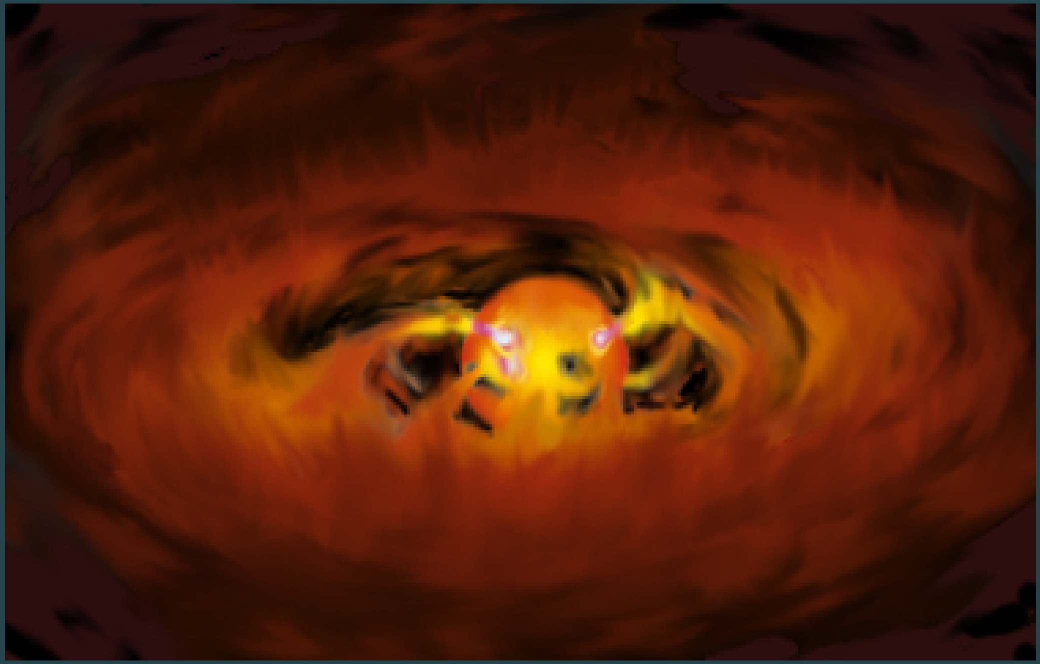
Exploring the Disc Accretion Proccess in Classical T Tauri Stars



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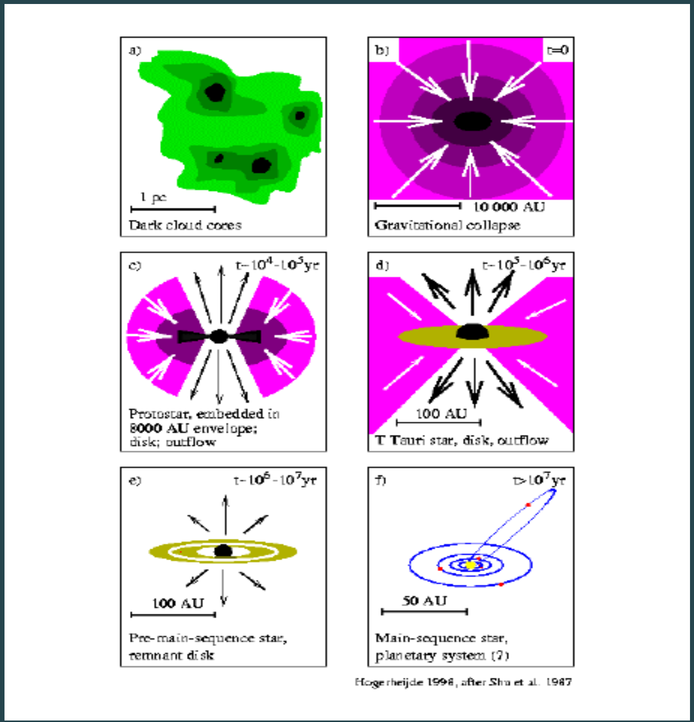
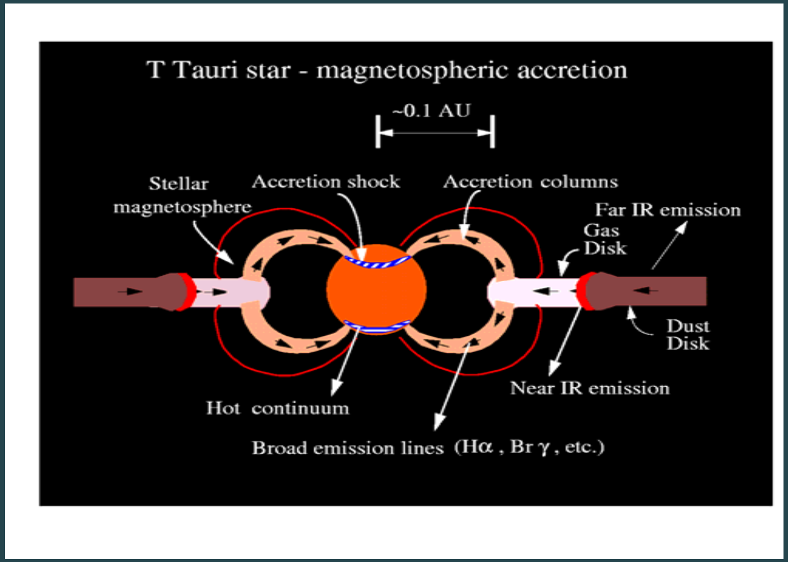
The Classical T Tauri stars

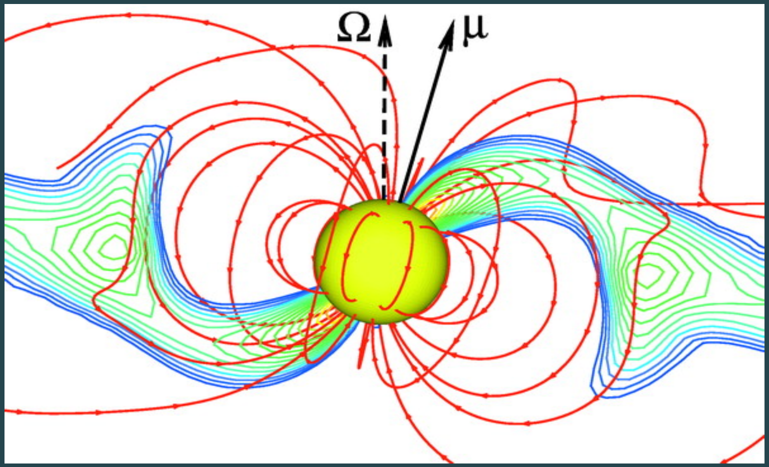
1. CTTS are Low mass PMS.
2. CTTS are surrounded by thick flared accretion disk.
3. Disk mass funnel through dipolar magnetic fields with free fall velocity(magnetospheric accretion model).
4. The broad emission lines come from accretion column. Outflow in the form of wind/ jets also noticed in few CTTS.
5. Near star surface shock forms and dissipates the kinetic energy of the inflow and makes hotspots(ring).
6. The blue excess emission found in optical spectrum is due to hot spots(rings).

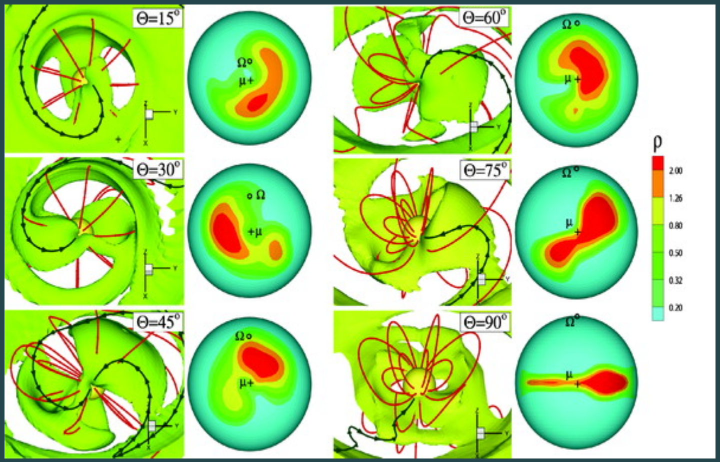


Hogerheijde 1998, after Shu et al. 1987



The Classical T Tauri Stars





- Excess NIR/IR emission comes from inner and outer disk.

- The inner disk can be warped by non-aligned dipolar magnetic fields.

- Other than hot spots, large fraction of stellar surface could be covered by cool spots.

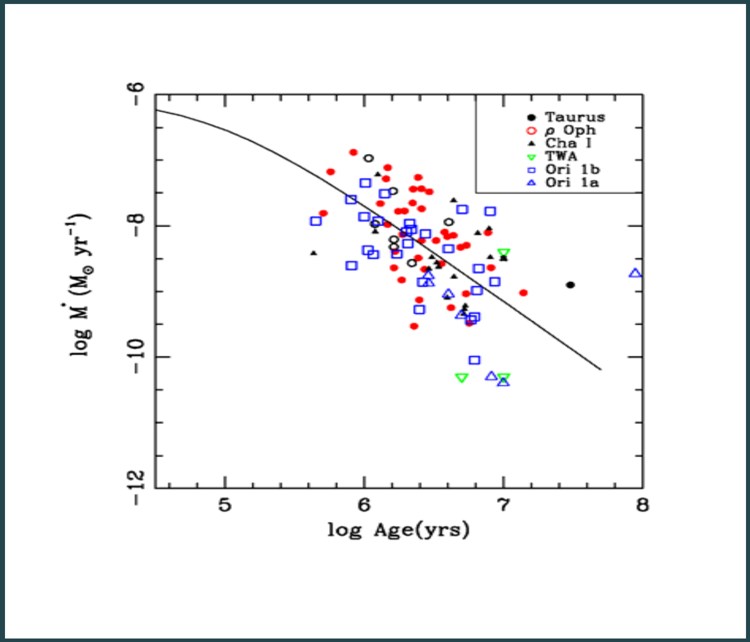
The Scientific Motivations

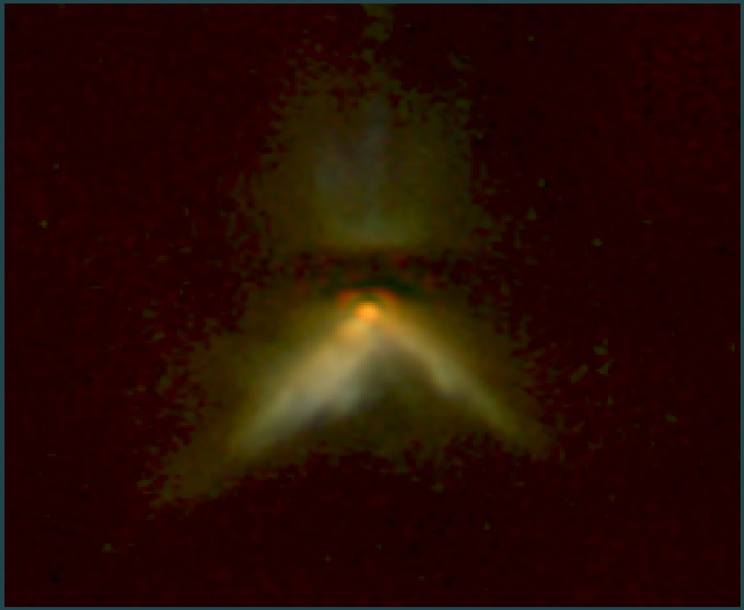
1. Variation of accretion rate with age: crucial to understand formation of planets.

2. Exploring long(Exor) & short term variations in.

3. Accurate measurment of disk and interstellar extinction.

4. Use of temporal variation in the disk extinction to explore the distribution of disk mass close to star.





Observations

1. The optical spectroscopic and photometric observations are carried using HFOSC of HCT.
2. Photometry in UBVRI band passes.
3. Spectroscopy with Gr7, Gr14 & Gr8 grisms, which covers entire optical spectrum (3600-9100A).
4. The typical average S/N of spectroscopic observations are >150.
5. Other than CTTS , large number of WTTS and Giant stars are observed to model CTTS photosphere (templates) .

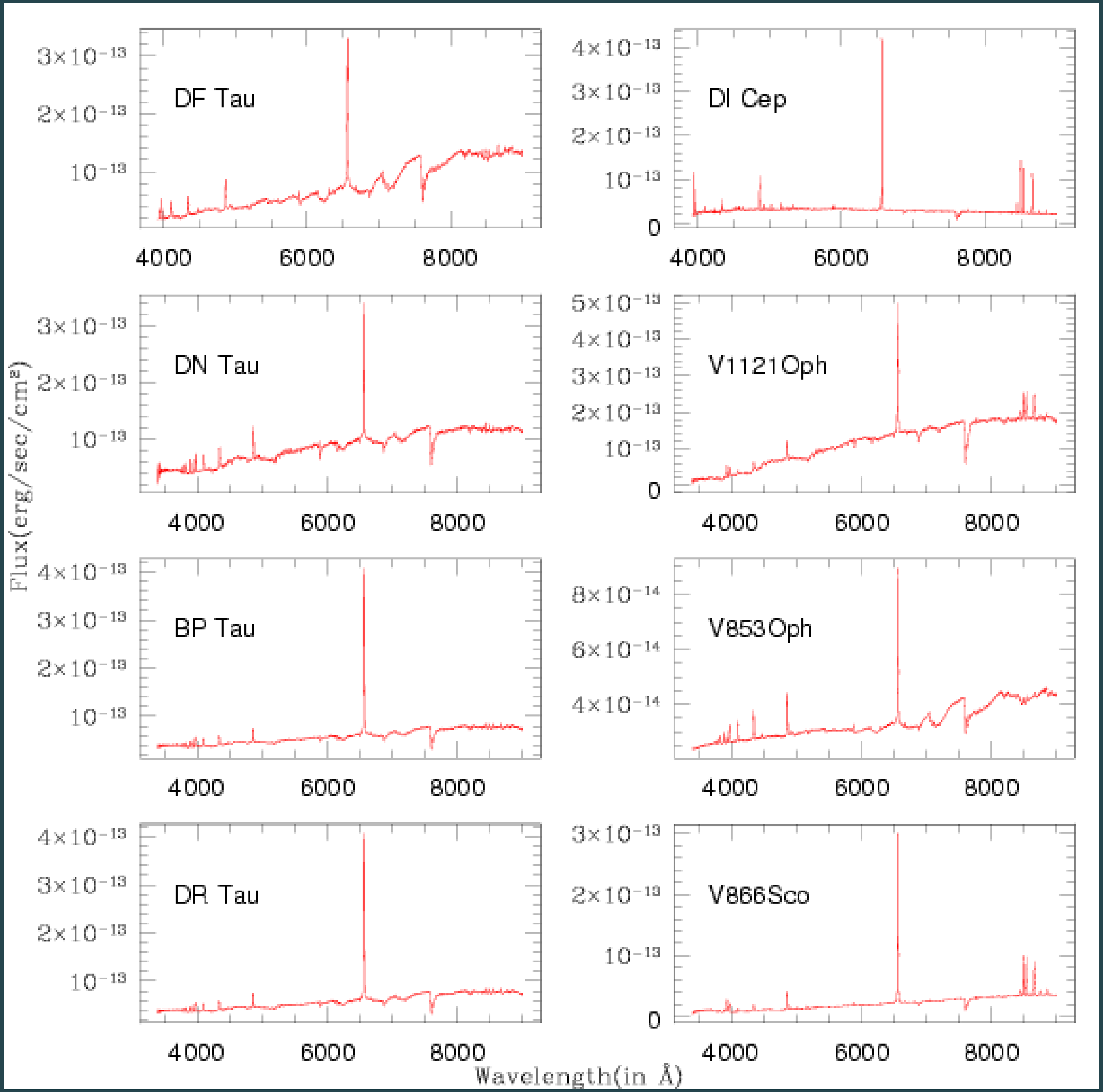
Classical Tauries

DF Tau	M1
DN Tau	M0
VY Tau	M0
DR Tau	K7
BP TAU	K7
V1121Oph	K5
V866 Sco	K0
DI Cep	G8

Template stars

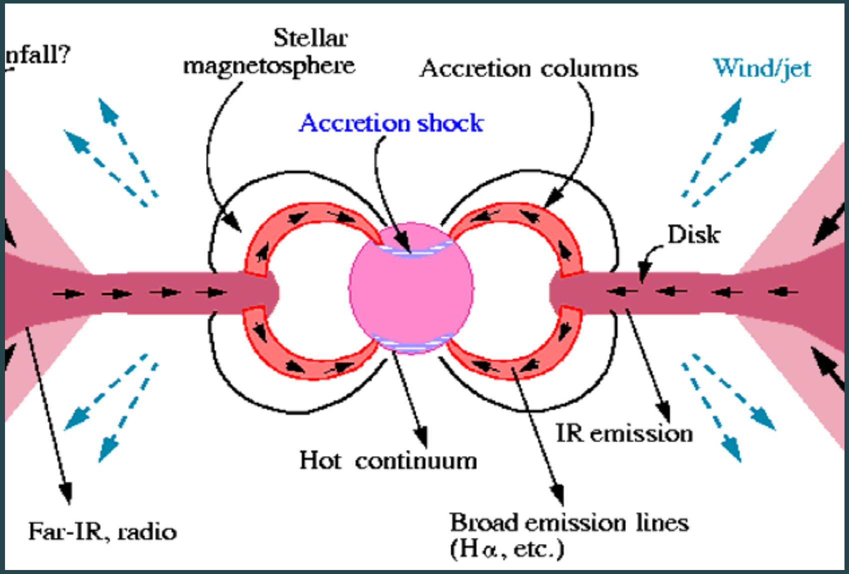
San1	WTTS	M1.5
LkCa7	WTTS	K7
V819Tau	WTTS	K7
V836Tau	WTTS	K7
HD139153	Giant	M1.5III
HD144542	Giant	M1III
HD139669	Giant	MK5III
HD100006	Giant	K0III
HD158133	Dwarf	K0V

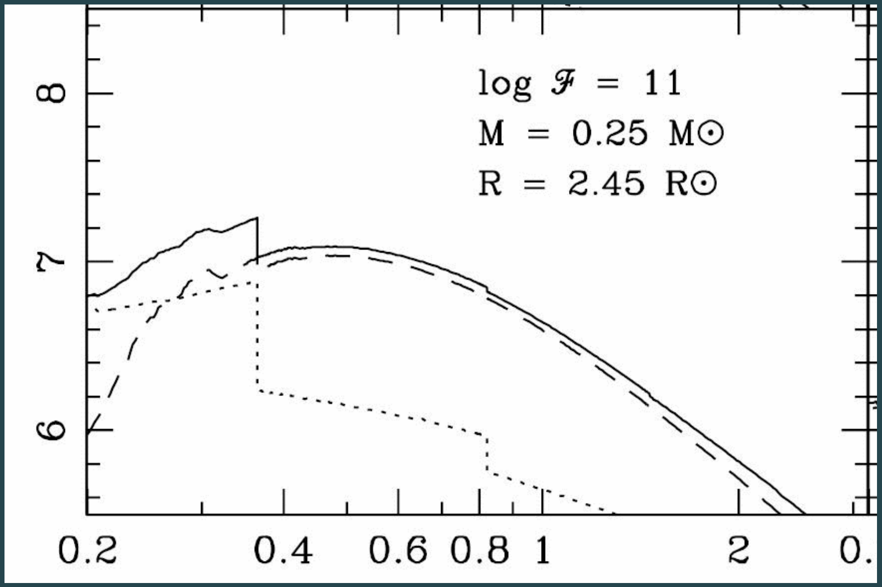
Observations

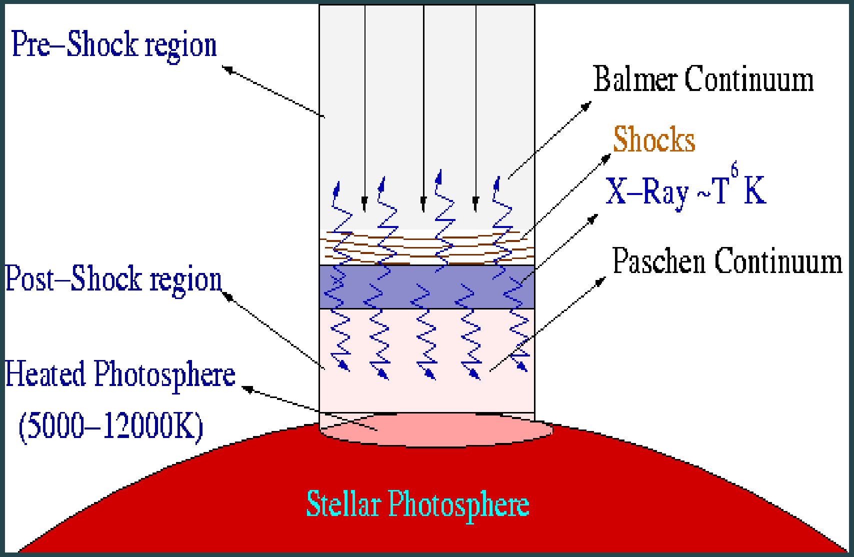


Magnetospheric accretion

(Modeling the Optical Spectrum)







Calvet & Gullbring (1998)

The Magnetospheric Modeling Technique

Based on:

Physical model proposed by : Calvet & Gullbring (1998)

Technical approach opted from : Chelli (1999)

$$O_c(\lambda) = p_o 10^{-0.4 f(\lambda) A_v} \left[S(\lambda)(1-f) + E(\lambda)\right] w(\lambda))$$

$$E(\lambda) = f B_\lambda(T_{eff}) + Emission\ from\ post\ and\ preshock\ regions$$

$$T_{eff} = \left(\frac{7.35}{\sigma} 10^{10} \left(\frac{\dot{M}}{10^{-8} M_\odot yr^{-1}}\right) \times \left(\frac{M}{0.5 M_\odot}\right) \times \left(\frac{R}{0.5 R_\odot}\right)^{-3} \times \left(\frac{f}{0.01}\right)^{-1}\right)^{\frac{1}{4}}$$

$$\chi^2(p_o, A_v, \dot{M}, f) = \sum_{i=1}^{N} \left(\frac{(O_{c,i}(p_o, A_v, \dot{M}, f) - O_i)^2}{(\sigma^2_{o,i} + \dot{\sigma}^2_{s,i})}\right)$$

$$\dot{\sigma}^2_{s,i} = p_o^2 10^{-0.8 f(\lambda) A_v} \sigma_{s,i}$$

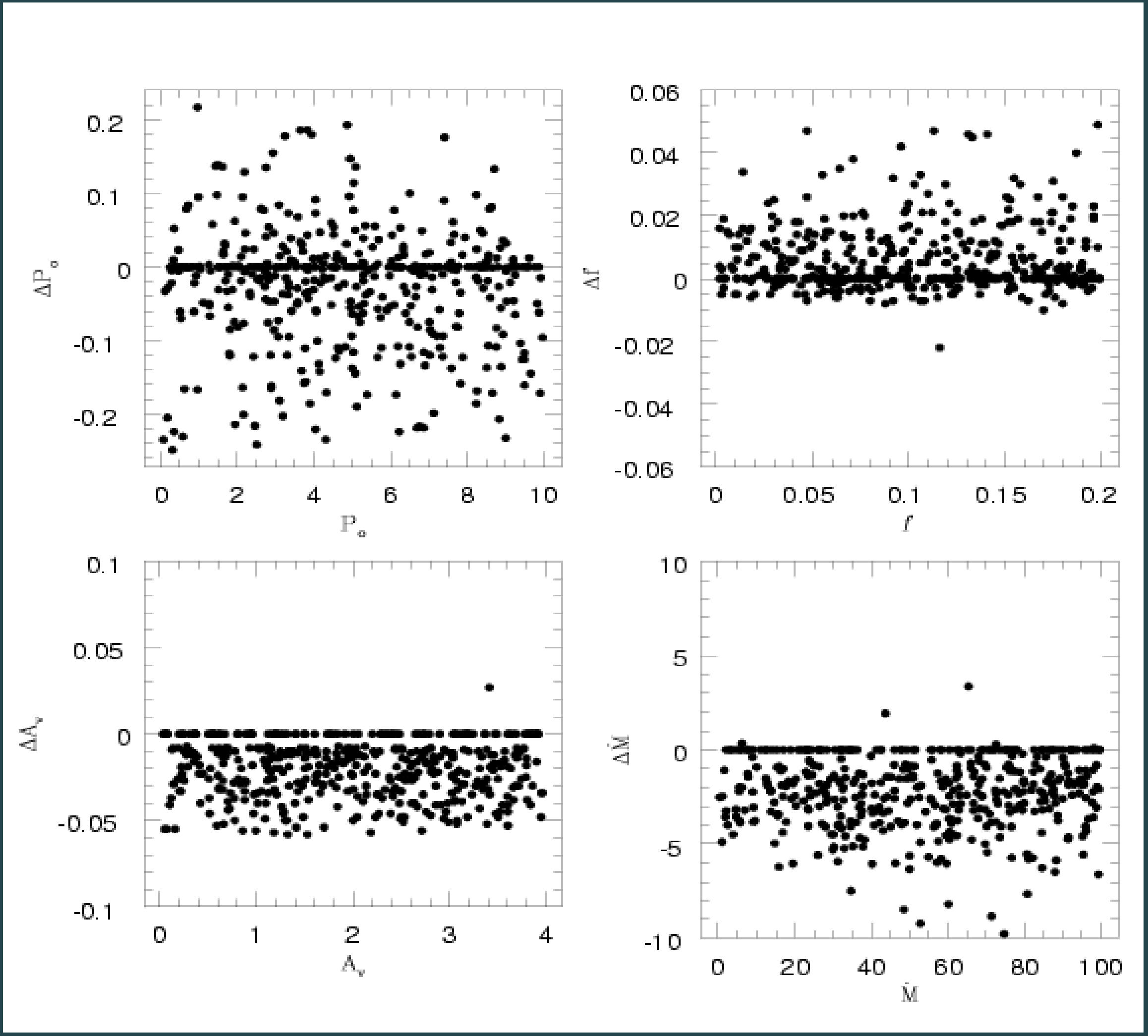
Testing the model

1. 100 CTTS data sets are simulated using the physical model and the template spectrum.

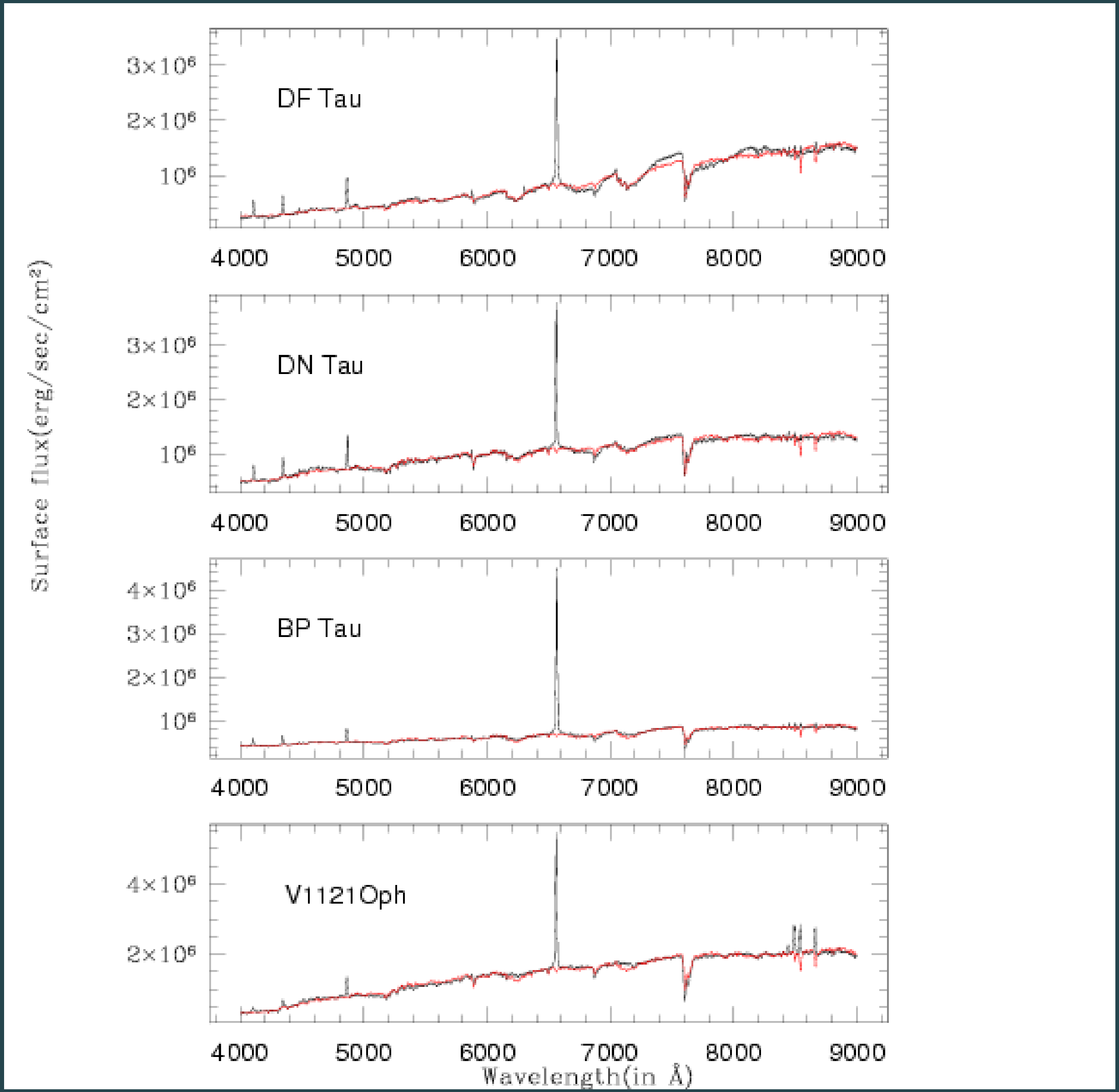
2. The magnetospheric modeling technique is applied to these synthetic data and parameters are retrieved.

3. The difference between the modeled parameters and original one is plotted.

4. Reliability of the modeled parameters are checked with different template & CTTS S/N.



Results from modeling optical spectrum



Results from modeling optical spectrum

CTTS	Temp	Av	f	Mdot	Teff	curl(f)
DF Tau	HD139669	0.27	0.005	2.82	9070	11.70
		0.45	0.023	1.77	-	11.00
BP Tau	HD139153	0.86	0.007	10.94	11853	12.17
		0.51	0.007	2.88	-	11.50
DN Tau	HD139669	0.27	0.005	2.82	9080	11.72
		0.45	0.005	0.03	-	10.50
V1121Oph	HD139669	0.40	0.016	1.22	5649	10.88
		-	-	-	-	-
DR Tau	HD139669	1.29	0.064	11.70	6975	11.25
		1.20	0.05	3.0	-	11.5
DI Cep	HD100006	0.63	0.013	3.61	7809	11.45
		-	0.025	2.50	-	12.00
V853 Oph	HD139153	1.00	0.014	13.50	10525	11.96
		-	-	-	-	-

Calvet & Gullbring (1998), Gullbring et.al (1998)

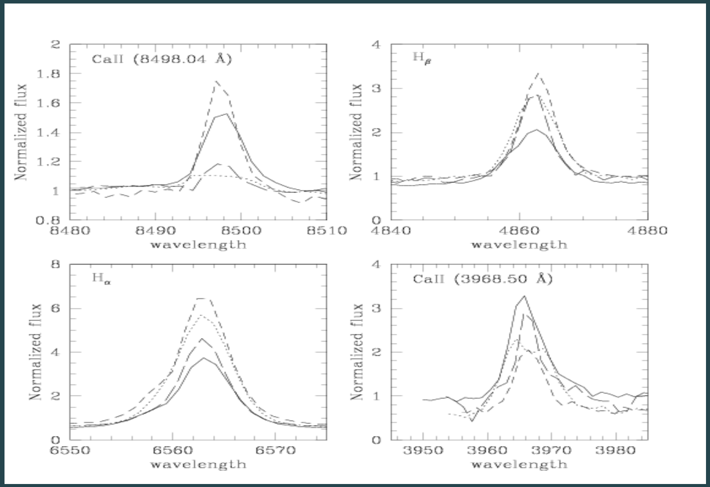
Gullbring et. al (2000)

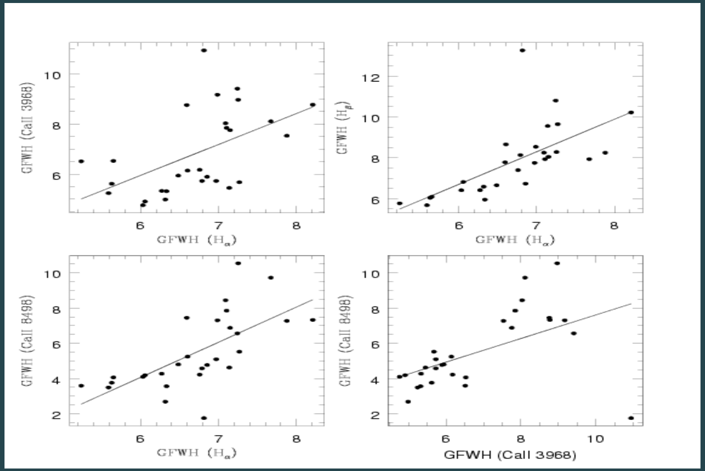
Gamiero; Folha & Petrov (2006)

Results (DF Tau)

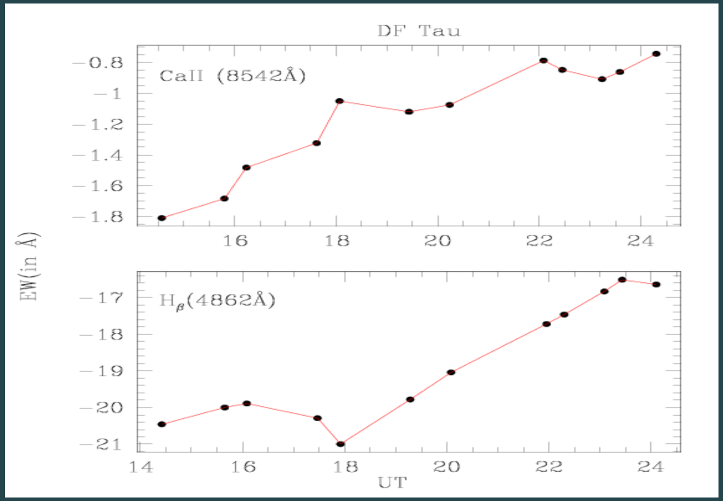
Nearly 70 nights data, stretched over 2 years

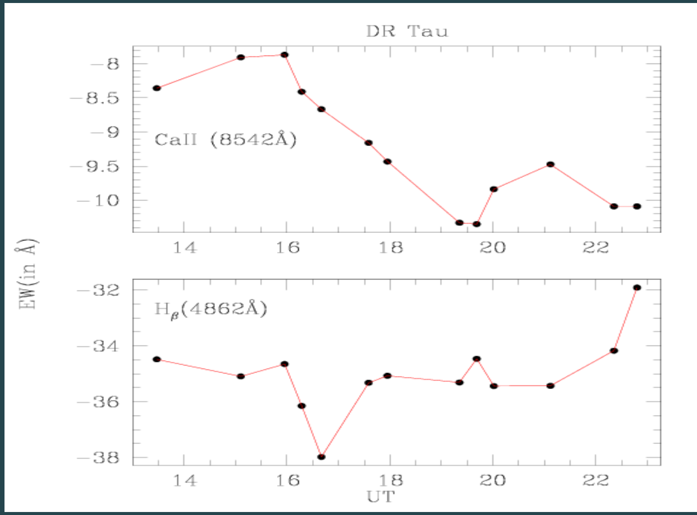
Variation in accretion diagnostic lines .



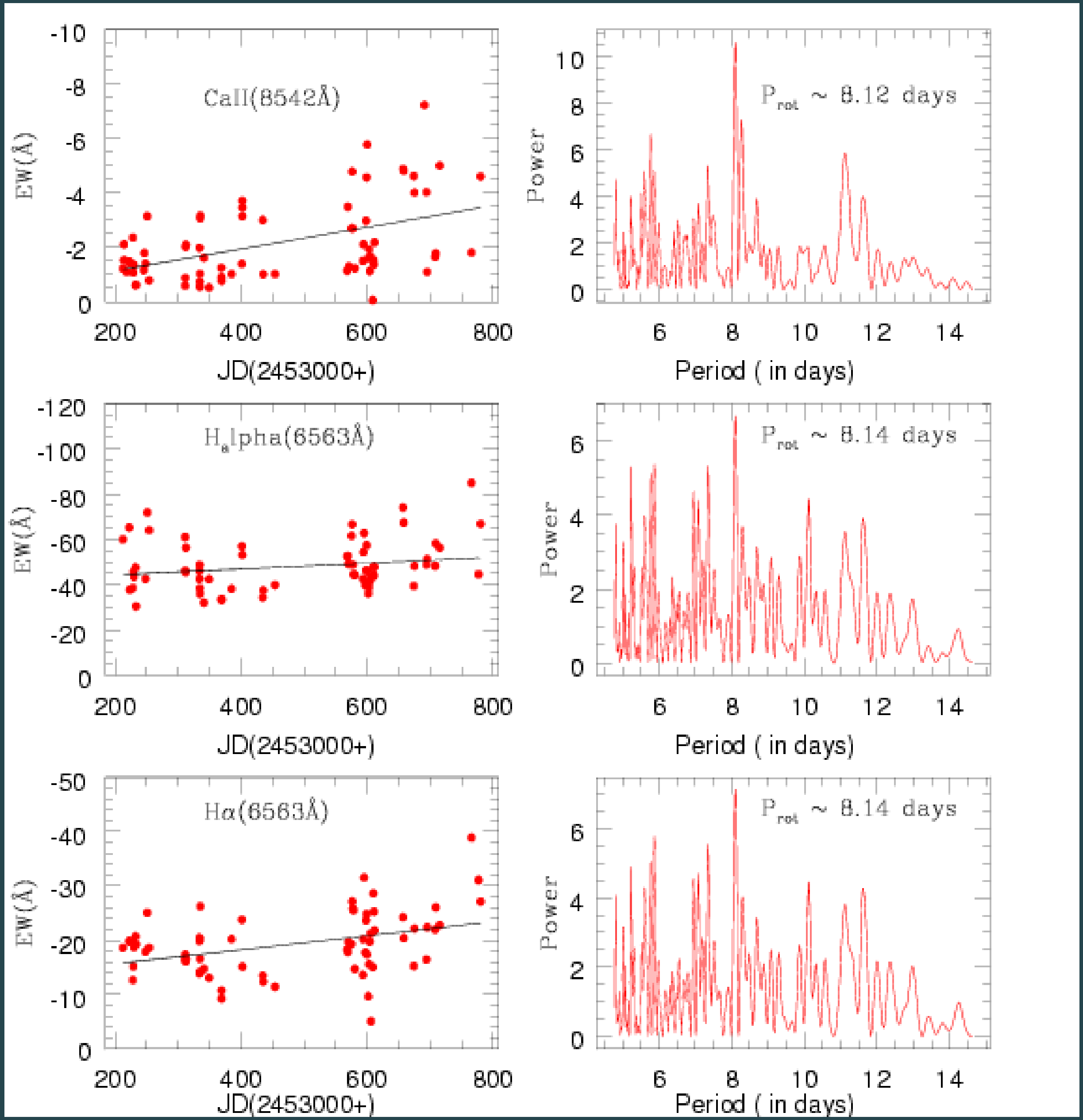


Intra night variation:





Results (DF Tau)



The Future Plan

→ Observing large sample of CTTS and exploring the disk accretion process.

→ Further improvement in the modeling of optical spectra

1) Accurate calculation of the CTTS excess emission coming from heated photosphere.

2) Using CLOUDY to generate optical emission coming from pre-shock region.

3) Exploiting the accretion information stored in various emission diagnostics lines.