UVIT/AstroSat study of T-Tauri Stars
(Can UVIT be used to study variability in T-Tauri Stars?)

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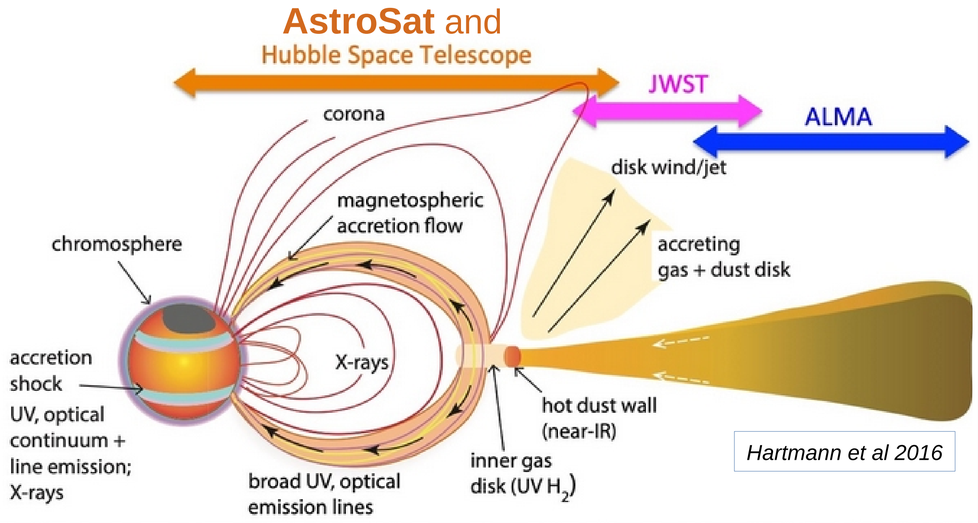
Introduction

- **T-Tauri stars (TTS)**: low-mass pre-main-sequence (PMS) stars.
- **Classical TTS (CTTS)**: characterized by strong H-α line emission and significant continuum excess emission in the UV ($T_{Blackbody}$~10^4 K) region over photospheric values due to strong accretion.
- **Weak-line TTS (WTTS):** non-accreting disk-less TTS, emit weak line emission and comparatively low UV excess (mainly in FUV) in WTTS is due to chromospheric activity.
- NUV emission: originates from dense pre-shock region of the accretion column;
  FUV emission: originates near the hot spot created due to accretion shock.
- TTS also show variability in line luminosities as well as in UV and optical continuum. The main source of variability is thought to be the change in accretion rate.
- Though there have been many studies on TTS in optical and IR regions, their UV properties are relatively less studied.



Schematic view of a young star accreting from a disk through magnetosphere.

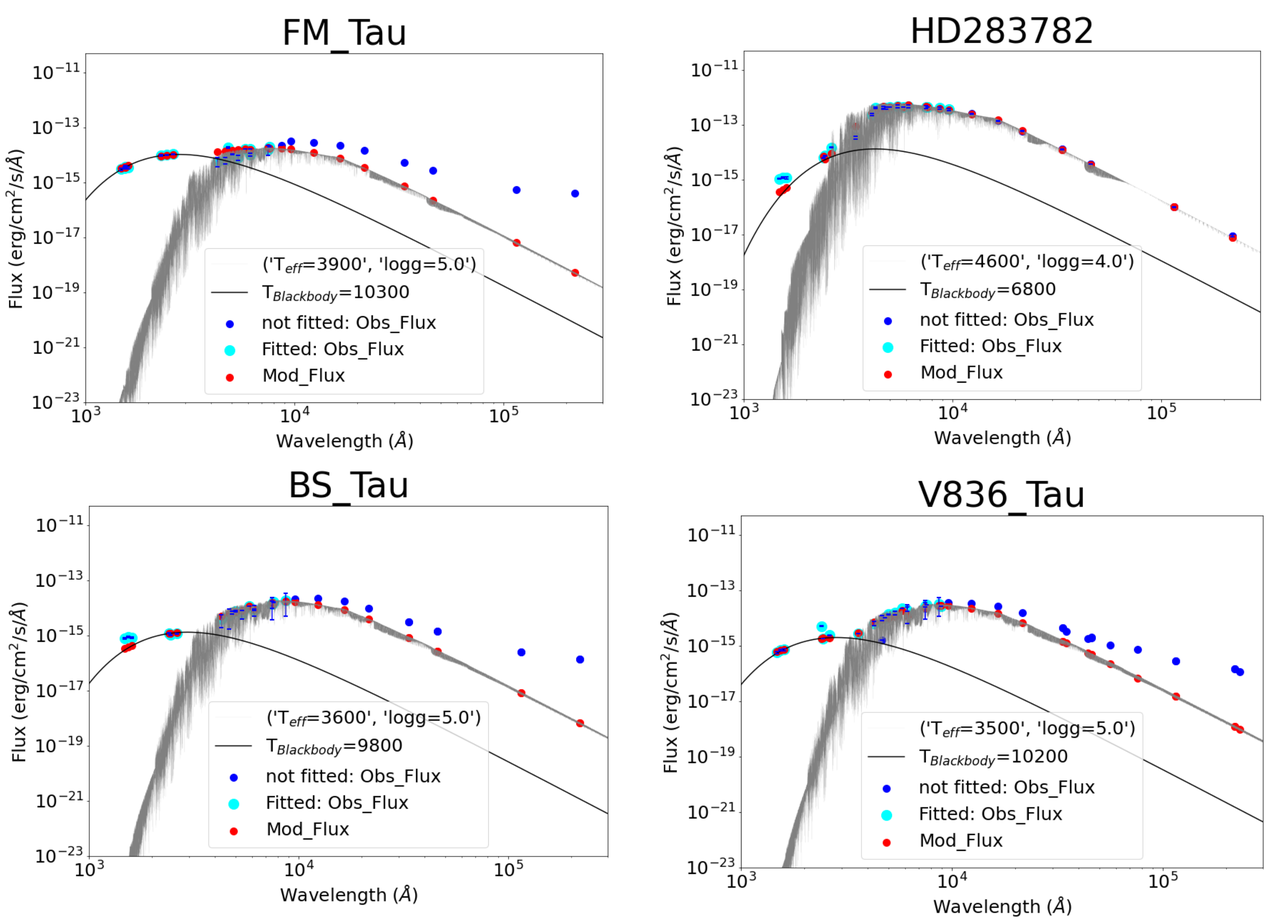
- We present preliminary results from simultaneous multiband UV (in both FUV and NUV) photometric and FUV spectroscopic observations of young TTS.

From the AstroSat archive, we found photometric (in both FUV and NUV) observations of seven TTS and FUV spectroscopy of one TTS (TW Hya) in Grating1.

Photometric Observations

Spectral energy distribution (SED) of TTS

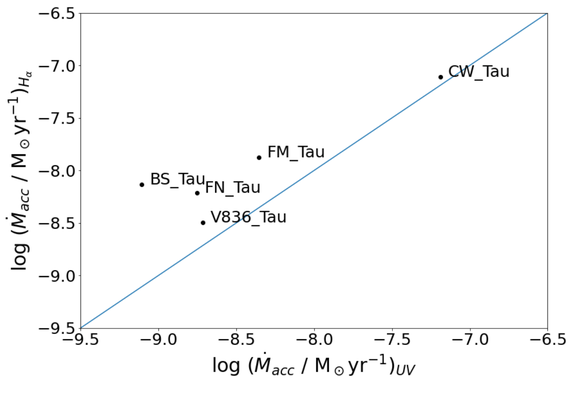
- To construct SED, we combined UVIT data with Gaia-EDR3, Pan-STARRS, 2MASS, and WISE.
- UV and optical regions of SED is fitted with two-component theoretical spectra of a dwarf star (BT-Settl-CIFIST) and a blackbody to estimate excess UV emission.
- Fixed parameters: distance, metallicity; Free parameters: T_{eff}, log(g), extinction.



- FM Tau and HD283782 are well known CTTS and WTTS, respectively. A clear differences in $T_{Blackbody}$ and UV excess over photospheric emission are observed.
- BS Tau and V836 Tau, previously classified as WTTS, show significant excess in UV region, with blackbody temperature ~ 10^4 K, suggesting them as CTTS.
- Spectroscopic observations of BS Tau and V836 Tau with strong H-α emission, obtained from HFOSC/HCT also support the above results from SEDs.

Summary-1

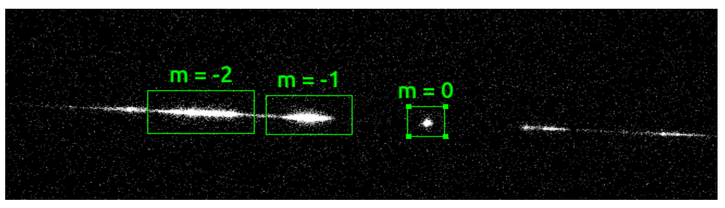
- We present first UVIT study of young TTS.
- Based on Strong H-α emission and large excess in FUV and NUV, we reclassified BS Tau and V836 Tau as CTTS.
- Mass accretion rate estimated using H-α equivalent width and UV luminosity matches well, with BS Tau as outlier could be due to accretion variability.



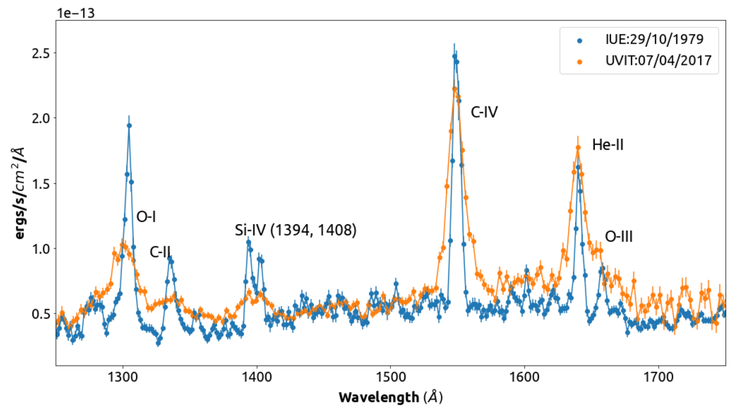
Simultaneous multiband photometry in FUV and NUV using UVIT is an excellent tool to characterise T-Tauri Stars and understand the accretion processes in them.

Spectroscopic Observation

UVIT spectrum of TW Hya and Compare with IUE

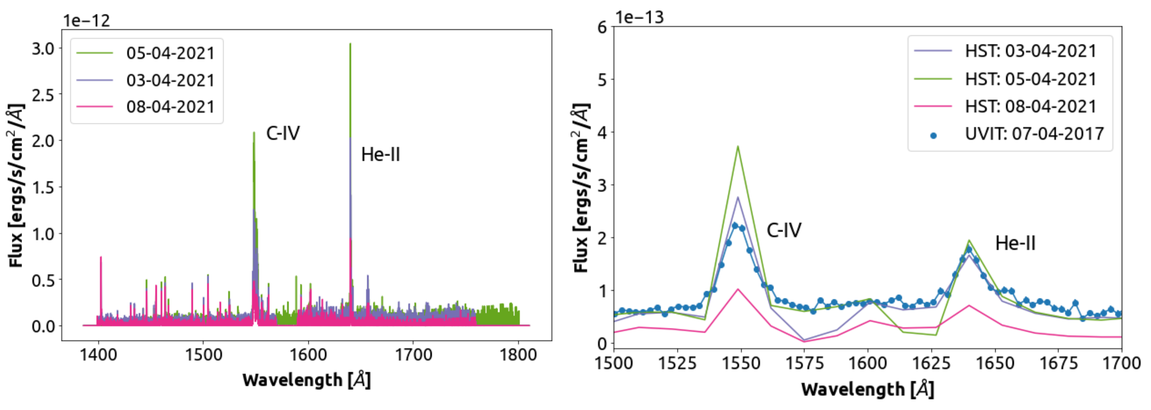


- FUV slitless Grating1 image of TW Hya. Different orders are marked.
- Order m = -2 is used to generate calibrated spectrum. (*Dewangan et al 2021*)
- UVIT spectrum matches well with low resolution IUE spectrum



FUV emission lines (O-I, C-IV and He-II), used as accretion indicators are very prominent in the UVIT spectrum.

Can UVIT detect variability in line emission?



(Left): Multi-epoch HST spectra of TW Hya. (Right): Multi-epoch HST spectra degraded to UVIT resolution. Observed UVIT spectrum is also overlaid.

- UVIT spectrum matches very well with the degraded HST spectra.
- Multi-epoch degraded spectra are clearly distinguished from each other.

UVIT can detect the variability in line emission.

Summary-2

- We present first UVIT spectroscopic study of young TTS.
- We detect strong emission lines in FUV: O-I, C-IV, He-II.
- UVIT spectra matches well with IUE and degraded HST spectra.
- FUV Grism1 has the capability to detect variability in line emission.
- We have proposed for FUV-Grating1 observations of three TTS in the AO-12 cycle to study accretion variability in them.

YES!!!

UVIT can be used to study accretion variability in TTS.