Confirming accretion in MY Lupi with UV-HST observations

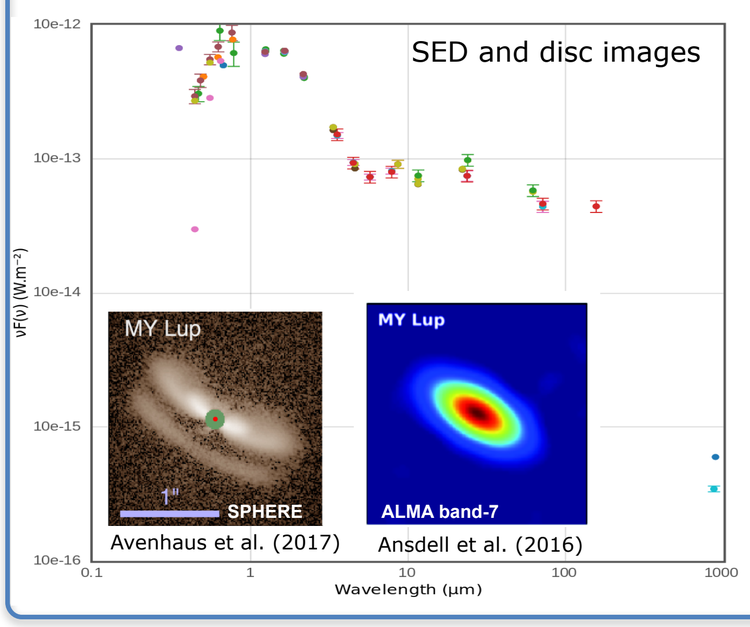
J.M. Alcala' (1) , C.F. Manara (2) , N. Arulanantham (3) , K. France (3) , P.C. Schneider (4)

1- INAF Osservatorio Astronomico di Capodimonte, Napoli, Italy
2- European Southern Observatory, Garching, Germany
3- Laboratory for Atmospheric and Space Physics, University of Colorado, USA
4- Hamburger Sternwarte, Gojenbergsweg, Hamburg, Germany

Abstract. The mass accretion rate is a crucial parameter for the study of the evolution of accretion discs around young low-mass stellar and substellar objects (YSOs). It sets important constraints for disc evolution models and disc clearing mechanisms, and is a key quantity for the studies of Pre-Main Sequence (PMS) stellar evolution and planet formation. Low-mass PMS stars with transitional discs accreting at very low rates are likely in the final stages of inner disc evolution, and probably have already formed protoplanets. Hence, identifying and investigating such low accretors may help understanding planet formation. However, measurements of low accretion rates are challenging. In this work, we used UV-HST spectra to unambiguously confirm and investigate accretion in the transitional YSO MY Lupi, an object previously classified as a weak or non-accretor. The puzzle here is that the HST data provide a Macc value an order of magnitude higher than the value estimated from optical spectra.

MY Lupi

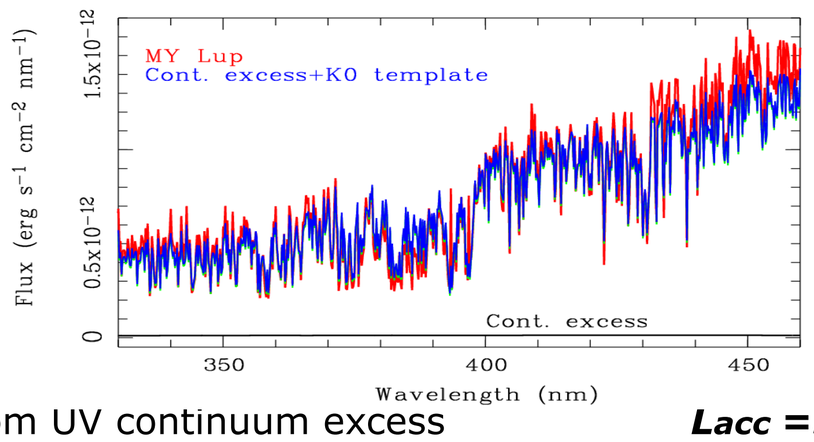
- d(Gaia)= 156(+/- 0.85)pc in the Lupus IV cloud (age ~ 3Myr)
- Av = 1.3 mag from VLT/X-Shooter spectroscopy
- SpT = K0; Teff = 5100 K; L = 1.3$L_\odot$; M = 1.1$M_\odot$



- transitional YSO
- age ~ 17 Myr : more evolved than the other YSOs in Lupus or sub-luminous ?
- highly inclined disc: ***i ~ 73°*** (Ansdell et al. 2016)

Previous Macc measurement (Alcala' et al. 2017)

- based on VLT/X-Shooter (UVB-VIS-NIR) spectra
- very weak UV-excess emission detected (c.f. Fig. below)
- fit using the methods by Manara et al. (2013)
- 8 well detected emission lines (Ha, Hb, Ca-IRT, Pab, Ca-H&K)
- but emission in lines close to the chromospheric level



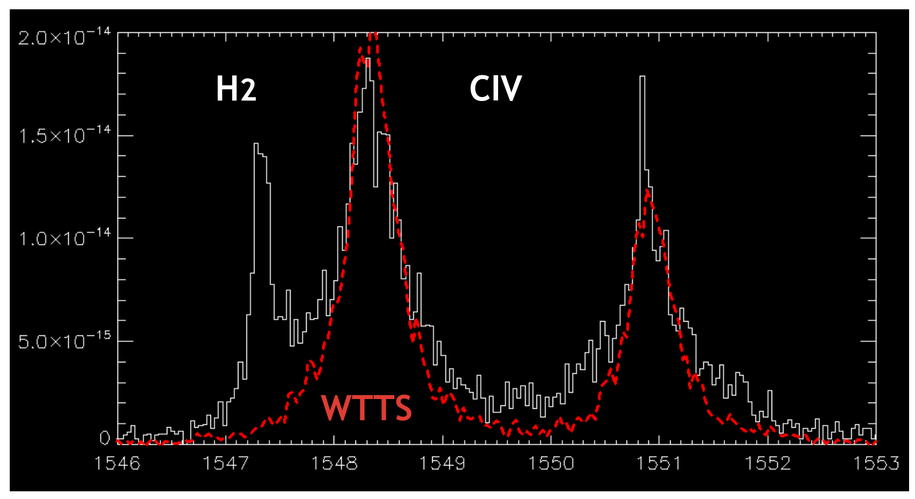
- from UV continuum excess ***Lacc =5e-3 $L_\odot$***
- from lines & Lacc-Llines relationships ***Lacc =7e-3 $L_\odot$***

- $\dot{M}_{acc} = \frac{R_\star L_{acc}}{G M_\star}(1 - \frac{R_\star}{R_{in}})^{-1} \approx 1.25 \frac{R_\star L_{acc}}{G M_\star}$; with $\frac{R_\star}{R_{in}} = 1/5$
- ***Macc = 2.5e-10 $M_\odot$/yr***

~10x less accretion than in YSOs of similar mass

Alternative method to investigate accretion

- FUV, NUV measurements of H_2 (Ly-a pumped) and CIV Lines
- HST - COS & STIS observations: PI. C. Manara (PID: 14604)
- H_2 and CIV lines are well detected in emission (see Fig. below)

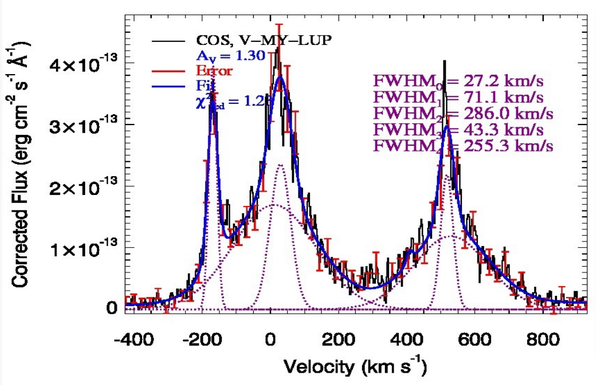


- the H_2 (1547.3A) emiss. line is detected only in accreting YSOs
- the CIV (1548.2A & 1550.8A) lines in MY Lup are broader than typical chromospheric WTTS lines

MY Lupi is definitely accreting

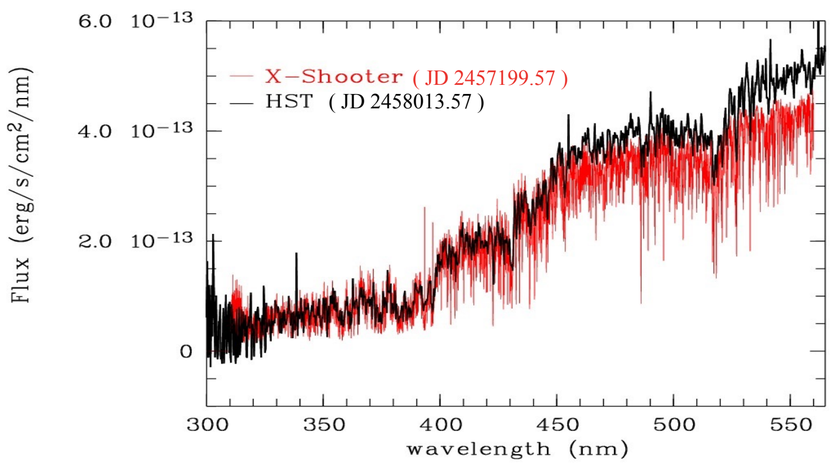
Lines analysis (see Talks by France & Arulanantham; France et al. 2012)

- line deconvolution; fits of broad/narrow components of CIV lines
- FWHM and Av corrected (Rv=3.1) fluxes are in the table below



Line	FWHM (km/s)	Flux (erg/s/cm^2)
H2	27.24	5.92e-14
CIV(1548)-N	71.12	9.21e-14
CIV(1548)-B	285.95	2.67e-13
CIV(1550)-N	43.34	5.21e-14
CIV(1550)-B	255.28	1.67e-13

- the H_2 luminosity of 4.42e-5$L_\odot$ is consistent with accreting YSOs according to the L(H_2) vs. age plot by Ingleby et al. (2012)
- the total CIV luminosity of 4.75e-4$L_\odot$ implies a ***Lacc ~ 1.5e-1$L_\odot$*** according to the L(CIV) vs. Lacc relation by Ingleby et al. (2011)
- ***Macc ~ 2e-9 $M_\odot$/yr*** similar to YSOs with full discs and similar mass



References. Alcala' et al. 2017, A&A, 600,20; Ansdell et al. 2016, ApJ, 828,46; Avenhaus, et al. 2018, A&A, 863, 44; France et al. 2012, ApJ, 756 , 17 ; Ingleby et al. 2011, AJ, 141, 127; Ingleby et al. 2012, ApJ, 752, 20; Manara et al. 2013, A&A, 558, 114; Miotello et al. 2017, A&A, 599, 113

X-Shooter — HST discrepancy ?

- X-Shooter data show weak or no accretion in MY Lup, but a "massive" dusty disc (Mdust=45Mearh, Ansdell et al. 2016) is present. A possibility may be a dusty disc with no (or little) gas: MY Lup has the lowest gas/dust ratio in Lupus (Miotello et al. 2017)
- accretion flows might be obscured by the highly inclined disc, but the UV tracers point toward strong accretion, more typical of full discs
- the low contrast of continuum excess emiss. vs. photospheric emission in early-type (< K3) YSOs, may hamper detection of excess emission in the X-Shooter UV range
- variability might be a reason, but HST-VIS and X-Shooter spectra are not significantly different despite acquired more than 2 years apart (see comparison on the left).
- possible anomalous extinction and scatter may affect the lines in a different way