Properties of accreting young stars and their disks: comparison between high energy observations and MHD models of accretion shocks

Rosaria Bonito[1]

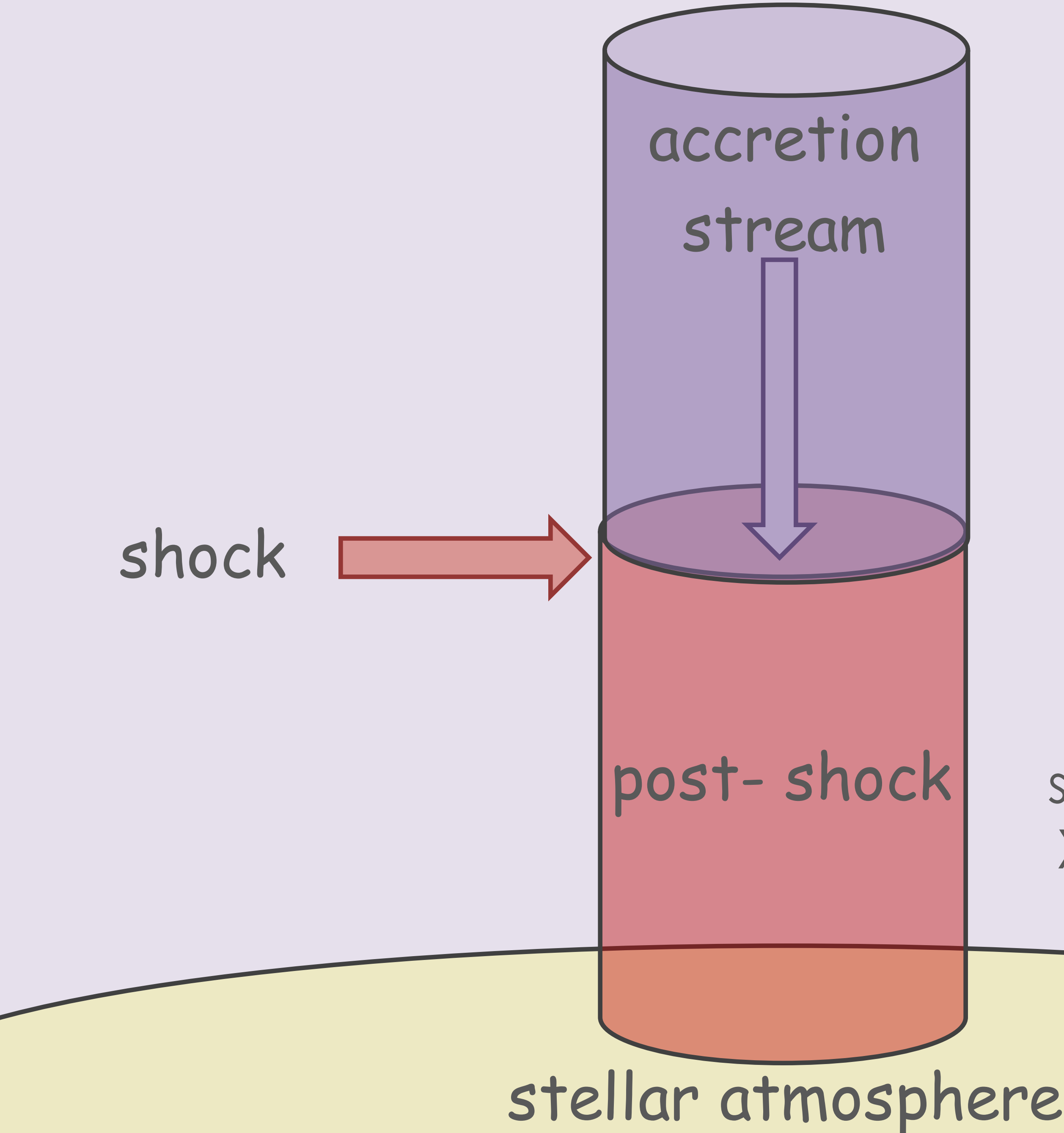
Salvatore Orlando[1], Costanza Argiroffi[2,1], Marco Miceli[2,1]

[1]INAF – Osservatorio Astronomico di Palermo
[2]Universita' degli Studi di Palermo

OUTLINE

- Context and open issues
- MHD models of accretion shock
- Multi-wavelength observations of young stars with accretion process
- Comparison between models and observations (X-rays, UV)
- Laboratory experiments
- Future perspectives (Athena)

ACCRETION



Accretion on classical T Tauri stars generate shocks at the stellar surface:

v_{ff} = 400 km/s

v_{ps} = 100 km/s:

T = 1-3 MK

soft X-rays

(high resolution spectra of CTTSs with XMM and Chandra)

ACCRETION

X-rays from YSOs:

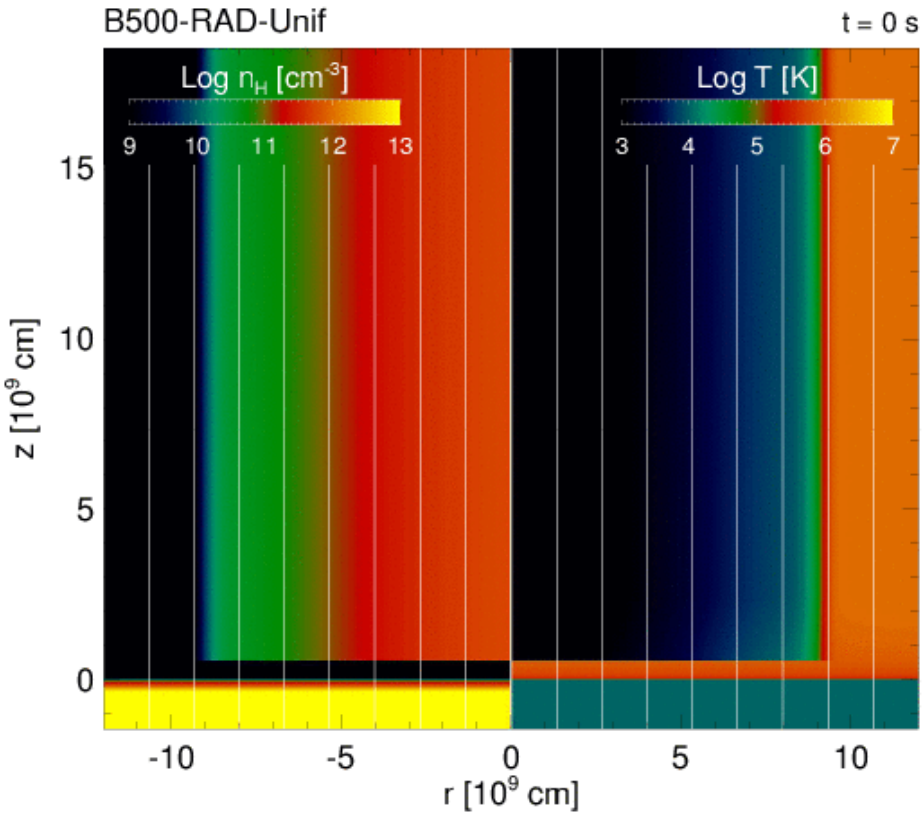
- influence on the physics, chemistry, and lifetime of circumstellar disks (heating, ionization)
- inhibit exo-planets formation
- investigate the properties of the accreting material and of the shock

OPEN ISSUES

- Role of the local absorption
- Detectability of the Doppler shift
- Origin of the soft X-ray emission
- UV vs. X emission

NUMERICAL SIMULATIONS:

(Orlando et al. 2013;
Bonito et al. 2014)



Radiative losses
Thermal conduction
Gravity
Stellar atmosphere

MHD
(PLUTO code, Mignone et al. 2007)

Radial profile:

$n = 5\text{x}10^{10}\ \text{cm}^{-3} - 5\text{x}10^{11}\ \text{cm}^{-3}$

(as suggested by
Romanova et al. 2004)

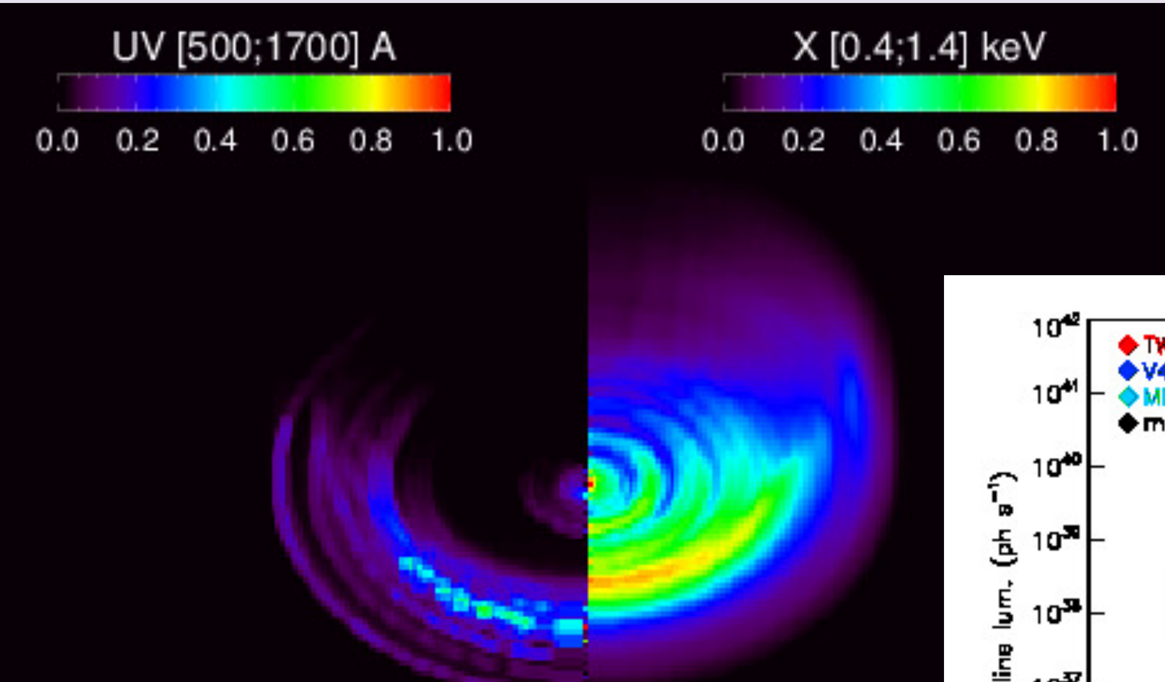
(Bonito et al. in prep.)

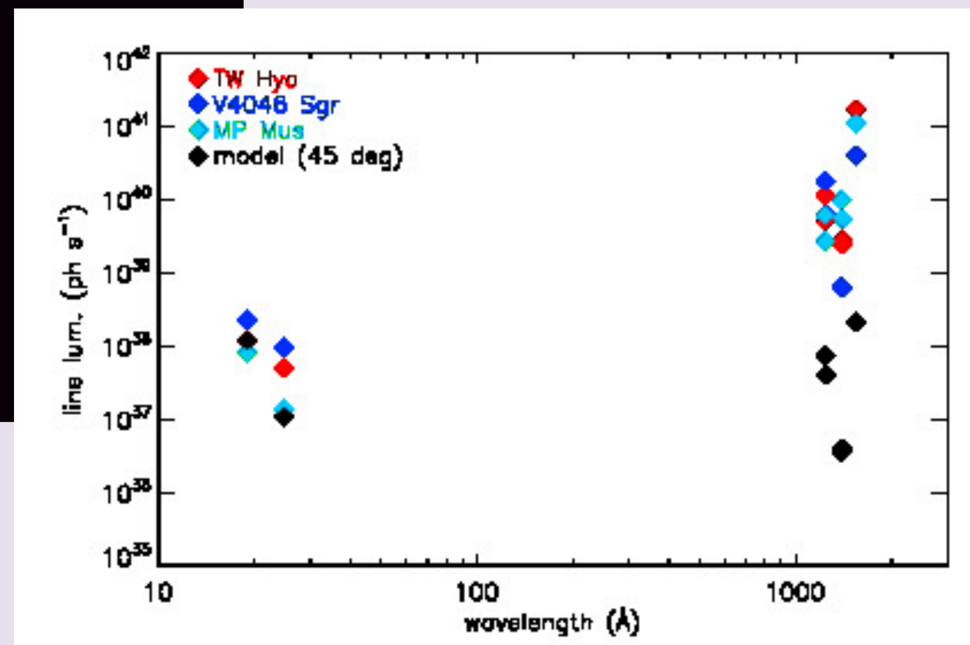
Spectral synthesis of the
UV and X-ray emission

Exploring the effects of:

- local absorption
- geometry
- Doppler shift

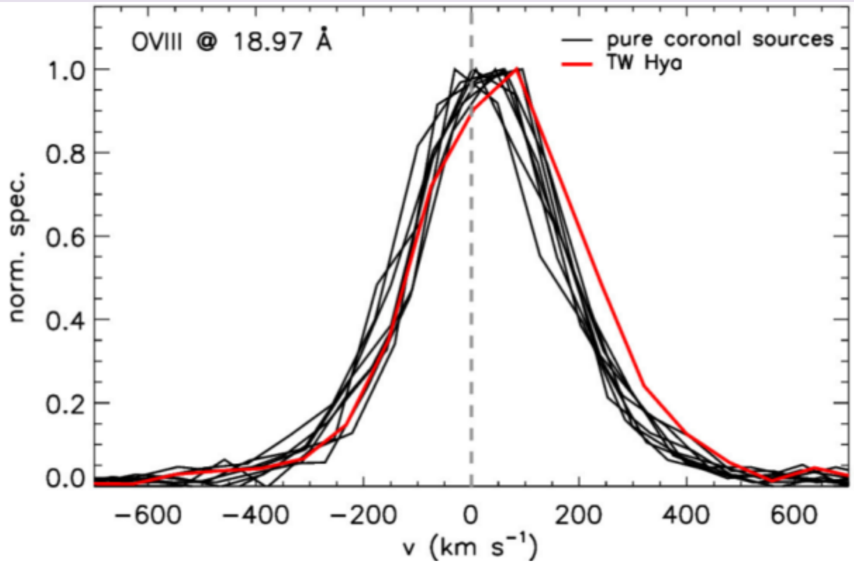
ACCRETION SHOCKS: UV/X



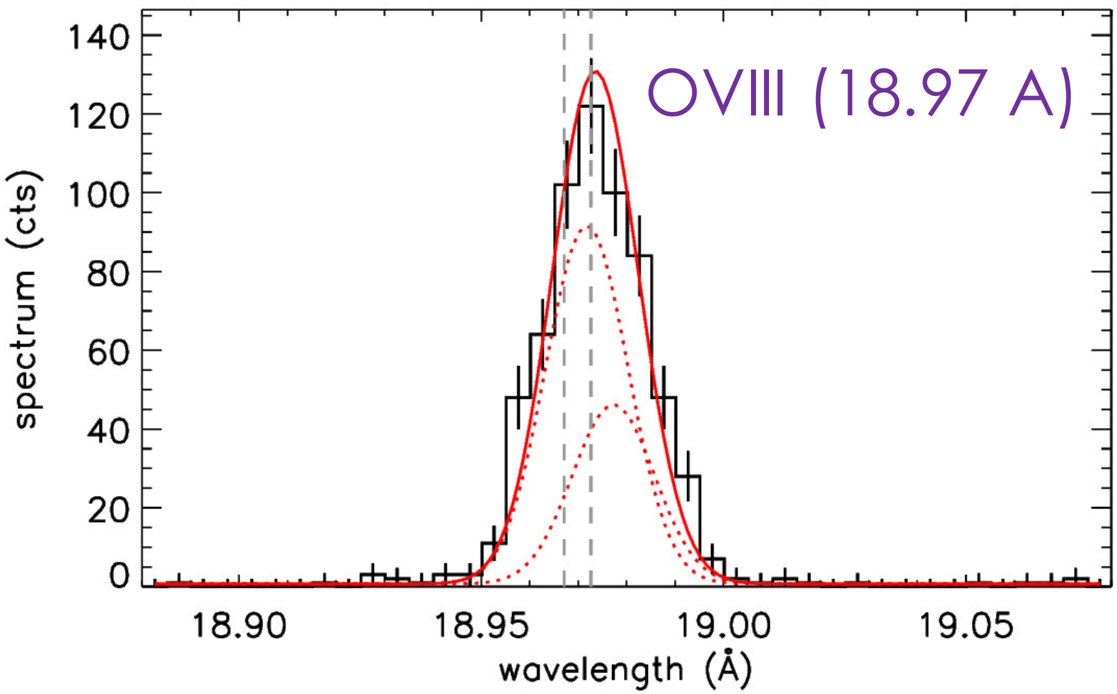


(Bonito et al. in prep.)

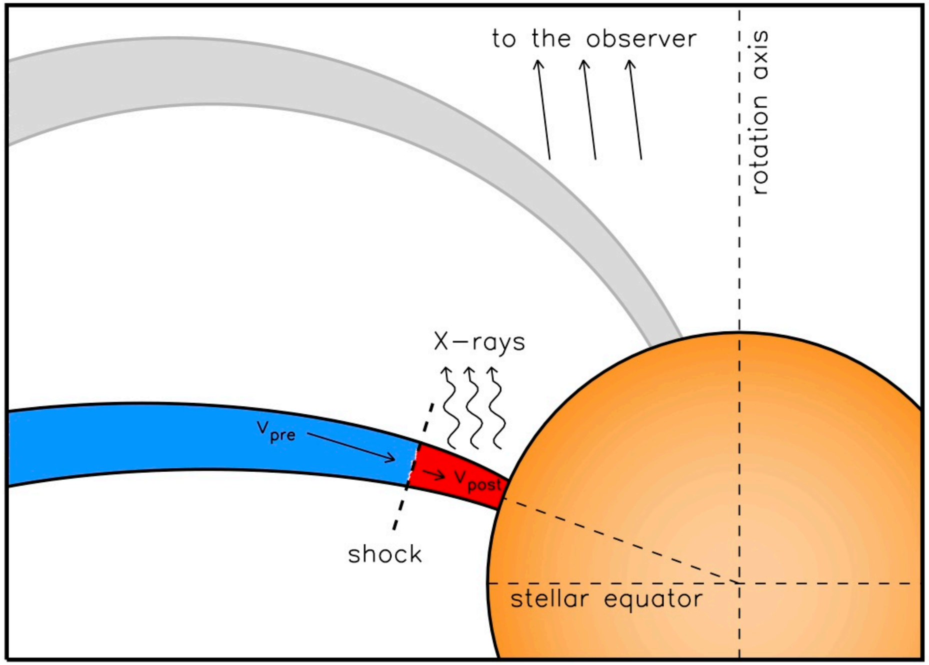
Red-shift



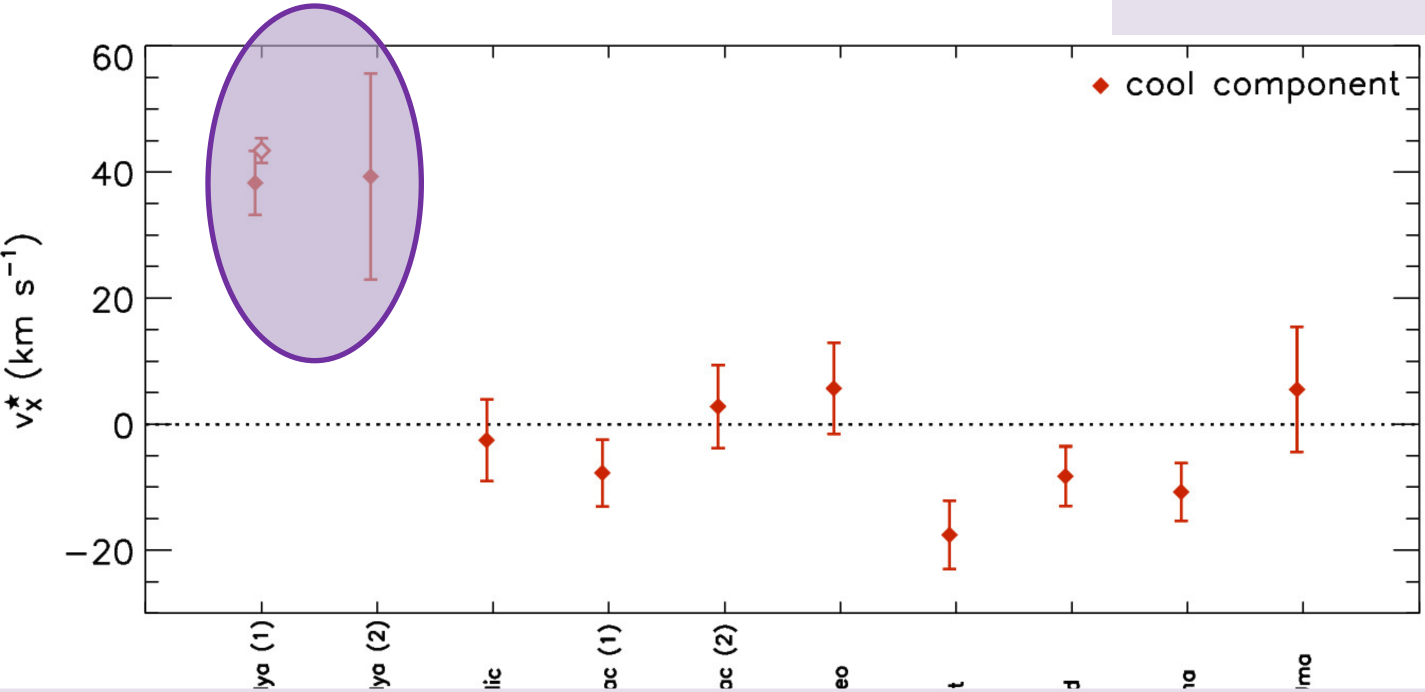
Observations
(Argiroffi, Drake, Bonito et al. in prep.)



Model prediction
(Bonito et al. in prep.)



(Argiroffi, Drake, Bonito et al. in prep.)



Redshift: 35 km/s

First detection

Infalling material

Geometry

LABORATORY EXPERIMENTS

For jets, based on:
Bonito et al. 2011

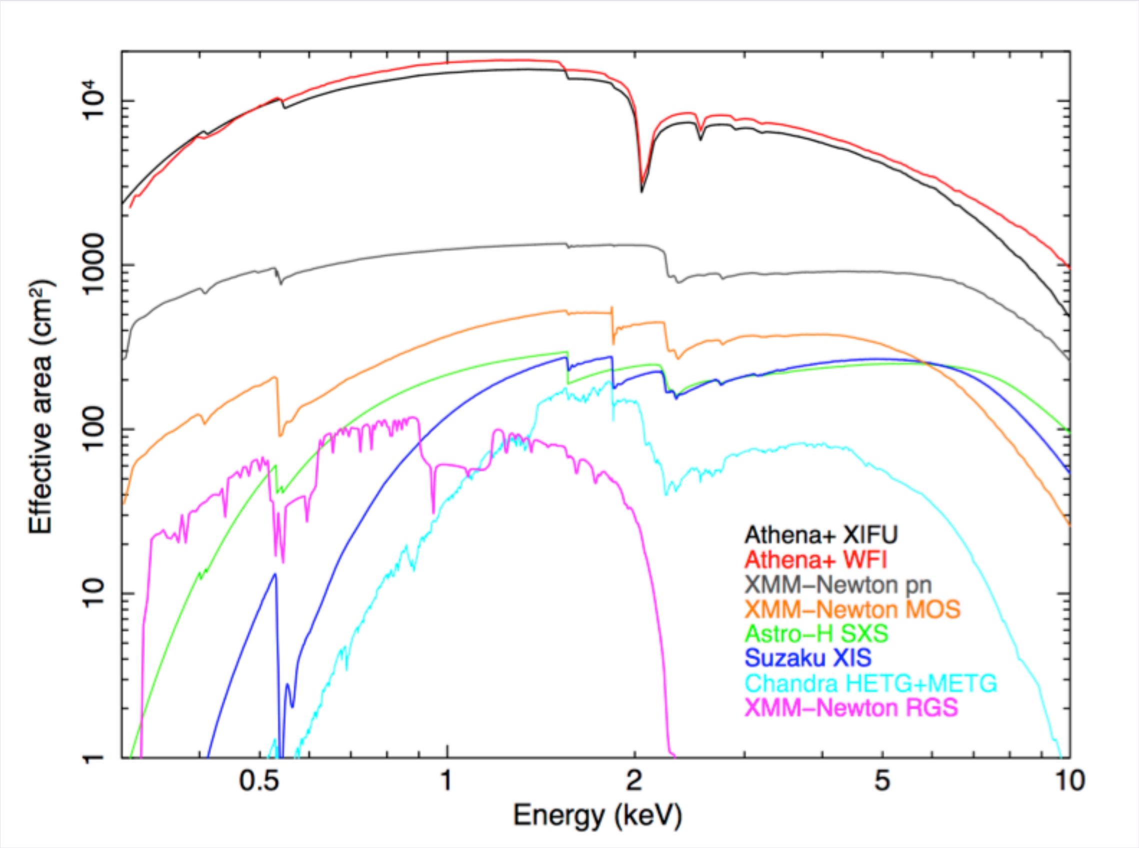
HH154

Laboratory formation of a scaled protostellar jet by coaligned poloidal magnetic field
B. Albertazzi, A. Ciardi, M. Nakatsutsumi, T. Vinci, J. Béard, R. Bonito, J. Billette et al. *Science 2014*

For accretion, based on: Bonito et al. 2014

(see also Young et al. 2017)

ATHENA



- Improve the statistics
- Different properties (age, mass, geometry, …)

CONCLUSION

- Importance of a proper treatment of the local absorption
- Doppler shift: predicted and detected
- Soft X-rays from post-shock region
- UV and X-ray emission from the same region
- Laboratory experiments of accretion shock
- Future: Athena