## Accretion shocks in young stars: the role of local absorption on the X-ray emission

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## OUTLINE

- Observations and previous models
- Open issues
- Numerical simulations
- Synthesis of the X-ray emission
- Conclusion

### ACCRETION



stellar surface: soft X-rays

## DENSITY DIAGNOSTICS

He-like triplets:

✓ O VII: 21.6, 21.8, 22.1 Å

✓ Ne IX: 13.45, 13.55, 13.7 Å



## DENSITY DIAGNOSTICS

#### Flux ratio:



(Argiroffi)

(Brickhouse et al. 2010)

## PREVIOUS MODELS

• Sacco et al. 2010:

stream density determines the stand-off height of the hot slab and the amount of sinking into the chromosphere;

X-ray luminosity lower than predicted (absorption?)



## OPEN ISSUES

>X-ray luminosity lower than predicted (Curran et al. 2011, Sacco et al. 2010)

- Density is higher where temperature is higher (O VII, Ne IX)
- > Several scenarios proposed
  - (corona/accretion, Brickhouse et al. 2010)
- Doppler shift

### EFFECTS OF THE MAGNETIC FIELD B500-D11-Dip1



## STRATEGY



MHD Radiative losses Thermal conduction Gravity Stellar atmosphere (PLUTO, Mignone et al. 2007)

Synthesis X-ray emission

(Orlando, Bonito et al. 2013)

(Bonito et al. in prep.)

## Exploring the effects of:

- local absorption
- geometry
- Doppler shift



## RESULTS: TEMPERATURE (3D)

Aborption coefficient (Balucinska-Church, McCammon, 1992)

t = 30 min.



(Bonito et al. in prep.)

## LOCAL ABSORPTION

For each cell: column density along the line-of-sight, aborption coefficient (Balucinska-Church, McCammon, 1992); add the contribution to derive the images and the spectra





1E+06

2E+06

3E+06

4E+06

5E+06

8E+06

9E+06



#### **RESULTS: X-RAY SPECTRA**

#### (Bonito et al. in prep.)



# RESULTS: X-RAY IMAGE





B = 500 G; radial profile

Local absorption effect: varies with  $\lambda$ 

O VII: > 20 % n reduction Ne IX: < 9 % n reduction

## CONCLUSIONS

Synthesis of the X-ray emission from accretion shocks (several magnetic field configurations):

- . detailed numerical models
- . local absorption
- . geometry

Spectral analysis: comparison model/observations:

- . Complex structure from a detailed model
- . X-ray luminosity lower due to the effect of absorption
- . Higher n<sub>stream</sub> : effect amplified
- . n reduction higher for cooler triplets