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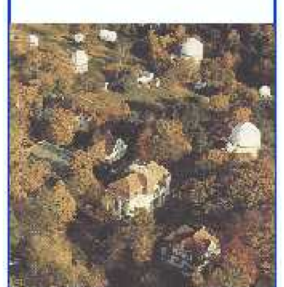

Soft X-rays from DG Tau: A physical jet model

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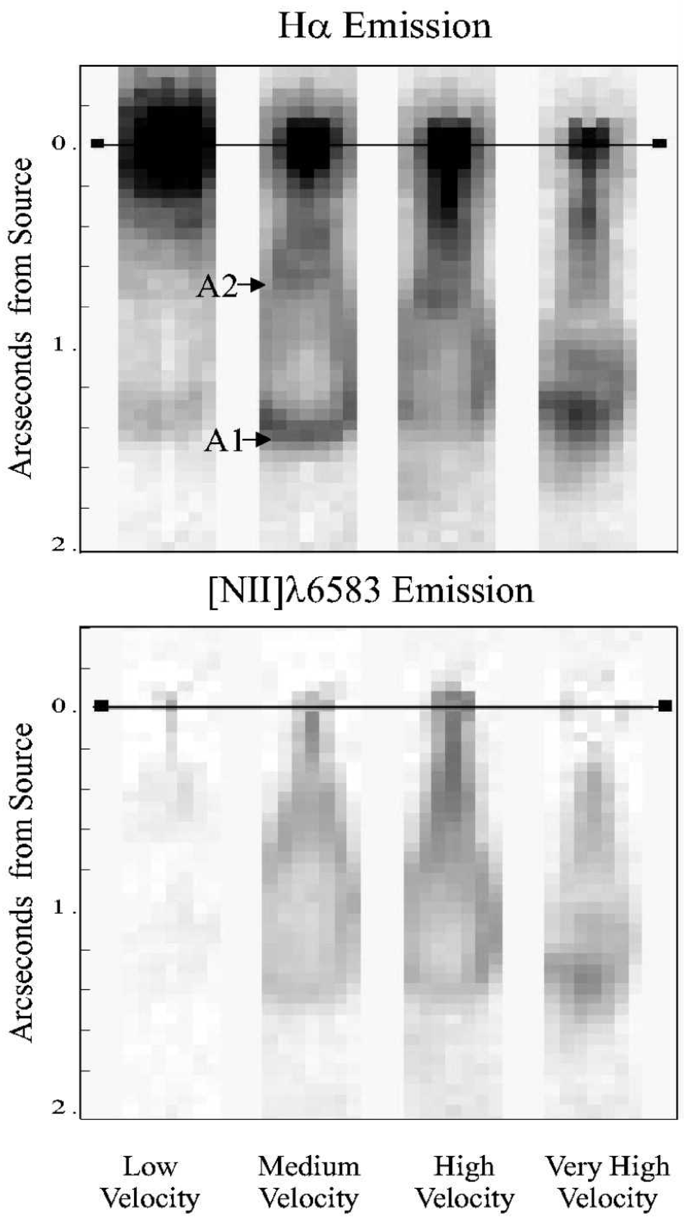
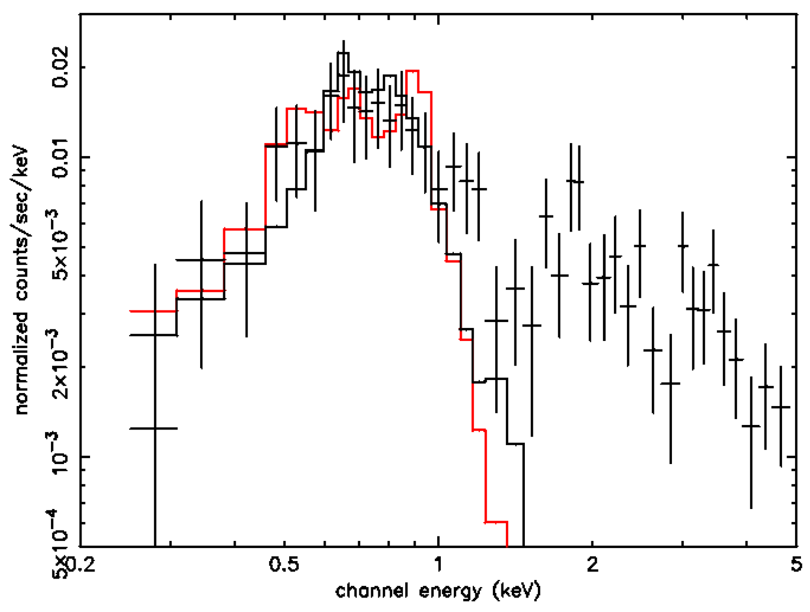
Abstract. DG Tau is a classical T Tauri star showing an unusual X-ray spectrum, best described by two thermal components with different absorption columns. The soft X-rays are less absorbed than the hard X-rays, presumably coronal, component. This rules out stellar accretion as the origin of the soft photons and requires an emission region above the circum-stellar absorption layer. We constrain the model space from the observed X-ray parameters and, adding information from the literature, we build a physical model that interprets the X-ray emission in terms of an outflow. We find that only a very small fraction of the total mass loss rate is required to explain the observations. We suggest that the X-rays originate from shocks in a narrow, fast inner wind component bracketed by slower outflows as observed in the optical. DG Tau also shows spatially resolved X-ray emission associated with the jet, which may be produced by the same fast outflow at larger distances.

Model ingredients.

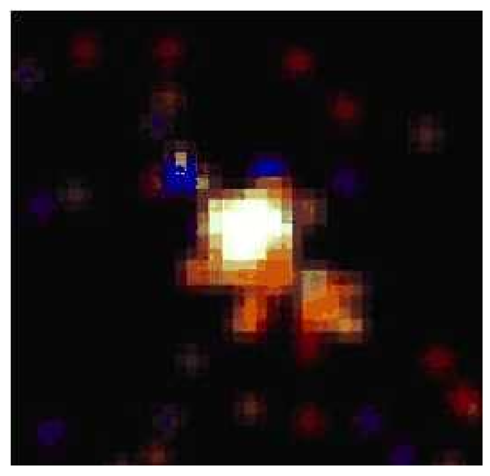
Optical emission: HST imaging shows the faster component to be more collimated than the slower components of the jet. (Bacciotti et al., ApJ 537: L49, 2000)





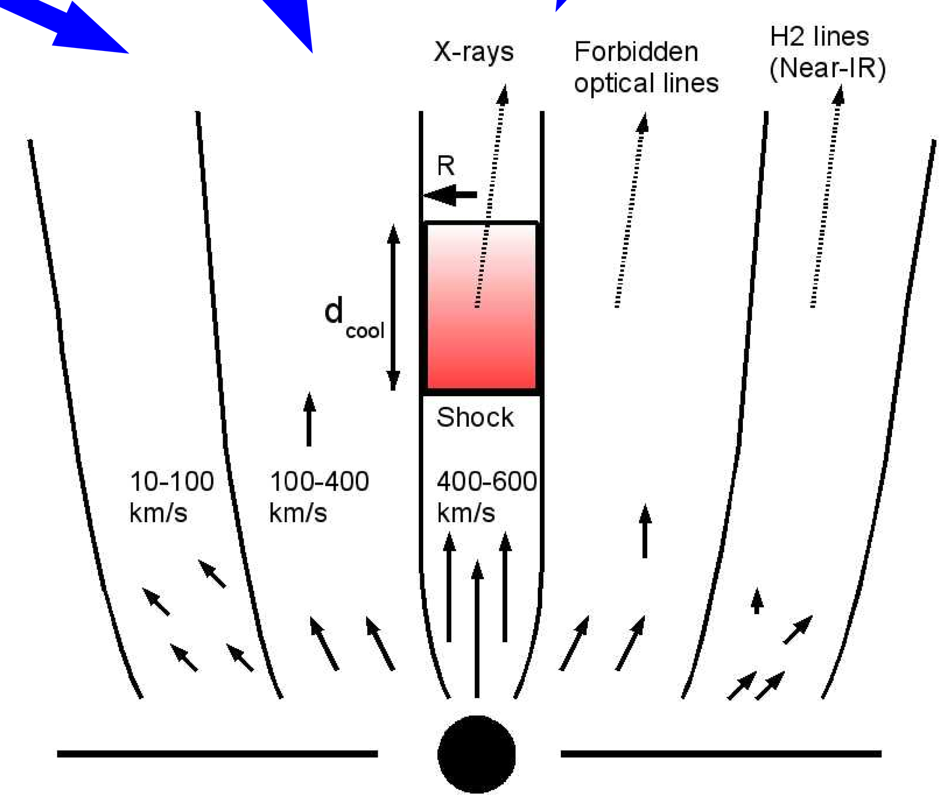
XMM-Spectra: Fits for different shock temperatures (black: kT=0.3 keV ; red: kT=0.08 keV) work well, if the cooler components have a much larger emission measure, but are heavily absorbed at the same time.

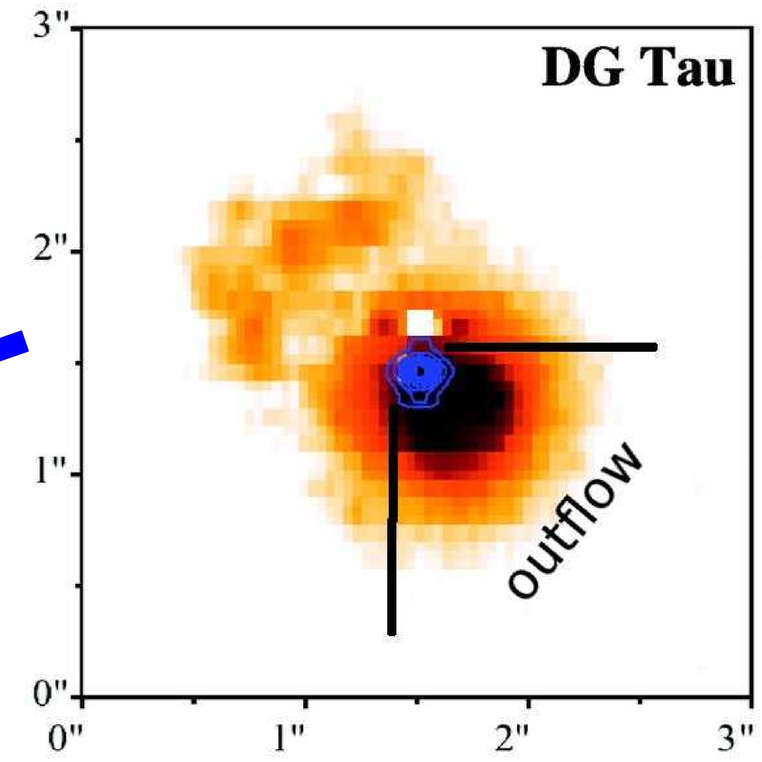
Chandra X-ray imaging resolves the jet to the SW (Güdel et al., A&A 478: 797, 2008). In this poster we concentrate on the central component only. The picture dimension is 20''.



Offset between star and soft component: Chandra imaging indicates that the shock is offset ~30 AU from the position of the star.

See Poster No.
(Schneider & Schmitt)

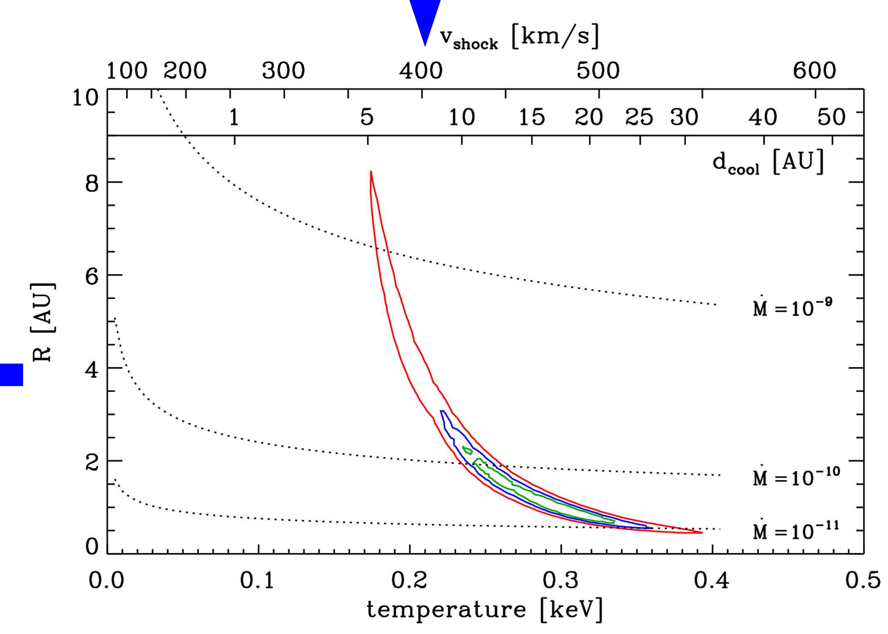




Molecular outflow: Near-IR imaging shows a strong H_2 concentration SW of the (stellar) continuum source (blue contours). (adapted from: Beck et al., ApJ 676: 472, 2008)

Results.

The shock zone is small: For a density of $n>10^5/cm^3$ all dimensions are only a few AU. This could easily go undetected in the optical pictures.



Confidence contours (68%,90%,99%): Dotted lines give the associated outflow rate in solar masses/year. R and d_{cool} are calculated assuming $n=10^5/cm^3$.

The mass loss of the fast components is small: 10^{-11} to 10^{-9} solar masses/year are sufficient to explain the X-ray flux.

Conclusions.

- **A shocked outflow can explain all properties of the observed soft X-ray emission from DG Tau.**
- **It does not violate any constraint obtained from other wavelengths.**
- **The mass outflow of the fastest (possibly stellar) component is small.**
- **Several scenarios lead to the formation of a suitable shock (collimation shock, time-variable outflow rates, multiple internal shocklets).**