The high-energy view of the CTTS DG Tau

P. Christian Schneider

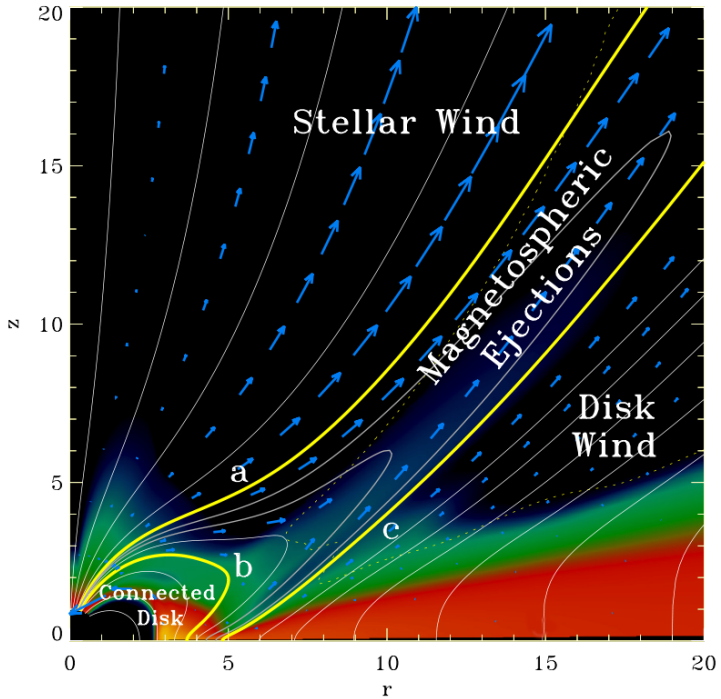
Hamburger Sternwarte

Challenges in UV Astronomy

ESO Garching, October 7, 2013

Disks, accretion and **outflows**

- Accreting objects drive jets and outflows, but launching mechanism is unclear
- (Can) regulate angular momentum balance
- For CTTS: Three launching possibilities
  1. Stellar wind
  2. Magnetospheric ejections (e.g., X-wind / Propeller)
  3. Disk wind
- Large initial opening angles
- Collimation by toroidal magnetic fields
- Compared to processes of Herczeg's talk: Observed on (much) larger spatial scales



Zanni & Ferreira 2013

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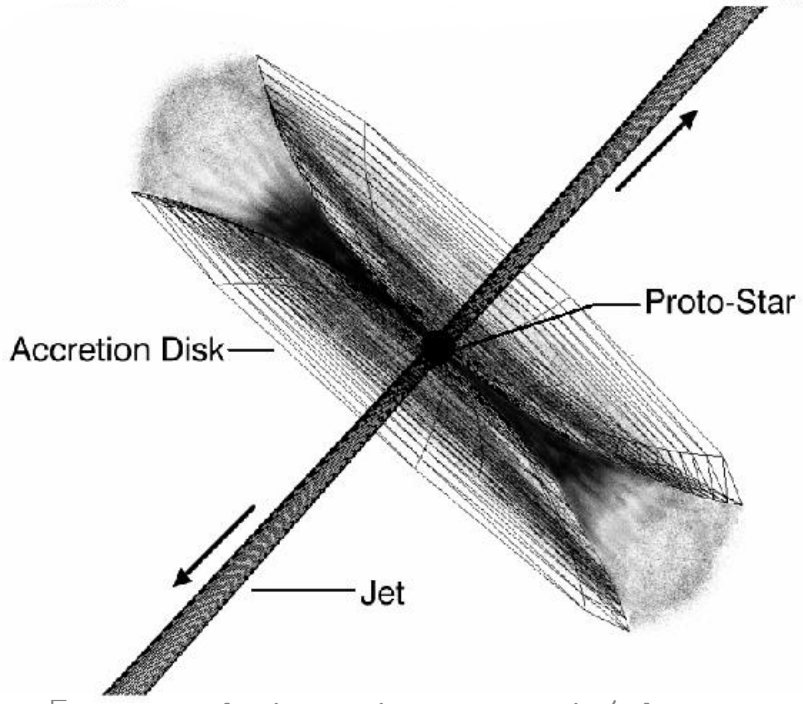

From www.edu.ics.saitama-u.ac.jp/~hara

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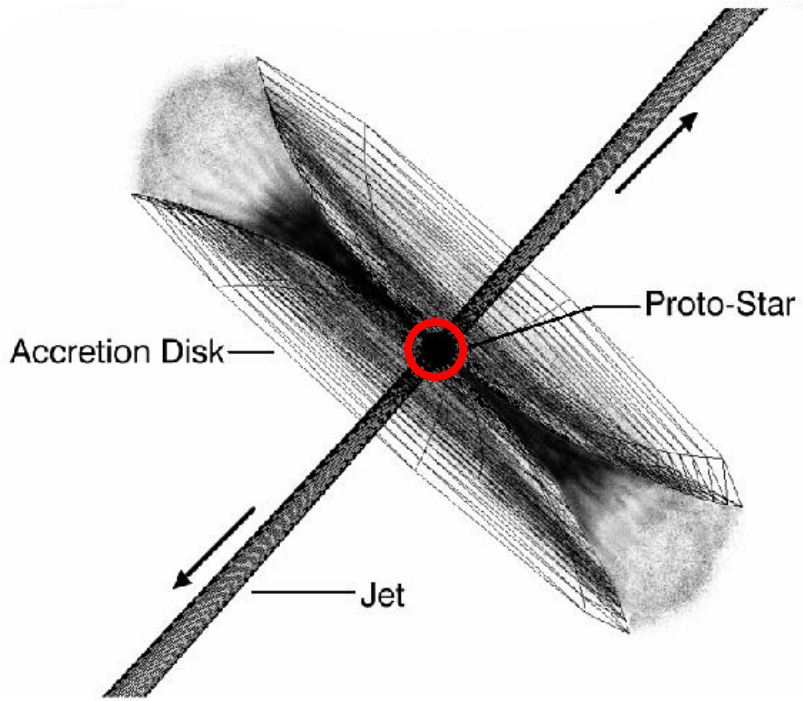

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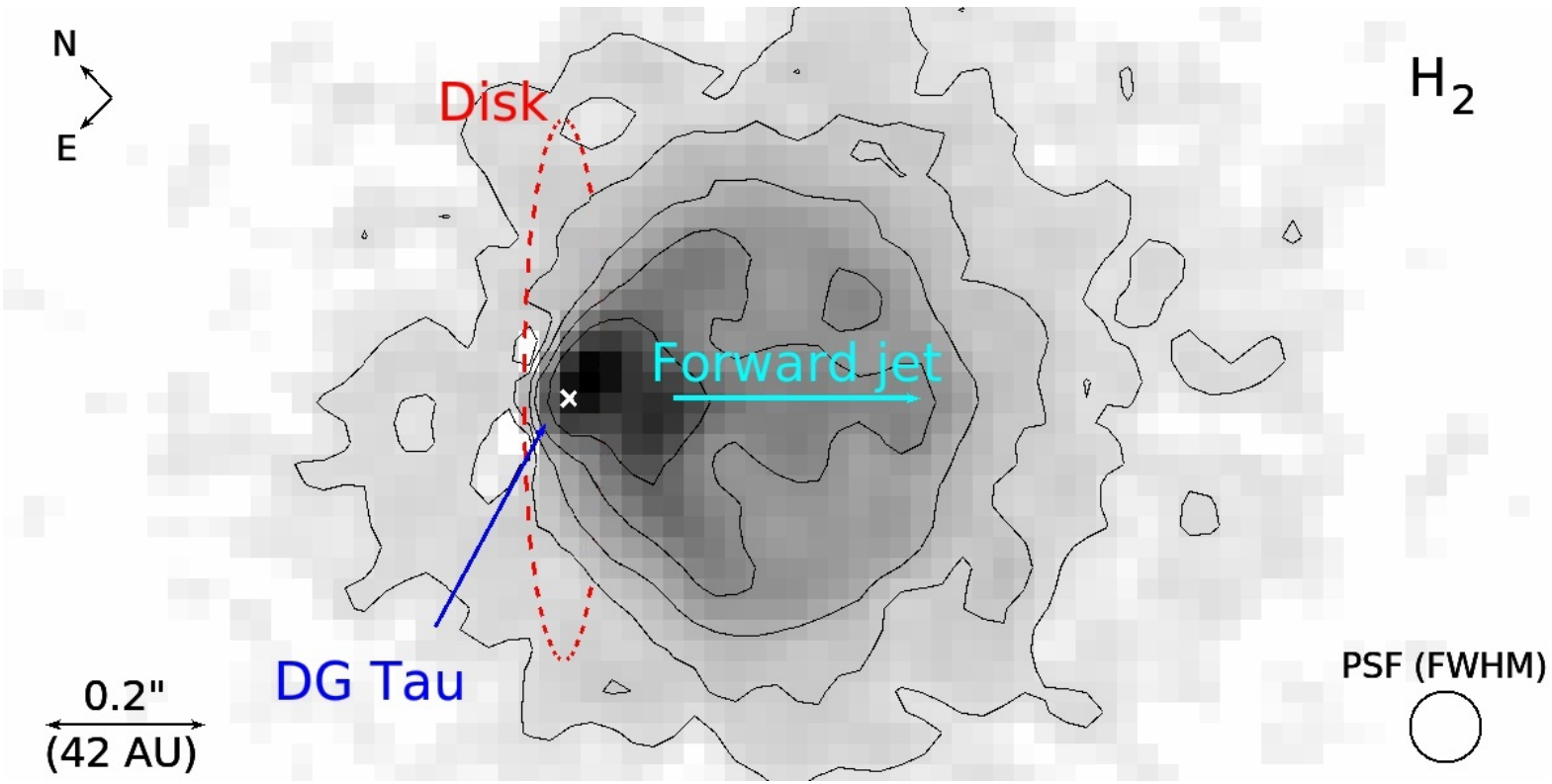
The spatial distribution of molecular hydrogen

The DG Tau outflow in H_2

From spectroscopy:

- No emission from stellar position ($\lambda \lesssim 1650\,\text{Å}$)
- Emission is blue-shifted ($v \approx 10 - 30\,\text{km s}^{-1}$)



Schneider et al. 2013a

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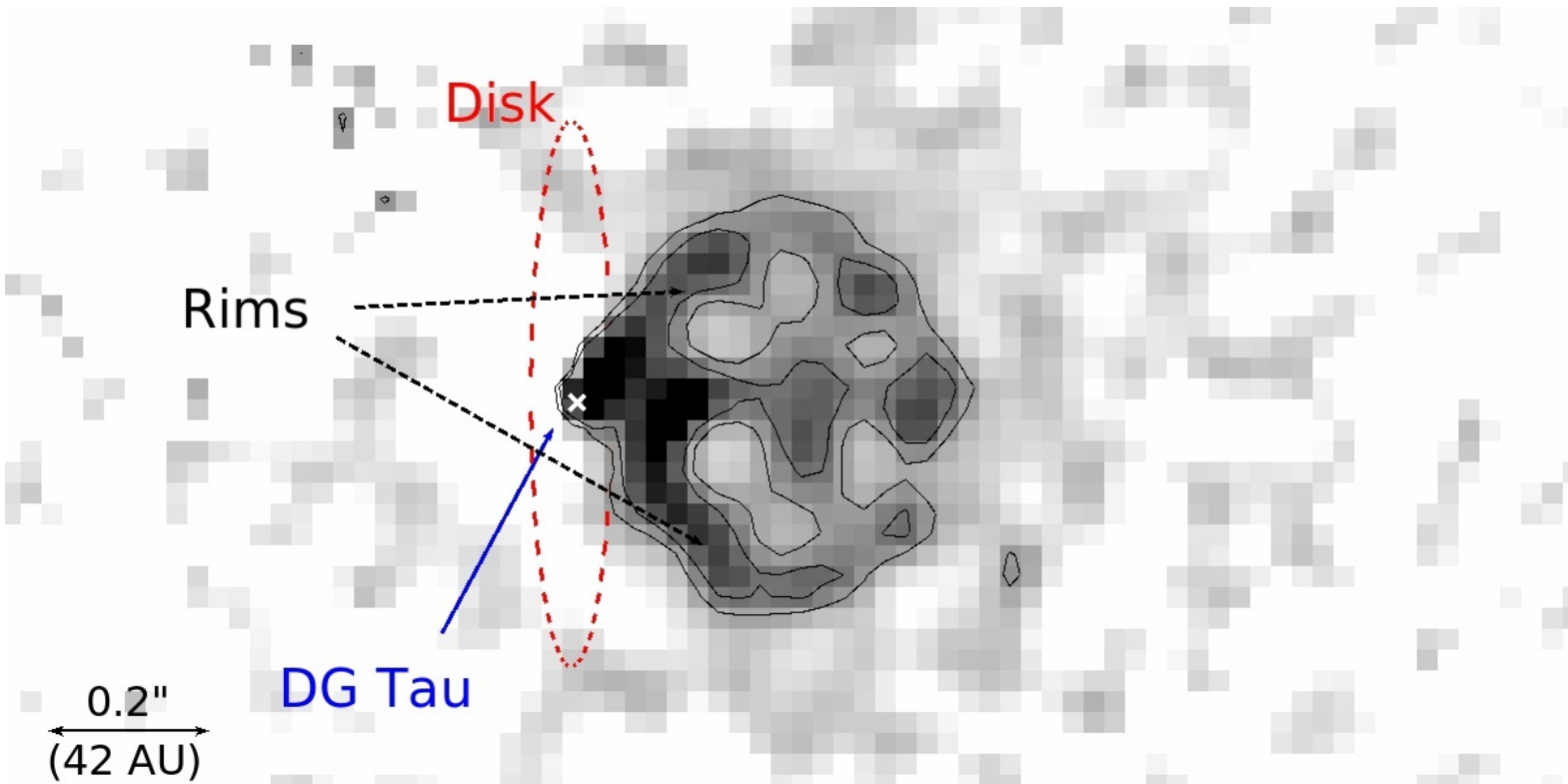

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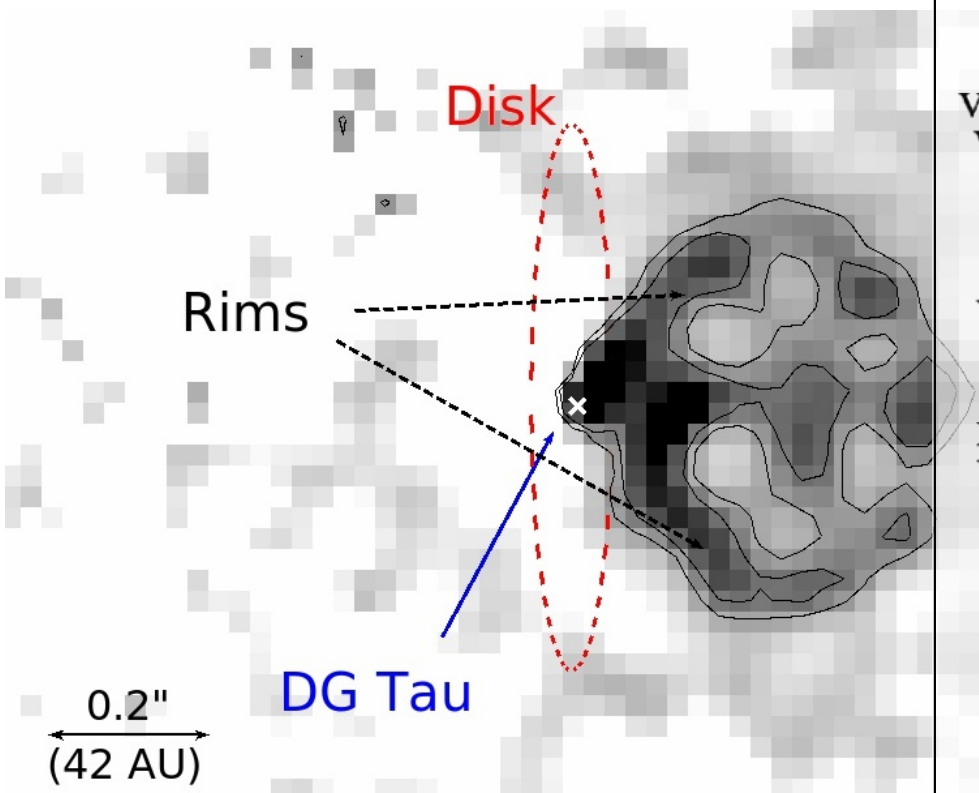

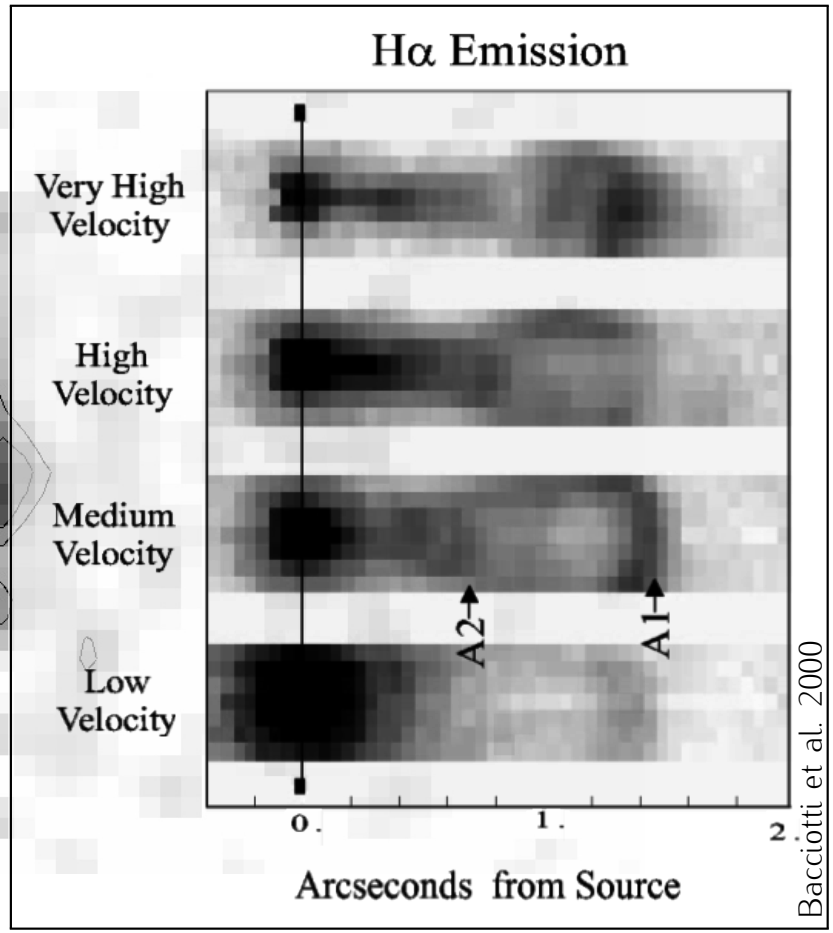

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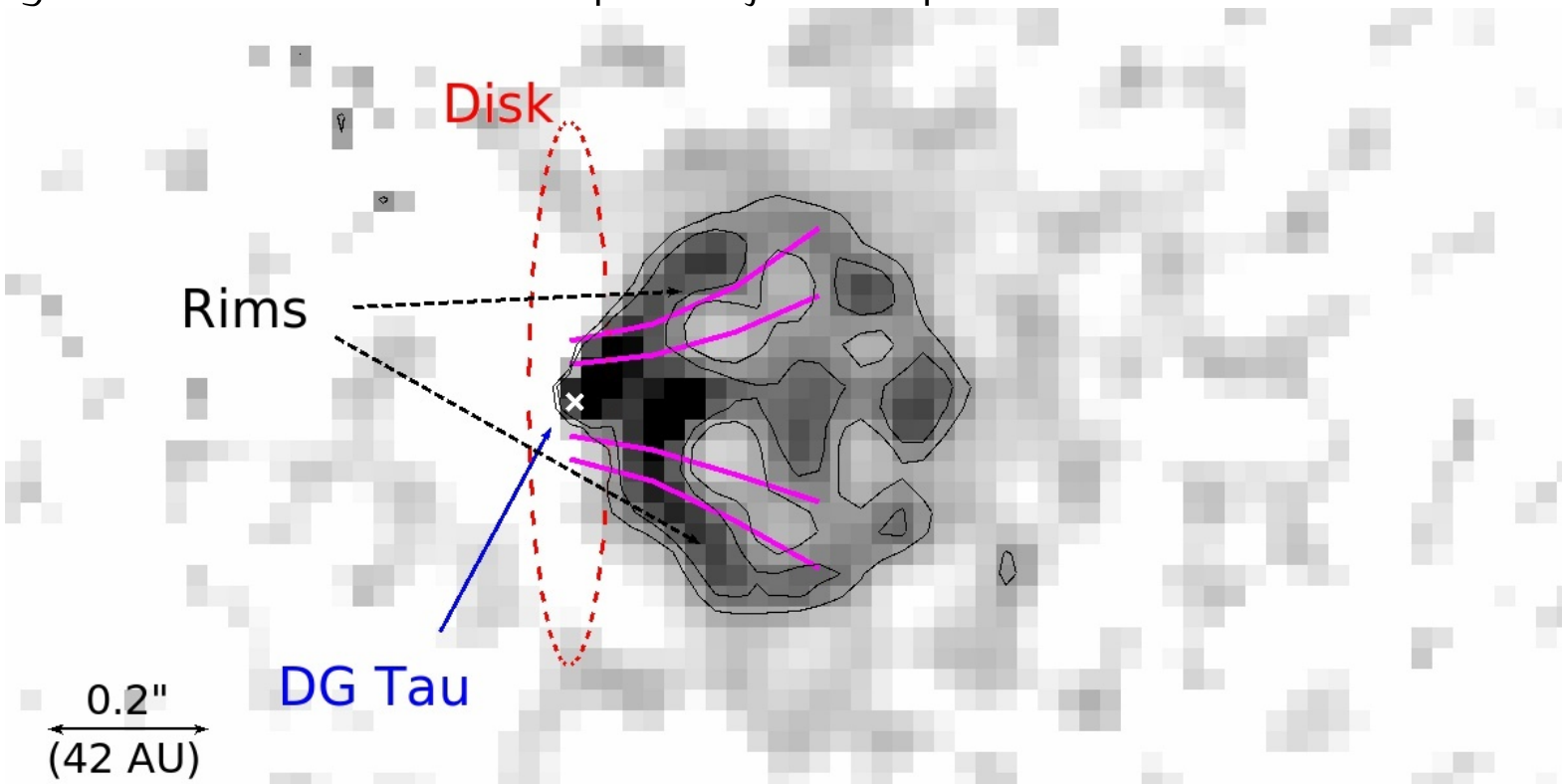
Larger extent than faster optical jet component



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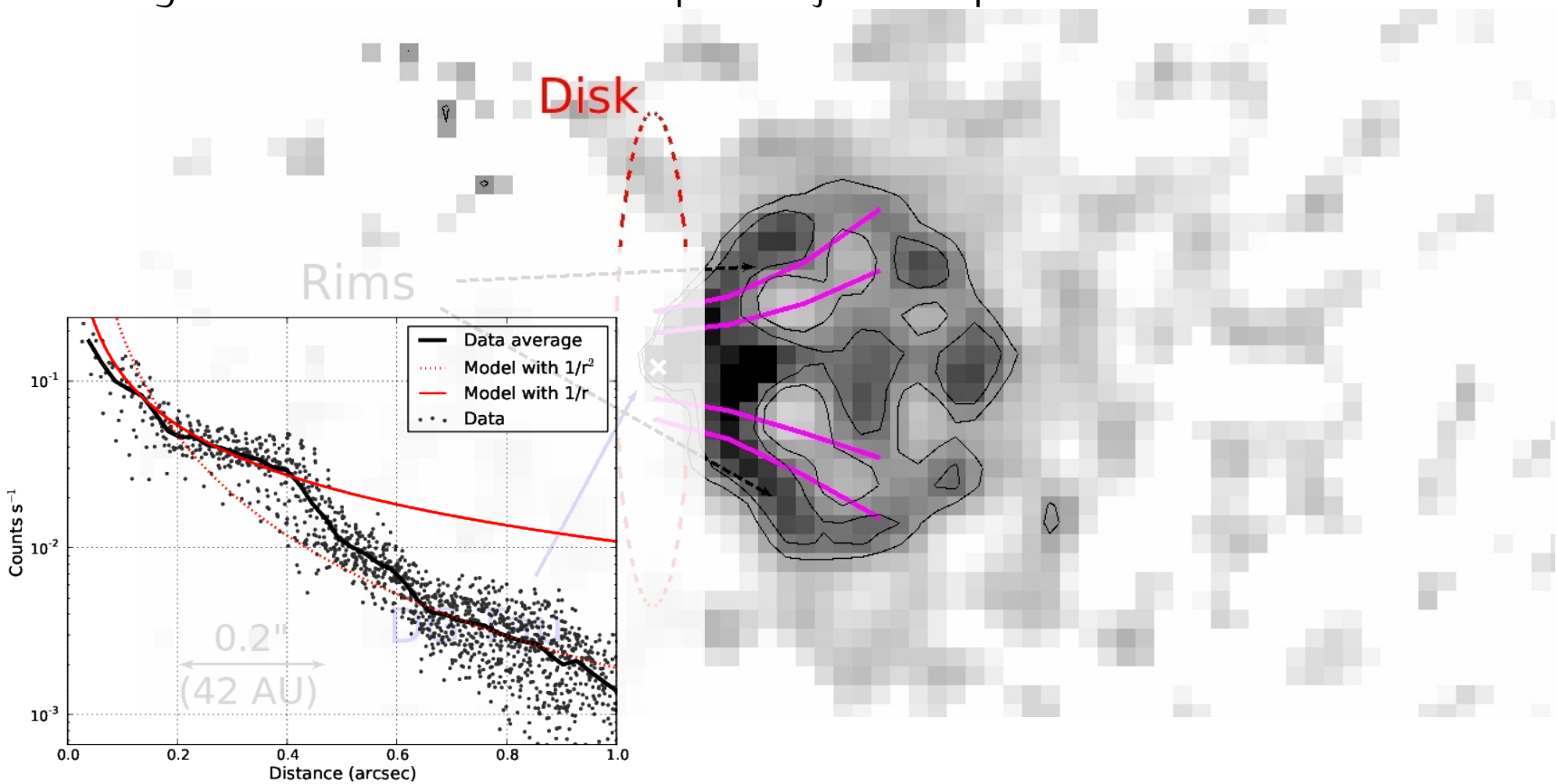

Schneider et al. 2013a

Higher temperatures
Why is DG Tau special?

X-rays from the DG Tau jet

- Low-temperature (10^4 K) jet
  - consists of individual emission regions (knots)
  - knots possess proper-motion
  - heating by internal shocks ($v_{shock} < 100\,\mathrm{km\,s^{-1}}$)

  Lavalley-Fouquet et al. 2000
- High-temperature jet ($T \gtrsim 10^6$ K)
  - Inner and outer component
  - Shock velocities $\gtrsim 400\,\mathrm{km\,s^{-1}}$
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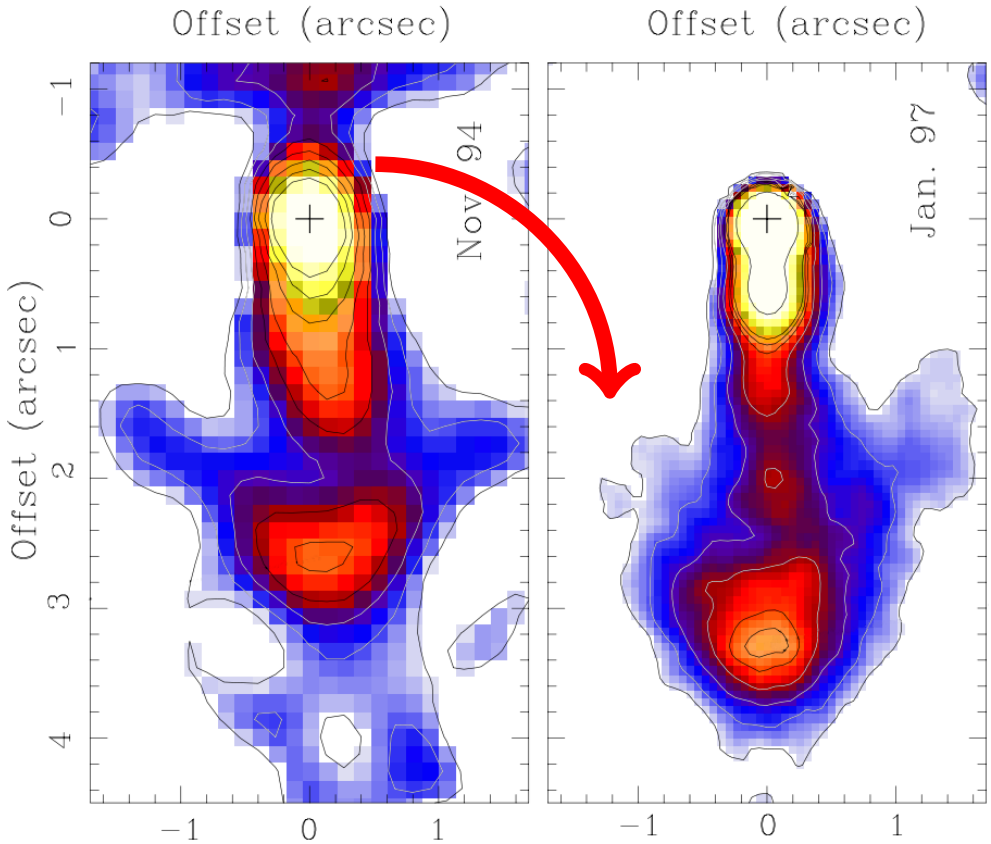

Dougados et al 2000

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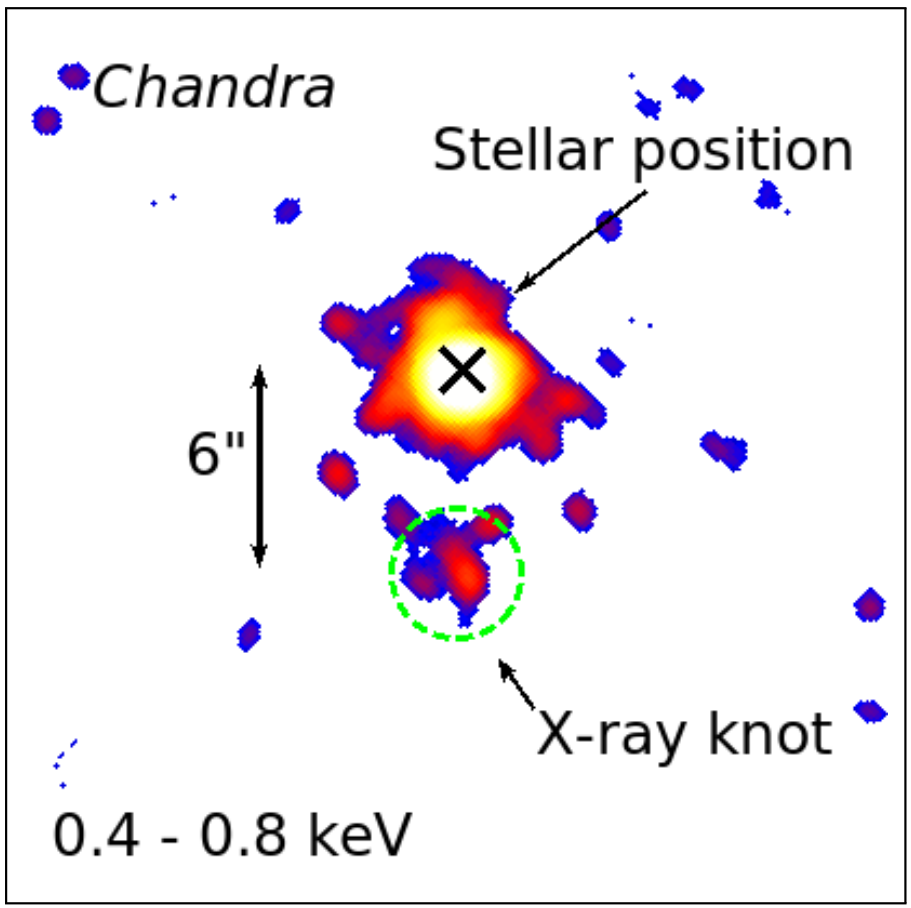

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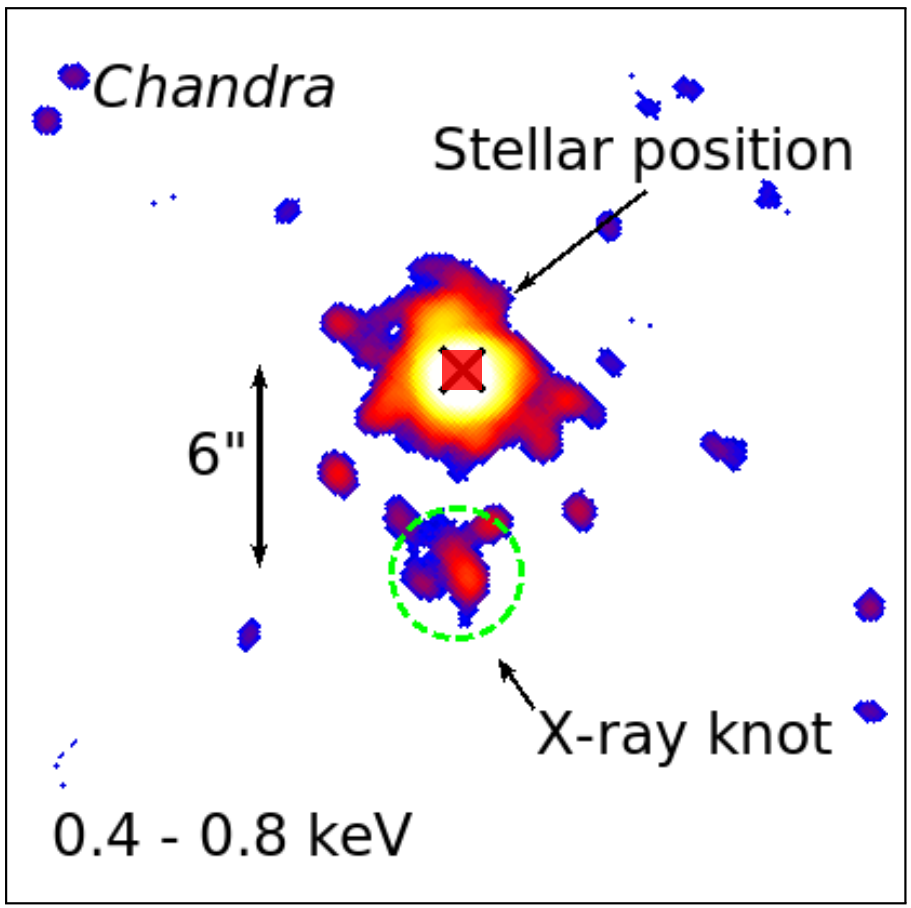

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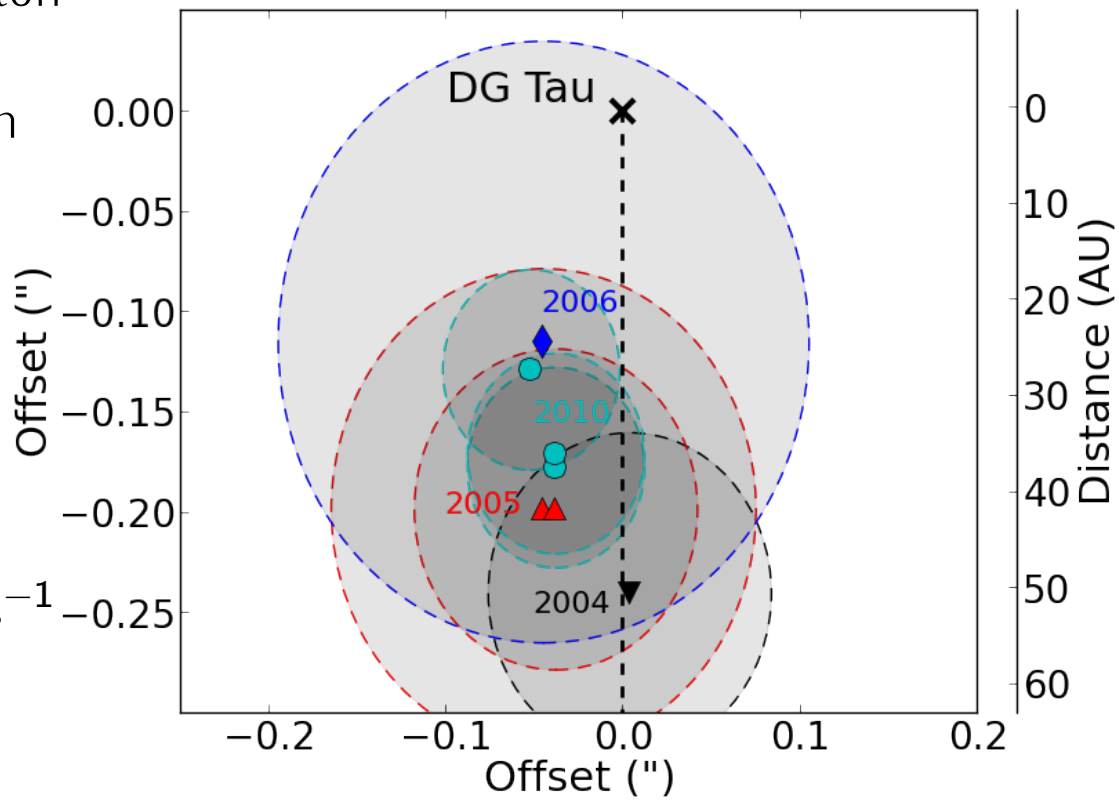

Adapted from Schneider et al 2008

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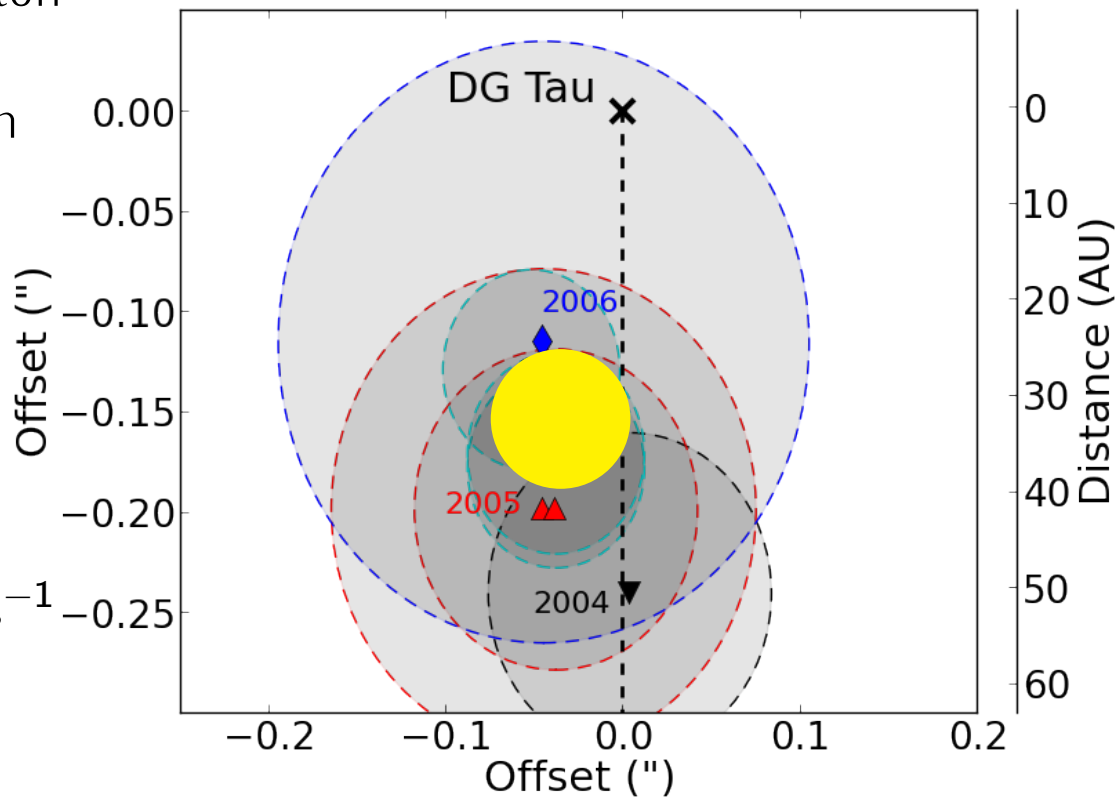

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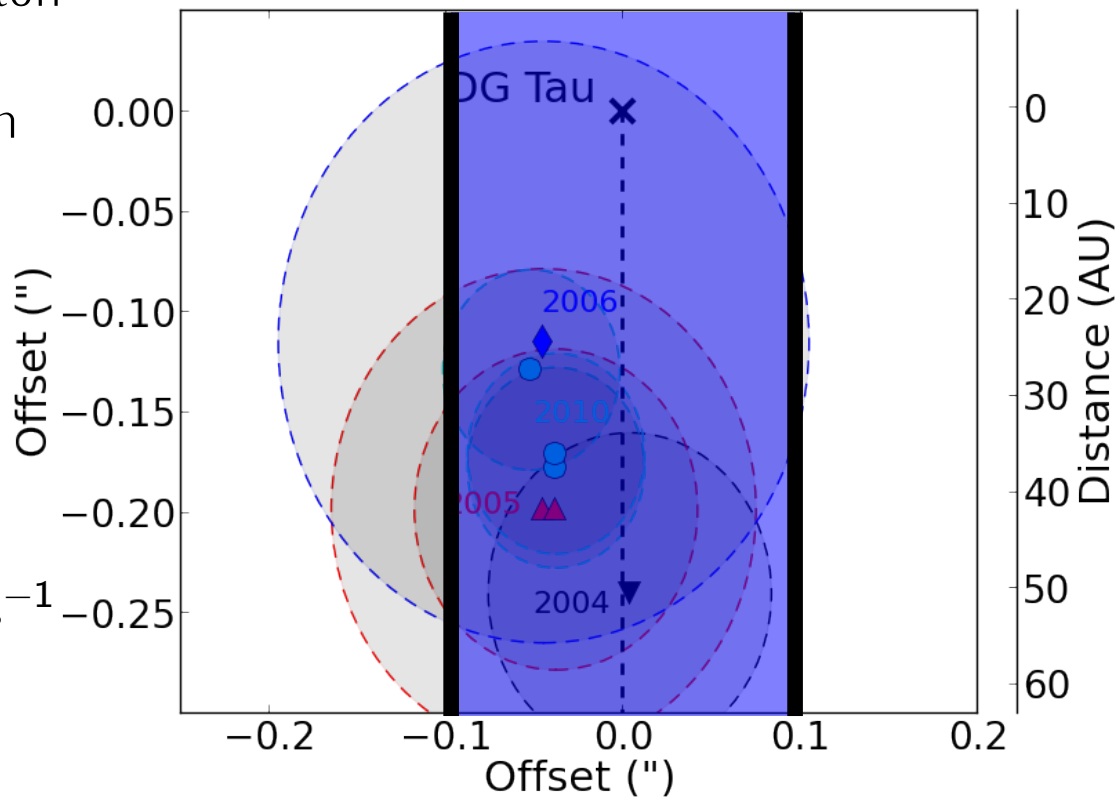

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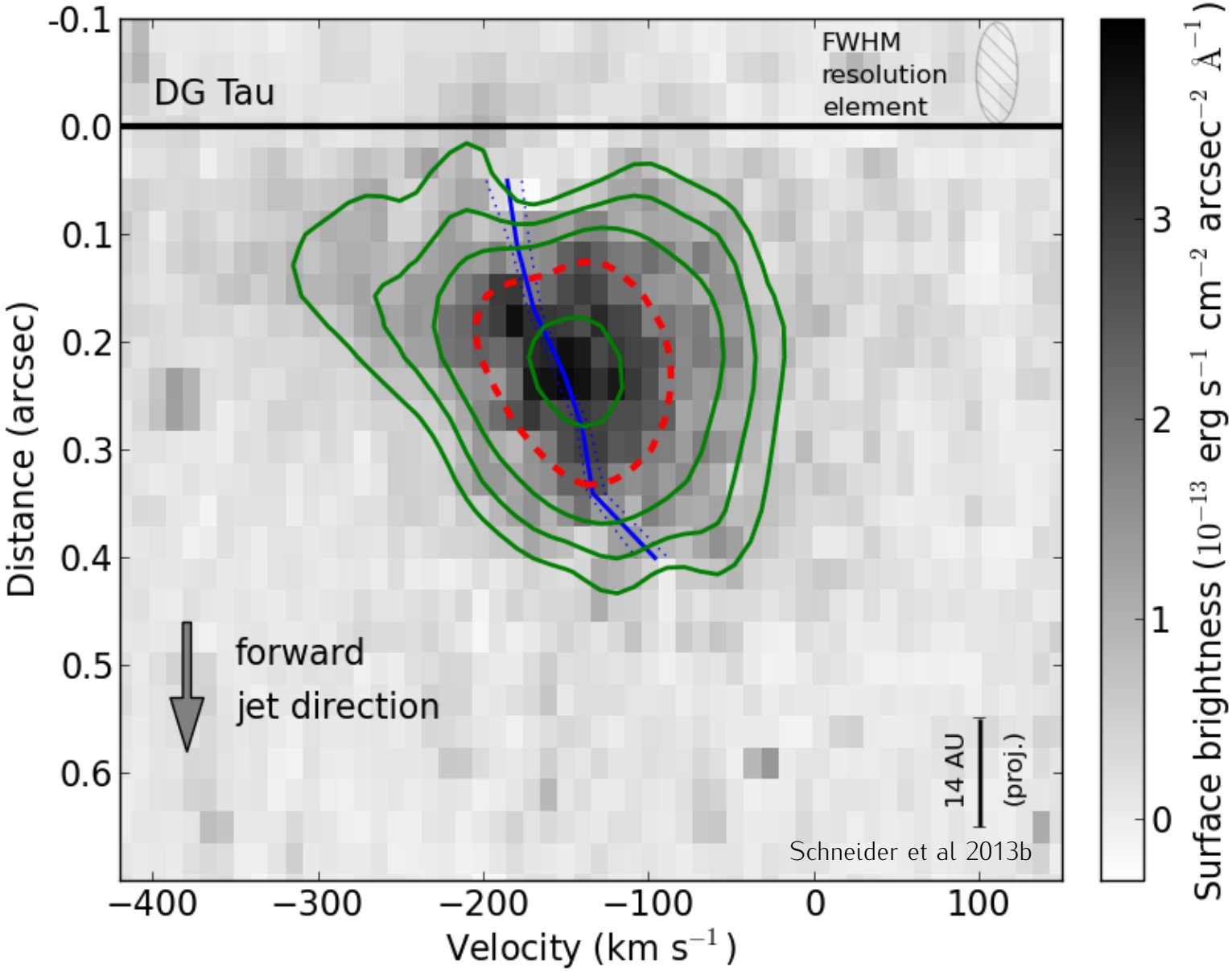
Intermediate temperatures ($T \sim 10^5$ K)



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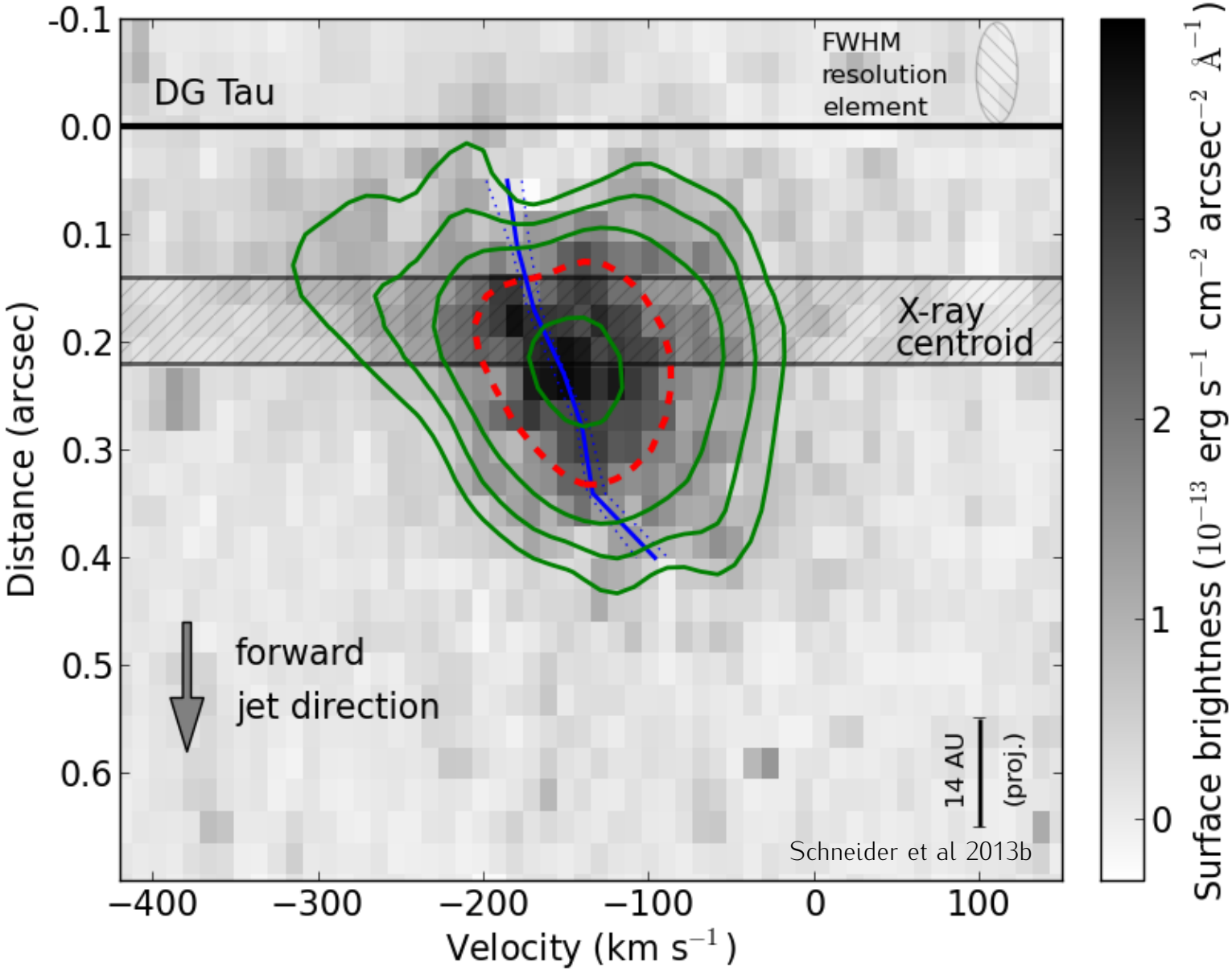

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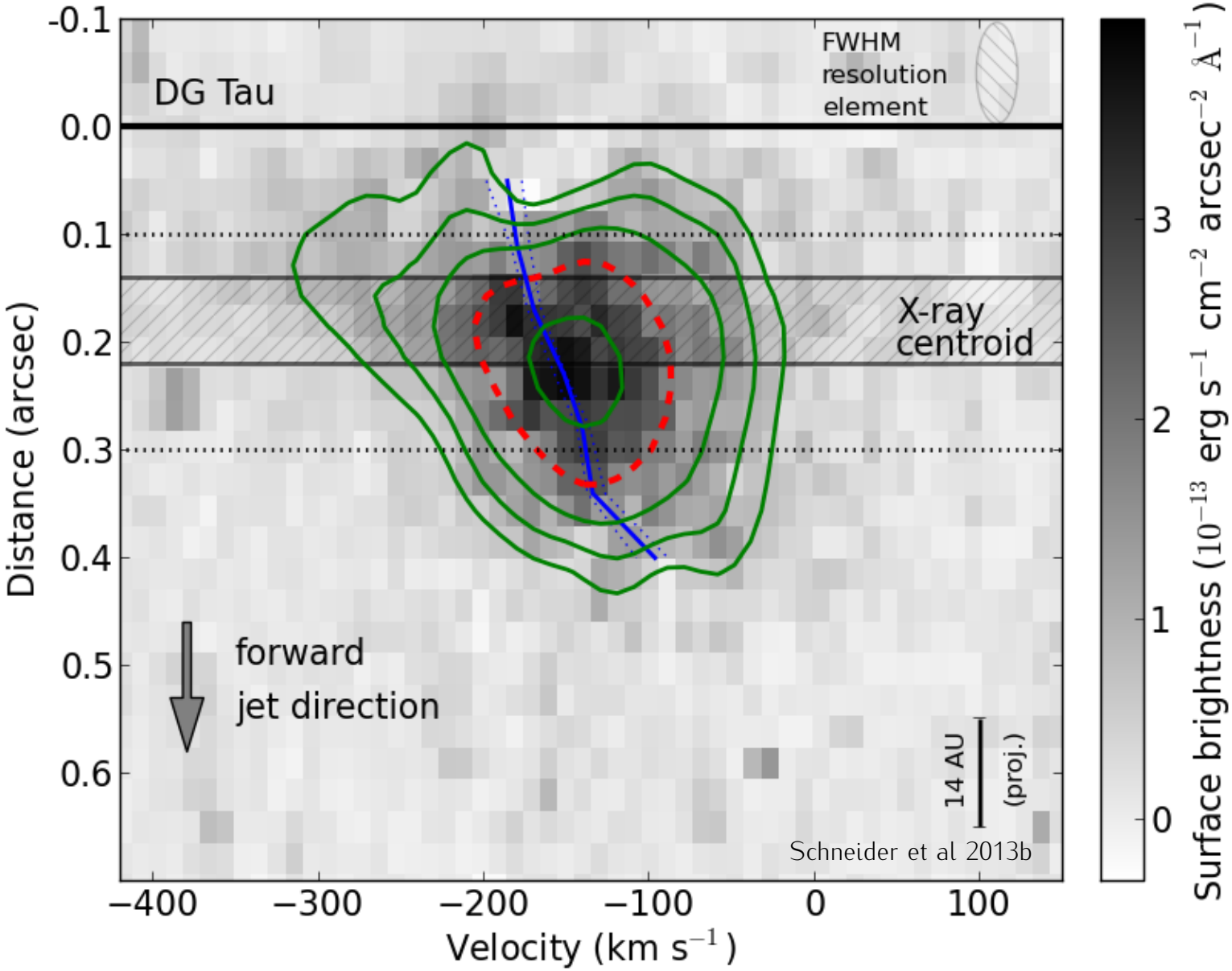

Conclusions

- Plasma cools too rapidly for a hot stellar wind
- Location is special: Collimation region
- Possibilities:
  - Standing shock
  - Magnetic heating
- Comparable objects exist
- Feedback