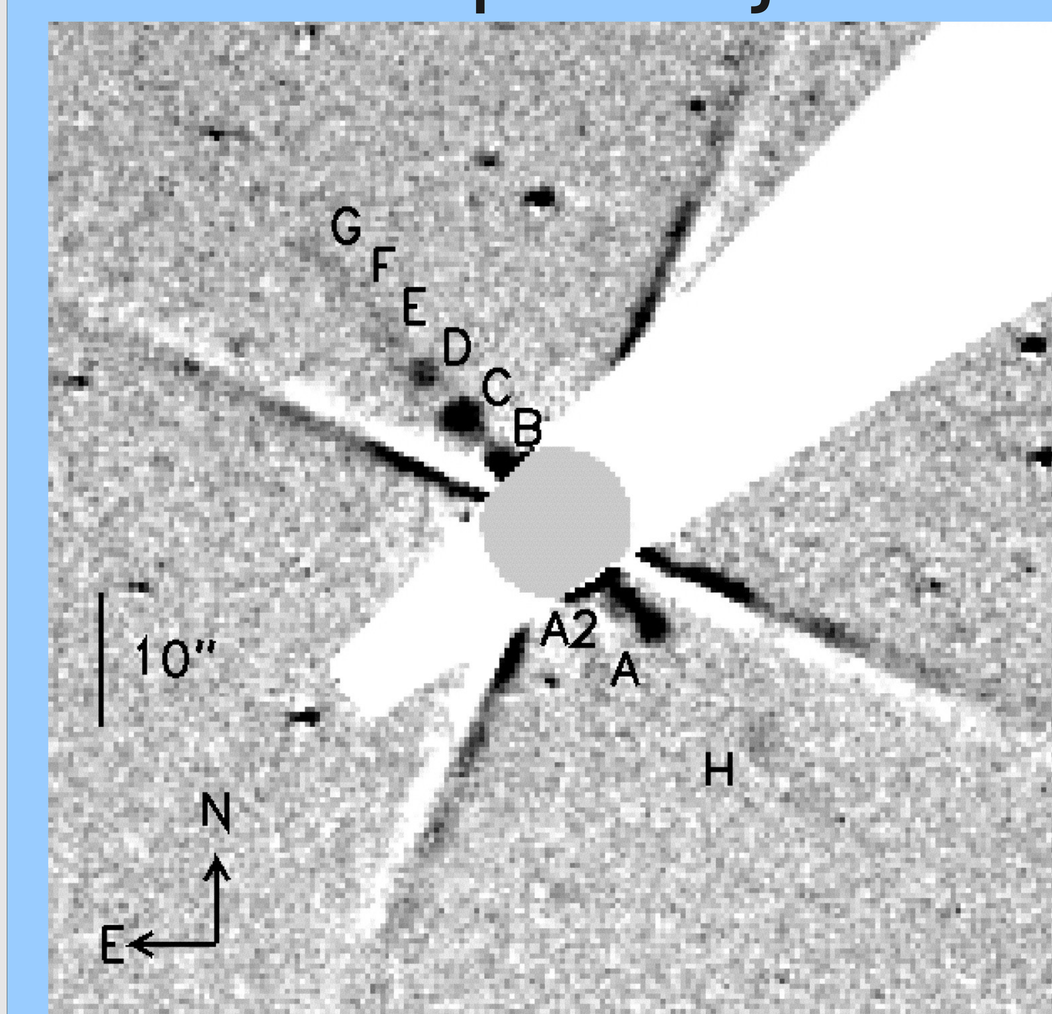
How can weakly magnetized stars drive fast jets?

H. M. Günther (hguenther@cfa.harvard.edu), Harvard-Smithsonian Center for Astrophysics, Cambridge, USA
P. C. Schneider, Hamburger Sternwarte, Hamburg, Germany
Z.-Y. Li, University of Virginia, Charlottesville, USA

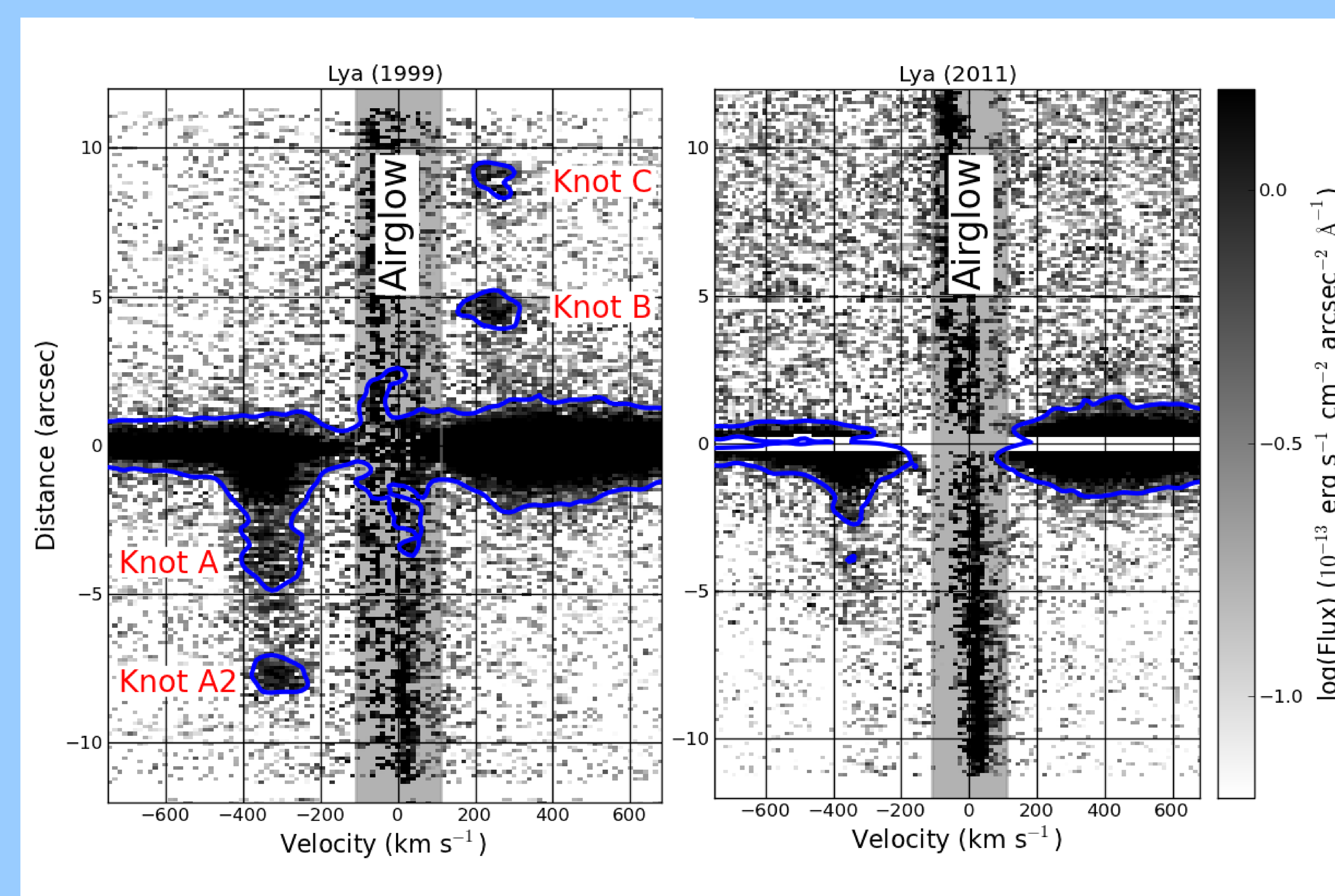
Most models of jet launching rely on a magnetic field in either the central source, the accretion disk or both. However, the well-studied nearby young Herbig Ae star HD 163296 has a measured weak stellar magnetic field (main-sequence A stars do not have magnetic fields at all), and even indications of X-ray emission in its jet. Comparing archival to new third epoch HST/STIS observations we have a long time baseline to study the evolution of velocity, temperature and density in the Herbig-Haro objects of the jet.

Start: Optical jet



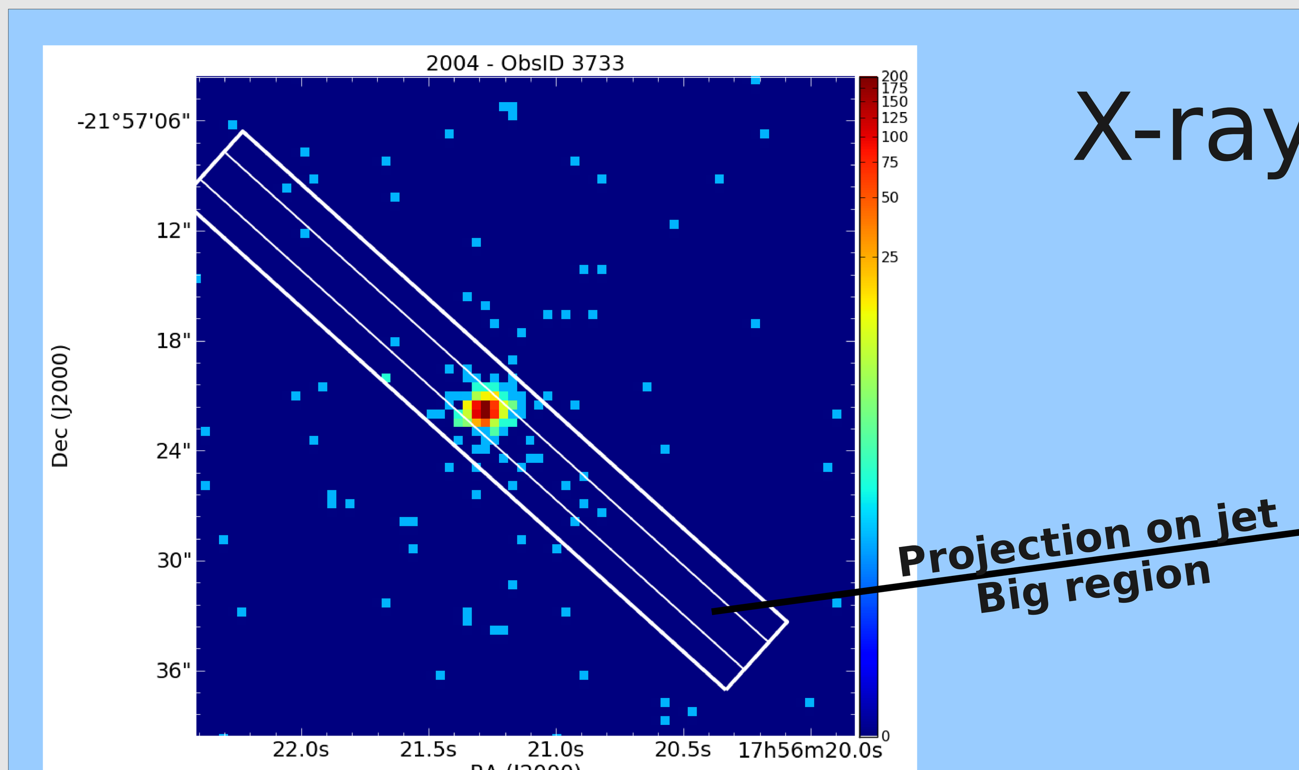
This narrow-band image (6724 Ang) clearly shows a jet with knots reaching > 3000 AU from the central star. In this poster we analyze the time evolution of the fastest and hottest components of that jet.
Picture from: Wassell et al (2006)

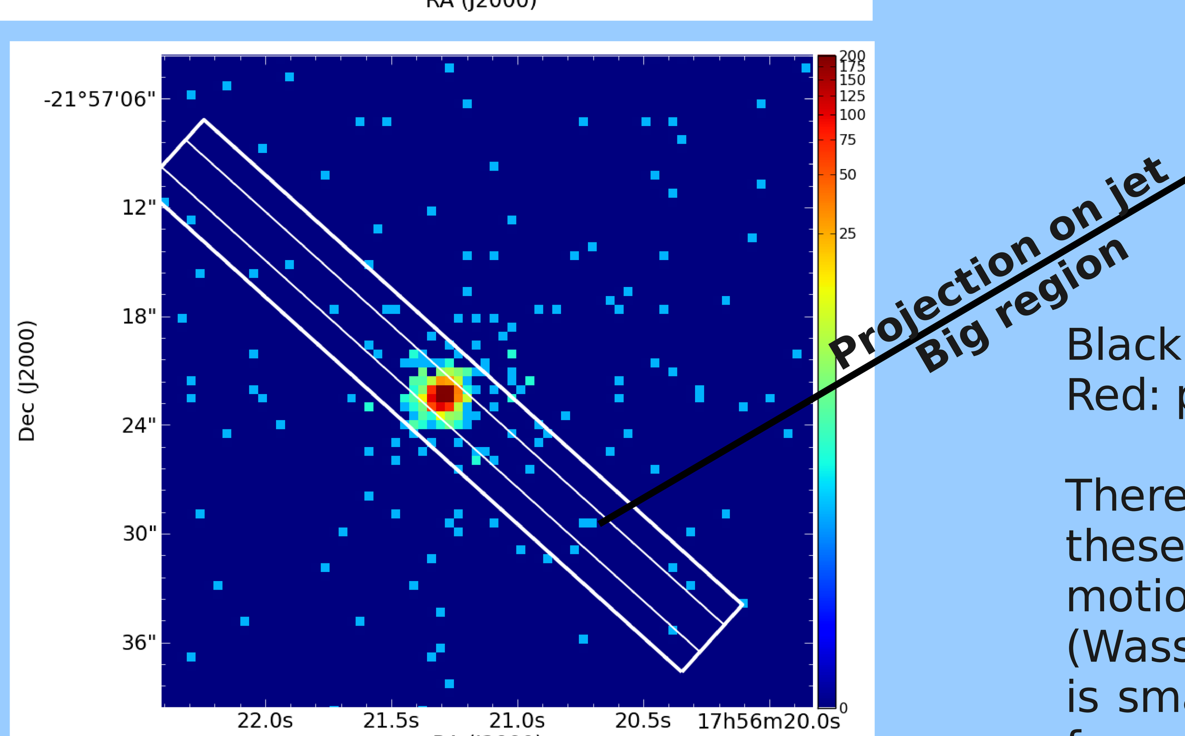
FUV observations

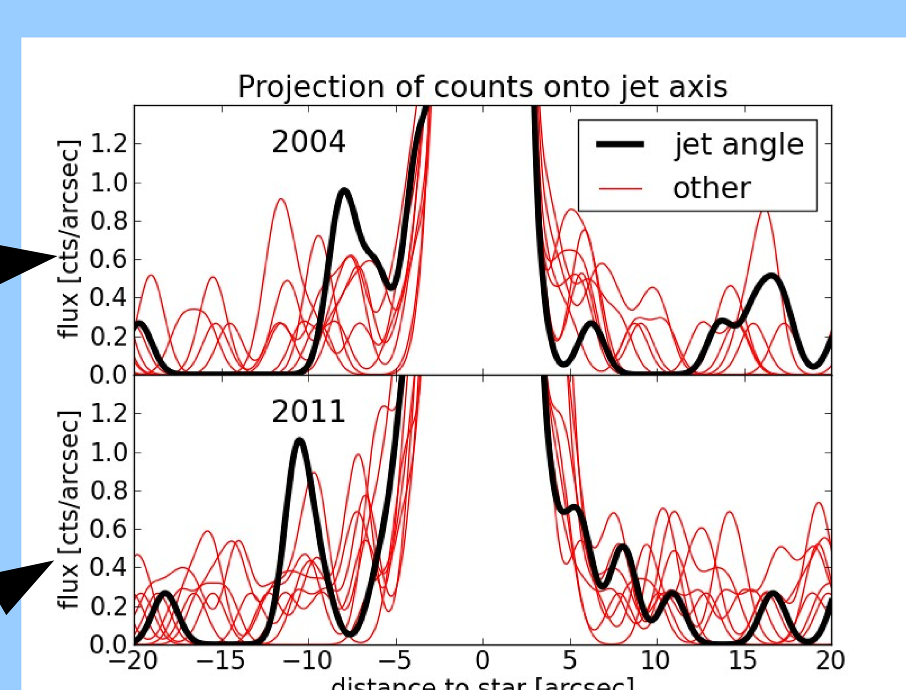


HST/STIS long slit position-velocity-diagrams of the Lyα line.
In 1999, 4 knots are clearly visible. The expected proper motion is 0.49"/yr * 12 yr = 5.9". No signal is visible at the new expected positions, no new knots appeared except for a very small signal around -5" (right plot).

X-ray observations







Chandra images (0.2-2.0 keV) from 2004 and 2011. The white rectangles enclose the optical jet (width of small box is 2", large box is 5"). The first exposure is 20 ks, the second 46 ks, so features of equal luminosity should have 2.3 times more counts.

Black: projection onto the jet axis (smoothed)
Red: projection on different position angles (smoothed)

There are peaks at -7.8" (2004) and -10.6" (2011). If these features are real knots in the jet, then the proper motion is 0.4"/yr, close to the 0.49"/yr seen the optical (Wassell et al. 2006). Thus, while the number of counts is small, this feature is compatible with what we expect from a real knot, which was 3 times brighter in 2011.

However, the knots are not significant using the smaller projection region only (plot not shown), which is about the size of the PSF.
This difference could be due to the low count number, or the knots could be spatially extended beyond the PSF.

Summary

- HD 163296 did drive a jet in the past.
- No bright knots are detected in Lyα now.
- Signal in the X-rays is dodgy.
- No new knots are detected in Hα.

Hypothesis

HD 163296 did drive a jet in the past for at least 80 yr (Wassel et al. 2006). So our hypothesis is: The central driving switched off some time between 2004 and 2012.
Hubrig et al. (2007) did not find a magnetic field. Maybe HD 163296 stopped driving its jet, because the magnetic field switched off and weakly magnetized stars in fact cannot drive fast jets?

This work is funded by Chandra award GO2-13015X and TM0-11002X.
References: Wassell, Grady et al., ApJ 650, 985 (2006); Hubrig, Pogodin et al., A&A 463, 1039 (2007)