The Time Scales of Accretion-Disk Flickering

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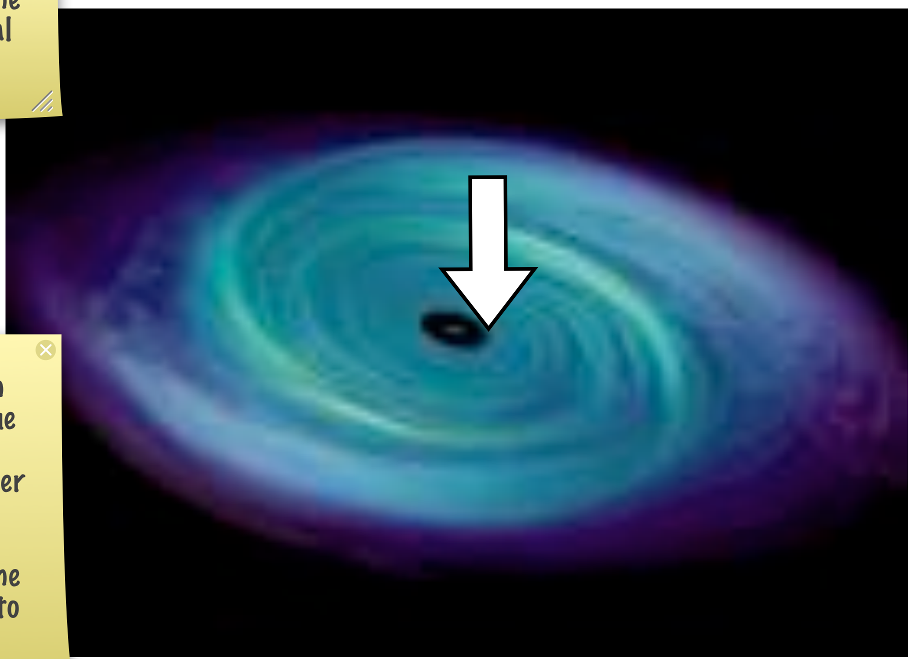
Proposal: The strength of the red-noise-type brightness fluctuations from an accretion disk reveals characteristic time scales in the innermost disk.

at a given frequency

such as the dynamical time



Note: I'm focusing on the strength of the red noise because 1) for some systems, that's all we have access too (explain); and 2) whereas other pds features such as QPOs and breaks tend to come and go or change with the accretion rate, the red-noise part of the pds appears to be fairly stable.

See Done+ 2007

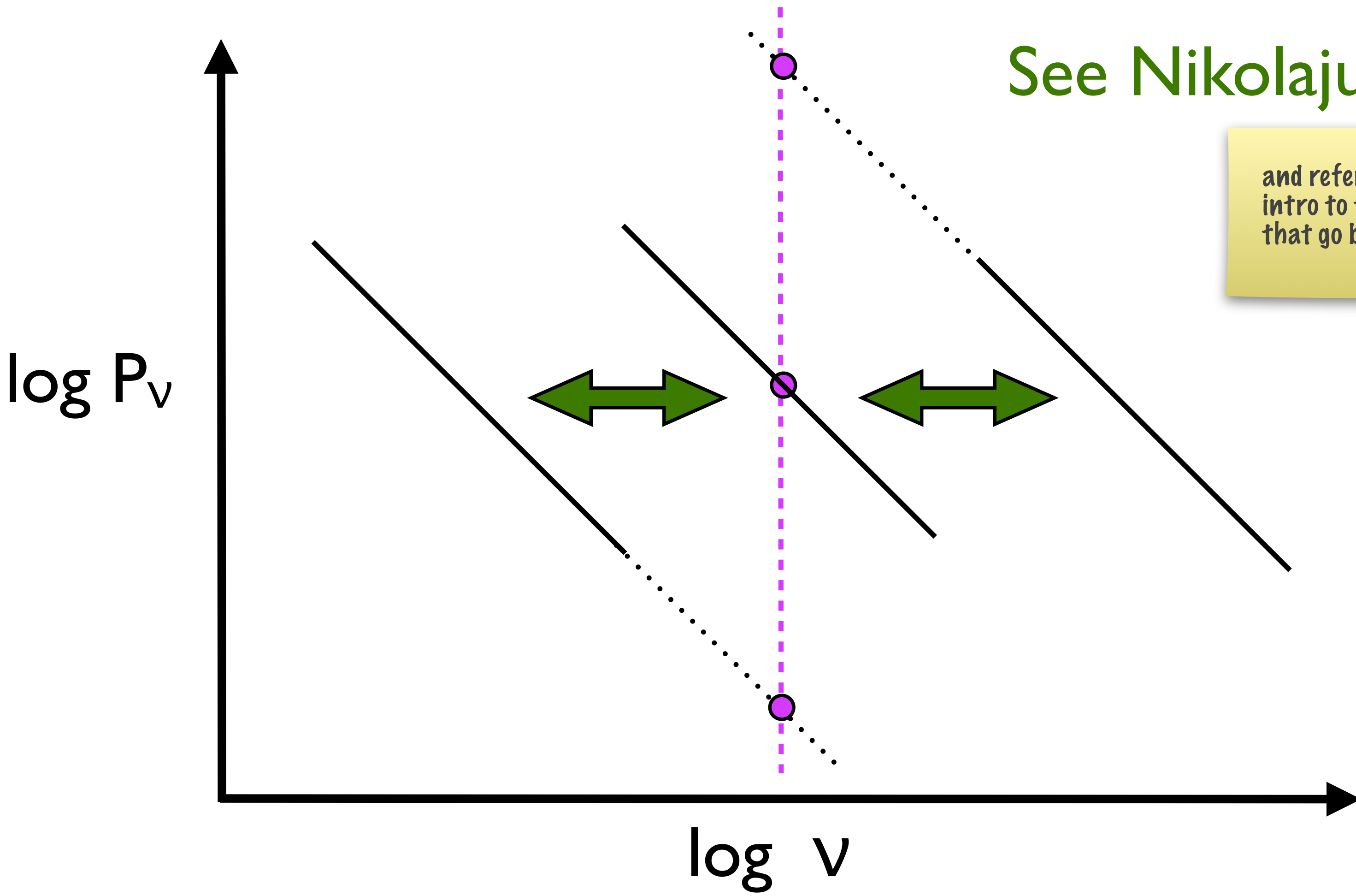
Featureless portion of power spectrum vs breaks, QPOs.

Why should this be true?

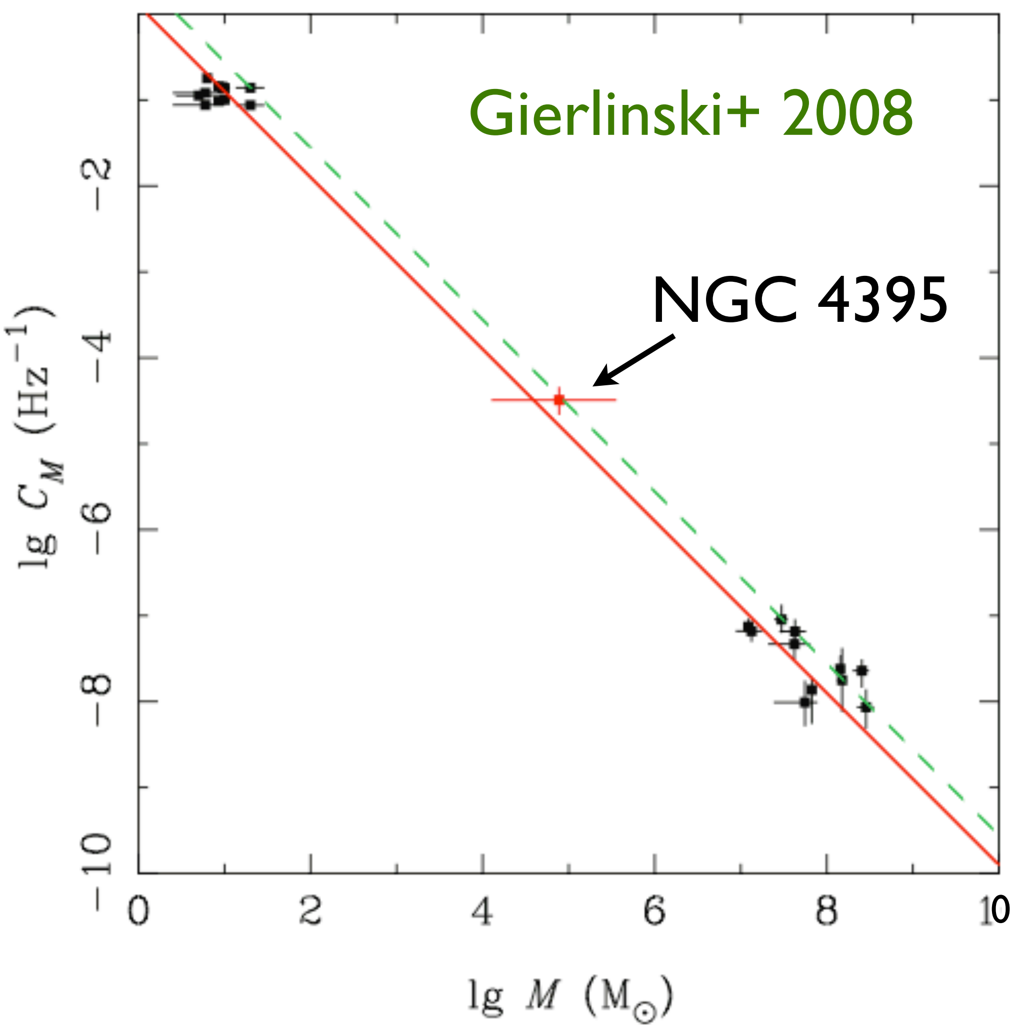
➡ True if a power spectrum simply shifts in frequency (e.g., to keep rms < 100%).

See Nikolajuk+ 2004

and references in the intro to that paper that go back to 1986



Weighing Black Holes



$P_\nu = C_m(\nu/\nu_0)^{-2}$

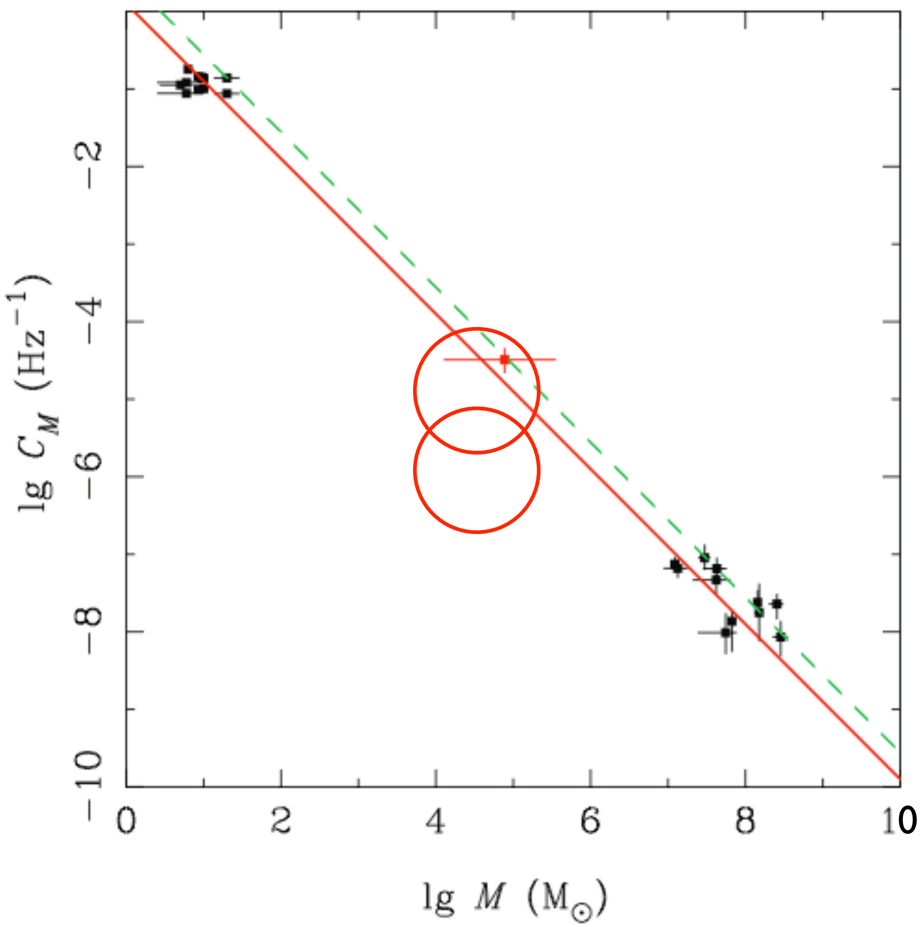
For α=-2, fractional change in normalization equals fractional shift in frequency.

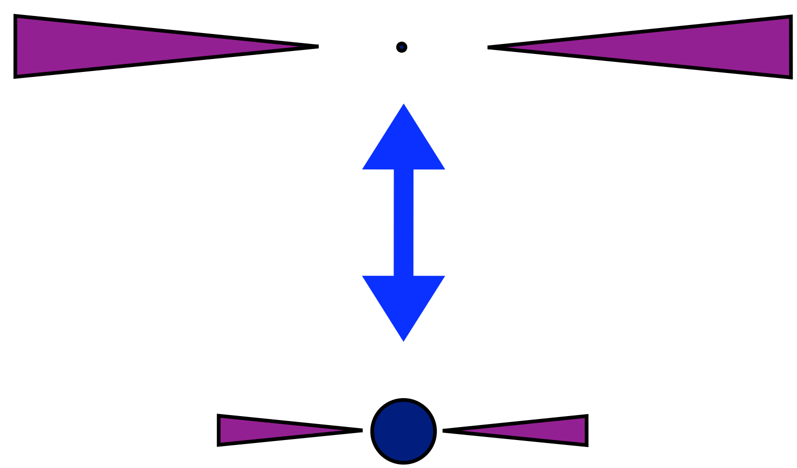
Since $t_{dyn} \propto M_{BH}$:

$C_m = C/M_{BH}$

For alpha
change in
fractiona
t_dyn pro
v_dyn pro
we expect

White Dwarfs Fall on the Same Line

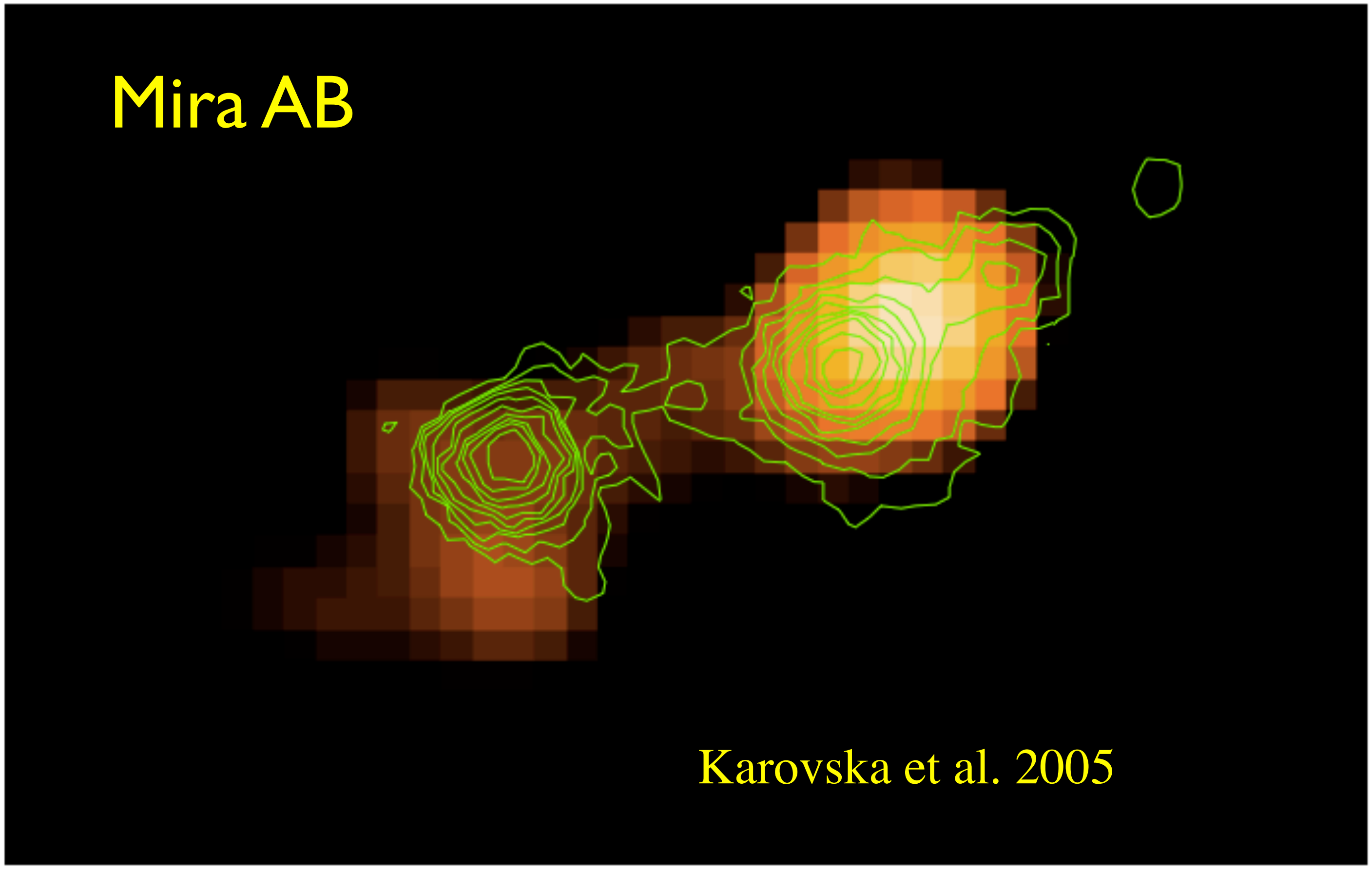




Example: White Dwarf vs Main-Sequence Star in Mira AB

binary sep < 1 arcsec; streams are ~2 arcmin

Chandra image
and Mira A, sep
overlayed cont
3729A image.
extended point
in the HST con
the NW dir are
due to a red le

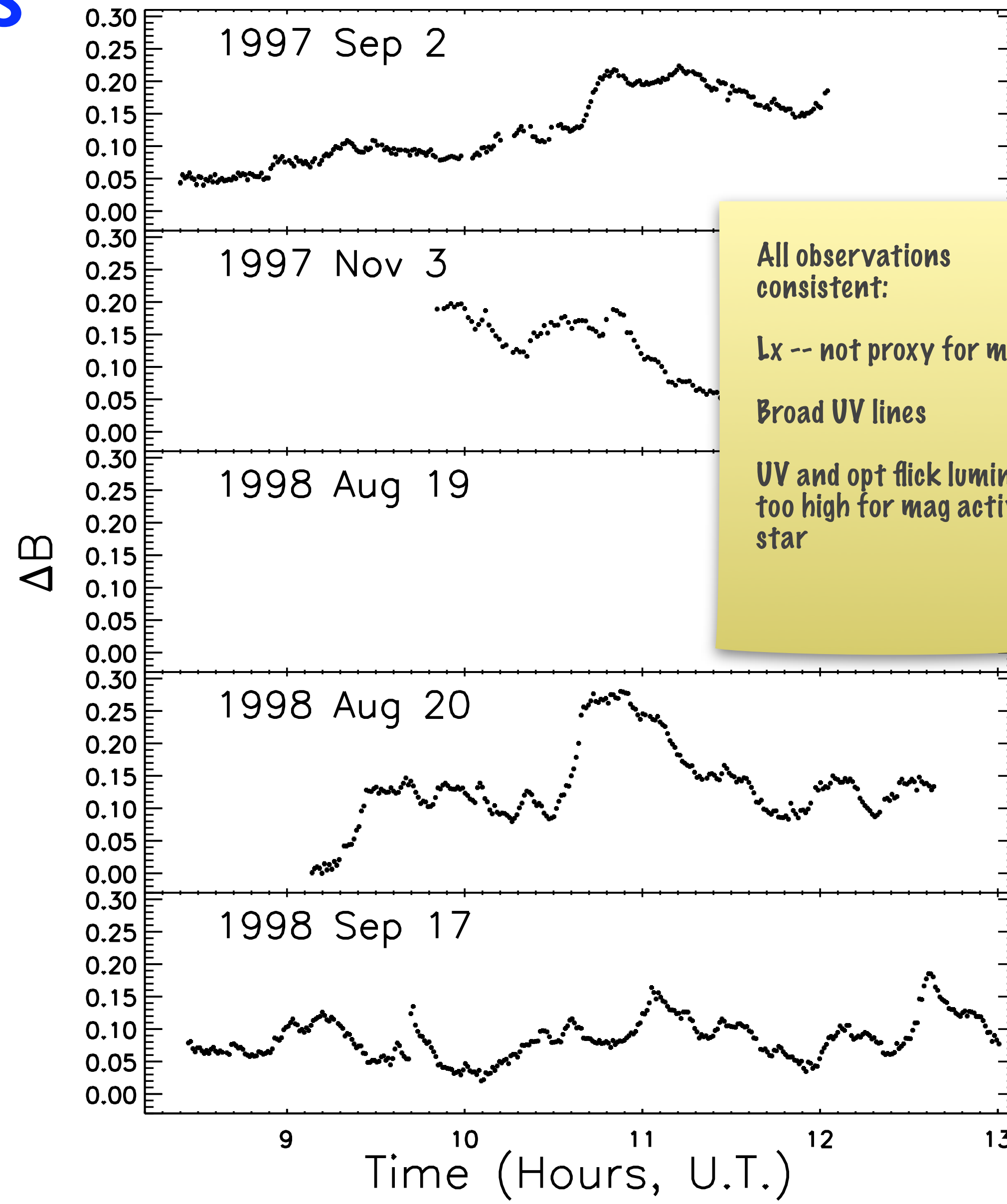


Flickering shows that Mira B is a white dwarf.

RMS between 1 and 10 mHz ≅ 3%, as in accreting WDs (Barros 2008)

Implications

Sokoloski & Bildsten, in prep



All observations consistent:

Lx -- not proxy for mdot!

Broad UV lines

UV and opt flick luminosities too high for mag active ms star

Summary

Recurrence time for FU Ori outbursts? ~10^5 yr

- The strength of the featureless, high-frequency portion of the power spectrum of brightness variations from an accretion disk can reveal intrinsic properties of the accretor.
- The companion to Mira is a white dwarf, which has implications for wind-fed mass transfer.

Mira WD Implications

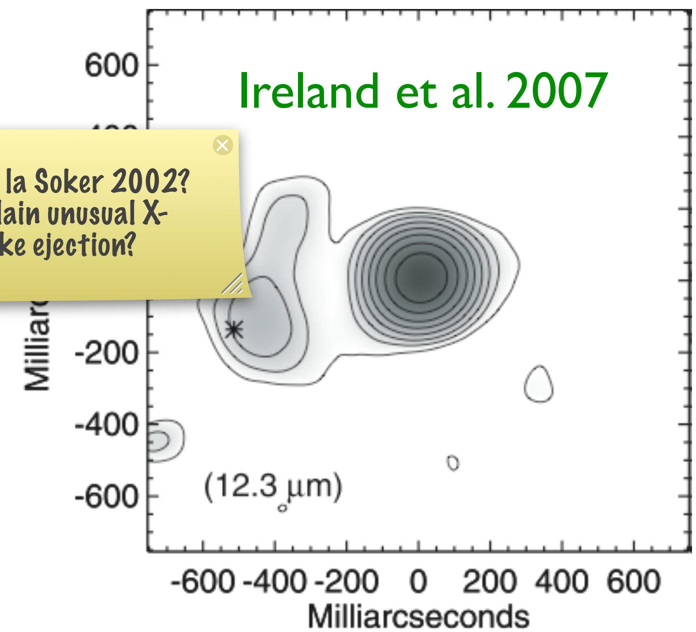
Go over Webbink paper?

probably

- Companion previously transferred material to Mir

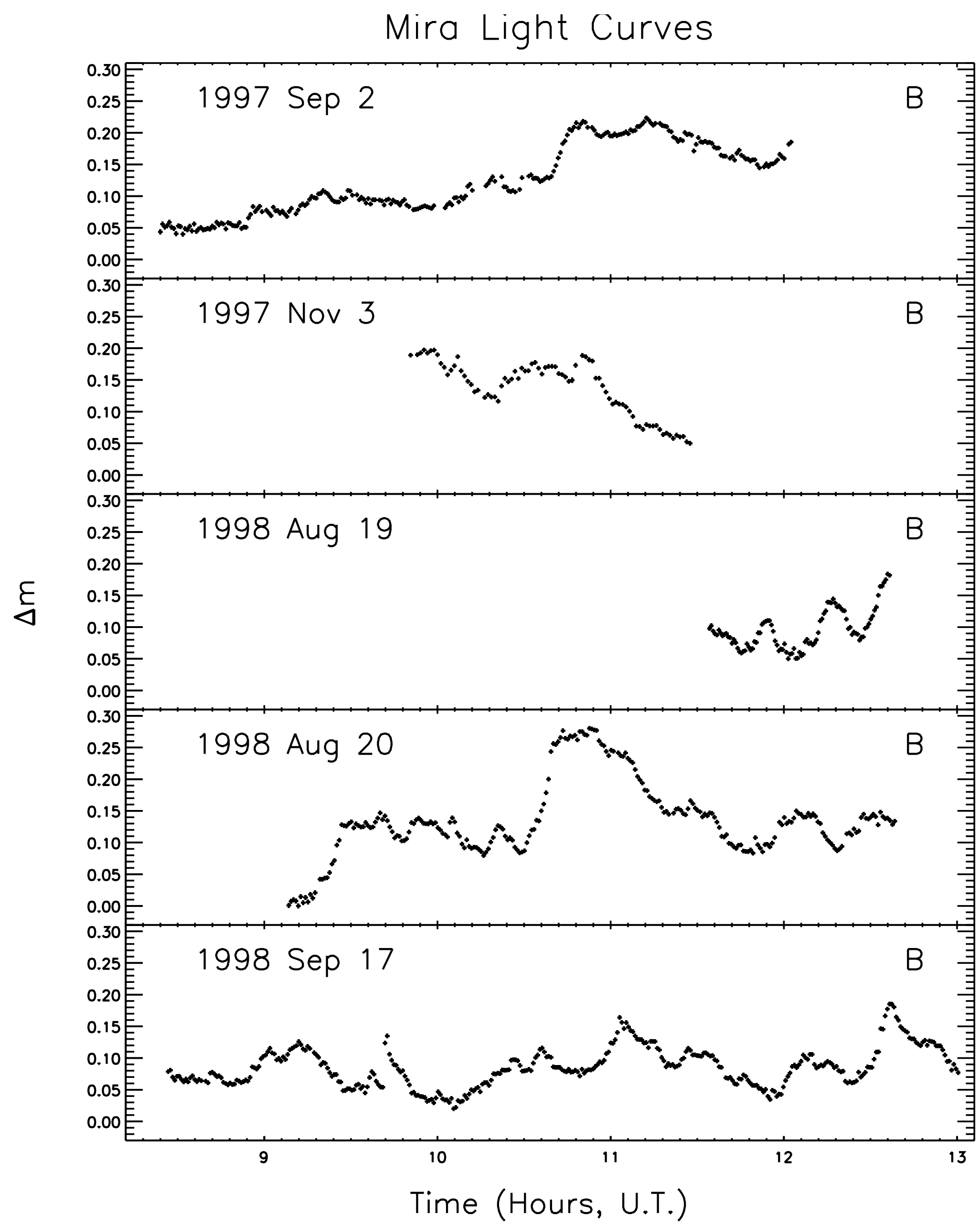
and possibly ang mom, a la Soker 2002? Could rapid rotation explain unusual X-ray outburst and CME-like ejection?

- Mdot onto the white dwarf is few $\times 10^{-10}$ M_{sun}/yr.



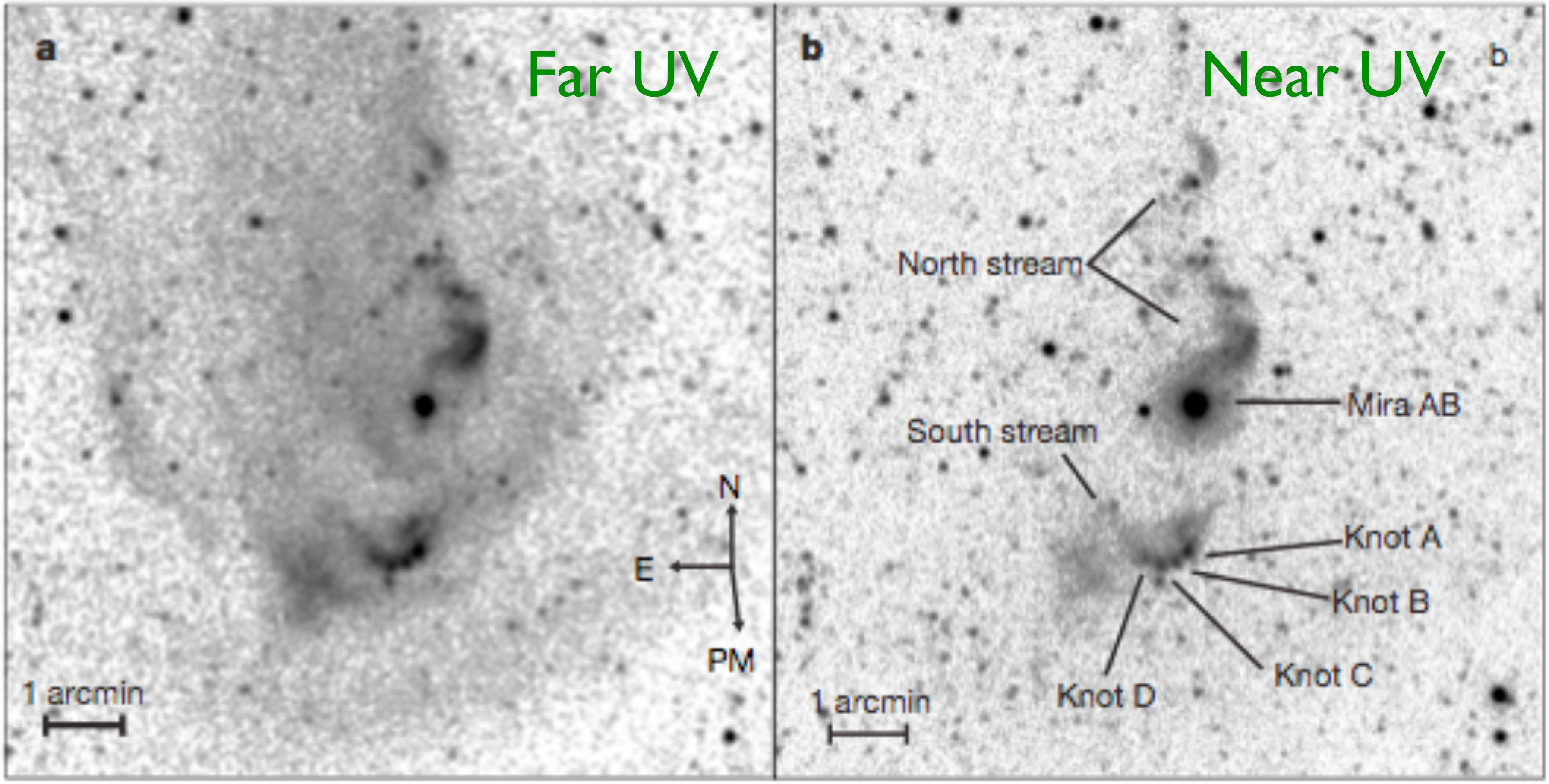
- Mass flow into the streams of $\sim 10^{-10}$ Msun/yr perhaps provided by the WD.

MENTION WOOD AND KAROVSKA PAPERS!



Mira Light Curves
1997 Sep 2
B
1997 Nov 3
B
1998 Aug 19
B
1998 Aug 20
B
1998 Sep 17
B
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Δm
9
10
11
12
13
Time (Hours, U.T.)

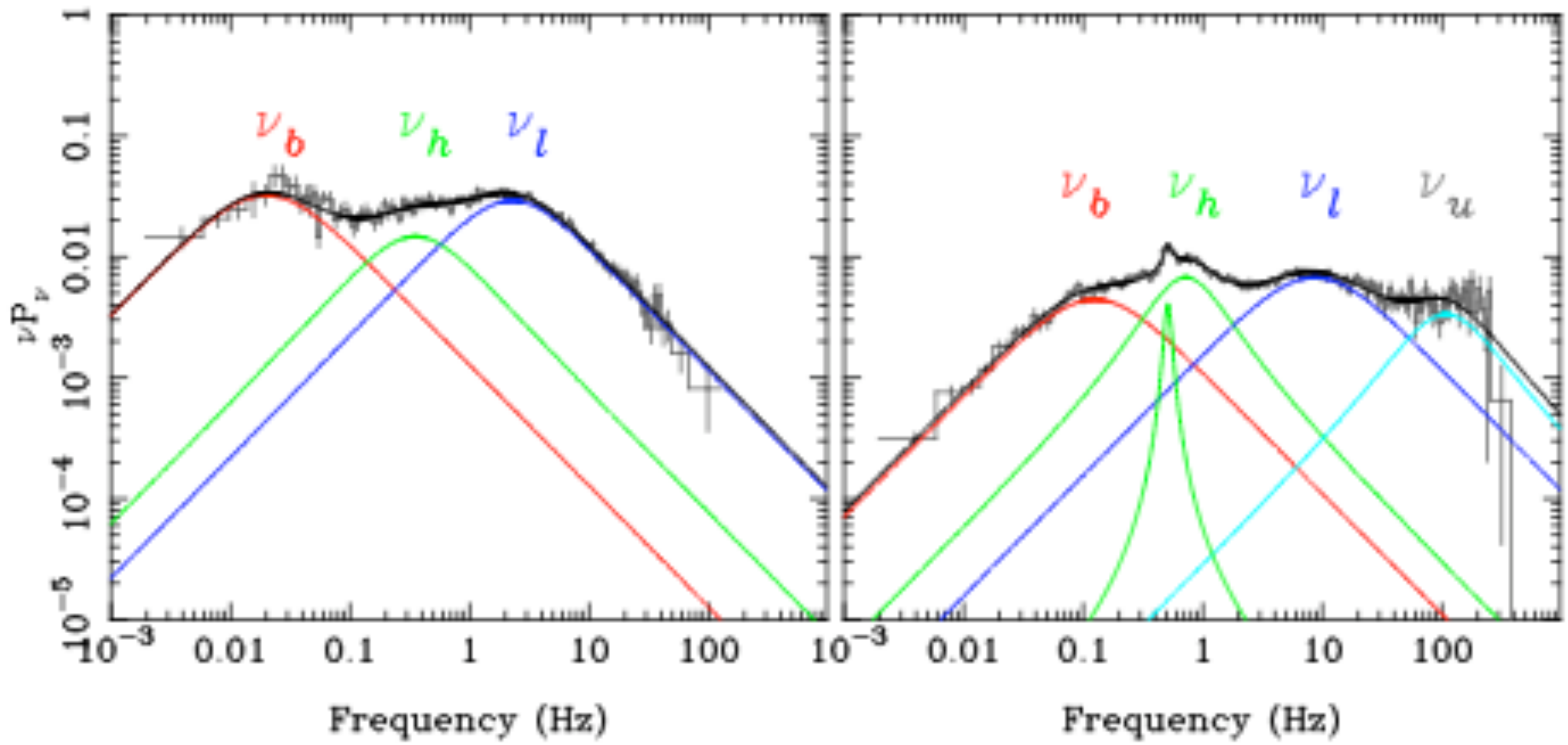
Mira AB



Martin et al. 2007, Nature

What can a featureless power spectrum tell you about an accreting object?

The Full Power Spectrum



Done et al. 2007, ARAA

All Observations Consistent with WD

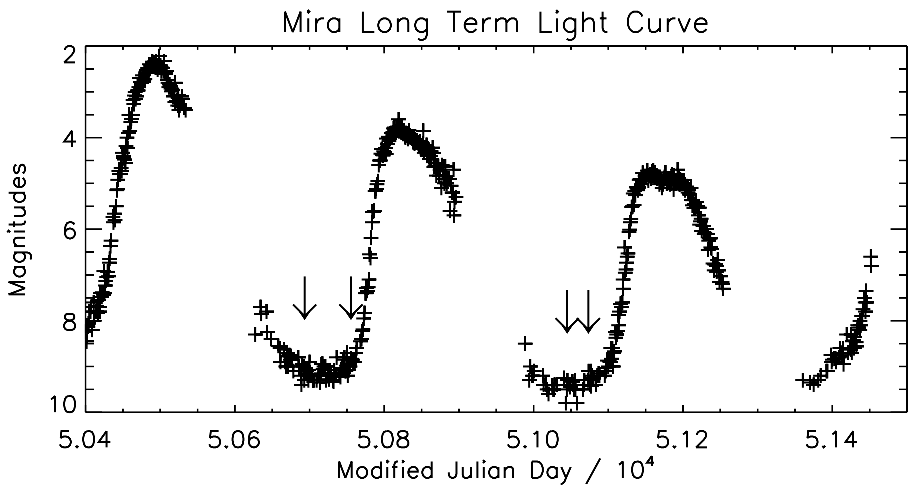
Mention Ireland HST spectrum.

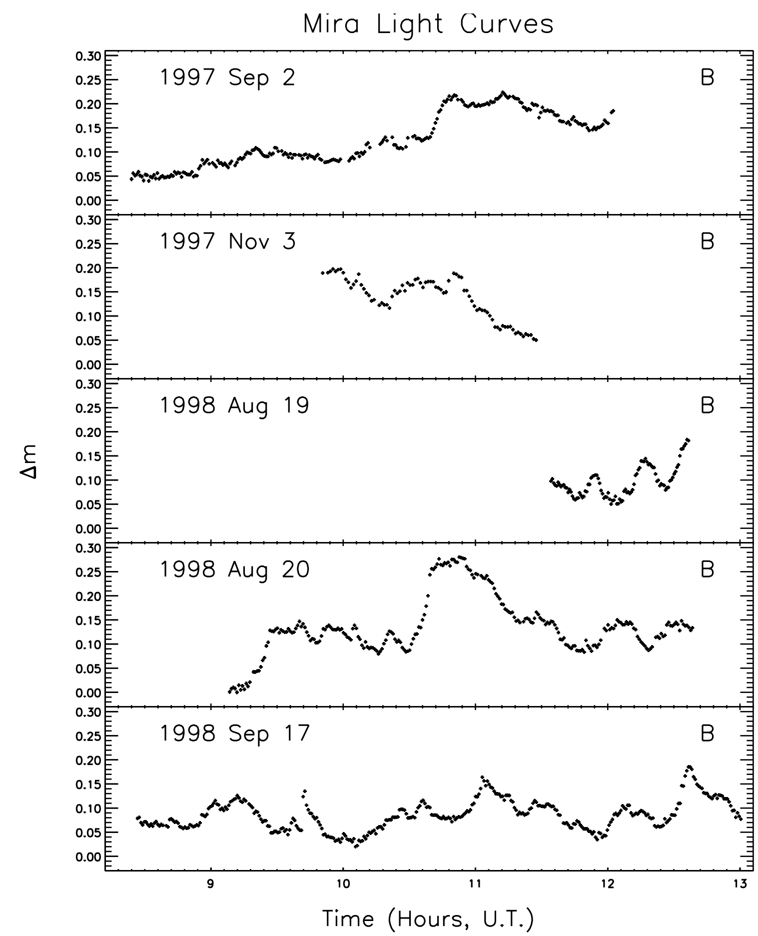
Low Lx

Broad UV (emission) lines

UV and optical flickering luminosities (both too high magnetically active MS star).

Mira AB


Mira Long Term Light Curve
Magnitudes
2
4
6
8
10
5.04
5.06
5.08
5.10
5.12
5.14
Modified Julian Day / 10⁴


Mira Light Curves
Δm
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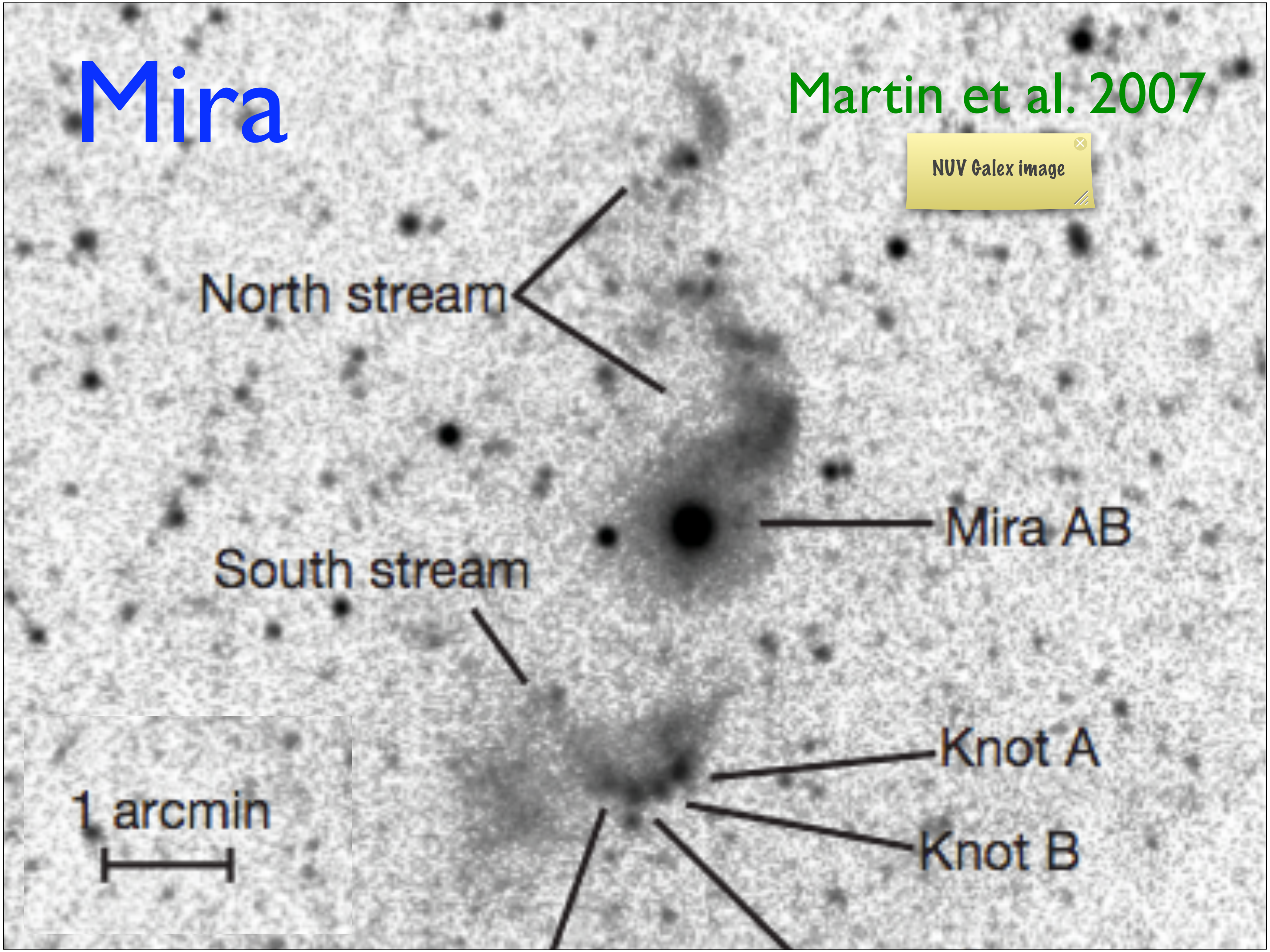
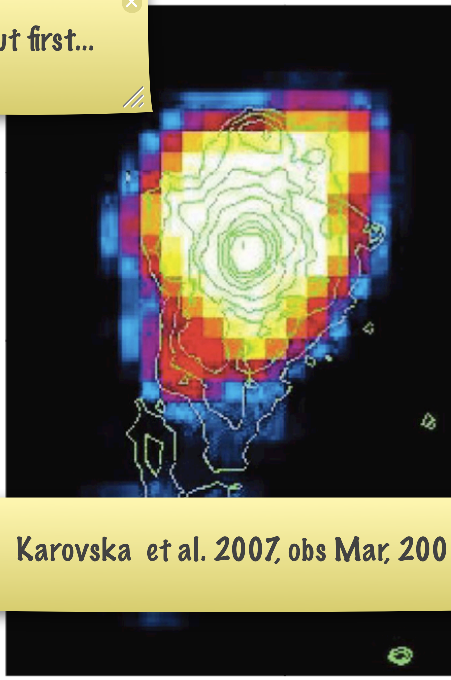
Time (Hours, U.T.)


Mira
Martin et al. 2007
NUV Galex image
North stream
Mira AB
South stream
Knot A
Knot B
1 arcmin

Symbiotic Stars

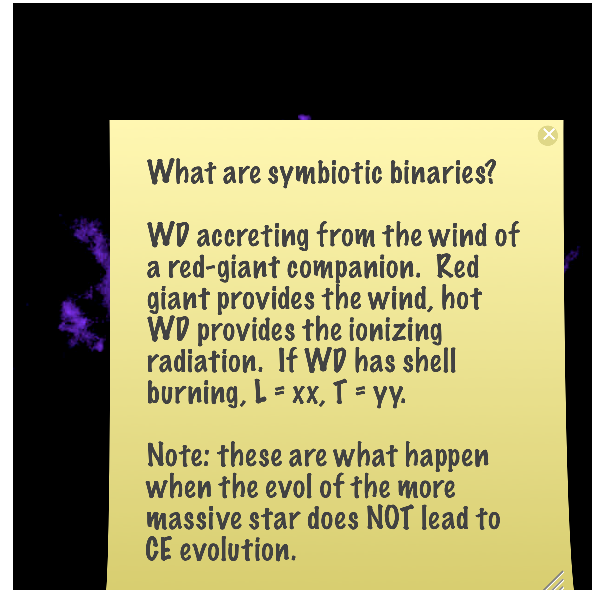
But first...



Karovska et al. 2007, obs Mar, 2001

corradi et al. 2001, I think

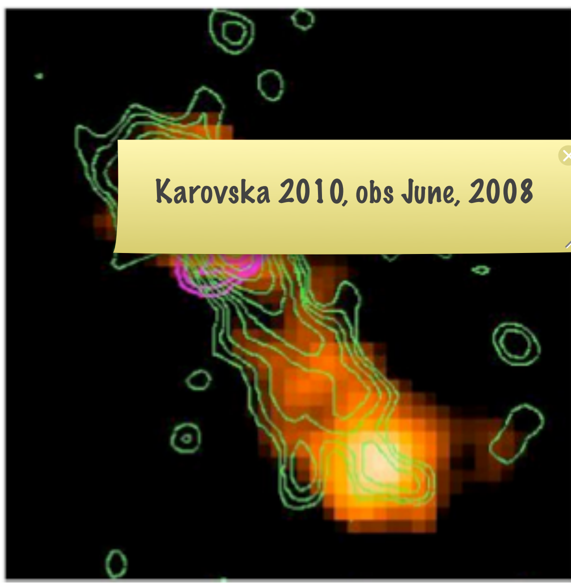
See Miguel santander-garcia 2008



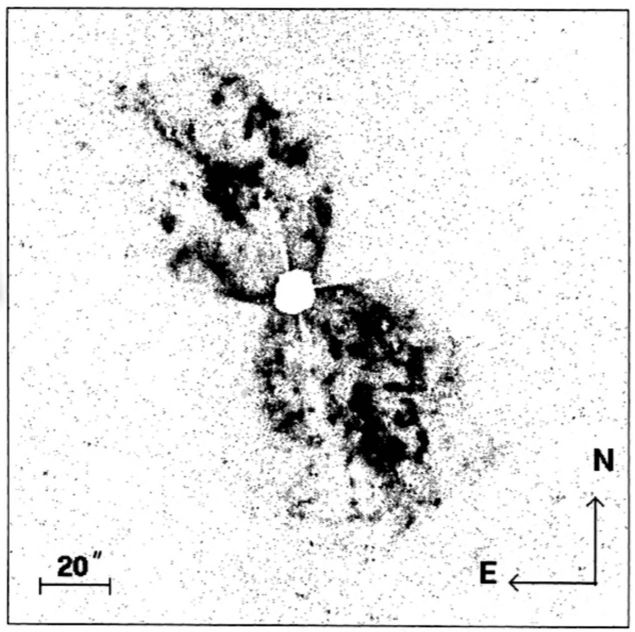
What are symbiotic binaries?

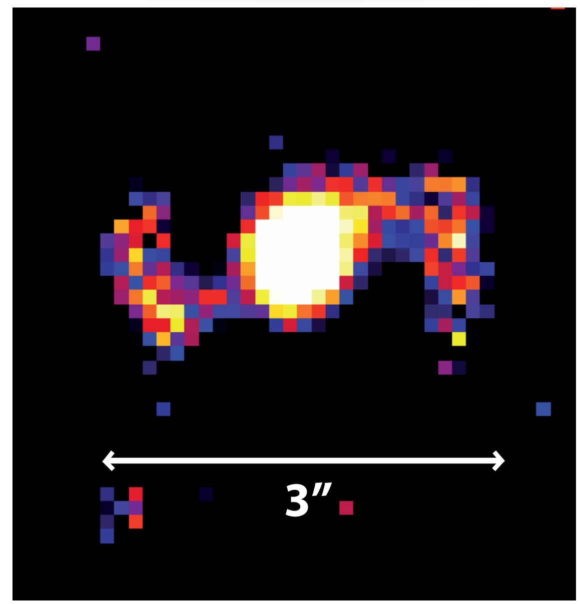
WD accreting from the wind of a red-giant companion. Red giant provides the wind, hot WD provides the ionizing radiation. If WD has shell burning, L = xx, T = yy.

Note: these are what happen when the evol of the more massive star does NOT lead to CE evolution.



Karovska 2010, obs June, 2008





I put this mechanism first because it is very clear.

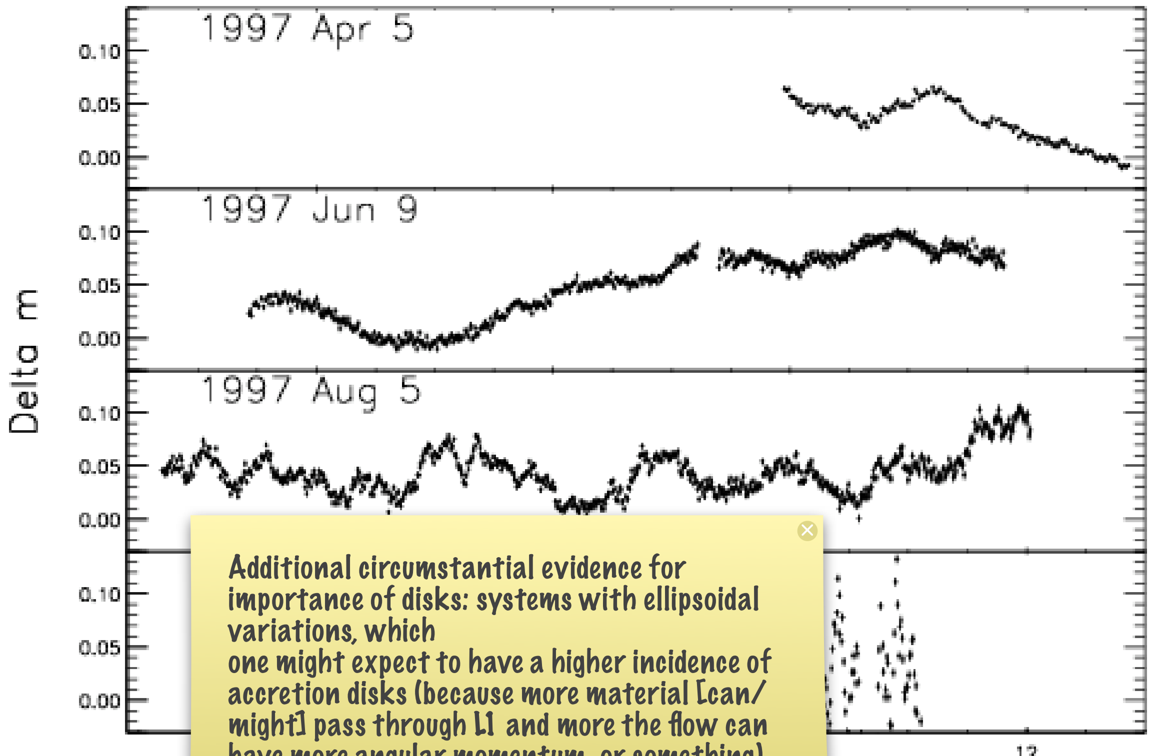
By "jets", I mean polar or bi-polar outflows collimated to the degree that xx.

The production of jets in symbiotics is very robust --- we see jets from WDs with and without shell burning, with and without strong B fields, in systems with orbits ranging from hundred of days to decades or more, and with RG or AGB mass donor stars.

...c... d... d jets

Although we can't see spectral signatures of disks

- Much of the bipolar str... iotics is due to jets (MHD driven a...



Additional circumstantial evidence for importance of disks: systems with ellipsoidal variations, which one might expect to have a higher incidence of accretion disks (because more material [can/might] pass through L1 and more the flow can have more angular momentum, or something), have a higher incidence of outbursts that look like disk instabilities, and jets (M'ska 2003).

Evidence for disks:

1. Outbursts and jet precession
2. Flickering changes with jet ejection
3. Image (Mira B)