HST Observations of the 2006 Outburst of RS Ophiuchi

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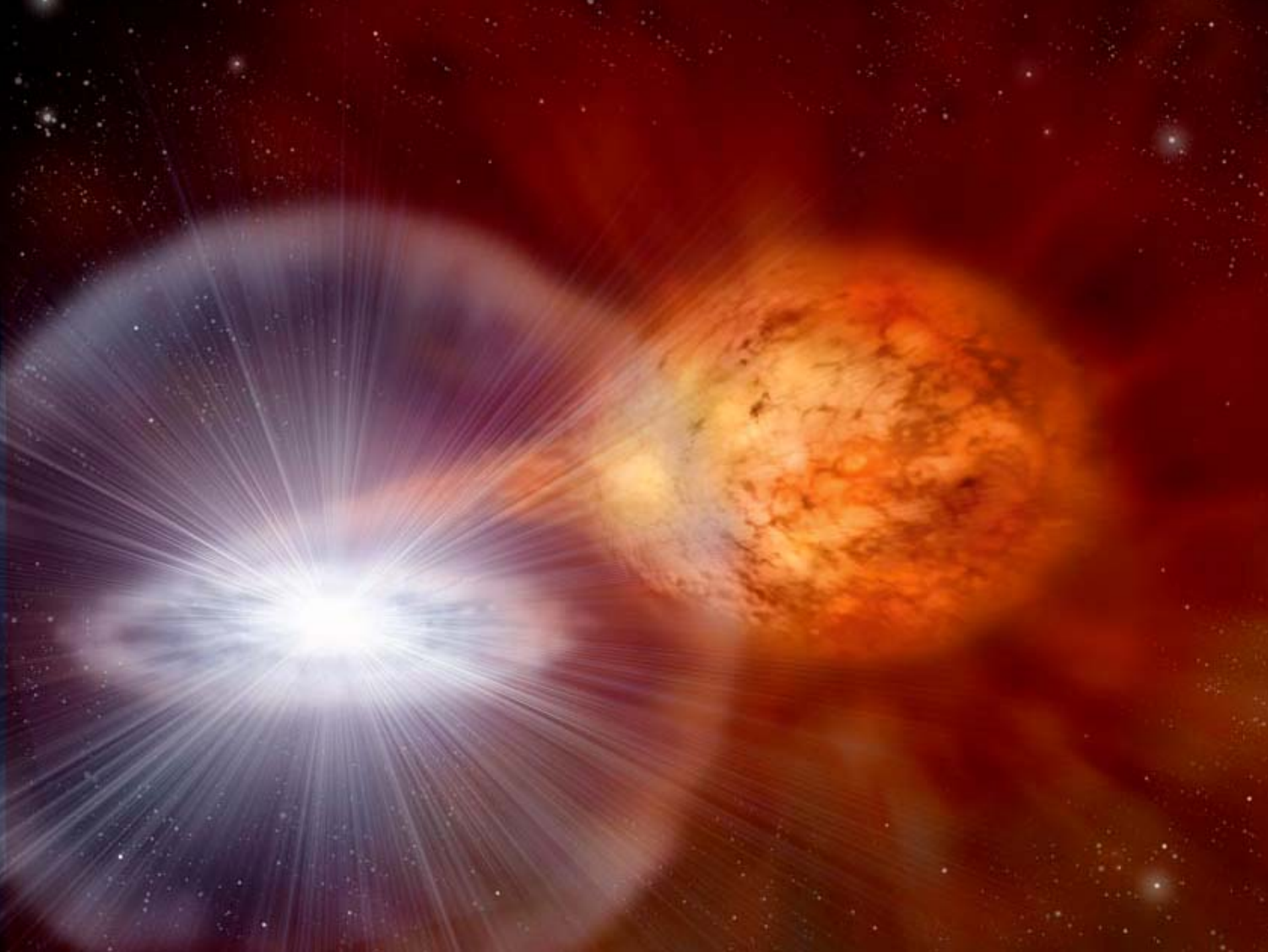
RS Oph Vital Statistics

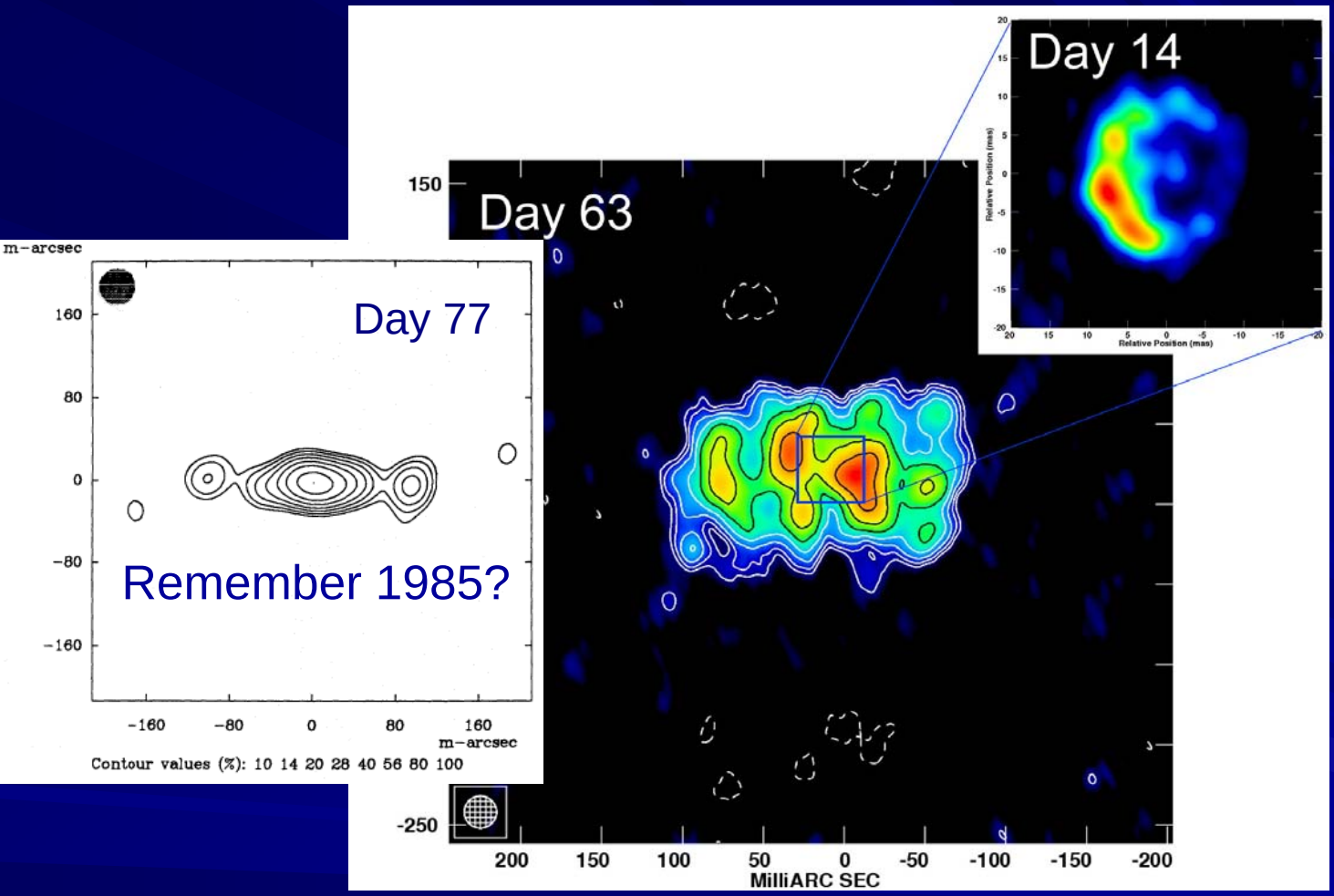
- Recurrent Nova – previous outbursts 1898, (1907), 1933, (1945), 1958, 1967, 1985
- d = 1.6 ± 0.3 kpc (via a variety of methods)
- Central system – high mass WD (1.2-1.4 $M_{\odot}$?) + Red Giant (M2III); p = 455 d; i = 30-40^{o}
- Outbursts due to Thermonuclear Runaway (TNR) on WD surface (*cf.* Classical Novae)
- Prior to 1985, spectroscopic evidence for red giant wind, systematic reduction in velocities post-outburst, and emergence of coronal lines, led to suggestion of ejecta (v_0 ~ 4000 km s^{-1}) interaction with RG wind (u = 20 km s^{-1}).
- 1985: X-ray observations from t = 55 days + radio → models of evolution *cf.* SNR (Bode & Kahn 1985; O'Brien et al. 1992)



2006 Outburst

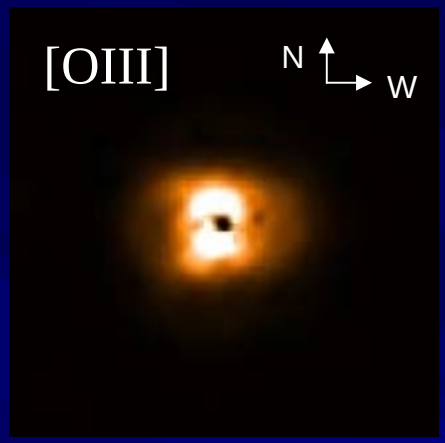
- Discovered Feb 12.83 UT (t = 0)
- Very similar optical behaviour to previous outbursts
- Within 2 days, ToO's granted on *Swift, XMM, Chandra, RXTE, MERLIN, VLA, VLBA, EVN, LT, UKIRT,* plus *GMRT, Ryle, Spitzer* a few days later, + *HST* July
- Detected in X-rays at outburst with *Swift* (BAT), then followed in great detail with XRT, plus other X-ray missions. Early *Swift* and *RXTE* data consistent with simple shock models (e.g. Bode et al. 2006 ApJ; Sokoloski et al. 2006 Nature)

The Evolving Radio Remnant

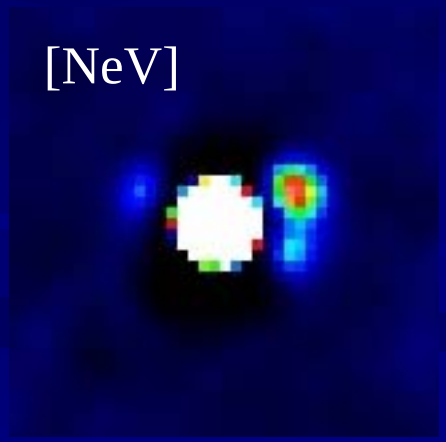


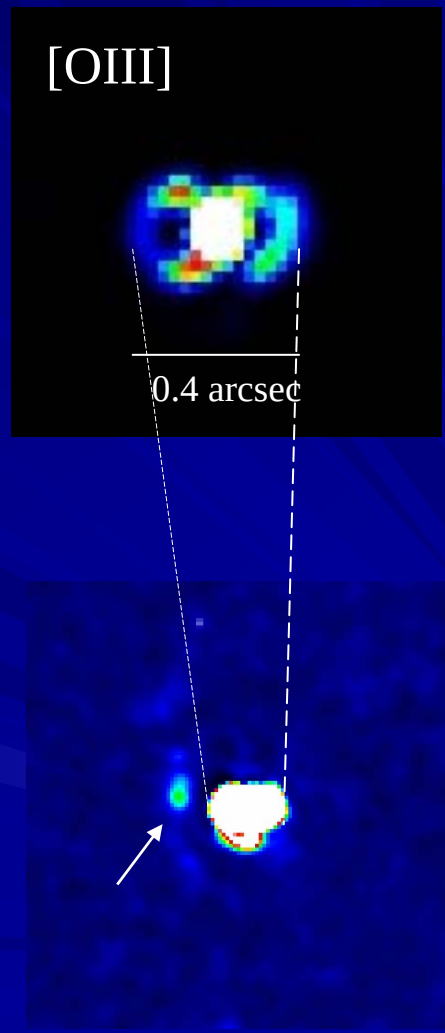
(VLBI observations – O'Brien et al. 2006, Nature)

HST Observations

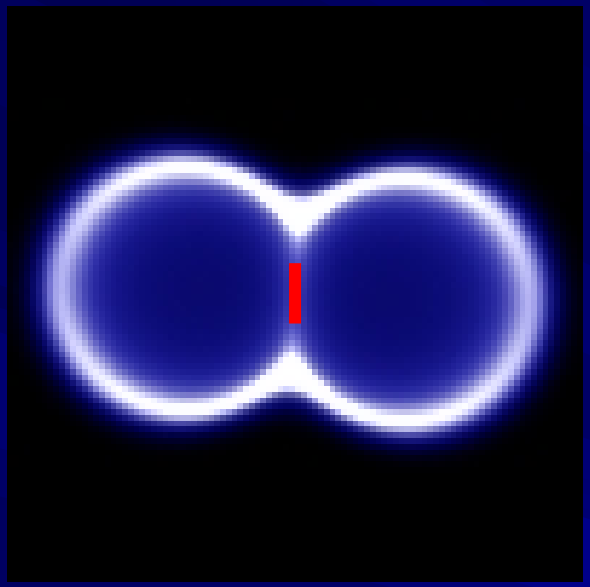


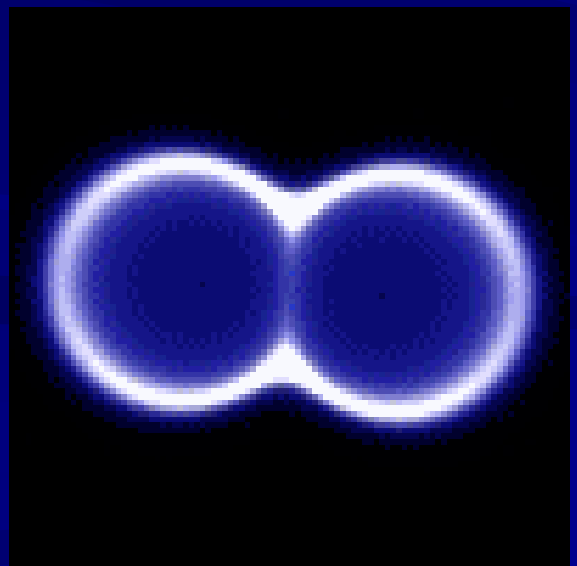
- HST ACS/HRC DDT, *t* = 155d
- 2 orbits, [OIII]5007, Hα, [NeV]3426 (+ HD16625)
- Extended structure detected in [OIII] and [NeV] (+possibly Hα)
- Elongated structure ~380 mas, E-W, comparable with constant velocity of expansion of outer radio lobes
- *v* ~ 3400 km/s (in plane of sky)
- [NeV] may be in “caps”
- Deeper image shows more extended structure to E





Model of Remnant Structure





- O'Brien et al. suggested VLBI evolution modelled by bipolar structure
- Here, "peanut" with axial ratio 3:1 consistent with v = constant (major axis), deceleration (minor) *cf*. radio
- $i = 35^{o} \rightarrow$ binary orbital plane in "waist"; $v_{ej} = 5900 \pm 1200$ km/s
- Consistent (first order) model of geometry

(Bode et al. 2007, ApJ, submitted)

Conclusions

- RS Oph potentially provides important information wrt progress of TNRs; SNR evolution and particle acceleration; SN (Ia?) progenitors; environments of Red Giants; “jet” collimation
- HST observations strongly support a bipolar remnant model
- Combination with contemporaneous high resolution spectroscopy will help confirm true geometry
- Collimation by anisotropic density distribution in RG wind (i.e. higher density along orbital plane – consistent with dust emission and X-ray evolution)?
- What is the origin of more extended structure?
- Further HST observations (3 orbits) imminent

Advertising Feature

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