Radio Continuum Emission from Classical Novae: eNova Project Early Results (and Surprises!)

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The eNova Team:

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Early Science with the EVLA: AAS, Jan. 12, 2011

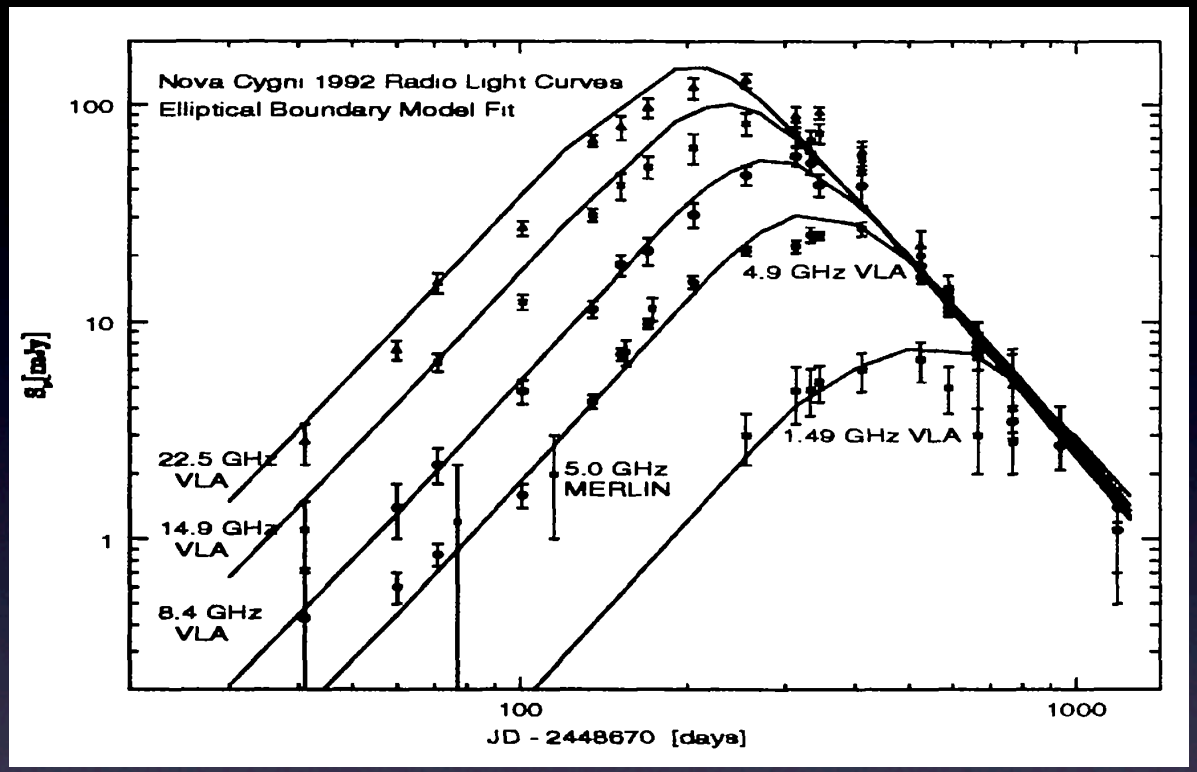
Radio emission from novae: Observational motivation

- Novae are nearby laboratories for accretion/ejection physics
- Long-lasting emission in radio; evolution is slower than at other frequencies
- Thermal bremsstrahlung simple to model — can derive physical parameters
- Ejected material optically thick at much lower densities
- Can be used to get mass estimates, addressing question of accreted vs. ejected mass

The eNova Project: A new era of observations

- Currently: EVLA monitoring of all new, nearby (< 5 kpc) novae – for each epoch (2.5 hours), get:
  - improved sensitivity: ~30 μJy at 5 GHz for 500 MHz BW
  - broad frequency coverage: 1 – 40 GHz (L, C, X, K/Ka/Q)
  - fast response: ~week
  - so far, two targets: V407 Cyg and V1723 Aql
- Upcoming: snapshot images of 23 recent (< 3 yr) novae; deeper images of brighter subset (A-config, summer 2011)
  - morphology and spectral properties of radio remnants
  - may double the number of published radio images (7)!
  - will tie to interpretation of light curves
- EVLA + eMERLIN + VLBA

Comparison: previous radio light curves



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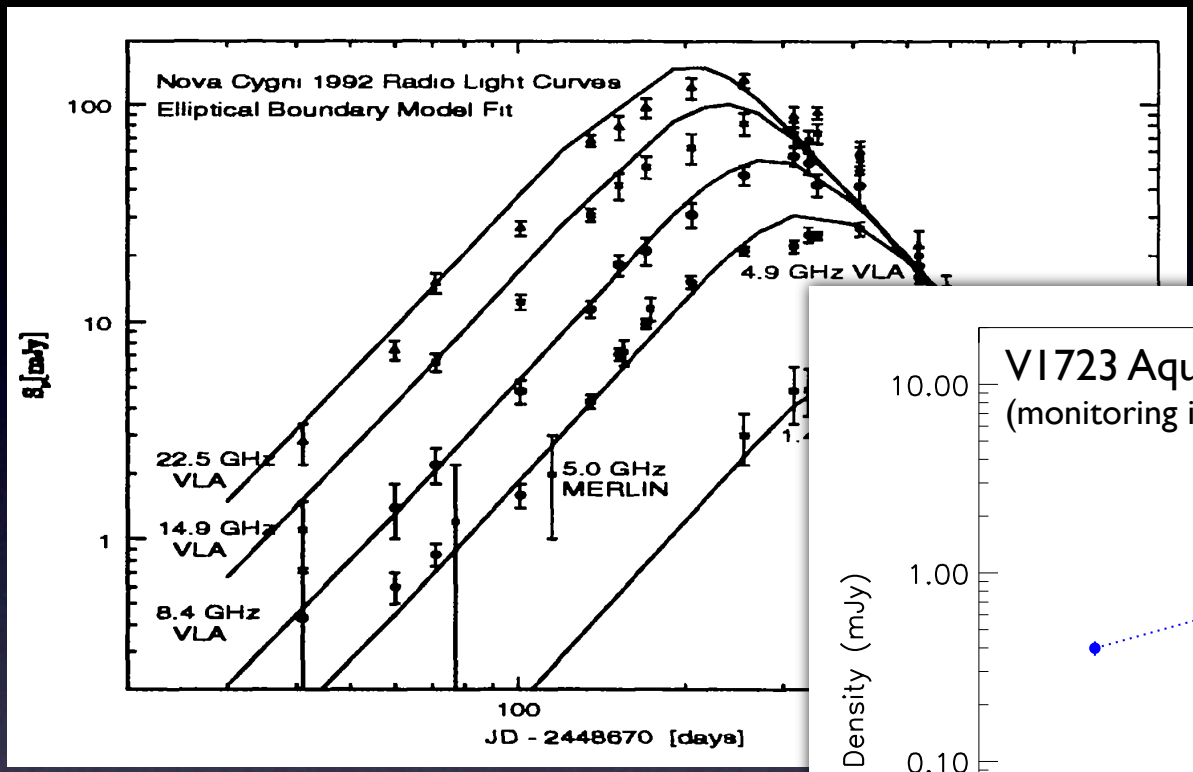
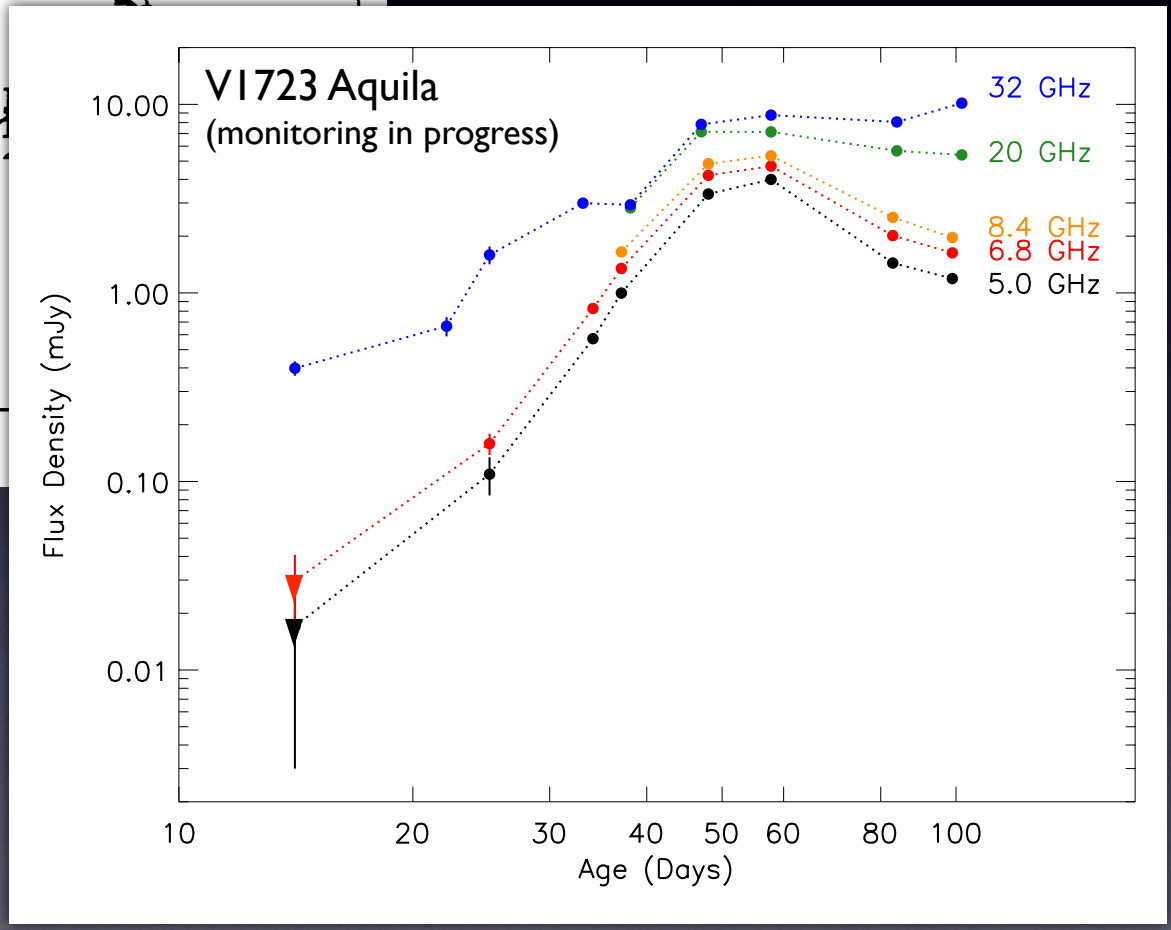


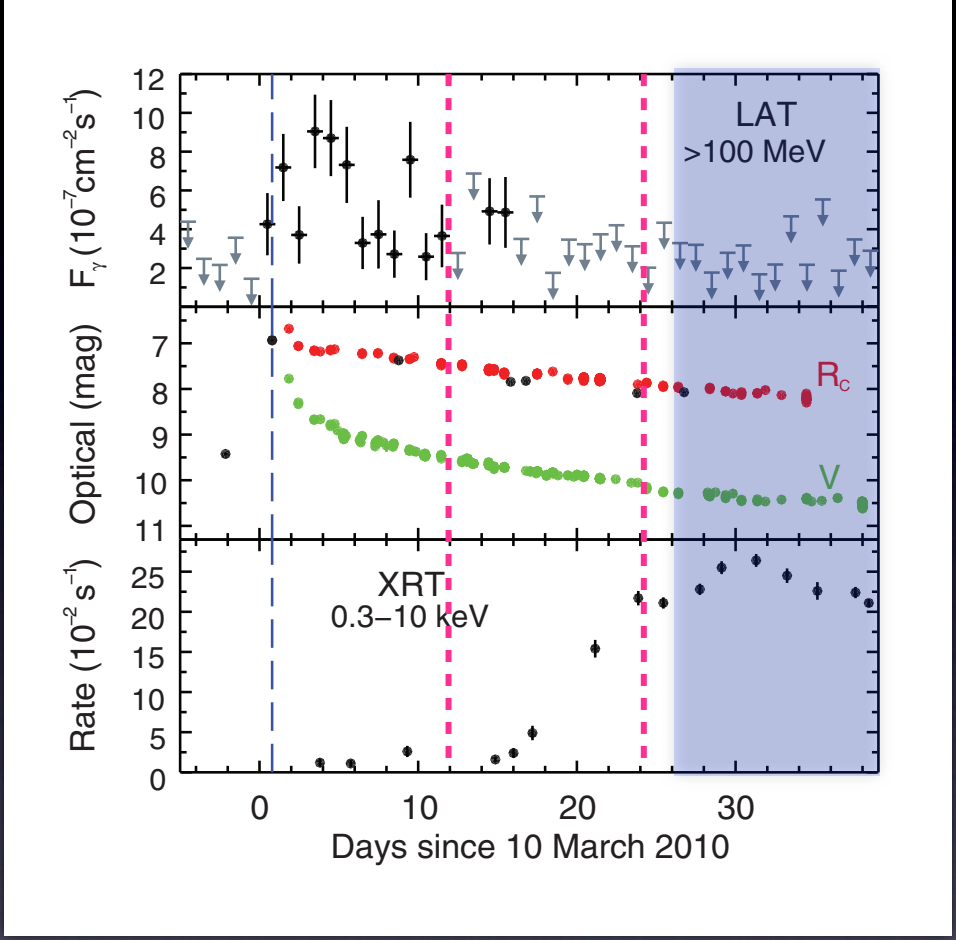
...with new EVLA data



CASA

The eNova Project: V407 Cyg

- 2x128 MHz subbands, ~0.1 mJy sensitivity
- 3–7 day cadence for 2 mo., then ~14 days for ~4 mo.
- Symbiotic system with Mira secondary – dense CBM
- First nova with detected gamma-ray emission (Abdo et al. 2010)
- Early Merlin observations show resolved shell



The Fermi-LAT Collaboration, 2010

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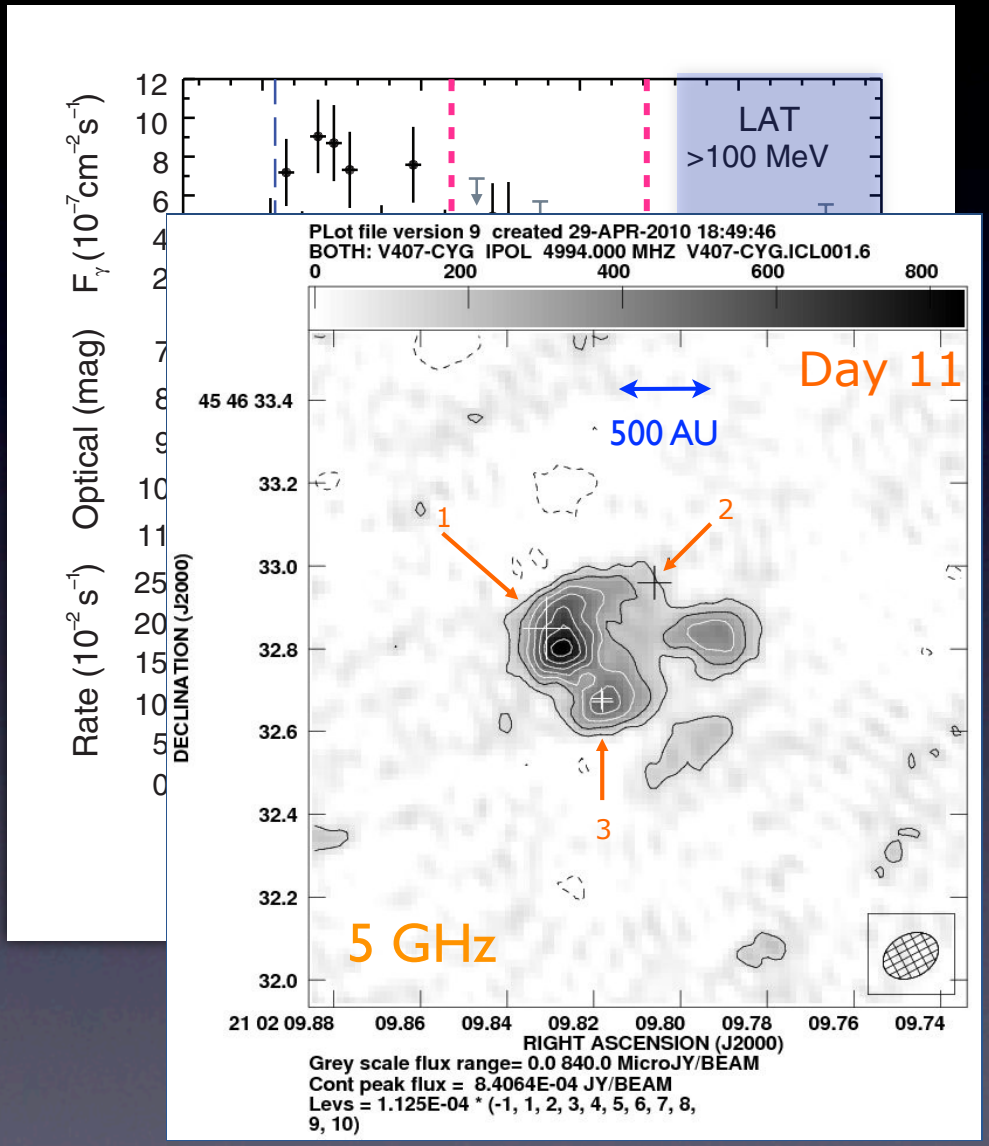

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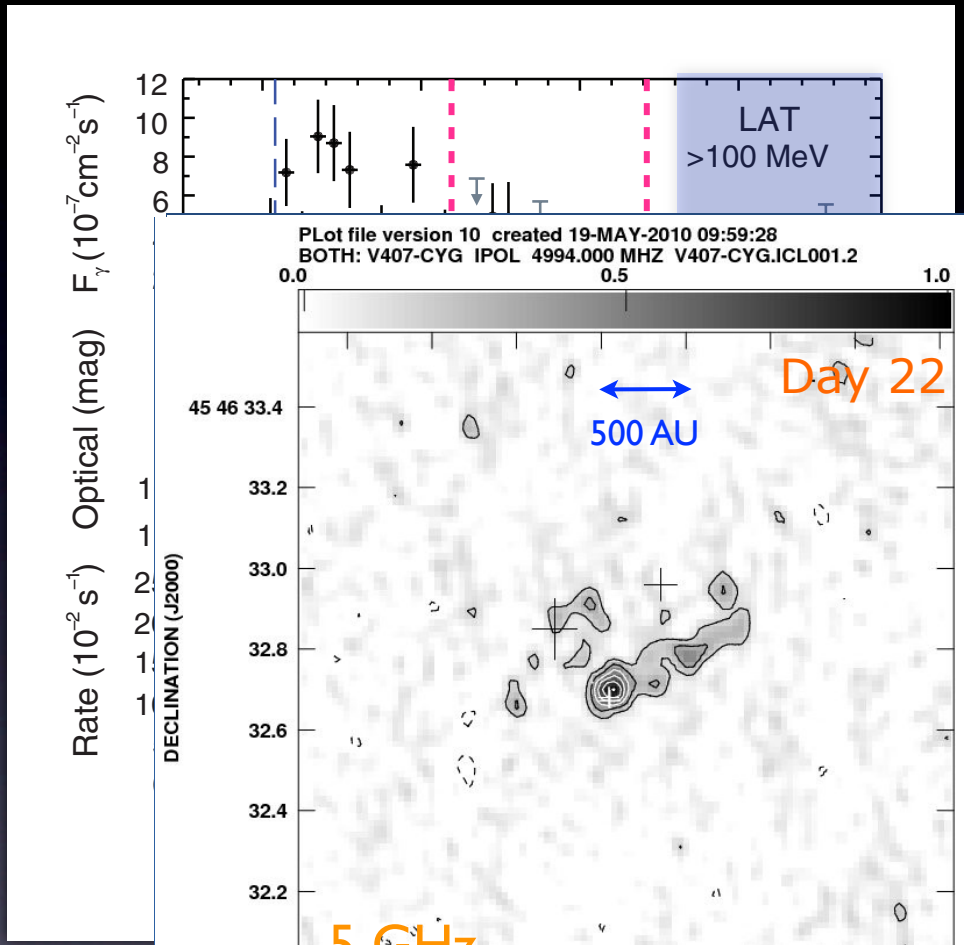
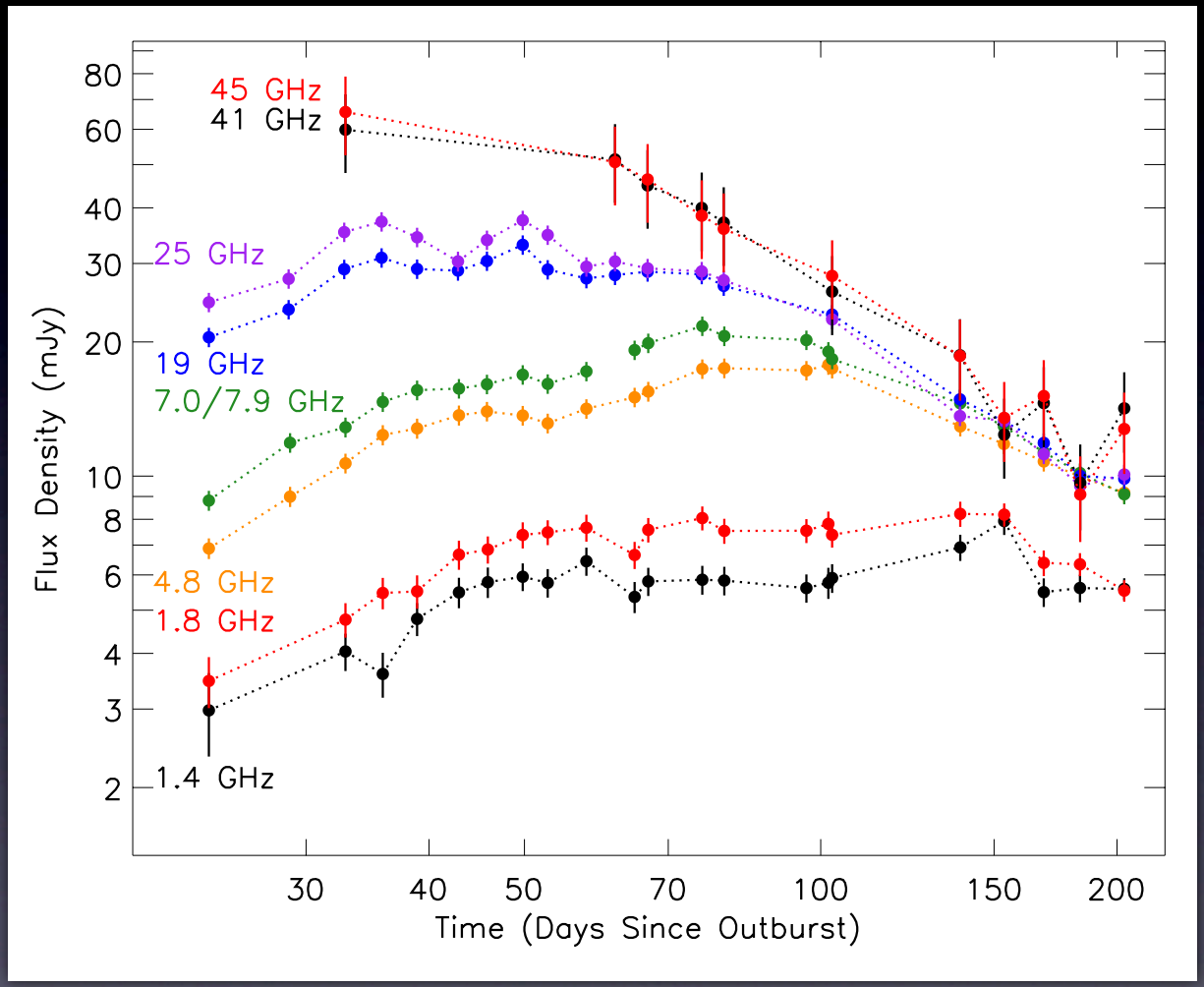
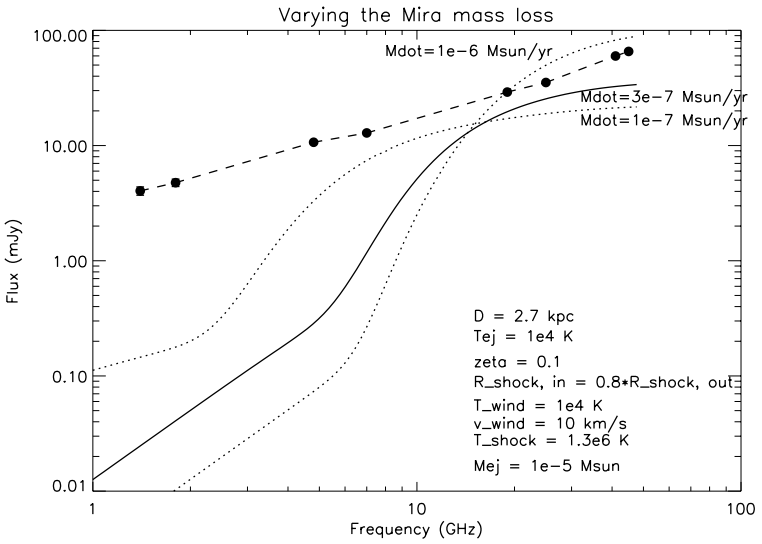


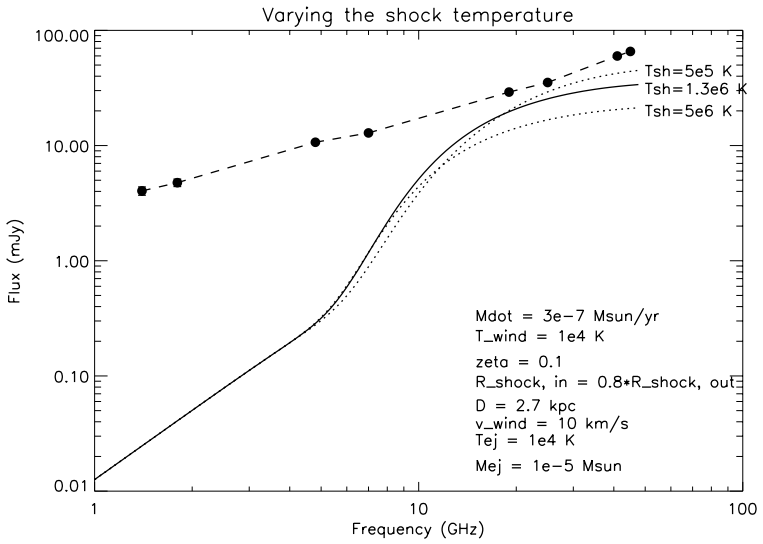
The eNova Project: V407 Cyg modeling

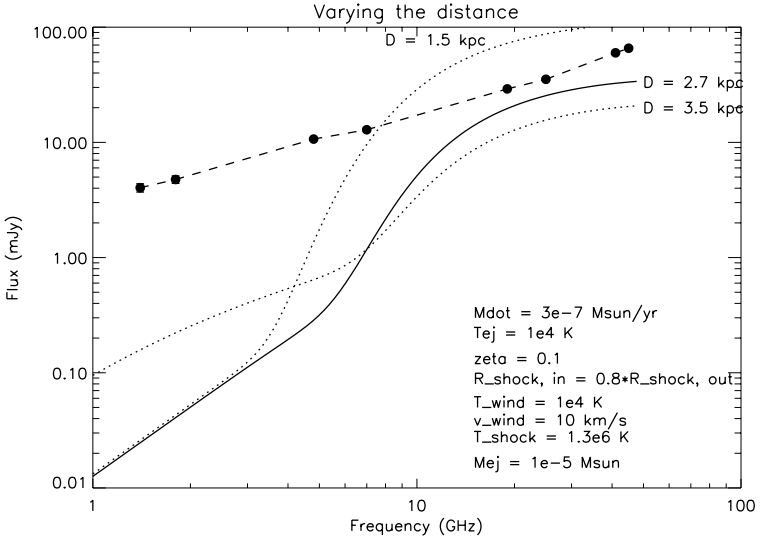


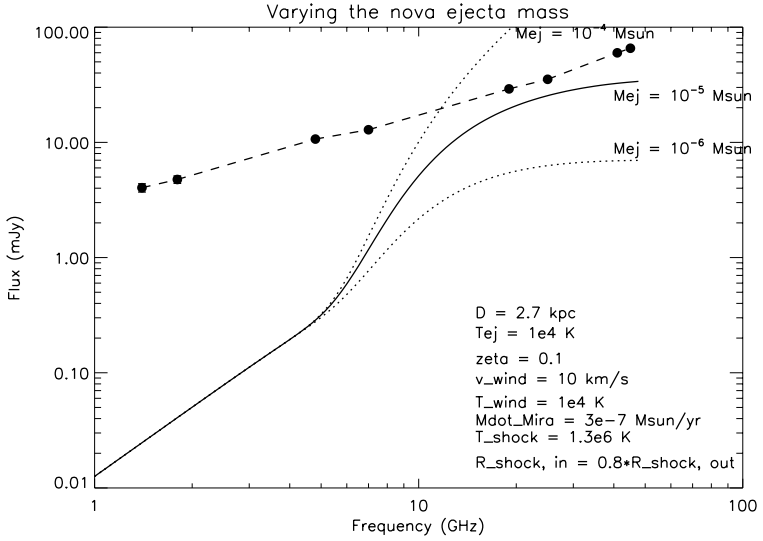
- "Classic" spherical-shell model does not work
- Updated model — layered spherical shells: nova ejecta, shock region, Mira wind
- Thermal bremsstrahlung, emission and absorption
- Physical constraints: X-ray fitting (Swift data), optical lines, distance estimate
- Spectral index: 0.8 at earliest epochs; ~0.1 at latest

The eNova Project: V407 Cyg modeling









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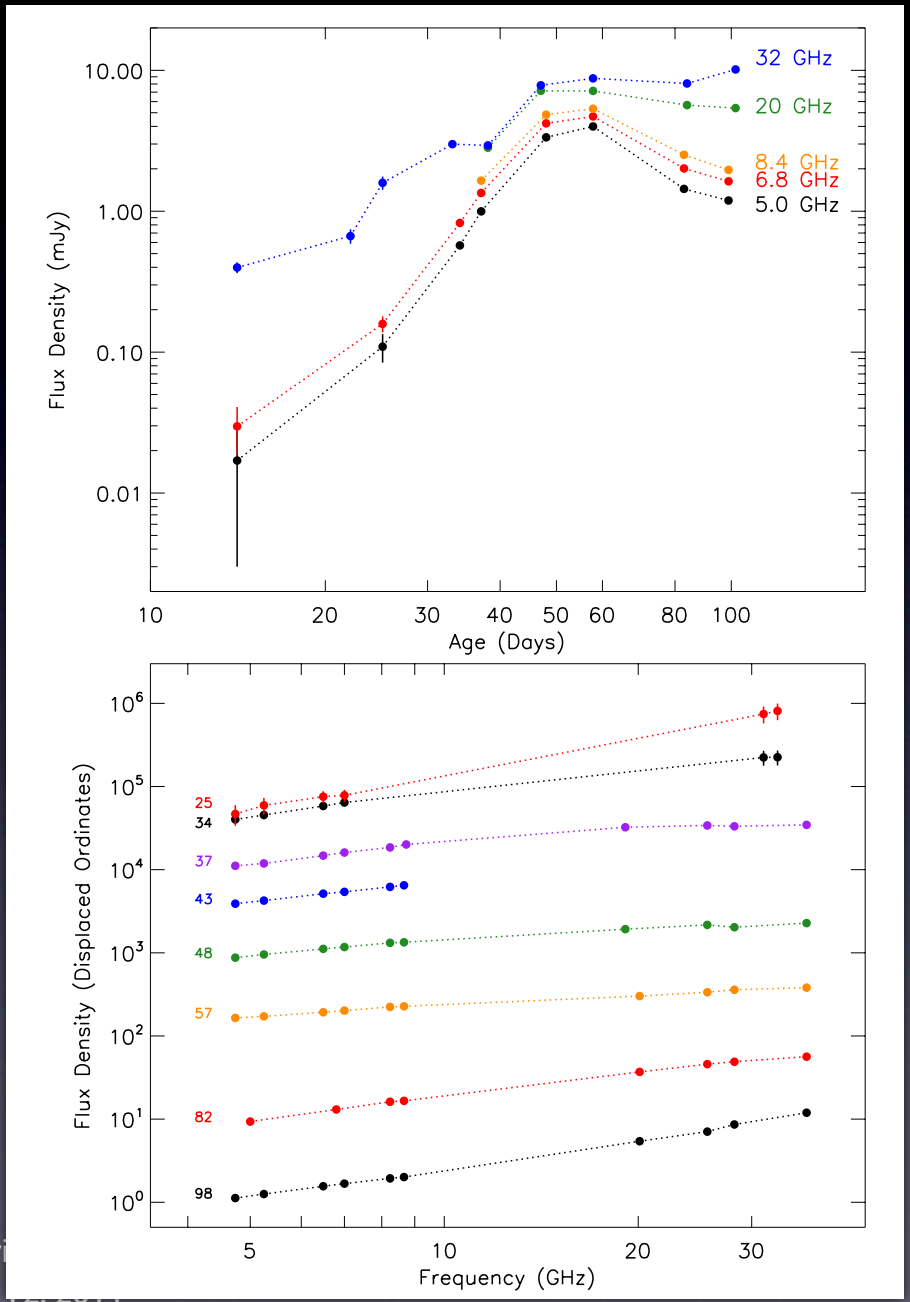
Asymmetry, clumpy material?

The eNova Project: V1723 Aql

- 2 GHz bandwidth, ~30 μJy sensitivity; L, C, X, K, Ka-band
- Highly extincted; source not previously known
- Variation of spectral index (~1.5 to 0.5 to 1.2), but not the expected $\alpha \sim 2$
- Classic model still doesn't work!
- Continued observations: how will radio source develop?



The eNova Project: Conclusions & future prospects

- First complete, rapid-response, multifrequency radio monitoring of Galactic novae
- Already, data are challenging classic models
- Imaging will be very important for current & future interpretation
- Will be the highest-quality radio data ever observed
- An exciting time for theory and interpretation!