The EVLA Nova (ENova) Project: First Results

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Classical Novae:
Introduction

Z Camelopardalis (NASA/JPL-Caltech, GALEX)
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 easy to model; can derive physical parameters
- Ejected material is optically thick at much lower densities
- Can be used to get mass estimates – but don’t agree with optical observations or theory
Radio emission from novae: Light curves and modeling

Linear velocity gradient (a.k.a. “Hubble flow”) model

- Optically thick rise: $S_\nu \propto \nu^2$
- Freely expanding, isothermal shell

![Graph of Linear Velocity Gradient Model, $\nu = 5 \text{ GHz}$](image)

Nominal parameters:
- $M_w = 10^{-5} M_\odot$
- $T_e = 10^4 \text{ K}$
- $D = 1 \text{ kpc}$
- $v_2 = 2,000 \text{ km/s}$
- $v_1 / v_2 = 0.1$

\[r_{1,2} = v_{1,2} \cdot t\]

\[\rho \sim r^{-2}\]
Radio emission from novae: 
Light curves and modeling

Linear velocity gradient (a.k.a. “Hubble flow”) model

- $M_{ej} = 4.5 \times 10^{-5} M_{\odot}$
- $D = 0.65$ kpc
- $v_2 = 990$ km/s
- $v_1 / v_2 = 0.05$

Nominal parameters:
- $M_{ej} = 10^{-3} M_{\odot}$
- $T_e = 10^4$ K
- $D = 1$ kpc
- $v_2 = 2,000$ km/s
- $v_1 / v_2 = 0.1$
The ENova Project:
A new era of observations

- EVLA + eMERLIN + VLBI: all galactic novae
- Monitoring of new, nearby (< 3 kpc) novae (currently underway)
  - improved sensitivity
  - broad frequency coverage
  - fast response
- Imaging of recent novae (proposed observations)
  - morphology and spectral properties of radio remnants
  - will tie to interpretation of light curves

Hjellming et al. 1979
The ENova Project: V407 Cyg

- Symbiotic system with Mira secondary – dense circumbinary medium
- $D \approx 2.7$ kpc
- First nova with detected gamma-ray emission
- Early Merlin observations show resolved shell
- VLBI detections

The Fermi-LAT Collaboration, 2010
The ENova Project: V407 Cyg

The Fermi-LAT Collaboration, 2010
The ENova Project: V407 Cyg
The ENova Project:
V407 Cyg – EVLA observations/modeling

- Observations at 1.5, 1.8, 4.8, 7.9, 19, 25, 41, 45 GHz
- “OSRO1” mode observing (2 x 128 MHz spectral windows per band)
- Light curves: 20–200 days
- Spectral index: 0.8 at earliest epochs; ~0.1 at latest
The ENova Project:
V407 Cyg – EVLA observations/modeling

- Light curves: 20–200 days
- Observations at 1.5, 1.8, 4.8, 7.9, 19, 25, 41, 45 GHz

Ultimately, very complex system – must consider multi-wavelength data
The ENova Project: V1723 Aql – a simpler source?

- Discovered Sept. 11; EVLA observations began Sept. 25
- 2 GHz bandwidth
- Highly extincted; source not previously known
- Early EVLA data: rising flux; $\alpha < 2$
- $D \approx 3$ kpc ($v_{ej} = 1500$ km/s, optically thick at 30 GHz)
- Swift X-ray detection on day 40
- 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 “standard” models
• Imaging will be very important!
• Will provide some of the highest-quality radio data ever gathered
• An exciting time for theory and interpretation!