Liverpool Telescope: Novae

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Novae

- Close binary systems containing WD primary and lower mass secondary
- WD accretes material from secondary
- TNR ensues in accreted layer leading to increase in luminosity and ejection of accreted envelope
- SN Ia progenitor candidates (SD-channel)
Novae and the LT

- Novae were one of the earliest science drivers for the LT
- Galactic programmes to follow specific eruptions in great detail
- Extragalactic programmes to study the population statistics of novae
- Largest users of the LJMU LT time by object type
Classical vs. Recurrent Novae

**Classical Novae**
- Only one observed eruption
- Recurrence timescales few thousand – million years
- Secondaries – main sequence stars
- Low mass transfer/accretion rates
- Range of WD masses
- Range of evolution speeds
- Fe II and He/N spectra
- 400 Galactic systems (900 M31)

**Recurrent Novae**
- >1 observed eruption
- Recurrence timescales 1-100 years
- Secondaries – sub-giants (U Sco) or red giants (RS Oph)
- High mass transfer/accretion rates
- High WD Masses
- Fast eruption evolution
- He/N spectra
- 10 Galactic systems (about the same confirmed in M31)
Progenitor Systems

Darnley et al. 2012

Darnley et al. 2013

M31 Nova Progenitor Survey

- LT observations of erupting M31 novae used to obtain high-precision astrometry

- HST archive searched for spatial coincident WFPC2 & ACS/WFC imaging

- 11 nova progenitors were recovered from input catalogue of 38 systems

Williams et al. 2014
Progenitor Catalogue Statistics

• Full statistical analysis of survey results undertaken

• Included observation biases such as availability of LT astrometric data, spectroscopic confirmation, HST data

• Detailed model of M31 nova populations, and determination of red giant distribution of M31

Williams et al. 2014, in prep
Progenitor Survey Results

- 38% (+0.16%, -12%) of M31 novae are associated with a resolved quiescent source
- These objects are dominated by RG-novae
- RG-nova population is almost entirely associated with the M31 disk
- Galactically, ~3% of novae are known to be RG-novae
- Pagnotta & Schaefer (2014) independently find ~25% of Galactic novae may contain red giants
- A separate, independent, M31 survey finds similar results

Williams et al. 2014, in prep
M31N 2008-12a

1. Eruption discovered in 2008
2. Initially unannounced 2009 eruption (PTF; Tang+ 2014)
3. Erupted again in 2011
4. Spectroscopically confirmed in 2012
5. iPTF announced eruption in 2013
   - At least one optical eruption in 1960s

Darnley et al. 2014
Progenitor System

Darnley et al. 2014
X-rays

- No detection of SSS following 2012 eruption
- First X-ray detection followed 2013 eruption
- “Turn-on” detected by Swift 6 days post eruption
- BB fit to X-ray spectra gives \( kT = 97\pm5 \text{ eV} \)
- Count rate declined at day 16, turn-off 19±1 days

Henze et al. 2014
Models

- Pre-existing models permitted such systems (Yaron+ 2005, Wolf+ 2013)

- WD mass ≥ 1.35 Mₜ
  dM/dt > 1.5 × 10⁻⁷ Mₜ/yr
  (Kato+ 2014)

- Timescale to reach Chandrasekhar mass < 1Myr
  (Tang+ 2014)

- Upper limit: RN with 2 month eruption period (Kato+ 2014)
  WD mass = 1.38 Mₜ
  dM/dt > 3.6 × 10⁻⁷ Mₜ/yr
  (Kato et al. 2014)
Conclusions / Implications / Questions

- All known Galactic RG-novae are recurrent (or suspected recurrent novae) – and hence SN Ia SD progenitor candidates
- Around 1/3 of novae in the Milky Way and M31 contain red giant secondaries
- M31 RG-nova population appears to be associated with disc stellar population
- Detection of a recurrent nova with an unprecedented 1 year inter-eruption time
- M31N 2008-12a is a prime SN Ia SD-channel progenitor candidate
- Are such systems rare or common?
- Secondary type (RG vs. SG) and white dwarf composition unknown
- Detection and follow-up campaigns for the expected 2014 eruption already in place and running