A Multiwavelength Survey of Novae, Recurrent Novae, and Other Variable Source in M31

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- M31 is a rich source of many active UV and X-ray bright active/binary stars at a known (nearby distance). Many of these are variable.
- A properly tuned time domain survey can discover populations of very interesting sources that have not been probed by other telescopes.
- Survey of M31 has legacy value and can be used for other stellar population studies (e.g. UV upturn in the bulge region)

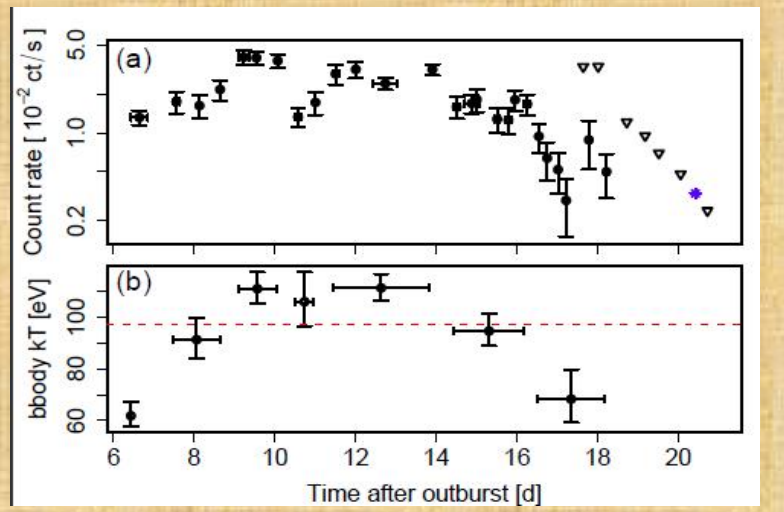
Novae and Recurrent Novae

- About ~400 nova eruptions in the MW of which ~10% are associated with 10 RNe
- RNe (recurrence time scales of 8-80 yrs) host high mass WDs that may be SN Ia progenitors that are gaining mass. This is a lower limit due to the difficulty of surveys in the MW
- ~1000 novae observed in M31 in the past century. Recent surveys put just the bulge rate at 38 per year. Simulations suggest that 20-30% may be associated with unrecognized RNe.
- At least 8% of Ne in M31 are known to show X-ray and UV bright SSS phase due to residual H burning. Phase lasts from weeks to years.

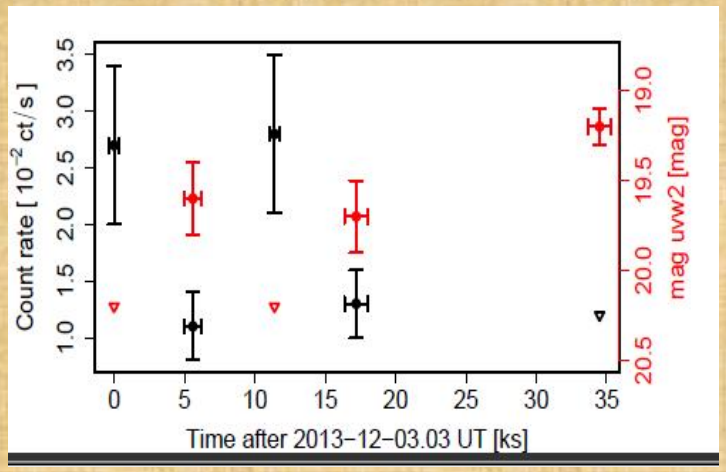
A M31 Recurrent Nova with 1 year Recurrence Timescale!

- Chandra, XMM etc. have monitored M31 over the years (on arbitrary timescales) and have uncovered ~80 SSS phases associated with Ne.
- Due to the lack of systematic observations M31N 2008-12a was only recognized as a RN with recurrence time of 1 yr in Nov 2013.
- Follow up SWIFT observations showed that the SSS phase lasted between days 6-19. Not picked up by any previous observations due to cadence.
- WD estimated to have 1.35 Solar Mass. There may be dozens of RNe in M31 spanning a larger discovery space than in known in the MW

SWIFT observations

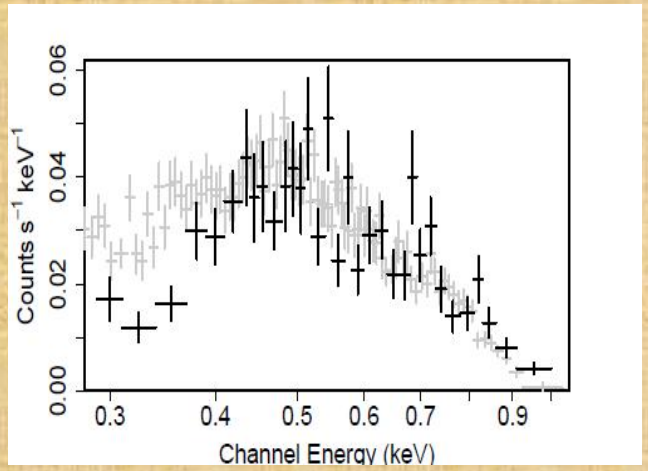


X-ray lightcurve. 1-5 ks SWIFT observations



SWIFT X-ray and UV observations.

Henze et al. (2014), Darnley et al. (2014)



Merged SED of the SSS source with spectrum of another suspected RN

Suggested Survey of M31

- Monitoring in the UV/X-ray with a cadence of ~7 days to discover the SSS phase of Novae
- No extant systematic study at these timescales and many eruptions might have been missed, especially short duration SSS phases.
- Shortest duration SSSs likely host the most massive WDs (and possible Ia progenitors)
- 1-5 ks observations will resolve individual Ne in the FOV. X-ray depending on location/crowding
- ~10 SSS per year based on highly incomplete current studies. Actual rate may be higher

Benefits of Survey

- Uniquely suited to discover an interesting class of objects, especially the rare RNe
- Many ongoing ground and space based surveys and imaging projects (iPTF, PHAT, Chandra and XMM programs) provide complementary data at other wavelengths resolutions, and time sequences.
- The optical/UV/X-ray data from ASTROSAT will allow studies of many other classes of variable objects
- Deep multiwavelength imaging of M31 has legacy value. Will allow stellar population studies.