
36 A comparative study of Cataclysmic Variable luminosities in Milky Way and M31

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ABSTRACT

We study luminosity of cataclysmic variables (CVs) in the M31 and Milky Way by analyzing photometric properties of eight known CVs discovered by the Robotic Optical Transient Search Experiment (ROTSE) sky survey. After we verified via lightcurve-shape analysis that optical transients are indeed novae, we calculated their apparent magnitudes from their relative intensities. We estimated the absolute magnitude of M31 CVs with the known distance of M31. We then made an assumption that the average absolute magnitude of galactic CVs is similar on the order of magnitude to those in the M31 to estimate distances of galactic CVs from the Earth. After we calculate the distance of CVs of the Milky Way galaxy, we have found that the distances are greater than the Milky Way galaxy's diameter. This method reveals that CVs in M31 and the Milky Way galaxy are difference types. And the luminosity of CVs in Milky Ways galaxy is less than CVs in M31. We also investigate the reddening effect of CVs due to the neutral-hydrogen column density in both the M31 and the Milky Way.

1. Find apparent magnitude and absolute magnitude of cataclysmic variables

Study the location and time of optical transient in M31 that use the ROTSE-IIIb detected and reported in the Astronomer's Telegram website¹. After we verified via lightcurve-shape analysis that optical transients are indeed novae. Blink two CCD images of CVs in M31 with DS9 software.

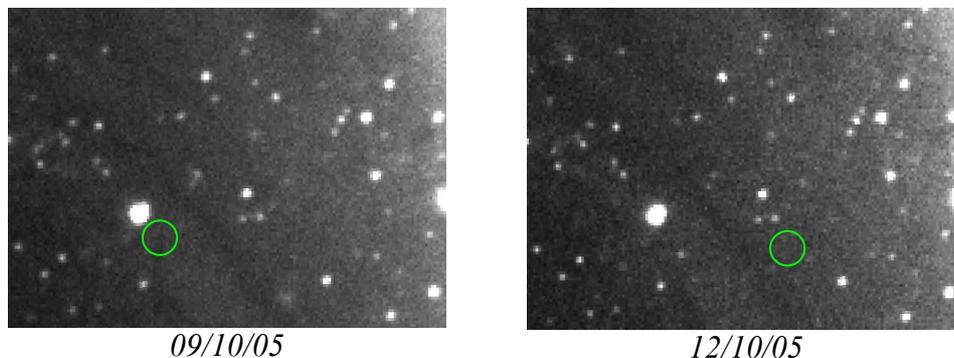


Figure 1. Nova CV ROTSE3 J004420.7+412311 The transient in M31 is located at RA 00h 44m 20.7s, Dec +41° 23' 11''

Choose reference star with The Sky software in order to find apparent magnitude and RA and Dec coordinate of the reference star, and find relative intensity of the reference star in same images with IRIS software. Calculate the apparent magnitude of CVs, by using relative intensity of CVs and the reference star from,

¹ Quimby, R. et al., 2005, "M31 Optical Transient", ATEL #379

$$m_1 - m_2 = -2.5 \log_{10} \left(\frac{F_1}{F_2} \right)$$

Calculate extinction (A_v) of each CVs in M31. Input RA, Dec coordinate of each CVs in N_H Calculator website ²(Kalberla, et al, 2005) in order to find column density (N_H) from

$$A_v = N_H / (1.8 \times 10^{21} \text{ atom/cm}^2) \text{ magnitude}$$

We assumed that column Density of CVs in M31 is similar on column Density of CVs in Milky Way, We estimate that the all column density has 2 times that we are calculate. Subtract the extinction in Milky Way and M31 from apparent magnitude of CVs in M31 and calculate absolute magnitude of M31 from (distance of M31 from Milky Way is 2.2 billion light years)

$$m - M = -2.5 \log_{10} \left[\left(\frac{10}{R} \right)^2 \right]$$

2. Find apparent magnitude and absolute magnitude of cataclysmic variables in the Milky Way

Study the optical transient in Milky Way with the same method of CVs in M31. Calculate the apparent magnitude and extinction (A_v) of each CVs in Milky Way then subtract the extinction in Milky Way from apparent magnitude of CVs.

If CVs in M31 and Milky Way are same types, their luminosity are less difference. We then made an assumption that the average absolute magnitude of CVs in M31 is similar to average absolute magnitude of CVs in Milky Way in order to calculate the distance of CVs of the Milky Way galaxy from

$$R = \sqrt{10^{2 + \frac{m-M}{2.5}}}$$

The distance of CV 1009 is 7.1×10^5 parsecs, CV 1540 is 1.3×10^6 parsecs, and CV 2123 is 1.0×10^6 parsecs. We have found that the distances are greater than the Milky Way galaxy's diameter (100,000 light years or 3.06×10^4 parsecs). This method reveals that CVs in M31 and the Milky Way galaxy are difference types. And the luminosity of CVs in Milky Ways galaxy is less than CVs in M31.

Conclusion

A comparative study of Cataclysmic Variable luminosities in Milky Way and M31, We have found 4 CVs in M31 and 3 CVs in Milky Ways that reported in the Astronomer's Telegram website. This method reveals that CVs in M31 and the Milky Way galaxy are difference types. And the luminosity of CVs in M31 is more than CVs in Milky Ways galaxy. Both M31 and Milky Ways is spiral shape, so we should discover CVs that their luminosities are similar CVs in M31 too. Because of we observe CVs in interstellar medium density in galactic plane of Milky Way that decrease intensity of CVs due to extinction of neutral hydrogen atom, so we cannot discover CVs in Milky Way that luminosity are similar CVs in M31 with ROTSE

² HEASARC: N_H Calculator, <http://heasarc.gsfc.nasa.gov/cgi-bin/Tools/w3nh/w3nh.pl>