Mira variables masquerading as Novae in M 31

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Abstract. Mira variables are often masquerading as novae in the nearby galaxies. In this paper we discuss this problem and focus on two Mira variables in M31 galaxy, one of them classified as nova by our team during novae search in M31 galaxy. Astrometry and photometry data, finding charts and light curves are presented.
Key words: Mira variable, Novae, light curves, M31

Променливи от тип Мира маскирани като нови в галактиката М 31

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В близките галактики е възможно променливите от тип Мира по време на максимум да "се маскират" като нови. В статията е дискутиран този проблем и са разгледани 2 мириди в галактиката М31, едната от които е открита от нашия екип в рамките на дългогодишния мониторинг за търсене на нови в галактиката М31. В статията са представени астрометрични и фотометрични данни, карти за идентификация и криви на блясъка за тези обекти.

Introduction

Mira variables, named after the star Mira (o Ceti), are a class of radial pulsating variable stars of spectral type K, M, S, or C (with molecular bands) that can be used as standard candles for estimating distances in the nearby Universe. They have mean absolute magnitudes M_R from –4 up to –8 mag, see Kinman et al. [1987]; Pierce et al. [2003], and brightness variations in optical from 2.5 up to 11 magnitudes, which allow detections even at large distances but only at maximum brightness. On the other hand, they pulsate with a periods of 80 up to 1000 days and their study requires long term observations. The study of these variables reveal that their light curves do not repeat exactly from cycle to cycle and the changes in the period are also possible.

Observational properties of Mira variables make them often masquerading as novae in the nearby galaxies. Their brightness increase can be referred to the nova phenomenon (M_R=–7 ÷ –9 mag). In 2003, a discovery of a nova (∼19.0 unfiltered mag) in NGC 6822 was announced, see Papenkova and Li [2003]. Spectral observations reveal M-type star (probably Mira variable) with strong TiO bands and very narrow H_α emission, see Filippenko and Chornock [2003]. Giant spiral galaxy M31 gives opportunity for studying different stellar populations and in the last few years novae search increased rapidly, see comprehensive surveys like POINT-AGAPE and Pietsch et al. [2003]. This contributes to the discovery of few Mira variables. Here we focus on two Mira variables in M31 galaxy, one of them classified by our team

Table 1. Observing log of a Mira-like variable in maximum brightness, see Ovcharov et al. [2005], and a Mira variable, spectroscopically confirmed after being announced as a nova, see Ovcharov et al. [2007]. Timing, astrometric and photometric data, the telescope and the observers names are presented. Observer: 1 - Ovcharov, Koleva et al. [2005]; 2 - Ovcharov, Valcheva et al. [2007]; Telescope: 3 - 50/70 cm Schmidt telescope, NAO Rozhen, Bulgaria. References are also included in the table.

Name	Date yyyy mm dd.ddd	R.A.(J2000) hh mm ss.ss	DEC(J2000) dd ' "."."	Offset from the M31 center	R mag	σ_R mag	Observer; Telescope
POINT - AGAPE Mira No.91772 (An et al. [2004])	2005 09 08.951	00 42 44.49	+41 03 43.6	1″.9E 774″.9S	18.8	0.1	1;3
	2005 09 10.014				18.8	0.1	
	2005 09 11.014				18.7	0.1	
	2005 09 12.023				18.8	0.1	
	2005 09 13.031				18.7	0.1	
M31N2007-11g Shafter et al. [2008b] - spectroscopic data	2007 11 28.716	00 44 15.88	+41 13 51.1	1032″.3E 137″.4S	18.73	0.05	2;3
	2007 12 07.891				18.84	0.05	

initially as a nova, spectroscopically confirmed as Mira variable one year later and another one, known as Mira variable, but 1.4 mag brighter than its previous maximum. Literature data, concerning two other Mira variables in M31, masquerading as novae, are also discussed.

1 Observations and data reduction

The observations of the two Mira variables in M31 galaxy, one of which initially classified by us as a nova, are carried out with the 50/70 cm Schmidt telescope at the National Astronomical Observatory Rozhen, Bulgaria in September 2005 and November 2007. The CCD camera ST-8 was used for the first observational runs and the STL-11000M camera for the latter ones. They both have same pixel scale (1.079 arcsec/pix). Data reduction, aperture photometry and astrometry are performed using standard IRAF routines. After the initial reduction, the individual images are combined and a median-filtered image is subtracted in order to remove the unresolved component of the M31 bulge. For the magnitude calibration, we have used secondary standards in the field of M31, obtained in photometric nights by the method, described in Ovcharov et al. [2008] and by the use of Stetson standards, see Stetson [2000]. The astrometry is done using coordinates of reference stars from Massey et al. [2006]. Table 1 presents the observing log of the variables. References from the literature are also included. Fig. 1 shows the finding charts of POINT - AGAPE Mira No.91772 and M31N2007-11g.

2 Mira variable or nova

Novae discoveries in nearby galaxies can be announced at special site for the reporting and commenting upon new astronomical observations of transient sources - http://www.astronomerstelegram.org. Such telegrams are necessary for evoking additional observations of the transients in order to reveal their real nature. Comparison between POINT-AGAPE Mira list with the catalog of M31 novae shows that no more than a few percent of novae can coincide

accidentally with Mira variables. Anyhow, until the spectral confirmation the object classification is not certain.

The last discovered variable object, firstly recognized as nova in M31, is M31N2008-09b. The spectrum is dominated by multiple TiO bands and weak narrow H_α line, see Brasukova et al. [2008]. The object is also visible in infrared or unfiltered images. It can be either a red supergiant, or a M-type Mira.

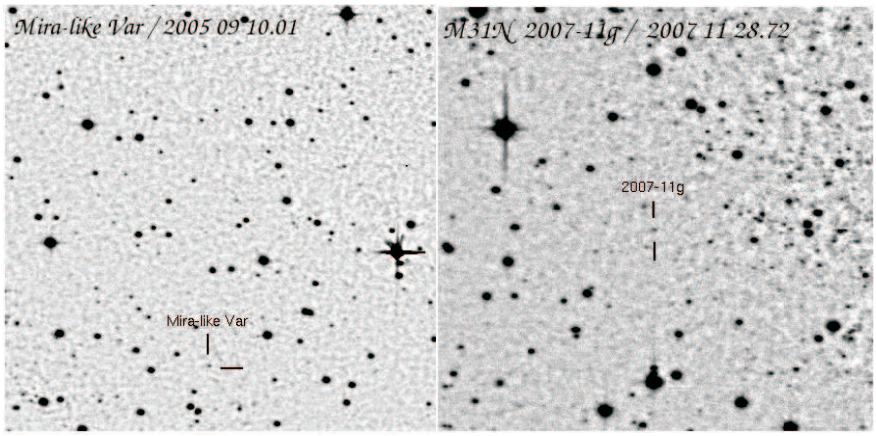

Fig. 1. Finding charts of POINT-AGAPE No. 91772 Mira variable, see An et al. [2004] (left panel) and M31N2007-11g (right panel). 50/70 cm Schmidt telescope charts cover 8×8 arcmin^2. North is to the top and East is to the left.

Another example is M31N1995-11e that was known as nova 13 years until the re-brightening on 2008 July 6.8 UT and the obtaining of the spectrum with the 9.2m Hobby Eberly Telescope, see Shafter et al. [2008a]. The spectrum has a strong TiO absorption and narrow H_α emission, typical for the M-type Mira variables.

M31N2007-11g was initially discovered as a nova by Ovcharov et al. [2007], simultaneously with another nova in M31 on 2007 November 28.716 UT. After the observed re-brightening one year later, Shafter et al. [2008b] obtained a spectrum with the Marcario Low-Resolution Spectrograph on the 9.2m Hobby Eberly Telescope and determined that this object is a Mira variable (probably M-type Mira, because of the TiO absorption bands).

Here should be pointed out that spectroscopic observations are crucial but require large aperture telescopes, which are not accessible all the time. And if we look at M31N2007-11g light curve (see Fig. 2 - right panel) it shows principle difference with novae light curves and can be indicative for the object nature and if detailed light curve, covering long period around the maximum brightness of the object, is available ones can distinguish novae from Mira variables.

On 2005 September 8.951 UT, Ovcharov et al. [2005] have discovered an object in the field of M31, that is not visible in older images. The derived coordinates coincide the ones of POINT-AGAPE Survey Mira variable No. 91772, see An et al. [2004], but the brightness in R-band was about 1.4 mag

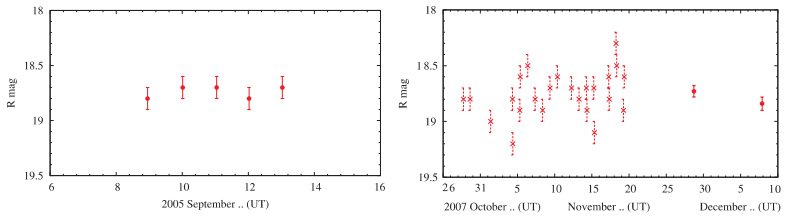

Fig. 2. Light curves of POINT-AGAPE No.91772 Mira-like variable, see An et al. [2004] (left panel) and M31N 2007-11g (right panel) - a spectroscopically confirmed Mira variable, see Shafter et al. [2008b]. Red dots represent our data and red asterisks the data from Pietsch et al. (see $http://www.cfa.harvard.edu/iau/CBAT\_M31.html$)

higher than the previously detected maximum ($R = 20.1$ mag). Light curve is presented in Fig. 2 - left panel. Such changes from cycle to cycle are possible for the Mira variables, but in this particular case it is not certain that this is the POINT-AGAPE Mira. It can be a nova along the same line of sight with the variable. If the next bright maximum is observed and if a spectrum is obtained, then the true nature of the object can be resolved.

Conclusion

Mira variables near their maximum brightness mimic the photometric behavior of classical novae. Thus, they are easily confused with novae. In order to avoid wrong classifications a spectral information or long-lasting photometric observations are essential together with a comparison with based POINT-AGAPE survey results. In the other hand, the active novae search in nearby galaxies in the last few years contributes to the discovering and studying of these interesting variables.

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