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MULTI-EPOCH OPTICAL PHOTOMETRY AND SPECTROSCOPY OF AT-2019BSD: A FAST FEII-TYPE NOVA IN M31

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Abstract: We have obtained multi-epoch BV photometry and optical spectroscopy of the unclassified transient AT 2019bsd that appeared in March 2019 within a few arcmin from the center of M31. Our observations show it to be a FeII-class nova, characterized by a t_2=9 days decline time and a FWHM=1650 km/s expansion velocity. The heliocentric radial velocity derived from hydrogen and FeII emission lines is about −400 km/s, in agreement with the bulk −300 km/s velocity of M31 galaxy. The absolute magnitude of AT 2019bsd close to peak brightness is M(V)=−9.6 mag with an uncertainty of 0.2 mag depending on the adopted reddening, and it is in agreement with prediction from magnitude at maximum vs rate of decline relations.

1 Introduction

The discovery (at mag ∼18.8) of the optical transient AT 2019bsd was reported to IAU Transient Name Server by Jiangao Ruan & Xing Gao after inspecting several 300-sec survey images (limiting mag about 20.5) taken on Mar. 13.580 UT with an unfiltered CCD on a 0.6-m f/8 Ritchey-Chretien telescope. The transient was located at R.A.=00:42:20.0 and DEC=+41:13:22.5 (J2000.0), about 274 arcsec west and 166 arcsec south of the center of the Andromeda M31 galaxy. Nothing was visible at this position on previous images taken on Mar. 11.594 (limiting mag 19.5). After the posting by Ruan and Gao to IAU-TNS, Hornoch & Wolf (2019) issued an ATel announcement for the same transient, providing photometry at two epochs as R fainter than 19.6 mag on Mar. 7.846 UT and R=18.6±0.2 mag on March 12.791 UT. This is basically all that is known on this unclassified transient. Based on its coordinates and apparent magnitude, it is listed as candidate nova 2019-03a on the on-line version of the catalog of novae in M31 maintaned by Pietsch et al. (2007).

2 Observations

We have obtained low resolution spectra of AT 2019bsd on March 20.773, 22.770 and 23.767 UT with the 1.22m telescope + B&C spectrograph operated in Asiago by the Department of Physics and Astronomy of the University of Padova. A 300 ln/mm grating blazed at 5000 Å provides spectra at a dispersion of 2.31 Å/pix covering the range

Table 1: BV photometry of AT 2019bsd.

HJD	2019 March	B	±	V	±
2458562.270	19.770	15.650	0.057	15.222	0.031
2458563.283	20.783	15.944	0.077	15.513	0.038
2458565.280	22.780	16.022	0.022	15.710	0.018
2458566.272	23.772	16.381	0.029	16.135	0.025
2458569.264	26.764	16.671	0.112	16.802	0.083

3300−8000 Å. The exposure time has been 1200 sec on all dates, and the slit was set to 2 arcsec width. The best spectrum was that for March 23.767 UT, and its Hβ−Hα interval characterized by the highest S/N is shown in Figure 1 (the other spectra look rather similar, only at lower S/N).

We also obtained B,V optical photometry of AT 2019bsd with the Asiago 67/92 Schmidt telescope. It is equipped with Landolt/Sloan $uBVgri$ Astrodon filters. The CCD camera houses a KAF-16803 detector (4096×4096 pixels, 9 μm size) with a plate scale of 0.87 arcsec/pixel and 59×59 arcmin field of view. The photometric local comparison sequences has been extracted from APASS DR8 (Henden & Munari, 2014) which has B,V bands strictly tied to Landolt equatorial standards. The resulting photometry is plotted in Figure 2 and listed in Table 1. The quoted uncertainties are the total error budget, which quadratically combines the measurement error on the variable with the error associated to the transformation from the local to the standard photometric system (as defined by the photometric comparison sequence).

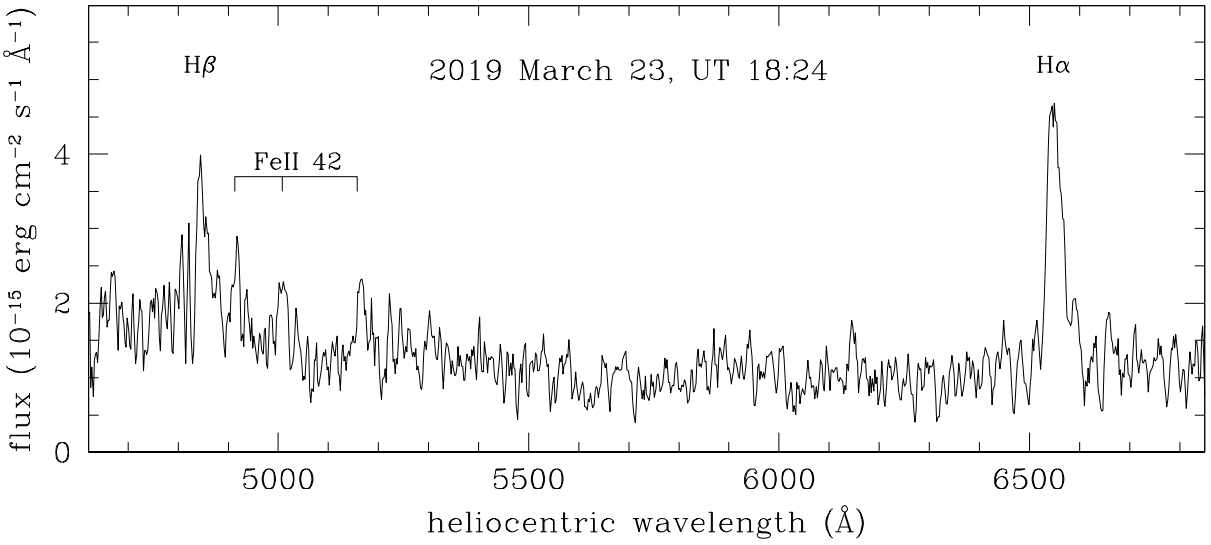

Figure 1: Optical spectrum of AT 2019bsd for March 23.767 UT.

3 Discussion

The spectrum in Figure 1, with prominent FeII 42 multiplet and Balmer lines, is typical of novae of the FeII type (Williams, 1992). The FWHM of the Hα profile is 1650 km/s, and the heliocentric velocity of emission lines is about −400 km/s in line with a membership to M31 galaxy which has a bulk heliocentric velocity of −300 km/s (Mateo, 1998).

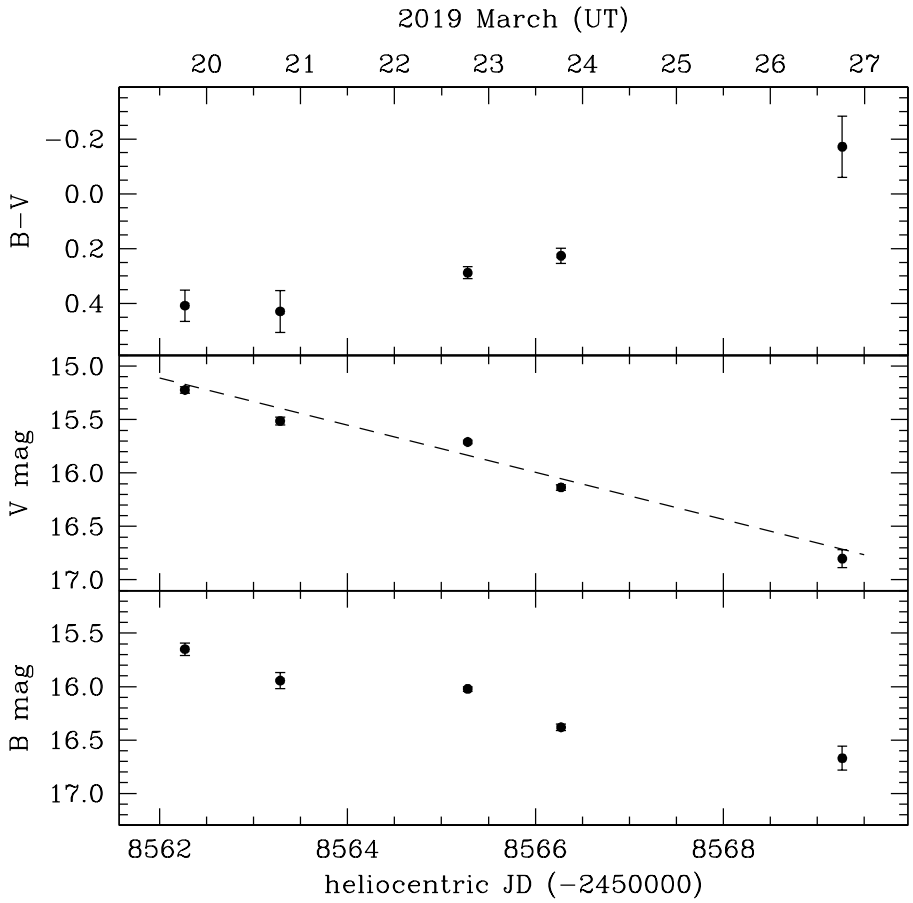

Figure 2: B,V lightcurve of AT 2019bsd built from our photometric observations listed in Table 1. The linear fit to the V lightcurve has a decline time t_2^V=9 days.

The photometric evolution in Figure 2 suggests a decline time t_2^V of about 9 days, as illustrated by the linear fit with that slope. It correspond to a classification of AT 2019bsd as a very fast nova following the criteria outlined in Warner (1995). With the available information it is not possible to estimate a precise time for passage through maximum brightness. Considering that Hornoch & Wolf (2019) measured R=18.6±0.2 mag on March 12.791 UT, the actual maximum should have occoured not too distant from our first observation on March 19.770 UT when we measured V=15.222 mag. This is supported by the color evolution presented in Figure 2, with the $B-V$ color flattening out at its reddest values around the time of our first observation, and becoming progressively bluer at later epochs, as typical for FeII novae. van den Bergh & Younger (1987)

derived a mean intrisic $B-V=+0.23$ for novae at optical maximum. Comparing with the $B-V=+0.42$ characterizing our photometry when AT 2019bsd was at peak brightness, the inferred reddening would be $E_{B-V}=0.19$, that well compares with $E_{B-V}=0.08$ listed by Mateo (1998) for M31 as a whole.

At M31 distance of 770 kpc (Mateo, 1998) and suffering a reddening $E_{B-V}=0.19$, the absolute magnitude of AT 2019bsd at the time of our first observation in Table 1, probably close in time with its peak brightness, is M(V)=−9.8 mag, or M(V)=−9.4 mag if $E_{B-V}=0.08$ is adopted instead. These values are in line with expectations from relations on magnitude at maximum vs rate of decline. Using their most recent calibrations by Downes & Duerbeck (2000), a $t_2^V=9$ days would lead to M(V)=−9.0 mag for a log-linear relation, and M(V)=−9.2 mag for the specific stretched S-shaped curve first introduced by Capaccioli et al. (1989) for the population of novae in M31.

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