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Low state in the post-nova V1315 Aql

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Abstract

Using Asteroid Terrestrial-impact Last Alert System (ATLAS) and Zwicky Transient Facility (ZTF) data, I found that the SW Sex star V1315 Aql entered a low state early in 2023. As far as I know, this is the first such an event since the discovery of this object with observations dating back to 1948. This object is renowned for its nova shell and the nova explosion was estimated to occur 500–1200 yr ago, although no direct detection of a nova eruption was present in the historical record. The present low state probably occurred as the mass-transfer rate from the nova-irradiated secondary decreased secularly. The present low state would provide an opportunity to study the secondary in detail, which has been hampered by the luminous accretion disk in the past. I also provide the recent light curve of the classical nova LV Vul, which now shows high and low states 50 yr after the nova eruption.

V1315 Aql was initially discovered as a variable star (=SVS 8130) by Metik (1961). During a search for ultraviolet-excess objects, Downes et al. (1986) detected this object (KPD 1911+1212) and identified it to be an eclipsing cataclysmic variable. Its spectrum was that of a high-excitation old nova0 (this term was used slightly differently from the modern meaning), and unusually singly peaked emission lines despite its high inclination and the unusual behavior of the emission lines against the orbital phase already attracted attention. Downes et al. (1986) classified V1315 Aql to be a member of high-excitation (all eclipsing) old novae, including SW Sex, LX Ser, DQ Her, RW Tri and V363 Aur as a group. These unusual emission lines have been studied by many authors (Szkody 1987; Szkody and Piche 1990; Dhillon et al. 1991; Smith et al. 1993; Dhillon and Rutten 1995; Hellier 1996). This object played an important role in establishing the concept of SW Sex stars (Thorstensen et al. 1991; Hellier 1996).

This object received attention again by the discovery of a nova shell (Sahman et al. 2015, 2018). Using the expansion velocity, Sahman et al. (2018) suggested that the nova eruption occurred 500–1200 yr ago. Sahman et al. (2018) could not find a corresponding "guest star" in old Chinese and Asian records compiled by Stephenson (1976). Schaefer (2019) could not find evidence for a nova eruption in archival plates starting from 1889.

While inspecting of Asteroid Terrestrial-impact Last Alert System (ATLAS: Tonry et al. 2018) forced photometry (Shingles et al. 2021) and Zwicky Transient Facility (ZTF: Masci et al. 2019)[1] data, I noticed that this object entered a low state starting from early 2023 (vsnet-alert 27760)[2]. As far as I know, this is the first such an event since the discovery of this object.

The typical high-state light curve (2016–2019) is shown in figure 1. The object gradually faded and entered a low state starting from 2023 (figure 2). Hellier (2000) suggested that SW Sex behavior is caused by episodes of very high mass transfer, which are balanced by VY Scl low states (i.e. to adjust to the long-term mass transfer by angular momentum loss from the binary). In the case of V1315 Aql, the origin of very high mass transfer in its high state appears to be the result of a nova explosion. The present low state would provide an opportunity to study the secondary (such as the chemical composition) in detail, which has been hampered by the luminous accretion disk in the past.

[1]The ZTF data can be obtained from IRSA <https://irsa.ipac.caltech.edu/Missions/ztf.html> using the interface <https://irsa.ipac.caltech.edu/docs/program_interface/ztf_api.html> or using a wrapper of the above IRSA API <https://github.com/MickaelRigault/ztfquery>.

[2]<http://ooruri.kusastro.kyoto-u.ac.jp/mailarchive/vsnet-alert/27760>.

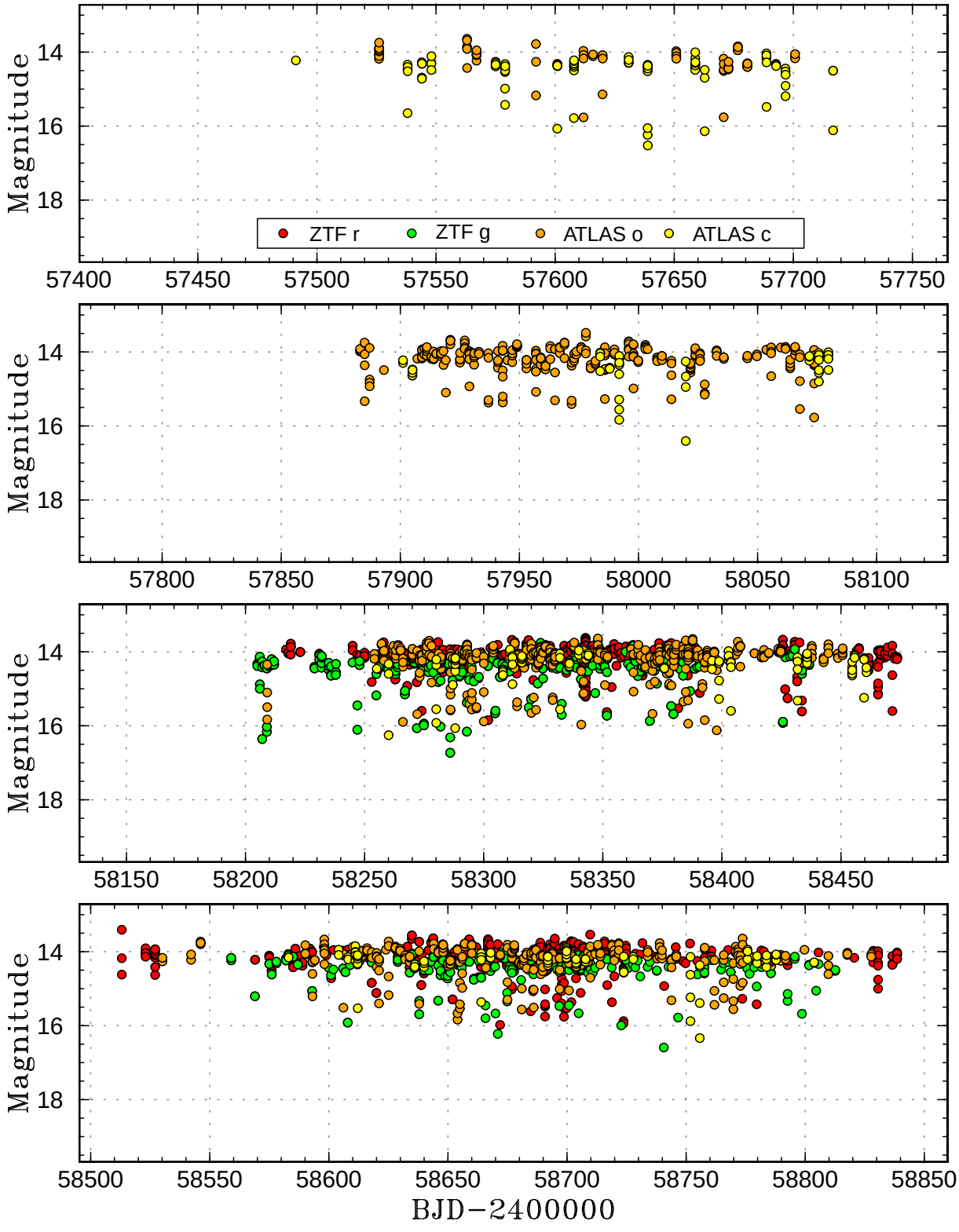

Figure 1: Light curve of V1315 Aql in 2016–2019. The object was in high state. Eclipses with depths of 1–2 mag were also present.

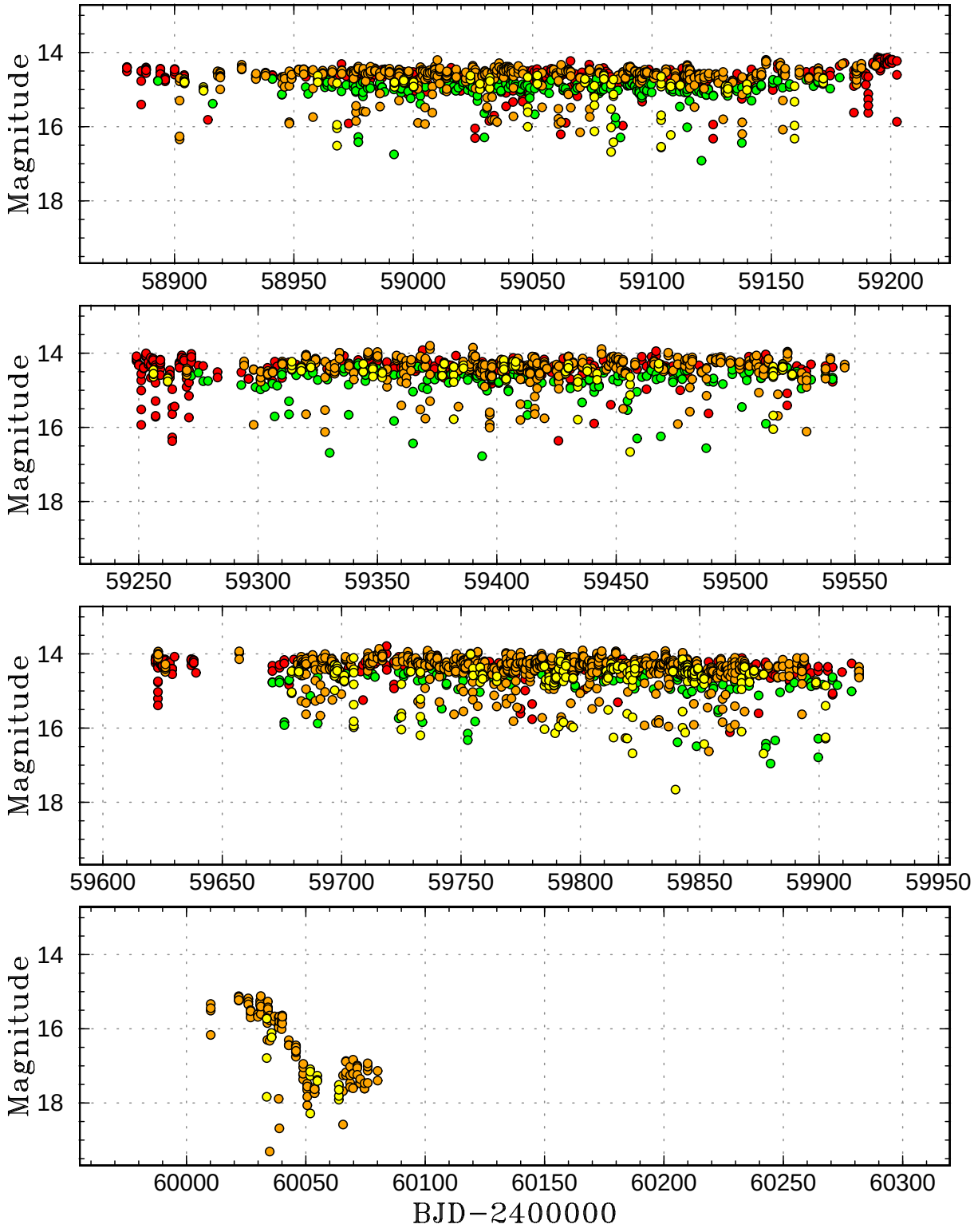

Figure 2: Light curve of V1315 Aql in 2020–2023. The symbols are the same as in figure 1. The object is in now low state in 2023 (fourth panel). The bottoms of eclipses in the low state were probably too faint to detect by ATLAS.

Table 1: Classical novae with low states.

Object	Eruption	Low states	References
CP Lac	1936	2019–2020	vsnet-alert 23621
DK Lac	1950	2000–2001, 2020–2022	Henden et al. (2001)
HR Lyr	1919	2010 (shallow)	Honeycutt et al. (2014)
LV Vul	1968	2018, 2020, 2022	this work
V1315 Aql	before 1889	2022	this work

Several classical novae (not necessarily SW Sex stars) have been known to show low states recently. They are summarized in table 1. For CP Lac see vsnet-alert 23621[3], which was originally detected by Gaia.[4] The 2020–2022 low state of DK Lac was detected in the ZTF data. The light curve of LV Vul from the ZTF data is shown in figure 3. In addition to them, there are also more candidates:

- IV Cep (1971): highly variable in the ZTF data. More than 1 mag fading in 2018 December–2019 April, 2020 June–August, 2021 September–? (ending not recorded due to the seasonal gap) and 2022 August–September.
- V400 Per (1974): likely low state in early 2022; only three positive ZTF observations.

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List of objects in this paper

V1315 Aql, V363 Aur, IV Cep, DQ Her, CP Lac, DK Lac, HR Lyr, V400 Per, VY Scl, LX Ser, SW Sex, LV Vul, KPD 1911+1212, SVS 8130

[3]D. Denisenko <http://ooruri.kusastro.kyoto-u.ac.jp/mailarchive/vsnet-alert/23621>.
[4]<http://gsaweb.ast.cam.ac.uk/alerts/alert/Gaia19elx/>.

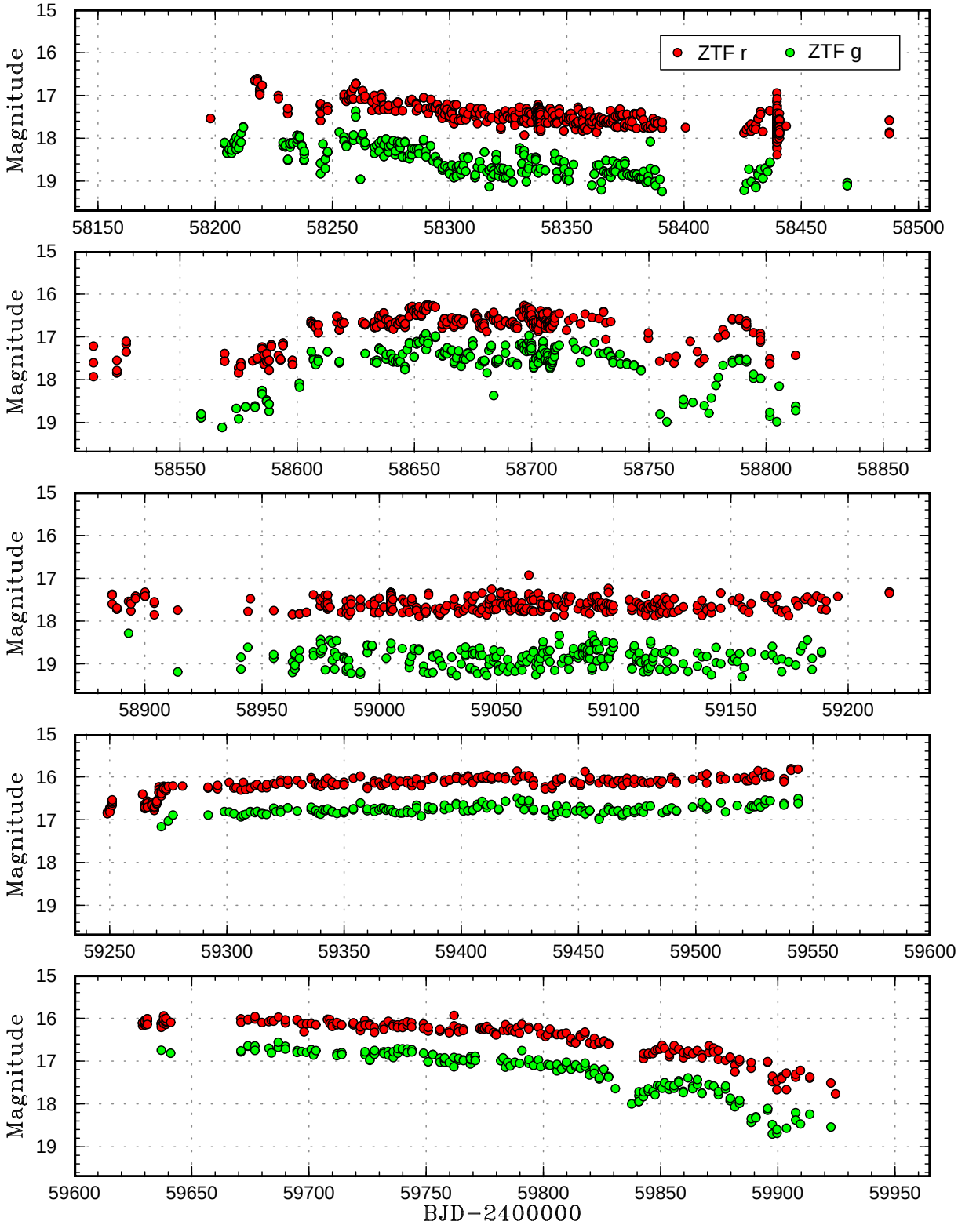

Figure 3: Light curve of LV Vul in 2018–2022. Low state (third panel) and high state (fourth panel); transition between these state in other panels.

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