On the identity of Tsesevich’s "YY Dra"

Taichi Kato,1 Elena P. Pavlenko2
tkato@kusastro.kyoto-u.ac.jp

1 Department of Astronomy, Kyoto University, Sakyo-ku, Kyoto 606-8502, Japan
2 Federal State Budget Scientific Institution “Crimean Astrophysical Observatory of RAS”, Nauchny, 298409, Republic of Crimea

Abstract

Hill et al. (2022, arXiv:2203.00221) recently published an analysis of the intermediate polar DO Dra (YY Dra) using TESS, ASAS-SN and ZTF data. They also attempted a search for the “lost” variable YY Dra using modern catalogs of variable stars and found no corresponding one. This search drew our renewed attention and we studied the original discovery paper of YY Dra by Tsesevich (Zessewitch). We found that two out of four variables reported by him were either lost or improperly studied. The coordinate offset from the correct position in another object was much larger than the expected error. Using the information of the published period and epoch of YY Dra, we suspect that Tsesevich used a couple of plates on which the object was invisible to derive the period rather than from a completely phased light curve. DO Dra sometimes spends high states around 14 mag for a month to several months and it would not be surprising if Tsesevich observed DO Dra in such a state and suspected it to be an Algol, urging him to examine the plate archive to obtain the moments when the variable was undetected. We suspect that Tsesevich indeed observed DO Dra, rather than a different, lost eclipsing variable. The final conclusion of this matter is almost impossible to reach due to the consequence of the World War II, destroying the large part of plate collections. Until the humanity becomes wise enough to restore this destruction and wise enough to be able to avoid further destruction of human achievements, the designation YY Dra would better be conserved as a record of our negative history and unambiguous DO Dra would better be used to designate the intermediate polar 3A 1148+719.

1 Introduction

Hill et al. (2022, arXiv:2203.00221) recently reported on analysis of the intermediate polar DO Dra (YY Dra) using Transiting Exoplanet Surveying Satellite (TESS), All-Sky Automated Survey for Supernovae (ASAS-SN) Sky Patrol data (Shappee et al. 2014; Kochanek et al. 2017), Zwicky Transient Facility (Masci et al. 2019) and other sources. The discussion about the identity of Tsesevich’s “YY Dra” in Hill et al. (2022) drew our renewed attention. This object was introduced to amateur variable star observers as a rarely outbursting new dwarf nova in the mid-1980s by the American Association of Variable Stars (AAVSO), initially under the name of YY Dra and then DO Dra twice in a row using the same chart issued in their monthly circulars. Knowing this complicated history, the identity of these two designations has long been a matter of interest for many amateur observers and we would like to clarify the matter a bit.

Original “YY Dra” was reported as one (SVS 504, Dra) of four variable stars discovered by Zessewitch (1934).1 The designation DO Dra was given in Kholopov et al. (1985) referring to the X-ray source 3A 1148+719 = 2A 1150+720 = PG 1140+719, following the identification of this object as a cataclysmic variable (PG 1140+719: Green et al. 1982, 3A 1148+719: Patterson et al. 1982), both giving YY Dra as the identification, and the subsequent identification as a long-period dwarf nova (Wenzel 1983a,b). In Kholopov et al. (1985), it was written as ≠ YY Dra. Following this official naming of DO Dra by the General Catalogue of Variable Stars (GCVS) team,

1 <https://tess.mit.edu/observations/>.
2 The author name W. Zessewitch is the German spelling of V. Tsesevich (Песевич, Владимир Платонович) in the original language. There is also a variety of Latin transcription (Tsesevich) of his name, in which “sse-” apparently came from the German spelling (in German, “-se-” is pronounced as “-ze-” in English, and “-sse-” was apparently used to reflect the original sound). We use the better known spelling Tsesevich, which agrees with the spelling in the original language, in the present paper when referring to the discoverer.
There have been attempts to search for the original Tsesevich’s YY Dra considering that the published position was in error. One of the authors (TK) noticed in 2000 that the coordinates of the Algol RW UMa precessed by 50 years have the right ascension very similar to that of YY Dra with a difference in declination by 20°. Furthermore, the published epoch of the minimum of YY Dra agrees with $E = -3544$ of the element of RW UMa in GCVS (T. Kato, vsnet-chat 3807). This finding was brought through the discussion with N. N. Samus. His message (vsnet-chat 3807) might help understanding the situation, and we quote it here for reader’s convenience:

Tsesevich’s observations used Simeiz plates. A part of Simeiz collection perished in the World War II, another part survived and is now in Pulkovo. The Pulkovo collection does not contain plates around the dates of minima originally announced by Tsesevich. Also, some plates could survive and be taken to Odessa, but, again, they could not be found so far.

Tsesevich was a VERY experienced person and could not mix up an eclipser with a dwarf nova.

Upon the query about the possible confusion with RW UMa, Samus replied (vsnet-chat 3814). We also quote it here:

Your finding is very interesting. However, I don’t believe that RW UMa and YY Dra are the same. Tsesevich told me that his star was “In a half degree” – I could not understand his remark, but now I know that his position was exactly in a half degree from the center of his plates, Z Dra [...] As far as I remember, no other minima of YY Dra are known.

The above explanation by N. N. Samus was partially presented as a form of private communication in Virnina (2011). There was some more details according to Samus (1988). Samus noticed in 1983 fall [i.e. after publication by Wenzel (1983)] about the bright eclipsing binary YY Dra, which had been virtually forgotten or lost and no one else had observed, while working on the 4-th Edition of the GCVS. Samus (1988) wrote that the X-ray source 3A 1148 had been found in this region and that Wenzel (1983, 1983) successfully identified it with an eruptive (cataclysmic in modern term) variable star. Samus (1988) wrote that some researchers applied the name YY Dra to this cataclysmic variable, while others considered that the true YY Dra was a different star which was not be able to be recovered possibly due to the error in the position. If there had been a chart by the name YY Dra for E1140.8+7158. A summary of this history was also described in Andronov et al. (2008); Babina et al. (2020).

Following this recommendation, DO Dra has been treated as the official designation of this cataclysmic variable, and it has been widely used in IAU Circulars and in the community of amateur variable star observers. The full papers by J. Patterson’s group were published as Patterson et al. (1992); Patterson and Szkody (1993), clarifying the nature of this object as an intermediate polar. Patterson et al. (1992) also mentioned that there is no variable star in the vicinity corresponding to the Algol star “YY Dra”.

2 New attempts

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\[\text{[1934]. Zessewitch (1934) only reported the position } 21^{h}42^{m}42^{s} +56^\circ 13/2 (1855.0), \text{ Amplitude: 12.9–14.5, Algol-type. Tsessevich apparently used Bonner Durchmustering to derive the coordinates.} \]
Tsesevich remembered the position of a star which he observed long time ago. Samus discussed this matter with his colleague M. S. Frolov and Frolov immediately replied about Tsesevich’s unique ability of remembrance about when and how the period varied of RR Lyr stars Frolov asked. Samus called Odessa, and Tsesevich replied that he remembered YY Dra. Here, Tsesevich replied “in a half degree” and asked to send a good plate to Odessa, on which he could mark YY Dra. A plate was quickly sent to Odessa, but Tsesevich had already been in a clinic. On October 26 he asked to bring the plate to the clinic, but after two days he passed away, bringing the mystery which he could mark YY Dra. A plate was quickly sent to Odessa, but Tsesevich had already been in a clinic.

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Since all-sky photometric data such as ASAS-SN became publicly available, at least two groups independently searched the possible counterpart of Tsesevich’s YY Dra: Hill et al. (2022) and Koji Mukai in the 2021 update of his “The Intermediate Polars” page. Mukai searched the ASAS-SN variable star database (Jayasinghe et al. 2018, 2019) matching the period in the 10° × 10° field as in Virnina (2011) and found none. Hill et al. (2022) searched the Catalina Surveys Periodic Variable Star Catalog (Drake et al. 2014) and the ASAS-SN variable star database for the entire sky observable from Russia. There was no object compatible with Tsesevich’s YY Dra even if they loosened the constraints on the amplitude and the period. Hill et al. (2022) wrote: “We cannot rule out the possibility that YY Dra really is an eclipsing binary whose position, period, and range of variation were all massively erroneous. This explanation, however, would require an unlikely confluence of errors and would probably be untestable, in that it would leave the search for YY Dra almost completely unconstrained”.

3 Discussion

We here provide new perspectives regarding this matter.

3.1 Reliability of Tsesevich’s classification and magnitudes

We studied three other variables discovered in Zessewitch (1934). The first object listed was YY Dra. The second one is AI Cep and was listed as a β Lyrae-type with an element of Min = 2426550.256+4.22524E. According to Albo (1964), Tsesevich discovered this object during observation of SU Cep. This ephemeris agrees with the modern one and Tsesevich apparently observed the full orbital cycle. The only small difference (0.003%) of the period from the modern one suggests that he should have used a very long (tens of years) baseline. According to Albo (1964), Tsesevich obtained this epoch for AI Cep from 296 visual observations. Another epoch of 2415615.385 was listed, which was based on two photographic observations. They were published in В. И. Левенчук, Олецка Зм. (Odessa Proceedings) 4, вып. 1 (1954). This indicates that the objects reported in Zessewitch (1934) used very miscellaneous types of observations. The small number of photographic observations reported for AI Cep suggests that Tsesevich’s conclusion for each object in Zessewitch (1934) was not based on a large number of plates.

The third object is NSV 14669 and the coordinates were given as J235727.28+23°38‡ (1855.0). The object Tsesevich found is currently identified with GSC 02251-0096, which is 1° away from the Tsesevich’s position. This object was listed as having a range of 12.5−14.0 and was classified as Longperiodic. The ASAS-SN data show that this object is constant (T. Kato, vsnet-chat 9004). and the absolute magnitude (Gaia Collaboration et al. 2018) is too faint for a long-period variable. We could not find an alternative candidate in the vicinity both using variable star catalogs [The International Variable Star Index (VSX): Watson et al. (2006); Asteroid Terrestrial-impact Last Alert System (ATLAS): Heinze et al. (2018); ZTF: Ofek et al. (2020)] and 2MASS catalog (Cutri et al. 2003). This case is as problematic as YY Dra, and either variation detected by Tsesevich was an illusion or the coordinates were perfectly wrong. This case alone indicates that Tsesevich’s reports were not as complete as supposd by Kholopov and Samus (1988).

The fourth object is NSV 14776 and the coordinates were given as J235727.38+23°38″ (1855.0). The object is currently identified with a Mira star NSVS J235727.2+240732 = ASAS J235727+2407.6 = ASASSN-V J235727.38+240731.3. Although the reported range and classification (11.1−14, Longperiodic) agree with the

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8 <https://asd.gsfc.nasa.gov/Koji.Mukai/iphome/systems/yydra.html>
9 <https://asd.gsfc.nasa.gov/Koji.Mukai/iphome/iphome.html>.
10 <http://ooruri.kusastro.kyoto-u.ac.jp/mailarchive/vsnet-chat/9004>.
modern one, the position is nearly 4′ different. This difference is too large even if Tseveich used a printed atlas of Bonner Durchmusterung.

As judged from this analysis, two objects out of four in Zessewitch (1934) were either lost or misclassified, casting doubt on the reliability of Tseveich’s report.

3.2 Information from period and epoch

The large number of significant digits in the period of 4.21123 d for YY Dra would suggest that observations with a long (tens of years) baseline was used as in AI Cep. Considering that Tseveich should have known that the duration of an Algol-type eclipse is an order of 10% of its period, he must have been aware that the reported uncertainty of the period (assuming ±5 at the end figure) corresponds to a baseline of 4.21\times0.1/0.00005 ≃8000 cycles ≃90 years. This is much longer than the time (10 years) between the epoch (2419852.4) listed in the table and the date of publication. We therefore consider that Tseveich did not make a formal analysis by creating a completely phased light curve. He probably instead used widely separated epochs of the plate on which the object was invisible and determined the unique period by finding the greatest common divisor between the intervals. This interpretation is consistent with the listed epoch corresponding to 1913 March 25, when he was at an age of 5 (Samus’ 1988) and he probably spotted an old isolated exposure on which the object was invisible. This interpretation is strengthened by the given precision of the epoch: he gave the end figure only to 0.1 d in contrast to AI Cep, having a period similar to that of YY Dra, for which he gave an epoch down to 0.001 d. The given epoch indicates that it was not derived from continuous observations of an eclipse, but only conveyed the information that the plate was taken at night in Russia.

The actual intervals used by Tseveich are difficult to estimate since we do not know at what time of nights when these plates were exposed. If he only used integer intervals (this would be a reasonable assumption, since the duration of an eclipse of a 4-d Algol is comparable to the duration of a night), an interval of 1575 day, where \( N \) is the integer, would be a candidate since the given period is exactly 1575/374.

As stated earlier, there would remain a possibility that he confused the element with that of RW UMa. As Samus noted, the only information from Tseveich was that it was “in a half degree”, and “a half degree from Z Dra” was an interpretation by Samus. We cannot rule out that Tseveich meant something else and the actual variable was far from the given location.

The Algol (rather than \( \beta \) Lyr etc.) classification would not be inconsistent if he observed DO Dra, since the object is either visible or invisible (in outburst/high state or quiescence). As judged from the rest of objects in Zessewitch (1934), the magnitudes were unlikely too bright as suggested by Kholopov and Samus (1988). All other objects in Zessewitch (1934) have Guide Star Catalog (GSC: Lasker et al. 1990) counterparts and the limiting magnitudes should have been brighter than 15 mag. YY Dra should have been as bright. According to the DASCH light curve of DO Dra presented in Hill et al. (2022), this object was detected at intermediate brightness slightly below 14 mag in the early 1920s. Long-lasting similarly bright states were recently observed in 2017 January (\( V \) above 14.5) for a month and in 2021 May when the object was near or above \( V =14 \). Tseveich might have observed such a long-lasting bright state when DO Dra was almost always visible on the plates he examined with occasional “invisible” moments, which could have been sufficient to convince him of the Algol-type nature and to urge him to obtain the moments in historical plates when the object was undetected.

4 Conclusion

We have shown that the results by Tseveich were not as complete and previously supposed. In his discovery paper of YY Dra, two out of four objects were either lost or improperly studied. The coordinate offset from the correct position in another object was much larger than the expected error. Using the information of published period and epoch of YY Dra, we suspect that Tseveich could have used a couple of plates on which the object was invisible to derive the period rather than from a completely phased light curve. Judging from him, his conclusion on YY Dra was not incompatible with what is expected for the current DO Dra.

In response to Koji Mukai’s judgement (typos corrected) “The main substantive point of Kholopov & Samus can be quickly dismissed. This object is not a (normal) dwarf nova; it is a Low Luminosity IP with occasional (dwarf nova-like) outbursts. If this was a normal dwarf nova, their statement might be true”, we note that DO Dra pretty much behaves like a normal dwarf nova (Wenzel 1983). The only apparent difference from a normal dwarf nova is the shortness (a few days) of outbursts compared to what is expected for its orbital period. If the orbital period and the nature of the secondary were unknown, the behavior of DO Dra would be indistinguishable
from dwarf novae below the period gap showing only normal outbursts and high/low states in quiescence (such as IR Com). In this point, Kholopov and Samus (1988) was correct. We consider what was probably wrong with Kholopov and Samus (1988) was that they assumed that Tseyesvich used a much more comprehensive data set than we suspect in this paper.

At the time of writing of this paper, crises are unfolding in Ukraine. As we have seen, the final conclusion on Tseyesvich’s YY Dra is almost impossible to reach due to the result of the World War II. The same thing also happened in various fields of science. For example, some of type specimens in biology were completely lost (see e.g. Eggli and Leuenberger 2008; Müller and Tennent 2018). We wish that no further destruction of our treasures should occur. The illustration is the Ukrainian dove for Peace designed by Moscow-born designer Natasha Alimova to support Ukraine during the Maidan revolution of 2014. TK learned this symbol from the page by the BirdLife International and I would like to share it to be with the people, including the second author with her colleagues in Ukraine and Russia, suffering from hard moments.

Acknowledgements

This work was supported by JSPS KAKENHI Grant Number 21K03616. The author is grateful to the ASAS-SN team for making their data available to the public. This research has made use of the AAVSO Variable Star Index and NASA’s Astrophysics Data System. We are grateful to Aleksandra Zubareva who made us accessible to Samus (1988). TK is grateful to N. N. Samus about the discussion in 2000.

List of objects in this paper

SU Cep, AI Cep, IR Com, Z Dra, YY Dra, DO Dra, RR Lyr, β Lyr, β Per, GM Sgr, V4641 Sgr, RW UMa, NSV 14669, NSV 14776, 3A 1148+719, ASAS J235727+2407.6, E 1140.8+7158, GSC 02251-00965, NSVS J235727.2+240732, PG 1140+719

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We provide two forms of the references section (for ADS and as published) so that the references can be easily incorporated into ADS.

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