

## **ST Chamaeleontis and BP Coronae Australis: Two Southern Dwarf Novae Confirmed as Z Cam Stars**

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**Abstract** Z Camelopardalis (Z Cam) stars are a subset of dwarf novae distinguished by the occurrence of “standstills”—periods of relative constant brightness one to one and a half magnitudes fainter than maximum brightness. As part of an ongoing observing campaign, the Z CamPaign, the authors focused attention on several Z Cam suspects in the southern hemisphere. Two stars, BP CrA and ST Cha, were found to exhibit standstill behavior in 2013, thus confirming them as Z Cam-type systems. This adds two more bona fide members to the nineteen confirmed Z Cams, bringing the total to twenty-one.

### **1. Introduction**

Dwarf novae are a subset of cataclysmic variables, close binary pairs consisting of a white dwarf (WD) primary and a main sequence secondary. The primary accretes matter from the secondary star through the inner Lagrangian point, forming a disk around the WD primary in non-magnetic systems.

Z Cam stars are a subset of dwarf novae that, along with the typical dwarf nova outbursts and relatively brief periods of quiescence, occasionally display standstills in their light curves. It is these standstills that set the Z Cam stars apart from all other dwarf novae (Simonsen *et al.* 2014).

Since their discovery in the late 19th century, our understanding of dwarf novae has grown immeasurably. Along the way, our classifications and definitions have evolved to what they are today, causing some stars to be reclassified. This is especially true for the Z Cam stars whose definition has evolved considerably since being introduced over eighty years ago.

## 2. History

As with nearly all the bona fide and suspected Z Cams in the literature, the classifications of BP CrA and ST Cha have been the subject of confusion and debate for many years. This has been caused, in large part, by the evolution of the definition of Z Cams over time (Simonsen *et al.* 2014). In the case of many southern Z Cams and suspects there has historically been sparse coverage, which has led to misclassifications based on incomplete light curves and a lack of reliable information.

### 2.1. ST Cha

ST Cha was discovered in 1934 as an irregular variable (Luyten 1934). During the next seventy-nine years it became variously classified as rapidly irregular, RW Aur, IS, T Tau, and a dwarf nova. Included in a study of RW Aur stars in 1974 (Glass and Penston 1974), ST Cha was not detected in the JHKL infrared bands. However, it was not included in the list of stars considered not to be RW Aur stars in that paper. Still considered a pre-main sequence star in 1975, ST Cha was classified as a T Tau star (Mauder and Sosna 1975). UBVR photometry obtained in 1986 (Cieslinski *et al.* 1998) suggested a dwarf nova classification. Downes and Shara adopted this classification in their *Catalog and Atlas of Cataclysmic Variables* (Downes *et al.* 2001). Another noteworthy CV catalog (Ritter and Kolb 2003) has it ambiguously classified as a possible nova-like variable or suspected dwarf nova that might be a Z Cam sub-type. The *General Catalogue of Variable Stars* (GCVS) still lists ST Cha as an IS type, a rapidly irregular variable not associated with nebulosity, as of December 2013 (Samus *et al.* 2007).

### 2.2. BP CrA

BP CrA was initially classified as an irregular variable of the SS Cyg (UGSS) type from plates from the Union Observatory, Johannesburg, South Africa (van Gent 1933). In 1960 it was suspected of being a Z Cam-type variable (Petit 1960), but in 1961 it was re-classified as a possible RW Aur-type variable by the same author (Petit 1961). It was later observed in a systematic attempt to determine which southern cataclysmic variables (CVs) might be binary stars by monitoring for eclipses (Mumford 1971). BP CrA is listed as a U Gem star in that paper. No eclipses were found. BP CrA's specific sub-classification remained unclear in papers published even after the nature of CVs was better understood, with some listing it as simply U Gem (Echevarria and Jones 1983) and others classifying it as a member of the Z Cam type (Vogt and Bateson 1982; Bruch 1983; Pretorius *et al.* 2006; Downes *et al.* 2001; Warner and Woudt 2006). The GCVS still classified BP CrA as a suspected Z Cam as late as 2013 (Samus *et al.* 2007). To this day, the orbital period of BP CrA is unknown.

### 3. Standstills of ST Cha and BP CrA

All observations in this paper are from the AAVSO International Database (AAVSO 2013). All light curves were created using VSTAR (Benn 2012). Black dots are visual data, other dots are CCDV data.

#### 3.1. ST Cha

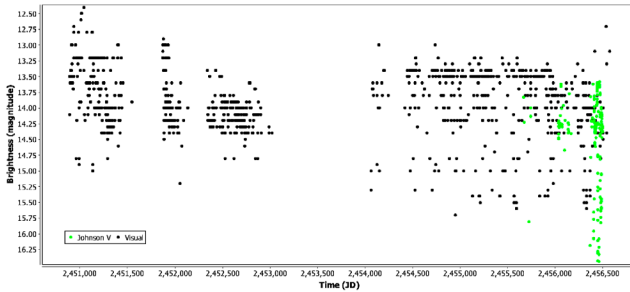


Figure 1. Long-term AAVSO light curve for ST Cha. It appears to show more-or-less common dwarf nova behavior from JD 2450892 to 2452134 (March 20, 1998–August 13, 2001). Then there is a period that could be interpreted as a standstill, or even nova-like behavior, from JD to 2452353 to 2453023 (March 17, 2002–January 18, 2004). After a significant gap in the data, typical dwarf nova behavior, with outbursts and quiescences, resumes from JD 2454062 (November 22, 2006) to the present.

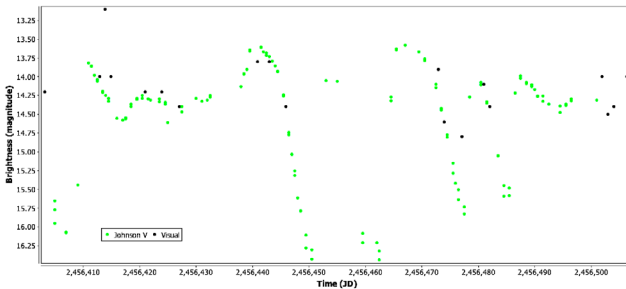


Figure 2. Embedded in the ST Cha light curve from 2013, the almost daily snapshot CCDV observations reveal a complex behavior featuring standstills followed by outbursts and minima in rapid succession, reminiscent of V513 Cas and IW And (Simonsen 2011; Szkody *et al.* 2013), confirming the Z Cam classification of ST Cha.

## 3.2. BP CrA

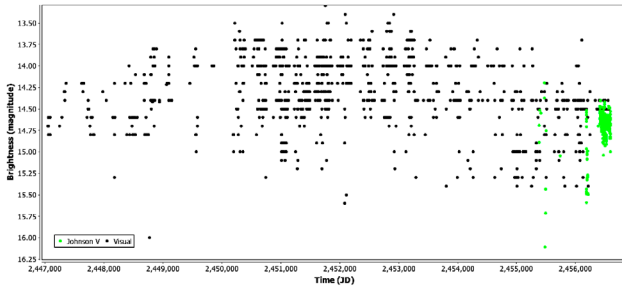


Figure 3. The long-term AAVSO light curve for BP CrA showing the spotty coverage dating back to 1987 and the recent concentrated effort beginning just before the first recorded standstill. There are no obvious standstills in the data until 2013 (beginning JD 2456362).

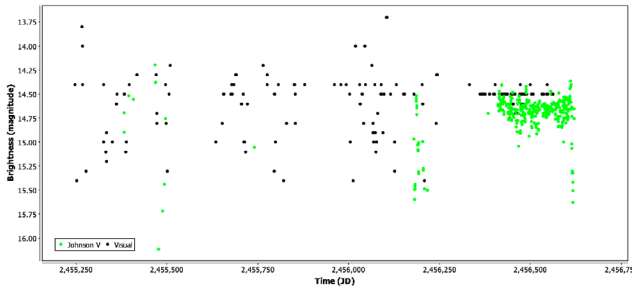


Figure 4. The more recent detailed AAVSO light curve, showing the first recorded standstill of BP CrA beginning JD 2456362 and ending JD 2456615 (March 10–November 18, 2013). This unambiguous example of a standstill confirms the status of BP CrA as a Z Cam dwarf nova.

## 4. Conclusions

Newly-acquired data clearly demonstrate the existence of standstills in the light curves of ST Cha and BP CrA, making them bona fide members of the Z Cam class of dwarf novae. This classification and their other known properties are listed in Table 1.

Table 1. Properties of two new Z Cam systems.

<i>Name</i>	<i>R.A. (2000)</i> <i>h m s</i>	<i>Dec. (2000)</i> <i>° ′ ″</i>	<i>Max.</i>	<i>Min.</i>	<i>Type</i>	<i>Orbital period</i>
ST Cha	10 47 15.91	−79 26 07.2	12.4V	16.4V	UGZ	6.84 hrs
BP CrA	18 36 50.89	−37 25 53.6	12.7V	16.4V	UGZ	unknown

## 5. Acknowledgements

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