

# TAU CASSIOPEIAE: NOT A VARIABLE STAR

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## Abstract

Tau Cassiopeiae (KlIIIa) appears to be non-variable in light and velocity, despite published indications to the contrary. The origin and propagation of the claims of variability are relevant, in a broader context, to (1) the certification and documentation of stellar variability and (2) the nature of the more than 200 suspected K-giant variable stars in the **Yale Catalogue of Bright Stars**.

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## 1. Introduction

Tau Cassiopeiae (HR 9008, HD 223165, KlIIIa,  $V = 4^m87$ ) is listed as entry NSV 14707 in the **New Catalogue of Suspected Variable Stars** (Kholopov *et al.* 1982) and as a suspected light and velocity variable in the **Yale Catalogue of Bright Stars** (Hoffleit 1982). Its suspected variability came to my attention during a detailed study of visual observations of rho Cas (Percy, Fabro, and Keith 1985), for which tau Cas is a convenient and often-used comparison star. According to Bailey (1978), however, the Variable Star Section of the British Astronomical Association (BAA) had gradually dropped tau Cas as a comparison star because it was independently suspected of variability by C. Henshaw, P. Hornby, and P. Quadt (Henshaw 1973; Howarth 1973; Henshaw 1976). The **New Catalogue of Suspected Variable Stars** credits Hornby with the discovery of the suspected variability, and gives an amplitude of 0.3 magnitude: (magnitude system unspecified, but presumably visual). It also gives reference to a paper by Keszthelyi (1973), to which I unfortunately do not have access. The American Association of Variable Star Observers (AAVSO) continued to use tau Cas as the primary comparison star for rho Cas, and this greatly complicated the intercomparison of the BAA and AAVSO observations.

Unfortunately, the reports by Henshaw and Howarth were not published in magazines readily available in North America, nor were these reports abstracted in **Astronomy and Astrophysics Abstracts**, so I was not aware of the nature of the evidence for the suspected variability. Copies of these reports have since been sent to me by I. D. Howarth and J. E. Isles of the BAA. The report by Henshaw (1976) - a detailed examination and comparison of visual observations made contemporaneously but independently in five countries - actually concludes that "it is very likely that tau Cas was constant during the period that the star was observed" but that this fact "does not prove that the star is not variable. This can only be decided by further observation of the star, preferably with a photoelectric device, since the range of variation, if any, is so small."

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## 2. New Photoelectric Observations

I have in fact been observing tau Cas photoelectrically for many years (Percy *et al.* 1979; Percy and Welch 1981). It is the primary photoelectric comparison star for rho Cas, and I have always observed it relative to a check star HR 9010 (HD 223173, K3IIb,  $V = 5^m51$ ). The observations are listed in Table I; they have been obtained in the same manner as those of rho Cas described in Percy *et al.* (1979) and Percy and Welch (1981). With the exception of one season in which it showed a range of 0.05 magnitude (based on a very few observations), it has shown no variability larger than 0.02 magnitude during or between seasons. It is possible that the star is variable by a few hundredths of a magnitude, but it is also possible that the scatter is observational: the standard error of the observations made at the University of Toronto in downtown Toronto is typically 0.01 magnitude - occasionally a bit better, occasionally a bit worse.

## 3. Suspected Velocity Variability

The suspected velocity variability of tau Cas is apparently based (Abt and Biggs 1972) on the fact that one listing of its velocity (+20.3 km/s) in **Lick Observatory Bulletin 7** differs from all other reported velocities, which are all close to the mean of -21 km/s. The most likely explanation is that the sign of the discordant velocity is incorrect. E. A. Harlan of the Lick Observatory has kindly verified that this is the case; the files of the Lick Observatory list only six individual velocities - all about -21 km/s - but there is a cryptic note in the margin which indicates (incorrectly) that the mean of these six velocities is +20.3 km/s. Actually, Hoffleit (1978) has already called attention to this error, but it has nevertheless crept into the most recent edition of the **Yale Catalogue of Bright Stars**.

## 4. Discussion and Conclusions

There is no evidence that tau Cas is variable in light or velocity. Although this result is a very minor contribution to scientific knowledge, it is relevant to two more general and important problems. One is the identification and certification of stellar variability. The reporting of suspected variability is often done quite casually but, once a star is "tainted" in this way, it requires a great deal of observational data to establish its non-variability. The **New Catalogue of Suspected Variable Stars** contains very little information about the reliability of the initial identification of the suspected variability. The editors of this **Catalogue** are not in a position to provide such information; the onus is on the discoverer of the variability to be sure that his suspicions are well-founded. In the case of tau Cas, publications describing the suspected variability were not readily available. The suspected velocity variability of tau Cas is due to a typographical error propagated from one catalogue into another.

The non-variability of tau Cas may also be relevant to the problem of the nature of the more than 200 K-type giants in the **Yale Catalogue of Bright Stars** which are suspected to be variable in brightness. According to photometric surveys (such as the monumental pioneering study by Stebbins and Huffer (1930)), K-type giants are generally not variable in light, except in a few cases in which they are found in an eclipsing or an RS CVn binary system. It is interesting to note that, among the 24 named variable stars among the K-type giants in the **Yale Catalogue of Bright Stars**, eight are actually non-variable, five are RS CVn stars, five are semi-regular or irregular variables, three are listed as "unknown" types, two as VV Cep binary systems, and one as a non-VV Cep eclipsing binary system. The eight semi-regular, irregular, and "unknown" variables are obviously worthy of further attention, though some or all of them could well be constant. Perhaps all but a

handful of the suspected K-type giant variables are - like tau Cas - also constant. To verify this possibility would probably not be considered as interesting and glamorous as "discovering" new variables, but it would certainly be useful. Perhaps this would be a good project for the new Automated Photometric Telescopes which are as content to produce a negative result as a positive one.

### 5. Acknowledgements

I wish to thank (as I have done before) the editor of the **Yale Catalogue of Bright Stars** for compiling such a gold mine of information. I also thank I. D. Howarth and J. E. Isles for sending and commenting upon the reports of the suspected light variability of tau Cas, and E. A. Harlan and G. D. Penrod for verifying the explanation for the suspected velocity variability. Paul Ford and Doug Welch made some of the observations in Table I. I thank Kitt Peak National Observatory for allocations of observing time over the years, and the Natural Sciences and Engineering Research Council of Canada for a research grant.

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TABLE I

Photometric Observations of tau Cas Relative to HR 9010

JD	$\Delta V$	JD	$\Delta V$
2444049.806	0.660	2444792.840	0.650
4059.786	0.667	4796.815	0.650
4060.776	0.661	4801.832	0.669
4088.711	0.613	4807.857	0.676
4094.783	0.652	4817.860	0.652
4101.712	0.645	4833.854	0.664
4116.714	0.625	4842.838	0.645
4407.7785	0.659	4921.6417	0.657
4411.7792	0.653	4924.6792	0.652
4430.7507	0.641	5614.8403	0.669
4433.7368	0.650	5715.6701	0.662
4451.7153	0.641	5716.5993	0.671
4455.7125	0.647	6002.5792	0.650
4560.740	0.647	6009.6194	0.652