The Journal of
Astronomical Data
1995 – 1999
Volumes 1 – 5

THE JOURNAL OF ASTRONOMICAL DATA

1995 – 1999

Volumes 1 – 5

Edited by

C. STERKEN
University of Brussels (VUB)
Brussels, Belgium

M. de GROOT
Armagh Observatory
Armagh, Northern Ireland

These proceedings were prepared with
LaTeX and PCTeX

Published by C. Sterken
Vrije Universiteit Brussel
csterken@vub.ac.be

ISBN 90-805538-1-6
NUGI 814

Cover picture: adapted from from Johannes Hevelius' star atlas of 1687, with annotated positions of notorious variables P Cygni and χ Cygni

Contents

Preface

The Journal of Astronomical Data (JAD) was founded in 1995 with the intention to provide a forum for publishing original astronomical research data in machine-readable form. The Journal accepts observational data as well as data from theoretical research, reduction software and computer code, complete descriptions of new instruments, Ph.D. theses with extensive data tables, data catalogues, and regular astronomy papers accompanied by the data on which their analysis is based. Papers on all aspects of astronomy and astrophysics are welcome: observational, theoretical and instrumental. There is no bias towards the technique used to obtain the data: results from space experiments as well as ground-based data (whatever electromagnetic wavelength range) are acceptable. Historical data (ancient data archives or re-worked catalogues) are just as welcome as recently-acquired measurements.

The Journal consists of one volume per year, each volume containing a variable number of papers. The data are embedded in or appended to a scientific paper describing the scientific rationale of the underlying project, how the data were acquired, the intrinsic accuracy of the numerical results, and a short presentation of some of the conclusions of the analysis. Except for these Proceedings, JAD appears in electronic form only—that is, the manuscripts and their associated data are reproduced on CDROM or DVD disks, with some of the data made available through the Internet.

These proceedings present the descriptive part of the scientific papers published in the first five volumes. For reasons of economy, we have restricted every paper to its most essential descriptive aspect, omitting extensive tables and long lists. As such, the original manuscripts as they have been published in Volumes 1–5 have been shortened and reformatted to suit the format of this book.

C.S. expresses his gratitude to the Belgian Fund for Scientific Research (FWO) and the Vrije Universiteit Brussel for financing several research projects related to his contributions in these Proceedings.

The Editors

Christiaan Sterken
Mart de Groot

The Journal of Astronomical Data Volume I

1995

1

uvby and *B* photometry of the dwarf nova EX Hydrae†

C. Sterken[1,*], N. Vogt[2]

1) University of Brussels (VUB), Pleinlaan 2, 1050 Brussels, Belgium
2) Astrophysics Group, Pontificia Universidad Católica de Chile,
Casilla 104, Santiago 22, Chile

Received 31 October 1994; accepted 28 December 1995

Abstract

The eclipsing dwarf nova EX Hydrae was monitored during 29 hours in Strömgren *uvby*, and, at the same occasion, during 45 hours in the B band of the Johnson system. We present these data (more than 18,000 discrete magnitudes) *in extenso*, and scrutinize their quality in relation to their future employment in an analysis of flickering.

Keywords: Photometry – stars: variable – stars: novae and cataclysmic variables – EX Hya

---

†Based on observations collected at the European Southern Observatory, La Silla, Chile and at the South African Astronomical Observatory, Sutherland, South Africa

*Belgian Fund for Scientific Research (FWO)

1.1 Introduction

EX Hydrae is one of the earliest detected eclipsing binaries among the cataclysmic variables. The most striking property seen in the light curve of the star is the presence of a coherent large-amplitude periodic variation with a period of 67 min that is secularly decreasing (Vogt, et al. 1980, Sterken et al. 1983). The existence of this shortening 67-minutes cycle, in turn, is one of the prime reasons why EX Hydrae has been so intensively observed during the last decade.

A second prominent feature of EX Hya's light curve is the flickering: the presence of rather irregular light variations on time scales of seconds to minutes, with amplitudes exceeding several tenths of a magnitude. The occurrence of flickering is a common property of all cataclysmic variables and of all dwarf novae, though very few studies of flickering in cataclysmic variables have been undertaken. The very first quantitative analysis of this phenomenon was carried out by Bruch (1992), who demonstrated that the spectrum of the flickering light source is variable, as well in time as from one object to another, and that a significant part of the total light of a cataclysmic variable originates in the source of the flickering light.

For EX Hya, in particular, Bruch (1992) — on the basis of 3 hours of $VBLUW$ photometry at about 30 seconds time resolution — derives an amplitude of flickering of almost 1 mag in the B band (quasi-Johnson B derived from Walraven $VBLUW$ data) and a flare rate of 5.7 ± 3.7 flares per hour (that is, flares of amplitude not below 0.05 mag). Concluding his paper, Bruch (1992) advocates the enlargement of the statistical data base by further observations. Besides observations from space, he argues, there is rather a need for investigating the numerous light curves obtained in the past, than for *new* observations — at least if these time-honoured light curves are of an appropriate quality, and are representative for analysis (many such curves only cover the eclipse phases of the orbital cycle). To our knowledge, only Mumford (1967) published his data (394 U, 1191 B and 393 V observations collected at time resolutions from about 15 sec to 1 minute with an accuracy of about 0.04 mag in all bands).

In the last six months, three different research teams instigated us to make our own EX Hya photometric data available to the scientific community for analysis. Our light curves, indeed, are long compared to the time scale of the flickering, and are thus statistically representative. In addition, the high sampling rate allows to resolve for the high-frequency part of the flickering, whereas the simultaneous character of some of our data makes them excellently suitable for analysing the spectrum of the flickering source and for assessing the level of significance of conclusions related to these flare events that are seen in *all* bands. Since the possibility exists that such a database is regarded as being to a standard of high quality — and thus its content be taken at face value — we settled to publish our data *in extenso* together with a description of the experimental environment to be taken into account in any further analysis.

Table 1.1: Journal of observations: *uvby* (top part), *B* (bottom)

HJD 2440000	nr.	Weather conditions
3960.666 – .839	404	good
3961.642 – .728	199	high humidity; stopped for clouds
3963.579 – .891	727	clouds at beginning of night
3964.580 – .888	546	good
3965.540 – .884	791	excellent
3961.313 – .498	2793	cirrus clouds in day and evening
3962.390 – .611	3411	cirrus clouds in day and evening
3964.346 – .436	1517	cirrus in day and evening; stopped for clouds
3965.319 – .604	4329	cirrus in evening; good-quality night
3966.410 – .612	3132	cirrus in day and evening; excellent after midnight
3967.411 – .579	2646	several stops for cirrus
3969.273 – .610	4748	excellent night
3970.275 – .592	4926	clear sky, windy
3971.478 – .532	796	some clouds and fog
3972.419 – .483	1107	partly cloudy

1.2 The observations and reductions

The *uvby* observations have been obtained at the Danish 50-cm telescope at ESO. Data were simultaneously taken in all bands at a time resolution of 30 seconds. Four uncooled EMI 6256SA photomultipliers were used. The B data were obtained with the SAAO Sutherland 75-cm reflector at a time resolution of 5 seconds. A 2-channel photometer, and a Johnson-B filter, were used to simultaneously monitor EX Hya and the sky background. Table 1 gives a journal of observations.

Only differential photometry, using one comparison star (star g, finding chart in Fig. 3 (Warner 1976)), was aimed at (see Sterken et al. 1983). As a rule, EX Hya was monitored continuously for about one hour, and in between those time intervals, the comparison star was observed for about one minute. The successive monitoring sequences were interrupted every five to ten minutes for checking the centering of the object in the $30''$ diaphragm.

The reductions consisted of sky-background subtraction, and correction for atmospheric extinction. The nightly extinction coefficients were determined with the Bouguer method, using measurements of the comparison star. No transformations to a standard photometric system have been attempted. Tables 2 and 3**, respectively, list the differential *uvby* and B magnitudes of EX Hya *minus* the comparison star. The data are represented at the original time resolution; no binning or filtering was carried out, since such actions could lead to the recognition of spurious frequencies or timescales in the temporal spectrum of the flickering. Figs. 1 and 2, respectively, give a sample light curve of EX Hya in *uvby* and B.

**see CD-ROM

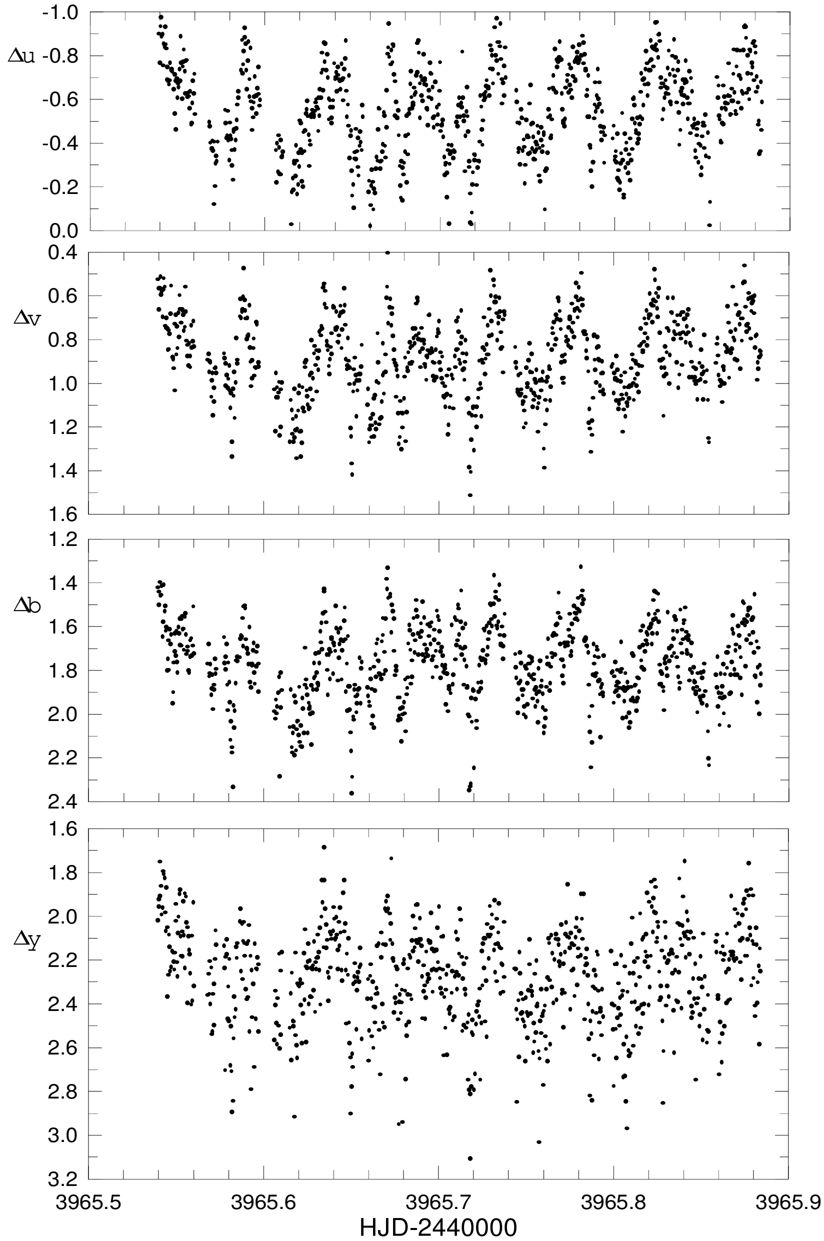

Figure 1.1: Sample of differential *uvby* light curves constructed with data from Table 2.

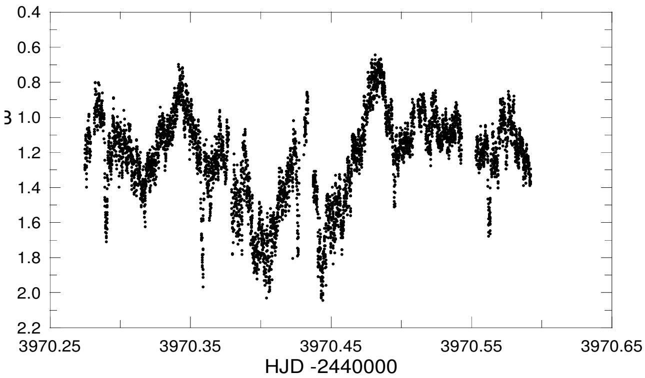

Figure 1.2: Sample of differential B light curves constructed with data from Table 3.

1.3 Quality of data

When considering the data given in Tables 2 and 3, one should bear in mind that

1. the atmospheric conditions were not of a very stable nature (see Table 1). The data represented in this paper, however, all refer to a good level of photometric quality, where no measurements were taken when there were indications for the presence of clouds

2. the photon shot noise for every data point amounts to $0.09, 0.06, 0.06, 0.13$ and 0.03 respectively in u, v, b, y and B.

3. all our data have been collected during uninterrupted time intervals of about one hour without opportunity for multiple observation of the comparison star. Thus, though nightly extinction in the field of EX Hydrae was fairly well determined through measurements of the comparison star g, the data could not be *optimally* corrected for atmospheric transparency variations

The last point entails the need for prudent assessment of the resulting time spectrum of the flickering phenomenon. Kurtz (1984) pointed out that scintillation noise is dominant at periods of a few minutes or less (note that at such short periods the B data — besides their smaller photon shot noise — have a slightly better level of scintillation noise than the $uvby$ data), and that for longer periods the noise is largely due to sky transparency and sky background variations. Thus, any resulting flickering frequencies of the order of the order of 2 mHz or longer (see the values given by Bruch 1992) must be scrutinized for contamination by the sky-transparency and sky-background variation component.

References

Bruch, A. 1992, AA, 266, 265.

Kurtz, D.W. 1984, in: Proceedings of the Workshop on Improvements to Photometry, (Borucki, W.J. and Young, A.T., eds), NASA Conf. Publ. 2350, 56.

Mumford, G.S. 1967, ApJS 15, 1.

Sterken, C. et al. 1983, AA 118, 325.