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A Practical Guide to Lightcurve Photometry and Analysis

Brian D. Warner

Second Edition

Springer

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Dedication

As always, this one's for my "rock star", Margaret (70030 Margaretmiller)

Foreword¹ (to First Edition)

It is a pleasure and an honor to offer a few words of foreword to Brian Warner's guide to photometry. In his preface, he makes a considerable point about amateurs and professionals and those who dare or deign to step across the line supposedly dividing the two. Here I would like to make a few observations about the two monikers and suggest that there is not, or at least should not be, a distinction between "amateur" and "professional." In preparing these remarks I referred to *Webster's New Collegiate Dictionary* (1960 edition; not so new anymore, but that was when my collegiate experience began):

am'a-teur, *n.* [F., fr. L. *amator* lover, fr. *amare* to love.] 1. One who cultivates a particular pursuit, study, or science, from taste, without pursuing it professionally; also, a dabbler. 2. In sports and esp. athletics, one who is not rated as a professional.

Well... a "dabbler" eh? "Not rated as a professional?" No wonder we have an identity problem here. Somehow in my youth as an amateur astronomer, I missed this connotation of the term. To me, the meaning of the term amateur was dominated by its root, "to love," that is, one who does what he does out of love of the subject, not for remuneration (to the extent one can get away with that). In that context, most "professional" astronomers I know are also "amateurs": they love what they are doing and choose the profession primarily for that reason, not how much money they could earn. Indeed, I have often advised students that if they are

¹ There is also another Alan Harris (also engaged in asteroid research, in Berlin, Germany). In this case we are both Alan William Harris, so a middle initial doesn't differentiate. I refuse to identify him as "the other" Alan Harris, as I think neither should suffer a diminutive term. The same goes for Brian Warner.

smart enough to eke out a living in astronomy, they are smart enough to get rich quick in some other field, thereby freeing themselves a bit later in life to become a “gentleman astronomer.”

This brings me to another perspective on “amateur” versus “professional.” Most folks need to earn a living somehow, so almost every “amateur” astronomer is a “professional” at something else. And curiously, most of us who call ourselves “professional” astronomers are amateurs in other fields that are essential to our pursuits. This basic fact of life further blurs the distinction between amateur and professional, in any field. Indeed, my own graduate training is as a theoretician. I have never taken a single course in observational astronomy. So as an observer, I’m one of you, an amateur, self-taught in my own backyard. Another conspicuous example is computer programming. “The other Brian Warner,” author of this book, is a professional when it comes to software development, and writing for that matter, talents many of my “professional” astronomer colleagues sorely lack. A result of this is that there are software packages out there, written by professional software writers for the amateur community, that are far more powerful, efficient, and user-friendly than their “pro” counterparts. The people who wrote them may be “amateur” astronomers, but they are highly professional in their computer skills. Amateurs now have at their disposal computer tools for telescope pointing, focusing, data taking, and reduction that far surpass what is in use at most professional observatories. You’ll find several such packages mentioned and described in this book.

I’ll now turn to a bit of history. In the late 1990s, my colleague Ted Howell and I noted that there was a dearth of activity among American amateur astronomers in minor planet (asteroid) observing, compared to various overseas observers, notably in Japan and Italy. Ted had just been to an amateur meeting in Italy and was favorably impressed by their organization and activities. We decided to organize a meeting of amateurs and professionals engaged in asteroid observations to try to stimulate interest in the amateur community in the United States. The meeting was hosted at Lowell Observatory in Flagstaff, AZ, 23–24 April 1999. I think we were successful in stimulating interest.

During the meeting, it became apparent, to me at least, that a key to amateur participation was the availability of understandable and user-friendly computer tools. At that time, amateur participation in asteroid work was mainly in astrometry, aided by the program *Astrometrica*, written by Herbert Raab of Linz, Austria. This program allowed amateurs to do positional astrometry on asteroids in a friendly environment without having to understand fully every detail of the process (*n.b.*, this is not the same as “in a state of ignorance!”). At the time of the Flagstaff meeting, I commented that in order to get amateurs involved in photometric observations of asteroids, what was needed was a *Photometrica* program.

In the years since that time, *Photometrica*, admittedly not by that name, has been written, in fact in several versions, as cited in this book. One is Warner’s own *Canopus* program, and this book serves as a companion for observers who want to

learn the game of asteroid or variable star photometry, using either *Canopus* or one of the several other options mentioned in the book. I think with the development of these user-friendly programs, and now with the publication of this book, CCD (charge-coupled device) photometry for amateurs has come of age, and I look forward to the contributions that will inevitably follow.

La Canada, CA, USA

Alan W. Harris

Preface (2nd Springer Edition)

For those with the two previous editions of *A Practical Guide to Lightcurve Photometry and Analysis* already on your shelf, thank you for adding this one to your collection. To clear the confusion, this is the second edition *published by Springer*. The “true” first edition is the one I self-published in 2003.

It has been 10 years since the first Springer edition was published. Things have changed since then. The equipment and software available to the backyard astronomer have improved significantly, making robotic operations relatively simple and (almost) very reliable.

On a typical night, five telescopes located 1200 miles from my Colorado home are imaging five or more asteroids. Software on each of the five on-site computers controls the roofs of three buildings along with the telescopes, cameras, focusers, and filter wheels. During the night, focus is maintained, the telescopes are kept centered on their asteroids, and hundreds of images are uploaded to the “cloud” and then to my computer here at home. The software resets itself a few minutes after sunrise and sits waiting for sunset to repeat the process.

All this is done while I am sleeping or working on other things (like this book), except for the times my internal alarm goes off and I check on things using remote desktop software. As I’m fond of saying, “Never trust a computer.” Using this setup in 2014, I was able to watch the telescopes in California operate while sitting at a Paris café sipping hot chocolate and watching the boats go up and down the Seine. After a visit to the Louvre, I retrieved the images from my cloud account and measured them while sipping a nice wine. Life can be good sometimes.

Remote and robotic setups are now almost considered to be the usual instead of the extraordinary. The proliferation of remote and robotic systems as well as the advances in telescopes and cameras has led to a nearly exponential growth in the

number of asteroid light curves being published by backyard astronomers in the *Minor Planet Bulletin* since 2000.

I'd been thinking about writing this new edition for a couple of years. Parts of the previous edition needed to be updated to account for new equipment and new ways of doing things. With another decade of asteroid lightcurve analysis under the belt, I also wanted to revisit the chapter on asteroid lightcurve analysis that covers some of the pitfalls when finding a period. Some astute readers found some errors throughout the book that needed fixing. I've done my best to correct them. If any remain, they are entirely my fault.

Others said they thought the book needed more substance so that they didn't need to go through a number of other resources to complete their understanding. I appreciate that: It's nice to have everything in one place. However, going too far in this direction would defeat the original purpose of *A Practical Guide to Lightcurve Photometry and Analysis*, which was to provide the core information necessary to make an informed start in photometry, how to develop an observing program, and how to analyze the resulting data. I've found that I learn more by doing rather than reading. I also believed that delving into more detailed and complicated material in midstream might intimidate those new to the subject, and so they would decide that stamp collecting would be a more worthwhile pursuit.

I've tried to reach a compromise by adding more advanced material as unobtrusively as possible. I *still* recommend reading other texts.

Variable stars have not been forgotten. I like variable stars, especially W UMa ("WOO-mah") close binaries and RR Lyrae types. Both of these usually have periods short enough to catch a complete cycle during the longer nights from autumn to early spring. The lightcurves are usually straightforward and repeat with little or no variation. For these reasons, I often recommend these variable stars as first targets for those starting out in photometry. This allows the observer to concentrate on developing his photometry and analysis techniques instead of trying to decipher a difficult data set to find a period. Once he's comfortable with the basics, then he can move onto asteroids, which provide a whole new set of challenges.

In the previous editions, I showed examples of measuring images and analysis using different programs and spreadsheets. In this edition, I'll be using screenshots from *MPO Canopus* almost exclusively to illustrate results. To be clear, however, this book is *not* a manual or tutorial for *MPO Canopus*. Simply put, it was more efficient to use and reference a single piece of software. Also, it happens to be the one with which I'm most familiar—I wrote it. That said, the appendices still include examples using spreadsheets so that the abstract concepts will have substance. The spreadsheet files are in a ZIP file and can be accessed at:

http://www.MinorPlanetObserver.com/pgbook/PG3_SpreadSheets.zip

Thanks to my friends at CS3, Bob Stephens and Daniel Coley, who did almost all of the work on the getting the Palmer Divide Station built and running and then kept the equipment going despite Murphy's best efforts. Thanks again to Dan and Dan Klinglesmith III of New Mexico Tech and Greg Crawford in Australia for reading through the text and offering their many helpful suggestions and a very big

thanks to Robert K. Buchheim for his thorough technical review and many suggestions that made this book infinitely better.

Thanks also to Nora Rawn at Springer for encouraging me to go from thinking about to actually writing this third edition and then guiding me through the machinations of getting this to press.

Eaton, CO, USA

Brian D. Warner

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