

What and Where to Publish:

Current, Valuable, and Publishable Research Topics for Amateurs

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1. Introduction

Amateur astronomers, either individually or in groups, can make important contributions to astronomical research – especially variable stars – using small telescopes, binoculars, or even the unaided eye. The same is true of students, especially those in schools, colleges, or universities with small telescopes and knowledgeable instructors. Many articles and books have been written on the subject; I do not hesitate to mention Percy & Wilson (2000, *Amateur-Professional Partnerships in Astronomy*, ASP Conference Series **220**), the proceedings of a joint meeting of the AAVSO, the Astronomical Society of the Pacific, and the Royal Astronomical Society of Canada. I especially recommend the article by Leif Robinson.

Some amateurs like to try out several kinds of research projects but, eventually, there are advantages to specializing in one or two areas, just as professionals do.

The results of research should be disseminated. To paraphrase Friedrich Argelander, the father of variable star astronomy, “observations in a drawer are no observations at all”. Disseminating once meant publishing. Now there are more options.

That being said: you should realize that there is considerable effort and cost involved in formally publishing a research paper, both on your part and on the part of the publication. It is not worth doing unless your work is sufficiently significant and interesting. In some branches of professional science, there is a concept called the “minimum publishable unit”: the least amount of content that would justify publishing another paper to pad the scientist’s bibliography. We discourage this approach.

So you should think carefully before you publish a paper. If you have the writing bug, you may want to satisfy it by writing non-technical articles on variable star topics for your club newsletter, or for a wider-circulation publication such as *The Reflector* or even *Sky & Telescope*.

2. Communal Observing Programs

A good way for the amateur to start is with a well-organized communal observing program such as the AAVSO’s visual, photoelectric, or CCD observing programs. There are good instruction manuals, and mentoring by experienced observers. The observations are quality controlled, and made available to researchers, so you can be sure that your efforts will be put to good use. Visual observations are still very powerful: the demand for the AAVSO’s visual observations has increased by a factor of 25 in the last three decades.

Other communal programs are coordinated by individual professional astronomers, such as Joe Patterson who coordinates the *Center for Backyard Astrophysics*. In this program, CCD and photoelectric photometrists observe the rapid variability of cataclysmic variables – variability which is due to a dizzying array of physical processes in these close binary stars.

Professional astronomers often coordinate observing “campaigns” on selected stars, such as the VV Cep stars – supergiant eclipsing binary stars with long periods. Many of the supergiant

components are pulsating stars as well. For example: ϵ Aur eclipses every 27 years, and pulsates; the next eclipse starts in 2009.

Back in the 1980's, it was fashionable for amateur photoelectric photometrists to monitor RS CVn binaries and other spotted sun-like stars, whose light curves changed from month to month because of changes in the spots on the star. Doug Hall was the main coordinator of this work. This field seems to have been taken over by robotic telescopes, but one of the RS CVn stars recently resurfaced as the guide star for the *Gravity Probe B* satellite. Several AAVSO photometrists participated in a campaign to observe this star.

One area in which amateurs and the AAVSO have recently stepped in to fill a gap is infra-red monitoring of variable stars. This requires a special photometer, and a reasonably good observing site. But it's useful, because many variable stars are brightest in the infra-red, and not many professionals work in long-term monitoring of stars. You can find out more by searching the AAVSO website.

In addition to the tried-and-true variable star observing programs, there are programs to search for novae and supernovae (success not guaranteed!), to search for transits of exo-planets (success certainly not guaranteed), and to search for optical counterparts of gamma-ray bursts. The AAVSO coordinates programs in all these areas. The most recent is a partnership with transitsearch.org.

There are also important long-term programs to measure times of minimum of eclipsing binaries, and times of maximum of RR Lyrae stars. These lead to information about period changes, which are still not well understood.

In the case of the RR Lyrae stars: about a third of these stars show long-term changes in the amplitude and shape of the light curve, a phenomenon called the *Blazhko effect*. The cause of this effect is still not known, so careful long-term monitoring of a selected sample of stars would be useful.

3. One-on-One Research Projects with a Professional Astronomer

These may be of any kind that makes use of imaging or photometric measurements, and include projects dealing with solar system objects, active galactic nuclei etc. I refer you to the articles in Percy & Wilson (2000) for many examples. They may also include examples of the types of projects listed below.

4. Independent Research Projects

Here are some thoughts of types of projects which might be of interest. Remember that, if you are working independently of professional astronomers, or organizations like the AAVSO, then you are responsible for your own quality control in making and reducing your observations. And one faulty observation may require dozens of good observations to make up for it!

- Using archival data to look at the long-term behaviour of stars whose dominant variability is on a shorter time scale. One example is the long secondary periods which are found in pulsating red giants. These can certainly be studied with photoelectric photometry, but they can also be studied with archival visual data, as long as there is sufficient data available. A related question is whether the so-called semi-regular and irregular pulsating red giants are really irregular, or whether they are perhaps multiperiodic. This project would require a fairly sophisticated knowledge of time-series analysis.

- Looking at the short-term behaviour of stars whose dominant variability is on a longer time scale. For instance: do Mira stars really show occasional short-term variability, as one or two observers have suggested?
- A related topic is searching for pulsations in components of eclipsing binary stars. If one component is a δ Scuti or β Cephei star, then it may be possible to determine its mass from the binary motion. And there are very few pulsating stars whose mass is known.
- Observing unique variables which should be monitored regularly. For instance: V725 Sgr is a pulsating star which has slowly changed its period from 12 days to 90 days over the past century. Yet, for several decades, it was not observed! It would be useful if the AAVSO could compile a list of such stars.
- Monitoring variables whose period and/or amplitude may possibly change measurably with time. For instance: W Vir, the prototype of the Population II Cepheids, is not regularly monitored, so knowledge of its period changes is incomplete.
- A field which was neglected, until recently, was the observation of long-period variables in globular clusters. This requires systematic monitoring over many years. Amateurs with CCD cameras are well-equipped to do it.
- Back in the 1970's, some AAVSO observers carried out systematic visual observing of T Tauri stars. At the time, it was not known whether the results were useful, so the data are only now being validated and analyzed. There is value in continuing the observations of these stars, especially those with coherent periodic variability.
- For photoelectric/CCD photometrists: obtaining multicolour photometry of stars which are normally observed in one filter only.
- For photoelectric/CCD photometrists: observing suspected variables (from surveys such as *Hipparcos*, for instance), or variable comparison stars, to determine whether they are variable or not. Note: it's probably not necessary to publish the results star by star, especially if they are negative; as with many projects, the publication can deal with many stars at a time.
- For photoelectric/CCD photometrists: remember that bright stars are "off limits" to large telescopes. So there can be value in determining the photoelectric light curves of stars such as γ Cas, the prototype of its class. There are also undoubtedly many unstudied or understudied variables in the *Bright Star Catalogue*.
- A rather neglected area of variable star astronomy is the *spectroscopic* monitoring of stars. A good example is the Be stars (γ Cas variables). Observers, with small telescopes and spectrographs, could do useful work by monitoring the changing emission in these stars.

You may also want to think about analyzing *existing* data. Thanks to surveys such as *Hipparcos*, OGLE, MACHO, TASS, and ASIS, there is large amounts of data which is unanalyzed,

or underanalyzed. If you have, or can develop some expertise in time-series analysis (Templeton 2004 *JAAVSO*, **32**, 51), then there is work for you here.

Even if you make your own observations, you can still make use of archival observations, including those in the AAVSO databases. A good strategy for undergraduate research projects on variable stars is to take some new measurements, and combine them with archival data for analysis purposes. And as long as the new observations are good, you can then contribute these to the archive for others to use.

5. Where to Publish

If you are part of a communal program such as the AAVSO's, then your observations will be effectively disseminated. You should be acknowledged, along with other observers, for your work, but you will not be a co-author of a research paper unless you have provided the bulk of the data.

If you work one-on-one with a professional, they should take responsibility for publishing the work. If you have contributed substantially, you should be a co-author, or should be effusively acknowledged.

If you are working independently, there are several places that you can submit your work for publication, two being the *Journal of the AAVSO* and the *International Astronomical Union Information Bulletin on Variable Stars*. [The *International Amateur-Professional Photoelectric Photometry Communications* was a popular alternative, but appears now to be defunct.

Another place for publication is in the proceedings of conferences. This is more common for professionals, but contributors to AAVSO meetings and conferences are encouraged to prepare their paper for publication. These papers are refereed and edited.

Undergraduate research students often present their work at professional meetings, or at local symposia with other undergraduates. In the latter case, there is often a proceedings, or the papers are published on-line, with the supervisor providing the quality control.

An alternative to publishing in a journal is publishing on-line. Almost everyone, these days, has a website. Your publication would be picked up by search engines. However, it would not be accessed by archiving services such as the *Astrophysics Data Service*, as it would if it was formally published in a print or on-line journal or conference proceedings. One advantage of publication in a journal is that your paper will be refereed and edited, which improves it and gives it credibility. When my students do on-line literature research, I always warn them to look for articles on "reputable" websites.

University libraries have developed an interesting archiving and dissemination process which, at my university, is called *TSpace*. My students' papers can be archived there; they appear in the library catalogue, and can be found by search engines; I am responsible for quality control.