Certified Citizen Astronomers - Progress, Collaboratives and Research

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Abstract

Two years ago, I presented a paper to the SAS proposing a "certification" process to assist qualified amateurs in locating professional research projects in which they might participate. The plan included:

1. locating and hosting dark sky observing sites
2. forming associations with other non-profit groups to identify, train, and qualify interested amateurs of all ages so that they can participate in meaningful professional/amateur projects
3. organizing a set of online training courses that could provide specific training in spectroscopic, astrometric, and photometric techniques

This paper describes the latest pro/am research projects, organizational progress, course development, faculty recruiting, as well as the completion of various remote observatories affiliated with this novel venture.

1. Introduction

Historically, the advancement of Science was propelled - not by professional scientists with large grants and modern laboratories – but by common people. Whether they were farmers, laborers, soldiers, teachers, or homemakers, they were curious by nature, with a desire to find out more about the universe around them. Some were young, others were old, but they shared some common traits: they were enthusiastic in their search for answers, they had driving spirits, and – more often than not – they saved specimens from their studies, and recorded their observations in notes, drawings.

Overriding all of these traits was one main characteristic, they were all passionate about their interests. They came to be known as "amateurs", a loose derivation of the Latin root, "amator", which loosely translates to: lover of, or devotee.

Today unfortunately, the term amateur is sometimes used in a derogatory fashion with regards to scientific research. In some sense, this is warranted because amateurs do not generally have the formal training necessary to solve complex problems. However, as with paralegals, and similar jobs, these amateurs can be trained to provide needed services to assist professional scientists in their research. The important key to this training is that the amateur must be exposed to training programs that are current in their content, and relevant to professional/amateur collaborations.

Astronomy is one of the most recent scientific disciplines to embrace amateurs into its research programs. For example, one citizen astronomer's observations in collaboration with professional scientists resulted in the discovery of the most unique

comet event ever witnessed in recorded history, when David Levy, a science writer by profession, and an avid amateur astronomer, teamed up with Eugene Shoemaker, a world-renowned geologist and astronomer, along his wife, Carolyn, to search for comets on Palomar Mountain. Finally, in July of 1994, after thirteen years of searching for comets, they discovered a comet that would revolutionize our knowledge of comets when it crashed into the cloud cover of Jupiter. Shoemaker-Levy 9 guaranteed David Levy a unique place in astronomical history…the first citizen astronomer to document a comet impacting a planet!

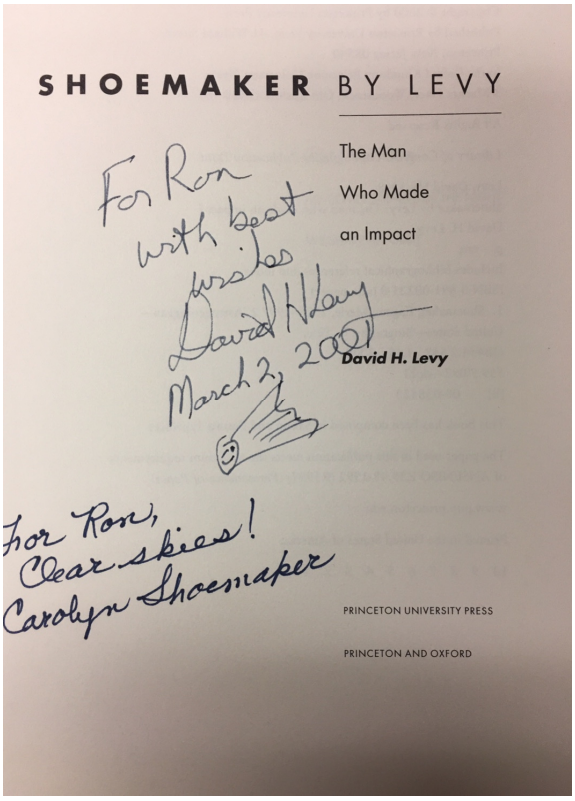

Figure 1- David Levy's Bio of Eugene Shoemaker

2. Locating and Hosting Dark Sky Observing Sites

Today, rapid technological development is providing important advancements in telescope design and implementation. Many citizen astronomers have access to equipment that exceeds the potential offered by some of the older "professional" systems designed and installed in some of today's professional observatories.

One obstacle that has become more intrusive is the expansion of our urban areas and the resultant diminished access to dark sky sites where citizen astronomers can set up their telescope systems to conduct small telescope research.

In 2015, during the 34th Annual Symposium on Telescope Science, I announced that plans were being completed for the University of North Texas astronomy program to install a small research telescope system at Dark Sky Observatory site near the McDonald Observatory in west Texas. This site, which regularly records skies as dark as Atacama, Chile (Bortle class 1), included a planned sever-pier, roll-off observatory with internet hosting.

By the time the facility was completed in 2016, it had been re-designed and expanded to include eleven piers. Today, all of the piers are occupied by companies including: OPT, ExoAnalytics, BRIEF, University of Dallas, University of North Texas, Universidad Technológica de Panamá, along with several private subscribers (including one NIST research scientist).

Figure 2 – Dark Sky Observatory (2017)

Due to the number of requests for pier space, Preston Starr, the owner of the Dark Sky Observatory, recently announced the

completion of a second roll-off observatory, identical to his current facility. It will allow for an additional 11 subscribers.

Figure 3 - Dark Sky Observatory, Bldg. #2, 2018

There are two additional observatory sites owned and managed by members of the citizen astronomer's collaborative. The first site, located near the border of Texas and Oklahoma, is operated by the University of North Texas. The site for the Monroe Robotic Observatory was funded through a gift from UNT alumnus John David Monroe, while the observatory was funded through a Grant from the National Science Foundation that proposed incorporating off-the-shelf, commercial telescopes within a remote, robotic observatory.

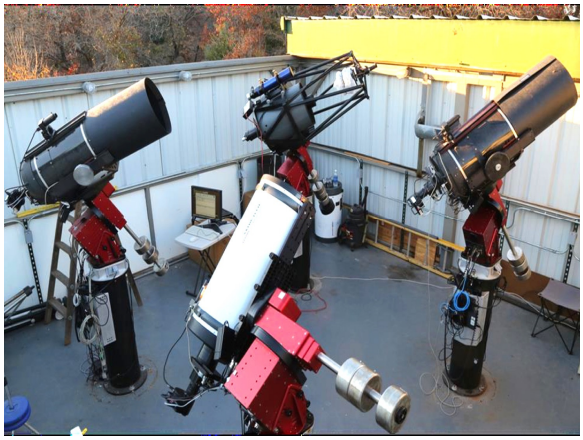

Figure 4 – UNT Monroe Robotic Observatory

A second observatory, the Cowtown Observatory, located south of Fort Worth, Texas is owned and managed by the Institute for Citizen Astronomy. At this site, deserving students from middle school through high school will have opportunities to image for an evening on a .36m, f/2 wide field telescope to develop remote astroimaging skills. The observatory will also be used as a proof-of-concept test bed for our other observatories when considering new hardware additions.

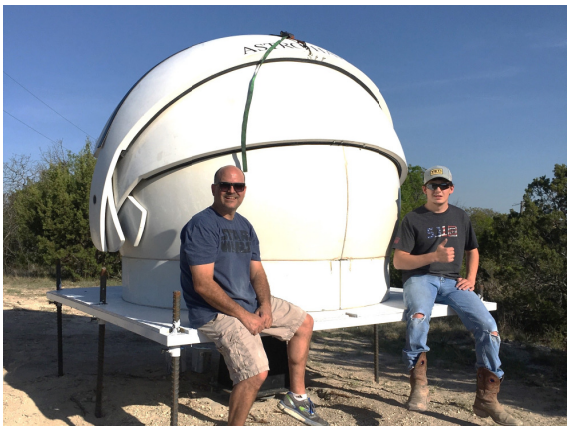

Figure 5 - The Cowtown Observatory

Another group of small telescopes is located on the campus of the University of North Texas where up to five telescopes can be used for solar viewing or solar spectral imaging. Conveniently installed just outside of UNT's astronomy program's computer laboratory, up to 25 students participate in one of the two labs that incorporate these scopes.

The first lab setup (offered during daylight hours as illustrated in the following image), allows students to view narrowband images of the sun in HA and Calcium frequencies, or image the solar spectrum for study in UNT's lab that presents the sun as a star, in preparation for the following semester when the spectral techniques learned in this laboratory class will be

utilized in their stellar spectroscopy imaging class.

The Stellar CSI lab, as it is called today, was custom designed by Tom Field, of Field Tested Systems and me, so that UNT students could, once again, have an opportunity to get hands-on experience using spectrographic instruments to gather spectra for later analysis in their lab, which are held immediately after they gather their data.

Figure 6- Solar Lab on UNT campus

The most recent instrument for spectroscopic research is being tested at Hubble Optics by its president, Tong. It will be managed through a collaboration among the Boyce Research Initiatives & Education Foundation, the University of Dallas, The University of North Texas, and the Institute for Citizen Astronomy.

To be located at the Dark Sky Observatory, the .5 meter CDK with @F/11 optics were originally made for Dr. Russ Genet. The optics are being installed and collimated in a Hubble Optics truss telescope.

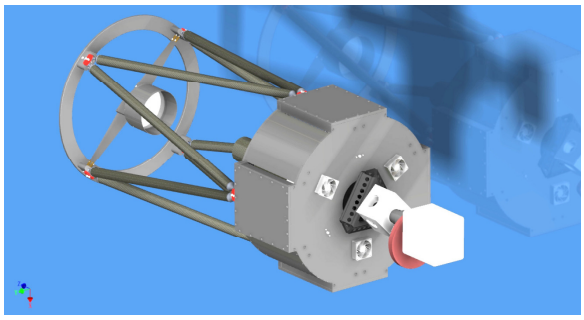

Figure 7 - Hubble Optics .5m F/11 OTA for spectroscopic and exoplanet research

3. Recent Associations and Research Opportunities

Since my SAS presentation in 2015 several important collaborations and associations have been created. The first, a formal MOU between the University of North Texas and Universidad Technológica de Panamá has been formed to allow Panamanian astronomers the opportunity to inexpensively lease a small, research-grade telescope at a world-class dark site to study selected SDSS galaxies for tidal stream interactions. Observations are conducted by students and citizen astronomers that work with the professional astronomers on each of the projects.

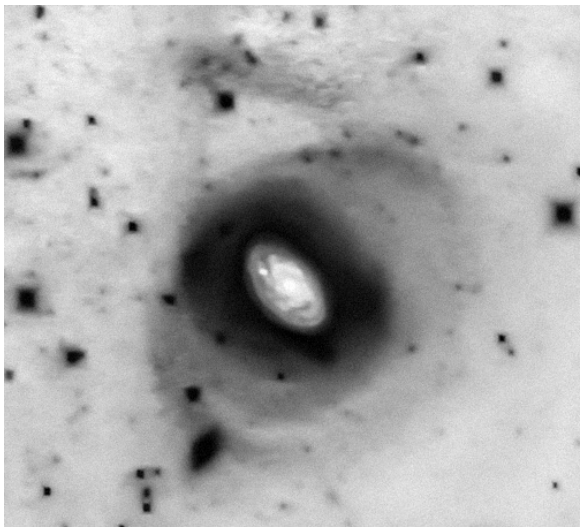

Figure 8 – There are at least three giant tidal arms surrounding NGC1084. Not known until they were first observed during close inspection of an SDSS image, the dark skies above the Dark Sky Observatory in west Texas simplified the acquisition of these faint objects. (Imaged for two hours through a 10" RC, using an Apogee Alta U8300 camera by Preston Starr (UNT Observatory Superintendent), and Don Waid, (Citizen Astronomer).

Our experience has shown that one of the most effective methods for motivating and training citizen astronomers to provide meaningful support for professional research is by allowing them to actually select their observing targets, plan their observing runs, create their own operational scripts, and then formulate conclusions as a team with the help of mentors who can guide them through any problematic processes.

One unique situation that resulted in a successful association was the arrangement made between the University of North Texas and The University of Dallas. UNT had assembled one of the largest collections of research-grade remote telescopes in the U.S., but found that many of its instruments were going unused. The University of Dallas, on the other hand, did not have a dark site, nor the funds to complete a research-grade observatory. The two institutions initiated a program whereby both institutions could work together and create some new observational astronomy classes.

The initial on-going program was designed to complete photometric exoplanet transit observations incorporating AstroimageJ to refine data on currently confirmed exoplanets, especially those exoplanets that are revolving around relatively bright stars.

In the following figure, a team of seven undergraduate students from the two universities recorded a transit of the exoplanet WASP 43b. While not a first observation of this target; what is interesting is that they observed discrepancies between the published transit times and those recorded through their observations using AstroimageJ. They plan on investigating these discrepancies to determine some possible causes.

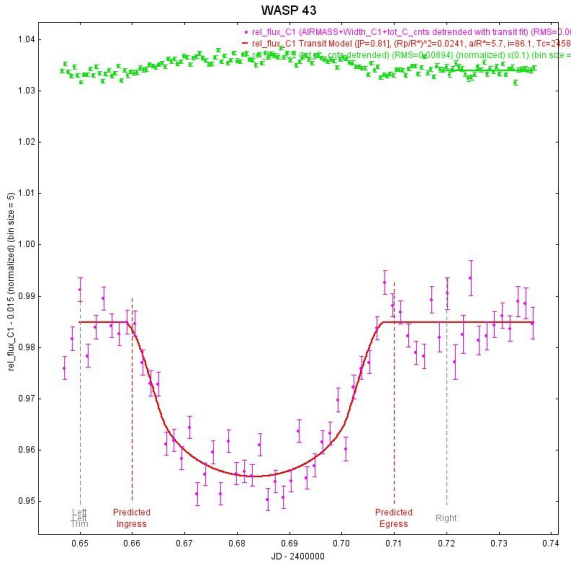

Figure 9 – Exoplanet curve of Wasp 43b recorded by the following students: Nick Bacsewski, Stephen Flowers (Department of Physics, University of North Texas, Denton, TX, USA), Cecilia Hassan, Samantha Garza, Gianna Milton, Clement Say (Department of Physics, University of Dallas, Irving, TX, USA)

University of Dallas recently announced that it had been selected to continue in its support of the NASA/Kepler Guest Observing Program. Once again, UNT's Monroe Robotic Observatory, and the Dark Sky Observatory will team up with UD to provide the technical and engineering support for the coming year (2018-2019).

One of the largest pro/am opportunities on the horizon will begin when Professor Ohad Shemmer, UNT astrophysicist, and Principal Investigator of a "Large and Long Program" to observe the rest-frame optical spectra of approximately 400 luminous quasars taken through the Gemini Telescopes spectrographs, initiates a six-semester observing run to create a Gemini Near-Infrared Spectroscopic Survey of 400 luminous quasars at the epoch of peak quasar activity. Once Gemini's spectrographs (the largest in the world) complete this program, they will have produced the largest and most uniform data set of its kind.

One major outreach component will be a competitive program for middle and high school students and citizen astronomers, who will have an opportunity to request an observing run at a quasar from a pre-selected list of brighter quasars. Each observing team will then be shown how to gather spectral redshift data using the association's Hubble Optics 20" spectrograph system. This research will assist professional astrophysicists to confirm current published redshift amounts, some of which have proven to be inaccurate. The teams that gather the most accurate data, will then may have an opportunity to examine some of the new Gemini data set to determine the extreme shifts that observed by these distant objects.

Ultimately, the project will more than double the existing inventory of near-infrared spectra of luminous quasars at these redshifts; allowing for the most accurate and precise quasar black hole masses, accretion rates, and red shifts, and use the results to derive improved prescriptions for UV-based proxies for these parameters.

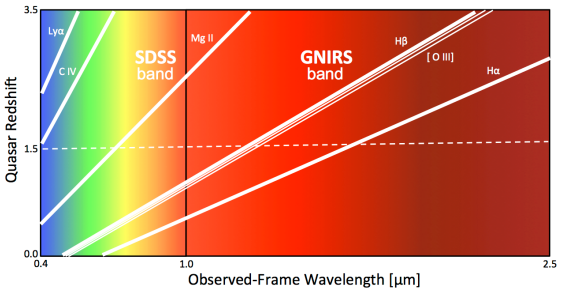

Figure 10 – At sufficiently high redshifts, several prominent quasar emission features (white solid lines) are no longer detectable in the optical spectral range, represented here by the SDSS band that extends between approximately 0.4 micron and 1.0 micron (solid black line). For the broad Hbeta and narrow [O III] lines, that are rich in diagnostic power, this occurs above redshift 1, including the era of fast quasar growth. The GNIRS spectroscopic survey will more than triple the observed spectral band, allowing astronomers to observe these and other emission lines in a uniform sample of 416 SDSS quasars at redshifts between 1.5 (dashed line) and 3.5. The available SDSS spectra of these sources, which cover at least the rest-frame ultraviolet C IV emission line, will enable astronomers to establish connections between optical and ultraviolet indicators of fundamental quasar properties, while more than doubling the statistics at such high redshifts.

4. Training for qualified Citizen Astronomers

With the increasing complexity of "amateur" astronomical hardware, combined with the powerful, new data processing tools that are becoming available for citizen astronomers, more and more astronomical organizations are beginning to offer short courses and tutorials to assist with learning some of the more popular hardware and software.

For example, since the publication of my SAS paper in 2015 where I suggested that more training programs should be designed and offered; the AAVSO initiated, under the tutelage of Dr. Dennis Conti, an excellent course on using AstroimageJ for exoplanet observations. This software has been a powerful tool for citizen astronomers by greatly improving the timing accuracy of exoplanet curves.

I took the online course to see if it might be useful to prepare participants for successful pro/am collaborations. After

successful completion of Dr. Conti's course, we were rewarded with a certification of qualification. This AAVSO program is a positive step towards providing the education necessary to qualify citizen scientists for pro/am collaborations in photometric exoplanet observations.

However, one stumbling block hindering the increase in the number of online training programs has been the lack of sufficient reward for the Time, Effort, and Expertise necessary to develop substantial new programs on Photometry, Spectroscopy, and Astrometry, as well as telescope hardware Setup and Operation.

In my discussions with some of the people who are currently offering these sorts of programs I found that, while continuing to find satisfaction in their efforts; in reality, some of them were becoming weary of the minimal recognition and financial remuneration that they receive for their efforts. This appears very similar to the "Burn Out" that many local astronomy club members experience after volunteering for years of public star parties.

As a result, I am currently organizing the Institute for Citizen Astronomy to recruit professional astronomers, veteran astronomy educators, and experienced citizen astronomers in the development of online curricula, conducting classes, and certification after successful course completion. The proposed courses would provide knowledge suitable to provide certification in Photometric, Spectroscopic, and Astrometric techniques, as well as certifications for various aspects of Telescope Integration and Operation. These could then be used by citizen astronomers to increase their pro/am research opportunities.

Over the coming months I hope to identify, recruit, hire, and offer online training, using telescopes from our network of telescopes, that will provide credibility to the certification of citizen astronomers for pro/am collaborations.

5. Conclusion

After arriving at what I believed to be the conclusion of this paper I realized that we, as citizen astronomers, have entered an era where we can provide valuable assistance and important data to clarify and fortify the ever-growing knowledge base of Astronomy and Astrophysics.

However, we must be mindful that mentoring young minds, and directing the Passion of interested people of all ages is one of our most important challenges.

6. Acknowledgements

I would not have composed this paper without a gentle request from Robert K. Buchheim to update the Society of Astronomical Sciences on the progress of our informal association of professional astronomers, citizen astronomers, students, observatory owners and operators.

Pat and Grady Boyce, of the Boyce Research Initiatives and Education Foundation deserve commendation for the work that they have done to advance the cause of small-telescope research to students through their remote telescope programs.

Thanks to the University of Dallas, and its faculty members, Dr. Richard Olenick, and Arthur Sweeney for working with Professor Christopher Littler, of the University of North Texas Department of Physics as they initiated a novel inter-college undergraduate, remote astronomy class resulting in successful exoplanet observations.

Lastly, thanks go out to Preston Starr and Don Waid, for their engineering and imaging efforts in support of the remote telescope network.