**Citizen Science Toolkit Conference**

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# astronomy for citizen scientists and citizen scientist educators

Suzanne Gurton
Education Manager
Astronomical Society of the Pacific

**CORNELL LAB OF ORNITHOLOGY**

607.254.BIRD telephone
www.birds.cornell.edu

159 Sapsucker Woods Road
Ithaca, New York 14850

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Note that this document did not originate as a formal paper. Rather, it combines an oral presentation with accompanying PowerPoint slides and reflects the more informal, idiosyncratic nature of a delivery prepared specifically for this live event.

Documentation of the conference is meant to serve as a resource for those who attended and for others in the field. It does not necessarily reflect the views of the Cornell Lab of Ornithology or individual symposium participants.

The following is one of three focus point presentations delivered on day three of the Citizen Science Toolkit Conference as part of a session titled "Community Building for Citizen Science."

For complete documentation of conference proceedings and to learn more about citizen science and the Citizen Science Toolkit, or to join the ongoing citizen science community, go to:

**http://www.citizenscience.org**

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# Astronomy for Citizen Scientists and Citizen Science Educators

Suzanne Gurton,
Education Manager,
Astronomical Society
of the Pacific

## Introduction

We've heard about birds and water and bugs and worms, and I've come to let you know that there is a whole universe of other citizen science projects going on. As people have been talking about their projects I've been thinking that I know an amateur astronomer like the person mentioned, or I know someone who is doing a project similar to the one described. As you have talked about scaling factors and the communities that you are working with, I have been thinking that the amateur astronomy community is very similar to many of the communities that you are dealing with. Some of them are making discoveries on their own, and some are working in what we call "Pro-Am collaboration," which is what I want to talk about today.

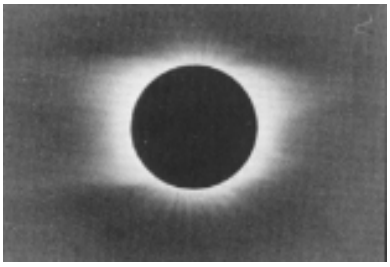
I am from the Astronomical Society of the Pacific. Until I understood what was meant by the term "citizen science," I didn't realize that we were born out of a citizen science project.

**http://
www.astrosociety.org**

*Discover dust grains from other star systems, monitor pulsating stars or share the excitement of discovery with your community.*

### Born out of Citizen Science

On February 7, 1889, a diverse group of men gathered in a meeting room in downtown San Francisco. They included a high school science teacher who was also director of a civic observatory, a Spanish gentleman from Catalonia who was a civil engineer, a professional astronomer educated at West Point, a distinguished corporate lawyer, a railroad clerk who was an avid amateur photographer, an insurance broker, a homeopathic physician, a college professor , and more than thirty others. The outcome of the meeting was the creation of the Astronomical Society of the Pacific whose aims — as admirable today as a hundred years ago —were set forth clearly in its very first bylaws: "…to advance the Science of Astronomy, and to diffuse information concerning it."



This fellow was the founding director of the Lick Observatory. There was a total solar eclipse in the Bay Area in 1889 and he decided to gather together people from the community—not professional astronomers, but amateur astronomers, professional photographers, and other members of the community to document this astronomical event. He decided he wanted to continue this partnership and it was out of that partnership that the Astronomical Society of the Pacific

was founded: "…to advance the Science of Astronomy, and to diffuse information concerning it."

Our mission has evolved over the past hundred years, but at its core it is still about spreading that excitement about astronomy. Today we focus more on educational programs, and in this talk I wanted to give you some examples of citizen science in the field of astronomy because as I've said I can see parallels with other projects I've been hearing about here and I want to take this opportunity to let you know some of the things going on in astronomy. I'm then going to talk about a program that we are just starting that I think is the one that is most relevant to everyone here, which is an NSF-funded project called Sharing the Universe. Martin Storksdieck, who is here, is the co-PI and he can tell you a little more about the key research part of that project, which is just starting.

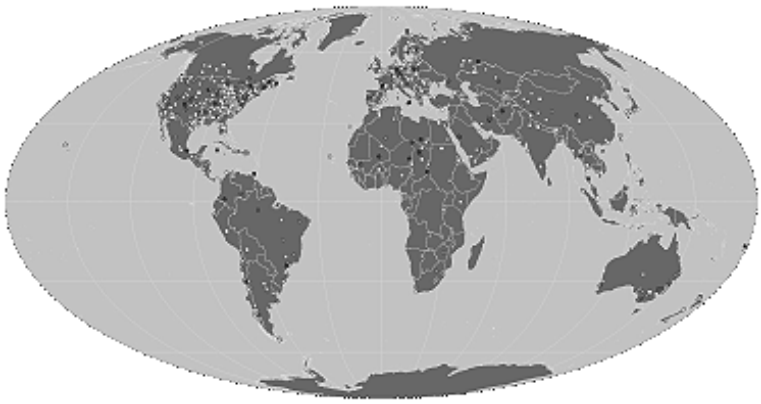
## Examples of Citizen Science in Astronomy

We already heard a presentation that included one example of astronomy citizen science, and that is the GLOBE at Night project. What it is most noted for is that it has these key educational goals.

**GLOBE at Night**
**www.globe.gov**

Educational Objectives:

- Engage students worldwide in observing the nighttime sky
- Encourage citizen and family science with a hands-on learning activity outside of the classroom
- Gather light pollution data from an international perspective



During the 2007 event there were 8,491 observations reported from 60 GLOBE countries, almost doubling the observations from 2006. The final data is being analyzed.

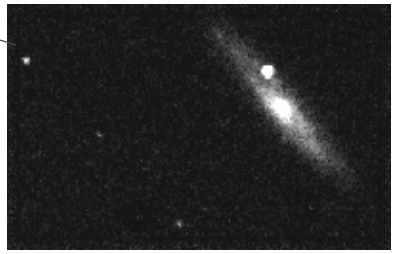
For me what made it most exciting was that the aim was to reach students worldwide, getting them out looking at the night sky. It wasn't just science that was being addressed, it was motivating them to get out and to be aware. Just as many of you are trying to make them aware of the water, the birds, the trees, the ecology around them, we are trying to get them to look even farther up at the night sky and become aware of a resource that is dimming. Because of all the light pollution that is here, we have lost a lot of that resource.

There are amazing individuals doing projects. This fellow is a Methodist minister in Australia and he loves astronomy. He goes out with

his Dobsonian telescope, which looks like a big cannon, a cardboard tube with an eyepiece, and looks at these funny little galaxies, and he has seen thousands of them. He looks through the galaxies for that little thing you see in the upper left corner of this picture, a supernova, a giant star that has exploded at the end of its life. He knows how to find so many of these that he has discovered more supernovae than any professional or amateur astronomer. He just does this for fun, and when he discovers them he reports them and then the professionals can follow up with spectroscopy and all of the other data gathering. You can't predict when these things are going to go off, so he just goes out and looks through gobs of galaxies.

**Robert Evans**

"There's something satisfying, I think, about the idea of light traveling for millions of years through space and just at the right moment as it reaches Earth someone looks at the right bit of sky and sees it. It just seems right that an event of that magnitude should be witnessed."

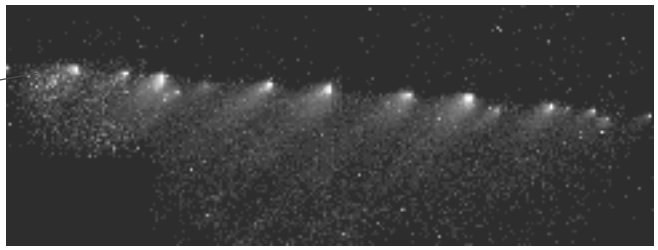


- Methodist minister in Australia
- Winner of the ASP Amateur Achievement Award in 1985
- Has discovered more supernovae than any other astronomer, amateur or professional

Then there is a friend of mine, David Levy. I used to work with him at a planetarium in Tuscon. His passion is comets. He would never go out with the rest of the staff after work. Instead, he would go home and look for comets. And sure enough, the man has discovered twenty-two comets. He is an amateur astronomer. He eventually paired up with some professional astronomers and he discovered this bizarre thing pictured here, Comet Shumaker-Levy 9.

**David Levy**

"Comets are like cats; they have tails, and they do precisely what they want."

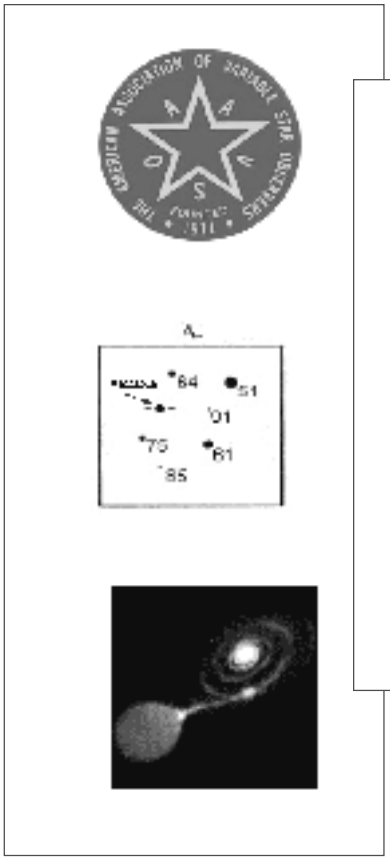


His 22 comet discoveries tie David for third place in history for the largest number of comet finds by an individual.

It was the ninth comet that team had discovered and it's the one that crashed into Jupiter. It was a new discovery since we'd never seen anything break up like this and become multiple comets and actually impact on a body, so that was a remarkable thing that he discovered. He is up there in third place in the history of folks who have discovered comets. Historically, most comets have been discovered by amateur astronomers and again, it is for the love of it. Once they make the discovery they often turn it over to the professionals to do all the calculation of the orbital circumstances and the like, but the initial discoveries are made by the amateurs.

There are also more formal relationships out there, and in the astronomy world we call them professional-amateur (Pro-Am) collaborations. Pro-Am collaborations permeate the entire culture of astronomy.

It started quite a while ago back in 1911 at Harvard College. They started the American Association of Variable Star Observers (AAVSO). The basic idea is that professional astronomers don't have enough telescopes and enough time to look at all of these variable objects. They started this network that uses all of these amateurs who do, and not all of them have high-tech equipment—a lot of it is just putting your eyeball to the eyepiece.



**Pro-Am Collaborations**

American Association of Variable Star Observers (AAVSO)

- Founded in 1911 at Harvard College Observatory
- Members in 45 countries
- Over 12.5 million observations
- Professional astronomers have neither the time nor the telescopes…
- Amateur astronomers do
- They submit their observations to the International Database
- The AAVSO coordinates, evaluates, compiles, processes, publishes, and disseminates variable star observations to the astronomical community throughout the world.

They go through a training process in which they look at little finder charts like the graphic above [*middle left*], and they do comparisons. They have comparison stars and decide: Is it brighter than that? Is it dimmer than this? Then they can make an estimate. So it doesn't matter if Luna is out, it doesn't matter if you are in a light-polluted sky, they can do this anywhere by relying on their training and comparing a target star with ones in the field and making an estimate of the brightness.

Often professional astronomers will call and say, "I'm going to be observing this star next month, can you give me some baseline data?" They want to make sure that it's not doing anything kinky before they do their observations, that it is in a stable period, and amateurs will provide that data. So it is a long-standing professional-amateur collaboration that has been going on through the AAVSO, and the amateurs get credit when the research is published.

This goes beyond variable stars. *Sky & Telescope* is one of the most popular trade magazines and it and *Astronomy* are the two main astronomy magazines in the U.S. The Chief Editor, Rick Feinberg, has started an AstroAlert system, which is an e-mail system in partnership with research astronomers. He will send out an e-mail saying, "There is an event happening that we want lots of data on. Can you observe

it?" When I was putting together this talk last week, this was the most recent e-mail posting on the Web site.

Recent AstroAlert: Occultations by Possible Rings of Pluto, May 11, 2007

At about 4.7h Universal Time on May 12, 2007, Pluto will occult the 13.3-magnitude star UCAC2 25822467 in a path passing over much of Antarctica and Patagonia. But in addition, Walker Vaning believes that rings of very small particles will also occult the star for observers in the whole hemisphere of Earth facing Pluto, which includes all of Central and South America, most of the Atlantic Ocean (including the Canary Islands), the Caribbean Sea, eastern Mexico, eastern USA, and eastern Canada. The star is at right ascension 17h 53m 32.0s, declination 16° 22' 47" (equinox 2000.0).

They think there might be rings around Pluto, and by watching a star as Pluto goes near that star, they look for that starlet to flicker as the dust from the rings goes in front of the star, and they asked people to observe that.

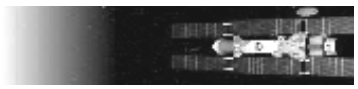
So there are a variety of observations that are requested and amateurs have the equipment to do it. Some of it is very low-tech, some of it is high-tech with the CCD cameras, which are charge coupled devices. It is a CCD chip that is in all of your digital cameras, but this is a bigger unit with which they can take long time exposures and then analyze the data.

The Lab of Ornithology was talking about watching birds in their nest boxes using nestcams. This next project is probably similar to that. With the nestcams you don't have to go out and observe the birds, you can just go online. Stardust@Home is a fascinating project. Did any of you ever participate in the SETI@Home project? That didn't require you to do anything but let them use your computer time. This one was modeled after that in terms of the idea of having many computers in use, but you have to do the work here.

This amazing spacecraft flew through the tail of a comet and it has this substance they call aerogel. The tester is pictured at right, and in all of those cells is the aerogel, which they describe as "frozen smoke." It is an amazing material, and this panel came up as it flew through the tail of the comet and all of the comet material whacked into the aerogel and got captured. Then the panel went back down and got protected. At that point, when it was far away from the environment of the comet and wasn't influenced by that, it opened up again and on the other side it was exposed to interstellar medium, dust coming from other stars that enters our solar system. We've never been able to capture these particles before.

**AstroAlert by *Sky & Telescope***
**http://skytonight.com/resources/proamcollab**

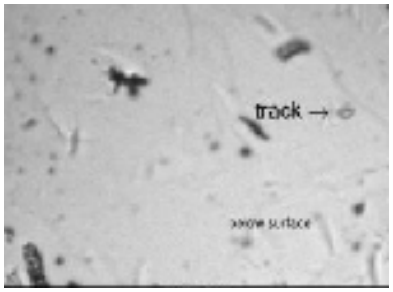

- Free e-mail news service to alert telescope users when significant celestial transients occur
- Scientists request CCD images or other observations from advanced amateur astronomers
- Typical AstroAlert will tell you what to look for, where and when to look, what kinds of observations are needed, and how and to whom to report your results

- On January 15, 2006, sample return capsule safely returned to Earth with bits of Comet Wild 2 and tiny particles of interstellar dust that originate in distant stars, light-years away.
- They are the first such pristine particles ever collected in space, and scientists are eagerly waiting for their chance to "get their hands" on them.
- Before the particles can be studied, though, they have to be found.
- If this project was taken on twenty years ago, the search for the tracks in the aerogel collector would be through a high-magnification microscope and the search would still be going on.
- Are using an automated scanning microscope to collect images of the entire Stardust Interstellar collector. These stacks of images are focus movies. All in all there will be nearly a million such focus movies.
- Stardust@Home users around the world view them with the aid of a special Virtual Microscope (VM) that works in a Web browser to accomplish in months what would have taken years.

It was finally returned to earth, and now we have to find these particles in this gunk, and that is a challenge. Even with an automated microscope scanning through all of this aerogel material, they think it would probably take about twenty years. Instead, what they are doing is asking you all to do this. They are using an automated scanning microscope to collect the images, but now they have to go through them very carefully to look for what might be a particle of interstellar medium, of stardust from another star not our own. What they have done is to set up a program in which they have a little test that you can take.

- In recognition of the critical importance of Stardust@Home volunteers, the discoverer of an interstellar dust particle will appear as coauthor on any scientific paper by the Stardust@Home collaboration announcing discovery of the particle.




**http://stardustathome.ssl.berkeley.edu/_tutorial_start.php**

They put you through this entire training program and above is an example of what one of these slides would look like. What you would do, thousands of times if you were so motivated, is look at these tracks and move your cursor. In a training exercise you move your focus from being above the surface to at the surface, and then as you go below the surface they point out where there is a track. You can see where there is a very distinct ring, and that has to do with the way they travel through the medium. They give you bunches of these to practice on (ones where it doesn't say "track") and then you have to take a test. If you pass the test they let you participate.

You can go to the "Community" section on their Web site where you will find rankings and a list of the top hundred people, including one guy who had nothing better to do than scan 170,000 of those slides. Even the hundredth person has done over 18,000. This doesn't require any equipment except Web access, and what they do is give you recognition. They also have a community bulletin board where you'll find fabulous ideas being exchanged.

I haven't heard of reports yet on particles that were found, but as they begin to study the ones that are found they will give full credit to the person who discovered them. Basically you could find one that you think has a track, and then the researchers will flag that as a slide they should spend more time on and see if they can recover that particle of interstellar medium and find out what it's made out of. If you are one of the people who flags that piece, then you will

get coauthorship on any research papers that are published. That is the way that they recognize their volunteers.

## Night Sky Network

Night Sky Network is how the Astronomical Society of the Pacific works with amateur astronomers. The National Science Foundation gave us a planning grant to discover what amateur astronomers wanted or thought they needed to do more and better outreach because we knew they were out there doing all sorts of outreach.

I found the list of motivating factors for joining Master Gardeners interesting. We know that there are a variety of things that motivate people to join the club. Some are observers, some come because of the social interaction, some want to learn more, and some want to share their passion for the night sky. Those are the ones that we wanted to know more about.

NSF gave us a planning grant and we found out what they wanted was training, materials and to be networked with other people who share that passion. NSF didn't fund us to give them that, but NASA did. What NASA didn't fund us to do was investigate more about the community. They were concerned whether or not these guys knew their stuff. I say "guys" because really it was mostly men who were in the amateur astronomy clubs. NASA was concerned about how we were going to deliver the training because it's very expensive to run workshops. They were giving us a lot of money and it takes a long time to develop each one of these toolkits, about sixteen months with all of the testing and beta testing. They wanted to make sure that it was going to be used.

We did a study and found that the amateurs who step up to do outreach know their stuff. They're not going to volunteer to be talking about it if they're not knowledgeable. In fact, there is a study that

**Night Sky Network**
**http://nightsky.jpl.nasa.gov**

*Highlights from movie clip about Night Sky Network:*

- Membership is free and open to all astronomy clubs in the US and provides toolkits, training, and access to online resources.
- In return, clubs are asked to log at least 5 outreach events each year.
- Member clubs receive toolkits and materials to explore a variety of astronomy topics, from the scale of the solar system, to how telescopes work, to black holes.
- Toolkits have hands-on activities and outreach presentations for all ages and for small and large groups, accompanied by training video and user manual.
- There is interaction and exchange with other members and exclusive access to teleconferences

**Night Sky Network**

*Astronomy Clubs bringing the wonders of the universe to the public*

- Some are observers
- Some like the social interactions
- Some like the educational nature of meetings
- Some want to **share** their passion for the night sky

NSF gave us a planning grant to determine what that last group needed/wanted to do more and better outreach.

They told us it was training, materials, and interactions with others who share this passion for outreach.

**Concerns:**

- Amateur astronomers are free agents. Their outreach activities are relatively unmonitored.
- Training amateurs across the country to have maximum impact could be prohibitively expensive.
- How can we insure they will be used?

**Why This Works:**

- Amateurs who choose to do outreach are very knowledgeable. (Astronomy Diagnostic Test)
- Training is delivered via a DVD demonstrating uses of the toolkit contents and best practices for facilitating the demonstrations.
- To maintain active status, clubs must log at least 5 events per year. The benefits of active status are receipt of new toolkits as they are developed, newsletters, and participation in telecons with NASA scientists discussing the latest discoveries.

The ASP, in partnership with the Institute for Learning Innovation, has received another NSF ESI award to:

- study the culture of amateur astronomy clubs;
- determine what factors support active, sustainable outreach programs;
- identify what if any interventions can be developed to affect the club culture in such a way to create a more sustainable outreach effort.

used the Astronomy Diagnostic Test and the only people who scored better on the test were university professors who teach astronomy, so the amateurs are very knowledgeable. The training is delivered via DVD, and the more outreach events you log the more you get. You can win prizes, you can get the next toolkit of materials. So we definitely have success.

We have something like McDonald's—so many millions served—and when they log in an event on the Web site it shows up. We are coming up on that half-a-million people served by Night Sky Network materials.

**Results:**

As of Monday, June 18, 2007, the Web site counter displays the following as an indicator of the impact the Night Sky Partnerships are having:

**Events held since March 2004: 5806 People Reached: 488917**

But NASA hasn't paid for us to develop a sense of community.

But NASA didn't fund us to find out more about the community and that is why we are now in partnership with the Institute for Learning Innovation to do what is really an anthropological study of this group of people. Martin Storksdieck is taking the lead on that to study the culture of these clubs. We want to find out what factors within that club culture support an active, sustainable outreach program. In our discussions, one thing that came up was the idea of "the power of one." What if there was one charismatic, ambitious person who was doing all the outreach? That is only sustainable as long as that one person is out there, but what kind of legacy are they leaving?

After we find out more about the culture we are going to try to develop interventions to help see which ones are healthy, what aspects of that culture made them healthy to sustain outreach, and if we can plant those seeds in other clubs that are struggling with their outreach and give them the same kind of healthy climate that we see in the successful clubs. At this point I don't have anything to report, but what we learn in a very general level may have relevance for your programs, so as we start learning about the culture, hopefully we will be able to share it with the rest of you.