INTERNATIONAL YEAR OF ASTRONOMY 2009

Citizen Science for the International Year of Astronomy

THE UNIVERSE : YOURS TO DISCOVER

USA NATIONAL NODE

A. Price (AAVSO/Tufts University), C. DePree (Agnes Scott College), L. Fortson (Adler Planetarium), M. Hartman (MIT Kavli Institute for Astrophysics and Space Research), S. Jacoby, (Large Synoptic Survey Telescope), R. Stencel (University of Denver) and the International Year of Astronomy Working Group for Research Experiences for Students, Teachers and Citizen Science (USA National Node)

The IYA 2009 working group on Research Experiences for Students, Teachers, and Citizen-Scientists is planning a multi-year project involving occulting systems. The project will include both observing and data analysis components. It begins with training programs of several types of binary and transient variable stars that are easy to observe from suburban locations with the naked eye. Participants will be trained both in observing and also in basic data analysis of photometric datasets (light curve and period analysis). Eventually it will lead to a capstone project: monitoring the rare and mysterious 2009-2011 eclipse of Epsilon Aurigae. In the summer of IYA 2009, third-magnitude Eps Aur will experience its next eclipse, which occurs every 27.1 years and lasts 714 days, nearly two years! However, the program is not limited to Eps Aur and will also include other occultation events such as monitoring mutual eclipses of satellites of Jupiter and Saturn. Planning is still underway; advice and offers to help are welcome.

What is Epsilon Aurigae?

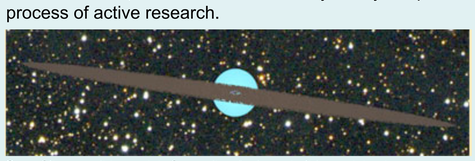
At *V*=3.0 **Epsilon Aurigae (Eps Aur) is bright enough to be seen with the unaided eye** even in most light polluted cities. It is well placed for observing in the fall, winter and spring skies (in the early summer it is blocked by the Sun).

Every 27 years the star goes into an eclipse that lasts approximately one and a half years. During previous eclipses, it has slowly lost about half its brightness, a phenomenon noticed by the public as far back as 1821. Then, near the very end of the eclipse, it has suddenly gained most of its brightness back in a matter of weeks. No one knows why this happens.

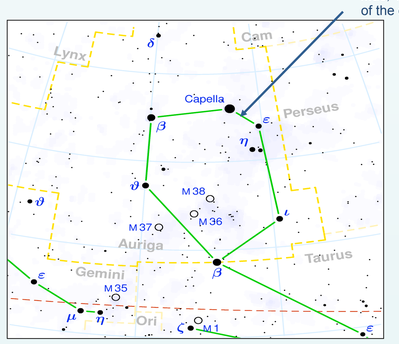
Even the likes of famous astronomers Henry Norris Russell and Bengt Stromgren could not explain the mystery. All eclipses since discovery have been scrutinized with an increasing sophisticated array of methods, but to no avail – the object causing the eclipses refuses to be detected. Something is blocking the light and we don't know what it is.

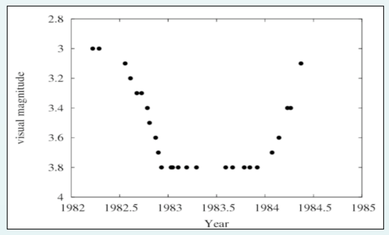
The next eclipse is forecast to begin in late summer 2009, during which visual and digital monitoring will be essential in support of multi-wavelength astrophysics. Because the star is 3rd magnitude, this object provides an easy entry point for research by all persons regardless of their background, training and equipment: with just good eyesight and some finder charts, the eclipse can be easily monitored; with digital cameras and a tripod, scientifically useful data become possible; with consumer level telescopes, CCDs, photometers and/or spectrometers, useful scientific data can be collected.

Indeed, the very brightness of the star makes it a very difficult target for professional astronomers because it overloads sensitive professional-grade camera detectors. Also, the length of the eclipse makes it difficult to get consistent, reliable observations from oversubscribed professional observatories. **The public, on the other hand, can be engaged to follow the star every few weeks for a year and a half.** To observe a star, the observer simply needs to compare the brightness of the star with the brightness of a couple of nearby stars given on a star chart. This will generate a large database of observations, which can then be analyzed by the public through a process of active research.

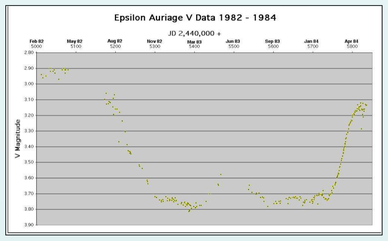


One of the possible models for epsilon Aurigae. In this model, a large, opaque disk seen nearly edge-on eclipses the primary star — an F0Ia supergiant. The center of the disk is partly transparent, due to the presence of one or more massive main-sequence stars. Because the disk is seen nearly edge-on to our line of sight, the F0I supergiant isn't completely obscured even at the eclipse minimum. (Background image: a subsection of M38, copyright NOAO, AURA, & NSF.)





Light curve of *visual* observations of the last eclipse of Epsilon Aurigae from AAVSO Observer Gerry Samolyk.



Light curve of *photometric* observations of the last eclipse of Epsilon Aurigae from AAVSO Observer Jeff Hopkins.

Funding Disclaimer: The scope of this project naturally relies upon appropriate levels of funding. Multiple grant proposals have already been submitted, but we are eager to approach other sources of funding this summer. If you have any tips or suggestions, please contact us!

At a Glance

- Citizen scientists will be recruited to observe and report data on Epsilon Aurigae's brightness
- They will also be trained in basic variable star data analysis techniques (light curve, phased diagrams and Fourier analysis of time series data) and provided with high quality software tools
- They will be mentored during the analysis phase and guided to write papers on their results
- Papers will be peer-reviewed by professional astronomers and published in a special edition of the Journal of the American Association of Variable Star Observers (JAAVSO)

To Get There from Here

- *HomeBase*, a web site portal, will be built based on best practices from the GalaxyZoo and AAVSO web sites (directed by Jordan Raddick).
- Observing and data analysis training materials will be based on the *Hands On Astrophysics (Mattei, et al. 1996)* and *In The Hunt for Variable* Stars (Richwine 2007) curricula.
- Current AAVSO data reporting and analysis tools will be reprogrammed in Java under the guidance of a professional user-interface expert (Christopher Watson) to make them more accessible to the general public.
- A 4-minute planetarium "trailer" will be developed with full production elements (state of the art video, score, narration, etc.) and distributed to planetariums free of charge for showing prior to a featured presentation. The visualizations will also be used for DVD and web site training materials. They will be developed by the California Academies of Science (under supervision of Ryan Wyatt).
- An interactive, flash-based animation of the system will be developed by the Adler Planetarium for participants to test various competing models of the system and compare the results with the data being collected.
- Three professional astronomers (Arne Henden, Robert Stencel and the AAVSO Staff Scientist), with the help of two graduate students, will monitor and mentor the discussion groups and participant teams.
- Two workshops will be held in the format of the three successful AAVSO/NASA High Energy Astrophysics Workshops for Amateur Astronomers. One will focus on data collection and basic analysis. The other will focus on intermediate analysis techniques and presentation of results (including paper authorship). Travel grants for the public will be available and both will be recorded with video placed online and DVDs mailed to 100 amateur clubs in the United States. One will be held at the Adler Planetarium (Chicago) and another at the California Academy of Sciences (San Francisco).

What's Unique About This?
- This is a very bright object almost anyone can see
- But even if you don't want to observe, you can still participate
- We are focused on data analysis in addition to data collection

Learning Experiences
- Develop an awareness of Epsilon Aurigae through media coverage.
- Visit website and be passively informed by reading its content.
- Regularly visit website, contribute to blogs, surveys, vote on visualizations posted, whatever, but contribute comments on work posted.
- Regularly contribute to data collection or interpretation through website.
- Participate in an Eps Aur team and involve others.
- Publish papers of scientific or educational research findings.

Our Expected Audience

Our audience for this project can be divided into three groups: **A)** amateur astronomers, **B)** members of the general public with an interest in science and **C)** members of the general public with no previous disposition towards science. We have successfully applied the citizen science model proposed here to group A over the past few decades. The focus of this proposal is aimed at expanding our activities to category B. These are members of the public who read science magazines and watch scientific documentaries, but do not work in a scientific field or participate in any scientific hobby. Some participants will come from the C category (usually through word-of-mouth from friends and family in category B) but they will not be the focus.

References

Mattei, J.A., Saladyga, M., Anderson, L. M., Percy, J. R. (1996). Hands-On Astrophysics: Variable stars in the math/science lab. In J. A. Percy (ed.) *Astronomy education: current developments, future coordination*. Astronomical Society of the Pacific: San Francisco. P. 247.

Rahm, J., Miller, H. C., Hartley, L., & Moore, J. C. (2003). The value of an emergent notion of authenticity: Examples from two student/teacher- scientist partnership programs. *Journal of Research in Science Teaching, 40*(8), 737-756.

Richwine, P. L. (2007). *The impact of authentic research experiences studying variable stars on high school students' attitudes and beliefs towards the nature of science and astronomy.* (Doctoral dissertation, University of Arizona, 2006). Dissertation Abstracts International, 68, 02.

Active Research - More Than Data Collection

By *active research,* we mean *full participation in the scientific method* from making predictions to reporting conclusions. There are many active citizen science projects that have been very successful in introducing the public to collaborative data collection and distributed computing. We propose to build on their successes by adopting their best practices for data collection and then extending them into the realm of data analysis and reasoning. We adopted the following stages to guide our inquiry extension program (Rahm, Miller, Hartley & Moore, 2003).

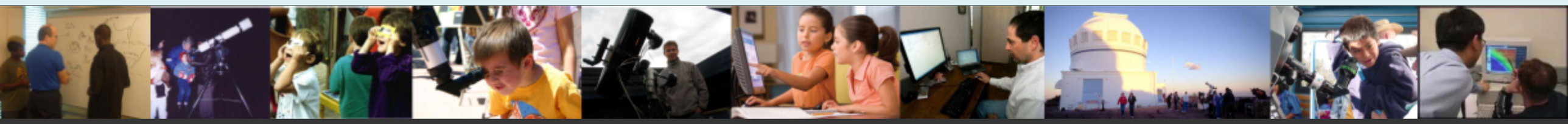
- o Working hand in hand with scientists to collect data
- o Analyzing and presenting data
- o Co-constructing and challenging the authority of scientists
- o Becoming an active and consistent member of a research community

Professional Science Mentors needed!

We are looking for professional astronomers who are willing to mentor small teams of participants via e-mail and/or to monitor and post in the discussion groups. Contact aaronp@aavso.org if interested.

The transformative nature of this project lies in its ability to expose non-scientists to the scientific inquiry process by allowing them to become real scientists. **They are not *assisting* scientists or even *acting* as scientists, but are *becoming* scientists** by posing their own questions, finding their own answers and sharing those answers – all in a collaborative environment.

Science is a process involving many people and steps, takes time, and does not follow a straight and narrow path. By experiencing how the entire process unfolds, participants will gain a familiarity with the scientific process that can only be accomplished through experience. We expect that this will have a recursive effect through their immediate environment including home, office and community activities. Understanding of the scientific process requires critical thinking skills we all need to function in an increasingly complex society that includes such ballot issues as stem cell research and global warming.



Learn more @ http://www.astronomy2009.us

Contact e-mail: aaronp@aavso.org

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