Highlighting ε Aurigae and Citizen Sky

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Welcome to this special issue of the *Journal of the American Association of Variable Star Observers*, featuring papers on ε Aurigae and the Citizen Sky project (www.citizensky.org). As Price *et al.* explain in the opening paper, Citizen Sky grew out of International Year of Astronomy 2009, brilliantly piggybacking on the international campaign to observe the 2009–2011 eclipse of a bright but mysterious star. It incorporated the "citizen astronomy" philosophy on which the AAVSO is founded—skilled volunteers participating in and advancing astronomical research. It was a complex multidisciplinary project which required careful organization, facilitated by a generous grant from the National Science Foundation. The papers in this issue represent the culmination of the astronomical research aspects of the project but, as Price *et al.* explain, there were many other positive outcomes of the project which, we hope, will continue to bear fruit in the future. In particular, it provides an excellent model for how to organize and manage a complex project, and evaluate the results—something which is rarely done.

I've been actively involved in astronomical research for exactly half a century, so I have experienced three eclipses of ε Aurigae (if I include the 1955–1957 one which I read about as a graduate student). I was educated in an astronomy department (at the University of Toronto) which had special expertise in variable and binary stars—of which ε Aurigae is a prominent example. I have a specific interest in the intrinsic variability of the supergiant component of the system so, unlike many observers, I don't have to wait for the eclipses every twenty-seven years. What fascinates me about the papers in this issue, and in Citizen Sky in general, is how they illustrate so many diverse and intriguing facets of variable star astronomy.

First and foremost: ε Aurigae is a genuine astronomical mystery. It consists of a pulsating blue supergiant and a secondary component, in a 9,896-day (27.09-year) orbit. The secondary component is surrounded by a donut-shaped disk of gas and dust, which eclipses the primary component for almost exactly two years each orbit. It is still not clear whether the primary is a normal massive supergiant, in which case the secondary is most likely a pair of stars in close orbit (the "high-mass model"), or whether the primary is a low-mass supergiant, and the secondary is a single star (the "low-mass model"). We hope that the papers in this special issue will help to resolve this mystery. For an excellent overview of ε Aurigae prior to the 2009–2011 eclipse, see Templeton (2008).

This is frontier astronomy. Disks of gas and dust are widely studied, because they are ubiquitous in the universe. They are found around forming stars, in cataclysmic binary systems, and around supermassive black holes at the nuclei of galaxies. Binary and multiple star evolution is poorly understood, even though binary and multiple stars are the norm, not the exception. It is a topic which is relevant to some of the most exciting topics in astrophysics today. The origin of Type Ia supernovae, which are the most important "measuring sticks" in modern cosmology, is one example.

ε Aurigae has an apparent V magnitude of about 3.0—not much fainter than the stars in the Big Dipper—so it is visible even in cities such as mine. Beginning skywatchers tend to think that all stars are the same so, at star parties, I like to tell them about the particular characteristics of individual bright stars, especially bizarre stars such as ε Aurigae. Beginning skywatchers can then become beginning observers; ε Aurigae is easy to measure with the unaided eye (though binoculars help). Indeed, this was the whole point of Citizen Sky; it brings astronomy and astronomical research to anyone, of any age, anywhere.

As others have pointed out, each eclipse of ε Aurigae brings a new generation of astronomers, and a new generation of technology. The 1982–1984 eclipse coincided with the blossoming of amateur photoelectric photometry (PEP). The 2009–2011 eclipse was observed with CCD and DSLR cameras, as well as PEP and visual techniques.

It was also observed with spectroscopy, a technique which is increasingly available to amateurs, and with polarimetry—a frontier technique for suitably-equipped advanced amateurs. Very few professional observatories are carrying out long-term spectroscopic and polarimetric observations, so this is an area in which amateurs could take up the slack in the future. This eclipse was also observed with an optical interferometer—Georgia State University's CHARA array—so, for the first time, we can "see" this mysterious system.

Finally, this eclipse campaign benefitted from modern information and communication technology, including email, the Internet, and social media. These made the transfer, display, and storage of information efficient and effective. They also helped to connect the international network of amateur and professional observers as never before.

You will notice that the authors of the papers in this issue come from many countries. The observations which amateurs and professionals have contributed during this eclipse campaign come from even more countries, so every contributor is part of an international community of variable star observers.

Furthermore, the archival data on ε Aurigae stretch back for over 160 years. The data in the AAVSO International Database cover the last seven eclipses (1847–1849, 1874–1876, 1901–1903, 1928–1930, 1955–1957, 1982–1984, and 2009–2011), including observations by the eminent Friedrich Argelander of the first of these. The variability of the star was first suspected by Johann Fritch in 1821, during the 1820–1822 eclipse. The 1847–1849 eclipse was observed systematically by Argelander and others. Hans Ludendorff (1904) suggested that the star was an eclipsing variable. By 1937, it had engaged the minds of some of the foremost astronomers of the time: Gerard Kuiper, Otto Struve, and Bengt Strömgren (1937) stated that "the photometric and the spectroscopic data on ε Aur seem to lead to contradictions unparalleled in the study of other eclipsing systems". By the 1955–1957 eclipse, the situation was even more critical, as stellar astrophysics had matured greatly. Various models were proposed, including the possibility (since ruled out) that the system contained a black hole. Today's observers are thus connected, across time, with yesterday's observers and interpreters. The AAVSO centennial, the centennial history (Williams and Saladyga 2011), and the historical papers in the centennial issue of *JAAVSO* (volume 40, number 1) were timely vehicles for helping to make these historical connections.

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References

Kuiper, G., Struve, O., and Strömgren, B. 1937, *Astrophys. J.*, **86**, 570.
Ludendorff, H. 1904, *Astron. Nachr.*, **164**, 81.
Templeton, M. 2008, http://www.aavso.org/vsots epsaur
Williams, T. R., and Saladyga, M. 2011, *Advancing Variable Star Astronomy: The Centennial History of the American Association of Variable Star Observers*, Cambridge Univ. Press, Cambridge.