

# Engaging Students in Authentic Astronomy Research Experiences

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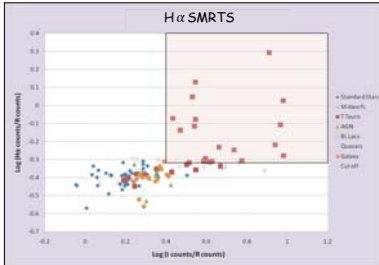


## Working on a New Method to Identify T Tauri Stars

Understanding T Tauri stars is essential if we are to more fully understand our own Solar System. Because T Tauri stars are young versions of our Sun, we can better understand our own history by studying these young stellar objects (YSOs). The Survey Method to Recognize T Tauri Stars (HaSMRTS), previously known as Spuck-Butchart-Optical Survey Method (SBOS) is a simplified method of identifying T Tauri stars using small-scale optical telescopes. Active Galactic Nuclei (AGN) and active M dwarf (dMe) stars emit excess in both infrared and Ha, similar to T Tauri stars, making it likely that objects such as these may contaminate any T Tauri selection method based on infrared and Ha. This study uses observations from the Kitt Peak National Observatory 0.9 meter telescope to further investigate HaSMRTS and its true ability to accurately distinguish T Tauri stars from other objects in space. Contamination by dMe stars is significant; however, a statistical analysis using Precision and Recall indicates a peak accuracy of 90.8% with a Matthews correlation coefficient of +0.74. These results indicate HaSMRTS shows great promise for both professional and amateur astronomers in identifying YSOs, and perhaps could one day lead to a fast and inexpensive all-sky survey and T Tauri star monitoring program. See our companion poster *Identifying T Tauri Stars using Small Scale Optical Telescopes - 422.04*



**Above:** Inga Saathoff filling up the dewar of the 0.9 meter Telescope. The project has received a total of 4 nights observing at Kitt Peak National Observatory through the RBSE – TOPS Program.



**Above:** The X-Y scatter plot of  $\log(I\text{-intensity}/R\text{-intensity})$  vs.  $\log(H\text{-alpha-intensity}/R\text{-intensity})$  displays all targets in the study to date including dMe stars, AGN, BL Lacs, Quasars, Galaxies, standard stars and T Tauri stars.

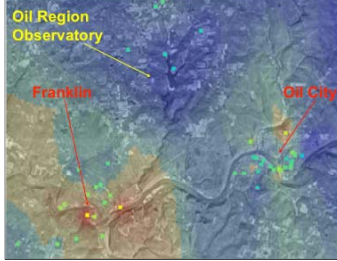
## Exploring Light Pollution in the Local Community

Light pollution is misdirected or misused light, and is quickly stealing the once dark night sky. It harms the nocturnal wildlife, and is threatening the population of many nocturnal species. ([www.starrynightlights.com](http://www.starrynightlights.com) 2009) Globes and wall-mounted non-directional lights are a main cause of light pollution. These types of lighting fixtures send light in every direction, instead of where it is actually needed; on the ground. Bad lighting leaks sideways and upwards and illuminates not only your property, your neighbors, and the once dark sky. ([www.astronomy.org](http://www.astronomy.org) 2009)

Light pollution comes in many varieties, and all are harmful to our environment. One of these damaging types is sky glow, which is light escaping into the night sky and causing a glow over urban and suburban areas. Another is glare, and that is light shining into people's eyes as they walk or drive by. The final is light trespass, unwanted light shining into people's homes. ([www.starrynightlights.com](http://www.starrynightlights.com) 2009)

The poorly designed lighting fixtures that cause light pollution also contributes to another major problem our world is facing today; global warming. The energy and light wasted unnecessarily contributes to greenhouse emissions. The wasted light serves no purpose. It does not aid safety, or security, nor does it enhance amenity. Outdoor lighting is a necessity, but very often it becomes a nuisance. There are better alternatives that will conserve energy and save our dark skies. ([www.assa.org](http://www.assa.org) 2009)

- A PASCO Sparkvue Unit and probes were used to measure latitude, longitude, and relative humidity.
- The Sky Quality Meter was used to measure the sky brightness.
- Care was taken to make sure measurements were made on clear moonless nights away from any direct overhead lighting.
- Data was entered in to Microsoft Excel, and saved as a text document, and then imported into My World GIS to generate a light pollution map (see **Right**).
- The majority of the data was collected during the Christmas season, so the additional lights on houses and snow on the ground may have impacted the results.

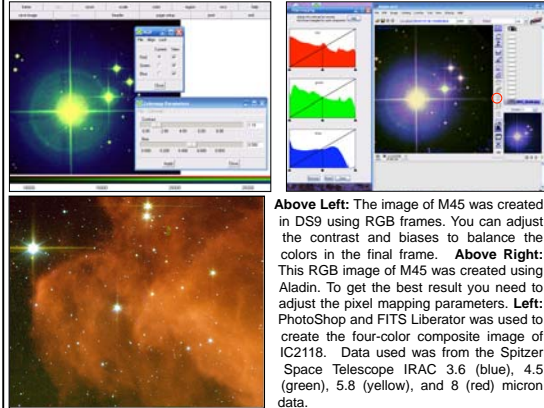


**Our goal is to one day create a map of the entire region that can be used to help community planning AND preserve our valuable asset, dark sky.**

## Astro-Art Creating Color Composite Images

Color composite images for Astronomy are used in different ways. One place we see them is in astronomical magazines catching the reader's eye. They attract them to the article and encourage people to read more about astronomy, thus helping them to become more scientifically aware. Beside the fact that the images are supposed to capture the viewers attention, it is important to consider that we want them to be an accurate scientific representation.

In recent years Oil City High School students have used a variety of software packages including MaxIm DL, Aladin, DS9, and Photoshop/FITS Liberator to create color composite images.



**Above Left:** The image of M45 was created in DS9 using RGB frames. You can adjust the contrast and biases to balance the colors in the final frame. **Above Right:** This RGB image of M45 was created using Aladin. To get the best result you need to adjust the pixel mapping parameters. **Left:** PhotoShop and FITS Liberator was used to create the four-color composite image of IC2118. Data used was from the Spitzer Space Telescope IRAC 3.6 (blue), 4.5 (green), 5.8 (yellow), and 8 (red) micron data.

## Citizen Science with GALAXY ZOO

Computers are better than humans at many things. They can calculate huge numbers, instantly search through millions of databases and help control machines to maintain maximum efficiency. There are some things humans are still superior to computers at. A machine could never paint a masterpiece or write a symphony or classify galaxies as accurate as humans can. Classifying galaxies can be difficult because sometimes there is no clearly correct answer, just another way of looking at it. Human brains however have proven very efficient at classifying galaxies accurately, which is why astronomers need your help. The Sloan telescope in New Mexico, has taken almost 250,000 images, and more data from other telescopes is being added to the Galaxy Zoo project. All of these galaxies need to be classified. This is where the citizen astronomer comes in, professional astronomers simply are too understaffed. Thanks to Galaxy Zoo, most anyone can help professional astronomers after undergoing a short online tutorial. To date over 50 students here at Oil City High School have participated in the project

**Q: Is the galaxy simply smooth and rounded, with no sign of a disk?**

Smooth Features or disk Star or artifact

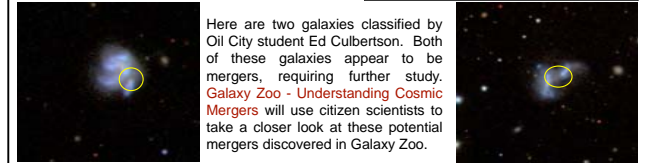
**Q: Is the odd feature a ring, or is the galaxy distorted or irregular?**

Ring Lens or ring Distorted Other Ring or shell Dual ring

**Above:** Snapshots from the Galaxy Zoo online tutorial. Two examples of the analysis done for each galaxy.

By learning about other galaxies, as well as galaxy trends we can learn more about

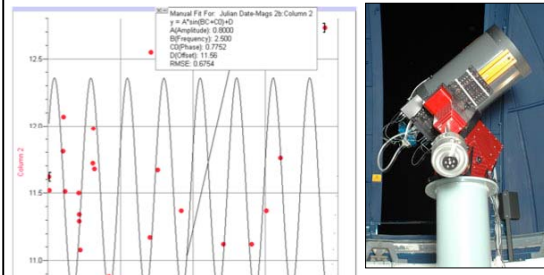
- ★ How galaxies form
- ★ How galaxies evolve
- ★ And averages, rates, and ratios of galaxy morphologies in an attempt to discover why a galaxy might have certain characteristics.



Here are two galaxies classified by Oil City student Ed Culbertson. Both of these galaxies appear to be mergers, requiring further study. **Galaxy Zoo - Understanding Cosmic Mergers** will use citizen scientists to take a closer look at these potential mergers discovered in Galaxy Zoo.

## Cepheid XZ CMA – Observing via a Robotic Telescope in Perth Australia

Cepheid variable stars are used to measure distance to star clusters in our galaxy as well as more distant galaxies. XZ CMA is a Cepheid variable star in the constellation Canis Major. This used the R-COP Telescope in Perth Australia to determine the current variability period for the star, and compare it to previously reported periods. If the variability of the period were to change over time, then the calculated distance to this and other Cepheids may be incorrect.



**Above:** The graph shows the change in V magnitude over time with a sine wave overlay on the data. The graph was created using Graphical Analysis software. The Cepheid period of the target seems to be consistent with the previously reported period of around 2.5 days. However additional data will be needed with less time between exposures to confirm this conclusion.

**Above:** C-14 Telescope with SBIG ST-10 XME CCD camera and CFW-10 Color Filter Wheel mounted on a Paramount ME Robotic Telescope Mount. This telescope is remotely accessed by Oil City students for observing programs.

## Citizen Sky – Solving the Epsilon Aurigae Mystery

Epsilon Aurigae is a star in the constellation Aurigae. Epsilon Aurigae is an eclipsing binary system, and it is different than most Binary systems because once every 27.12 years epsilon Aurigae falls into an eclipse period. The eclipse period lasts approximately 700 days. Scientists are uncertain as to what is eclipsing the star. Oil City students have been engaged in research programs this year to monitor the star and submit results to the American Association of Variable Star Observers (AAVSO) – Citizen Sky database at <http://citizensky.org>. Students and their teacher have taken digital photos of the star to compare the brightness of epsilon Aurigae to two comparison stars in the field of view. In addition visual observations of the same targets were also made using binoculars. Citizen Sky allows people with a minimal astronomical background to take part in authentic science research.

**Left:** 15 second digital image taken by Inga Saathoff using a Cannon Power Shot camera. **Above:** Epsilon Aurigae finder chart from the AAVSO.

**Left:** One model of what scientists believe may be causing the eclipse. (S & T Casey Reed). **Right:** Results of observations submitted via the AAVSO Citizen Sky website.