

### **“The Effects of Age on Brown Dwarf Spectral Features in the Near-Infrared”**

**Adam Solomon, John F. Kennedy High School, Bellmore, New York**

**2005-06 National Individual Finalist**

Abstract: Brown dwarfs are the coldest known stellar objects, not massive enough to fuse hydrogen into helium as true stars do, yet too massive to be considered planets, instead straddling the border between the two. Unlike the spectra of typical stars, which are shaped almost solely by temperature, brown dwarf spectra show significant variations in the near-infrared even amongst objects of the same temperature, suggesting that there is a second and possibly even a third parameter influencing their spectral features. Theoretical models show that the formation of dust clouds in the atmospheres of brown dwarfs may be one such parameter. Far-red optical (i.e.,  $\sim 6000 - 9800 \text{ \AA}$ ) and near infrared (i.e.,  $\sim 1.0 - 2.5 \text{ \mu m}$ ) spectra of a sample of 53 brown dwarfs and low-mass stars of spectral type L are analyzed in an effort to characterize the observed discrepancies. It is found that while clouds may still play their suggested role, one of the most significant spectral discrepancies in brown dwarfs can best be attributed to low surface gravity and, in turn, youth, providing an important new way to infer information about a brown dwarf's age and mass, two of its most essential properties.

### **“A Search for Variable Stars in Two North Open Clusters”**

**Morgan MacLeod, Greely High School, Cumberland, Maine**

**-- 2004-05 National Individual Finalist**

Abstract: Variable stars are stars whose brightness changes over time. The project goal was to search for undiscovered variable stars using amateur astronomy equipment. A 10" telescope, CCD camera, and BVRI photometric filters were used. It was decided to search for variables in open star clusters. NGC 381 and NGC 637, both in Cassiopeia, were selected. Time series of images were taken, totaling 72 hours, between September and November 2003. Images were searched for variables using several open source software programs which plotted each star's brightness against its variability. Outliers were investigated further. No new variables were found in NGC 381. However, two previously undiscovered variable stars were identified in NGC 637. Analysis of the data shows one is an 11.1 magnitude Delta Scuti (spectral type F) star pulsating in two modes. The other is spectral type F; further investigation is needed to characterize its variation. Atmospheric extinction coefficients were determined, allowing absolute photometry of the variables. This, along with distance data to NGC 637, allowed the stars' positions on the H-R diagram to be plotted.

### **“The Discovery of a Type II Seyfert Galaxy Behind the Supernova Remnant 3C397”**

**Andrew C. Foster and Ivana Vu, North Carolina School of Science and Mathematics, Durham, NC**

**-- 2003-04 National Team Finalists**

Abstract: We present the discovery of a type II Seyfert galaxy using archival data from the Chandra X-Ray Observatory's ACIS instrument. This active galaxy is located just outside the southeastern lobe of the supernova remnant G41.1-0.3 (3C397) at a J2000 right ascension of 19 07 41.3 and declination of +07 06 50.75. We present high resolution X-ray images and spectra, and show that the object has an X-ray signature which more closely resembles a type II Seyfert galaxy than our other possibilities, which include a pulsar, X-ray binary, BL Lacertae object, or quasar. The spectrum is characterized by a column density of  $\sim 7.2 \times 10^{22}$  atoms per square centimeter, an equivalent width for an iron line of  $\sim 700 \text{ eV}$ , photon index of 0.47, and a hardness ratio of  $\sim 0.96$ .

**Mentor:** Dr. Jonathan Keohane

## **“Investigation of an Intermediate Mass Black Hole Candidate in Starburst Galaxy M82”**

**Elysa Wan and Nigel K. Mesta, North Carolina School of Science and Mathematics, Durham, NC –  
-- 2002-03 National Team Finalists**

Abstract: We used recent data from the Chandra telescope, analyzing both the spectral and positional characteristics of nine of the most luminous sources, in the close-by starburst galaxy M82. We compared the position of the most luminous X-ray source and a very luminous mid-infrared feature. Our multi-wavelength comparison of compact sources in M82 has revealed the concurrence of the hardest X-ray source and the second most luminous mid-infrared feature. We attribute the X-ray brightness to the strong X-ray binary of an intermediate mass black hole (IMBH). We expect that the bright infrared source is an aged superstar cluster (SSC). This supports the theory that IMBHs originate from compact remnants such as star clusters or globular star clusters. We propose that the brightest mid-infrared feature is an aged SSC which fuels the IMBH that is located in approximately the same position.

**Mentor:** Dr. Jonathan Keohane