Michigan State University
2003-present
Dr. Megan Donahue
The Entropy-Feedback Connection and Quantifying Cluster Virialization

Some of the intracluster medium (ICM) has a cooling time shorter than the age of the Universe. And as the ICM cools it radiates away much of the energy acquired during formation. As the ICM cools, portions of it condense and flow to the bottom of the cluster potential well. But, the hypothesized products of these "cooling flows", such as stars or molecular clouds, are not observed in the cores of clusters. There is clearly some feedback mechanism operating within clusters which retards unabated cooling. The most likely candidate for the feedback is currently active galactic nuclei (AGN), and this area of study is under heavy focus by both observationalists and theoreticians.

The picture of the ICM entropy-feedback connection emerging from my work suggests that cD radio luminosity and Hα emission are anti-correlated with cluster central entropy. I have explored these relations with my sample of clusters observed with *Chandra* and am finding a trend of high central entropy favoring low $L_{H\alpha}$ and low L_{Radio}. These results fit well with the current framework for AGN heating and cooling flow retardation through the inflation of bubbles in the ICM and star formation in the cores of cooling flows. I am following up these results by examining the distribution of central cooling times as a window onto the timescale of AGN feedback. In addition, I am exploring the dependence of the X-ray loud AGN distribution on redshift and amount of cluster substructure.

One method of quantifying cluster substructure – a property of clusters which results in the underestimate of cluster temperatures and therefore cluster mass – employs the ratios of X-ray surface brightness moments to quantify the degree of relaxation. Although an excellent tool, power ratio suffers from being aspect dependent, much like other substructure measures such as axial ratio or centroid variation. The work of Mathiesen & Evrard (2001) found an auxiliary measure of substructure which does not depend on perspective and could be combined with power ratio, axial ratio, and centroid variation to yield a more robust metric for quantifying a cluster's degree of relaxation.

I have studied this auxiliary measure: the bandpass dependence in determining X-ray temperatures and what this dependence tells us about the virialization state of a cluster. The ultimate goal of this project is to find an aspect-independent measure for a cluster's dynamic state. I have investigated the net temperature skew in my sample of the hard-band (2.0_{rest}-7.0 keV) and full-band (0.7-7.0 keV) temperature ratio for core-excised apertures. I have found this temperature ratio is statistically connected to mergers and the presence of cool cores. Having confirmed the prediction of Mathiesen & Evrard (2001), the next step is to make a comparison to the predicted distribution of temperature ratios and their relationship to putative cool lumps and/or non-thermal soft X-ray emission in cluster simulations.

Michigan State University
2002-2003
Dr. Jack Baldwin
***s*-Process Abundances in Planetary Nebulae**

In my earliest work as a graduate student I identified and analyzed spectral lines for the planetary nebulae IC 2501, IC 4191, and NGC 2440 using data taken with MIKE, a double echelle spectrograph at the Las Campanas Observatory. In this work we found enhancements above Solar of s-process element abundances. This is indicative of a progenitor star which has experienced slow neutron capture and dredge-up in its giant phase. These results go directly to the efficiency of the s-process in stellar models, and ultimately to a better understanding of ISM enrichment.

Georgia Institute of Technology
2000-2002
Dr. James Sowell
Orbital Solutions for the Eclipsing Binary ET Tau

I participated in a project to find an orbital solution of the Algol eclipsing binary ET Tau using UBV data taken with the 0.9 meter Fernbank Telescope. By combining the light curves and radial velocity curves over a baseline of four years we were able to generate a stable solution using the Wilson-Devinney code which yielded a period of 6.0 days for a semi-detached configuration. We were also able to infer mass, radius, temperature, luminosity, and specific gravity for both of the binary members.