

Investigation of Radioactive X-ray Sources in the Tycho and Cas A Supernova Remnants

During the summer of 2002, I participated in an internship at Clemson University under the direction of the Southeastern Association for Research in Astronomy (SARA). While at Clemson, I gained my first deep experience in astronomical research, in specific, investigating x-ray lines in the spectra of supernova remnants. My research advisor, Dr. Mark Leising, had spent past years studying radioactive decay in super nova remnants using data from orbiting gamma ray observatories. Such observations give clues and information into the processes behind the formation of the heavier elements in these high temperature regions. Unfortunately, there are no gamma ray observatories currently in orbit. The goal of my project would be to determine if such measurements were achievable in the x-ray region, using such instruments as the Chandra X-Ray Observatory, or perhaps the XMM-Newton satellite.

As mentioned before, previous research had been performed using the gamma rays emitted directly by the decay of high mass radioactive isotopes formed in super nova explosions. The desired x-ray lines occurred from the de-excitation of electrons in the decay products of these reactions. To complicate matters, these x-ray lines would be tremendously weak and very near the capabilities of telescopes like the Chandra Observatory. Using archived images of supernova remnants such as Cas A and Tycho's supernova, I attempted to analyze the regions using a software package designed specifically for use with Chandra x-ray images. Using a pipelined procedure, I could obtain spectra for a specified region of the remnant, and then attempt to fit these spectra with known x-ray characteristics. Once a sufficient fit was made, an additional parameter would be added, representing the desired x-ray line.

Initially, after completing several sets of data for the two remnants, my reaction was less than excited. In each spectrum, there was obviously no visual evidence for the lines we hoped to see. Statistically, we could obtain an upper limit on the intensity of the desired lines using the fitting and modeling software. In each case, this upper limit on the flux of the lines was on the order of 10^{-5} to 10^{-6} photons per square centimeter per second. While these estimates may be on the edge of the capabilities of the instrument, they were very closely matched with theoretical estimates produced by research advisor. This conclusion made us hope that with further study, it could be possible to justify longer exposures in order to detect these indicators of radioactivity.

In conclusion, I found that the value of this research experience may not have shown itself directly on the surface. At first, I was certainly disappointed by what many could argue was a null result. However, by understanding the premise behind this research, I was able to see how even a null result can be scientifically important. It is obviously justifiable to determine whether type of measurement is possible, considering the research and information that could result from a success. In addition, this experiment can be thought of as a first step toward determining what adjustments, such as exposure time and sensitivity, could be made to make future observation of these lines possible.