Image Analysis of Planetary Nebula NGC 6543

Faculty Mentor
Dr. Donald Walter

Team Members
Ms. Jennifer Sanders
Ms. Korressa Williams

South Carolina State University
July 15, 2005
Planetary Nebula
Planetary nebula is an expanding shell of gas ejected from a star during its red giant stage. Star must be low mass like the sun or a few times more massive.
Planetary Nebulae have round, elliptical or bipolar cores, a series of rings and extended halos.

Planetary nebulae display paired lobes, jets, hourglass shaped shells or other bipolar forms.

Planetary nebulae has a range of shapes such as circular, elongated, dumbbell figure or opposing lobes.
NGC 6543

“The Cat's Eye Nebula”

Hubble Space Telescope Image
Cat's Eye Nebula .......

was discovered by William Herschel on February 15, 1786.

has a series of gas loops that resemblance a cat's eye.

has a tiny, hot stellar core.

shows intricate structures of concentric gas shells with unusual shock-induced knots of gas.

has nine faint, regular spaced rings ejected every 1,500 years.

has outer polar caps and other debris that were created in an earlier bursting of the central star.
Processes in the Interstellar Medium

**Ionization**
energetic photons absorbed by atoms in the gas.

**Collisional Excitation**
occurs when an electron collides with an ion. This process creates a more energetic.

**Spontaneous Deexcitation**
The ion drops to a lower energy level and releases energy as a photon.
White Dwarf

Emits UV Photons

Sulphur Ions in the production of photons

Emits Photons

Excited S+ ion

Frees Electrons

Ionize Gas

CCD
Data Set & Analysis
Data was collected with Robotically Controlled Telescope at the Kitt Peak National Observatory using filters.

<table>
<thead>
<tr>
<th>Name</th>
<th>CWL (nm)</th>
<th>FWHM (nm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sulphur II 6717</td>
<td>671.6</td>
<td>0.9</td>
</tr>
<tr>
<td>Sulphur II 6731</td>
<td>672.9</td>
<td>0.8</td>
</tr>
</tbody>
</table>
A software package that uses commands to operate in astronomical image processing.

Image Math  Statistics
Display
Bias Frame - shows electronic noise

Dark Frame - shows thermal noise

Flat Frame - shows sensitivity variations

Object Frame - shows NGC 6543
Major Steps to Image Processing

* create an average bias frame

* subtract average bias frame from each image

* dark is very low - ignored

* create an average flat field image, then normalize it

* divide normalized flat into all images

* fix bad pixel columns and remove cosmic ray hits

* create a image of the sum of all the object images for each filter separately

* create a sulphur ratio map from the two filters
Cosmic rays Hits

Before

After
Sulphur Ratio Map
Density Results from Ratio Map

Electron Densities in NGC 6543 from Ratio Map of [SII] 6731/6717

- Dark Red - 2000 electrons/cm³
- Light Red - 1600 electrons/cm³
- Yellow - 1200 electrons/cm³
- Green - 800 electrons/cm³
Future Work

convert ratio map to density values pixel by pixel

compare results to previous research

make research available for future use
Acknowledgements

Dr. Donald K. Walter
Ms. Irene Scott
Mr. Joseph Bartolini
Other URIA Faculty Mentors

This work has been supported in part by NASA/MU-SPIN (NNG04GD62G), NASA's Science Mission (NNG04GD62G) and NASA URC through a subgrant from Tennessee State University (NCCW-0085).