Prospecting for Iron in the Galactic Supernova Remnant W49B

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Abstract: *We have analyzed an archival 54 kilosecond observation made of the Galactic supernova remnant (SNR) W49B with the Chandra X-ray Observatory. W49B is an X-ray and infrared luminous SNR that lies at an estimated distance of 11 kiloparsecs: while some observers have claimed that this source was produced by the death of a white dwarf in a supernova explosion, others have argued that the SNR was created in the aftermath of a gamma-ray burst. To investigate the true nature of the stellar progenitor of W49B, we have extracted spectra from multiple regions of the SNR and measured the abundances of iron relative to oxygen. Our initial spectral analysis indicates that iron is overabundant relative to iron at each location of the SNR and thus an origin associated with the death of a white dwarf star appears to be more likely.*

Introduction

Supernova remnants (SNR) refers to the expanding shell of material produced by a supernova explosion and SNR's got their name because they were perceived to be "new" stars when in fact they are the left over material from an old star when it dies and explodes. When the star explodes material, such as elements and dust are blown away in a uniform distribution the majority of the time. For the supernova we observed, mater near the poles of the remnant was ejected at a much higher speed than its equator. The way that the matter was ejected from the remnants poles is how W49B got its unusual shape. By tracing the distribution and abundance of different elements present in the supernova remnant, we were able to conclude that W49B has an abundance of Iron, and other heavier elements which means that the star that formed this remnant is unique and quite rare.

W49B Facts

W49B is a highly distorted supernova remnant, produced by a rare type of explosion.

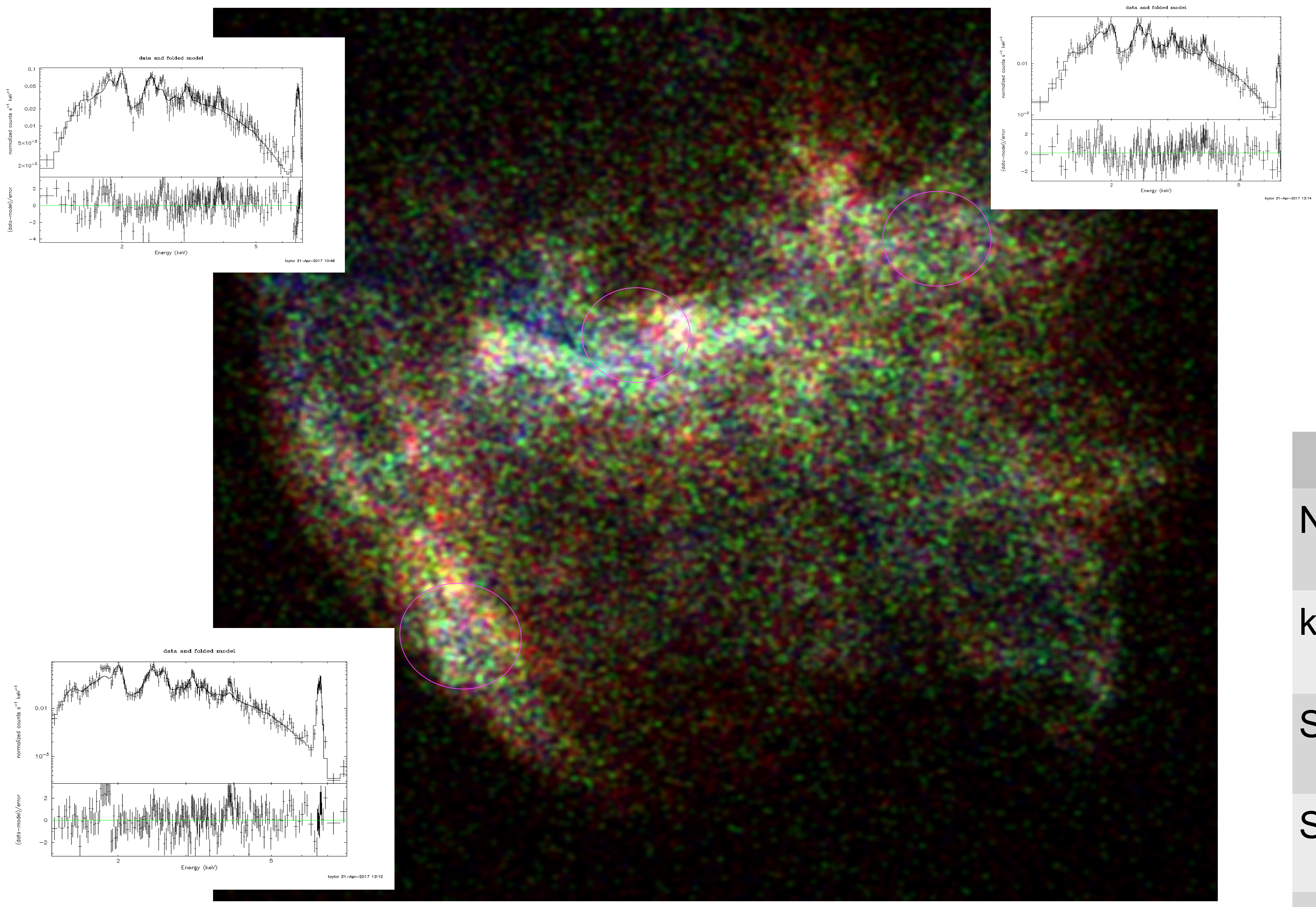
Instead of radiating out symmetrically, W49B's exploding star shot more material out from its poles versus from its equator.

There is evidence that W49B left behind a black hole - not a neutron star like most other supernovas.

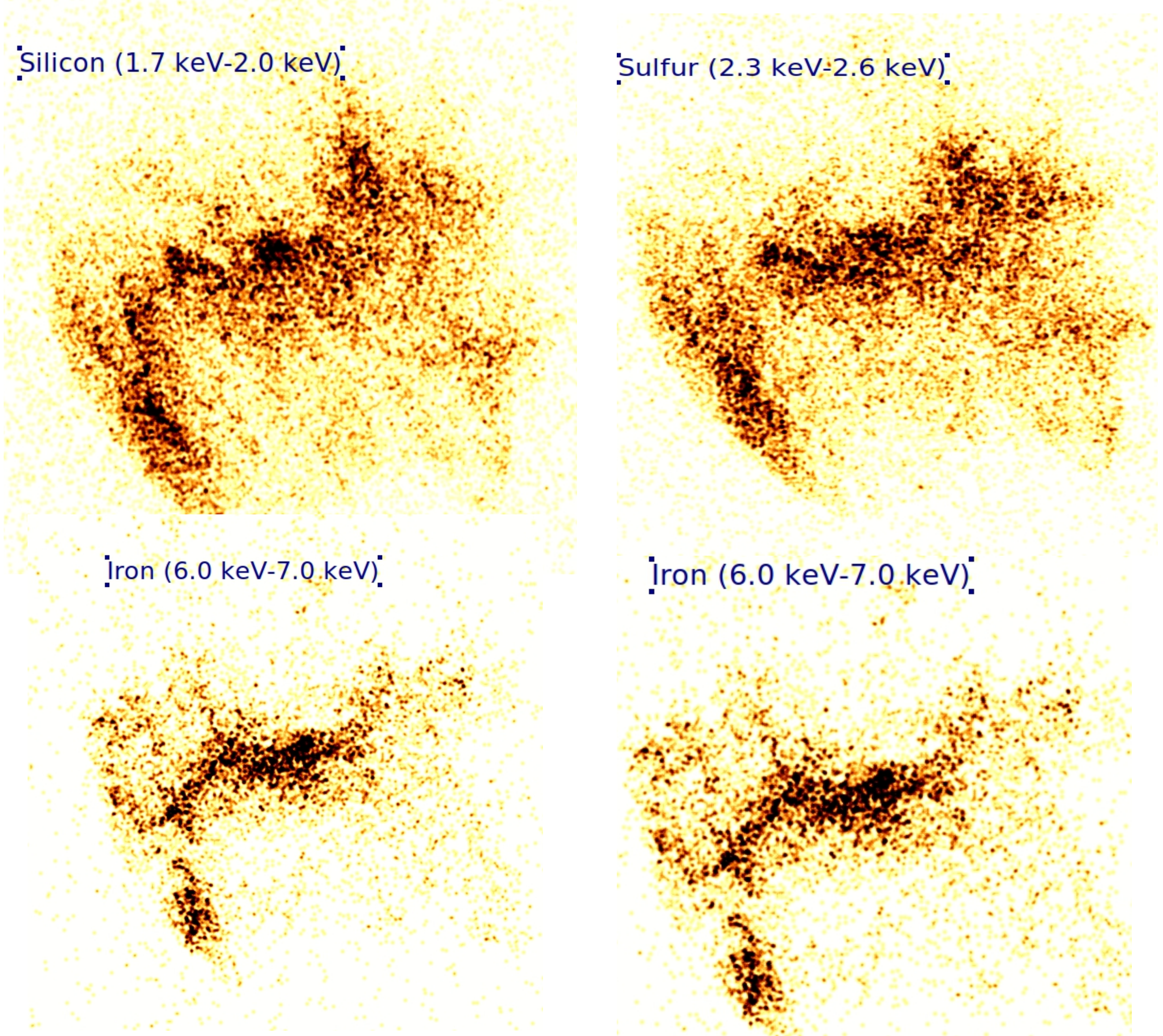
If confirmed, W49B would be the most recent black hole formed in our Galaxy.

Data Reduction

Data reduction was done with CIAO 4.8, which is a standard tool to do analysis of data from the Chandra X-ray Observatory. The CIAO tool called chandra_repro was used to apply standard calibration to the datase while the CIAO tool specxtract was used to extract spectra from regions of interest along with generating other needed files for spectral analysis.



Three-color *Chandra* image of W49B. Red, green and blue emission corresponds to energy ranges of 500 eV-2500 eV, 2500 eV-3000 eV and 3000 eV- 7000 eV, respectively.



Elemental maps of W49B (clockwise from upper left): silicon, sulfur, argon and iron. Notice variations in the spatial distributions of the elements across all of W49B.

Results

Each data extraction and fitting of the three regions showed that SNR W49B is heavy in Iron as well as other heavier elements found in the core of a star. This means that the star that caused the supernova explosion was very dense and able to fuse together these heavier elements. After plotting the distributions of heavier elements you can see that the distribution of Silicon, Sulfur, and Argon are somewhat uniform, while the distribution of Iron, while very abundant, is more skewed towards the upper middle of the SNR.

	Region 1	Region 2	Region 3
N_H (10^{22})	4.36	4.67	4.51
kT (keV)	1.95 (-0.09, +0.06)	1.81 (-0.12,+0.06)	1.97 (-0.36, +0.30)
Silicon	3.91 (-0.68, +0.85)	3.3 (-0.58,+0.70)	1.31 (-0.24, +1.16)
Sulfur	3.52 (-0.58, +0.77)	2.39 (-0.46,+0.55)	1.45 (-0.31,+0.84)
Argon	2.68 (-0.92, +1.06)	2.15 (-0.77,+0.86)	1.86 (-0.59,+0.65)
Iron	6.14 (-1.04, +1.23)	7.04 (-1.32,1.88)	1.80 (-0.43,+0.60)
Tau (10^{11})	3.81 (--,--)	3.54 (–,--)	4.1 (>2.59)

Further research

In the future, we can use more observations of W49B and use those observations to get more data and to get more accurate results. We can collect more data from more regions scattered across the remnant to get more accurate data of how the elements were distributed. We could also use smaller regions.

References

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