Novel method used to investigate supernova remnant DEM L71

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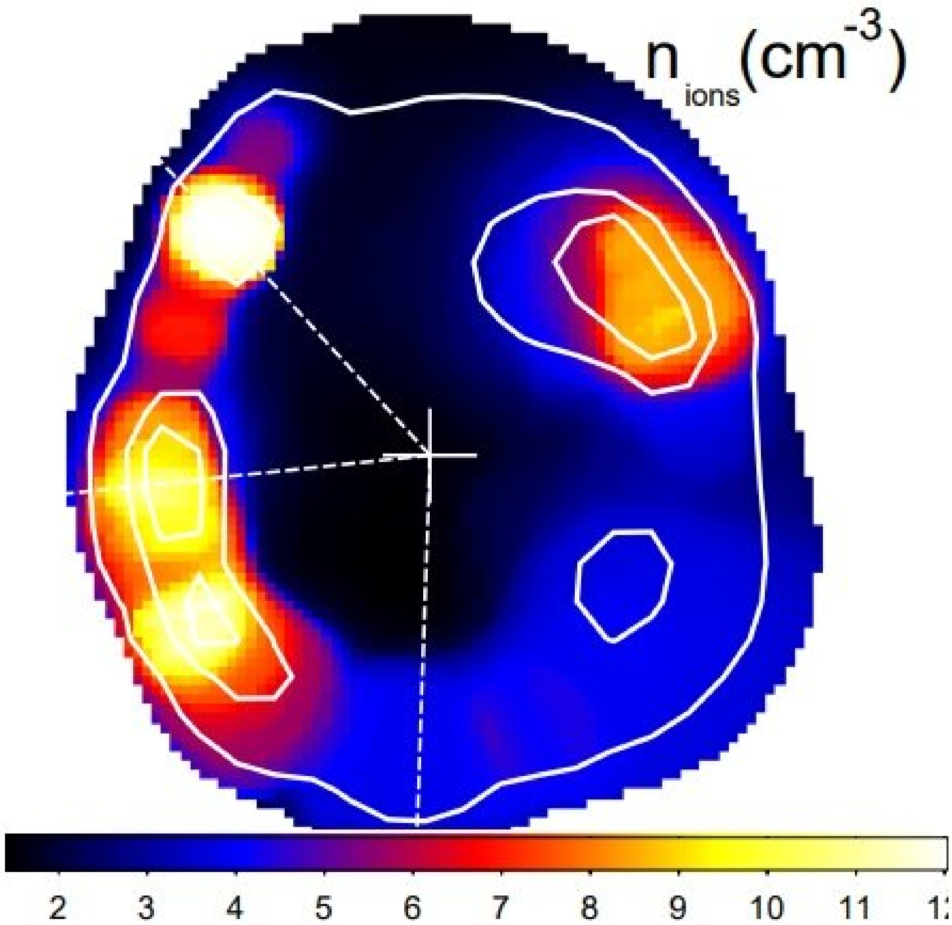

DEM L71: Emission measure-weighted density map of the swept-up medium, with the density calculated using the SPI measured abundance. Credit: Siegel et al., 2020.

Using the smoothed particle inference (SPI) technique, astronomers have investigated the supernova remnant (SNR) DEM L71, mainly analyzing the X-ray emission from this source. Results of the study, presented in a paper published January 28 on arXiv.org, shed more light on the nature of this SNR.

Supernova remnants are diffuse, expanding structures resulting from a supernova explosion. They contain ejected material expanding from the explosion and other interstellar material that has been swept up by the passage of the shock wave from the exploded star.

SNRs are in general complex, three-dimensional objects, which makes studying them quite challenging, especially when investigating their X-ray emission. SPI is a method that addresses this problem. It is a flexible technique for fitting X-ray observations of extended objects, allowing modeling of the plasma as a collection of independent "smoothed particles," or blobs, of plasma.

A team of astronomers led by Jared Siegel of the University of Chicago, Illinois, has employed SPI to characterize the X-ray emission from the supernova remnant DEM L71, which was observed by ESA's XMM-Newton spacecraft. DEM L71 is classified as a Type Ia SNR in the Large Magellanic Cloud (LMC), about 4,000 years old, showcasing a more or less regular shape. The new study is complementary to the one conducted by Siegel's team last year, providing chemical abundance analysis of the material ejected from the SNR and comparing it to supernova explosion models.

"Here, we extend the analysis of the SPI fit by calculating the composition of the swept-up material and the ejecta of DEM L71, and comparing those to a large set of supernova explosion models," the astronomers wrote in the paper.

In particular, as part of the new research, the scientists have better isolated the ejecta and computed the abundance of various elements, when compared to the previous study. The total mass of the swept-up material was calculated to be about 228 solar masses and it was confirmed that DEM L71 shows an excess of iron (Fe) in its central region.

The researchers noted that the total mass of the swept-up material is much larger than that derived by a study conducted in 2003. They assume that this could be due to the volume of our surrounding medium, which exceeds the volume derived by the research carried out almost 20 years ago.

In general, the results suggest, especially the excess of iron in the central region of DEM L71, that it is a Type Ia explosion. The astronomers noted that high iron abundance is totally inconsistent with an origin either in typical LMC material, or in core-collapse explosions.

"It can only be matched by the mass range predicted by Type Ia models. The Fe abundance therefore has the most discriminating power, and clearly suggests a Type Ia rather than a core-collapse SN explosion," the authors of the paper concluded.

Encouraged by the results, Siegel's team now plans to apply the SPI method to other SNRs observed with XMM-Newton, including W49B—a supernova remnant probably from a Type Ib or Ic supernova, located about 33,000 light years away.

More information: SPI Analysis and Abundance Calculations of DEM L71, and Comparison to SN explosion Models, arXiv:2001.10129 [astro-ph.HE] arxiv.org/abs/2001.10129

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