Ohio state research team uses manganese to find clues about how galaxies evolve

thelantern.com/2026/09/ohio-state-research-team-uses-manganese-to-find-clues-about-how-galaxies-evolve

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September 4, 2026

THE LANTERN

Ohio State's Arne Slettebak Planetarium, where some astronomy classes take place. Credit: Anbo Yao | Lantern File Photo

A research team including Ohio State professors identified chemical signals that could give astronomers a new way to study how galaxies evolved throughout the history of the universe.

Ohio State astrophysics professors Sultana Nahar and Anil Pradhan led the research in collaboration with Zher Samak, the study's first author and a professor at Al-Aqsa university in Gaza, Palestine.

The team used more than 700 models of manganese emission lines, or wavelengths of light produced by atoms, to determine which signals could be detected by telescopes. Pradhan said the findings could help astronomers study the chemical makeup and history of distant galaxies.

“Manganese and iron, these are important elements in astronomy,” Pradhan said. “Their relative proportion is a tracer of the evolution of the universe itself.”

Pradhan said that manganese acts as a “tracer” of the universe’s evolution because its abundance in the universe changes over time. Comparing the amount of manganese with other elements, like iron, can help scientists understand when stars and galaxies were formed.

Pradhan said the researchers used advanced atomic physics calculations to predict which manganese signals could be observed from a distance. Pradhan said the calculations are important because astronomers need to know what a particular element’s signal looks like before they can identify that element in observations.

The predicted manganese lines have not yet been detected through astronomical observations. Pradhan said they plan to test their predictions using NASA’s James Webb Space Telescope and through ground-based observatories. According to NASA’s website, the James Webb Space Telescope is the largest telescope in space which can view objects at a large distance using infrared light.

Nahar said the findings can also be useful for studying distant galaxies from the early universe. Light can take billions of years to travel from distant galaxies to Earth. Telescopes allow astronomers to observe objects as they appeared billions of years ago, Nahar said.

Pradhan said the James Webb Space Telescope’s ability to detect infrared light makes it useful for studying distant objects.

“[The] James Webb Space Telescope opened up a whole new era in the study of astronomy, going back almost to the time of the origin of the universe, 13.8 billion years ago,” Pradhan said.

Pradhan said if the predicted manganese signals are detected, researchers could use them to identify manganese in distant galaxies and learn more about the conditions and chemical history of those galaxies.

Samak’s contribution to the study came while working under difficult conditions in Gaza. Nahar first met Samak when Samak was her student at Cairo University in 2015. Their collaboration continued as Samak became a professor at Al-Aqsa University in Gaza.

During the war, Nahar said Samak's home was destroyed and she lived in a tent with around 20 people. Access to technology was also a weighing issue.

"She did so much work," Nahar said. "Just to charge her laptop, she had to go about a mile away to charge her battery, come back and work on it."

Nahar helped Samak obtain a laptop, and Samak used an account at the Ohio Supercomputer Center to complete the calculations needed for the research.

Pradhan said Samak's continued work demonstrated the importance of scientific collaboration.

"All the educational institutions and research institutions in Gaza have been destroyed," Pradhan said. "So it's remarkable that something can come out of this at the highest intellectual, scientific level, up to world-class standards."

The manganese research is part of a broader effort by the Ohio State researchers to study elements throughout the periodic table and determine how their chemical signals can be used to study astronomical objects, Nahar said.

Pradhan said they plan to continue studying different forms of manganese as well as other elements, including iron and oxygen. Pradhan said the team is currently waiting for astronomical observations that could determine whether the manganese signals predicted by its models can be detected.

Their study was published online in *The Monthly Notices of The Royal Astronomical Society*, and their results were made publicly available online.