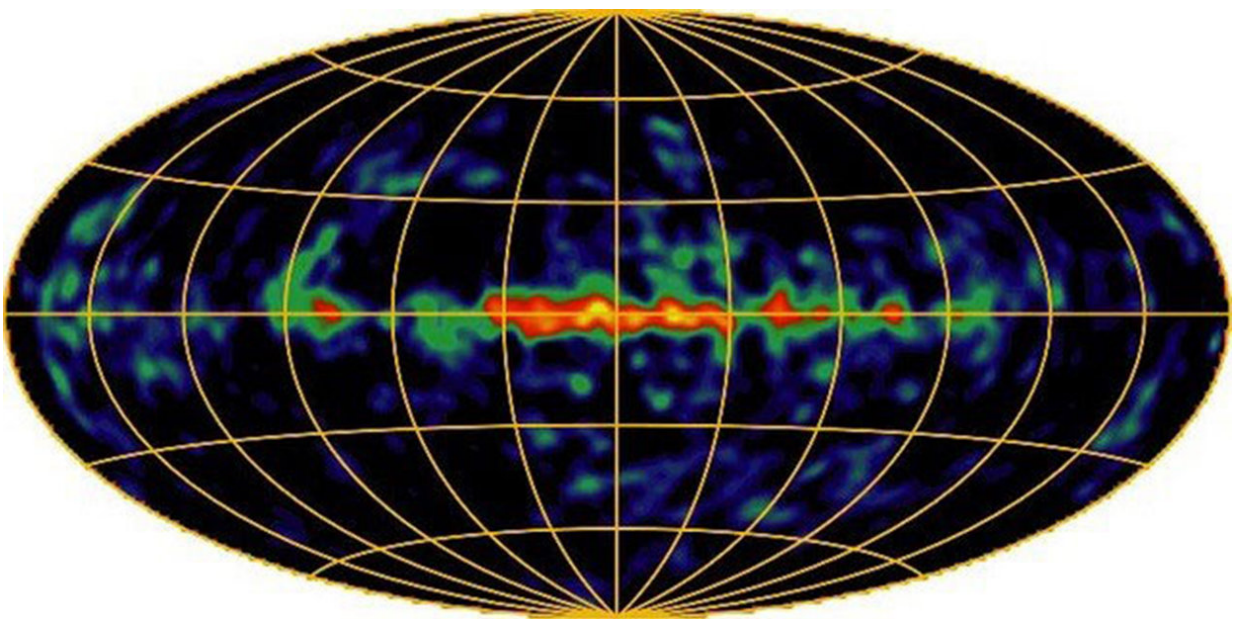


New tech uses isomeric beams to study how and where the galaxy makes one of its most common elements

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The map shows the galactic gamma radiation from aluminum-26 decay as measured by the COMPTEL telescope. Credit: US Department of Energy

Our galaxy produces and destroys the element aluminum-26 in the process of making magnesium-26. As it forms, it can be momentarily "stuck" in a mirror-image (isomeric) state. Getting stuck lets other reactions occur that destroy the element. Measuring how much aluminum-26 the galaxy makes is tough because scientists have to know

how much is destroyed. For the first time, scientists produced an aluminum-26 beam in an isomeric state. They used the beam to determine how fast aluminum-26 is destroyed. The resulting study offers the first experimental result for aluminum-26 synthesis.

As a consequence of this new isomeric beam, our understanding of how much aluminum-26 is being formed and destroyed in the galaxy has changed. The impact? We have more realistic data to use in the calculations that attempt to explain the observations made by gamma-ray telescopes. Further, the successful production and use of an isomeric beam can be generalized to other examples. It lets researchers explore the influence of long-lived [excited states](#) in the creation of elements by the stars.

Satellites equipped with gamma-ray telescopes have proven to be powerful tools for finding evidence that elements are continually being produced in our galaxy. For example, the detection of a gamma ray associated with the decay of radioactive aluminum-26 would not be possible if aluminum-26 wasn't being continually formed, as it would all have decayed away long ago. However, while this observation indicates that aluminum-26 is continually being formed in the galaxy, it does not tell us where the formation occurs (e.g., novae, supernovae, or giant stars). To understand the observations, experiments in the laboratory must be performed to determine what conditions are most suited to form aluminum-26 in the cosmos. One problem in determining this is the fact that aluminum-26 has an excited state that survives for a few seconds before it decays to the [ground state](#) of magnesium-26. Because this state lives so much longer than other excited states, it is classified as isomeric. When aluminum-26 is formed in the galaxy, it is possible that it could be momentarily "stuck" in the isomeric state, allowing time for another reaction to occur that destroys the [element](#). To fully understand how much aluminum-26 is being formed in the galaxy, one needs to understand how much of this isotope is destroyed while "stuck" in this

long-lived state.

To determine the production and destruction rates of aluminum-26, one must create a beam of aluminum-26 when it is in the ground state and when it is in the long-lived state. While the former has been accomplished at a number of laboratories, the latter was only recently made possible at the ATLAS facility at Argonne National Laboratory. Using this isomeric beam of aluminum-26, researchers determined for the first time the probability that a portion of the aluminum-26 was destroyed before reaching the ground state because the [beam](#) passed through the isomer.

More information: S. Almaraz-Calderon et al. Study of the $\text{Al}^{26}(\text{d},\text{p})\text{Al}^{27}$ Reaction and the Influence of the Al^{26} 0^+ Isomer on the Destruction of Al^{26} in the Galaxy, *Physical Review Letters* (2017). DOI: [10.1103/PhysRevLett.119.072701](https://doi.org/10.1103/PhysRevLett.119.072701)

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