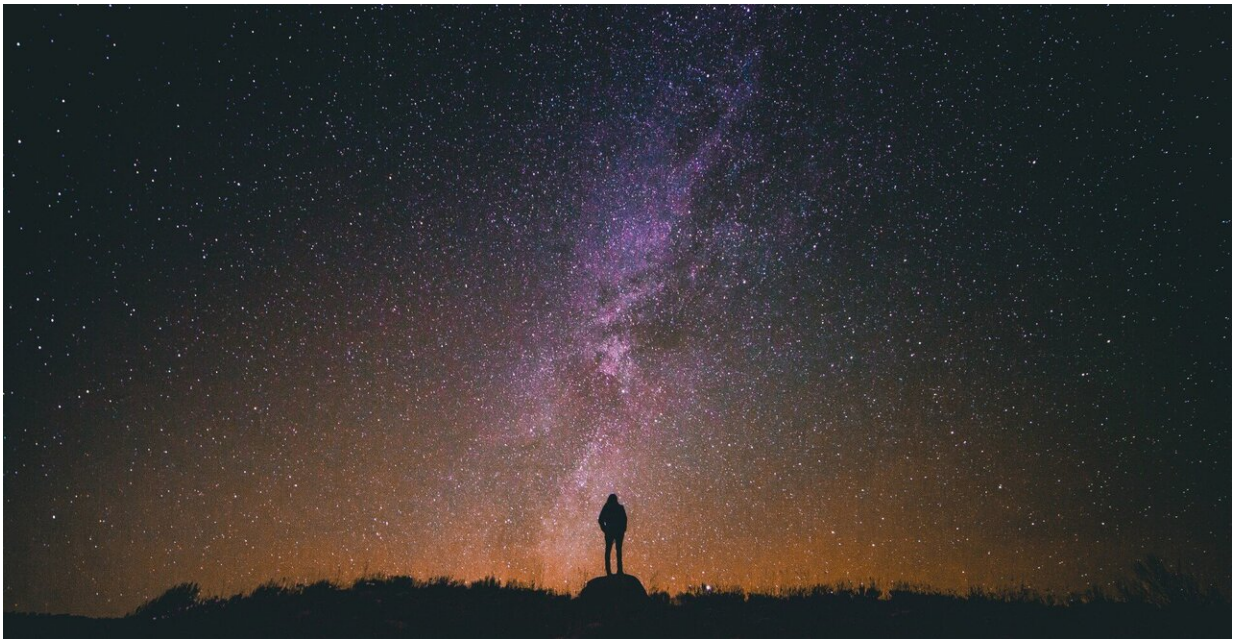


The universe is getting hot, hot, hot, a new study suggests

November 10 2020, by Laura Arenschiold



A new study has found that the universe is getting hotter. Credit: Greg Rakozy on Unsplash

The universe is getting hotter, a new study has found.

The study, published Oct. 13 in the *Astrophysical Journal*, probed the thermal history of the [universe](#) over the last 10 billion years. It found that the mean [temperature](#) of gas across the universe has increased more than 10 times over that [time period](#) and reached about 2 million degrees

Kelvin today—approximately 4 million degrees Fahrenheit.

"Our new measurement provides a direct confirmation of the seminal work by Jim Peebles—the 2019 Nobel Laureate in Physics—who laid out the theory of how the large-scale structure forms in the universe," said Yi-Kuan Chiang, lead author of the study and a research fellow at The Ohio State University Center for Cosmology and AstroParticle Physics.

The large-scale structure of the universe refers to the global patterns of galaxies and [galaxy clusters](#) on scales beyond individual galaxies. It is formed by the gravitational collapse of dark matter and gas.

"As the universe evolves, gravity pulls dark matter and gas in space together into galaxies and clusters of [galaxies](#)," Chiang said. "The drag is violent—so violent that more and more gas is shocked and heated up."

The findings, Chiang said, showed scientists how to clock the progress of cosmic structure formation by "checking the temperature" of the universe.

The researchers used a new method that allowed them to estimate the temperature of gas farther away from Earth—which means further back in [time](#)—and compare them to gases closer to Earth and near the present time. Now, he said, researchers have confirmed that the universe is getting hotter over time due to the gravitational collapse of cosmic structure, and the heating will likely continue.

To understand how the temperature of the universe has changed over time, researchers used data on [light](#) throughout space collected by two missions, Planck and the Sloan Digital Sky Survey. Planck is the European Space Agency mission that operates with heavy involvement from NASA; Sloan collects detailed images and light spectra from the

universe.

They combined data from the two missions and evaluated the distances of the hot gases near and far via measuring redshift, a notion that astrophysicists use to estimate the cosmic age at which distant objects are observed. ("Redshift" gets its name from the way wavelengths of light lengthen. The farther away something is in the universe, the longer its wavelength of light. Scientists who study the cosmos call that lengthening the redshift effect.)

The concept of redshift works because the light we see from objects farther away from Earth is older than the light we see from objects closer to Earth—the light from distant objects has traveled a longer journey to reach us. That fact, together with a method to estimate temperature from light, allowed the researchers to measure the mean temperature of gases in the early universe—gases that surround objects farther away—and compare that mean with the mean temperature of gases closer to Earth—gases today.

Those gases in the universe today, the researchers found, reach temperatures of about 2 million degrees Kelvin—approximately 4 million degrees Fahrenheit, around objects closer to Earth. That is about 10 times the temperature of the gases around objects farther away and further back in time.

The universe, Chiang said, is warming because of the natural process of galaxy and structure formation. It is unrelated to the warming on Earth. "These phenomena are happening on very different scales," he said. "They are not at all connected."

More information: Yi-Kuan Chiang et al, The Cosmic Thermal History Probed by Sunyaev–Zeldovich Effect Tomography, *The Astrophysical Journal* (2020). [DOI: 10.3847/1538-4357/abb403](https://doi.org/10.3847/1538-4357/abb403)

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