

Early universe 'warmed up' later than previously believed, study finds

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A new study from Tel Aviv University reveals that black holes, formed from the first stars in our universe, heated the gas throughout space later than previously thought. They also imprinted a clear signature in radio waves which astronomers can now search for. The work is a major new finding about the origins of the universe.

"One of the exciting frontiers in astronomy is the era of the formation of the first stars," explains Prof. Rennan Barkana of TAU's School of Physics and Astronomy, an author of the study. "Since the universe was filled with hydrogen atoms at that time, the most promising method for observing the epoch of the first stars is by measuring the emission of

hydrogen using radio waves."

The study, just published in the journal *Nature*, was co-authored by Dr. Anastasia Fialkov of TAU and the École Normale Supérieure in Paris and Dr. Eli Visbal of Columbia and Harvard Universities.

Cosmic archaeology

Astronomers explore our distant past, billions of years back in time. Unlike Earth-bound archaeologists, however, who can only study remnants of the past, astronomers can see the past directly. The light from distant objects takes a long time to reach the earth, and astronomers can see these objects as they were back when that light was emitted. This means that if astronomers look out far enough, they can see the first stars as they actually were in the early universe. Thus, the new finding that cosmic heating occurred later than previously thought means that observers do not have to search as far, and it will be easier to see this cosmic milestone.

Cosmic heating may offer a way to directly investigate the earliest black holes, since it was likely driven by star systems called "black-hole binaries." These are pairs of stars in which the larger star ended its life with a supernova explosion that left a black-hole remnant in its place. Gas from the companion star is pulled in towards the black hole, gets ripped apart in the strong gravity, and emits high-energy X-ray radiation. This radiation reaches large distances, and is believed to have re-heated the cosmic gas, after it had cooled down as a result of the original cosmic expansion. The discovery in the new research is the delay of this heating.

The cosmic radio show

"It was previously believed that the heating occurred very early," says Prof. Barkana, "but we discovered that this standard picture delicately depends on the precise energy with which the X-rays come out. Taking into account up-to-date observations of nearby black-hole binaries changes the expectations for the history of cosmic heating. It results in a new prediction of an early time (when the universe was only 400 million years old) at which the sky was uniformly filled with radio waves emitted by the hydrogen gas."

In order to detect the expected [radio waves](#) from hydrogen in the early universe, several large international groups have built and begun operating new arrays of radio telescopes. These arrays were designed under the assumption that cosmic heating occurred too early to see, so instead the arrays can only search for a later cosmic event, in which radiation from stars broke up the [hydrogen atoms](#) out in the space in-between galaxies. The new discovery overturns the common view and implies that these radio telescopes may also detect the tell-tale signs of cosmic heating by the earliest [black holes](#).

More information: [dx.doi.org/10.1038/nature12999](https://doi.org/10.1038/nature12999)

Provided by Tel Aviv University

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