It is now widely agreed that the universe started in a hot big bang. The quantum fluctuations which were present shortly after the Planck time were blown up onto macroscopic scales by a short period of highly rapid growth during the first $10^{-32}$ seconds of the universe. The early period of rapid growth is called inflation and is thought responsible for the remarkable degree of homogeneity seen in the early universe as well as the small amounts of structure present then. This early inflationary phase of the universe was a more gradual, normal evolution, where the universe continued to cool and expand. During this cooling phase, the first protons and neutrons condensed out of the mix, and then hydrogen, helium, lithium, and beryllium froze out. Eventually, when the universe was 400,000 years old, the universe had cooled to the point where the ambient photons in the universe were no longer energetic enough to keep hydrogen ionized. This resulted in one of the first truly great phase changes in the state of elemental hydrogen during our universe’s history. Hydrogen at this point existed in the fully ionized form as free protons — recombined with the available electrons to form neutron hydrogen. At the same time, the ambient radiations — now too low energy to ionize hydrogen — was simply left free to wander the universe. This background radiation is still with us today in a much cooler form and provides us with one of the first and powerful pieces of evidence for existence of the hot Big Bang. The significance of this epoch is such that it has earned the special name "recombination" to highlight this significance. The formation of the first stars and first galaxies brought about several fundamental changes in the rapidly evolving universe. These stars provided the universe with its first source of elements heavier than beryllium. While conditions early on in the big bang were not appropriate for the generation of the heavier elements, such elements could easily be generated at the cores of massive stars and then later expelled into the surrounding universe when these stars explode as supernovae. The second profound change brought about this first generation of stars was the introduction of high-energy photons into the universe. Astrophysicists have developed a theoretical framework for understanding how the first stars and galaxies formed, only now we are able to begin testing those theories with actual observations of the very distant, early universe. Jamie Bock, CIBER principal investigator from the California Institute of Technology, said, "The first massive stars to form in the universe produced copious ultraviolet light that ionized gas from neutral hydrogen. CIBER observes in the near infrared, as the expansion of the universe stretched the original short ultraviolet wavelengths to long near-infrared wavelengths today. CIBER investigates two telltale signatures of first star formation -- the total brightness of the sky after subtracting all foregrounds, and a distinctive pattern of spatial variations. CIBER is a cooperative instrument designed and built by the California Institute of Technology, University of California Irvine, the Japan Aerospace Exploration Agency (JAXA), and the Korean Astronomy and Space Science Institute (KASI). The same team is also developing an improved follow-on experiment, with more capable optics and detector arrays, that will be completed next year.

REFERENCE
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