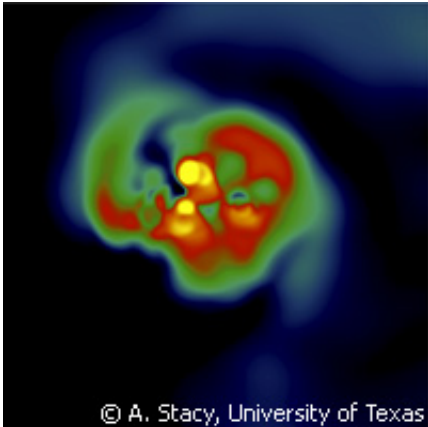


Study: First stars were massive, fast-spinning

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The first stars that dotted the universe were not only immense, but probably also fast-spinning, according to a new study that sheds light on the nature of stellar evolution.

Astronomers using data from the Very Large Telescope (VLT) of the European Southern Observatory (ESO) have spotted the remains of some of the Universe's very first stars in the Milky Way. The gas cloud left behind when the stars exploded billions of years ago contains elements in proportions different to those found in new stars, shedding light on the 'missing links' between the Big Bang and today's Universe.

Even with the most powerful telescopes, it is not possible to observe these stars directly. They are so old that only the most massive, with

eight times or more the mass of our sun, would have had the time to die and pollute the gas from which they were formed with elements heavier than helium. These stars lived fast and died young, after no more than 30 million years.

'We think that the first generations of massive stars were very fast rotators - that's why we called them spinstars', explains Christina Chiappini from the Leibniz Institute for Astrophysics Potsdam (AIP) in Germany and the Istituto Nazionale di Astrofisica (INAF) in Italy, who led the study published in the journal *Nature*.

Dr Chiappini and her colleagues have found the remains of these stars in the oldest known globular cluster in our Galaxy, the 12-billion-year-old NGC 6522 which probably witnessed the early phases of the seeding of heavy elements across the Universe. Professor Georges Meynet, from the University of Geneva in Switzerland, explains that it is like trying 'to reveal the character of a cook from the taste of his dishes'.

The researchers discovered eight old stars with strangely high levels of the rare elements strontium and yttrium. They also calculated that the stars would have whirled with a surface speed of 1.8 million kilometres per hour. By comparison, massive stars in the Milky Way typically spin at about 360,000 kilometres per hour.

This high rate of spin would cause overlap between inner and outer gas layers of the stars that would not otherwise mix. The resulting cascade of nuclear reactions would generate radioactive neon, which in turn would emit neutrons that would collide with iron and other heavy atoms to create strontium and yttrium. After the spinstars' death, these elements made their way into new star-forming clouds and eventually into the stars of NGC 6522.

These findings suggest that these fast spinners may have changed the

face of the Universe in dramatic ways. For instance, their fast spinning could have led them to create and disperse heavy elements across the Universe much earlier than previously thought. It could also have led to a greater-than-expected number of gamma ray bursts, the most powerful explosions known in the Universe.

However, 'alternative scenarios cannot yet be discarded, but we show that if the first generations of massive stars were spinstars, this would offer a very elegant explanation to this puzzle!', says Cristina Chiappini. Therefore, Urs Frischknecht, a PhD student at the University of Basel in Switzerland, is currently working on further testing the proposed scenario.

More information: Imprints of fast-rotating massive stars in the Galactic Bulge, *Nature* 472, 454–457 (28 April 2011)
doi:10.1038/nature10000 [www.nature.com/nature/journal/...
ull/nature10000.html](http://www.nature.com/nature/journal/full/nature10000.html)

Abstract

The first stars that formed after the Big Bang were probably massive¹, and they provided the Universe with the first elements heavier than helium ('metals'), which were incorporated into low-mass stars that have survived to the present^{2, 3}. Eight stars in the oldest globular cluster in the Galaxy, NGC 6522, were found to have surface abundances consistent with the gas from which they formed being enriched by massive stars⁴ (that is, with higher α -element/Fe and Eu/Fe ratios than those of the Sun). However, the same stars have anomalously high abundances of Ba and La with respect to Fe⁴, which usually arises through nucleosynthesis in low-mass stars⁵ (via the slow-neutron-capture process, or s-process). Recent theory suggests that metal-poor fast-rotating massive stars are able to boost the s-process yields by up to four orders of magnitude⁶, which might provide a solution to this contradiction. Here we report a reanalysis of the earlier spectra, which

reveals that Y and Sr are also overabundant with respect to Fe, showing a large scatter similar to that observed in extremely metal-poor stars⁷, whereas C abundances are not enhanced. This pattern is best explained as originating in metal-poor fast-rotating massive stars, which might point to a common property of the first stellar generations and even of the ‘first stars’.

Provided by CORDIS

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