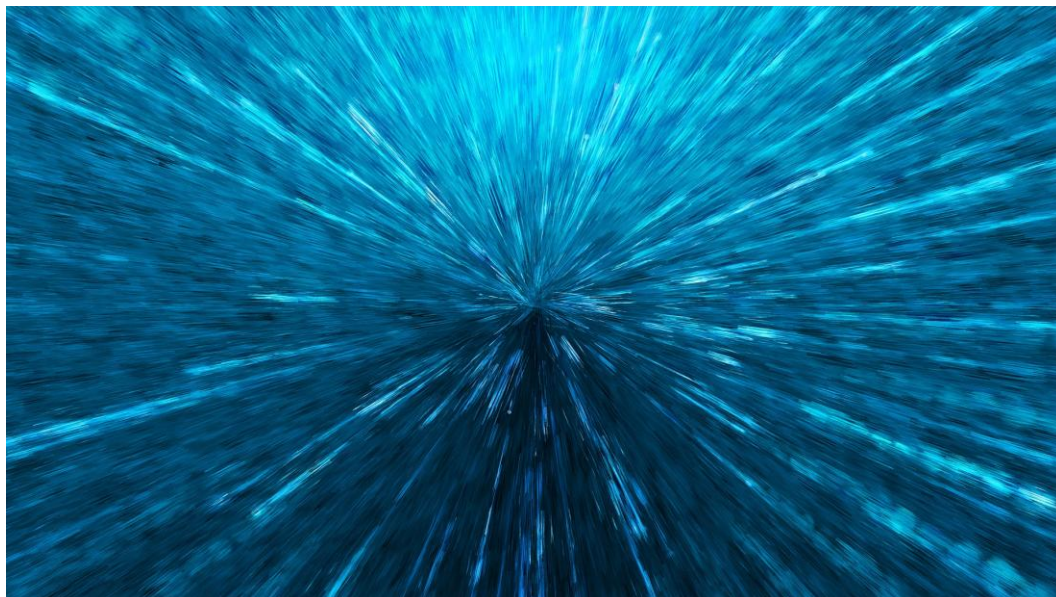


PRESS RELEASE

Within a Second After the Big Bang: The Birth of the First Black Holes, Boson Stars, and Cannibal Stars

A new study reveals that during a possible phase of primordial matter domination, interactions between particles could have given rise to the first compact cosmic objects. The research, done by researchers from SISSA in collaboration with INFN, IFPU and the University of Warsaw, has been published in Physical Review D.



Trieste, 10 November 2025

Before atomic elements came together, less than a second after the Big Bang, if particles condensed into halos of matter, these halos may then have collapsed, creating the first black holes, boson stars, and so-called cannibal stars.

This is the conclusion of a new study just published in Physical Review D, conducted by a team of researchers from SISSA – Scuola Internazionale Superiore di Studi Avanzati, in collaboration with INFN, IFPU, and the University of Warsaw.

Starting from the hypothesis, proposed by some cosmological models, that in the earliest phases of the Universe there was a brief Early Matter-Dominated Era (EMDE), the authors investigated how particles might have interacted with each



other, discovering that such interactions could give rise to a surprising variety of cosmic objects.

The study thus shows that even in the very first instants after the Big Bang, the Universe could already be a stage for a rich and complex physical phenomenology.

Right After Inflation: What Happened Next

Recent advances in cosmology have made it possible to reconstruct in detail the history of the Universe, from the rapid initial expansion known as inflation to primordial nucleosynthesis, the formation of the first atomic nuclei heavier than hydrogen, which occurred between 10 seconds and 20 minutes after the Big Bang.

The intermediate period, however, remains largely unexplored.

As the authors explain: "An intriguing possibility is that during this interval, matter temporarily dominated the Universe."

In this scenario, matter halos can naturally be formed. Furthermore, if the particles could interact with one another, then the interactions can lead to a gravothermal collapse, resulting in compact objects such as black holes and other exotic cosmic structures.

Strange Structures at the Dawn of the Universe

Among these compact objects, researchers suggest that cannibal stars could have formed. Cannibal stars are similar to traditional stars, except that it is the particle self-annihilations instead of nuclear fusion that powers the stars.

At the same time, the authors note, boson stars may also have formed, where the quantum nature of particles supports the star. These stars might have populated the newborn Universe for only a few seconds before collapsing further into primordial black holes (PBHs). Alternatively, the PBHs could have formed directly from the collapse of the matter halos.

New Hypotheses on Primordial Black Holes

According to the study, the halos formed during an EMDE had relatively small masses (smaller than 10^{28} grams) and, following gravothermal collapse, could have generated even smaller primordial black holes.

Using a simplified theoretical model, the researchers showed that in some cases, PBHs might be overproduced, violating observational constraints; in others, asteroid-mass PBHs could form, potentially accounting for all the dark matter in the Universe. Finally, some PBHs might evaporate quickly, disappearing before primordial nucleosynthesis, that is, before the formation of light atoms such as hydrogen and helium.

New Perspectives on the Universe

The results also open up broader perspectives. As the authors conclude, “It would be interesting to explore the formation of cannibal stars and boson stars in the present-day Universe, through the collapse of self-interacting dark matter halos. Moreover, though more speculative, studying star formation and accretion in simple particle models could provide new insights into the complex astrophysical processes that shape our Universe.”

USEFUL LINKS

[Full paper](#)

IMAGE

Crediti: Geralt Altman on Pixabay

SISSA

Scuola Internazionale
Superiore di Studi Avanzati
Via Bonomea 265, Trieste

W www.sissa.it

Facebook, Twitter

[@SISSAschool](#)

CONTATTI

Nico Pitrelli

M ramani@sissa.it

T +39 3391337950

Donato Ramani

M ramani@sissa.it

T +39 3787513