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**PRESS RELEASE**

# Back to the past: the death of stars reveals their birth

**Starting from supernovae and gamma rays and following a backward approach in the history of these celestial bodies, researchers at SISSA have achieved a new result that defines the mass of newly formed stars, even in previously unreachable parts of the cosmos. The study has been published in the journal *Universe*.**

Trieste, 18 December

A new article published in “Universe” describes an approach that looks back from the deaths of stars to their births, allowing the so-called initial mass function (IMF), i.e. the way in which star masses are distributed after their formation, to be derived from observations of supernovae and gamma radiation. By applying a common computational method of parameter estimation, scientists have managed to derive the IMF of regions of the cosmos that are too distant for direct observation by telescope. The work was conducted by a team of researchers from the International School for Advanced Studies (SISSA) of Trieste, the National Institute for Nuclear Physics (INFN), the Institute for Fundamental Physics of the Universe (IFPU) and the National Institute for Astrophysics (INAF). The IMF obtained by the authors of the study was surprisingly similar to that measured in regions of the Universe closest to us. The scientists consider this to

be possible evidence of a universal IMF. The result will now be tested by observations made by telescopes such as the JWST and Euclid.

**Is the IMF a universal constant? Possibly**

“All stellar populations observed in our neighbourhood appear to display a surprisingly similar initial mass function (IMF). This may indicate that the IMF is a universal constant of star formation in any region of the Universe. Unfortunately, instrumental limitations prevent scientists from examining stellar populations beyond the local Universe to test the IMF universality” explains Francesco Gabrielli, researcher and author of the study, along with Andrea Lapi and Mario Spera.
Star formation is one of the most fascinating processes in the Universe, occurring in dense internal regions of galaxies through the collapse and fragmentation of clouds of molecular gas. When a mass of gas becomes sufficiently hot and dense it starts burning hydrogen, and shining: this is when a star is born.

**Supernovae and gamma-ray bursts used to calculate the IMF**

The new research began with a backward look and, more specifically, from the knowledge that the course of a star's life depends on its mass. Massive stars end their lives in spectacular explosions called supernovae. Some supernovae are believed to eject a high-velocity jet of material that emits gamma-rays in a so-called “gamma-ray burst.” Since the occurrence of a particular type of explosion depends on the mass of the star, the number of such explosions occurring in the Universe will depend on the number of stars that form with the right mass - in other words, on the IMF.
Francesco Gabrielli explains: "My group and I have developed a new method, based on these considerations, to determine the IMF beyond the local Universe. In particular, we have used a computational method that is actually quite common but has now been used for the first time to reproduce the number of supernovae and gamma-ray bursts observed in the Universe. Since these quantities depend strictly on the IMF, this has allowed us to precisely determine the form of the IMF that best represents the observations".

**Test by observation**

Using this approach for the first time, the researchers succeeded in developing a new methodology for determining IMF. One particularly fascinating discovery was that the IMF calculated for the distant Universe was surprisingly similar to that measured in the local Universe, providing possible evidence of a universal IMF.

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Gabrielli concludes: “This is an exciting time for astrophysicists, with many new telescopes such as the JWST and Euclid now beginning to take observations. As a result, exceptional numbers of observations of supernovae and gamma-ray bursts are expected in the coming years. It will be exciting to see what this new wealth of data can tell us about the IMF and its universality. A deeper understanding of the IMF would lead to important advances in various areas of astrophysics, including the formation and evolution of stars, the chemical enrichment of the Universe, and the observation of gravitational waves emitted by colliding black holes”.

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**IMAGE**
Crediti: David Kopacz on Pexels

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