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The evolution of CNO isotope ratios: a litmus test for stellar IMF variations in galaxies across cosmic time

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Determining the shape of the stellar initial mass function (IMF), and whether it is constant or varies in a range of environments, is the Holy Grail of modern astrophysics, because of its profound implications for the theories of stars and galaxy formation. On a theoretical ground, it is expected that the extreme conditions for star formation encountered in the most powerful starburst events in the Universe near and far favour the formation of massive stars. Direct methods of IMF determination, however, cannot probe such systems, because of the severe dust obscuration affecting the UV stellar light. The next best option is to observe CNO bearing molecules in the interstellar medium at millimetre/submillimetre wavelengths, which, in principle, provides the best indirect evidence for IMF variations. In this contribution, we present our recent findings on this issue. First, we reassess the relative roles of massive stars, asymptotic giant branch stars, and novae in the production of the rare isotopes 13C, 15N, 17O, and 18O, along with the more abundant 12C, 14N, and 16O. Then, we calibrate a proprietary chemical evolution code using Milky Way data from the literature, and extend it to discuss extragalactic data. We show that, though significant uncertainties still hamper our knowledge of the evolution of CNO isotopes in galaxies, compelling evidence for a IMF skewed towards high-mass stars can be found for galaxy-wide starbursts. In particular, we analyse a sample of submillimetre galaxies observed by us with the Atacama Large Millimetre Array at the peak of the star formation activity of the Universe. We underline that, in order to draw firm conclusions, one has to carefully select those CNO isotope ratios that are more sensitive to possible IMF variations, and less affected by observational uncertainties. At the end, ongoing and future developments of our work are briefly outlined.

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