Measurements yield precise atomic masses for nuclear reactions in the stars

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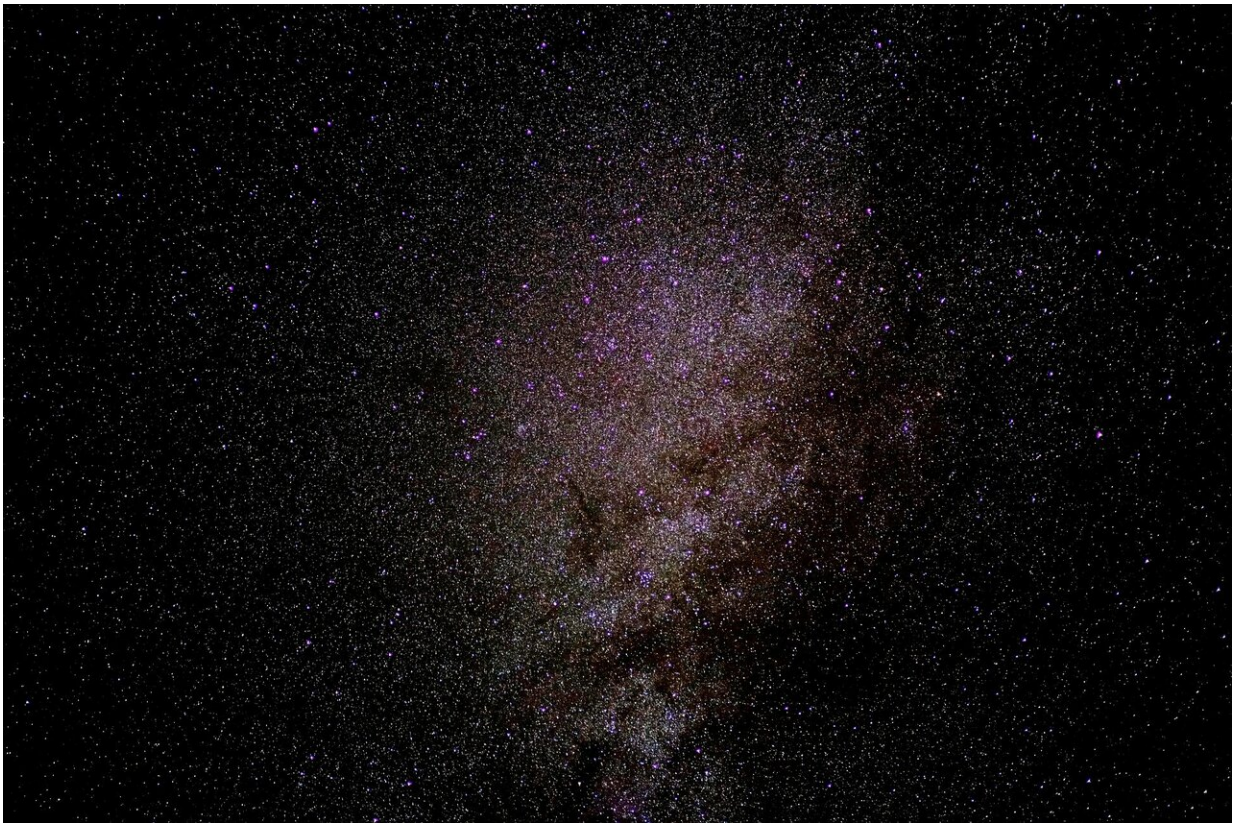

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Matter is composed of chemical elements mainly created in stars via nuclear reactions and complex nuclear reaction networks. To understand these processes, we need to know properties of participating nuclei, such

as their masses. In her doctoral thesis in the field of nuclear physics at the University of Jyväskylä, M. Sc. Laetitia Canete has precisely measured the atomic masses of the radioactive isotope of six elements. The measurement data can be used to better model different astrophysical processes.

In the JYFL Accelerator Laboratory of the University of Jyväskylä, stable ion beams from the K-130 cyclotron are used to produce nuclei relevant for nuclear astrophysics by impinging them into a thin target foil at the IGISOL (Ion Guide Isotope Separator On-Line) facility. The produced radioactive isotopes are transported into the JYFLTRAP double Penning trap mass spectrometer where their atomic mass values are determined with a precision of around 10 ppb. During her Ph.D., Laetitia Canete measured masses of six radioactive nuclei, ^{25}Al, ^{30}P, ^{31}Cl, ^{67}Fe, ^{69}Co and ^{70}Co.

The measurements are relevant for various astrophysical problems. The production of the observed cosmic 1809-keV g-rays originating from ^{26}Al can be bypassed by proton captures on ^{25}Al. The proton-capture rate, and thus the amount of produced 1809-keV g-rays, is affected by the mass of ^{25}Al. The mass of ^{30}P is important for constraining the proton-capture rate on ^{30}P(p,g)^{31}S controlling the production of elements heavier than sulphur in novae. The mass of ^{31}Cl plays a role in type I X-ray bursts, and is also important for understanding fundamental properties of the nuclear force between protons and neutrons. The masses of ^{67}Fe, ^{69}Co and ^{70}Co play a role in the rapid neutron capture process producing around half of the elements heavier than iron.

Laetitia Canete completed her Master degree in subatomic physics and astrophysics at the University Lyon 1, France, in 2014. She entered at the Department of Physics of the University of Jyväskylä in summer 2014 and started her doctoral studies within the IGISOL group in the Accelerator Laboratory of the University of Jyväskylä.

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