universität innsbruck

Innsbruck Physics Colloquium

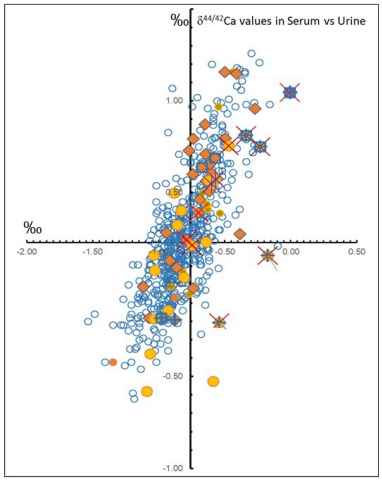
Anton Eisenhauer

GEOMAR Helmholtz Centre
for Ocean Research
Kiel, Germany

The measurement of non-radioactive calcium isotope ratios and their application in medicine

The variability of the isotopic composition of the element calcium (40.078 amu) plays a prominent role in the study and understanding of physical, biological, geological and medical processes. Calcium, in addition to a variety of radioactive isotopes, has six stable isotopes: ^{40}Ca, ^{42}Ca, ^{43}Ca, ^{46}Ca, and ^{48}Ca, but their natural ratios have been poorly determined by classical thermal mass spectroscopy (TIMS). The introduction of modern multicollector plasma mass spectrometry (MC-ICP-MS; multicollector-ionization-coupled-plasma-mass-spectrometry) provided a “quantum jump” in precision and accuracy of isotope ratio measurement, which now allows calcium isotope ratios to be measured with precision in the range of less than 100 ppm. This "quantum jump" in instrumental analysis led to a variety of new applications, especially in the marine geosciences, which also triggered translational processes into medicine, enabling the "know-how" of calcium isotope determination to be applied as a diagnostic tool. The key for medical application is that calcium isotopes undergo kinetic isotope fractionation during incomplete chemical processes, leading to an enrichment of the light calcium isotopes in the chemical product. The latter can be used as an "isotopic fingerprint" or "biomarker" for early detection of significant calcium-related diseases such as bone loss (osteoporosis), renal dysfunction or cancer. The application of calcium isotopes is superior to classical diagnostic methods in this regard, detecting diseases years to decades earlier than it is possible with the classical clinical diagnostics.

The medical application of calcium isotopes is a beginning, as the isotope measurement technique can be applied to other elements in the human body, the so-called essential nutrients, and may lead to a new type of bio-inorganic markers in medicine. However, the application of isotope techniques in medicine requires that they can be measured as rapid as possible and on low costs. However, the latter is only feasible to a limited extent with the MC-ICP-MS approach because Ca isotope measurements do not reproduce well and the measurement procedure takes too much time. Hence, there is a need to search for alternative analytical methods which has been recognized as a new instrumental/analytical challenge for the future.



Tuesday, 10.10.2023, at 16:45 h, HS C (Technik)

Innsbruck Physics Colloquium,
Organisation: K. Erath-Dulitz, H.-C. Nägerl, T. Schrabback