



# NITheCS

National Institute for  
Theoretical and Computational Sciences

## COLLOQUIUM

# Nuclear thermometers reveal the origin for the universal abundance of heavy elements

Prof Nico Orce (University of the Western Cape)

**DATE:** Monday, 28 October 2024 | 16h00–17h00 SAST

**VENUES:**

- Neelsie Cinema, Stellenbosch University
- Online

--- A recording of the talk will be published on the NITheCS YouTube channel afterwards ---

### ABSTRACT

The question of why we observe the same amounts of gold, silver, platinum and other heavy elements beyond iron throughout our Universe has remained open until now. Here I present on how nuclear interactions act as nuclear thermometers to measure the cooling of the kilonova ejecta in neutron-star mergers down to the production of heavy elements via the rapid neutron-capture or r-process. In particular, a smaller nuclear dipole polarizability at the temperatures of interest results in a shift of the frontiers of nuclear existence (neutron drip line) towards the line of stability that explains the universality of heavy-element abundances in the universe, as inferred from the similar r-process abundances observed in extremely metal-poor stars and the Sun.

### BIOGRAPHY

Prof Nico Orce is a nuclear physicist whose passions are novel science and true transformation. His research includes 150 publications (~1/3 led by him) in Fundamental Nuclear Physics (mainly) as well as in top Mathematics, Biology and Astronomy journals. He has broadly explored the nuclear chart using a variety of nuclear techniques and theoretical calculations and discovered new types of collective excitations and shell phenomena in nuclei. Prof Orce and collaborators recently discovered changes in nuclear polarization that narrow down the reaction network for element production in stellar explosions and may explain the universality of elemental abundances in our universe (<https://bit.ly/48iXBYZ>).

As Principal Investigator, he has secured funds worth over R50M. He has led to completion African-led experiments at CERN and the implementation of major infrastructure research projects in South Africa, namely the GAMKA spectrometer at iThemba LABS; and the Modern African Nuclear DETector LABORatory at UWC.

Prof Orce has active experiments and observations at different laboratories and observatories around the world, including iThemba LABS, TRIUMF, CERN and SALT. He is Chair of the Tastes of Nuclear Physics conference series and the Science Research Open Day 2013. He also brought the 2012 Nobel Laureate Serge Haroche to UWC. He is the referee of most nuclear physics journals, associate editor of *Atomic Data and Nuclear Data Tables* (Elsevier) and Honorary Visiting Professor at the University of York. He has given talks at CERN, Yale, Cambridge and Oxford, and was nominated for the Margarita Salas Award in 2021. His postgraduate students are world-trained and find jobs in the nuclear-energy, big-data and machine-learning industries, as well as national facilities. For more information about Nico's work, visit <https://nuclear.uwc.ac.za/> or <https://github.com/UWCNuclear>.



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