



NITheCS

National Institute for
Theoretical and Computational Sciences



INTERNATIONAL YEAR OF
Quantum Science
and Technology

COLLOQUIUM

Quantum correlations in nuclear physics

Prof Nico Orce (University of the Western Cape)

DATE: Monday, 9 June 2025 | 16h00–17h00 SAST

VENUES:

- Neelsie Cinema, Stellenbosch University
- Room P215, 2nd Floor, Physics Building, University of the Witwatersrand
- Online

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

ABSTRACT

The Many-Body Problem in nuclear physics is the Mother & Father of all problems, being both mathematically and computationally practically intractable. In this talk I will focus on our published work where novel science was defined to tackle this problem from all possible angles: theoretically, experimentally and phenomenologically. This work include: 1) the use of Coulomb-excitation reactions that gently excite the nucleus without "waking up" the short-range nuclear force, 2) inferring new macroscopic variables from quantum correlations that could only be predicted using large-scale computing, 3) inventing new physics to determine the dipole polarizability and triaxial deformation of nuclei, or 4) performing the first ab initio and shell model calculations of the dipole polarizability for excited nuclei. In synergy, new state-of-the-art research infrastructures and possibilities had also to be developed: a) pipeline for particle-gamma coincidence measurements, b) leading science at CERN with research proposals, experiments and designing new electron spectrometers, c) the GAMKA spectrometer at iThemba LABS, commissioned in 2021 remains the largest grant given by the National Research Foundation in a competitive call (R35M), d) handling of big and complex data from large gamma spectrometers with hundreds of channels, e) run high-performing simulations and minimizations of electric quadrupole matrix elements, f) design and build modern detector laboratories at UWC and the University of Zululand equipped with the fastest digitizers, g) world train students who are now relevant assets of the nuclear, big data and machine learning industry in South Africa. Accordingly, it will be shown how our work has provided a deeper insight into nuclear physics and astrophysics and perhaps created the means to finally knock out the most insurmountable problem.

BIOGRAPHY



Prof Nico Orce is a nuclear physicist driven by a passion for cutting-edge science and meaningful transformation. He has authored more than 150 publications, primarily in fundamental nuclear physics, with notable work also in top mathematics, biology, and astronomy journals. His research spans the nuclear chart, combining experimental techniques and theoretical models to uncover new types of collective excitations and shell phenomena in nuclei. His recent work, with collaborators, revealed changes in nuclear polarization that refine the reaction pathways for element formation in stellar explosions – potentially explaining the universal pattern of elemental abundances.

As Principal Investigator, Prof Orce has secured over R50 million in research funding. He has led pioneering African-led experiments at CERN and spearheaded major infrastructure research projects locally, including the GAMKA spectrometer at iThemba LABS and the Modern African Nuclear Detector Laboratory (MANDELA) at UWC. He is actively involved in research at iThemba LABS, TRIUMF, CERN, and SALT. He chairs the Tastes of Nuclear Physics conference series and organised the 2013 Science Research Open Day. In 2012, he hosted Nobel Laureate Serge Haroche at UWC. Prof Orce is a referee for most nuclear physics journals, Associate Editor of *Atomic Data* and *Nuclear Data Tables* (Elsevier), and an Honorary Visiting Professor at the University of York. He has delivered talks at CERN, Yale, Cambridge, and Oxford, and was nominated for the Margarita Salas Award in 2021.

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