NITheP Colloquium
Monday, 27 September 2021, 16h00

Prof Nico Orce | University of the Western Cape

"On the universality of the r-process (or why we see the same abundance of elements around us)"

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The abundance of about half of the stable nuclei heavier than iron via the rapid neutron capture process or r-process is intimately related to the competition between neutron capture and beta-decay rates, which ultimately depends on the binding energy of neutron-rich nuclei. The well-known Bethe-Weizsäcker semi-empirical mass formula describes the binding energy of ground states, with the symmetry energy parameter converging between 23-27 MeV for heavy nuclei. In this work we find an unexpected enhancement of the symmetry energy at higher temperatures, T~0.7-1.0 MeV, from the available data of giant dipole resonances built on excited states. Although these are likely the temperatures where seed elements are created - during the cooling down of the ejecta following neutron-star mergers or collapsars - the fact that the symmetry energy remains constant between T~0.7-1.0 MeV, suggests a similar trend down to T~0.5 MeV, where neutron-capture may start occurring. Calculations using this relatively large symmetry energy yield a reduction of the binding energy per nucleon for heavy neutron-rich nuclei and inhibit radiative neutron-capture rates. This results in a substantial close in of the neutron dripline - where nuclei become unbound – which elucidates the long-sought universality of heavy-element abundances through the r-process; as inferred from the similar abundances found in extremely metal-poor stars and the Sun. More work is clearly needed, but our conclusion supported by data, theory and astronomical findings [1].

[1] José Nicolás Orce, Balaram Dey, Cebo Ngwetsheni, Srijit Bhattacharya, Deepak Pandit, Brenden Lesch, and Andile Zulu, submitted to Physics Letters B (2021).

BIOGRAPHY

Nico Orce is a nuclear physicist whose passions are quality science and transformation. Nico's research mainly involves fundamental and applied nuclear physics, but also astronomy and mathematical modelling. He has broadly explored the nuclear chart using a wide variety of nuclear techniques and theoretical calculations, and discovered new types of collective excitations and shell phenomena in nuclei. Nico is leading research proposals at different laboratories and observatories around the world, including MANDELAb, iThemba LABS, SALT, MLL, TRIUMF and CERN, and has secured research funds worth > R50M. He is the leading Investigator and spokesperson of the GAMKA spectrometer, chair of the Tastes of Nuclear Physics, Referee of most nuclear physics journals, and Honorary Visiting Professor at the University of York. Nico has graduated 20 MSc and PhD students with research projects generally approved by international committees. His students have travelled the world to gain hands-on experience, presented at international conferences, run their own experiments in world-class facilities such as TRIUMF and CERN and led publications in top international journals such as Physics Letters B and Nature Communications. For more info: http://nuclear.uwc.ac.za/

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