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Neutron-rich nuclei and the low-energy enhancement of the photon strength function*

As excitation energy increases towards the particle separation energy, the level density increases rapidly, creating the quasi-continuum. Nuclear properties in this excitation energy region are best characterized using statistical quantities, such as the photon strength function (PSF) which is the ability of atomic nuclei to emit and absorb photons.
For several Fe isotopes an unexpected increase in the PSF has been observed [1] for which the probability to decay with low energy gamma-rays was found to be more than an order of magnitude larger than predicted by theories. Similar observations have since been reported in other isotopes across the nuclear chart.
The enhancement of low energy gamma-ray emission is controversial since it changes our view of how the nucleus emits gamma-rays in the region of high level density. No conclusive theoretical results exist which can reproduce or explain these experimental observations although different models suggest that the low-energy enhancement may be due to: 1) transitions within the single particle continuum producing E1 radiation [2], and 2) a reorientation of the spins of high-j neutron and proton orbits producing M1 transitions [3].
Although, the underlying mechanism remains largely unexplored and unknown the enhancement has nonetheless a dramatic impact on elemental formation in the universe. It has been shown that this modification to the low energy part of the PSF can have order of magnitude effects on the neutron capture rates of very neutron-rich nuclei which lie in the r-process path [4].
Unfortunately, our knowledge of the PSF comes exclusively from measurements using stable beams and targets which is then extrapolated to the neutron-rich regime where r-process nucleosynthesis takes place. Low-energy PSF measurements have never been performed in nucleonic systems with very asymmetric proton to neutron ratios and the persistence of the enhancement is only based on assumptions. Measurements in the neutron-rich regime are not only of fundamental interest to nuclear physics research but have wide reaching consequences in the field of nuclear astrophysics. In light of many open questions and their importance, a proposal has been submitted and was subsequently accepted by the INTC to run an HIE-ISOLDE experiment on 66,68Ni and investigating statistical decay properties of these nuclei.
In this talk I will give an overview of the current status on our understanding of the low-energy part of the PSF, its impact on nucleosynthesis, and discuss our plans to measure the PSF at HIE-ISOLDE.

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Author: WIEDEKING, Mathis (iThemba LABS)

Co-authors: Dr VOINOV, Alexander (Ohio University); GOERGEN, Andreas (U); LARSEN, Ann-Cecilie (University of Oslo (NO)); Dr BLEUEL, Darren (Lawrence Livermore National Laboratory); Dr NEGI, Dinesh (iThemba LABS); Dr SAHIN, Eda (University of Oslo); GIACOPPO, Francesca (University of Oslo (NO)); BELLO GARROTE, Frank Leonel (U); TVETEN, Gry Merete (University of Oslo); NYHUS, Hilde-Therese (U); Prof. REKSTAD, John (University of Oslo); Dr WILSON, Jon (IPN Orsay); Dr BERNSTEIN, Lee (Lawrence Livermore National Laboratory); Ms KLINTFJORD, M. (University of Oslo); Prof. GUTTORMSEN, Magne (Department of Physics, University of Oslo, Norway); Prof. HOFF, P (University of Oslo); Prof. BUTLER, Peter (University of Liverpool (GB)); Ms

ROSE, Sunniva (University of Oslo); Dr SIEM, Sunniva (University of Oslo); ERIKSEN, Tomas Kvalheim (University of Oslo); Ms HAGEN, Trine (University of Oslo); Mr KHESWA, Vincent (iThemba LABS)

Presenter: WIEDEKING, Mathis (iThemba LABS)