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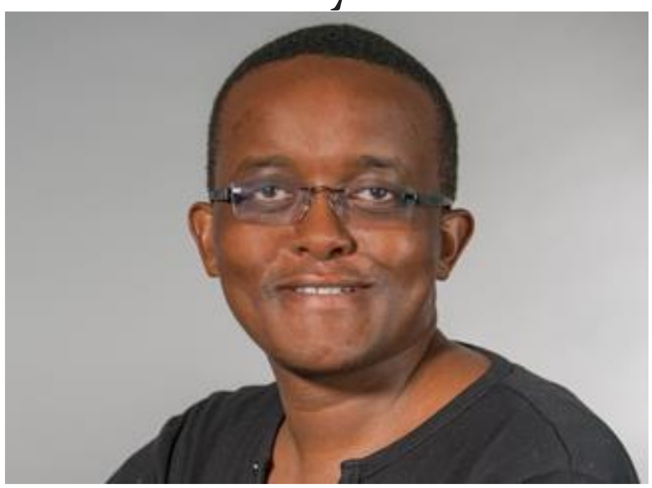
The East African Institute for Fundamental Research (EAIFR)

invites you to:

A Colloquium on the Lightsources for Africa, Americas, and the Middle East Project (LAAMP)

Title: Synchrotron Light Sources and their Diverse Applications

by



Prosper Ngabonziza, PhD

(A Rwandan in Diaspora)

Max Planck Institute for Solid State Research, Stuttgart, Germany

Date: Wednesday, 20 December 2017

Time: 15:00 – 16:00 hrs (Tea and coffee: 14:45 hrs)

Venue: EAIFR, top floor
(KIST2 Building of the Univ. of Rwanda in Nyarugenge)

Sponsors: * LAAMP Project
* International Centre for Theoretical Physics (ICTP) Trieste, Italy

Synchrotron Light Sources and Their Diverse Applications

A synchrotron light source is one of the most brilliant man-made light sources in the world. It can be more than a million times brighter than the Sun. 'Synchrotron light' refers to the range of the electromagnetic spectrum that is produced by a dedicated synchrotron machine. It is produced when electrons, moving at velocities close to the speed of light, are forced to change direction under the action of a magnetic field [1].

In the first part of this presentation I will introduce the basic concepts of synchrotron light; and then exemplify how synchrotron light source has greatly revolutionized basic and applied research in many disciplines like nanotechnology, physics, biology, medical applications, archaeology, chemistry, environmental science and geology. Synchrotron radiation has also provided, in many cases, the key to solving problems arising from technological challenges in industrial research or development [2].

In the second half of the talk, I will focus on the applications of synchrotron light in condensed matter physics and materials science for probing the electronic band structure of correlated electrons materials and topological insulator quantum materials. One of the prominent synchrotron techniques is spectroscopy, in particular, the X-ray photoemission spectroscopy (XPS) and angle resolved photoemission spectroscopy (ARPES). These techniques allow detailed study of the band structure and determination of elemental composition, chemical state and physical properties of different materials. I will show one of our electronic structure measurements on strontium ruthenate materials performed at Soleil synchrotron facility using ARPES. In particular, I will discuss the near Fermi level band dispersion and the Fermi surface topology of $Sr_4Ru_3O_{10}$ single crystals [3]. Next, I will discuss our XPS and ARPES data on intrinsic Bi_2Te_3 topological insulator thin films [4]. I will demonstrate how in-situ characterization of topological insulator nanomaterials using several, complementary surface analysis techniques enable to investigate topological surface states without exposing the samples to ambient conditions; and by using vacuum suitcase technology allows samples transfer in ultra-high vacuum conditions for further in-situ analysis at different locations like synchrotron radiation facilities [5].

I will end with a brief discussion on the opportunities that an African light source can bring to the continent by, for example, contributing not only to the return of African science diaspora, but also attracting international scientists to come to Africa for their synchrotron based researches. An African light source will also contribute to the improvement of University education in Africa, offer career opportunities to graduate students; and foster cross-border research collaborations in key areas of science and technology.

<u>Reference</u>

1. **P. Willmott**, *Introduction to synchrotron radiation: techniques and applications*; John Wiley and Sons, West Sussex, UK (2011).
2. **D. H. Bilderback** *et al., Review of third and next generation synchrotron light sources*; Journal of Physics B: Atomic, Molecular and Optical Physics **38,** 9 (2005).
3. **P. Ngabonziza**, *et al.*, *Signature of electron-phonon correlation in the band structure of $Sr_4Ru_3O_{10}$*, Proceeding of the South African Institute for Physics **2012**, 153-157 (2014).
4. **P. Ngabonziza**, *et al.*, *In-situ spectroscopy of intrinsic Bi_2Te_3 topological insulator thin films and impact of extrinsic defects*, Physical Review B **92**, 035405 (2015).
5. **P. Ngabonziza**, *et al.*; *In-situ Characterization Tools for Bi_2Te_3 Topological Insulator Nanomaterials*, Book chapter in the Springer book series; Springer-Verlag Berlin Heidelberg 2018 (currently in press).