Second African Conference on
Fundamental and Applied Physics
ACP2021

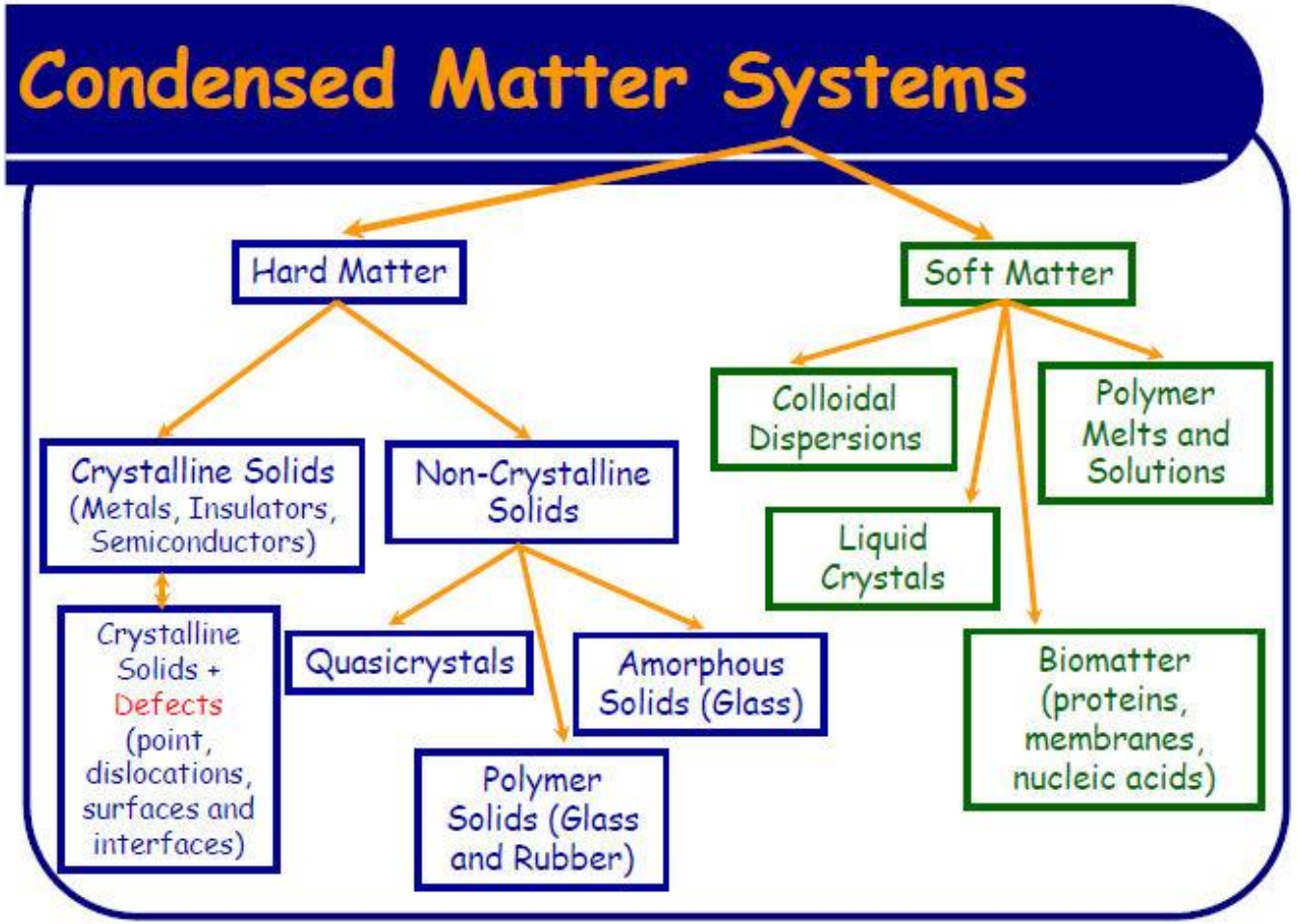
Condensed Matter and Materials Physics Capacity Building and Research for African Development

By Samuel Chigome

International Union of Materials Research Societies
Member of the International Science Council

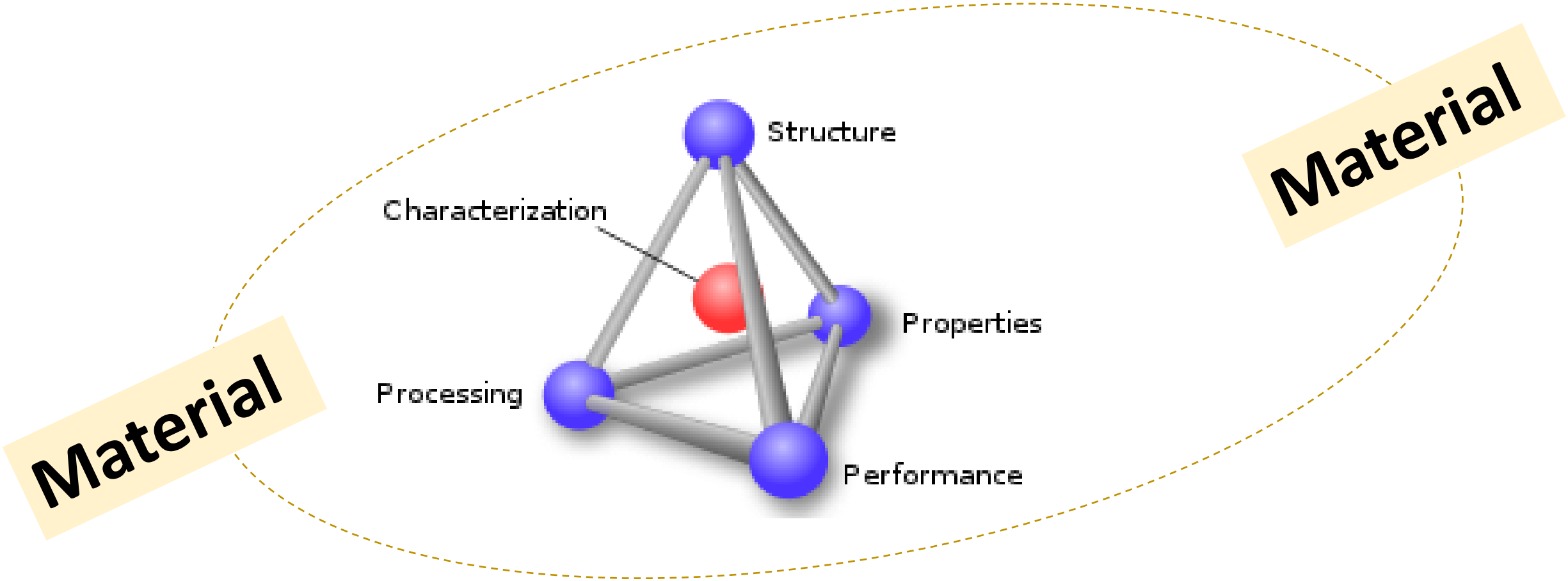
Condensed Matter Physics

Condensed matter physics: seeks to understand how matter arises from a large number of interacting atoms and electrons, and what physical properties it has as a result of these interactions.



Materials Physics

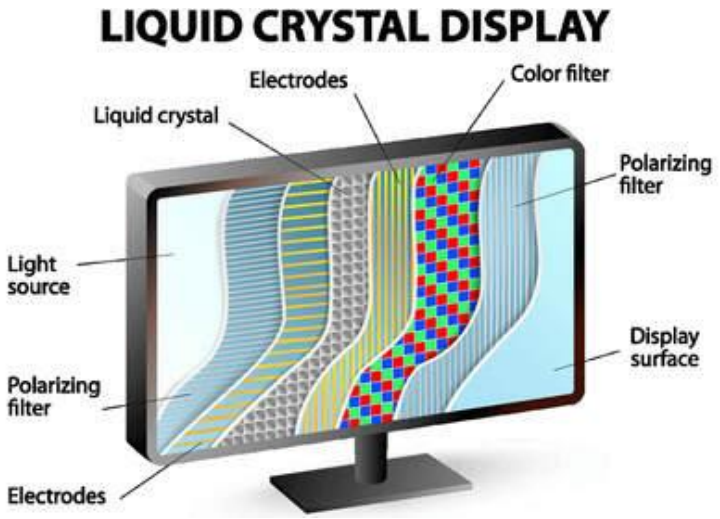
Materials physics: considered a subset of condensed matter physics because it applies fundamental condensed matter concepts to describe the physical properties of materials.



Condensed Matter and Materials Physics

Overlap with Materials Science and Engineering

Largest subfield of physics because of its direct link to material development.



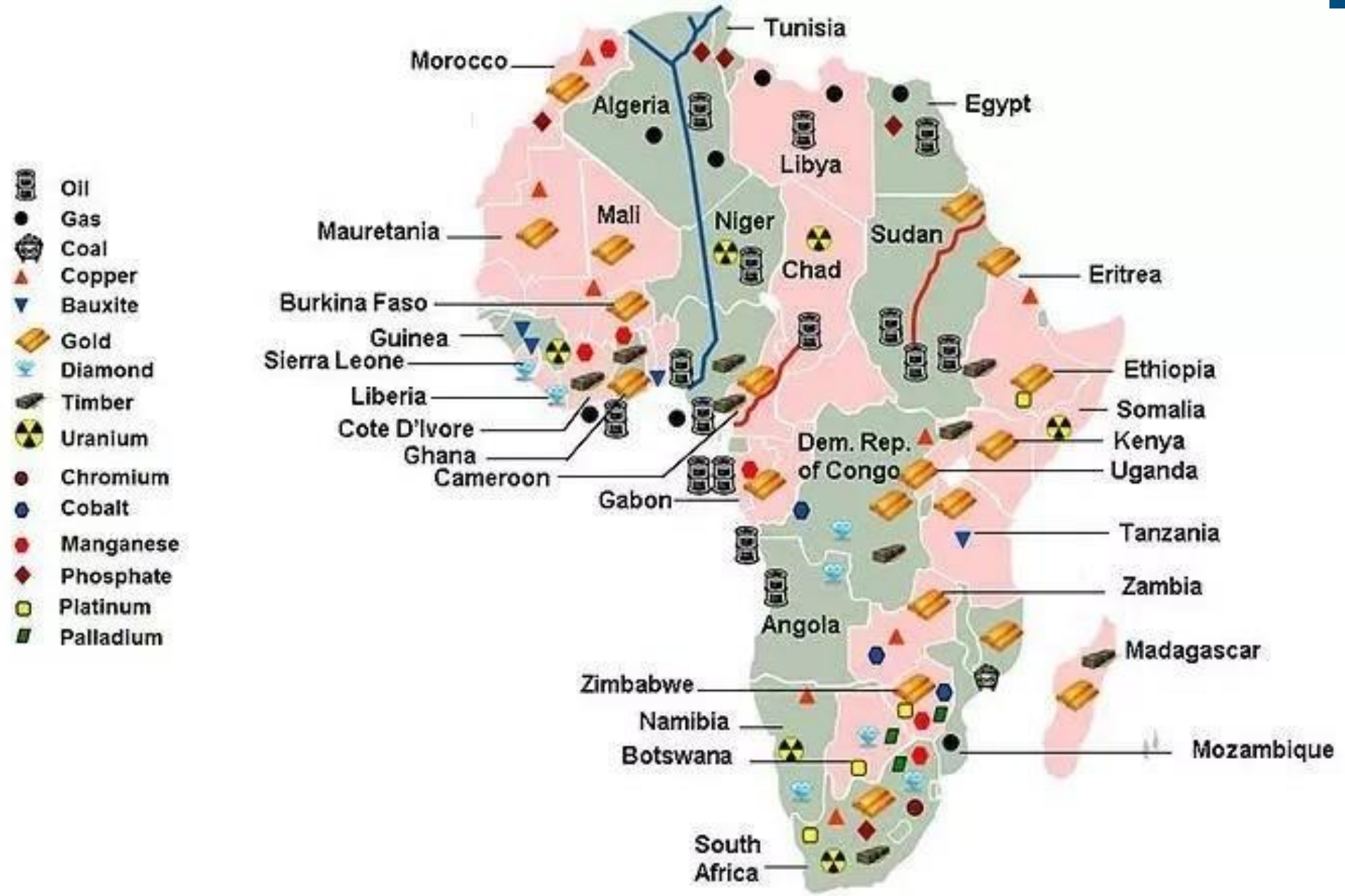
Breakthrough of Condensed matter physics

Africa

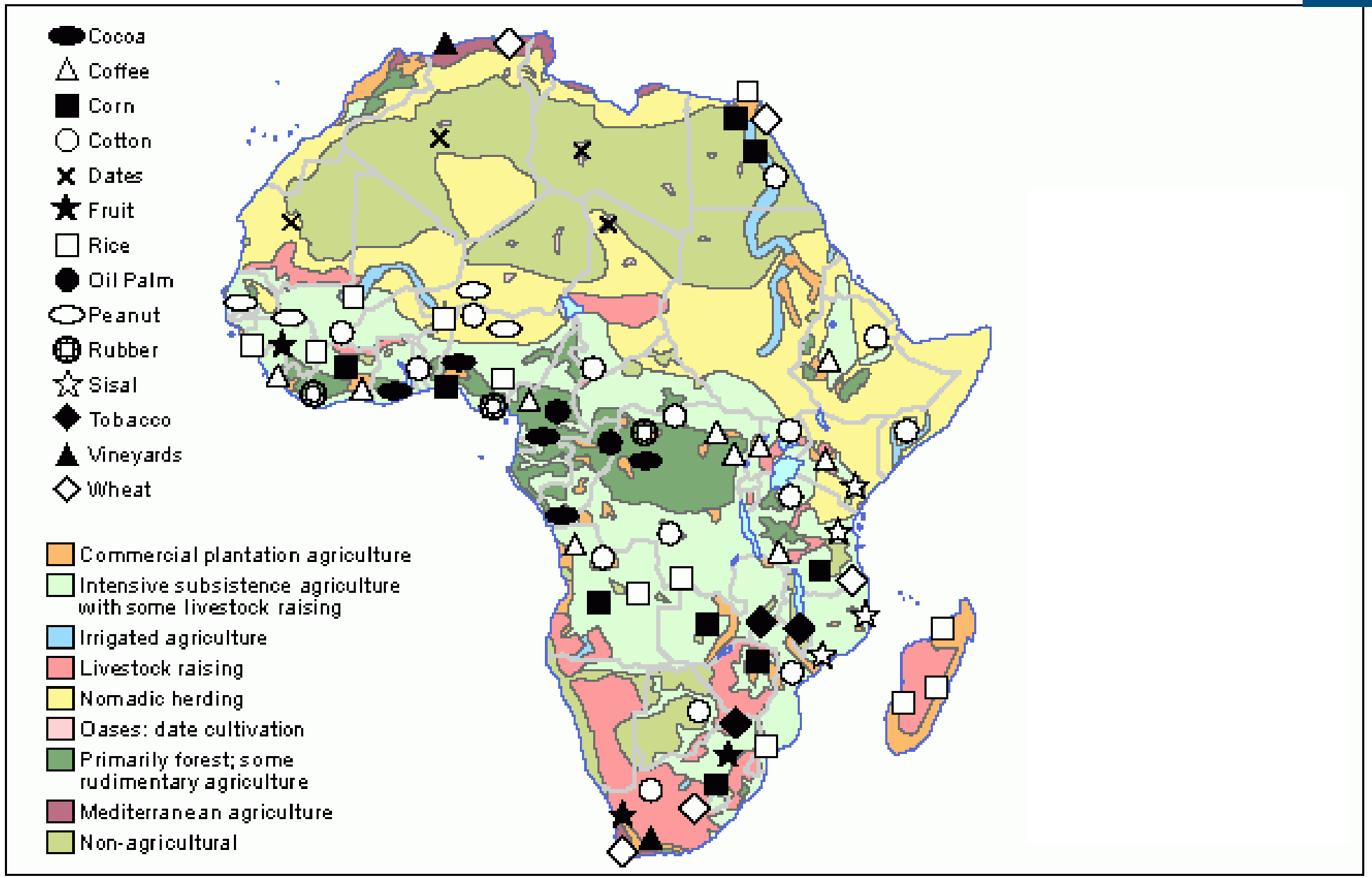
Facts

- World's second largest continent = 30.37 million km^2
- Second most populous = 1,386,337,673
- Literacy rate rate = 22 – 96%
- 30% of the earth's mineral resources are in Africa

Africa's Mineral Resources



Africa's Agricultural Resources



Lu Yu: the past and future of condensed matter physics

Mu-ming Poo, Ling Wang

National Science Review, Volume 2, Issue 3, September 2015, Pages 371–376,
https://doi.org/10.1093/nsr/nwv050
Published: 24 August 2015

Abstract

Lu Yu, a distinguished theoretical physicist at the Institute of Physics (IOP) of Chinese Academy of Sciences (CAS), has witnessed the development of Chinese physics over the past five decades, from the difficult period of 1960s when physicists worked in a 'half-fed' state to the present flowering springtime of Chinese physics in which many breakthroughs at the frontier of physics are attracting international recognition. He considers these achievements to be not merely 'intermittent bubbles', but the cumulative result of sustained governmental support of basic research over the past decades. In his area of condensed-matter physics, Yu sees 'a big deep-rooted tree with many branches —some old branches have withered away, but new shoots continue to appear'. In a recent interview with NSR, Yu reflected upon the recent history of condensed-matter physics in China—what has been accomplished and what lies ahead—and his view on the development of physics in general.

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Viewpoint | Published: 18 September 2020

Physics in Africa

Rabia Salihu Sa'id, Ibiyinka Fuwape, Alain Moise Dikandé, Jamal Mimouni, Francis Hasford, Delia Haynes, Igle Gledhill, George Amolo, Omololu Akin-Ojo & Nashwa Eassa

Nature Reviews Physics **2**, 520–523 (2020) | Cite this article

Abstract

Africa tends to be isolated and sometimes forgotten when it comes to scientific research and in particular physics. But the region has great potential, being home to the youngest population in the world, and despite a variety of issues, there has been steady, albeit uneven progress towards establishing a scientific infrastructure. Ten African researchers discuss the diverse challenges and opportunities faced by physicists across the continent.

Three challenges of physics in Africa

First, there is the challenge of numbers: there are few physicists engaged in research and in academia. This is perhaps because of a lack of research institutes and industry that would otherwise require people with a PhD or master's degree in physics.

Second, there is the challenge of catch-up. Many African institutions and universities lack the requisite facilities to conduct research at the fast pace that research is conducted elsewhere.

Third, there is the challenge of the paucity of research institutes and industry, which limits job opportunities for physicists to teaching in secondary schools and universities. Bachelor of Physics graduates who do not want to teach usually opt to work in revenue services or banks. These institutions gladly employ them because physicists have better affinity with numbers.

Sa'id, R.S., Fuwape, I., Dikandé, A.M. *et al.* Physics in Africa. *Nat Rev Phys* **2,** 520–523 (2020)

Ways to strengthen physics in Africa

One: Many African governments and the industrial sector in African countries do not pay sufficient attention to research in the fields of basic and applied physics, in terms of funding and the use of research findings. This situation is due to a limited ability to recognize research in physics as a priority and appreciate its role in developing technologies that may lead to economic growth and sustainable development. Therefore, promoting research in physics in African countries is a necessity.

Two: There is also a need to strengthen the research capacity in conducting, managing and sharing research results, besides developing the research environment.

Three: Another action that could be taken is to use research outcomes and results to advise policy-makers through policy briefs on topics such as the use of solar energy, knowing that sunlight is available, and that there is a shortage of electricity supply in many African countries.

Four: Advocacy for science-based evidence to inform decision-making processes is very important and should also include extra mobilization of resources for research within universities in African countries.

Five: Universities should formulate interdisciplinary research groups and strengthen collaborative research projects with the private sector and non-governmental organizations to secure funding and ensure the use of research findings.

Six: It is important to strengthen the research impact at the national, regional and international levels, through publications, evidence-based policies and engagement with stakeholders.

Sa'id, R.S., Fuwape, I., Dikandé, A.M. *et al.* Physics in Africa. *Nat Rev Phys* **2,** 520–523 (2020)

African Strategy for Fundamental and Applied Physics

The initiative aims at producing a strategy for reforming and transforming the Fundamental and Applied Physics research, and Education in Africa for African Development.

Physics Working Groups

1. Accelerators
2. Astrophysics & Cosmology
3. Atomic & Molecular Physics
4. Biophysics
5. Computing & 4IR
6. Earth Science
7. Energy
8. Fluid and Plasma
9. Instrumentation & Detectors
10. Light Sources
11. **Condensed Matter & Materials Physics**
12. Medical Physics
13. Nuclear Physics
14. Particle Physics
15. Optics and Photonics
16. Complex Systems

Condensed Matter and Materials Physics Working Group: Co-Conveners

Name	Affiliation	Country	
Prof Lalla Btissam Drissi	Mohammed V University in Rabat **Head, Modelling and Simulation of Physical Properties of Emergent Materials Laboratory**	Morocco	
Dr Samuel Chigome	Botswana Institute for Technology Research and Innovation **Senior Researcher, Nanomaterials**	Botswana/Zimbabwe	
Prof Sonia Haddad	University of Tunis El Manar **Head, Condensed Matter Physics Laboratory**	Tunisia/Algeria	

Condensed Matter and Materials Physics

"subgroups"

1. Theoretical and computational Condensed Matter Physics
2. Nanomaterials
3. Superconducting materials
4. Quantum Matter and topological Materials
5. Advanced 2D materials
6. Materials for optics
7. Magnetic Materials
8. Soft matter
9. Materials for energy
10. Materials for water purification
11. Materials for biology
12. Materials for quantum computing
13. Construction and manufacturing Materials
14. Electronic materials

Condensed Matter and Materials Physics

Peanuts for high performance energy storage

nanomaterials MDPI

Article

Enhanced Electrochemical Behavior of Peanut-Shell Activated Carbon/Molybdenum Oxide/Molybdenum Carbide Ternary Composites

Ndeye F. Sylla [1], Samba Sarr [1], Ndeye M. Ndiaye [2], Bridget K. Mutuma [1], Astou Seck [3], Balla D. Ngom [2], Mohamed Chaker [3] and Ncholu Manyala [1,*]

1 Department of Physics, Institute of Applied Materials, SARChI Chair in Carbon Technology and Materials, University of Pretoria, Pretoria 0028, South Africa; ntoufasylla@gmail.com (N.F.S.); ssarr3112@gmail.com (S.S.); bridgetmutuma@gmail.com (B.K.M.)
2 Laboratoire de Photonique Quantique, d'Energie et de Nano-Fabrication, Faculté des Sciences et Techniques, Université Cheikh Anta Diop de Dakar (UCAD), Dakar-Fann, Dakar B.P. 5005, Senegal; mmatyndiaye@gmail.com (N.M.N.); ballangom@ucad.edu.sn (B.D.N.)
3 Institut National de la Recherche Scientifique Centre—Énergie Matériaux Télécommunications 1650, Boulevard Lionel Boulet, Varennes, QC J3X 1S2, Canada; astou.seck@emt.inrs.ca (A.S.); chaker@emt.inrs.ca (M.C.)
* Correspondence: ncholu.manyala@up.ac.za; Tel.: +27-12-420-3549; Fax: +27-12-420-2516

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Home > News > Africa > Senegal: biomass, a hope for storing energy

Senegal: Biomass, A Hope For Storing Energy

How do you contribute?

1. Identify a subgroup that you would like to join.
2. https://twiki.cern.ch/twiki/bin/view/AfricanStrategy/AfMaterialsPhysics
3. Letter of Interest (LOI)

African Conference of Fundamental and Applied Physics
ACP2021

Joint Session
African Strategy for Fundamental and Applied Physics (ASFAP)

Light Sources and Applications:
Light Sources, Accelerators, biophysics, Earth Science, Atomic & Molecular, Condensed Matter & Materials Physics, Optics & Photonics, Energies, Instrumentation, and Computing

Sonia Haddad
Faculty of Sciences of Tunis, University Tunis El Manar, Tunis, Tunisia

8th March 2022, Virtual Event

ASFAP-Cond Mat and Materials Physics Working group- 8-03-2022 1

Questions to CMP & MP Professors in Africa?

What is the spread of CM and MP across African Universities?

Limited

Looking at the five regions of Africa, is the spread of CMP and MP well balanced or there are some regions that are lagging behind? If there are differences, do we know why they are there?

Not balanced, some regions are lagging behind

How can CMP and MP contribute to African Development?

Design and discovery of new materials is a key to innovation in the race of making things cheaper, stronger, durable and more effective.

What are some of the challenges that are hindering growth of both theoretical and experimental CMP and MP in Africa?

Lack of infrastructure, brain drain, private sector absence. Failure to adopt innovative programmes

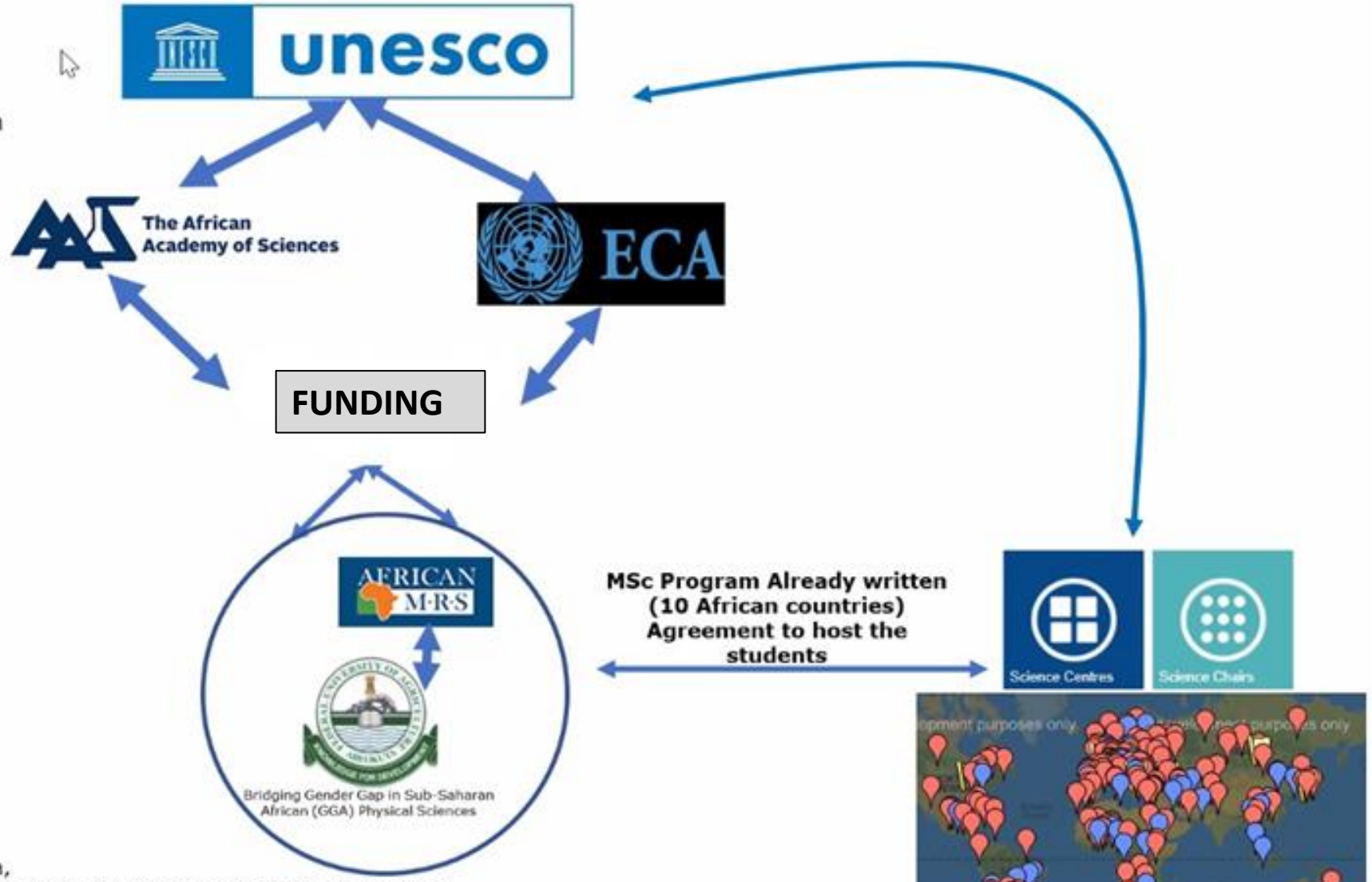
What are the proposed solutions for improving CMP of MP for education and research in Africa?

Development of Pan African Curricula for example Materials Science and Nanotechnology that will allow students in Africa to access material characterization facilities all over Africa.

https://youtu.be/Z9-wazpKiRU

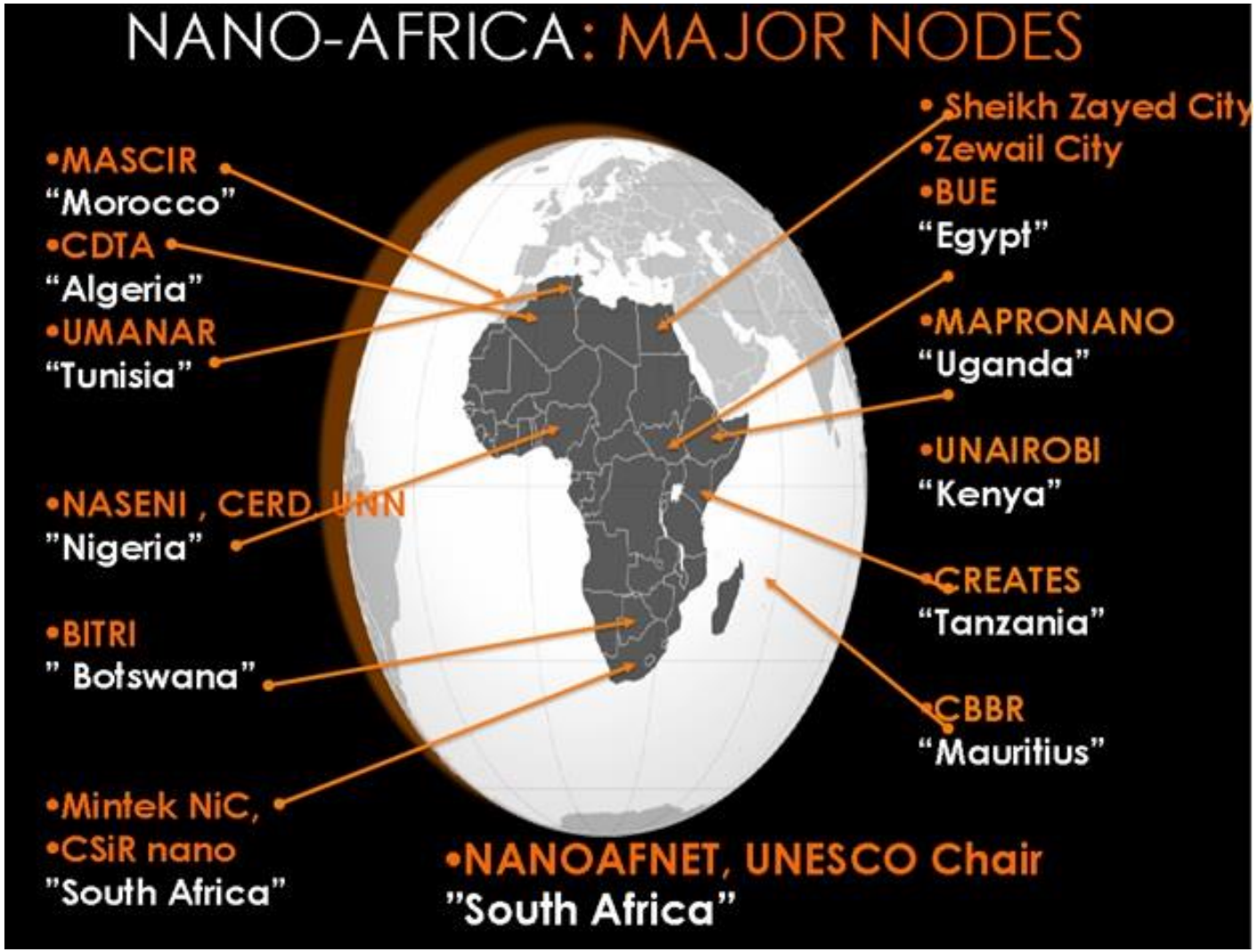
A proposed Program to Foster Bridging the Gender Gap in the fields of Materials Science and Nanotechnology in AFRICA

Initial Target: 25 MSc students in the field of Materials Science and Nanotechnology, with at least 50% Women (2 years)
Medial Target: 50 MSc and PhD students in the field of Materials Science and Nanotechnology, with at least 50% Women (4 Years)
Final Target: 100 MSc and PhD students in the field of Materials Science and Nanotechnology, with at least 50% Women (4 Years)



- Students will be recruited from all over Africa,
- to be hosted in the institutions that have the best facilities in the 10 different countries
- The students will be linked to the CATII Centres in the field of Materials Science, or Nanotechnology or related fields.
- The program will be also linked to the UNESCO Chairs in Europe to host the students for 3-6 months to do part of their research and transfer the knowledge back to their African institution.

Nanotechnology in Africa



WMRIF

World Materials Research Institutes Forum

NANYANG TECHNOLOGICAL UNIVERSITY SINGAPORE

NETWORK4SUSTAINBLE NANOTECHNOLOGY

THE UNIVERSITY OF SYDNEY — Nano Institute

WATERLOO INSTITUTE FOR nanotechnology

INTERNATIONAL INSTITUTE FOR NANOTECHNOLOGY Northwestern University

C (N) S I California NANOSystems Institute

Relationships

NEPAD
TRANSFORMING AFRICA
African Union Development Agency (AUDA-NEPAD)

AHRI
AFRICA HEALTH RESEARCH INSTITUTE

EAST AFRICAN SCIENCE & TECHNOLOGY COMMISSION
EASTECO
JUMUIYA YA AFRIKA MASHARIKI

The African Academy of Sciences

African Union
An Integrated, Prosperous and Peaceful Africa

United Nations Economic Commission for Africa

ASFAP
African Strategy for Fundamental and Applied Physics

science & innovation
Department:
Science and Innovation
REPUBLIC OF SOUTH AFRICA

International Science Council
The global voice for science

IAEA
International Atomic Energy Agency
Atoms for Peace and Development

ARUA
African Research Universities Alliance

UN TECHNOLOGY
UNITED NATIONS TECHNOLOGY BANK FOR LEAST DEVELOPED COUNTRIES

Microscopy Society of Southern Africa

UNESCO
UNITED NATIONS
Educational, Scientific, Cultural Organization

www.ansole.org
www.baleware.org
https://diode.zone/c/ansole_videos

African Network for Solar Energy (ANSOLE) : A Pan African Platform Fostering Capacity Building and Entrepreneurship in Renewable Energies

Prof. Dr. Daniel Ayuk Mbi EGBE

International Coordinator & Chairperson of ANSOLE e.V. & BALEWARE

ANSOLE e.V., Schillerstrasse 5, 07745 Jena, Germany

College of Science and Technology, University of Rwanda, KN 7 Ave, P.O.Box 3900, Kigali, Rwanda

Email: daniel.egbe@ansole.org, Tel: +4917620925862 (WhatsApp, Signal & Telegram)

nature photonics

ARTICLES

PUBLISHED ONLINE: 28 JULY 2013 | DOI: 10.1038/NPHOTON.2013.188

Ultrathin, highly flexible and stretchable PLEDs

Matthew S. White[1]*, Martin Kaltenbrunner[2,3,4], Eric D. Głowacki[1], Kateryna Gutnichenko[1], Gerald Kettlgruber[4], Ingrid Graz[4], Safae Aazou[5,6], Christoph Ulbricht[7], Daniel A. M. Egbe[1], Matei C. Miron[8], Zoltan Major[8], Markus C. Scharber[1], Tsuyoshi Sekitani[2,3], Takao Someya[2,3], Siegfried Bauer[4] and Niyazi Serdar Sariciftci[1]

We demonstrate ultrathin (2 μm thick) red and orange polymer light-emitting diodes with unprecedented mechanical properties in terms of their flexibility and ability to be stretched. The devices have a luminance greater than 100 cd m^{-2}, sufficient for a variety of optoelectronic applications including indoor displays. They can be operated as free-standing ultrathin films, allowing for crumpling during device operation. Furthermore, they may be applied to almost any surface whether rigid or elastomeric, and can withstand the associated mechanical deformation. They are shown to be extremely flexible, with radii of curvature under 10 μm, and stretch-compatible to 100% tensile strain. Such ultrathin light-emitting foils constitute an important step towards integration with malleable materials like textiles and artificial skin.

Ms Safae Aazou from Morocco, using the Africa-North Exchange (ANEX) programme,, spent 2 months in 2012 in Austria and contributed substantially in the publication of a Nature Photonics article. She completed her PhD in 2014 and is now heading a research lab in Rabat Morocco!

African School for Electronic Structure Methods and Applications

ASESMA

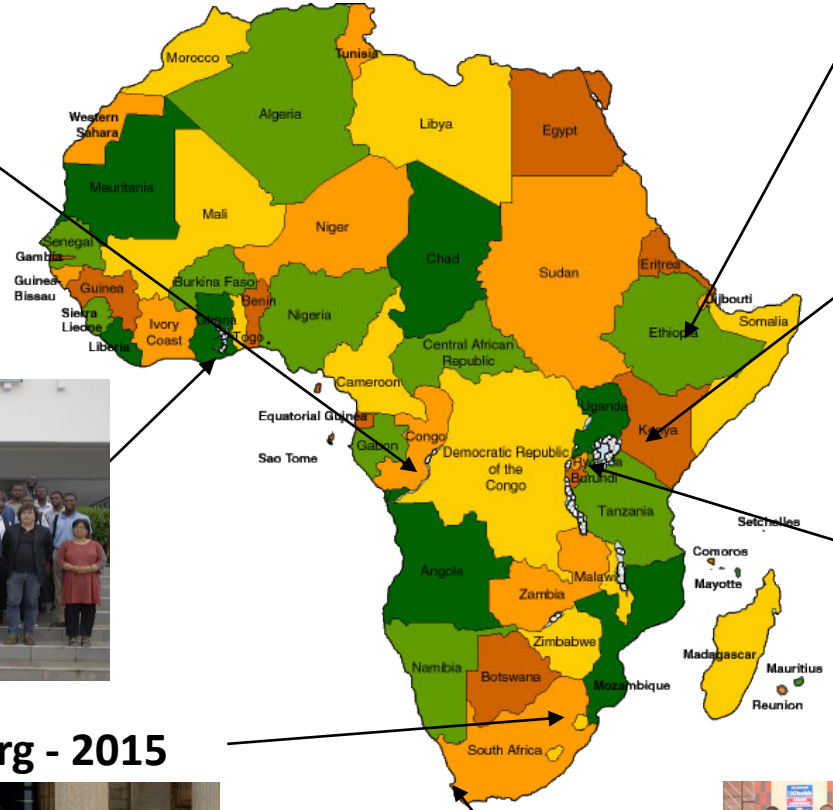
The Abdus Salam International Centre for Theoretical Physics

IUPAP International Union of Pure and Applied Physics

ASESMA Schools

Ethiopia - 2018

Mini-ASESMA
Rep. of Congo



Kenya - 2012

Ghana - 2016

Rwanda - 2020

Johannesburg - 2015

Capetown
– 2010

ASESMA

A 10-year program from 2010 to 2020

Endorsed by IUPAP (International Union of Pure and Applied Physics)
Supported by ICTP (International Centre for Theoretical Physics) , …..

Schools each 2 years to foster
a collaborative network for research and higher education within Africa

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United Nations Educational, Scientific and Cultural Organization

ICTP - East African Institute for Fundamental Research under the auspices of UNESCO

A new larger vision for ASESMA – 2020-2030

Based on
Accomplishments in the first 10 years
New developments

EAIFR (East African Institute for Fundamental Research), ASESMANET, ……

Expanded
Activities - Focused workshops, visits, meetings, collaborations, ….
Topics - Materials Science, Chemistry, Biology, …..
Education – Teaching the teachers, computational sciences, …..

Director, Prof Omololu Akin-Ojo, PhD Condensed Matter Physics

Sponsors – so far

The Abdus Salam International Centre for Theoretical Physics

IUPAP International Union of Pure and Applied Physics

Board on International Scientific Organizations
U.S. Liaison Committee for IUPAP
National Academy of Sciences

APS physics

THE THOMAS YOUNG CENTRE TyC

NSF

MARVEL
NATIONAL CENTRE OF COMPETENCE IN RESEARCH

NITheP National Institute for Theoretical Physics

Key Roles of Supporting Organizations

IUPAP

Without IUPAP, ASESMA would not exist

Sponsor of ASESMA as a program for 10 years
by
Commissions on Computational Physics (C20), Physics Education (C14) and Structure and Dynamics of Condensed Matter (C10).

Financial support for individual schools
Key to get support from other organizations

Key Roles of Supporting Organizations

The Abdus Salam International Centre for Theoretical Physics

ICTP

Without ICTP ASESMA would not exist

Largest amount of funds
Handles applications and travel arrangements
Support of lecturers from ICTP

Development of codes like Quantum Espresso, with tutorials, ….

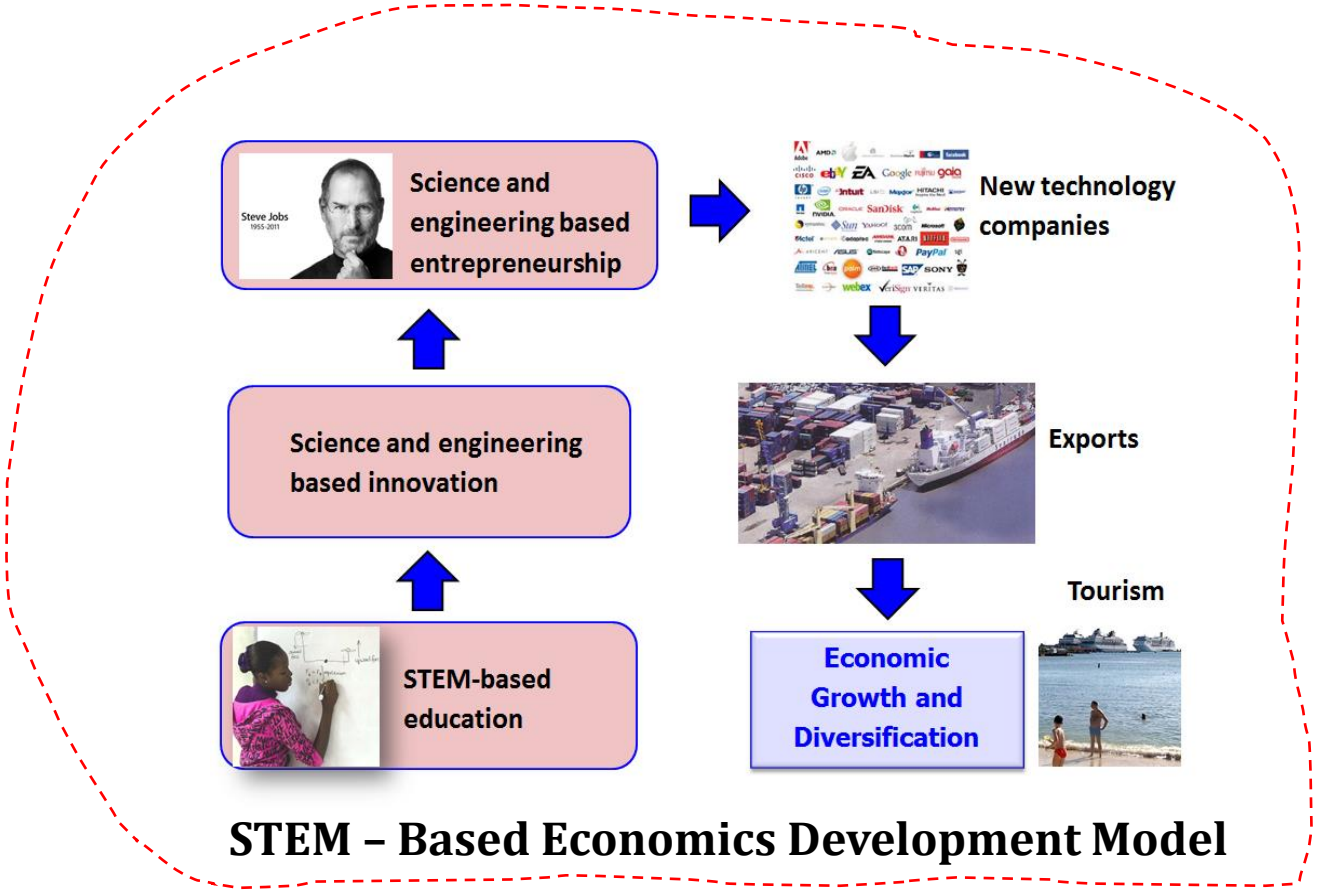
NSF, APS, MARVEL, TYC

Support of mentors and some lecturers

Summary

Key points

1. Aim for high international standards in Africa.
2. Training is important. Co-supervision of our PhD students will be helpful.
3. Access to international research infrastructures is critical.
4. We cannot cover all areas in material science in Africa. We should focus on a few areas of strategic importance, e.g. materials for solar energy generation, battery materials, Copper for example in Zambia, and so on.
5. Links with governments and private sector.
6. Influence policy.



Acknowledgements

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3. Prof Nashwa Eassa, Al-Neelain University
4. Dr Nicola Seriani, ICTP
5. Prof Sonia Haddad, CM & MP WG
6. Prof Lalla Btissam, CM & MP WG
7. Prof Omololu Akin-Ojo, EAIFR
8. Prof Daniel Egbe, ANSOLE
9. Prof Balla Diop Ngom, UCAD

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