

The role of nuclear and particle physics, astrophysics, and cosmology in building capacity for Physics in Africa

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Outline

- The need for physics capacity development in Africa
- Connecting nuclear physics, particle physics, astrophysics, and cosmology (NPAC) – initiatives to drive physics development in Africa
- Summary and Outlook





Challenges Africa faces in SET sector

- Shortage of human resources in SET to service a population of over 1.2 billion citizens;
- Human resources that are not renewed adequately, nor rapidly enough;
- Currently in SA about 50% of the national scientific output is produced by scientists over the age of 50.
- There are very few females professionals in SET fields, with the result that there is a lack of female role models that female learners can emulate
- Africa's youth is about 20% of the global youth
- So we need to get more youth into STEM workforce that can solve Africa's future challenges
- It has been challenging to get more students into basic sciences such mathematical and physical sciences



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The need for more students from Africa into NPAC

Only South Africa:
2 institutes with 5 members.
Collaboration over 1000 members



LHCb: 60 institutes, over 800 members. No African participation.
There may be a few Africans through participating institutes.

The need for more students from Africa into NPAC

Major research research facilities coming to Africa

SKA - The largest radio astronomy observatory to be (co-) hosted by South Africa (70%) and Australia (30%) : meaning that two Global/Geographical South nations will be at the heart of managing and driving the project; and this will need a large African STEM workforce

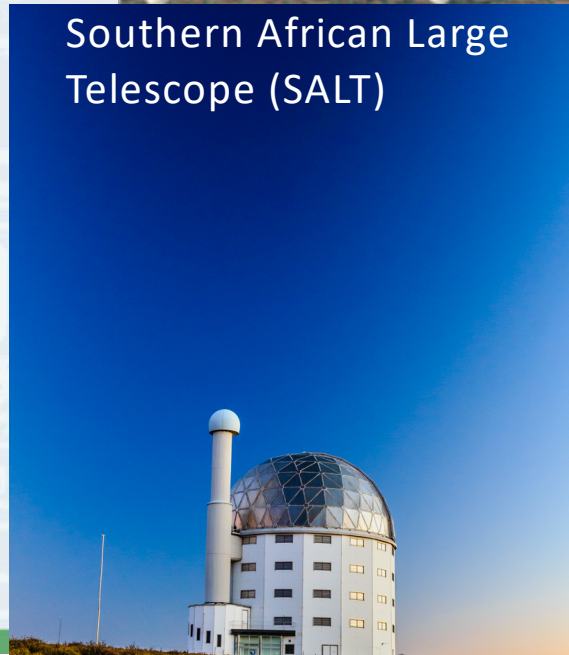
Africa and in particular Southern Africa has geographic advantage in astronomy research (besides point of human origins)

In Africa the diversity challenge is both local and global.

Multi-messenger astronomy

SKA

Southern African Large Telescope (SALT)





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SKA science and the birth of multi-messenger astronomy

THE ASTROPHYSICAL JOURNAL LETTERS, 848:L12 (59pp), 2017 October 20

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<https://doi.org/10.3847/2041-8213/aa91c9>



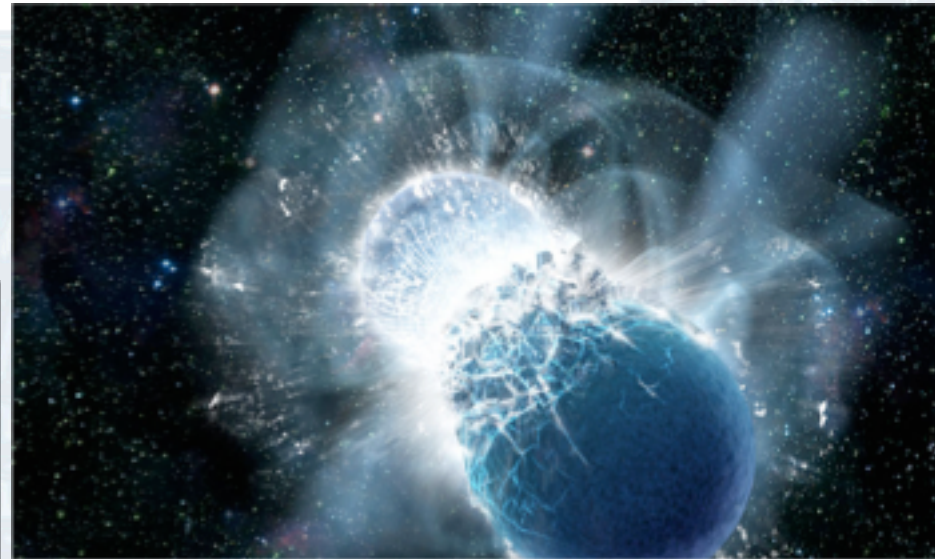
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Multi-messenger Observations of a Binary Neutron Star Merger

LIGO Scientific Collaboration and Virgo Collaboration, Fermi GBM, INTEGRAL, IceCube Collaboration, AstroSat Cadmium Zinc Telluride Imager Team, IBN Collaboration, The Insight-Hard X-ray Collaboration, ANITA-BES Collaboration, The Swift Collaboration, AGILE

A comparison between SALT/SAAO observations and kilonova models for AT 2017gfo: the first electromagnetic counterpart of a gravitational wave transient – GW170817

Buckley et al.
McCully et al.



Discovery of Higgs boson and the study of primordial matter

The South Africa CERN Programme

The main aim of the SA-CERN programme is to make the facilities at CERN available to South African researchers, engineers, technicians and students.

SA-CERN sub-programs:

SA-ALICE, SA-ATLAS, SA-ISOLDE, and SA-THEORY

10 Years of SA-CERN Celebration

November 19-21, 2018





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Early interventions in primary and secondary schools

South African Institute of Physics (SAIP)
Outreach Programmes

Going from province to province visiting
schools and HEIs

Talking about careers in nuclear physics,
particle physics, astrophysics, and
cosmology

Science Centres in SA has transformed
into training Centres for STEM learners
and educators



Outreach to schools for capacity building in physics

Programmes for STEM in schools

Most schools are in rural areas – so we put our stalls under trees

Annual National Science Week
platform to talk about NPAC – this happens throughout 9 provinces in SA simultaneously

SAIP has a hub and spoke model which assist us in distributing manpower





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Programmes for STEM educators

Training teachers has ripple
Effects – as evidenced by schools
which improved their results

SAIP has an educators development
programme which has been very
successful

The programme is now rolled to the
provinces and neighbouring African
countries

Teachers in STEM education





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Hot and Dense Matter in Heavy Ions Collisions and Astrophysics - for university students

Annual Hot and Dense Matter in Heavy Ion Collisions and Astrophysics (HDM) school and workshop

The HDM schools are aimed at students who just finished their BSc up to PhD level

The school curriculum covers introductory topics including mathematical physics, computational physics, nuclear physics, particle physics, astrophysics and cosmology

These schools are mainly hosted by rural universities in order to attract students from these universities

We also partner with visiting academics - e.g., LHC in Kruger



Training futures researchers in NPAC

The National Institute for Theoretical Physics (NITheP) Internship Programme

NITheP Associates submit research topics

Students apply and indicate which topic of their interest

NITheP Associates select suitable students

I have worked with an average of 7 students/year
for the past 8 years with 95% coming from rural universities

Students work over summer on topics cutting through
NPAC

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THEY DID IT: Final-year BSc and maths and physics postgraduate students on the National Institute of Theoretical Physics Internship Programme last month, photographed in the New Science Building at Nelson Mandela University. Like these students, matriculants who achieve in maths and science have the opportunity to pursue undergraduate and postgraduate degrees and join the global science community. BACK, FROM LEFT: Mphahlela Enos Bule (University of Limpopo), Precious Matodzi Madi (University of Limpopo), Sindiswa Shukusa (University of Johannesburg), Ndlovu Ndu (University of Venda). COUCH FROM LEFT TO RIGHT: Thabani Ngoboko (University of KZN), Shifhwa Khoromai (University of Limpopo), John Tshepoletso Tshepo (University of Pretoria). FRONT: Rudzani Foster Nemaunda (University of Venda), Tebo Kibe (University of Stellenbosch).

Far more can excel in maths, science





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NPAC at ASP and ACP

THE BIENNIAL AFRICAN SCHOOL OF FUNDAMENTAL PHYSICS AND APPLICATIONS

The science topics for the school includes lectures, demonstrations, experimentation and hands-on tutorials in the following areas:

- *Astrophysics and Cosmology;*
- *Nuclear and Particle Physics;*
- *Accelerator, Medical and Radiation Physics;*
- *High Performance Computing;*
- *Physics Education;*
- *Physics Communication;*
- *Renewable Energies and Energy Efficiency;*
- *Material Physics*

THE FIFTH BIENNIAL

AFRICAN SCHOOL OF FUNDAMENTAL PHYSICS AND APPLICATIONS

University of Namibia, and
Namibia University of Science and Technology
Windhoek, Namibia
June 24 - July 14, 2018



APPLICATION asp2018-registration@cern.ch

DEADLINE Open for application from November 1, 2017 to January 31, 2018. Bursaries & full support for selected students. Provide a CV, transcripts, letter of motivation & one recommendation letter with your online application.

CONTACT ASP-IOC@CERN.CH

WEBSITE www.africanschoolofphysics.org

The Scientific Program Includes:

- Workshop for High School Teachers
<https://www.africanschoolofphysics.org/teachers/>
- Outreach for Secondary Schools
<https://www.africanschoolofphysics.org/teachers-program/>
- Physics Lectures and Tutorials for Students
<https://www.africanschoolofphysics.org/asp2018/>
- Forum to Discuss Capacity Development & Retention
<https://www.africanschoolofphysics.org/forum/>
- African Conference on Fundamental Physics & Applications
<https://www.africanschoolofphysics.org/acfp2018/>







Summary and Outlook

Using the connection between nuclear physics, particle physics, astrophysics, and cosmology we can develop physics capacity in Africa

The recent discovery of Higgs boson and the detection of gravitational waves has generated much interest amongst the youth in Africa

The NPAC initiatives and programmes within Africa are a huge investment in the 20% of the global youth

We need to strengthen partnerships and collaborations with colleagues beyond Africa in order to realize this dream

Partnering with APS and other international Physical Societies we are on a journey to strengthen the development of Physics in Africa – starting with 3 priority areas of experimental physics, physics education, and physics communication.

There are other initiatives and programmes in Africa that are contributing to physics development in the continent such as the African Institute of Mathematical Sciences (AIMS) – based in South Africa with associated network of linked institutes in 5 other African countries