Symposium Quantum Science and more in Ghana and Germany (SYGG)

jointly organised by
the German Physical Society (DPG), and
the African Physical Society (AfPS)

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Overview of Invited Talks and Sessions

(Lecture hall WP-HS)

Invited Talks

SYGG 1.1	Tue	11:00–11:05	WP-HS	**Welcome Adress** — •Birgit Münch
SYGG 1.2	Tue	11:05–11:20	WP-HS	**Quantum Education in Ghana** — •Dorcas Attuabea Addo
SYGG 1.3	Tue	11:20–11:45	WP-HS	**Mathematical and Computational Physics Research In Ghana: To Cultivate a Knowledge-Based and Sustainable Development Economy** — •Henry Martin, Henry Elorm Quarshie, Mark Paal, Francis Kofi Ampong, Eric Kwabena Kyeh Abavare, Matteo Colangeli, Alessandra Continenza, Jaime Marian
SYGG 1.4	Tue	11:45–12:10	WP-HS	**Forecasting the Economic Health of Ghana Using Quantum-Enhanced Long Short-Term Memory Model** — •Peter Nimbe, Henry Martin, Dorcas Attuabea Addo, Nicodemus Songose Awarayi
SYGG 1.5	Tue	12:10–12:40	WP-HS	**Quantum Technology with Spins** — •Joerg Wrachtrup
SYGG 1.6	Tue	12:40–13:00	WP-HS	**Renewable Energy Technologies for Rural Ghana: The Role of Appropriate Technology for Tailored solutions** — •Michael Kweku Edem Donkor

Sessions

SYGG 1.1–1.6	Tue	11:00–13:00	WP-HS	**Quantum Science in Ghana and Germany**

SYGG 1: Quantum Science in Ghana and Germany

Time: Tuesday 11:00–13:00 Location: WP-HS

Invited Talk SYGG 1.1 Tue 11:00 WP-HS
Welcome Adress — •Birgit Münch — University Bonn

The Prorektor of International Affairs will deliver a heartly welcome adress.

Invited Talk SYGG 1.2 Tue 11:05 WP-HS
Quantum Education in Ghana — •Dorcas Attuabea Addo — University of Education, Winneba, Ghana

Quantum science and technology hold transformative potential in shaping the future of education, innovation, and industrial development. However, the rapid global advancements in quantum technologies contrast sharply with the minimal awareness and engagement in many parts of the developing world, including Ghana. This talk highlights ongoing efforts to introduce and integrate quantum science and technology education into Ghana's academic and technological landscape, focusing on creating a sustainable pathway for knowledge dissemination and capacity building. The presentation will explore key initiatives, including grassroots education programs targeting senior high school students (GQuantum Education), capacity-building workshops for educators (Quantum Educators), and the development of advanced graduate programs in quantum science and technology (ELAIS), and other initiatives in Ghana. Furthermore, this talk will address the challenges encountered, such as limited resources and the technology gap, and propose innovative strategies to overcome these barriers. By leveraging Ghana's unique cultural and academic context, we aim to position quantum science education as a tool for social transformation, economic growth, and global competitiveness. The insights shared will provide a roadmap for policymakers, educators, and researchers interested in fostering the growth of quantum science education across Africa and beyond.

Invited Talk SYGG 1.3 Tue 11:20 WP-HS
Mathematical and Computational Physics Research In Ghana: To Cultivate a Knowledge-Based and Sustainable Development Economy — •Henry Martin[1], Henry Elorm Quarshie[1], Mark Paal[1], Francis Kofi Ampong[1], Eric Kwabena Kyeh Abavare[1], Matteo Colangeli[2], Alessandra Continenza[2], and Jaime Marian[3] — [1]Kwame Nkrumah University of Science and Technology, Kumasi, Ghana — [2]Universitá degli studi dell Aquila, LAquila, Italy — [3]University of California, Los Angeles, US

Physics, the central backbone of science known for describing nature (thus Quantum Mechanics), unlocks the secrets in many areas of materials science and energy. This has led to innovations such as crystalline porous materials (CPMs), solid solutions and others. In Ghana, the lack of funds for laboratory set-up and maintenance, coupled with other factors, has caused research and education in physics to decline. Mathematical and computational physics, as an alternative, is the path my group and others have championed to rejuvenate the study and research in physics over the last decade. In this talk, I will show some of our research works conducted to: 1) Understanding how atmospheric gases such as H, O, N and others interact within bcc refractory metals - Transition pathways and 2) Explore features such adsorption, ion exchange, diffusivity and others of crystalline porous materials (CPMs) such as zeolites and metal-organic frameworks (MOFs) to remove the pollutants (combination of heavy metals, bacteria, ions and others) from our water bodies (source of drinking water). These address SDGs 6, 15, 3, 8, 12, and 11.

Invited Talk SYGG 1.4 Tue 11:45 WP-HS
Forecasting the Economic Health of Ghana Using Quantum-Enhanced Long Short-Term Memory Model — •Peter Nimbe[1], Henry Martin[2], Dorcas Attuabea Addo[3], and Nicodemus Songose Awarayi[1] — [1]University of Energy and Natural Resources — [2]Kwame Nkrumah University of Science and Technology — [3]University of Education

This research aims to develop a 12-month prediction system for Ghana's economic health using quantum-enhanced machine learning model and macroeconomic datasets obtained from Bank of Ghana. The model aims to deliver timely forecasts and provide actionable insights and recommendations for policy interventions, fiscal adjustments, and trade strategies. The predictive model aims to assist government officials, businesses, and stakeholders in making informed decisions, while promoting Ghana's advancement toward achieving the United Nations Sustainable Development Goals (SDGs). By providing timely economic insights, it will aid in better resource distribution, promote equitable growth, and support sustainable development across various sectors. The evaluation of the model is based on key metrics including loss, mean squared error, root mean squared error and mean absolute error. The results have shown that the quantum-enhanced machine learning model is very effective for forecasting the economic state and health of Ghana's economy. These results highlight the potential of quantum machine learning in financial and economic forecasts and propose directions for future work as quantum computing advances.

Invited Talk SYGG 1.5 Tue 12:10 WP-HS
Quantum Technology with Spins — •Joerg Wrachtrup — University of Stuttgart, Center for Applied Quantum Technologies, 70569 Stuttgart — Max Planck Institute for Solid State Research, Stuttgart

Spin defects in wide band gap semiconductors are leading contenders in various areas of quantum technology. Early forerunners in the field, like the NV center in diamond have shown impressive progress for sensing, communication, and quantum computing. Single NV electron spin qubits, e.g., have matured into a new tool for imaging and sensing in material science. Multiple interacting spins in a spin network enable quantum algorithms for signal analysis, for example via a quantum Fourier transformation of AC signals. In the talk I will highlight the use of new multiqubit spin systems like spin defects in silicon carbide, to apply quantum algorithms to quantum sensing and simulation of a quantum thermodynamic processes. I will also show the use of quantum non-linear spectroscopy for enhanced quantum sensing and discuss the role of quantum spin microscopy in the discovery of a new magnetic phase.

Invited Talk SYGG 1.6 Tue 12:40 WP-HS
Renewable Energy Technologies for Rural Ghana: The Role of Appropriate Technology for Tailored solutions — •Michael Kweku Edem Donkor — Department of Physics, KNUST, Kumasi, Ghana

Rural Ghana is endowed with abundant natural and renewable energy resources which offers substantial potential solutions to solving energy problems in these communities. Commercially available high-tech resource-intensive technologies for harnessing these resources in contrast pose great limitations to an effective use of these resources. Appropriate technology which can be considered a driver for sustainable rural development holds potential to offer affordable, environmentally friendly, and socially equitable community specific solutions. Rural community targeted renewable energy technologies can leverage on appropriate technology to develop tailored solutions critical for creating resilient, low-carbon rural communities that can thrive both economically and environmentally.