Address at the PACOM Symposium:
Influence of the International Scientific Community
on Development of Mathematical Talent in Africa

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Dear professorial colleagues, dear students and young mathematical scientists. This is the third PACOM that I have the opportunity and pleasure to attend. Unfortunately, I must note that I am the only participant from Europe, in fact, apart from a few members of the Nigerian diaspora, there is only one other participant from outside Africa. As we know there are diverse reasons for that, only some of which can be influenced by the conference organizers and the AMU executive board. Still we must work on this.

I represent several organizations of the international scientific community to whom I will give feedback regarding the status and future chances of mathematics in Africa. Unfortunately, I did not have a chance to speak at the opening ceremony, certainly long enough already, and cannot stay until the closing ceremony on Sunday. So let me take the opportunity to greet you on behalf of the following organizations.

- First and foremost, the German Mathematical Society (DMV), whose president, Prof. Kramer of Berlin, could not follow the invitation to Abuja extended to him by the AMU.
- Second, the German Society for Mathematics and Mechanics (GAMM), headed by Prof. Volker Mehrmann also of Berlin,
- Third, the International Council on Industrial and Applied Mathematics, headed by Prof. Barbara Keyfitz of the USA,
- Finally, the Committee on Developing Countries of the EMS headed by Prof. Waldschmidt of France.

The two more applied mathematics oriented organisations are particularly relevant for the emphasis on *tools for the scientific and technological transformation of Africa.*

But all these professional organizations are continually looking for ways to advance the cause of international collaboration in mathematics with developing countries, and most importantly with those in Africa.

However, as we all know, during the last four years the international balance seems to have shifted dramatically. While especially the Southern and Western rim of Europe, hitherto considered a show case of market induced development, is in severe trouble, Africa, hitherto considered a basket case has made great strides at least on the macro-economic level.

Naturally, the economic troubles of the EU have shifted attention away from Africa and have negatively effected the support for international scientific cooperation. My colleagues at the CDC of EMS reported that Spain and Portugal have severely curtailed programs for collaboration with developing countries. On the other hand, the ICTP at Trieste, Italy, has so far miraculously escaped major budget cuts. Not only on a per capita basis, but also in absolute terms, the Scandinavian countries, especially Sweden and the populationwise even smaller Norway, have always been at the forefront of collaboration with Africa and other developing countries. Fortunately, they are least effected by the financial turmoil in the Eurozone so that we can expect these programs to continue for the benefit of mathematical sciences in Africa.

So far this is also true for the big programs run by the European Union, some of which are specifically targeted to the ACP regions, i.e., countries from sub-Saharan Africa, the Caribbean and the Pacific rim. Unfortunately, mathematicians have made little efforts to tap into these comparatively large resources. Partly because of the very significant bureaucratic overhead, and partly because they fear there is not enough scope for true research. I have spent much time in the last two years to bring together a proposal in the EU Program ACP Science and Technology, where one could obtain a million Euros or even more over three years. Apparently, to avoid overlap with the more academic Edulink and Erasmus Mundus programs, the call emphasized technological transfer, science policy, and educational outreach in contrast to pure research and other scientific activities. Moreover, there was a focus on Food Security, and Energy Sustainability.

We chose the somewhat unwieldy theme *Value Chain Analysis, Management, Optimization, and Sustainability* short, VACAMOS. The African partners are the Universities in Thiess, Senegal, Douala in Cameroon, Nairobi in Kenya, Lilongwe in Malawi, Kampala, Uganda and others. The proposal is still under review.

A key aspect of the proposal is that it relies on well established mathematical methods that are often already well implemented. I have noticed in the program that there are many talks on mathematical models and solution algorithms that, just a few years ago might have been considered low brow, compared to the highly sophisticated models that were formulated in attempt to analyze the increasingly unregulated financial markets. At the same time methods of operations research have become more and more prevalent in controlling and optimizing the flow of goods, services and information throughout the globe (possibly too prevalent as fas as the storage and minding of data is concerned.) In fact, especially in the domain of food production and distribution processes, the standards of quality and traceability have reached such a level of complication that smaller producers in the developing world can hardly compete and are increasingly at the mercy of global retail payers head quartered in the North. This is an important area, where mathematicians can be of help.

To some colleagues in Europe and in Africa the term modeling seems to have become almost a dirty word, perhaps suggesting some superficial playing around with commercial software tools without much mathematical analysis and understanding. Of course, there are toy models and there are real models, with the latter requiring a significant amount of sustained effort and collaboration within larger projects. I myself have worked extensively on methods for optimizing the shape of aircraft wings, and could fortunately resort to aerodynamical models developed at the DLR, the German equivalent of NASA. Toy models, once they are formed can easily be solved by standard software. For real models, their discretization and numerical resolution may require a lot of thought and not only computing power. So in conclusion, real modeling of complex structures provides serious mathematical challenges but requires a certain technological environment, which is as yet harder to come by in Africa than in the North.

When I was growing up academically in Germany, it seemed indispensable for ones career to spend some time as a doctoral or post-doctoral student in the US, I actually went first to Australia and briefly to the UK. Nowadays, young German scientists learn better English in school and often just spend short periods of time abroad, cooperating otherwise with groups all over the world through electronic channels.

Africa is also benefiting from that revolution of technology, certainly in terms of access to the literature, so that books and journals need no longer be shipped across the globe. In the CDC of EMS we have an expert on electronic libraries, Anders Wandahl, who observed that these information sources are only used by very few African universities, even when they can be accessed free of charge, like for example Zentralblatt. This is a way, in which not only the international scientific community, but also the publishers can positively influence Africa. By the way, the CDC also still has a book donation program. I will lay out a list of books that we have currently in Berlin and that can be shipped to African universities with a well defined recipient.

As some of you know there has been a very successful program of the French based center CIMPA, which runs about 15 summer schools each year, about half of them in Africa. I have 50 copies of a flyer on the current program, which you can pick up here in front of the lecture hall.

Of course, there are many other organizations and support schemes, which I cannot possibly mention here all. One possibility to get more information is to go to the CDC website and to approach one of its members. One of its schemes is that of designating so called ERCEs Emerging Regional Centers of Excellence, one of which has been established in Lahore, one in Hanoi and one in Mexico. So there is definitely room for ERCEs in the various regions of Africa.

Especially here in Nigeria, the Anglo-American academic tradition has shaped the university landscape. In continental Europe there is a turmoil in the transition to the Bachelor/Master System with a melange of 3-4 year Bachelors and 1-2 year Masters. In this nascent framework there is formally no accounting for the diplomas awarded at ICTP, AIMS and other places. Still, they are immensely useful.

Let me wind up by relating an individual story as an encouragement to young

African mathematicians, who are facing a steep and windy path ahead. Eight years ago we had a first selection round for a temporary graduate school at my university in Berlin. One of the applicants was a young Senegales, who had studied with a focus on numerical analysis at the university Gaston Berger in Saint Louis and then did a one year diploma at ICTP, Trieste. We accepted neither him nor any other African because they were judged by my colleagues to be lacking in mathematical background. He may have been the one who responded to the question, how he solved the linear system arising from the discretization of PDEs, quite simply by drawing the Matlab backslash symbol on the blackboard. Fortunately, named Mouhamed Moustapha Fall, that is his name, was not discouraged, wrote his PhD elsewhere, and at the beginning of this year, he was appointed to an endowed chair of the Humboldt Foundation at AIMS Senegal. From what I hear, he is doing an excellent job there, still just in his mid thirties. Colleagues on the search committee have told me that he could have easily gotten a professorship at German university, but he chose to further the course of mathematics in his native Senegal and Africa as a whole.

We must all hope that there are enough such young Africans in all domains of science and other societal domains, such that the current flashes of economic growth in parts of Africa turn into a sustained and broad development for the whole continent. As in the particular story we told, this will not work without some assistance from outside, probably less and less from the economically troubled North and hopefully more and more from other Southern players, like the BRICS states, Brazil, India, and possibly even China, but that is another story. I hope that these countries will all be represented at the next PACOM and wish you once more a successful conference here in Abuja.