Physics in South Africa

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Preface by the President of the South African Institute of Physics

The South African Institute of Physics (SAIP) is the professional body representing the discipline of Physics in South Africa. The Council of the SAIP commissioned this book – a chronicle of the professionally practiced research and tertiary-level teaching of Physics in South Africa, with some focus on the period for which the SAIP has been in existence. We are a relatively young professional body, having been founded in 1955. Nonetheless, we have reached the stage where we should carefully archive our historical records and take advantage of the opportunity to solicit the remaining recollections from living memory. This book is a result of this process. There was, however, another reason to commission this work. Physics in South Africa is currently in a stage of unprecedented growth. Part of the reason for this growth has been the advent of full democracy in South Africa. For another part, the membership of the SAIP itself can take some credit.

Through its mission to be the "Voice of Physics", the SAIP developed a programme to coordinate the many messages coming from the Physics Community, and to finally distill a series of recommendations. This project, which started in 2004, was called "Shaping the Future of Physics". It had very essential support from government, its agencies, and also from international colleagues. Most of its fifteen recommendations have been implemented to some significant extent, and some of them rather substantially so. The effect on the discipline has been a trajectory of dramatically improving the health of the discipline. These events needed to be recorded, and are now part of this book.

However, the role of the book should not simply be limited to recording the development of Physics in South Africa over this period. We would like to see it contribute to building excellence by recognising excellence, and to building the culture of learning and research, by providing this resource for analysis and discussion. We would like to inspire the next generation of physicists, since they stand, as always, on the shoulders of those who went before. But, there is an additional aspect which is peculiar to our South African history. We need to learn from our mistakes, and understand the consequences of our past, so that we can better move forward. Of course this refers to the Apartheid period, which led to exclusion from participation or prejudice of that participation, to the stunting of the growth of certain institutions, and to styles of interaction that required transformation. This has had a continuing (but now decreasing) legacy. Council hopes that this book will be part of the process of on-going development, and that it will stimulate the submission of additional material. The companion web-site to this book solicits accounts of the "untold stories" that will be used in a further edition of this book.

In the meantime, since this book neared completion, Physics in South Africa has continued to grow. Very recent highlights have been the award of the majority of the international Square Kilometre Array (SKA) project to Africa led by South Africa, the participation of six South African institutions at CERN, with some of them participating directly in the discovery of the Higgs-like Boson, and the signing of a formal Association between South Africa and the European Synchrotron Radiation Facility. These represent some of the examples of the continuing trajectory of growth. Our largest threat to this growth, which we increasingly try to address with our partners, is the continuing poor state of basic education. This aspect has not been a focus of this book, but is a concern to which the physicists of South Africa are addressing themselves.

It remains for me to thank the editors, Profs Runan de Kok and Harm Moraal, for their herculean effort in collecting and editing the material for this book and to wish you, the reader, a fruitful reading experience.

Prof Simon Connell
Council President (2011-2013)

Preface

This book has been a long time in the making. Its origins can be traced back to the mid 1980s when Prof CA (Chris) Engelbrecht started with a project to collect material about the formation years of the South African Institute of Physics. As part of the project he conducted interviews with prominent role players during those years and recorded them on audio cassette tapes.

Regrettably, Engelbrecht passed away untimely on 30 July 1991, and this terminated the initiative. The material he had collected passed through the hands of several people and got half forgotten.

From a very different quarter, the American Institute of Physics donated an amount of $ 1500 to the SAIP to write up its history, but once again good intentions did not produce a product. The donation eventually became a part of the SAIP balance sheet.

In 2005 the SAIP would celebrate its Golden Jubilee. In addition, the United Nations had declared 2005 as The International Year of Physics to commemorate Einstein's theory of Special Relativity of 1905. The Council of the SAIP realised that it should take special initiatives for this double celebration. It led to many projects during the year, some of which are described in this book. One of them was to write up the formation history of the SAIP 50 years earlier, in 1955. After a prolonged search, the Engelbrecht material was rediscovered in the attic of a garage in Pretoria, and Prof PC (Pieter) Wagener researched the material and wrote it up. This document was distributed with the registration material of the 50th Annual SAIP conference. It is included as Chapter 2 of this book.

But Council wanted more. In 1977 AC Brown had written/edited *A History of Scientific Endeavour in South Africa*. This book comprehensively captures the development of science in South Africa predominantly in the first half of the 20th century, with three chapters devoted to physics and physics-related subjects.

These circumstances led to the Council decision to write another, more recent history of South African physics, coinciding more-or-less with the life-span of the SAIP, and picking up approximately at the point where the Brown-book had left off. Council commissioned one of us (RdK) for the task. HM assisted because of his interest in the project. Runan did the conceptualisation, the research, the communication with contributors and soliciting the material from them, as well as the structuring and organisation of the material. We decided to divide the book into three sections. The two main sections describe physics as practised at the universities and at the country's research laboratories. A separate, introductory section on physics in South Africa in general, as seen from the perspective of the SAIP, was compiled by Harm from collected material.

We distributed guidelines for contributions. These indicated that it was not to be a scientific, verifiable, or citable account, or a window to display excellence of individual institutions, but rather an account of the professional activities of real people, within the ethos of their respective institutions. Despite these guidelines, the style of the material that came in varied from factual and formal, to anecdotes about people rather than their science. We only edited these differences moderately, because the variation itself is an expression of the multifaceted character of South African physics. One noteworthy aspect that pops up in several places is, naturally, the role and effect of the country's apartheid policies, and how it affected practising (and aspiring) physicists.

A notable aspect in the research phase was the (re)discovery of the extensive technical capabilities in physics as we went through the institutions and collected their material: we communicated with the people who were the accelerator, reactor, and macro-plant builders, and who have now mostly retired. In some cases these people continue in their retirement just to keep their respective machines going. They are a breed of applied physicists who are gradually disappearing to the detriment of physics. Either they were trained as physicists and then focused their careers on the

applied aspects of their field, or they were engineers and technologists who became fully conversant with the physics of their field. This concept is entirely different from the current practice of establishing new facilities where “the engineers move out when the scientists move in”.

We started our actual work in January 2007. We arranged two months of joint work in November 2008, and in March 2010.

We gratefully acknowledge our contributors who, often under difficult circumstances, participated enthusiastically in this. We thank the Council of the SAIP for its support of the project. The Stellenbosch Institute for Advanced Study (STIAS) offered one of us (HM) a month-long fellowship, and also their superb facilities free of charge on more than one occasion to do some of the actual work, and which enabled our vital personal contacts with several important role players. Towards the end, Dr Daan Reitmann made an invaluable contribution by doing the copy-editing for the book. He dramatically improved the consistency of our writing style and the correct use of physics terminology. We thank the American Institute of Physics for suggesting to us 15 years ago that such a project is, in fact, worthy and important. We are proud to demonstrate that its donation has finally produced a product.

Lastly, it is fitting to acknowledge that this concludes an initiative that Chris Engelbrecht started more than 20 years ago.

Runan de Kock
Harm Moraal
2011-31-01

Physics in South Africa

Part A

Physics in South Africa

1 Introduction

When does the history of physics begin? Which of the different histories should be told? Did all potential contributors have a full opportunity to participate?

Particularly in southern Africa, one can rightfully imagine that the story begins over two million years ago. The paleo-record is widely interpreted to indicate that this region of the planet is the “cradle of humankind” which hosted the first emergence of the hominids that were the ancestors of homo sapiens, the “wise human”. This is the wise human that was to develop science as we know it today. Taking the clock forward to around a hundred thousand years ago, the paleo-record has revealed evidence of the earliest emergence of abstract thought, the use of tools and an understanding of materials – also in southern Africa. Again, taking the clock forward to a few thousand years ago, one notes that few ancient peoples have ignored the heavens, and not learned something of the predictability of heavenly objects. In southern Africa, one also finds a rich tradition based on applications of this knowledge. However, the chronicling of this period, potentially rich in evidence of knowledge generation and innovation, is still ongoing, and will be revealed in due course by other disciplines which are expert in deciphering the records that remain of this important heritage.

This book then confines itself to the documented formal practice of modern physics. In South Africa, this dates from the earliest significant astronomical observations of Nicholas Louis de Lacaille at the Cape of Good Hope from 1751 to 1753, who surveyed the rich southern sky. Sir John Herschel established the track record of the Royal Observatory in Cape Town between 1834 and 1838, searching for nebulae, clusters, and double stars. At that stage, the country did not exist in a form that resembles the South Africa of today. It was a divided region, with little infrastructure, and the economy was dominantly agrarian. The subsequent discovery of diamonds and gold in the 1860s and 1870s ushered in a new period of economic growth and development, but also further conflict, leading ultimately to the formation of the Union of South Africa in 1910. However, the process of development was not equally shared, and a large part of the population, identified on racial grounds by the policy of Apartheid, remained in poverty and was excluded from full participation in the science system. An increasing degree of isolation of South Africa from the rest of the world developed, which ultimately progressed to sanctions. This affected the development of physics. The government efforts were increasingly directed to issues of independence under conditions of sanctions, often with a focus on military requirements. There were indeed pockets of excellence within universities and government institutions, but it was not a sustainable situation.

The interval from 1830 to 1994 spans a variety of political contexts in which science was carried out. During that time, many aspiring physicists were discouraged, and many practicing physicists were lost to the field or to the country. In many cases, records of these life stories have not survived. Therefore, while no history can claim to be complete, this particular one leaves out the acknowledgement of many thinkers, and many thoughts. Indeed, there are many such untold stories, and these may be of exclusions, difficulties, campaigns for broader participation and transformation, and the successes in managing to continue to participate under difficult conditions. It is hoped that this account may encourage some of the untold stories to be heard and recorded.

South Africa became a full democracy in 1994. In publishing this account, almost two decades after this profound change in law and social structure, the South African Institute of Physics hopes to place on record what is now known and remembered: to assess and ponder, to acknowledge achievements, and inform our way forward.

Having clarified where this book starts, and what it omits, we continue on from the early foundations of astronomy in the 1830s. The next practice of physics was the introduction of geomagnetic and surveying work, and the establishment of several university colleges as frontrunners of universities in the second half of the 19th century. The establishment of the mining industry early in the 20th century and the subsequent industrialisation in the years before World War II significantly boosted the discipline, with physics research at several universities becoming a mature activity. On the international scene, South Africa became a founding member of the International Union of Pure and Applied Physics (IUPAP) in 1923.

It was not until the founding of the Council for Scientific and Industrial Research (CSIR) in 1945, however, under the patronage of then Prime Minister Jan Smuts, that physics emerged as a nationwide and unified discipline. Smuts had been a member of Churchill's war cabinet, and through his active involvement in the subsequent restructuring of the world order, recognised the need for South Africa to have a strong science establishment for its development. The CSIR's National Physical Research Laboratory (NPRL) immediately created a new market for physicists, as did similar laboratories for chemistry and mathematics. In response to new research funding from the CSIR, the universities also began to strengthen their postgraduate research and training programmes.

Most of the early developments up to the middle of the 20th century are covered in three chapters of AC Brown's (1977) book *A History of Scientific Endeavour in South Africa*. The main purpose of the present book is to document further developments since then, particularly through the perspective of the South African Institute of Physics (SAIP), founded in 1955. This founding history is described in Chapter 2.

The mentioned political and economic isolation led to a centralist approach from government to use science and technology to meet the perceived strategic needs of the country. This development already started with the founding of the Atomic Energy Board (AEB) in the 1950s, with the vision to utilise and enrich South Africa's uranium to make the country self-sufficient in nuclear energy. During this time, there was also an emphasis on nuclear weapons, and in 1993 the government revealed that it had developed six such nuclear devices. Similarly, over the same period, the National Institute for Defence Research at the CSIR developed into a sophisticated armaments industry, with the establishment of Armscor and its subsidiaries, to overcome the ever-stricter arms boycott.

Physics, ironically, prospered under these developments because most of the technologies that were needed were physics-based. A by-product was generous funding for large physics laboratories such as the Southern Universities' Nuclear Institute (later the National Accelerator Centre, and currently the iThemba Laboratory for Accelerator-Based Sciences). There were also extensive non-military projects at the AEB (later the Atomic Energy Corporation, AEC, and currently the Nuclear Energy Corporation of South Africa, Necsa). Two older laboratories were those of Mintek for minerals research and beneficiation, and the Hermanus Magnetic Observatory (HMO) for geomagnetic information, needed for navigation and exploration. Experimental nuclear physics and materials science research at universities directly benefited from the developments at these laboratories, performing high-quality and innovative work, especially at the level of technological physics. While it is ironic that physics in South Africa should have been strengthened by the country's isolation, the downside is that much of this work was confidential and even secret, hence many scientists who wished to develop their careers submitted 'classified' MSc dissertations and PhD theses at accrediting universities, and most publications were not in the public domain.

In 1983 the agency function by which the CSIR funded university research was transferred to the newly-established Foundation for Research Development (FRD). The FRD became independent from the CSIR in 1990, and in 1999 it expanded to become the National Research Foundation (NRF), also taking on responsibility for the social sciences and humanities. Initially, the FRD vision

was one of funding open or ‘blue skies’ research, which was meant to support and retain high-quality scholars. Physics research naturally falls into this category, and hence physics again benefited. A second benefit for Physics from this new development was that the centrally-driven physics research on behalf of the government at large laboratories, such as the CSIR and the AEC, imploded at this time. Within the CSIR, a major restructuring exercise in the mid-1980s changed the driving force to one that was largely commercial. Under its new mission, the CSIR favoured technology, engineering and applied science above basic science. At the AEC, the change was mainly due to changing strategic/political considerations leading up to the democratic dispensation of the country in 1994. These changes had a ripple effect on many other laboratories and universities. Large numbers of nuclear physicists, many of them only in mid-career, became redundant. In this climate the new FRD/NRF evaluation system played a significant role to ensure that the broad academic sector of physics did not suffer the same fate, and it provided an opportunity for the subject to readjust itself within rapidly changing national priorities.

After this Introduction, Part A of the book continues with two chapters on the foundation of the South African Institute of Physics, and the role of this Institute over the past half century. The main body of the book, in Parts B and C respectively, is an account of the practice of physics at university departments and research laboratories. It is not a formal history, but written in the style of personal experiences of the scientists who participated in them. We trust that this material may become a useful source for a future comprehensive study of Physics in South African society.

Events are mostly covered up to the second half of 2009.