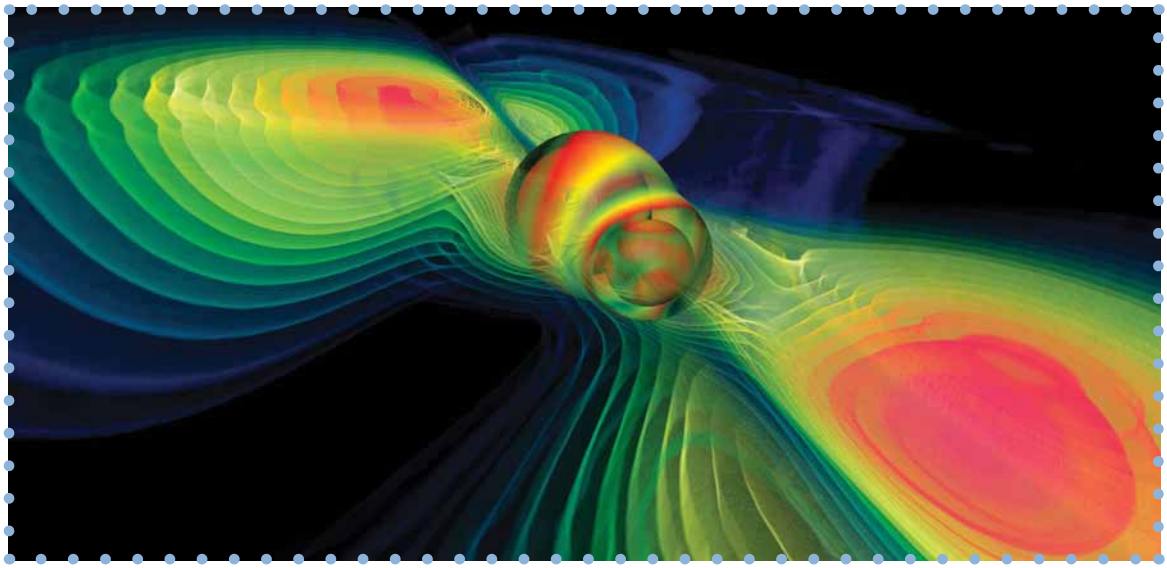
Annual report

1 January - 31 December 2011



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Abbreviations

AIMS	African Institute for Mathematical Sciences
CoE	National Centre of Excellence
CPUT	Cape Peninsula University of Technology
CSIR	Council for Scientific and Industrial Research
ITF	Institute for Theoretical Physics, Stellenbosch University
NMMU	Nelson Mandela Metropolitan University
NRF	National Research Foundation
NWU	North-West University
RFP	Request for Proposal
RU	Rhodes University
SAAO	South African Astronomical Observatory
SAASTA	South African Agency for Science and Technology Advancement
STIAS	Stellenbosch Institute for Advanced Study
SU	Stellenbosch University
SUST	Sudan University of Science and Technology
UCT	University of Cape Town
UFH	University of Fort Hare
UFS	University of the Free State
UJ	University of Johannesburg
UKZN	University of KwaZulu-Natal
UNISA	University of South Africa
UNIVEN	University of Venda
UP	University of Pretoria
UWC	University of the Western Cape

Director's Report

2011 WAS A BENCHMARK YEAR FOR NITHEP in which the first international review took place. This was an extensive exercise involving a broad range of stakeholders from government, funding agencies, tertiary institutions, staff and the community. Overall this was a positive experience and the recommendations emphasised and encouraged the NITheP policy of capacity development, especially in disadvantaged or marginalised communities and institutions, as well as broad community involvement.

The second associate workshop was held in April 2011. These workshops aim firstly to inform NITheP strategies and policies on the needs of the community and, secondly, to create a networking and collaborative opportunity for associates. To encourage the latter, a scientific component was introduced in which new associates had the opportunity to present their research. As before, this was a useful and successful exercise for NITheP management and associates.

2011 was the second year that the request for proposal system was implemented. Under this system associates can apply for support for international workshops, visitors and mobility. In 2011 this programme supported a total of 10 workshops that involved a substantial number of local students and researchers. In addition, long-term visits totalling 14.5 visitor months were supported.

As part of NITheP's policy to engage with and build capacity at marginalised institutions, a road trip targeting rural universities in South Africa was undertaken in 2011. The aim was firstly to gain insight into the needs of these environments and, secondly, to inform them about the programmes offered by NITheP. Under the same policy considerable support was also given for mobility, specifically in the Gauteng, North-West and Limpopo regions.

As the aim is to extend this policy beyond South Africa's borders and to also engage with institutions in Africa, the first and very successful faculty development workshop on Field Theory and General Relativity was held at the University of Mauritius in July 2011. Similar workshops are planned for 2012 to target rural universities in South Africa.

On the research front the growing trend in research publications continued with a 31% increase relative to 2010. This is remarkable if it is kept in mind that 2011 did not see any growth in funding or staffing relative to 2010.

With the first funding cycle and review completed and the longer-term future of NITheP secured, the institute will focus on developing a balanced portfolio of capacity development, supported by quality research.

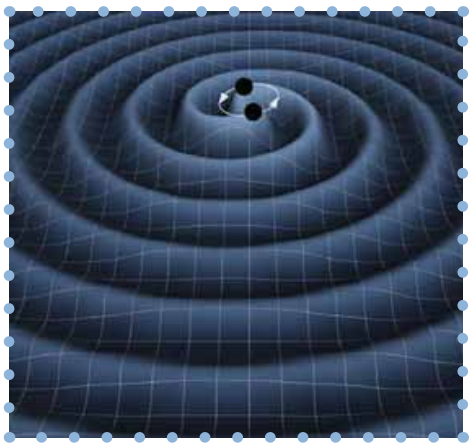
Frederick Scholtz

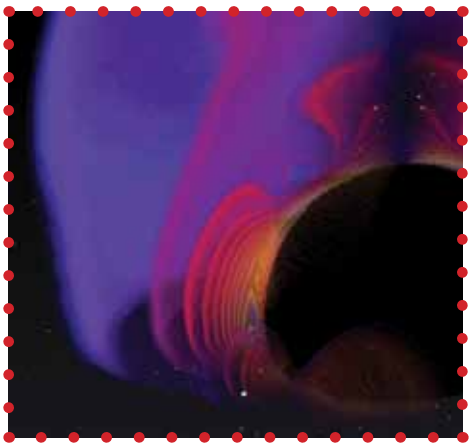
Introduction

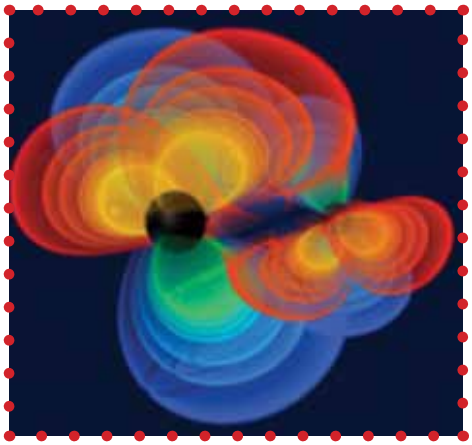
NITHEP IS A GEOGRAPHICALLY DISTRIBUTED INSTITUTE with regional centres at the Stellenbosch Institute for Advanced Studies (STIAS), the University of the Witwatersrand (WITS) and the University of KwaZulu-Natal (UKZN). Stellenbosch University (SU) acts as the host institution and the regional centre at STIAS remains its headquarters.

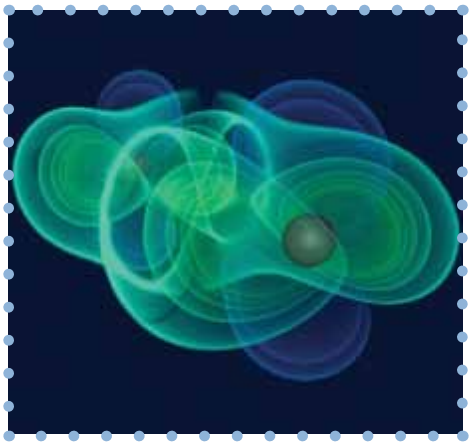
The governance system is that of a national centre of excellence (CoE), which is subject to the notarisation of a binding contract between the granter, the National Research Foundation (NRF), and the grantee, namely SU, as the host institution of NITheP headquarters. It should be noted that NITheP operates in an independent environment (STIAS) with SU providing administrative support. This is critical in the South African (and African) context to ensure non-alliance to a particular institute and to develop an independent identity.

Interaction between the regional centres is governed by a consortium agreement between the hosts of the three regional centres, namely WITS, UKZN and SU.









Mandate and Strategy

Vision

NITHEP'S VISION is to be Africa's leading and an internationally competitive research and training institute in theoretical physics, a discipline that provides the conceptual framework for the natural sciences.

Mission

NITHEP AIMS to sustain a stimulating theoretical physics research and user facility that links South Africa internationally through excellence in research and training, thereby supporting scientific innovation, transformation and socio-economic development in South Africa.

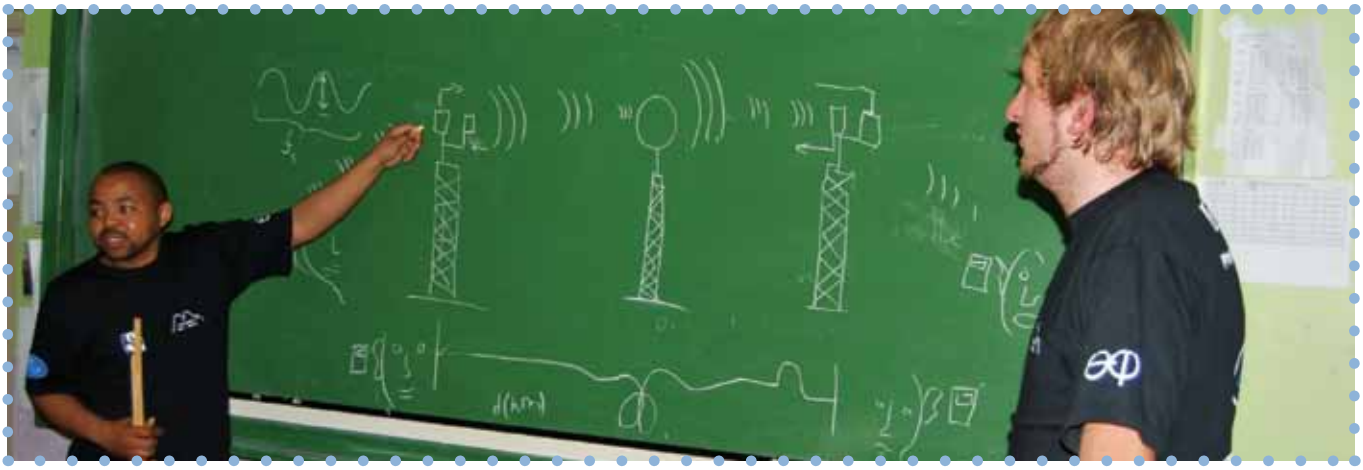
Strategic goals

TO IDENTIFY and pursue high-level research projects and expand existing expertise in the fields covered by theoretical physics in South Africa;

TO ACT as a national and African user facility for theoretical physics, which optimises communication and collaboration between the existing centres of expertise and stimulates joint initiatives in line with international developments;

TO PROMOTE equitable participation from all communities in South Africa in theoretical physics programmes and to strengthen ties with similar communities on the African continent; and

TO PROVIDE a source of expertise that can feed into broad national scientific policies and goals.



Governance and Structure

Governance

THE GOVERNANCE STRUCTURE, as set out in the governance document for a CoE, makes provision for the establishment of a board of directors, a scientific advisory committee and a management committee. The composition of these three core governance committees were as follows on 31 December 2011:

Board members:

Prof A. van Zyl (vice rector research, SU)
Dr A. Kaniki (NRF)
Prof J. Rodrigues (deputy director, WITS)
Prof F. Petruccione (deputy director, UKZN)
Prof N. Chetty (UP)
Prof R. de Mello Koch (WITS)
Prof H. B. Geyer (SIAS)
Prof T. Hillie (CSIR)
Prof F. G. Scholtz (director)
DST Representative

Scientific advisory committee:

Prof P. Knight (Kavli Royal Society International Centre)
Prof S. J. Gates (University of Maryland)
Prof J. Govaerts (Catholic University Louvain)
Prof N. Turok (Perimeter Institute)

Management committee:

Prof F. G. Scholtz (director, chair)
Prof J. Rodrigues (deputy director, WITS)
Prof F. Petruccione (deputy director, UKZN)
Prof R. de Mello Koch (elected associate representative)
Mrs R. Kotzé (communications officer)
Ms M. Louw (secretary)

Staff

THE STAFF PROFILE of NITheP as on 31 December 2011 is shown in Table 1.

Table 1: Staff profile on 31 December 2011

Position	Node	Number
Director	SU	1 (five-year contract)
Deputy director	WITS/UKZN	2 (five-year contract)
Chief researcher	SU	1 (five-year contract)
Senior researcher	SU/WITS	2 (five-year contract)
Researcher	SU/UKZN	3 (two five-year and one one-year contracts)
Senior admin. officer	SU/WITS	3 (one full time, one 3/8, one 5/8; positions all five-year contracts)
Secretary	UKZN	1 (five-year contract)
Total		**13**

Postdoctoral fellows

THE POSTDOCTORAL FELLOWS per node as on 31 December 2011 are shown in Table 2. All positions comprise two-year contracts.

Table 2: Postdoctoral fellows

Node	NITheP funded	Outside funded
SU	4	2
WITS	2	0
UKZN	2	0
Total	**8**	**2**

Activities in 2011

Service rendering

Marketing

FOR AN INSTITUTE such as NITheP that functions as a user facility, it is important to maintain a high level of visibility within the community. Marketing was emphasised right from NITheP's inception and 2011 was no exception.

As usual, an exhibition was held at the annual conference of the South African Institute of Physics (SAIP) in July 2011.

As part of NITheP's policy to engage with and build capacity at marginalised institutions, a road trip targeting rural universities, specifically the universities of Zululand, Limpopo, Venda and North-West (Mafikeng), was undertaken in 2011. Visits to Fort Hare and Walter Sisulu are scheduled for 2012. The aim of the trip was to gain insight to the needs of these environments and to inform them about NITheP's programmes.

Networking

Associate programme

To achieve NITheP's strategic goals it is crucial to develop a national network throughout South Africa. In 2011 NITheP's highly successful associate programme continued growing. The current status of the network, which now comprises 46 individual and four institutional associates, is shown in Table 3. Associates have access to the NITheP visitor, mobility and workshop programmes through the request for proposal (RFP) system.

Table 3: Associates on 31 December 2011

INDIVIDUAL ASSOCIATES	
Prof Jacek Banasiak	UKZN
Prof Igor Barashenkov	UCT
Dr Bruce Bartlett	SU
Prof Bruce A. Bassett	AIMS, SAAO & UCT
Prof Moritz Braun	UNISA
Prof Erwin Brüning	UKZN
Prof Nithaya Chetty	UP
Prof Jean Cleymans	UCT
Prof Robert de Mello Koch	WITS
Prof Cesareo A. Dominguez	UCT
Dr Rocco Duvenhage	UP
Prof Hans Eggers	SU
Prof George Ellis	UCT
Prof Arthur Every	WITS
Dr Kevin Goldstein	WITS

INDIVIDUAL ASSOCIATES	
Prof W. Dieter Heiss	SU
Prof Manfred Hellberg	UKZN
Dr William Horowitz	UCT
Prof Daniel Joubert	WITS
Prof Steven Karataglides	UJ
Prof Thomas Konrad	UKZN
Dr Mantile Lekala	UNISA
Prof Roy Maartens	UWC
Prof Richard Mace	UKZN
Prof Sunil Maharaj	UKZN
Prof Oluwole Daniel Makinde	CPUT
Prof Kavilan Moodley	UKZN
Prof Harm Moraal	NWU
Prof Kristian Müller-Nedebock	SU
Prof Azwinndini Muronga	UJ
Dr Jeff Murugan	UCT
Prof André Peshier	UCT
Dr Dimitri Polyakov	WITS
Prof Martin Porrmann	UKZN
Prof Marius Potgieter	NWU
Prof Alex Quandt	WITS
Prof Sergei Rakitianski	UP
Dr Stef Roux	CSIR
Dr Alessandro Sergi	UKZN
Dr Gary Tupper	UCT
Prof Raoul Viollier	UCT
Prof André Weideman	SU
Prof Herbert Weigel	SU
Prof Heribert Weigert	UCT
Dr Amanda Weltman	UCT
Dr Caroline Zunckel	UKZN
INSTITUTIONAL ASSOCIATES	
Alice Group	UCT
Centre for Theoretical Physics	UCT
Cosmology Group	UCT
Centre for Space Research	NWU

African development programme

Capacity development in theoretical physics in Africa is very much part of the NITheP mandate and agenda. The first step in this direction was taken in 2010 when a NITheP delegation visited the University of Mauritius to investigate possible modes of cooperation and capacity building. As a result of this visit, the first African faculty development workshop on General Relativity and Field Theory was held at the University of Mauritius in July 2011. The course was given by a NITheP associate from WITS, Prof Robert de Mello Koch, and Dr Sanjaye Ramgoolam from Queen Mary College.

Request for proposal (RFP) system

The mechanism through which NITheP gives associates and staff access to NITheP resources and, particularly, the mobility, long-term visitor, workshop and research programmes, is a competitive proposal-driven system. Table 4 summarises the support given to staff and associates under this programme in 2011. The individual activities listed below are reported in detail under the appropriate headings (note that not all the proposals approved for support materialised due to a variety of reasons).

Table 4: Proposals supported under the RFP programme in 2011

Activity	Number
Workshops	8
Schools	1
Long term visitors	9 (14.5 visitor months)
Mobility	2

Mobility

Under the mobility programme, support is provided for associates to travel between South African higher educational institutions and, in particular, to the three nodal centres at SU, WITS and UKZN. Support is given for a period of up to two months per year and includes accommodation and subsistence, as well as transport costs in cases that are strongly motivated and justified. In 2011 two proposals were supported under this programme. Particularly noteworthy is the substantial support given to Prof A. Muronga to stimulate interaction and movement of students between tertiary institutions in Gauteng, North-West and Limpopo.

Visitors

A vibrant visitor programme is vital for NITheP's success. There are two mechanisms that attract visitors to NITheP.

The first is the long-term visitor programme, accessed through the RFP system, whereby staff and associates can apply for support for longer-term visiting collaborators, typically for a period of one to six months. This support covers accommodation and subsistence. Travel costs are covered only in exceptional cases. In addition, NITheP budgets annually for short-term visitors who typically spend a few weeks (less than a month) at a NITheP centre or tertiary institution of an associate. In both cases, foreign researchers may apply for support under these programmes.

Table 5 summarises the long-term visitors supported under the RFP system while Table 6 reflects the short-term visitors supported through the regular NITheP visitor programme.

Table 5: Long-term visitors supported under the RFP system in 2011

Visitor	Home institution	Host institution	Term
Prof Vladimir Belyaev	Joint Institute for Nuclear Research, Dubna, Russia	Profs S. Rakitianski (UP) and S. A. Sofianos (UNISA); Dr Rob Adam (NECSA)	27/4 to 26/5
Prof Harald Fritzsch	Max Planck Institute, Munich, Germany	Profs Raoul Viollier and Cesareo Dominguez (UCT)	24/1 to 4/3
Prof Stéphane Peigné	SUBATECH, Université de Nantes, France	Andre Peshier (UCT)	3/8 to 12/9
Prof Martin Bucher	Laboratoire AstroParticules et Cosmologie, Université Paris 7, France	Dr Kavilan Moodley (UKZN)	1/2 to 28/2 1/9 to 30/9
Prof John W. Bieber	University of Delaware, USA	Prof A. Burger, Unit for Space Physics (NWU)	9/11 to 21/11
Prof Raoul R. Nigmatullin	Kazan State University, Tatarstan, Russia	Prof Francesco Petruccione and Dr Filippo Giraldi, NITheP (UKZN)	
Prof Francesco Mainardi	University of Bologna, Italy	Prof Francesco Petruccione and Dr Filippo Giraldi, NITheP (UKZN)	19/9 to 28/9
Prof S. Nagamachi	The University of Tokushima, Japan	Profs Erwin Albert Karl Brüning (UKZN) and Francesco Petruccione NITheP (UKZN)	

Table 6: Short-term visitors supported under the regular visitor programme in 2011

Visitor	Host institution	Host institution
Dr A. Avdeenkov	NITheP (SU)	WITS
Prof J. Barbour	University of Oxford	WITS
Prof B. Bassett	AIMS	SU & WITS
Dr P. Benito	WITS	WITS
Dr J. Brink	NITheP (SU)	WITS
Prof J. Cleymans	UCT	WITS
Dr D. Dai	UCT	WITS
Dr J. Degorre	Centre for Quantum Technology, University of Singapore	UKZN
Dr T. Dey	WITS	WITS
Prof C. Dominguez	Centre for Theoretical & Mathematical Physics, UCT; Department of	SU & WITS
Dr J. Doukas	YITP, Kyoto, Japan	WITS

Visitor	Host institution	Host institution
Prof P. Dunsby	UCT	WITS
Prof V. Dzhunushaliev	Institute for Basic Research, Eurasian National University	SU & WITS
Prof H. Eggers	SU	SU
Prof G. Ellis	UCT	SU
Prof J. Engelbrecht	Boston College	WITS
Dr R. Fantoni	NITheP (SU)	SU
Prof S. Ghosh	Indian Statistical Institute, Kolkata, India	SU
Dr D. Giataganas	WITS	WITS
Dr K. Goldstein	WITS	WITS
Dr R. Gwyn	King's College	WITS
Dr W. Horowitz	UCT	WITS
Prof L. Hughston	Imperial College	WITS
Prof S. Karataglidis	WITS	WITS
Prof M. Kawamura	Okayama University of Science, Japan	UKZN
Dr N. Khosravi	AIMS	WITS
Prof R. Maartens	UWC	SU and WITS
Prof F. Mainardi	University of Bologna, Italy	UKZN
Dr H. McCreadie	UKZN, Westville Campus	UKZN
Prof S. Mukherjee	IUCAA Reference Centre, Kolkata	UKZN
Prof B. Mukhopadhyay	Indian Institute of Science, Bangalore, India	SU
Prof S. Nagamachi	University of Tokushima, Japan	UKZN
Dr R. Paškauskas	NITheP (SU)	SU
Dr G. Pellicane	UKZN	SU
Dr A. Prinsloo	UCT/NITheP (SU)	WITS
Dr A. Sheikhan	NITheP (SU)	SU
Prof D. Sherwell	CAM, WITS	WITS
Dr I. Snyman	NITheP (SU)	SU
Dr P. Sundin	UCT	WITS
Dr R. Warmbier	UCT	WITS
Prof H. Weigel	SU	WITS
Prof H. Weigert	Centre for Theoretical & Mathematical Physics, UCT	SU
Dr T. Wellens	University of Freiburg, Germany	UKZN
Dr A. Zimmerman	Caltech	SU

Bursaries

In total, 60 bursaries were awarded in 2011. The total amount paid out was R3 306 666. The bursaries awarded are summarised in Table 7.

Table 7: Bursaries awarded in 2011

Level	Number	Amount allocated per bursary	Budgeted cost
Hons.	16	R 40 000	R 640 000
M.Sc.	23	R 55 000	R 1 265 000
Ph.D.	21	R 75 000	R 1 575 000
Total	**60**		**R 3 480 000**

The bursary holders per institution and degree are reflected in Table 8.

Table 8: Bursary holders per institution in 2011

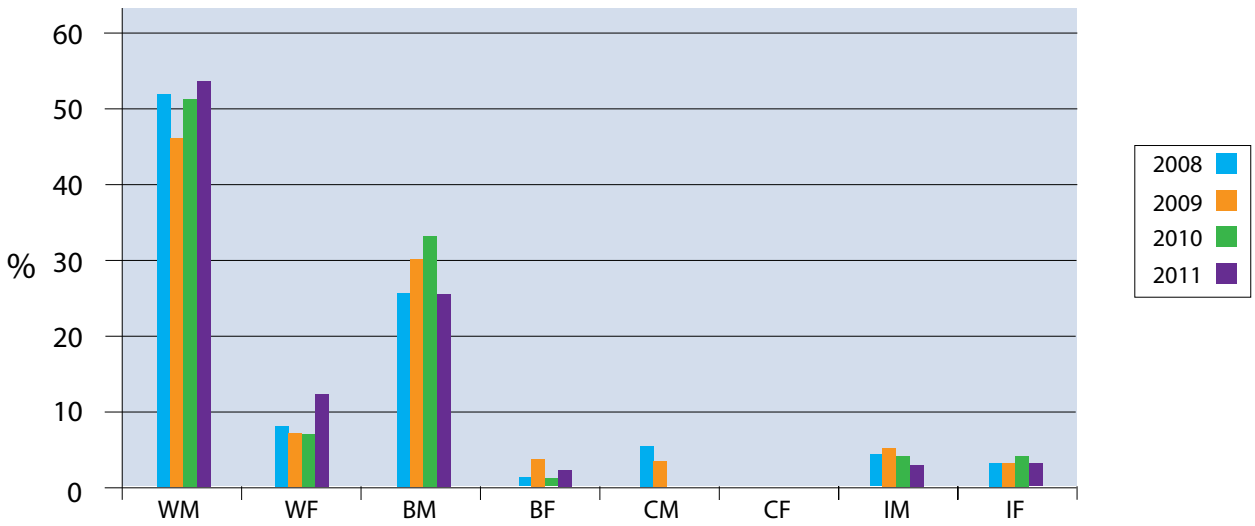
Institution	Hons.	M.Sc.	Ph.D.	Total
SU	0	7	2	9
UCT	3	3	8	14
UFH	1	0	0	1
RU	2	1	0	3
UFS	1	0	0	1
UJ	1	0	0	1
UKZN	3	5	4	12
UNIVEN	0	2	0	2
UP	4	2	3	9
UWC	0	0	1	1
WITS	1	3	3	7
Total	**16**	**23**	**21**	**60**

Table 9 shows bursary holders by race and gender. The bursary profile still does not reflect satisfactory demographics, particularly in terms of gender, but it must be kept in mind that theoretical physics is a non-traditional line of study for many under-represented groups and it will take some time to reach a more satisfactory demographic profile. On the Ph.D. level, however, the demographic profile shows an encouraging trend. The change in demographic profile from 2008 to 2011 is reflected in Figure 1.

Table 9: Bursary holders by race and gender in 2011

Degree	White		Black		Coloured		Indian	
	Male	Female	Male	Female	Male	Female	Male	Female
Honours	9	2	4	1	0	0	0	0
M.Sc.	14	3	5	0	0	0	0	1
Ph.D.	9	2	7	0	0	0	2	1
Total	**32**	**7**	**16**	**1**	**0**	**0**	**2**	**2**

Figure 1: Demographic profile of bursary holders in the period 2008 to 2011



Internships

The internship programme was continued in 2011. Applications were invited in the first half of 2011.

This programme has two components. The first makes it possible for students at Honours or M.Sc. level to join NITheP workshops and complete a small research project, typically on the scale of an honours project, under the supervision of one of the invited workshop participants. This project is also evaluated by the supervisor and an independent local examiner, usually from the student's home institution. Students may use the marks generated in this way for credits at their home institutions, if this is approved by the home institution.

The second component makes provision for students, mainly at honours level or at the start of their M.Sc., to join NITheP staff or associates during recess periods to complete a research project. Once again these projects are evaluated by a supervisor and an independent examiner, who is usually from the student's home institution. The mark may be used for credits if the home institution approves of this.

By providing a training opportunity, often under the guidance of a leading researcher, NITheP alleviates the pressure of project supervision on departments. From 2012, 25% of honours training is required to be project driven, which could make this support vital to many physics departments. Typically, NITheP supports students who pass the screening process for this programme in terms of travel cost, accommodation and subsistence.

Table 10 summarises the statistics of this programme for 2011. Particularly encouraging is the considerable number of interns who continue with a higher degree in theoretical physics.

Table 10: Internship statistics for 2011

Student's home institute (host institute)	Number of students	Number of students earning credits	Continued with higher degree
AIMS (NITheP WITS)	1	0	1
SU (NITheP SU)	1	0	1
SU (SU)	1	0	1
SUST (NITheP SU)	1	0	1
UCT (UCT)	1	1	1
UCT (NITheP UKZN)	1	1	1
UKZN (NITheP SU)	1	1	1
UKZN (NITheP UKZN)	3	0	1
UJ (UJ)	1	0	0
UKZN (UJ)	1	1	1
WITS (NITheP UKZN)	1	1	1
Total	**13**	**5**	**10**

Travel grants

NITheP also offers support to enable students to travel to international and national conferences and schools. Support is only given if the student delivers a presentation or poster or, in the case of schools, if a supervisor strongly motivates for the student's attendance.

Support is limited to R15 000 for international conferences and R5 000 for national conferences. Table 11 indicates the travel grants allocated during 2011.

Table 11: Travel grants allocated in 2011

Institution	International	National
SU	R 30 000	R 3 862
UP	R 15 000	R 1 654
UWC	R 7 500	0
WITS	R 15 000	0
UCT	R 30 000	0
Total	**R 97 500**	**R 5 516**

Outreach, community service and the popularisation of science

Public talks

Part of NITheP's outreach is the popularisation of science. As part of this activity, NITheP presented a gala evening of public talks on 13 October 2011 in collaboration with iThemba LABS. The event was held at STIAS in Stellenbosch and schools in the Stellenbosch and wider area were invited to send learners to this event. iThemba LABS provided transport for learners from schools that were not able to provide their own transport. Attendance was excellent with around 180 learners, students and members of the public.

The following speakers participated in the event:

• *Einstein for Everyone,* Prof Naresh Dadhich, Inter-University Centre for Astronomy and Astrophysics, Pune, India. Public talk on 13 October 2011 at STIAS.

• *Answering Gauguin's Questions with the Large Hadron Collider,* Prof John Ellis, CERN, and Clerk Maxwell, Professor of Theoretical Physics, King's College of London, Switzerland/ United Kingdom. Public talk on 13 October 2011 at STIAS.

• *Einstein for Everyone,* Prof Naresh Dadhich, Inter-University Centre for Astronomy and Astrophysics, Pune, India. Public talk on 1 November 2011 at UJ Faculty of Science, Auckland Park Kingsway Campus, Johannesburg.

As part of the Mauritius Workshop, two public talks were held in Mauritius on *Quantum Fields and Cosmological Inflation:*

• *From Spacetime and Quantum Mechanics to String Theory*, Prof Robert de Mello Koch (WITS) (NITheP associate representative). Public talk on 9 June 2011 at the University of Mauritius.

• *Symmetries and Extra Dimensions in String Theory,* Prof Sanjaye Ramgoolam, Queen Mary, University of London. Public talk on 16 June 2011 at the University of Mauritius.

ESCOM Expo for Young Scientists

In 2011 NITheP also sponsored a Mathematics and Physics prize at the national ESCOM Expo for Young Scientists. At this event NITheP staff and associates also acted as judges for the mathematics and physics prizes.

Boyden Science Adventure Camp

NITheP bursary holder and Ph.D. student Chris Rohwer gave a talk highlighting theoretical physics at the annual Science Adventure Camp at the Boyden Observatory near Bloemfontein. This camp is a collaboration between UFS and the Boyden Science Centre and is attended by top achievers in grade 12. NITheP associate and director of the UJ Science Centre, Prof Azwinndini Muronga, accompanied five learners from the UJ Science Centre based in Pimville, Soweto, to the Boyden Camp.

Rhodes University Physics Department Educational Tour of the Western Cape

NITheP gave a talk at the SU Physics Department during the Rhodes University Physics Department September 2012 Educational Tour of the Western Cape. The group consisted of 30 students from first to third year, as well as Honours students. The tour also visited the South African Astronomical Observatory (SAAO), the Southern African Large Telescope (SALT), iThemba LABS, the Karoo Array Telescope (KAT), Koeberg and the Institute for Maritime Technology (IMT).

iThemba LABS Undergraduate Intervention 2011

NITheP staff, postdoctoral fellows, associates and students gave talks at iThemba LABS during the Undergraduate Intervention 2011, *Unleash your Potential*, on 7 September 2011. This is an annual collaboration between iThemba LABS and SAASTA.

The talks were:

- *An Introduction to Theoretical Physics and String Theory* by Dr Andrea Prinsloo (NITheP SU)
- *Cosmology and Astrophysics* by Amare Gidelew (UCT student)
- *Simulations and Condensed Matter Physics* by Dr Ameneh Sheikhan (NITheP SU)
- *Theoretical Physics in Cells* by Prof Kristian Müller-Nedebock (NITheP associate, SU and ITF).

Outreach Road Trip , West Coast

NITheP and the Stellenbosch Faculty of Science supported six students from the Laser Research Institute (LRI), the ITP as well the greater part of the department's student body on the Outreach Road Trip. The event took place during September 2011 and the aim was to visit schools in underprivileged communities along the West Coast. Popular physics demonstrations were done and pupils were informed about physics as a career path. The students explained the basic philosophies of mathematical modelling of physical systems and experimental physics. The feedback was overwhelmingly positive.

Research and training

Research focus

NITHEP HAS CLEAR research focuses that are derived from existing research capacity at the nodal centres and strategic priorities. With the appointment of associates, the research focus is extended to include existing research capacity outside these centres. The current core research activities are centred along the following themes:

- Statistical and Condensed Matter Physics (SU, WITS)
- Quantum Information and Computation (UKZN)
- High Energy Physics:
  - String Theory and Matrix Models (WITS, UCT)
  - Phenomenology (WITS, UCT)

A researcher in the field of gravitational waves, appointed to fill a temporary two-year position, started on 1 November 2010. The aim of this appointment is to seek closer linkage with the astronomical and SKA communities. The researcher was timeously appointed as nationally there is growing awareness of the development of gravitational wave astronomy. Indeed, 2012 will see a workshop on this topic with the possibility of a follow-up Chris Engelbrecht Summer School in 2013.

Schools, workshops and short research programmes under RFP system

NITheP's workshop and short research programme makes provision for the support of workshops and research programmes organised at NITheP nodal centres or the home institution of an associate. Typically workshops span three to five days and research programmes a period of one to three months. Often these activities are combined. These programmes are accessed through the RFP system.

NITheP's flagship training programme, the Chris Engelbrecht Summer School series, runs annually. This is a proposal-driven programme under which any member of the theoretical physics or broader physics community may propose a topic, speakers and organising committee for the school.

In 2011 the following schools, workshops and short research programmes were supported through the RFP system.

Schools

The 22nd Chris Engelbrecht Summer School was entitled *The Standard Model of Particle Physics and Beyond*. This school took place from 19 to 30 January 2011 at the Stellenbosch Hotel in Stellenbosch. The invited speakers were Profs Yuri Dokshitzer (Paris), Harald Fritzsch (Munich), Jean Iliopoulos (Paris), Boris Kayser (Fermilab), Paul Langacker (Princeton), Peter Nilles (Bonn), Antonio Pich (Valencia) and Stuart Raby (Ohio). A total of 35 participants, including the eight speakers, attended the school.

Workshops

1. International Workshop *The Quantum Physics of Low Dimensional Systems and Materials* was arranged by Dr Izak Snyman (NITheP, SU) and held from 3 to 7 January 2011 at STIAS. There were 22 invited speakers, five students and 16 ordinary participants.

2. International Workshop *Nonlinear Effects in Quantum Electrodynamics* was arranged by Prof Cesareo Dominguez. The workshop was held at the UCT Department of Physics from 3 to 15 January 2011. There was one South African and five international participants.

   This workshop is the third in a series that started in 2007 and sought to follow up on the results of research work done after the second workshop in 2009. All six participants presented lectures and worked on a first draft of a paper that resulted from the workshop.

3. International Workshop *Relativistic Quantum Information* was arranged by Prof Francesco Petruccione (NITheP, UKZN) and held from 7 to 11 March 2011at the UKZN School of Physics. There were eight invited speakers, 15 students and seven ordinary participants.

4. International Workshop *2nd Stellenbosch Workshop on Statistical Physics: Equilibration and Equilibrium* was arranged by Prof Michael Kastner. It was held from 7 to 18 March 2011 at STIAS. There were 12 invited speakers, seven students (including postdoctoral students) and 13 ordinary participants.

5. International Workshop *Nuclear Physics* was arranged by Prof F. G. Scholtz. The workshop was held at STIAS from 16 to 27 May 2011. The goals of the workshop were to serve as a practicum for young physicists in Southern Africa regarding the current status of experimental and theoretical nuclear physics and to establish or enhance research contacts with physicists in South Africa for the purpose of creating future collaborations. The workshop was sponsored by the US National Science Foundation, HIC for FAIR in Germany and NITheP. There were 23 lecturers and 23 students, who were from South Africa (14), Africa (6), the USA (2) and Germany (1).

6. International Workshop *3rd Joburg Workshop on String Theory: String Theory and Higher Spins* was arranged by Dr Dimitri Polyakov. The workshop was held at the WITS Rural Facility from 7 to 11 July 2011. There were 13 invited speakers, six students and six ordinary participants. In conjunction with the workshop, an intensive pre-workshop school for graduate students was held from 4 to 5 July 2011 at the WITS Physics Department.

7. International Workshop *Constructive and Perturbative Aspects of Quantum Field Theory* was arranged by Prof Martin Porrmann (UKZN) (NITheP associate) and held from 17 to 22 August 2011 at UKZN, Westville Campus. There were seven invited speakers, five South African students and five ordinary participants.

8. International Workshop *Quantum Biology* was arranged by Prof Francesco Petruccione (NITheP, UKZN) and held from 7 to 11 November 2011 at UKZN/NITheP. There were seven invited speakers, 18 students and 12 ordinary participants.

9. International Workshop *Ultracold Molecules* was arranged by Dr Alexander Avdeenkov (NITheP, SU) at STIAS from 7 to 11 November 2011. There were 28 invited speakers, four South African students and six ordinary participants.

10. International Workshop *Computational Modeling with Open Source Physics (OSP) and Easy Java Simulations (EJS)* was arranged by Prof Nithaya Chetty. Prof Wolfgang Christian (Davidson College, USA) and Prof Francisco Esquembre (Univ. Murcia, Spain) presented a workshop on computational modeling at the Physics Department, University of Pretoria, from 4 to 6 July 2011. The workshop, sponsored by NITheP and the UP Physics Department, drew more than 20 participants from universities and research institutions across South Africa.

    Open Source Physics, a facility championed by Prof Christian, enables the open sharing of computational code for curriculum development, computational physics and physics education research. A goal of the project is to make a large number of Java Simulations available for education using the GNU Open Source Model. Easy Java Simulations, developed by Prof Esquembre, makes it possible to utilise this growing computational resource in an environment that does not make it too onerous to use Java. This way, a large community of computational physics teachers and researchers are able to easily integrate computation in an education and research setting.

The participation of local and African students in these training events is summarised in Table 12.

Table12: Student participation in NITheP organised training events in 2011

Event	SA participants	African participants
SCHOOLS		
22nd Chris Engelbrecht Summer School: The Standard Model of Particle Physics and Beyond	23	4
WORKSHOPS		
The Quantum Physics of Low Dimensional Systems and Materials	21	0
Nonlinear Effects in Quantum Electrodynamics	1	0
Relativistic Quantum Information	7	5
Equilibration and Equilibrium	3	2
Nuclear Physics	14	6
Quantum Fields and Cosmological Inflation	0	15
3rd Joburg Workshop on String Theory: String Theory and Higher Spins	14	0
Constructive and Perturbative Aspects of Quantum Field Theory	5	0
Quantum Biology	10	4
Computational Modeling with Open Source Physics (OSP) and Easy Java Simulations (EJS)	17	5
Kruger 2010: Workshop on Discovery Physics at the LHC	13	0
Total	**128**	**41**
Overall total	**169**	

Faculty development

NITheP has embarked on an initiative to engage with faculties and students at more remote centres to enhance the research and training in theoretical physics there. In 2011 the first workshop of this initiative was held.

This was the Mauritius Workshop on *Quantum Fields and Cosmological Inflation,* arranged by Prof Robert de Mello Koch (WITS) (NITheP associate representative). The workshop was held at the University of Mauritius from 6 to 20 June 2011. Two public talks were held during this time. Lectures alternated between Prof Robert de Mello Koch and Prof Sanjaye Ramgoolam. Four faculty members of the University of Mauritius attended, together with one faculty member from the University of Reunion and 15 students from the University of Mauritius.

More workshops are planned for 2012, focusing particularly on South African rural universities.

Teaching and postgraduate supervision

The mandate given to NITheP clearly states an involvement of NITheP staff members in teaching and postgraduate supervision. Table 13 shows the 2011 involvement of NITheP staff in teaching, while Table 14 displays the number of Honours (projects), M.Sc. and Ph.D. students under the supervision of NITheP staff.

Table 13: Teaching (hours) by NITheP staff in 2011

Node	Undergraduate (hours)	Honours (hours)	Advanced (M.Sc./Ph.D.) (hours)	Total
SU	0	126	21	147
UKZN	45	42	0	87
UWC	0	42	0	42
WITS	62	55	0	117
Total	**107**	**265**	**21**	**393**

Table 14: Postgraduate supervision in 2011

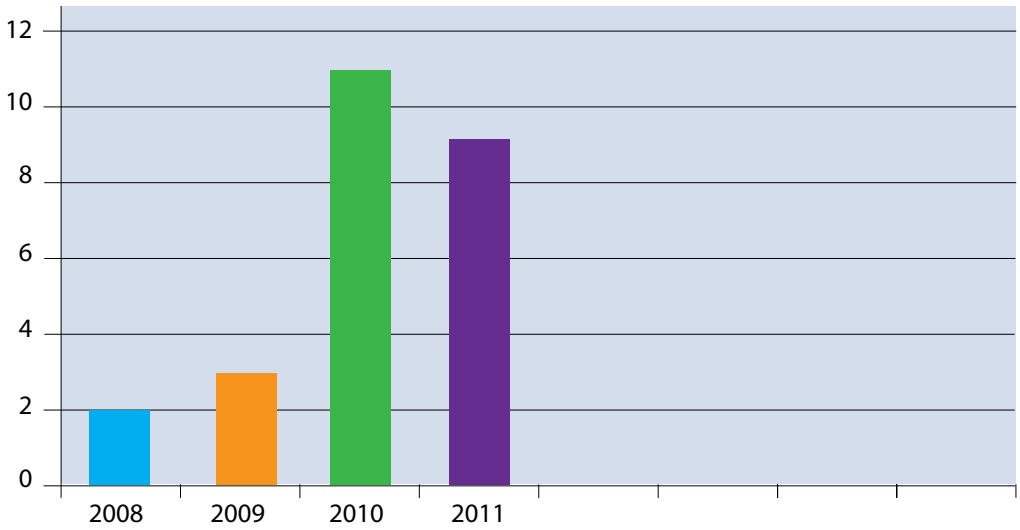
Node	Honours (projects)	M.Sc.	Ph.D.	Total
SU	0	4	0	4
UKZN	2	9	8	19
WITS	3	1	3	7
Total	**5**	**14**	**11**	**30**

The number of M.Sc. and Ph.D. students who were under the supervision of NITheP staff and who graduated in 2011 is displayed in Table 15.

Table 15: M.Sc. and Ph.D. students who graduated in 2011

Node	Students
SU	4
UKZN	1
WITS	4
Total	**9**

Figure 2: Postgraduate students who graduated in the period 2008 to 2011



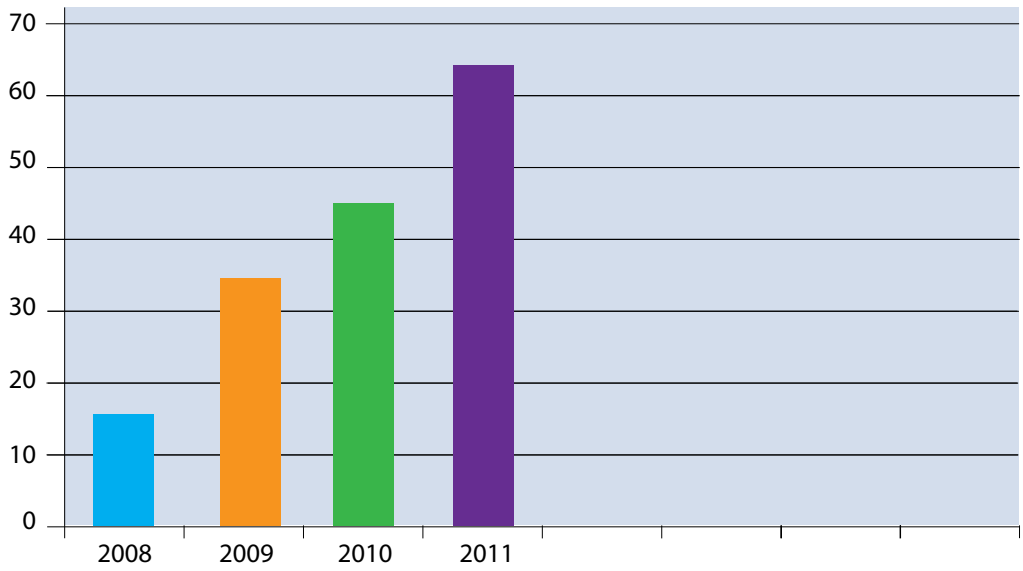
Publications

The publication statistics are shown in Table 16 and Figure 3 summarises the trend for the period 2008 to 2011.

Table 16: 2011 publication statistics per geographical region

Geographical region	Publications
Gauteng	20
KwaZulu-Natal	9
Western Cape	34
Total	**63**

Figure 3: Publication trend for the period 2008 to 2011



List of publications

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3. *Ferromagnetism in Neutron Matter and its Implication for the Neutron Star Equation of State*. Diener, J. P. W.; Scholtz, F. G.; Astrophysics of Neutron Stars 2010, Cesme, Izmir, Turkey, American Institute of Physics 2011: 224-225.

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5. *Non-hermitian Observables in Non-commutative Quantum Mechanics*, F. G. Scholtz, Quantum Physics with Non-hermitian Operators, Max-Planck-Institut für komplexer Systeme, Dresden, 15 to 25 June.

6. *Temporal Evolution of Ultracold Polar Molecules in a Circularly Polarized Microwave Field*. T. Kirova, A. Avdeenkov. The 43rd Congress of the European Group on Atomic Systems (EGAS 43), Fribourg, Switzerland, 28 June to 2 July.

7. *Diverging Equilibration Times in Long-range Quantum Spin Models*, M. Kastner, Workshop on "Equilibration and Equilibrium", Stellenbosch, 8 to 18 March.

8. *Closed Long-range Quantum Spin Systems In and Out of Equilibrium*, M. Kastner, Thematic Programme "Dynamics of Complex Systems", Cergy-Pontoise, Paris, 30 May to 3 June, invited talk.

9. *Diverging Equilibration Times in Long-range Quantum Spin Models*, M. Kastner, SigmaPhi Conference on Statistical Physics, Larnaca (Cyprus), 11 to 15 July.

10. *Diverging Equilibration Times in Closed Long-range Quantum Spin Models*, M. Kastner, Theory Colloquium, Stuttgart, 31 October, invited talk.

11. *Long-range Ferromagnets: Exact Results and Probabilistic Description*, M. Kastner, ZiF-conference "Stochastic Dynamics in Mathematics, Physics and Engineering", Bielefeld (Germany), 2 to 4 November, invited talk.

12. *Diverging Equilibration Times in Closed Long-range Quantum Spin Models*, M. Kastner, Workshop on "Ultracold Molecules", Stellenbosch, 7 to 11 November.

13. *Temporal Evolution of Ultracold Polar Molecules in Circularly Polarized Microwave Field*, T. Kirova and A. V. Avdeenkov, poster presentation, 7th International Workshop "Control of Quantum Dynamics of Atoms, Molecules and Ensembles by Light" (CAMEL 7), 3 to 9 July, Nessebar, Bulgaria.

14. *Temporal Evolution of Ultracold Polar Molecules in Circularly Polarized Microwave Field*, A. V. Avdeenkov and T. Kirova, 43rd meeting of EGAS, 28 June to 2 July, Fribourg, Switzerland.

15. *Interference of Laser-Dressed States in the Autler-Townes Effect*, J. Ulmanis, M. Bruvelis, N. N. Bezuglov, K. Miculis, C. Andreeva, T. Kirova, A. Ekers, I. I. Ryabtsev, poster presentation, 43rd meeting of EGAS, 28 June to 2 July, Fribourg, Switzerland.

16. *Creation of Dark States in the Autler-Townes Spectrum of Na Hyperfine Levels*, T. Kirova, N. N. Bezuglov, A. Ekers, I. I. Ryabtsev, M. Auzinsh, and K. Blushs, poster presentation, 43rd meeting of EGAS, 28 June to 2 July, Fribourg, Switzerland.

17. *Electromagnetically Induced Transparency in an Open V-type Molecular System*, A. Lazoudis, T. Kirova, E. H. Ahmed, P. Qi, J. Huennekens, and A. M. Lyyra, poster presentation, 42nd Meeting of DAMOP, 13 to 17 June, Atlanta, Georgia, USA.

18. *Dynamics of Ultracold Polar Molecules in a Microwave Field*, T. Kirova and A.V. Avdeenkov, poster presentation, 4th IUPAP International Conference on Women in Physics (ICWIP 2011), 5 to 8 April, Stellenbosch, South Africa.

19. *Evolution of Physics in the Extra Dimension*, Lu-Xin Liu, Phenomenology 2011 Symposium, University of Wisconsin at Madison, Madison, USA, 9 to 11 May.

20. *Engineering Inverse Power Law Decoherence of a Qubit,* Francesco Petruccione and Filippo Giraldi, Meeting of the American Physical Society, Dallas, Texas (USA), 23 March. http://bit.ly/R3X1FD

21. *Structured Band Gap Reservoirs for 1/t Decoherence Processes in a Two-level Atom,* Filippo Giraldi and Francesco Petruccione, Camel 7 workshop, Nessebar, Bulgaria, 6 July.

22. *Designing Reservoirs for 1/t Decoherence Process in Jaynes-Cummings Model*, Filippo Giraldi and Francesco Petruccione, SAIP 2011, Pretoria, 14 July. http://bit.ly/UDr3ir

23. *Designing Reservoirs for 1/t Decoherence Process in Jaynes-Cummings Model,* Filippo Giraldi and Francesco Petruccione, Quantum Information Processes, Communication and Controls (QICP^2), Mont Aux Sources Hotel (Northern Drakensberg), 9 December. http://bit.ly/SJ33bA

2011 Financial Statements

The statement of income and expenditure, cash flow and balance sheet for 2011 are reflected here. It is important to note that NITheP's financial year, which runs from 1 January to 31 December, is out of phase with that of its funders, the National Research Foundation and Department of Science and Technology, which runs from 1 April to 31 March. The practical implication of this is that NITheP receives its grants only in June and November of the financial year. For this reason it is important that NITheP ensures a reserve equal to the bursary values (to be paid in the first semester) plus 50% of salaries and running costs is available at the end of the financial year on 31 December. This reserve is reflected in the statements below.

Balance Sheet at 31 December 2011

	2011 R	2010 R
ASSETS		
NON-CURRENT ASSETS	42 368.83	72 397.61
Computers and office equipment	39 326.51	56 056.94
Intangible assets	3 042.32	16 340.67
CURRENT ASSETS	3 897 126.21	7 543 431.48
Other receivables	519 184.57	734 620.23
Petty cash	1 000.00	1 000.00
Stellenbosch University	3 376 941.64	6 807 811.25
TOTAL ASSETS	**3 939 495.04**	**7 615 829.09**
EQUITY AND LIABILITIES		
CAPITAL AND RESERVES	3 898 802.54	7 413 749.63
Accumulated funds	3 898 802.54	7 413 749.63
CURRENT LIABILITIES	40 692.50	202 079.47
Trade and other creditors	40 692.50	202 079.47
TOTAL FUNDS AND LIABILITIES	**3 939 495.04**	**7 615 829.10**

Income Statement for the year ended 31 December 2011

	2011 R	2010 R
INCOME	9 188 586.62	10 995 954.79
Sundry income	87 600.00	-
National Research Foundation grant	8 996 000.00	10 963 000.00
Interest income	-	9 018.95
Contribution from Stellenbosch University	84 928.00	23 626.56
Contribution from the University of the Witwatersrand	19 251.00	-
Exchange rate gain	807.62	309.28
EXPENDITURE	12 703 533.70	12 968 167.59
Advertisements	-	12 807.65
Audit fees	-	166 654.32
Affiliation and registration	611 030.97	850 425.62
Amortisation of intangible assets	13 298.35	13 298.35
Books	95 870.62	-
Bursaries - postgraduate	4 570 097.76	4 462 325.19
Computer materials and software	40 042.79	120 502.26
Conference fees	319 842.15	212 522.56
Consultation	10 000.00	156 299.70
Consumables	13 361.09	13 319.32
Contribution to Stellenbosch University: Cold Molecules Workshop	122 220.00	-
Contribution to Stellenbosch University: NITheP Workshop	150 000.00	-
Contribution to Stellenbosch University: Travel	20 000.00	-
Contribution to workshops	30 000.00	-
Copying and stationery	25 611.48	51 836.23
Depreciation	41 230.23	47 495.98
Entertainment	125 530.82	151 430.35
Furniture and equipment not capitalised	62 768.89	28 770.62
Levies	20 793.22	156 355.94
Marketing and promotions	53 202.88	31 193.32
Office administration	11 583.09	9 631.17
Postage, telephone and fax	134 543.90	80 658.74
Prizes and medals	3 000.00	2 300.00
Rent paid for facilities	212 000.00	212 773.97
Repairs and maintenance	240.15	650.00
Salaries	4 588 540.13	3 917 680.50
Sponsorships and donations	-	5 000.00
Sundry expenses	10 067.02	8 149.90
Translation work	250.00	6 622.40
Travel and accommodation	1 404 625.50	2 249 463.50
SHORTAGE FOR THE YEAR BEFORE TRANSFERS	**(3 514 947.08)**	**(1 972 212.80)**
TRANSFERS BETWEEN NODES	-	-
Transfer to Kwazulu-Natal	(2 351 299.70)	(2 208 748.00)
Transfer to Gauteng	(1 717 514.41)	(1 919 275.40)
Transfers from Stellenbosch	4 068 814.11	4 128 023.40
SHORTAGE FOR THE YEAR	**(3 514 947.08)**	**(1 972 212.80)**

Cash Flow Statement for the year ended 31 December 2011

	2011 R	2010 R
CASH FLOW FROM OPERATING ACTIVITIES		
Shortage for the year	(3 514 947.08)	(1 972 212.80)
Adjustment for:		
Interest received	-	(9 018.95)
Depreciation and amortisation	54 528.58	60 794.33
Operating loss before working capital adjustments	(3 460 418.50)	(1 920 437.42)
Working capital adjustments	54 048.69	(297 240.10)
Increase in trade and other receivables	**215 435.66**	**(420 014.44)**
(Decrease)/increase in trade and other payables	**(161 386.97)**	**122 774.34**
Cash utilised in operations	(3 406 369.81)	(2 217 677.52)
Interest received	-	9 018.95
NET CASH FLOW FROM OPERATING ACTIVITIES	**(3 406 369.81)**	**(2 208 658.57)**
CASH FLOW FROM INVESTMENT ACTIVITIES		
Computers and office equipment purchased	(24 499.80)	(20 490.37)
Decrease in amount owed by Stellenbosch University	3 430 869.61	2 229 148.94
NET CASH FLOW FROM INVESTMENT ACTIVITIES	**3 406 369.81**	**2 208 658.57**
NET INCREASE IN CASH AND CASH EQUIVALENTS	-	-
CASH AND CASH EQUIVALENTS AT THE BEGINNING OF THE YEAR	1 000.00	1 000.00
CASH AND CASH EQUIVALENTS AT THE END OF THE YEAR	**1 000.00**	**1 000.00**