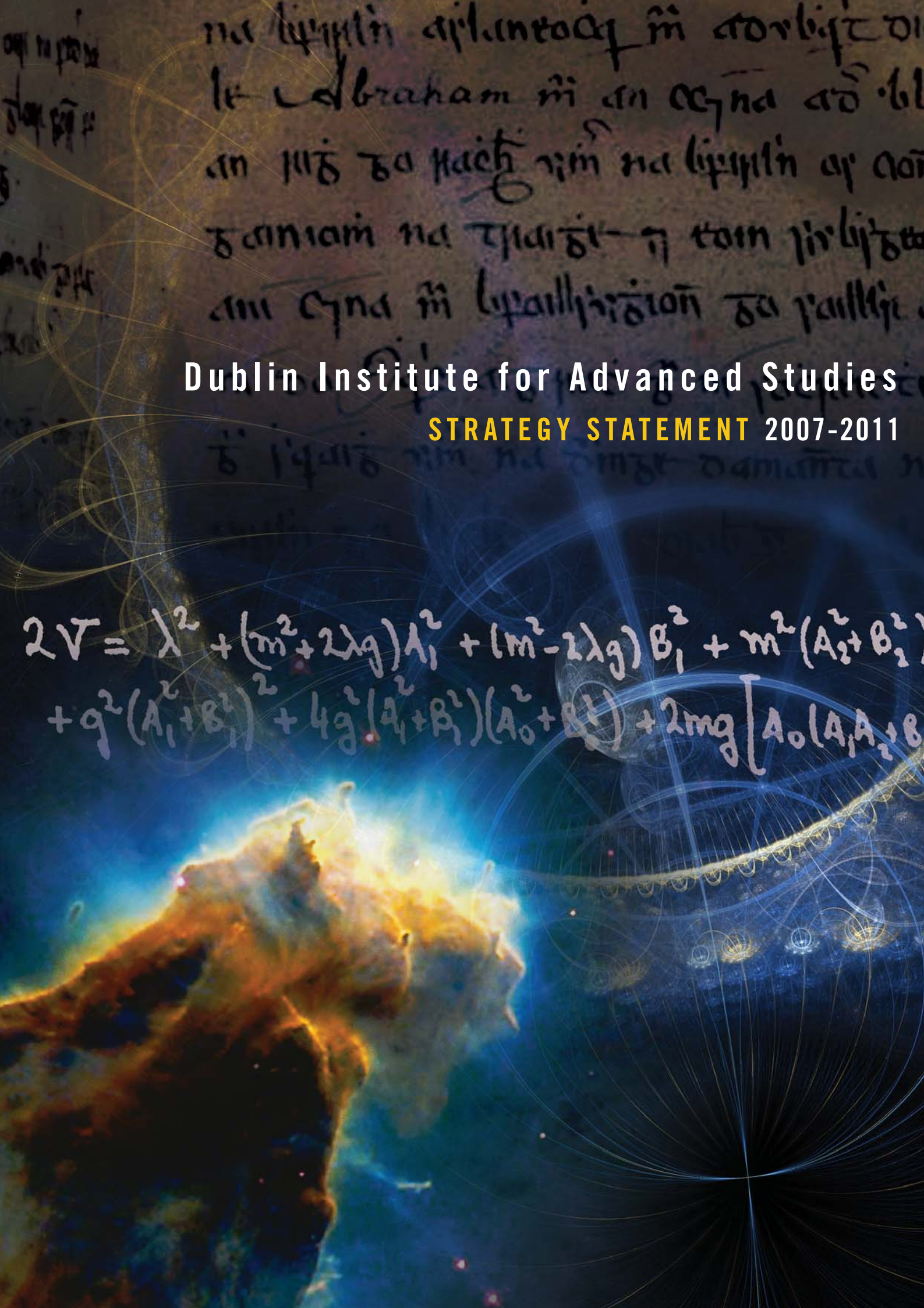
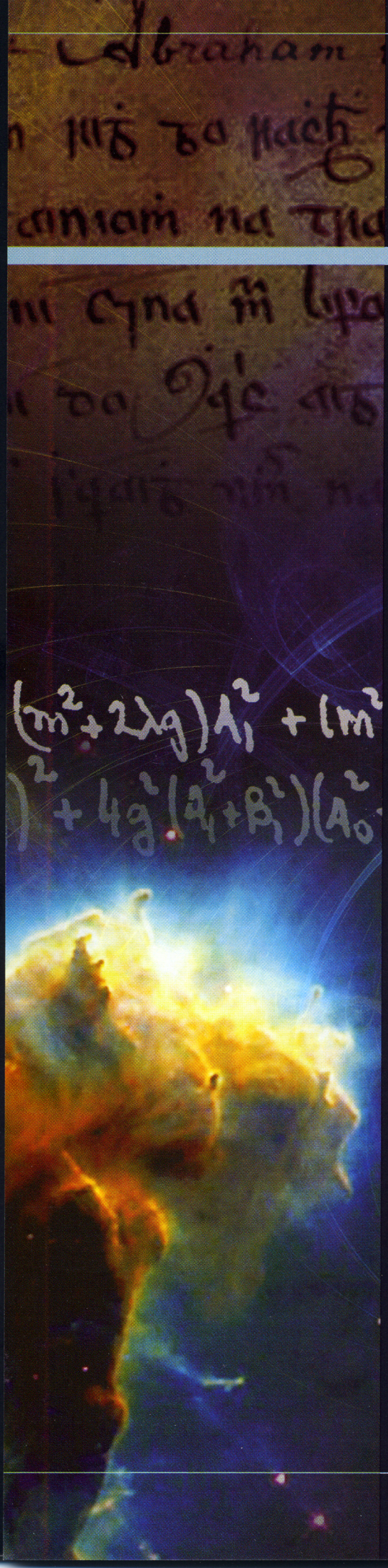
Dublin Institute for Advanced Studies

STRATEGY STATEMENT 2007-2011





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Chairman's Foreword

The development of a strategy of excellence accompanied by a campaign to improve quality at all levels of the innovation system should guarantee Ireland's position as an international front runner. For some years, there has been an awakening in public policy of the vital importance of knowledge as intellectual capital for the development of the country's economy. Scientific advances require outstanding achievements that stand out from the average. The international state-of-the-art is the benchmark for evaluating such achievements. Thus, a focus on excellence is a practical category for evaluating research projects, qualifications levels and research institutes.

This Strategy Statement 2007-2011 puts forward proposals describing the potential of the Dublin Institute for Advanced Studies (DIAS) to contribute to accelerating Ireland's progress towards this knowledge based society. The Institute (DIAS) is aware of the need to promote its competitive advantage and to define structures and procedures to sustain its position and its attractiveness to international scholars and the leading research scientists. To study at the frontiers of knowledge has been the hallmark of DIAS and the Institute is well placed to contribute to the development of basic research in its area of expertise and to the training of specialist scholars in cutting edge research. The ideas from such basic research are crucial for the development of new practical applications although a full realisation of the practical applicability may sometimes be slow to develop. Quantum theory and relativity - two basic applications of mathematics to physics pursued at DIAS - permeate almost every advance in modern science and technology. Their application created industries that fuel our modern economy and have led to a standard of living unimaginable half a century ago.

The Strategy Statement 2007–2011 herein defines the way forward for the Dublin Institute for Advanced Studies. The strategy develops its original mission in a more transparent manner and takes into account the guidelines laid down in the Government programme. It is recognised that there is a need to increase networking with the universities and to assist in the promotion of the DIAS international networks through providing support services for selected postgraduate and doctoral scholars and for post-doctoral fellows. Research at DIAS is becoming increasingly relevant in today's interconnected and technologically advanced world.

Dervilla M X Donnelly
Chairman, Council of the Institute

Executive Summary

The Dublin Institute for Advanced Studies (DIAS) was established to conduct fundamental research in specialised areas of advanced scholarship. These are : Celtic Studies; Theoretical Physics; and Cosmic Physics. As an integral part of its research activities, it also provides :

- training for scholars in advanced research,
- publications in both print and electronic form resulting from its research,
- other support services for selected postgraduate scholars.

This document is the immediate successor to the first strategy statement that was published by the Institute in 2002 and covered the period up to 2006. The purpose of the document is to chart a course for the Institute for the next four years.

Throughout the twentieth century, academic research, both fundamental and applied, has been one of the main driving forces of social and economic progress around the world. In order to maintain its competitive position in what has become a global environment, Ireland must continue to make substantial annual investment in the development of a world-class research infrastructure and of a dynamic research community. For obvious reasons, in Ireland institutes of higher education and research must be the main beneficiaries of the financial investment. As an institute whose main task is to engage in fundamental and applied research, DIAS is well positioned to make a seminal contribution to the national research effort over the next five years.

The Institute, given its statutory position, is *sui generis* among Irish publicly-funded research bodies. For example, the absence of a mandate to teach undergraduate courses differentiates it from Universities. It has, nevertheless, a formal link to the Universities through the structure of its Council, and it cooperates with them in both research and postgraduate studies. Accordingly, it has been successful in forging important and valuable links with outside researchers and in providing a forum within which staff and scholars from universities and research bodies can meet and work together. It is the intention of DIAS that this relationship, which makes a major contribution to the scale and quality of research in Ireland, should be preserved and strengthened.

In order to maintain its status as a world-class Institute, DIAS must at all times dedicate itself to the application of the highest standards of scholarship in its designated fields of research and in its publications. It is required by its founding legislation to operate in the field of advanced studies and it is mainly by its output, in both research publications and provision of trained researchers, that it should be judged. In order to fulfil its role as the only independent Irish Institute for Advanced Studies, working at the cutting edge of science and humanities, it is also important that the Institute achieves the necessary critical mass in its fields of research and provides its researchers with appropriate facilities so that they can undertake their work and reach their highest possible potential.

Complementing its research role, the Institute discharges an important function in the provision of training to specialist scholars in advanced research. It has provided, and will continue to provide, an important contribution to the intellectual life of Ireland. In deciding on the measures, as set out in this strategy, DIAS has taken into account the role that is proposed for the newly-established Graduate Schools in the Universities – see section 5.2. Where appropriate, support will be provided to the Schools. The Institute will also continue to assist scholars who wish to carry out postdoctoral research. This is seen as an important and distinctive part of the work of the Schools. Its role in this area is reflected in the large number of international applications for research positions that are advertised. In addition, the Schools of Celtic Studies and Theoretical Physics plan to reintroduce Summer Schools for selected postgraduate and postdoctoral scholars

who are studying in Ireland and abroad. The School of Cosmic Physics has introduced a series of short-term courses and workshops.

The measures proposed in this strategy statement reflect the on-going commitment of DIAS to safeguard and improve standards of research, scholarship and publications. Measures are also included that will assist the Institute in competing for funding in the global research environment, allow it to attract world-class researchers and provide an infrastructure that offers research staff the opportunity to undertake their work in a suitable environment.

By virtue of its expertise in its specialised areas, DIAS proposes measures that will facilitate its participation in the planning and preparation of national programmes for research. This strategy statement also deals with the changes that are necessary in order to improve the available support services. In view of the increase in the number of Institute staff, and the ever-changing legislation for dealing with staff matters, this functional area will need appropriate resources. Today, more than ever, improved standards of reporting and accountability are demanded and it is necessary that best practice is applied in the manner that DIAS deals with these responsibilities.

To sum up, this strategy statement puts forward a range of proposals describing the potential of DIAS to contribute to accelerating the country's progress towards a knowledge-based society. The programme of activities, including the provision of additional staff, as set out in this document will require the allocation to the Institute of additional public funds in the period immediately ahead. Once-off capital funding is required to deal with the urgent accommodation needs of the Institute and increased funding is also needed to upgrade existing equipment and facilities. Aware of the need to safeguard the reputation of DIAS for caution in the application of resources, a coherent argument is presented to support each cost-increasing proposal contained in the document. The next five years will be a period of defining significance for DIAS as it seeks to establish itself as a major contributor to social, cultural and economic development in Ireland. In implementing the programme set out in this document, DIAS looks forward to working closely with the Department of Education and Science and its other stakeholders.

The presentation of the Hamilton and O'Donovan Scholarships by Dr Garret Fitzgerald on the 13th February 2007.

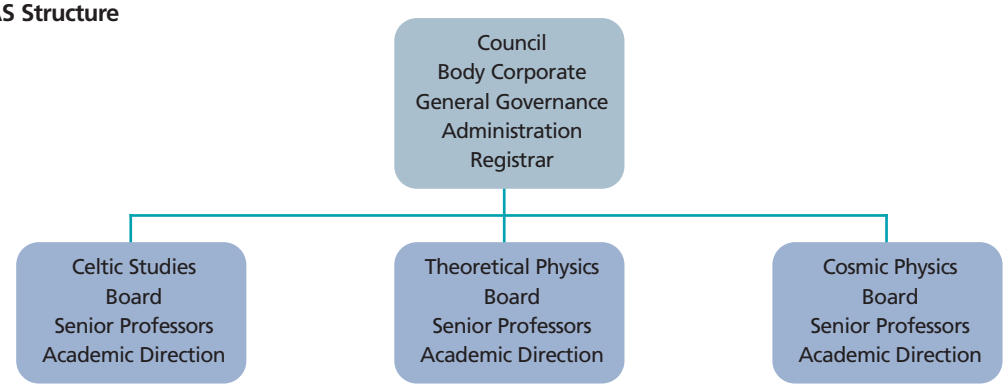
1. Background

Foundation of DIAS

The Dublin Institute for Advanced Studies (DIAS) is a statutory body established in 1940 under the Institute for Advanced Studies Act, 1940. The Institute has three constituent schools - the School of Celtic Studies, the School of Theoretical Physics and the School of Cosmic Physics. The latter School has two sections – Astronomy/Astrophysics and Geophysics. The Central Administration, the School of Celtic Studies and the School of Theoretical Physics are situated at 10 Burlington Road, Dublin 4. The School of Cosmic Physics is located at three premises, at 5 Merrion Square, Dublin 2, at 31 Fitzwilliam Place, Dublin 2 and Dunsink Observatory, Castleknock, Dublin 15.

Each School has an independent Governing Board which is responsible for the research direction of the work of the School.

DIAS Structure



The Council of the Institute, its body corporate, is responsible for the general governance of the Institute, financial and administrative affairs. The Council consists of a Chairman appointed by the President, on the advice of the Government, three ex-officio members, the Provost of Trinity College Dublin, the President of University College Dublin and the President of The Royal Irish Academy, and six members appointed by the Governing Boards of the three Schools.

The Institute operates under the direct control of the Department of Education and Science.

1.1 Dual (Humanities/Science) Structure of DIAS

It is accepted that the three schools within DIAS are grounded in different areas of human thought and experience. However, they have the common purpose of both illuminating the human imagination and fostering an analytical frame of mind crucial to the development of new ways of thinking and imagining.

1.2 DIAS Research Orientation

The structure of the Institute suggests that its founders sought, as a matter of deliberate policy, to achieve a balance between the humanities and the sciences. The location of these two broad areas of learning within a single institute may be assumed to signal the founders' intention that the humanities and the sciences should complement one another, and that the acknowledged importance of the sciences to economic progress should be balanced by the recognition of Ireland's traditional attachment to the humanities.

DIAS has concentrated its research activities on basic research. The ideas from such research are crucial for the development of new practical applications, although a full realisation of the practical applicability may sometimes be slow to develop. Quantum theory and relativity - two basic applications of mathematics to physics pursued at DIAS - permeate almost every advance in modern science and technology. Their application created industries that fuel our modern economy and have led to a standard of living unimaginable half a century ago.

Research at DIAS is becoming increasingly relevant in today's interconnected and technologically advanced world. For example, in theoretical science, the mutual interaction between Mathematics and Physics is flourishing like never before. Mathematical concepts and analysis is nowadays particularly important in understanding and developing physical theories, and at the same time, ideas from Physics have stimulated many new developments in modern Mathematics. Work at the School of Theoretical Physics has contributed to several of these developments. Indeed, the founding fathers of the Institute showed great foresight in formulating the mission of the School of Theoretical Physics as: "The investigation of the mathematical principles of natural philosophy and the application of these principles to the physical and chemical group of sciences and to geophysics and cosmology". There is no better time to foster this exciting atmosphere and to build on the proliferation of recent progress by strengthening the core scientific mission of DIAS and hence the position of Irish theoretical science.

Some researchers at DIAS have used their theoretical advances to invent specific practical applications. In one case, a Director left the Institute to found a highly successful technology company. This illustrates that the common ground linking basic research with its practical application is a single basic principal: total commitment and focus on quality and excellence. DIAS will foster increased interaction between its researchers and those who lead high-technology industries in Ireland.

1.3 DIAS : Tradition of Scholarship and Collaboration

1.3.1 Scholarship

DIAS was fortunate in its early years to attract scholars of acknowledged excellence so that the Institute quickly acquired an international reputation for intellectual rigour that has continued to characterise its work through the generations. Publications in high-quality refereed journals, the provision of highly trained researchers, as well as presentations at national and international conferences, meetings and seminars, are an essential element of research activity, and ultimately the most reliable and enduring contribution the research at the Institute makes to the development of Irish society. In Celtic Studies an impressive reference library has been built up and it continues to expand. But DIAS has made other, no less enduring, contributions to Ireland's standing as an important centre of scholarship. Chief among these must be considered the Institute's commitment to the training of talented scholars in the methods of advanced research in order to create new scientific and cultural knowledge. Former scholars of DIAS have made, and continue to make, an acknowledged contribution to the advancement of society, with some having distinguished themselves in fields that are far removed from their original areas of specialisation. DIAS is determined that this influence should grow and develop through measures proposed in this strategy statement.

In looking to the future DIAS will establish the required critical mass in each of its constituent Schools. In so doing it will refer to the recommendations, as set out in the Irish Universities Quality Assurance initiative based on EU guidelines.

1.3.2 Collaboration

DIAS has a long tradition of research collaboration with other research bodies and institutions.

The School of Celtic Studies has received wide recognition for its Irish Script on Screen (ISOS) project, the success of

which is based on the voluntary participation by Irish Universities and other institutions in which Irish manuscript holdings are located. The project has made a large number of manuscripts available on the World Wide Web and as a result many scholars of Celtic Studies all over the world can now gain electronic access to this new resource.

In the School of Cosmic Physics, staff within the school lead a major Information Technology project funded under the Programme for Research in Third Level Institutions (PRTLI - 3). The project – Cosmogrid - involves collaboration with four Irish Universities and a number of other research institutions and organisations, including Met Éireann and Armagh Observatory. The project aims to study natural phenomena occurring in the cosmos using a powerful computer grid - hence its abbreviated title 'Cosmogrid'. These natural phenomena range from earthquakes to climate change to star formation. The new grid technology is being used to facilitate large-scale, data-intensive computation and analysis thereby enabling the scientists involved in the project to research and model more effectively the complex systems that exist in our universe.

In the School of Theoretical Physics an annual lecture series in honour of the late Prof. John Lewis was set up in collaboration with the Hamilton Mathematics Institute of Trinity College, and the Ó Raifeartaigh lecture will be given at the Annual Irish Quantum Field Theory Conference. The School also collaborated in organising a mathematics conference in honour of the late Prof. John Lewis at the Dublin Institute of Technology in 2005. The School is currently involved in organising a further conference on Quantum Computing that will take place later in 2007.

1.4 DIAS Standing within the Academic Community

There is statutory provision for the representation of University College Dublin (UCD), Trinity College Dublin (TCD) and the Royal Irish Academy (RIA) on the Council of the Institute. By tradition the Boards of the Constituent Schools have always had representation from the national and international academic community. These structural arrangements facilitate international collaboration and enhance the opportunities for joint research projects. Moreover, the academic staff of DIAS has numerous informal contacts with individual academics in Ireland and abroad that ensures a regular flow of information between the Institute and the broader network of higher education institutions.

The standing of DIAS within the international community can be seen in the level of applications that are received for academic vacancies. The majority of applicants come from outside Ireland and this has helped create a unique atmosphere within DIAS where scholars from all over the world are working together for a common purpose.

It should also be noted that DIAS has always been strongly committed to the support of post-graduate and post-doctoral scholars. This has been normally provided through seminars, short courses, workshops and summer schools. DIAS will expand this aspect of its activities over the next four years.

1.5 DIAS Its Contribution to the National Research Effort, the economy and industry

Advanced knowledge has great economic value, as has been confirmed in numerous studies over the past 25 years. This economic value is not just in the form of new knowledge and information generated, which may be useful for the development of new or improved products, but also, and perhaps even more importantly, in the form of tacit knowledge, training in methodologies and problem-solving skills. This latter "embeddedness model" for basic research is particularly important for the economic well-being of developed countries. The Institute concentrates on fundamental research as opposed to directly applicable research. However, it is nowadays well understood that fundamental research is essential for maintaining the necessary knowledge base from which useful applications can be derived. It might be

thought that a small country like Ireland need not spend resources on fundamental research. Basic research can be left to others and the results imported. This argument is false. Investigative skills cannot be acquired without true understanding of basic laws based on a hands-on experience of research. It is in this regard that the apprenticeship system of the Institute is particularly valuable and effective.

The research work of DIAS, in addition to its contribution to knowledge:

- provides links with other international research institutions and facilities,
- trains research personnel and generates new research skills and problem solving abilities at the highest level,
- raises the scientific profile of Ireland internationally.

It is widely acknowledged that original research, carried out in Ireland and in particular within DIAS, has made a major contribution to the rapid social and economic progress achieved by the country over the past decade. As an acknowledgement of its confidence in the capacity of indigenous researchers, the Government has, in recent years, approved the allocation of substantial amounts of public funding to basic and applied research. This funding is made available to institutes of higher education and research, either directly in their annual grants or indirectly through a number of agencies that the government has established in recent years, such as The Programme for Research in Third Level Institutes (PRTLI), Science Foundation Ireland (SFI), Irish Research Council for Research in the Humanities and Social Sciences (IRCHSS), Irish Research Council for Science, Engineering and Technology (IRCSET), The Health Research Board (HRB), Enterprise Ireland and others. The EU remains a further important source of research funding.

In the National Development Plan 2000-2006, the Government clearly signalled the need for an even greater contribution from indigenous research if the country is to improve its competitive position in what has become a global research environment. DIAS believes that, within its fields of competence, it has made a major contribution to the national research effort. The Government proposals for research, as outlined in the recent Strategy for Science, Technology and Innovation 2006-2013, provide further opportunities to enable DIAS to build on the contribution already made. DIAS will participate fully in the relevant Government Funded Programmes.

The contribution that DIAS has already made to Irish industry is referred to elsewhere in this document. There remain many opportunities for DIAS to develop its connectivity with industry within the term of this plan and beyond. It will continue to provide highly trained researchers to industry and will explore other possible options in the sector, such as examining the connection between quantum field theory and statistics where there exists potential spin-off for financial management.

DIAS will publicise its contribution to research and industry, both at national and international level, and steps will be taken to deal with any information deficit that may currently exist.

2. Influencing Factors

2.1 External Review

One of the measures proposed in the 2002 strategy statement was that the research work of DIAS's three Schools be reviewed by separate panels of international experts. The proposal was adopted and the reviews of each School were carried out during 2004. This procedure has similarities to exercises carried out in other countries, e.g., the Research Assessment Exercise in Britain.

Following the reviews, each panel submitted a report to the Council of the Institute which it considered at its meeting in November, 2004. The Governing Board of each School also discussed them. The reports, which commented favourably on the research activities of the Schools, also contained a number of recommendations. Since 2004, the Council of the Institute has worked with the School Boards and administration to implement the recommendations that were made by the external panels.

The overall impression made by the reports is of a vibrant and respected Institute which can look to the future with considerable confidence. They pointed to a need to employ additional research staff together with the necessary enhanced administrative support. They also recommended that the Institute's accommodation difficulties should be addressed. Although there has been much progress, not all of the recommendations have been implemented.

2.2 External Environment

In setting out the future vision for DIAS, its statutory responsibilities must remain central to its activities. However, it must recognise that there has been a fundamental change in the research environment in Ireland in recent years. The effects of this change can be seen in both the significant increase in funding and the establishment of new structures for basic and applied research. Research institutions and universities are currently radically restructuring and repositioning themselves to deal with this new landscape.

The strategies adopted by DIAS should reflect not only its statutory responsibilities but also the intention of full participation in appropriate national policies, priorities and funding programmes. In this manner, DIAS will expand its own research capability and provide opportunities for its research staff to engage in collaborative projects with Irish Universities and other research organisations. It will participate in research programmes that are funded by agencies or bodies outside Ireland, thereby allowing existing international collaborations to flourish and new arrangements to be established. Participation in both nationally and internationally funded schemes will be an integral part of the future development and enlargement of DIAS.

3. Mission, Vision and Values

3.1 Mission

The Dublin Institute for Advanced Studies was founded in 1940 by an Act of the Oireachtas - the "Institute for Advanced Studies Act 1940" - to establish Ireland's position in two areas of advanced scholarship, namely Celtic Studies and Theoretical Physics. In 1947 a third area - Cosmic Physics - was added. The Institute's mission is :

- to conduct fundamental research to the highest international standards in its areas of expertise, and
- to train talented scholars in advanced research.

As part of its mission the Institute has also traditionally provided seminars and discussion groups for selected graduate and doctoral scholars and for postgraduate fellows, and has informed the public through its outreach programme.

3.2 Vision

In carrying out its mission DIAS will :

- continue to develop and expand as a recognised world-class research centre in its areas of expertise,
- recruit the leading researchers in its specialist fields,
- maintain the highest standards of research and scholarship,
- apply best practice in its dealings with its scholars and staff,
- provide appropriate support for national research strategies,
- play an important role in shaping the direction of research in Ireland,
- provide value for money for its stakeholders.

3.3 Values

Among the values embraced by DIAS are the following :

- excellence and innovation,
- freedom in the pursuit of research,
- transparency and openness.

4. Strategic Aims for the Period under Review

The Institute has identified the following strategic aims for its activities over the period covered by the strategy statement.

4.1 Research and Training

- Enhance DIAS' position as the leading contributor to basic research in its areas of expertise and to the training of specialist scholars in cutting edge research,
- Expand national and international collaborative research arrangements,
- Develop the role of DIAS in shaping national research structures and policies,
- Expand scholarly publication.

4.2 Support for Post Graduate and Post Doctoral Scholars

- Provide support services for selected post graduate and doctoral scholars and for post doctoral fellows.

4.3 Support Structures

- Provide additional resources to enhance the support areas of Administration, Finance, Outreach and HR.

5. Proposed Programme of Activities

The programme of activities to be undertaken by each Constituent School is classified by each strategic aim.

5.1 Research and Training.

Enhance the position of DIAS as the leading contributor to basic research in its areas of expertise and to the training of specialist scholars in cutting edge research.

5.1.1 (a) Research

It is critical that DIAS maintains and enhances its position as an acknowledged world-class research centre in its specialist areas. To do so, it must ensure that a culture of excellence applies in regard to its research work and scholarship. It must continue to attract leading scholars from around the world. It must also be aware of today's competitive research environment and be ready to adapt accordingly. Other factors, both internal and external, will also influence strategies that will be followed by DIAS. These include, the national funding policy for basic research, research programmes of the schools, the quality of the Institute's infrastructure, available resources and the need to increase its staffing levels in order to achieve and maintain the necessary critical mass.

The findings of the 2004 research review panels, together with current staffing, DIAS structures and national proposals for the funding of research, enables DIAS to plan for the future with optimism.

Measure : DIAS will continue to have the research work of each school reviewed by separate panels of international experts every five years. The reports issued following the reviews will be published on the Institute's website. This process supports the ongoing work of the Schools' Governing Boards, one of whose primary functions is to oversee the research work of the schools.

DIAS will implement, where possible, the recommendations of the review panels,

DIAS will establish the necessary critical mass of researchers in its areas of expertise,

DIAS will seek to recruit the leading researchers in its specialist fields and will continue to operate a rigorous and transparent policy in the appointment of staff,

DIAS will vigorously continue its efforts to collocate the three schools and administration in a single building on a suitable site. This will reflect the ethos of DIAS as a modern and vibrant institution that provides the best facilities for its staff,

DIAS will embrace and take advantage of the priorities set out in national and international policy documents e.g. National Development Plan and EU Framework 7.

5.1.1 (b) Training of Scholars

One of the other important roles of the Institute is the training of specialist scholars in the conduct of cutting edge research. DIAS must continue to attract exceptional scholars from both Ireland and abroad, who wish to develop their research skills.

Scholars who have studied and trained at DIAS subsequently take up careers in both academic life and industry. For example, virtually every faculty of Celtic Studies in Ireland and further afield has among its staff, a past scholar of the Institute. Other former scholars hold senior academic posts abroad, whilst an increasing number are finding positions in industry and finance.

Measure: Scholars in DIAS will participate in an enhanced training and support programme. The current system of mentoring will be enhanced so that all scholars have the opportunity to develop their skills with the full support of the Institute. On completion of their period of training with DIAS, these scholars will rank among the best available in their fields.

DIAS will establish an Alumni programme that will enhance existing channels of communication and mutual support.

5.1.2 Expand national and international collaborative research arrangements.

As mentioned earlier, a considerable network of contacts has evolved over the years between DIAS and other researchers and institutions. This is indeed the very nature of basic research, which is international in character. Collaborative arrangements are now more important than ever as research institutes do not want to utilise scarce resources in replicating facilities. Since its foundation, DIAS has been part of many successful national and international networks. At present, both the Science Schools and the School of Celtic Studies are successfully participating in a number of collaborative projects.

A number of formal arrangements have also been agreed between DIAS and other research organisations both in Ireland and abroad including The National University of Ireland, Galway (NUI,G), University of Barcelona and GeoForschungsZentrum Potsdam, Germany. It is important that DIAS develops formal arrangements for research collaboration with appropriate institutions.

Measure : Symposia, short courses and workshops, conferences and Summer Schools will be organised and video links established.

Further reciprocal arrangements will be put in place so that research staff at DIAS can share in the facilities that are available at other research institutions in Ireland and abroad. It will also allow scholars and other research staff from these institutions to come to DIAS and be part of its research effort.

5.1.3 Develop the role of DIAS in shaping national research structures

DIAS staff are already playing an important role in the development of the emerging Irish research structures and policy through its representation on key committees and working groups. In many instances this has been based on individual contacts and influence, rather than in a structured manner. This practice needs to change. Given its pivotal role in the Irish research community, DIAS will endeavour to expand its input into the development of national research strategies and will establish, on a more formal basis, its representation on relevant committees or bodies dealing with research issues. DIAS should be one of the natural sources of information to which the Government (and industry) refer when discussions take place in the areas where the Institute has acknowledged expertise.

Measure: DIAS will seek to have formal representation on appropriate strategic committees that deal with policy and funding as well as continued informal input into the structure of research education.

5.1.4 Expand scholarly publications

The high standard of research and published work, for which DIAS has an international reputation, will be maintained and developed further into new areas. Specific research projects are set out in the sections dealing with the research plans of the individual Schools.

Publications in high-quality refereed journals, as well as presentations at national and international conferences, meetings and seminars, are an essential element of research activity, and are ultimately the most reliable and enduring contribution by DIAS to the development of Irish society.

DIAS emphasises to its researchers the importance of frequent publication of articles in appropriate publications as a means to raise its national and international profile.

Measure: DIAS will provide resources and encourage staff to publish the results of their research in a timely manner.

DIAS will exploit all opportunities, including the use of electronic publications, to disseminate its work.

5.2 Continued Support for Post-Graduate/Doctoral Scholars

A major attraction for staff working at DIAS is the fact that they can combine their research commitments with providing support to post-graduate and post-doctoral students. This allows staff to give specialist courses for scholars and others without compromising their core function, conducting basic research.

DIAS welcomes the discussions that are taking place in regard to the formation of Graduate Schools in Universities. Given its present role and experience as a trainer of specialist scholars DIAS will play an important part in assisting Government to achieve its target of doubling the number of PhD scholars in Ireland. In addition, the Institute will continue with its policy of providing assistance to postdoctoral researchers. Although this activity requires a limited formal teaching element, it does require significant supervisory input from the established research staff of DIAS in giving practical training and support to the scholars.

These will be very valuable (and cost-effective) contributions to Ireland's development and standing.

Measure : DIAS will continue to participate in the discussions on how it can play its part in delivering on the proposal of Government to double the number of PhD scholars by 2013,

DIAS will continue to develop programmes for assisting postdoctoral scholars in how to conduct cutting edge research.

5.3 Support Structures

5.3.1 Finance

Exploit all resourcing opportunities

Details of the Institute's annual grant-in-aid are set out in Chapter 7. The level of aid so provided is based primarily on historical staffing levels and in recent years any increases in the level of the basic grant have only matched changes in inflation, at best.

In addition to the work undertaken with the resources provided through the grant-in-aid, the Institute has collaborated on many projects with other similar national and international research organisations. It was mainly through collaboration and participation in externally funded programmes that DIAS could expand its research base. However, it will seek through this Strategy Statement to have additional Government Funded research positions funded in the Institute. Set out in Section 7.3 are the external resources generated by DIAS over the last ten years. Significant efforts are made each year to participate in relevant national and international research collaborations and funding programmes, and this will continue.

On a more limited and selective basis, DIAS has also undertaken projects with industrial partners.

DIAS fully supports the principle of augmenting the resources that are available through the grant from public funds. It will continue to seek collaboration with fellow researchers and to apply for funds from relevant support programmes. However, it does not wish to compromise its commitment to carrying out fundamental research by over-reliance on external funding.

Measures : DIAS will seek additional Exchequer Funds in order to meet the pay and non-pay costs that arise in regard to the additional staffing sought in this Strategy Statement. It will also continue with the annual and multi-annual budgetary process as operated by the Department of Education and Science. At present this provides an annual grant to meet the pay and recurring non-pay costs of DIAS. The requirement to incur on an annual basis significant capital expenditure demands the provision of a capital budget. This would be in addition to the current pay and non-pay allocations and would allow DIAS to plan its capital expenditure on a more rational basis.

DIAS will participate in appropriate collaborations with other institutions and will apply for funding that is available from other national and international research programmes. Additional resources will be set aside to ensure that the participation of DIAS in both nationally and internationally funded programmes is successful.

DIAS will actively pursue the possibilities of endowments from private sector donors and foundations. It is proposed that this will be established as part of the work undertaken by a group to be called "Friends of the Institute".

5.3.2 Administration

The relationship between the Council of DIAS and the Governing Boards of the Constituent Schools is well defined in the relevant Act and has worked well in recent years. This is due, in no small measure, to the pragmatic approach of the Chairpersons of Council and of the School Boards. The harmonious modus operandi that has emerged is a major source of strength and encouragement to DIAS and must be continued. The role and support of both Council and the Governing Boards of the Schools is critical to the successful implementation of the strategies outlined in this statement.

There are increasing reporting, compliance and accounting responsibilities for all organisations both within and outside the Public Service. These follow changes in labour legislation, financial reporting and other statutory obligations, such as the Official Languages Act and the Freedom of Information Act. The Institute must apply best practice in the manner in which it deals with these emerging and ever-changing requirements. It is important that the required information is available on a timely, accurate and comprehensive basis so that informed decisions can be made.

It is also important that DIAS maintains a good working relationship with all Government Departments, especially the Department of Education and Science.

Measures : DIAS, through both its statutory and in-house structures, will review the manner in which it adopts best practice in regard to administration. This will be supported by the appointment of external experts who will advise on specialist issues. Recommendations to improve the administrative procedures will be adopted and implemented, where possible,

DIAS management will meet, on a regular basis, those to whom it reports. This will involve both internal and external stakeholders and will facilitate the resolution of any reporting difficulties that arise.

5.3.3 Staff Development

The successful implementation of the strategies set out for the next four years will depend on a number of factors. Foremost amongst these will be the commitment and support of the staff of DIAS. It is important that there is in place a structure that recognises and supports its most important asset, its staff. The support of its staff and the support of the staff for this strategy statement will together help define to a significant extent how successful DIAS is in achieving its aims.

Measures : DIAS will

- *Provide systems that will allow staff to reach their full potential.*
- *Provide the required level of support for staff to deal with their welfare and training.*
- *Provide the optimum career structure for its staff, within the constraints of its size.*
- *Provide clear guidelines for the employment of staff and internal structures for dealing with all staff issues.*

5.3.4 Increased public awareness of DIAS including the development of the DIAS brand

In recent years there has been a significant improvement in the level of exposure given to the three Schools of DIAS in the national press, radio and television. Nevertheless its stakeholders, who include taxpayers, researchers, policy makers, industrialists and legislators are only aware of a small segment of the work and successes of DIAS. As a result, the work of the research staff does not achieve the appropriate public profile, especially within in Ireland. This public information deficit will be addressed as part of this Strategy Statement.

Measures : Increased efforts will be made to bring public events that are organised or supported by DIAS to the attention of the wider public. It will seek to develop Dunsink Observatory into a more professional centre for public awareness of science,

DIAS will continue to develop its successful dialogue with Science and Humanities correspondents of national newspapers. Increased contacts with the electronic media will also be sought,

At the beginning of the period to which this document refers, DIAS will issue a statement summarising and explaining, in a publicly accessible way, its main projected activities,

DIAS will establish its own unique logo. This logo, which will be used by each of the three schools, will reflect the ethos of the organisation and will be identifiable with DIAS. It will be used in all correspondence, press releases, radio or television commentaries, advertising, television programmes etc.,

Improved signposting of DIAS properties will be undertaken.

6. Resource Implications

The implementation of the above programme has clear resource implications in a number of areas. It is arguable that DIAS has not maintained its baseline resource position relative to other research institutes, particularly in view of the greatly enhanced allocation of public resources to research in recent years. A review of existing staffing indicates that the present level is not adequate to meet the research plans of the three Schools over the period of this Strategy Statement and to meet the administrative requirements of the Institute. Accordingly, DIAS will seek an increase in its resources, including the sanctioning of new posts, in order to implement the programmes set out in this strategy statement.

6.1 Capital Funding

6.1. (a) Accommodation

The accommodation problems of DIAS are a matter of ongoing concern. It is clear from the 2004 reports of the Review Panels and the findings of our internal reviews that the work of DIAS is hampered by the lack of suitable accommodation. In order to address the problem DIAS carried out a detailed review of its needs and will shortly present a proposal to Government so that its three constituent Schools and Administration can be collocated on a single site.

6.1 (b) Capital Grant

At present, the purchase and replacement of equipment must be funded from the grant that is provided for routine non-pay expenditure. Recent efforts to appoint academic staff at a senior level have highlighted the requirement for DIAS to be able to offer to incoming senior staff the required technical resources so that they can immediately commence their research at the appropriate level. Its inability to give commitments to potential appointees for specific capital funding makes it very difficult to persuade top candidates to accept offers of positions.

DIAS requires an annual allocation to meet capital expenditure on equipment for both the Schools and Administration. The provision of a capital grant will allow it to profile its capital expenditure and allow for the replacement of assets on a planned basis and provide a solution to the recurring problem referred to above.

6.2 Staffing

Two main issues arise: an increase in existing staffing levels and an acceleration of the appointment procedures. Set out below is the required increase in staff numbers and the associated salary costs. Additional allocations will also be necessary to meet the non-pay costs for the proposed new staff.

6.2.1 New Posts

The following table sets out the additional staff required to meet the plans as set out above:

Post	Celtic Studies	Cosmic Physics	Theoretical Physics	Administration
Senior Professor	1	1	3	
Professor		2		
Fellow	2	4	6	
IT Manager		1		
Admin. Staff				4
Sub – Total	3	8	9	4
Associated Cost €'000	281	636	845	220

6.2.2 Acceleration of Appointment Procedures

The existing appointment procedures can operate so that delays of up to twelve months occurs between approval in principle and actual appointment to posts, particularly at senior levels. (It is appreciated that the Department of Finance has an acknowledged role in the matter of appointments to the Public Service.) An agreement should be worked out between DES and DIAS on a time limit for each stage of the appointment process with a view to reducing the overall delay for senior appointments.

6.3 Expanded Visitor Programme

A review of the visitor programme is overdue. It appears to the staff of the schools and to the members of the Review Panels that the visitor programme is a valuable and economic means of increasing the schools' range of activities with consequent beneficial effects on their international reputation and research output. Existing levels and methods of funding visitors will be reviewed and new protocols developed with collaborating institutions and the Department of Education and Science.

6.4 Sources of Income

It is estimated that the full implementation of the work proposed in this document will require an increase of circa 31% in the annual pay costs. A further increase of approx. 30% in the annual non-pay grant is also required. In addition, DIAS will seek the allocation of an annual capital grant. This will vary with the level of activity taking place. The current annual capital funding that is required amounts to €0.5m. The present estimated capital costs associated with the provision of a single site are estimated to be in the region of €30m. At present the majority of that income comes from funds voted annually by the Oireachtas to the Department of Education and Science. Table 1 shows the contribution by funding source (DES, other) to the annual income of DIAS from 1996 to 2006.

While there can be little doubt that DIAS will continue to rely mainly on public funding, the Council in consultation with the School Boards will explore over the next four years the possibility of increasing even further the amount of annual income from other sources. DIAS gratefully acknowledges the support of its existing sponsors and expresses the hope that they will continue and, if possible, increase the level of their support.

7. Structure, Staffing and Funding of the Institute

7.1 Structure

DIAS consists of three Constituent Schools, each reporting to its own Governing Board in respect of its work programme. The Boards report to the Council, which is the overall Governing Authority. DIAS reports directly to the Department of Education and Science. Council consists of a Chairman, appointed by the President on the advice of Government, three ex-officio members, the Provost of Trinity College Dublin, the President of University College Dublin and the President of The Royal Irish Academy, and six members appointed by the Governing Boards of the three Schools.

7.2 Staffing

The staffing of the Institute, at the end of August 2007 can be summarised as follows:

Staff Exchequer Funded *Schools*	Celtic Studies	Cosmic Physics	Theoretical Physics	Administration
Senior Professors	3	3	3	
Professors	2	3		
Assistant Professors	3	2		
Fellows	2	4	3	
Research Assistants	1			
Experimental Officers		2		
Scholars	4	6	4	
Technicians		9	1	
Other	5	4	2	
Administration				
Registrar				1
Admin. + HR				2
Finance				4
Other				11
Total Exchequer 84	*20*	*33*	*13*	*18*
Non – Exchequer Funded				
IRCSET			5	
PRTLI		9		
SFI		4	2	
Others		7	2	
Total Non –Exchequer 29		*20*	*9*	
Overall Total 113	**20**	**53**	**22**	**18**

The above relates to the positions as at August 2007.

7.3 Funding

At present the majority of DIAS funding comes from moneys voted by the Oireachtas to the Department of Education and Science. Set out below are details of the Institute's annual Exchequer Grant and other income for the period 1995-2006.

Year	Exchequer Grant	Other Income	Total
	€	€	€
1996	3,657,000	930,000	4,587,000
1997	3,744,000	592,000	4,336,000
1998	3,840,000	499,000	4,339,000
1999	4,236,000	585,000	4,821,000
2000	4,531,000	755,000	5,286,000
2001	4,065,000	382,000	4,447,000
2002	4,336,000	787,000	5,123,000
2003	5,656,000	963,000	6,619,000
2004	6,159,000	2,866,000	9,025,000
2005	6,578,000	2,589,000	9,167,000
2006	6,952,000	3,250,000	10,202,000
	53,754,000	**14,198,000**	**67,952,000**

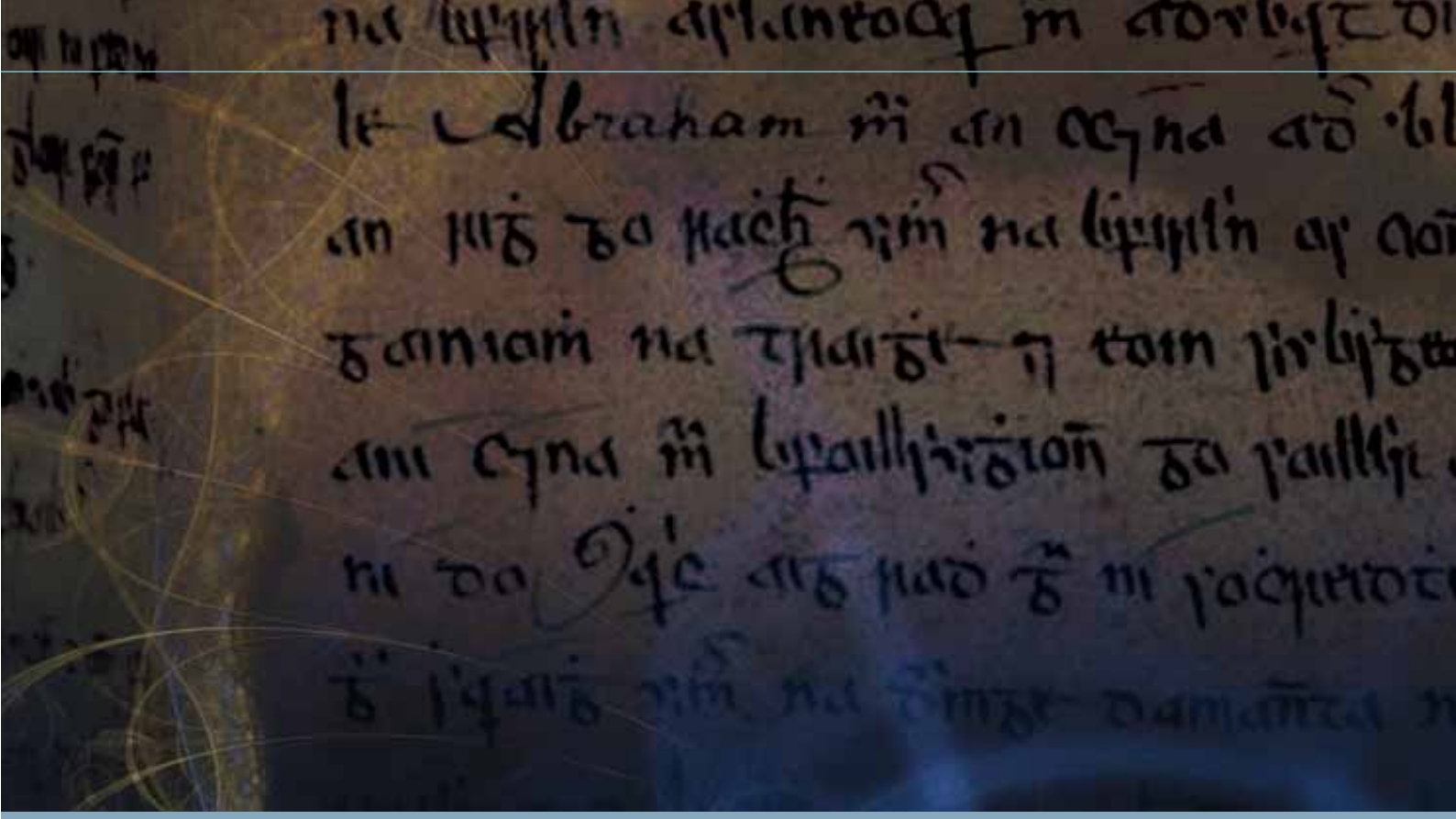
8. Functions of Constituent Schools

The functions of the individual schools may be briefly summarised as follows:

1. The School of Celtic Studies (SCS) has a symbolic as well as a practical role given the pivotal position of Irish in the world of Celtic languages and literatures. The School also has an important role in intellectual leadership. The School's contribution to the corpus of research publications in its areas of expertise is widely acknowledged.

2. The School of Theoretical Physics (STP) concentrates on its core tasks of carrying out and publishing original research into the mathematical principles of physics and on training talented postgraduate scholars in research methodologies. The School has a fundamental contribution to make at a time when Ireland is trying to transform itself into an innovation-driven society and at a time of eminent advances in this area of research.

3. The School of Cosmic Physics (SCP) has, at present, two main sections: geophysics and astrophysics/astronomy. It proposes during the period covered by this strategy statement to introduce a third section dealing with computational cosmic physics.



CELTIC STUDIES

Strategy Statement for the School of Celtic Studies

1. Staff

The core staff form the basis of the DIAS School of Celtic Studies (SCS) research teams, and will continue to develop proposals for collaborative projects, and engage in outreach in Ireland and internationally.

2. Publications

SCS has played and will continue to play a leading international role as publisher of specialist scholarly works in medieval and modern language, literary, legal and historical studies. In addition to the journal *Celtica*, an extensive list of books, produced by members of SCS and of other institutions, covers spoken and written Irish in all its stages, law, history and literature, the other Celtic languages and Hiberno-Latin. The publishing function is overseen by the Publications Committee, comprising all permanent members of staff, under the chairmanship of Professor Fergus Kelly, and a Board Member.

A peer-review system applies to all publications, with every potential publication read by at least two external referees. Once the essential worth of a work has been recognised, SCS adopts the role of nurturer, with individual members of staff making important contributions to improving the quality of each book – an example of the kind of collaborative research at which SCS excels, and whose worth is attested by the reception and lasting value of its finished products. The fact that all stages of publication, except printing and binding, are conducted in-house facilitates close involvement with and mentoring of authors throughout.

Maintaining the highest possible standards of scholarship and book production requires considerable investment of time and effort, as does ensuring that the list is kept in print. Despite budgetary constraints, SCS has maintained its position as the international point of reference for scholarly publication in its areas of expertise. As will be shown below, it is actively engaged in exploring the potential of new media for the dissemination of its work.

Most recently, electronic publication has proved particularly suitable for provisional editions of extensive texts such as *Saltair na Rann*, or for making expertly transcribed texts available alone (without the copious annotations that go to make a finished edition), as part of a searchable corpus.

3. External Links

In addition to its extensive list of publications, SCS makes and maintains a variety of links with the wider community of Celtic Studies scholars, in Ireland and internationally.

Research Seminars

Attendance at the weekly Research Seminars conducted by SCS during academic terms is open to all interested persons, with scholars from Irish and international universities attending regularly. These seminars benefit those who attend – both senior and junior scholars – as well as the member of SCS staff or guest researcher who presents his / her work in progress, for such discussion can play an important role in the preparation of a text for publication.

Conferences and Public Lectures

Another and particularly important way in which SCS interacts with the broader scholarly community is its annual two-day conference called *Tionól* (gathering), together with the annual SCS statutory lectures, delivered at UCD and TCD in alternate years, which attract audiences often well in excess of 100. In recent years SCS has extended this aspect of its

activities with the organisation of the 'Digital Image, Digital Text' colloquium on December 4, 2004, and the hosting of the annual Teangeolaíocht na Gaeilge (Linguistics of the Irish Language) conference on April 9, 2005.

Further Links

Conscious that it must continue to look outward, SCS plans three major initiatives:

(i) SCS will revive the international Summer School in Celtic Studies, as a result of the recent restoration of the complement of Senior Professors to three;

(ii) SCS will participate centrally in the planning and organisation of the 2011 International Congress of Celtic Studies, provisionally planned to be held in Dublin, and

(iii) SCS will organise one-day conferences on particular issues where it can provide significant leadership.

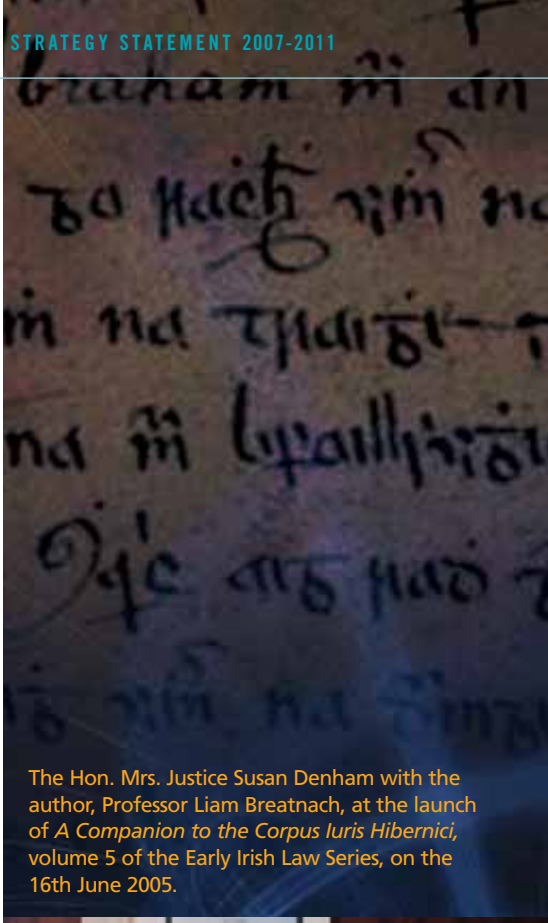
4. Projects (and plans for the future).

(a) SCS's first major project is of its nature open-ended and ongoing, viz., the *Bibliography of Irish Language and Literature*. The most urgent task is to bridge the gap between 1971, the end-date of the period covered in Rolf Baumgarten's *Bibliography*, and the present; this task is currently being undertaken by Alexandre Guilarte. Material is made accessible on the SCS website as it is gathered.

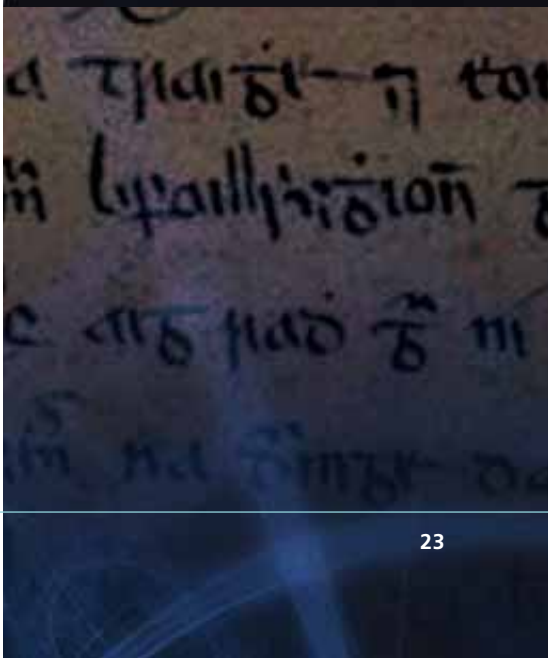
(b) The second major project is Irish Script on Screen (ISOS), directed by Professor Pádraig Ó Macháin.

Mediaeval and Modern Irish manuscripts are national treasures and unique documents, the value of whose replication has been recognised since the nineteenth century, when the production of facsimiles began. Major resources of money, time and effort were invested in the production of facsimiles, whether of transcribed copies, such as *Lebor na hUidre* (1870), *An Leabhar Breac* (1872-6) and the *Book of Leinster* (1880), or of manuscripts such as the *Book of Ballymote* (1887), *Rawlinson B502* (1909), the *Milan Commentary on the Psalms with Glosses in Old Irish* (1936), the *Book of Uí Maine* (1941), and Royal Irish Academy manuscript 23 N 10 (1954). Unfortunately, this great scheme subsequently fell into abeyance. The ISOS project represents a new departure in terms of technology, yet renews a tradition of concern for the conservation and replication of our primary sources, providing for their wider availability.

In addition to ISOS, SCS will keep a register of and provide links for similar projects managed elsewhere. It is for instance a cause for very special satisfaction that the important Priscian Codex 904 has now been made available on-line by the St. Gall Diocesan Library. SCS will advise other libraries in respect of manuscripts of particular relevance to its mission. This applies notably to the libraries of Carlsruhe, Leyden, Milan and Würzburg.



The Hon. Mrs. Justice Susan Denham with the author, Professor Liam Breatnach, at the launch of *A Companion to the Corpus Iuris Hibernici*, volume 5 of the Early Irish Law Series, on the 16th June 2005.

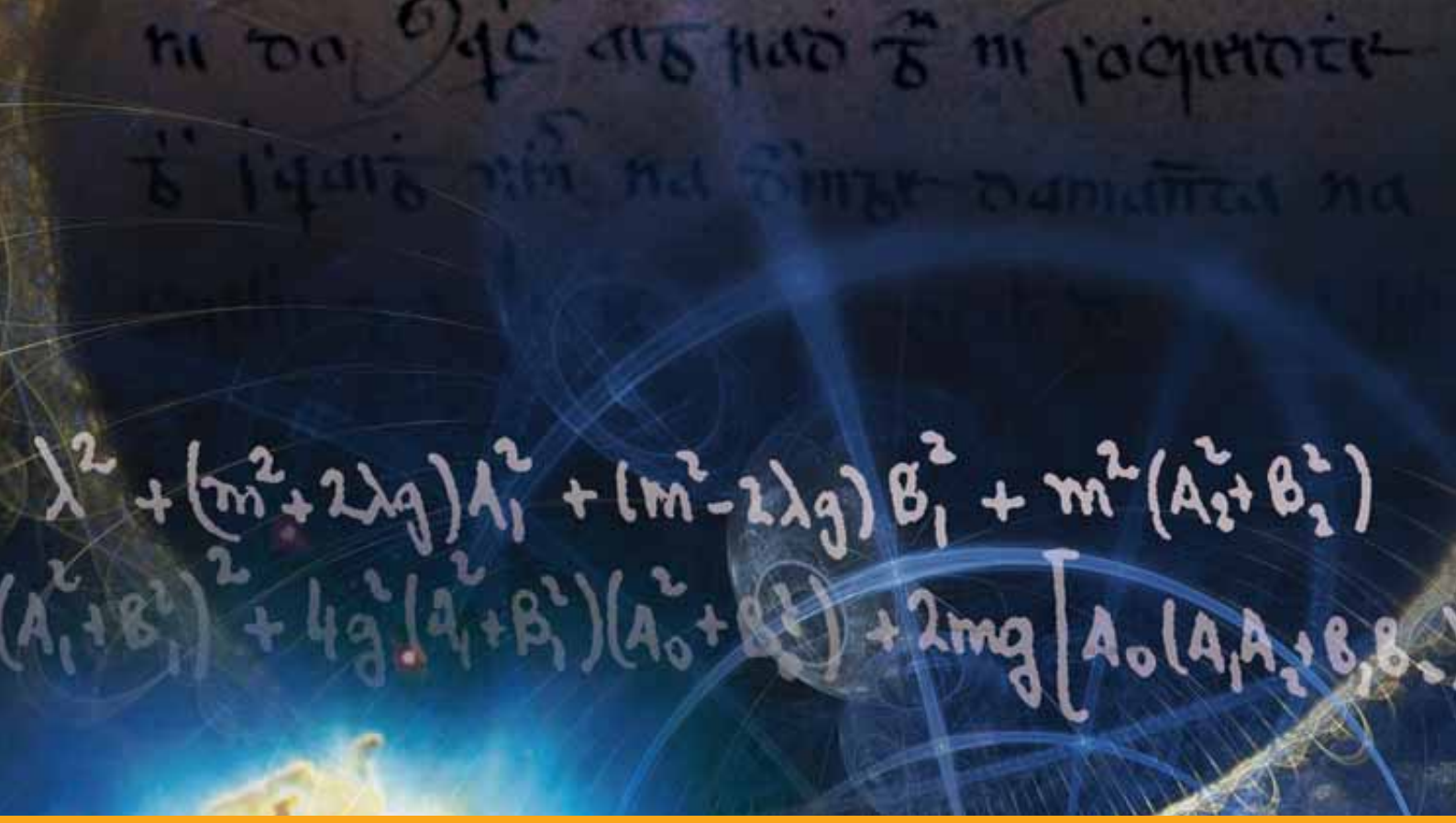


(c) It is proposed to add a third project, closely related to the second, to the work of SCS: producing diplomatic editions (i.e. transcriptions in which the many abbreviations found in original manuscripts are expanded by expert scholars, for greater ease of reading).

Strictly speaking, the three earliest 'facsimiles' are not in fact such, as technological limitations meant that they had to be made from transcribed copies, rather than from the original manuscripts. The production of diplomatic editions of Lebor na hUidre (1929) and the *Book of Leinste*r (1954-83) was to a large degree motivated by the need to make up for errors in the 'facsimiles'. There can be no doubt, however, that they are in themselves extremely useful, in that a printed text, with abbreviations expanded, is much easier to read than a manuscript and greatly expedites source consultation and textual comparison. At present, technological developments make the case for producing further diplomatic editions all the stronger. All such work would be computer-based and could go hand in hand with the creation of an extensive database of Old and Middle Irish texts. A start could be made with the third of these first 'facsimiles', *An Leabhar Breac*.

The proposed project would involve manageable growth, and at the same time be in keeping with the other major projects, which aim to provide the essential research tools which can only be created through long-term commitment of resources.

On the 11th June 2007, the Dublin Institute for Advanced Studies presented a copy of the work *The Irish of Iorras Aithneach*, County Galway by Dr Brian Ó Curnáin to the President of Ireland, Mrs Mary McAleese.



THEORETICAL PHYSICS

Strategy Statement for the School of Theoretical Physics

The School of Theoretical Physics (STP) has a distinguished research record and includes among its former professors some of the most illustrious names in the history of theoretical physics, including its first Director, Professor Erwin Schrödinger. These outstanding physicists set a standard of scholarship which has established STP's reputation as a world leader in its field. The report of the external review group - *External Review: School of Theoretical Physics, November 2004* - provides assurance that the school continues to attract physicists of world class who will provide the leadership needed for the school's "important role in focusing on science in Ireland and linking it with leading science in the rest of the world" (page 2 of the report).

STP concentrates on its core tasks of carrying out and publishing original research into the mathematical principles of physics and of training talented postgraduate scholars in research methodologies. (Like SCS, it has no undergraduate teaching duties.) At a time when Ireland is endeavouring successfully to transform itself into an innovation-driven economy, the role of indigenous research in the physical sciences can hardly be overstated. At this critical stage in Ireland's economic development, STP's contribution is of fundamental and growing importance:

Through its research, it strengthens the prestige of Irish science in the world. This will allow to attract more top scientists to Ireland and to attract students from abroad to Irish universities.

Through its own research and its outreach activities it raises the profile of Mathematics and Physics in Irish society.

The School will help in the establishment of a Summer School Programme, with courses given by first rate physicists and mathematicians to students from Ireland and abroad.

STP will provide leadership for selected European research activities of strategic importance for Ireland.

The presentation of Professor Edwin Schrödinger's lecture notes (16th May 2007).

1. Current Research Activities

The School pursues research in the general areas of theoretical physics and mathematics. Particular areas of expertise are: theoretical particle physics, quantum field theory, quantum gravity, quantum mechanics, quantum information theory, quantum and classical statistical mechanics, disordered systems, geometry and topology, noncommutative geometry and infinite-dimensional algebras, Lie groups and algebras, C*-algebras, functional analysis, and probability theory.

There are currently three research groups, headed by Profs. Dorlas, Nahm and O'Connor.
Specific research projects are as follows:

Quantum Information Theory

At present, information is transmitted (over the internet for example, or between banks) in digital form, that is, in the form of 'bits' which are expressed in terms of electrical signals in a 'high' or a 'low' state. However, there are proposals for more secure and efficient transmission in the form of 'quantum information', which is given by the quantum state of a stream of microscopic quantum systems, e.g. atoms or particles of light, called photons.
Theoretical research is carried out to investigate the optimal rate at which such quantum information can be transmitted such that it is robust against noise in the information channel.

Solvable models in Statistical Mechanics

In 1931 Hans Bethe introduced a new method for determining the energy spectrum of the one-dimensional Heisenberg model. The Heisenberg model was put forward by Heisenberg in 1925 as an explanation of the origin of ferromagnetism as a result of quantum effects. Bethe's method has since been shown to be applicable to many other models, all either one-dimensional quantum models or two-dimensional classical models. Several of these models are being studied by members of the School.

Bose-Einstein condensation

Bose-Einstein condensation is a phenomenon first suggested by Einstein in 1925 on theoretical grounds, as a consequence of a new form of statistics proposed by Bose. It is long known that particles with integral spin obey Bose statistics, but it proved very difficult to observe Bose-Eistein condensation experimentally in its purest form, even though it is thought to play a role in the phenomena of superfluidity in liquid helium and in superconductivity. In 1995, Wieman and Cornell succeeded in observing Bose-Einstein condensation in atomic vapours at extremely low temperatures (nano Kelvins). In the mean time, the effect of interactions between the particles on this phenomenon is still poorly understood. It has been a subject of theoretical research in the Institute for many years.

Noncommutative geometry and field theory

One of the particular features of quantum mechanics is that observable quantities in general do not commute. That means that if one measures first quantity A and then quantity B of a microscopic system, the results will in general be different from those obtained if one first measures B and then A. It was proposed by Connes in the 1980s that one can construct analogues of geometric notions like distance and curvature for spaces where such noncommuting objects play the role of 'points'. These new constructs are now being investigated in applications to quantum field theory, i.e. the theory of elementary particles. This gives rise to new approaches to computational approximations for calculating properties of these particles as well as proposals for new theories beyond the current Standard Model. In particular, it also gives rise to a new approach to quantum gravity. Both Monte Carlo calculations and theoretical studies are being pursued in the School.

Conformal field theory and integrable deformations

Conformal field theory is a theory of fields which are invariant not just under the usual space translations and rotations, but also under dilations. This high degree of symmetry allows many aspects of these theories to be calculated exactly, i.e.

without approximations. They play an important role in understanding critical phenomena, esp. in low dimensional systems, where many so-called critical exponents can be calculated and compared with experiment. They are also important for understanding certain aspects of string theory, the most promising theory of elementary particles incorporating Einstein's general theory of relativity. In the School of Theoretical Physics, small deviations from conformal theories are being studied, which can nevertheless be solved and give insight into the breaking of conformal invariance.

Edge states in the quantum Hall effect

The quantum Hall effect was discovered by Von Klitzing in 1980 in a very pure sample of semiconducting material at low temperatures and in a high magnetic field. He found that at low temperatures the conductivity in the transverse direction, first discovered by Hall in 1879, exhibits so-called plateaus as the strength of the field is varied. This can be explained in terms of currents flowing at the edges of the sample. Initially it was found that the Hall conductivity exhibited plateaus at integer multiples of a certain fundamental quantity, but more accurate experiments later showed that there are also plateaus at certain fractional values. Recently, a similar effect has been discovered in sheets of graphite, one atom thick, which can now be routinely manufactured with great precision. The explanation is somewhat different from the usual quantum Hall effect and relies on the specific electronic structure of graphite. Remarkably, this structure has a mathematical similarity with Dirac's theory of relativistic electrons, which makes mathematical techniques from this theory applicable. Consequences for the presumed corresponding edge currents are now being researched.

Vanishing theorems

Original research is also taking place in more mathematical areas, notably the geometry of vector bundles . This concerns symmetries of such bundles which are similar in nature to symmetries found in Calabi-Yau varieties, which are geometric spaces of a particular kind.

2. Relation between Fundamental and Applied Research

Traditionally, DIAS has concentrated its research activities to fundamental or basic areas. Its overall thrust was to add to the sum of human knowledge for its own sake, by extending the frontiers of knowledge in its fields of expertise. It has placed less emphasis on the other broad category of research referred to as applied research. A notable exception is the research by the late Professor Lewis, who carried out research into applications of probability theory to communication networks. This led to the founding of a successful company, Corvil Networks. This example illustrates the general principle that applied research relies for its raw material on the outcomes of fundamental research. On the other hand, insights gained in the course of application of principles formulated by original investigators can lead to a reassessment of those principles or the germ for new principles. It may be noted that the first function assigned to the School of Theoretical Physics in the Act is: "the investigation of the mathematical principles of natural philosophy *and the application of those principles to the physical and chemical group of sciences and to geophysics and cosmology*". This suggests that the founders of the Institute already recognised the importance of fundamental research for applications. It should be recognised, however, that at the time the fundamental research is carried out, these applications are usually unforeseen.

To further emphasise the importance of fundamental principles in applications, it may be useful to give a few examples.

1. The first Director of the School of Theoretical Physics, the famous Professor Schrödinger, discovered the wave equation of quantum mechanics. This equation is at the root of all of chemistry as well as much of physics. It is used on a daily basis by chemists to describe and predict the properties of new and existing materials. It is also the basis of electronics and led directly to the development of transistors.
2. Einstein's General Theory of Relativity was long considered of little practical value. This has now changed as a result of the development of the *Global Positioning System*, which would not be accurate enough if the effect of gravity on the clocks in the satellites used were not taken into account. The necessary corrections are computed using Einstein's theory.

3. Number Theory, the most abstruse area of Mathematics, was developed purely because of scientific curiosity. It has now found important applications in *cryptographic and error-correcting codes*, which are used to transmit information securely and error-free over the internet. Error-correcting codes are also used for example in mobile phones and CD and DVD players, as well as to transmit data over long distances in space.
4. The *World-Wide Web* was developed as a result of a need that arose in the European centre for particle physics (CERN) for particle physics researchers to communicate within this large organisation and to visualise the massive data bases used for analysing particle reactions.
5. While working on purely theoretical problems in Statistical Mechanics, an area of physics dealing with systems of many particles, Prof. Lewis noticed in 1992 an analogy with the *transmission of information*. Although this analogy was in fact well-known, it had not been noted that a particular method, common in Statistical Mechanics, could also be applied for the efficient transmission of information. The realisation of this idea led to the founding of a successful company.

3. Strategic Objectives

3.1 Appointment of new staff

In 2004 the research of the School was assessed by a panel of international experts. It recommended in particular that the School should be strengthened by the appointment of at least 2, preferably 3 new Senior Professors during the period 2006-2010. In this document we concur with this recommendation. Indeed, research in the fields of Theoretical Physics and Mathematics is thriving internationally, and we argue that it would be of great benefit to the well-being of research in Ireland if the complement of senior staff in the School could be enlarged. Indeed, research in the School is internationally recognised for its quality, as is demonstrated by the large number of high-quality applicants to Scholarship and Fellowship positions (in 2006, the School received about 140 applications for postdoctoral positions), as well as by the constant stream of eminent international researchers visiting the School. Due in particular to its reputation and to the present favourable climate for grants, the School has been able to attract a number of externally funded Fellows, which has put considerable strain on the senior staff. Increasing the number of junior fellows further would jeopardise the quality of support to Scholars. In addition, the appointment of new senior staff would allow the School to expand into new promising areas of research, which are currently in rapid development.
The following list is not exhaustive, one might include
areas like high temperature superconductivity, quantum optics, chaos and turbulence. It indicates where we are particularly active in exploring the possibilities for an appointment of new Senior Professors.

General Relativity and Cosmology

In earlier years, work in the School has contributed substantially to research into General Relativity. The General Theory of Relativity was of course formulated by Einstein in the period 1912-1918 and he worked out some of the consequences at the time, notably the perihelion shift of Mercury, the bending of light rays around the Sun and the existence of gravitational waves, but the theory is extremely rich and many other consequences were calculated by workers in the Institute. Unfortunately, some of this expertise has been lost with the death of Professors Synge and Lanczos. General Relativity Theory has recently become of technological importance due to the development of the Global Positioning System, which would not be possible without taking account of the corrections needed to take account of general relativistic effects. It has also become of increased importance in Astronomy and Cosmology. Gravitational waves have still not been detected directly, but they have recently been detected indirectly in systems of double stars. Cosmology, the study of the evolution of the early Universe, has recently evolved into a true observational science with the precise measurement of the cosmic microwave background radiation and the accurate determination of the Hubble constant using supernovas as standard candles for distance measurement. This has led to new theoretical puzzles and models.

There have been remarkable recent developments in Cosmology. Since Einstein proposed his general theory of relativity various people have constructed models of the Universe compatible with the Einstein equations. Observational work by Hubble then indicated that the most feasible models were those in which the Universe has expanded from an initially much smaller size. This is called the Big Band model. This model still has a number of undetermined parameters like the total amount of matter in the Universe, etc. Recent very accurate observations have narrowed down the possible values of these parameters, and it has in particular become clear that ordinary matter constitutes only about 30% of the total amount of mass present. The remaining mass is called dark matter, the nature of which is currently very unclear. It is an intriguing problem, but the Institute has at the moment no researchers pursuing or specialising in this area.

Quantum computation and quantum information

Another rapidly developing area is that of quantum computation and quantum information. This may indeed have important technological implications in the future. It is critical for Ireland to be involved in this development. Quantum computation is a general term for the proposal to harness the quantum nature of matter to construct a new generation of computers which are much faster and efficient for certain tasks. The School of Theoretical Physics would be a particularly suitable place to be involved in this venture, but there is at the moment no researcher in the School for whom this is the main interest. However, a Schroedinger Fellow in this area has recently been attracted, and a Conference on Topological Quantum Computing is planned.

A related area is that of quantum information theory. This is the theory of the information that quantum computers manipulate and how this is transported over communication lines, inside a quantum computer as well as over longer distances. The latter is in fact closer to practical realisation, and will in particular have serious implications for the transmission of confidential information.

Condensed Matter Theory/Quantum Hall Effect

Another important development in Condensed Matter Theory was the discovery of the Quantum Hall Effect by Von Klitzing in 1982, and the related Fractional Quantum Hall Effect by Tsui and Stormer in 1998. The integer effect has important technical applications in the accurate measurement of resistance in particular, as well as for the determination of fundamental constants. Its theoretical basis is now well-understood however. The fractional effect is much more delicate and can only be observed in extremely clean semiconductors and at extremely low temperatures. Also it is theoretically far less well-understood. The existing theory of this effect has striking links with topological quantum field theory. There is some expertise in the School already in this area, especially in relation to a similal phenomenon which has recently been observed in graphene, an atomic layer of carbon. There are also possible applications to quantum computing.

Other fundamental questions in Condensed Matter Physics are for example the derivation of non-equilibrium behaviour and the first-principles calculation of properties of materials.

String Theory

String theory has been, and still is the most prominent theory for extending the existing Standard Model of particle physics and unifying it with Einstein's theory of gravity. Although it has so far not led to experimentally verifiable predictions, this may change in the nears future with the completion of the Large Hadron Collider in CERN. In the mean time, it has led to important developments in pure mathematics, resulting in a number of conjectures which have since been proved by other means, and in the formulation of new natural structures and unexpected relationships between originally quite distinct areas of mathematics.

Number Theory and Algebraic Geometry

Perhaps the most famous problem in mathematics is Fermat's Last Theorem, which states that there are no integer numbers x, y and z which are solutions to the equation $x^n + y^n = z^n$ for any n>2. It has recently been proved by Andrew Wiles. His solution has given rise to many new developments in mathematics and much work is currently done in this

area, which is also of importance for coding theory. His proof was based on connections with algebraic geometry, which as a result is also in rapid flux.

Any Senior Professor position should come with funding for a minimum of 2 Fellows. This is essential in order to be able to attract the highest-profile candidates. Indeed, the main purpose of appointing new senior staff should be to significantly increase the profile of the School. It is also essential for the optimal achievement of the goals as set out under 3., 6. and 8. below.

It is of course understood that the appointment procedure has to be transparent and timely. A panel of international repute and with a broad range of contacts in various areas of research should be constituted to actively canvass prospective candidates.

This takes time and it is therefore important that we get early approval for at least some of these appointments. We believe that STP should have the highest priority in the appointment of new staff as it is currently significantly smaller than the other Schools.

3.2 Attendant increase in administrative staff

An increase in the administrative staff may also be necessary. The current Administrator is already overstretched, having to deal with the administration for 3 Senior Professors, large numbers of visitors, several conferences per year, orders, leave sheets, accommodation, visa enquiries, staff meetings etc. We suggest a full-time but lower-grade assistant administrator.

We also need more help in the library as the present librarian is only half-time and the library is very heavily used both by staff and by Research Associates.

3.3 Involvement with Graduate Schools and organisation of Summer Schools in Ireland

We support the recent initiative of IRCSET to start up Graduate Schools in the physical sciences in Ireland and envisage contributing to it in a constructive way. We believe that we are particularly well-placed for this purpose because we do not have any formal undergraduate teaching duties and we have extensive international contacts and a regular visitor programme. It should be borne in mind that the number of graduate students in Mathematics and Physics in the Dublin area is limited. This means that in order that graduate courses are worthwhile it is essential that they are pitched at the right level, which on the one hand is specific enough to provide a useful addition to the knowledge base for beginning graduate students, but on the other hand, is broad enough that the number of attendants does not fall below a reasonable minimum of about 5 students. The Science Schools, and STP in particular, have the advantage that its staff is both highly qualified and free from undergraduate teaching duties which might be compromised by the graduate teaching effort. (In some cases, staff members do give undergraduate courses at present, but those would generally also be suitable for graduate students, or could easily be adapted for that purpose.) Moreover, we already have many international visitors, some of whom could be asked to give graduate courses as part of the Graduate School programme. Obviously, this will need additional funding.

In view of the limited number of prospective graduate students, we propose that a better way to start off a graduate teaching programme might be to organise international Summer Schools. In our experience these are particularly effective ways to introduce graduate students to the latest developments in a field. They have the advantage that they are very intensive but of relatively short duration so that the School does not take up too much of a graduate student's time needed for their individual projects. Moreover, Summer Schools do not require large numbers of students, because students from abroad would also be invited to participate. Lectures are given by selected international experts in a given area. Thus Summer Schools have the added advantage that students also come into contact with other researchers in

Governing Board Members and the Research Staff Representative of the School of Theoretical Physics (16th May 2007).

the same area, at an early stage of their career. We propose that the two Science Schools could organise a Summer School in alternate years if appropriate funds are provided. We propose to include in the programme of such Summer Schools an industrial element in the form of a presentation and/or reception with representatives from industry, in particular the industrial research community, to make the students aware of the opportunities in this direction. A meeting with representatives from the main universities could also be included to highlight job opportunities there.

3.4 Increased visitor funds

In line with other comparable research institutes, an increase in funds for visitors would be very advantageous for the working environment of the School. We propose additional funds for inviting at least one long-term visitor per year. This could be in the form of an agreement with the Irish universities that the Institute would pay half the salary of a Professor on sabbatical who spends 6 months or a year at the Institute, the university providing the other half. This will require a new understanding with the Department in the form of a fast-track semi-automatic approval of temporary visitor appointments.

3.5 New Building

The School supports the Institute's strategy of moving to a shared building, provided it has good public transport access from both Trinity College and UCD, and there is enough room for expansion to accommodate staff expansion. Indeed, a new larger building will be essential to accommodate the expansion in staff as outlined under 1.

3.6 Links with other research institutes

We aim to form stronger and more formal links with similar research institutes abroad, and in Europe in particular. This will help to bolster our position as an important player in the international network of fundamental research institutes. It should also improve our chances for obtaining European grants and attracting the best postdoctoral researchers.

3.7 New plan for Mathematics funding

The present climate for research in Ireland is more favourable than it has ever been. New funding initiatives are opening up and we endeavour to take advantage of these. However, we feel that the current SFI mathematics initiative puts too much emphasis on collaboration with industry, which is inappropriate for fostering high-quality research. We intend to formulate a plan for advanced mathematics research funding ourselves, incorporating a number of proposals, notably funding for:

- International Conferences
- Summer Schools
- Long-term visitors
- Sabbaticals for Irish researchers

3.8 Improved public profile

Another goal the School will pursue is to improve its public profile.
Some progress has already been made in this regard, but more needs to be done. The speakers giving the Statutory Public Lectures have been chosen for their ability to deliver talks suitable for a general audience and they have on the whole been very successful in that regard. However, despite attempts to contact secondary schools, the attendance has often been disappointingly low. More effort will be devoted to this. We will try to give more visible public notice of these events and attract high-profile speakers. We will also continue to contribute to the Irish Scientist Yearbook as we have done for the last 4 years, and organise public events for the Science Week.

COSMIC PHYSICS

Strategy Statement for the School of Cosmic Physics

Vision Statement

A premier-destination academic school training scholars and conducting and leading advanced research within Ireland, Europe and globally in its areas of expertise.

Mission Statement

The School of Cosmic Physics promotes the use of Physics in increasing our knowledge and understanding of the world around us by:

- being a leading international centre for studies of the Earth and the Universe;
- providing a focus within Ireland for these areas of research;
- facilitating Irish involvement in relevant international programmes;
- providing specialised advanced training;
- and by publishing and publicising advances in Cosmic Physics.

Strategy Statement

During the second half of the first decade of the 21st century, the school will endeavour to be Excellent, Aligned, and Linked.

Excellent: in the science that we do and the training that we undertake,
Aligned: with Irish, EU and International initiatives, and
Linked: to Irish, EU and International partners.

Process

The process of updating the School research strategy was coordinated by the School Director, Prof Alan Jones. A number of general staff meetings were held in late 2005 and early 2006 to discuss the strategic direction of the school, and in particular the question of a possible new research area was discussed at some length. There was also a number of smaller focus group meetings held to explore in depth particular areas. These meetings were facilitated by Ms Carol Beigneux MBA who was employed as a consultant on the process. The Governing Board of the School received regular reports from the Director and also provided input into the process.

Introduction – An agenda of change

This Strategic Plan updates the School's 2001 and 2003 Research Strategy documents, and should be read in conjunction with those. In particular, the mission, organization and administration of the Institute, explained in detail in the 2003 Research Strategy Update, will not be repeated here. The chronicle of the next five years will be one of change and adjustment with a bright future ahead. Changes will occur as a consequence of both internal and external factors and influences, and how well the School adjusts to these changes will determine its success over the 5 year medium term of this plan, and over the longer term. As a consequence of the 2004 School Review Committee report, the School has undergone significant internal restructuring. This leads to an opportunity to form a third Section with a related but different science focus. In addition, external initiatives provide opportunities for School growth in numbers unprecedented since its formation in 1947.

This Strategic Plan lays out the current situation we are in, and gives a roadmap for where we believe the School must travel to over the quinquennium of this plan. However, as with all such plans, it is only useful when viewed as indicative rather than totally prescriptive, as we must be responsive to the ever-changing Irish, European and international scientific landscape.

The Green Review of 2004

The most influential event during the last quinquennium was the review by an external committee chaired by Professor Alan G. Green of the Swiss Federal Institute of Technology in Zurich (ETH). In line with the Institute's overall strategic plan this review was commissioned by the Council of the Institute, in contrast to the previous reviews, the Lynden-Bell Review of 1994 and the Longair Review of 1999, which were commissioned by the School's Governing Board.

The review committee's report was generally favourable, commenting that *"the Review Panel has a high regard for the research activities of the DIAS School of Cosmic Physics"*. Nonetheless, the committee made a number of specific recommendations, which have been, or are being, addressed, most notably a strong recommendation that the Astronomy and Astrophysics research work be merged at a city centre location.

Organizational Structure of the School

As a consequence of the Green Review report, described above, the Governing Board made the decision in October 2004 to merge the Astronomy and Astrophysics Sections into a single section based in the city and under the administrative leadership of Professor Luke Drury. The School now has two Sections, an Astronomy and Astrophysics section, and a Geophysics section, and there is thus an opportunity, explored below, to create a new third section within the school.

Strengths and Weaknesses, Opportunities and Threats

Strengths

The broad nature of our remit, as specified in the Establishment Order of 1947 (77/1947) is our greatest strength. We are established to carry out advanced research in any area of cosmic physics, and to train students as we undertake our studies.

Weaknesses

Whilst reporting directly to the Department of Education and Science is one of our strengths, the procedures put in place in 1940 are cumbersome and often inappropriate to the present day situation.

Opportunities

As a consequence of Government and EU initiatives, there are a number of opportunities that present themselves to the School over the quinquennium of this strategic plan. These are discussed at greater length in the next section, but to list them here for completeness they are:

PRTLI cycle IV: The Government's fourth Programme for Research in Third Level Institutions offers an opportunity to continue on the gains accrued under CosmoGrid.

Enhancing Ireland's 4th Level Education: The State's stated goal in the recently-published Strategy for Science, Technology and Innovation 2006-2013 of doubling the numbers of PhD graduates by 2013 offers an opportunity for School growth.

FP7: The launch of the seventh framework pogramme opens up new possibilities for European collaborative research, an area where the School has a strong track record.

Threats

The greatest external threat to the School is that we become seen as irrelevant to Irish research needs for the future. This will happen if our research is not excellent, if we do not take advantage of Government, EU and international initiatives, and if we do not enhance old linkages and create new ones with Irish, EU and international academic sector.

The greatest internal threat is complacency. We must ever be vigilant about the externally-changing research landscape, and react and modify appropriately.

The School of Cosmic Physics – Quo Vademus

The strategic objectives of the period 2006-2010 are presented below (the goals being marked by bold face type). These goals consolidate and enhance the School's research activities, and are also consistent with Irish needs as articulated in the Strategy for Science, Technology and Innovation and complementary to Irish science undertaken at the Third and Fourth Levels.

Growing the School

Given the advantages that the School has, and given the opportunities at the national, European and international levels, now is the time to **grow the School and to consolidate its position as a significant, recognized and respected institution on the Irish and international research landscape.**

Adoption of the European Charter for Researchers

In September, 2006 the Governing Board of the School adopted, at the suggestion of the Senior Professors, the European Charter for Researchers (www.europa.eu.int/eracareers/europeancharter). The School is the first academic body in Ireland to adopt this Charter, and **the general principles and requirements will be implemented over the next two years.**

These include:

- Professional responsibility and attitude,
- Accountablity,
- Safe working practices,
- Dissemination of results,
- Public engagement,
- Supervision and managerial duties,
- Stimulating research training environment, and
- Evaluation/appraisal system.

A new research area

Given that the School must be dynamic and respond to changing times, we believe that scientific flexibility comes from having more than the two focus areas of astrophysics and geophysics. Clearly impossible at present would be to envision a School with many (>5) focus areas. The attendant dilution of resources would result in small, sub-critical groups with little possibility of global impact. However, consistent with the other Schools in the Institute we believe that the School should have at least a third focus area. The question that then arises is what should be the nature of the new third focus area?

Sensibly, the new third area should complement the School's current strengths, whilst simultaneously be designed for success, as in be amongst the world leaders in its designated field. The current strengths of the School are in theory (Drury, Aharonian) and observational science (Jones, Meurs, Ray, Aharonian). Traditionally, science rested on the two support pillars of theory and observation. However, modern science now also has a third pillar to support it, which is numerical simulation and the computer-assisted analysis of extremely large data sets.

After much deliberation, particularly with all School members as part of the process for developing this Strategy document, we suggest that a new third area that maximises and enhances the School's current activities is numerical computation and simulation of physical processes. Through CosmoGrid and ICHEC, the School has access to world-class computational facilities, and thus is in a position to attract high quality applicants.

We propose that, as a major thrust in the quinquennium period of this strategy, the School should seek to establish a third section focussed on "Computational Cosmic Physics".

We further propose that the actual research focus of the Senior Professor should be open-ended, from those undertaking numerical simulation studies of tectonic processes to mantle dynamics to core dynamics and dynamo theory to atmospheric dynamics to planetary dynamics to solar dynamics to solar system dynamics to computational astrophysics and computational cosmology, and we should hire the most capable and outstanding candidate we can find to lead this section. We emphasise that in addition to the traditional simulations on high performance computers, we see computational cosmic physics as increasingly involved with the problems of handling very large volumes of data, often distributed over many sites and heterogeneous in organisation and nature. This is perhaps the area where Grid-technology will make its first significant advance in enabling such concepts as virtual observatories and data mining to move from computer science concepts to real tools used by working scientists. The section would naturally also be involved in the visualisation of these large datasets leading to the need for a high specification 3D visualization room that would be of benefit to the whole Institute and the wider community.

While it should not be a major determining factor in choosing this as the third research area, the fact that this is an area which is obviously relevant to the economic development of Ireland and which is strongly supported by national research funding policy makes it easier to argue the case with Government for the new positions and resources that will be needed to develop Computational Cosmic Physics as the third focus area for the School. In addition, this research area will contribute significantly to the growth of 4th Level education in Ireland.

Enhancing 4th Level Education

Ireland is moving towards a four-year PhD training programme. This model would depart from the traditional 3-year research-only PhD programmes to date in the State, and move towards the North American model of training during studies for a graduate degree. In particular, University College Dublin is accepting students this year for a four year programme, with a loosely structured training/learning component lasting approximately a year. While many details remain unclear, there is a strong drive towards multi-institutional graduate schools. Both Geophysics and Astrophysics are natural candidates for all-island graduate schools and proposals were put forward in both areas for the exploratory grants programme of the research councils. **The school will work hard to participate in, and preferably to lead, graduate schools in Astronomy and Geophysics.**

Enhancing Scientific visibility

The School will maintain and enhance its scientific visibility through leadership and membership of national, European and international initiatives. These are discussed in more detail in the strategies for each Section.

Enhancing Public visibility

The School will **enhance its public profile through expanded outreach programmes, such as**

- Greater visibility of the Statutory Lecture series.
- A public role for Dunsink Observatory.
- Involvement in Science Foundation Ireland's "Bringing Science to Schools" programme.

Expanding and consolidating the Schrödinger Fellows program

As part of the previous Strategic Plan, the School has brought on four Schrödinger Fellows, three in Astrophysics and one in Geophysics, with a second one in Geophysics to be appointed shortly. These fellowships are designed as longer-term (max. 5 year) advanced post doctoral fellowships awarded to emerging rising stars in fields related to the focus of the School. Such long term fellowships for senior fellows are relatively rare, not only in Europe but around the globe, and provide an excellent springboard for the Schrödinger Fellows to launch their careers whilst simultaneously offering to the School the opportunity to undertake research in different areas from those of the senior academics.

This programme has been highly successful at attracting a high number of high quality candidates for the respective competitions. Also, the present incumbents have had some success in launching their career interests. Given this success we are encouraged **to seek to grow the numbers of Schrödinger Fellows to the total of twelve envisaged in the Longair review of 1999.**

Longer terms for PostDoctoral Fellows

The standard term of externally funded PostDoctoral Fellows tends to be two years. This is, in the main, governed by the nature of the funding of the fellowships. Two years is rather short; the first year the Fellow is often working on writing up PhD thesis work, and the second year the Fellow is searching for the next position. **The School will seek to obtain longer term postdoc positions.**

Capital Replacement Plan

The School needs to have a Capital Replacement Plan. The lifetime of our capital resources varies from 3 years, for IT infrastructure, to 5-10 years for field geophysical equipment, to 10-15 years for our research facilities. **As part of a general review of relations with the Department and funding procedures the case for a separate capital equipment budget will be made.**

Enhanced Visitor Programme

The School's Visitor Budget is a resource that must be enhanced and more fully utilised to augment and expand School activities. In particular, senior academics engaged in research aligned with that of the School, or of interest to the School, should be enticed to spend sabbaticals for extended periods under **a new, high-profile Senior Visiting Professorship programme.**

Expanding Geophysics

The Geophysics Section has undergone considerable growth since the hiring of Professor Alan Jones as Head of Section in May, 2003. The numbers are now approaching those of the Astronomy and Astrophysics Section.

Professorships

During 2007 the Mallet Professor of Seismology should be appointed. This will re-energize the School's long-term (since mid-1970s) interests in seismological studies of the Earth.

Over the 5 year period there will be a retirement of one of the academic members of staff. This will open the opportunity for Geophysics to expand into other areas of relevance to the mandate of the School by hiring a professor in a designated field.

Two fields of geophysics suggest themselves as appropriate for the Section. One of these would be a Professorship in Marine Geophysics. Nine tenths of Ireland's national territory is beneath the Atlantic Ocean, and is "undeveloped, undiscovered and under water" (Marine Institute). The Section has been involved in offshore active and passive seismic surveys since the mid-1980s, and our interpretations of the extent of continental crust form the basis of Ireland's claim, under the United Nations Convention on the Law of the Sea, for 900,000 square kilometres of territory. This huge contribution by DIAS to Irish society is arguably the most significant in DIAS's history. **It would be appropriate to maintain DIAS's involvement in the offshore in a major way by appointing a senior, high profile, scientist to the position of Professor in Marine Geophysics.**

The second area of desired growth is in numerical simulation of tectonic and geodynamic processes through a Professorship in Numerical and Computational Geophysics. Through CosmoGrid support the Section has seen the initiation of such activity with a Postdoctoral Fellow and a graduate student. **Given the availability of ICHEC/CosmoGrid resources and our desire for a third Section focussed on simulation of general cosmic physics problems, a Professorship in advanced simulation of geophysical phenomena would be highly appropriate.**

Both of these envisaged professorships complement well the existing geophysical expertise within Ireland, both north and south, and both would build programmes and activities that are broadly-based and inclusive in nature.

The presentation of the Griffith Award to DIAS for the IGGP by Mr. Eamonn Ryan (centre), Minister for Communications, Energy and Natural Resources, to Professor Dervilla Donnelly (Chairman of Council of DIAS) and Professor Alan G. Jones (Head of Geophysics, School of Cosmic Physics)

National activities - CHIGI

Professor Jones, as Head of the Geophysics Section, is a member of the recently-formed Committee of Heads of Irish Geocience Institutes (CHIGI). Other members includes the Chairs of Geosciences at TCD, UCD, Cork, Galway and Coleraine, and the Heads of the two geological surveys, GSI and GSNI. To date, CHIGI has provided the Government with arguments for a Geoscience Initiative, some of which appear in the recent Strategy for Science, Technology and Innovation 2006-2013, and has submitted a proposal to form the Irish Geoscience Graduate Programme (IGGP). Under IGGP students would undertake their training in Short Course modules given where the relevant expertise lies, and their research at their home institute.

European and international activities

The Section **will continue its tradition of leading and being involved in major European and international geoscientific programmes.**

Professor Jones will continue to promote EuroArray (www.euroarray.org), which is now an activity beneath the umbrella of TOPO-Europe, accepted as a EUROCORES in 2006. The pilot project for EuroArray/TOPO-Europe is PICASSO, for Program to Investigate Convective Alboran Sea System Overturn. This is a multi-national, multi-institutional, multi-disciplinary geoscientific study centred on southern Iberia and Morocco. Irish involvement is facilitated through a Science Foundation Ireland grant to Professor Jones for the magnetotelluric deployments. In addition, DIAS' seismological equipment will be made available to Spanish colleagues.

The SAMTEX project, for Southern African Magnetotelluric Experiment, has completed three phases of acquisition resulting in data from almost 500 sites in an area of greater than a million square kilometres in South Africa, Namibia and Botswana. Another phase is anticipated in Namibia and Botswana in 2007, and extension into Zambia and Zimbabwe in 2008 is under negotiation.

DIAS is a member of the AfricaArray initiative (http://africaarray.psu.edu), a unique programme for geophysical research and research training in Africa. The Geophysics Section of the School is attempting to secure funding to aid an African member state of AfricaArray by installing a seismic station or stations, and provide relevant training in that country and at DIAS.

Marine activities

The Section will continue to contribute to the State's knowledge-based economy by conducting geophysical surveys of the crust and mantle beneath the waters of the Atlantic Ocean. In particular, the Section will grow a strong marine electromagnetism group to complement the traditional seismic activities.

The Irish National Seismic Network

The seismic network in Ireland is woefully inadequate to meet societal needs in the broadest sense. The 3 station short period array run by the Section, in operation since the mid-1970s, provides essential seismicity information for predominantly the east-central part of Ireland. The broadband station at Valentia (VAL), run in cooperation with Met Eirean, and the broadband station in the Dublin mountains (DSB), run as part of the German GEOFON network, provide data, but are not reporting in real-time. None of these stations provide real-time information, and Ireland has the unique distinction of being the only western European nation without a modern national seismic network.
Within the first two years of this period, the VAL station will be upgraded to a real-time reporting system using the internet for transmission. A similar upgrade for DSB, but using cellular transmission, may occur. However, for compelling scientific, State and societal reasons, the whole network needs to be upgraded to modern standards with data transmission, analysis and archive coupled with automatic alerting of potentially damaging events). **The School will attempt to obtain funding and support for a modern national seismic monitoring network, perhaps using "sensor grid" concepts.**

Expanding Astronomy and Astrophysics

With the recent appointment of Professor Felix Aharonian, the Astronomy and Astrophysics Section has a good permanent academic complement of two senior professors and two professors. In addition, a third Schrödinger Fellow is being appointed to work in the areas of interest of Professors Aharonian and Meurs. The key interests are in high energy astronomy (Meurs, Aharonian), theoretical high energy Astrophysics and Astroparticle Physics (Aharonian, Drury), star formation (Ray, Meurs) and interstellar gas dynamics (Drury, Ray). The section has been very successful in attracting external funding from national (in particular the PRTLI funded CosmoGrid programme) and European (the research training network JETset, the Km3NeT design study, Marie Curie fellowships) sources. **A key objective is to maintain this position by making strong bids in the upcoming cycle 4 round of PRTLI and under FP7.**

Membership of ESO

Irish membership of the European Southern Observatory (ESO) is seen as a key national objective of the Irish Astronomical Community, and has been identified as an important strategic aim of the School. Membership of ESO would allow access to the best optical observing facilities in the world as well as the pioneering ALMA millimetre wave radio telescope (of particular relevance to studies of star formation). It would also provide access to the full range of ESO support services in such areas as software development and public outreach. Of particular interest, in connection with the aim of developing computational cosmic physics and data science, is the role of ESO as coordinator of the European Virtual Observatory project. **The School will initiate an Irish virtual observatory project linked to the EVO which will both strengthen the Irish case for membership and make our application more interesting to ESO.**

ESO membership should be seen as having a major role to play in building up Ireland's science infrastructure: *it is not necessary, nor even desirable, that all infrastructures be national.* **Towards this goal, DIAS will assist by encouraging Irish involvement in the newly formed European consortium ASTRONET.** ASTRONET itself was created by a group of European science funding agencies with the aim of producing a long-term plan for the development of European astronomy. Current membership includes ESO, CNRS/INSU for France, BMBF and PT-DESY for Germany, INAF for Italy, MEC for Spain, NOTSA for the Scandinavian countries, NWO for the Netherlands, and PPARC for the United Kingdom. There are also two associate members, ESA and the Max Planck Society. ASTRONET is currently drafting the so-called Science Vision document mirroring in Europe a process that has gone on in the U.S. for many years. After this, the Astronomy Infra-structure Roadmap will pick up speed. Membership of ASTRONET will ensure that Ireland plays a role, and is involved, in the development of astronomy infrastructure within Europe.

Afterburst studies of GRBs

It has become apparent over the last five years or so, that the afterglows associated with Gamma Ray Bursters (GRBs) provide unique and powerful tools to study the very distant and early universe. In using GRBS as probes of cosmology, early galaxy formation and the history of star formation access to data from various robotic observatories and networks is crucial. The school has, in collaboration with Italian and other partners, invested significantly in the REM (Rapid Eye Mount) robotic telescope located in La Scilla, Chile which is now delivering data, including infra-red observations, of burst afterglows. Professor Aharonian is also a member of the ROTSE collaboration and thus has access to the data from this network of robotic optical telescopes. **The School will use GRB afterglow studies to probe starformation at early epochs.**

TeV Astronomy

The last few years have seen an astonishing transformation in high-energy astronomy with the development of the Imaging Atmospheric Cherenkov technique to the point where there is now a genuine TeV astronomy, with images, light curves, energy spectra etc and a multiplicity of both Galactic and extragalactic sources. The School, through its membership of the HESS collaboration (one of the three winners of the 2006 Descartes prize for European Collaborative

research) has been a participant in this development and with Professors Drury and Aharonian is now well placed to play a central role in the organisation of the next large scale European project. **An application is currently being prepared for an FP7 design study of a future Cherenkov Telescope Array and DIAS aims to be an important member of this collaboration.**

In connection with the phase two expansion of HESS we intend to explore the possibility that the School could bid to host the main data centre for HESS and future large TeV projects **(this would require storage capacity of at least 100TB per year). Such a development would link naturally to the data science aspects of this strategy as well as the work of ESO on virtual observatories.**

Neutrino Astrophysics

Neutrino astronomy is potentially the most powerful probe of high-energy processes occuring in astronomical objects and provides a unique signature of hadronic processes. However the technical challenges are extreme, although possible with modern technology. On the theoretical side there is a very natural link to TeV astrophysics and the models used to explain high-energy gamma-ray production also provide constraints on the expected high-energy neutrino production. The School has recently been invited to join the EU funded Km3NeT design study which is looking at an installation instrumenting at least one cubic kilometer of water in the deep Mediterranean. There is an interesting prospect of using this infrastructure to also carry out some Marine Geophysics, an aspect which will be explored during the design study and which provides a nice example of an unexpected link between the interests of the two sections.

With its strong tradition in high-energy astrophysics and cosmic ray studies, and the new interest in neutrino astronomy and astrophysics, **the section should aim to the leading Irish centre, and one of the main European centres, for the emerging field of Astroparticle Physics.**

Particle Acceleration Theory

Underpinning all the models for Gamma-ray burst emission, TeV sources, high-energy neutrino sources, non-thermal X-ray emission etc is particle acceleration. All of these signals and processes originate from high-energy charged particles accelerated in or near the sources. Thus an understanding of particle acceleration is the central unifying theme in all the schools theoretical work on high-energy astrophysics. Here very substantial advances have been made over the last two decades, but there is still much to be done, both at the fundamental level (eg in understanding the Lucek-Bell mechanism for magnetic field amplification) and in the appplication of fully nonlinear calculations of particle acceleration to realistic simulations of astronomical objects. **The section will seek resources, both human and computational, to pursue these studies.**

Star formation

DIAS is a recognised leader in star formation and in particular the striking jets that young stars produce during the first million years in their lives. It coordinates a EU funded research-training network, known as JETSET (Understanding **Jet**s through **S**imulation, **E**xperiment and **T**heory), consisting of 10 European institutes and involving around 80 scientists. The network directly employs some 20 Early Stage (Pre-doctoral) and Experienced (Postdoctoral) researchers. Its goal is to bring together scientists working on jet physics in the laboratory, through numerical simulations and observation. The project began in February 2005 and will formally end in January 2009. During this period DIAS will have funding for 3 postdoctoral fellows, one fellow will also have a science management role. For logistical reasons, it is likely that the project will continue, with EU support, until the end of 2009. **During this period the section will seek to ensure that there are strong interactions between the JETSET personnel and other DIAS groups particularly those working in computational astrophysics.**

In the next 5 years, there will be major opportunities to carry out high spatial resolution studies in optical/near-infrared astronomy with the development of interferometers such as ESO's VLTI in Chile and the Keck Interferometer. Through

our collaboration with Arcetri Observatory, one of the instrument builders for the VLTI, DIAS will have access to guaranteed VLTI time and it is hoped to exploit this to study the cores of young stars. In particular the VLTI will allow us to capture detail on scales 50 to 100 times finer than currently possible and explore distances comparable to those between the Sun and the Earth, 450 light-years away in the nearest star forming regions.
Aside from optical/near-infrared interferometers, conventional radio interferometers, such as the Very Large Array (VLA) and the Multi-Element Radio Linked Interferometer Network (MERLIN) are about to undergo an enormous enhancement in their capabilities due to the installation of inter telescope dark fibre links and vastly improved correlators. This will allow a 40-50 increase in sensitivity making it possible, for example, to image deeply embedded newborn stars that are only tens of thousands of years old. The group in DIAS have been asked to help define the star formation key programme to be undertaken by e-MERLIN in 2008-2010 and to become involved in the commissioning phase of this instrument. **The star formation group will seek to leverage long-term advantage for its research interests through these projects.**

The James Webb Space Telescope

The James Webb Space Telescope (JWST) is due for launch in 2013 as the planned replacement for the Hubble Space Telescope. With a mirror spanning over 6.5m, it will have a light collecting area 7 times greater than Hubble. As JWST will be optimised to work in the infrared, the telescope has to be kept cool (down to 7K) and, with this in mind, it will be positioned beyond the Moon far away from the heat of the Earth. JWST is a joint NASA/ESA venture, which will be launched on a European rocket; the Ariane V. Prof. Ray is a Co-Principal Investigator for one of JWST's 3 instruments, the Mid-Infrared Instrument (MIRI). MIRI will provide unrivalled imaging and spectroscopy at wavelengths between 5 to 27 microns. Its excellent sensitivity in the mid-infrared, combined with the outstanding collecting area of the JWST mirror, will open up whole new areas of study. Many programs that are, and will remain, impossible to carry out from the ground, will be feasible with MIRI. These include studies of how galaxies formed and evolved in the very early Universe, the processes by which stars and planets are born and the creation of the first heavy elements.

DIAS has already contributed to the design and procurement of the MIRI hardware; in particular all of the long wavelength filters, blocking filters and beam-splitters for the imager and spectrometer. The plan is to integrate these into the Flight Model towards the end of 2007. As testing and calibration of the instrument begins, it will be necessary to develop software for instrument assessment purposes as well as first-look and pipeline data reduction. Funding for Irish involvement in JWST to date has come from ESA's PRODEX program. **From 2007-2011, the intention is to switch the emphasis from hardware to necessary human resources. In particular we hope to employ two people to work on this project in house. Towards the end of 2010, DIAS will play a major role in defining the guaranteed time program, particularly in the star formation area, that MIRI will undertake.**

Finally it is worth noting that NASA and ESA will hold its major review of JWST in 2007 in the Royal Hospital Kilmainham at the invitation of DIAS. Some 250 people are expected to attend.

The James Webb Space Telescope model stands majestically on the lawns at the Royal Hospital Kilmainham, Dublin (June 2007).

Expanding Public Outreach

Dunsink Observatory is ideally suited to be a major centre for public outreach and indeed, through the programme of open nights and special events, is already making a substantial contribution in this area. The move of the Astronomical research work into the city centre will allow the School to focus on developing Dunsink as the primary centre for its public outreach activities. **The school intends to develop this role in a more systematic and professional manner in collaboration with suitable partners and/or sponsors.**