

Some comments on the report on 'The Future
of Danish astronomy'

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General comments

Let me first say that I am impressed by the effort and thoroughness of this report. It provides a very useful overview of the current activity in the various areas, and I think it is fair to say that given the size of the astronomical community, Danish astronomy is well living up to its traditionally high standard. Because I have been able to follow the development of Danish astronomy closely over the last 25 years, I have also noted a dramatic change from 'classical' astronomy to modern astrophysics, with strong groups active in many of the most competitive areas. With this general background I will now make a number of specific comments to the report. I will sometimes refer to the Swedish situation, not because I think it is ideal and certainly not superior to the Danish, but because I know it better than others, and there may be a few examples where we have had some positive experience to share.

Specific comments

1. Given the stringent economic boundary conditions, I support most of the recommendations in the report. In particular the gradual announcement of new positions to replace retired astronomers sends out a positive signal to the young astronomers, and also ensures that there will be enough competent applicants for each of these. Having said this, I am nevertheless surprised, and somewhat depressed, to see that this report only has one main alternative, implying a severe cut in the number of positions in astronomy. A country with one of the strongest traditions in astronomy, with astronomers like Tycho Brahe, Römer, Hertzsprung, and Strömgren, should, in an epoch which probably represents the most rapid and exciting development in the history of the subject, be able to afford a more aggressive policy. Given the fantastic number of new telescopes and instruments, both in space and on ground, there is a clear danger that the Danish community will not be able to fully exploit these possibilities. I will return to some specific examples of this below. In relation to the investment in these projects, five or ten positions represent a minor cost! To illustrate the possibilities this would imply, it would have been of great interest to discuss one alternative with a modest increase in the number of positions.
2. Given the already close to sub-critical nature of several groups, still doing

first rate science, I agree that it is reasonable to strengthen the existing strong areas of Danish astronomy. At the same time, this always represents a danger of conserving the present structure, and not being able to respond to new exciting developments in the field. A possibility to solve this dilemma, used by the Swedish Research Council, is to create special research positions at Associate or full Professor level in particular fields, which are then internationally announced.

3. At the post-doc level, a system, which has been very successful in Sweden, has been the creation by the Research Council of a large number of post-doc positions for young Swedish scientists, who want to go abroad. Further, the Research Council finances open post-docs for a large number of the most successful research groups. These are only intended for foreign applicants. Both these programs have had a very positive effect in promoting a rapid development of new, previously not existing areas of astrophysics.
4. I find it surprising that one of the main efforts during the last decade, the establishment of the Theoretical Astrophysics Center (TAC), has received so little attention in the report. Given the size of this project, as well as its time limited nature, it would have been very interesting, both for Danish astronomy and in an international context, to have a more detailed evaluation of its impact in its two main subfields, cosmology and astro-seismology. A simple exercise would e.g., have been to single out these subfields in Table 1, or in terms of citations in these fields.
5. There is little mentioning of astroparticle physics in the report. This is a rapidly evolving field at the interface of astronomy and physics. Denmark has several prominent physicists working in this area, and it is likely that it will expand even more. While the existing theoretical activity is impressive, there seems to be less experimental efforts. In Sweden this field has expanded rapidly, but not at the expense of astronomy. Instead, many physicists working in particle physics have gradually become active in this field. It has also lead to an increased general interest in astronomy among the physics community, and a better understanding for the need for new instruments and satellites.
6. I would have expected to see some discussion of the future of NOT. Already now NOT is a small telescope. In the past NOT had a niche in

view of its superior image quality. Today, with active and adaptive optics, NOT is behind other much larger telescopes, like VLT. The uniqueness of NOT is therefore not obvious. At the same time the Danish contribution to NOT represents roughly two full-time professors, or four post-docs. In principle, NOT can have a scientific future, if it is equipped either with some unique instrumentation, or more realistically with a dedicated scientific program, where its small scale operation can be used to its advantage. A good example of this is the gamma-ray burst program headed by Danish astronomers, and this may well motivate a continued operation. An increased level of service operations, as has been a major success with VLT, would greatly improve the capacity for this type of projects. This should, however, be discussed in more detail from other points of view, as well as with the other partners of NOT.

7. The next large ESO projects after VLT are VLTI, and on a time scale of 5-10 years ALMA. There is at present little activity in Denmark in the field of radio astronomy, which may be explained by the lack of instruments in this wavelength range directly available to the Danish community. This situation will, however, change already next year with APEX, the forerunner to ALMA. The total investment in ALMA is ~ 600 MEuros, and the Danish contribution about 6 MEuros. A similar reasoning can be applied to VLTI, although the size of this project is considerably smaller than ALMA. To be able to exploit VLTI and especially ALMA, the creation of dedicated positions in this area would be well motivated.
8. NORDITA represents a major resource to Danish theoretical physics and astrophysics. There are already fruitful collaborations between Danish astronomers and NORDITA in e.g. hydrodynamics and astroparticle physics. Efforts to further strengthen this may be possible, in particular in promoting new fields of astrophysics, as well as for educational purposes in the form of summer schools and for increased Nordic collaboration. There may also be possibilities of more intense collaborations with the astronomers in Lund in terms of e.g., instrumentation, and graduate education.
9. With regard to various educational efforts, I think it is important to continue to provide the students with a strong general physics background. This, I think, is one of the reasons why Danish astronomy during the last decades has been able to respond to the general rapid development of

the subject. It is in general easier to pick up the necessary astrophysical knowledge at a later stage, than it is to compensate for a weak physics education.

10. In the section of education it is suggested that it should be investigated if there is a sufficient basis for establishing ' Astro-101 ' courses. With the exception of some bureaucratic problems at the university level, which can always be solved with a bit of creativity, I think the answer is clear. There is already more than sufficient experience in many countries that there is a very strong interest among students, as well as e.g., high school teachers, for this type of courses. In Sweden all universities have one or more courses of this type. In Stockholm we are running a set of 5-6 courses over a cycle of two years. One is a general 101 course, while the others are more specialized, like cosmology, stars, life in the universe etc.
11. Danish astronomy (as well as Nordic in general) suffers from a serious imbalance in terms of permanent positions filled with women. I think this is an important point to discuss in connection to the future development of the subject, because it sends the wrong signals to young female students, and the subject therefore risks to loose many talented students. This is a too important and complex issue to be discussed here, but I think it is an important topic for the future discussion. For the future discussionIn this context, I think it would be a good idea to involve some representative female astronomers, as well as graduate students and post-doc. After all, they will be the ones mainly affected by these plans.

Comments on „The Future of Danish Astronomy“

It is not easy for an outsider in two ways, not Danish, not an astronomer, to do justice to this report and provide relevant advice.

First, my impressions on the text. It is well written and contains as its major part an excellent and concise account of the present state of astronomy and astrophysics. Even somebody only weakly familiar with modern astronomy (here I do not mean myself), when reading this text, will be convinced of the exciting past, present and future of this discipline and its broad educational value. No doubt, the Danish academia must see to it that astronomy and astrophysics is in a healthy state.

But now to the main deficiency of the text, at least in my eyes. It does not provide any description or analysis of the competencies and weaknesses of present days' astronomy and astrophysics in Denmark, except for a few general mentionings of participation in ESA, ESO, the Nordic Optical Telescope, a 1.5 m telescope and hardware contributions to a few space missions, including INTEGRAL. But what are the highlights, where does Danish science excel? Investing into the future must respect the strengths of past and present, not only the attractions of the new frontiers, because science lives on education and transfer of specific know-how. So, I am lost when I read on page 8 about the modelling of charged particle dynamics and do not know whether this is supported, for instance, by any in situ or direct observation in space or on the sun. Or, on page 11, what is the exact Danish contribution to the Planck mission? A large number of grand themes are listed, from the exploration of the Dark Ages to astrobiology, but not where Danish astronomy can make an impact.

Perhaps the greatest surprise for me is the absence of any mentioning of solar system research, although one refers to the formation of planetary systems. I believe that participation in ESA should take into account the heavy investment of the Agency in future planetary exploration. One should recognize the proximity to astrophysics and, in technology, the intimate relations of the arts of hardware building for space missions and for ground-based astronomy.

Finally, I want to address the recommendations. I fully subscribe to the statement on page 16 that the astronomy education must be based on a solid training in physics. For some students further training in chemistry and biology may be advisable. Secondly, I think collaboration between the universities of Århus and Copenhagen on the level of graduate courses is a very good idea. In part this can be achieved by installing modern video conferencing facilities. Thirdly, I am not so convinced that the transition from two semesters to four quarters is such a good idea, but that depends on how it is being managed.

The final recommendations of the memorandum contain some very explicit advice which, I am sure, has emerged from a very careful analysis of the personnel situation and the financial capabilities of Denmark's educational system. So, I can only support the proposed strategy for rejuvenation of the university personnel. I applaud also to the installation of a Danish Graduate School in Astron-

omy/Astrophysics. But there is one proposal for which I would like to consider an alternative, the creation of a national center for ground and space-based astronomy. This is certainly a good idea whose feasibility, however, I cannot judge. But if feasible, would it not make sense to integrate such a center with the DSRI? The main reason is three-fold. The first is the strong overlap of technological background for the development of ground-based and space-based instrumentations. The second is the low rate of projects and long lead-times in conception and execution of any individual project so that the demands on manpower tend to undergo large amplitude variations. The broader the scope of a hardware institution, the easier is the equilibration of the workload. Thirdly, and perhaps most importantly, I think that astronomy and in situ research in the solar system should be closely linked because both look at the same universe, only from different perspectives.

Because of what is said in my opening statement I refrain from going into further details.

Gerhard Haerendel

Bremen, 26 May 2003

The Future of Danish Astronomy

Comments on the Draft Report by Malcolm Longair.

I enjoyed reading the document concerning the Future of Danish Astronomy. It seems to me a fair and accurate description of the current state of astronomy in Denmark and how it is proposed it should evolve over the next decade or so. I was struck by the fact that it was not overambitious but addressed what could realistically be achieved within the limits of available financial and manpower resources. Personally, I would have wished the targets to be more ambitious for the reasons outlined below.

Let me first reinforce the comments made in Section 1.1 about the renaissance in Danish astronomy over the last 15 years. The scene has changed out of all recognition as compared with what I knew say 20 years ago. The astronomers have responded to the new opportunities and challenges. There is no question but that Danish astronomers now have access to many world-leading facilities in both space and ground-based astronomy. It is imperative that the access to the facilities be matched by the quantity and quality of astronomers and physicists to exploit these opportunities.

Central to the future programme is finding posts for young people and filling the senior professorships with outstanding candidates. I have no doubt that there are many outstanding Danish candidates for these positions and it seems to me imperative that these be refilled with younger people as soon as possible. I was struck by the similarity of the problems of age structure and of finding posts for very bright young scientists to that which I found in Sweden when I helped carry out Review of the Swedish programme in Astronomy and Astrophysics for the NFR a few years ago. I think many of the conclusions and concerns of that Report to the Swedish NFR has many resonances with the situation in Denmark. I append to this document a few extracts from that report. It would be best if you obtain a copy of the complete document from the Swedish NFR.

There was not enough detail in the Report on Danish Astronomy to understand the numbers of young people supporting the programme, but my guess would be that the number is quite large and certainly much larger than the number of astronomers who hold permanent staff positions. These young people are absolutely crucial for the success of the programmes and it is an important challenge to work out satisfactory career structures for them.

One exercise which I carried out following the Swedish Review was to work out the number of professional astronomers in first world countries per million of the population. By professional astronomer, I took this to mean, say, the number of members of the IAU or the number of people who will be active researchers in astronomy for most of their working lifetimes. I included both space and ground-based astronomers. The figure is remarkably constant with France, the UK, the Netherlands and the USA typically having about 10 astronomers per million of the population. On this basis Sweden seemed to be in line with the above countries. An

exception was Canada where there were only about half the number quoted above. It is not easy to judge how many astronomers there are in total in Denmark, but I would have expected there to be about 50 to 60 professional astronomers. It may be that the simplest comparison would be with the numbers in Sweden which should be quite easy to derive from our Report. You may wish to consider how Denmark compares with its international competitors. This is important from the point of view of making sure that Denmark receives a fair return upon its national and international investments in astronomy, which are considerable. However it is achieved, people are needed to exploit the present and future facilities.

Let me commend the work of Theoretical Astrophysics Centre. This has undoubtedly been a considerable success and I believe has brought new perspectives to Danish astronomy. The programme will end in 2004 but I understand that some of those who participated in that programme have secured permanent jobs in the Universities. I believe the research associated with Professor Novikov's Group was particularly important since it developed relativistic astrophysics very rapidly into an area of excellence in Denmark. It is important to maintain the momentum built up around that programme, particularly when two of the three main themes of the future programme are cosmology and galaxy formation and extreme astrophysics. In the same vein, I am very impressed by the work of Professor Christiansen-Dalsgaard's group, which I believe also was part of the Theoretical Astrophysics Centre at Aarhus. This is an excellent example of a small group becoming world-leaders in helio- and astero-seismology and gaining a leadership role in the Eddington project of ESO. I am very pleased to see that these initiatives inform strongly the future directions of research proposed in the Report.

Now turning to the specific recommendations:

1. I fully support the recommendation that the programme be focussed on a limited number of areas and those identified will undoubtedly be exciting and developing areas over the next decade. The observational facilities are well matched to these scientific objectives. I also endorse the need to be flexible, in response to new challenges, but these should be areas where the appropriate astronomical or technical base is already present in Denmark. The advance of research in these areas and others through interdisciplinary research with physicists, chemists and geologists is to be strongly welcomed. ALMA will undoubtedly play a major role in the future of the programme and interesting chemists in interstellar chemistry is an obvious point of contact.
2. The renewal of the permanent astronomical staff in the Universities is essential. In the appended notes from the Swedish exercise, some of these suggestions may also be relevant to the Danish situation. I fully endorse the plan that associate as well as full professorships should be advertised as soon as possible. Indeed, the whole manpower structure for the support of astronomy through post-docs, research students and support staff needs to be brought up to full strength in order to capitalise upon the investments already made by the Danish Research Organisations and the Universities. I am fully supportive of everything written in this paragraph, which I understand reflects what can reasonably be expected to be achieved. My own view is that I would wish significantly more posts to be made available to support these areas of astrophysics and cosmology which are of the greatest importance in bringing

young people into the exact physical sciences. The close relation with physics and the strong emphasis in our research and teaching upon exact quantitative analysis in non-trivial ways are aspects of training which are desperately needed in many roles in society. In the UK, we have a policy of overproducing PhDs and post-docs, knowing that those who do not stay in astronomy will contribute in a major way to society through their rigorous scientific training.

3. I strongly welcome the proposal to consolidate the infrastructure for the support of major facilities and projects, both in space and on the ground. My impression when I visited Copenhagen and the new facilities for the Space Research Institute and the instruments being built for ESA was that these were already in rather close proximity and that it would not need a major change of direction to consolidate the activities of the project and technical personnel. There is no question but that technical support facilities are essential if Denmark is to win its fair share of the instrumentation activities for the ground and space-based activities in which Denmark is an international partner. This will necessarily involve collaborations with industry and the Universities. If it were possible to involve some of the physics and engineering departments in these activities as well, that would be very much to everyone's benefit.
4. I welcome strongly the idea of increasing the number of graduate students and post-docs, moving towards the UK model of overproducing at these levels on the understanding that the programme produces trained research workers of high academic and technical expertise. The national effort would ensure broad coverage of all aspects of astrophysics, although the core of the programme would have to be built around the three main themes of the Danish programme. If the best way of achieving these objectives is through a Danish Graduate School, I would welcome that initiative. I very much like the idea of a national post-doc programme. To make it even more attractive, it could be tied in to programmes involving the use of the international facilities and increasing their chances of winning time on these facilities.
5. This is a very sensible proposal if it can be made to work effectively. Even at a distance of 200 metres, or within the same building, collaboration can be difficult. But, if there is goodwill and the problems of travel between Aarhus and Copenhagen are thought to be surmountable, this initiative is to be welcomed.

Finally, outreach is essential, but it is not just through the traditional ways in which this is done. I believe that scientists have lost touch with society and that accounts for a lot of the scepticism about what scientists do. At a very deep level, we need to persuade ordinary people of the value of pure scientific endeavours and how these enrich society, both directly and through raising their appreciation of what we do.

There are some other reflections on some of these points in the attached notes which are part of the Swedish Review.

Good luck with your programme. I very much hope it will be even more successful than your excellent document proposes.

Malcolm Longair
Head of the Cavendish Laboratory, Cambridge.

28 May 2003.

Some sections from the draft report on Swedish Astronomy and Astrophysics 2000.

(b) RATIO OF PERMANENT VERSUS NON-PERMANENT SCIENTIFIC STAFF, AGE DISTRIBUTIONS, NEEDS FOR "OVERLAP APPOINTMENTS"

The Committee observed that the number of permanent scientific staff in each of the Swedish Astronomy Departments is quite modest and a large fraction of the active consists of graduate students and postdoctoral fellows. Many of the most active staff members are on temporary, often long-term, contracts. For many of these untenured staff members there seems to be no clear career path beyond the termination of their contracts, even though they may have a very good scientific track record and already be quite senior. Furthermore, the age distribution of the permanent scientific staff in most institutes is unbalanced, with many of the permanent scientists being within 5 to 10 years from retirement - the committee considers this to be an unhealthy situation. As an example, in the Astronomy Department at Lund University, all permanent staff members are over fifty, and, with one exception, even over 55 years of age.

The committee considers that "new blood" is urgently needed in the permanent staff of most institutes, in order to maintain the vitality of the research endeavour into the future. This situation is not unique to Sweden. In many European countries the same is true, partly because of the large expansion of the universities in the 1960s. Several European countries have introduced programs to rejuvenate the permanent scientific staff, for example, by creating "overlap appointments" so that, for example, five years before a professor retires, his or her successor can be appointed. Other countries have introduced "new-blood" lectureships supported by the research councils for, say, five years on the understanding that the Universities guarantee a permanent position after that time.

We recommend that Swedish universities consider seriously ways in which the age distribution of permanent staff members can become more balanced. The present rather unbalanced age distribution poses a serious threat to the vitality of Swedish astronomy in the near future.

(c) MOBILITY OF STAFF

All scientists we met had considerable international experience, often having spent quite long periods in institutes abroad. Many take part in international scientific collaborations. The committee considers it an excellent rule in Swedish astronomy that, after obtaining a doctorate, a young scientist generally spends at least two years abroad as a postdoctoral fellow. The committee is convinced that this "international aspect" is a very important element contributing to the high international standing of Swedish astronomy. There is also some mobility of staff members between institutes within Sweden, although there is quite a strong tendency, after a stay abroad, to return to one's original institute. The committee was pleased to note that among the permanent staff of almost every department there are one or more foreigners, and that there are many postdocs and graduate students from foreign countries.

(d) GENDER BALANCE

The Committee made a point of discussing career development with women staff members at each of the Institutes visited. It is an unfortunate fact that there are very few women in permanent staff positions in the Swedish Astronomy Departments. This was recognised by everyone with whom we talked, but there were few suggestions about how the position should be improved. This is a very complex issue and one which has not been solved in many countries which are leaders in astronomy. In some countries, such as France and Italy, our impression is that the situation is much better than in, say, the UK, the USA, Germany or the Nordic countries.

With Sweden's enlightened social policies, we are convinced that there are equal opportunities for women being candidates for permanent University positions, but for various reasons, they are not being appointed. We do not believe that affirmative action is necessarily any solution to the problem. One suggestion, which may contribute to the problem, is that typically in those countries where there is a strong gender imbalance, the age at which even the brightest post-docs can expect to obtain a permanent position is in the age range 30 to 40. This discriminates biologically against women who will often wish to bring up families during this age range. It might be helpful if the age at which tenured positions became available could become somewhat younger. Then, women would have a better chance of carrying both their scientific and family responsibilities. This is, however, a complex issue and the Committee urges the Universities and the Funding organisations to set up a special study group to find out how best to tackle this problem.

3.4 Astronomy and Astrophysics in a scientific and social context

(A) ASTRONOMY AND PHYSICS

The committee was pleased to observe the strengthening of relations between the astronomy and physics departments in all universities we visited. In each of the four universities, the department of astronomy is moving to a new building, together with the department of physics. This practically simultaneous move can hardly be a coincidence: clearly in all departments the need has grown to be closer to colleagues in physics and to physics students. The isolated locations of the astronomy groups in their separate Observatories no longer matches the way in which modern astronomy is carried out. Today practically all observations are carried out with instruments elsewhere, either on the Canary Islands or in Chile, or in space, and the data are transferred through satellite communication or through Internet. The techniques applied in astronomy and physics, for reduction of large amounts of observational and experimental data, respectively, and in model-simulations (computational astrophysics) are becoming more and more similar and both groups will profit from these new closer relationships. Also the emergence of new interdisciplinary fields such as Particle Astrophysics (see above) will benefit much from the closer relations between physicists and astronomers.

(B) ASTRONOMY AND PHYSICS - ATTRACTING YOUNG PEOPLE INTO SCIENCE

Due to the high visibility of its many exciting discoveries, astronomy nowadays fulfils an important function in society in attracting students to the "hard" natural sciences (physics, chemistry, applied mathematics, etc). The number of students choosing to study the "hard" physical sciences has been decreasing rapidly in all developed countries over the past decade, just at a time when our technological society needs more and more people trained in these sciences.

Students find astronomy a very fascinating and attractive subject in that in there are still many important unsolved problems, while the present new generations of telescopes on the ground and in space offer a multitude of opportunities for making exciting new discoveries. As a result, in all developed countries, alone among the "hard" physical sciences, the number of students studying astronomy has been steadily increasing over the last decade. In some universities in the Netherlands and the UK, their numbers are already comparable to the number of physics students. In several universities in the UK, physics departments have started up astronomy in order to attract students into physics. Astronomy offers an excellent training ground for young people in the physical sciences, as the core curriculum for astronomy is the same as that for physics. Experience shows that astronomy students who decide not to continue in astronomical research after graduating or obtaining a Ph.D., easily find jobs for which a training in the physical sciences is required. These range from industrial research laboratories, software companies and geophysical exploration to oceanography, space research, atmospheric sciences and management consulting.

Thus, astronomy should be seen as a key component in attracting young people into the exact physical sciences where there is a desperate need for trained manpower in all the developed countries. We believe it will be helpful to the support of astronomy if the Swedish Funding Agencies can provide factual statistics about the future destinations of undergraduate and post-graduate students of astronomy.

(C) ASTRONOMY, SOCIETY AND PUBLIC OUTREACH

The Swedish contributions to astronomy, astrophysics and cosmology deserve wide public dissemination. Time did not allow the Committee to discuss in any detail with our Swedish colleagues their endeavours in public outreach in astronomy, but we regard this as an important responsibility of all astronomers. Public outreach has many ramifications for the astronomy programme. The fact that the general public, and particularly young people, have a natural curiosity about astronomical matters means that it is perhaps the most readily accessible of the modern sciences and one in which many of the issues which the professionals are struggling with can be communicated to the public. A second important point is that, as discussed in Section (B) above, astronomy is a means of gently introducing young people and the general public into the remarkable power of the exact physical sciences. A third aspect is that we owe it to the public to show the excellent use to which their substantial financial support is be applied.

The Committee encourages the Swedish astronomical community to develop a stimulating and exciting outreach programme, particularly aimed at young people. We encourage the Funding Bodies to make resources available to all the astronomy groups to enable the science to be communicated effectively to the public. In the UK, for example, besides small grants specifically aimed at public understanding of science, a certain small percentage of all research grants can be used for public outreach.