

EVALUATION OF ESTONIAN RESEARCH INSTITUTES

IN ASTRONOMY, ATMOSPHERIC PHYSICS AND RELATED SUBJECTS

Report to the Estonian Higher Education Accreditation Centre, Tallinn (EHEAC)

March 5 –11, 2001

I. Introduction

At the request of the Estonian Higher Education Accreditation Centre, Tallinn (EHEAC), an evaluation team (hereafter the ‘**Evaluators**’) visited institutes in Estonia carrying out research activities in astronomy and atmospheric physics and related subjects. The Evaluators consisted of: Prof. Ilkka Tuominen (Oulu University, Finland), Prof. Clemens Simmer (University of Bonn, Germany), Prof. Cesare Barbieri (University of Padua, Italy), Prof. Ken Phillips (Rutherford Appleton Laboratory, U.K.), and Prof. Claes-Ingvar Lagerkvist (Astronomical Observatory, Uppsala, Sweden). The Evaluators were provided with extensive self-evaluation reports written by staff at the Institutes concerned. The Institutes were: Tartu Observatory at Tõravere (Director: Dr L. Leedjärv), Chair of Astrophysics at the Institute of Theoretical Physics at Tartu University (Prof. Dr. Ene Ergma), Institute of Environmental Physics at Tartu University (Head: Prof. Hannes Tammet), and two groups at the Institute of Physics, Tallinn Technical University (Head: Prof. Dr. R.-K. Loide), namely Tallinn Observatory (Dr. P. Kalv) and the gravimetric station in Tallinn (Mr. J. Paesalu).

After a brief orientation meeting at EHEAC, the Evaluators visited each of these institutes. As well as the self-evaluation reports, the Evaluators were given much additional information including reprints of papers, annual reports etc. and presentations, both formal and informal, were given by members of staff at the institutes visited.

The EHEAC asked the Evaluators to judge the research of the institutes visited based on the following criteria:

- A. The novelty of the results of research and development,
- B. The quality of research and development,
- C. The strategy and perspective of research,
- D. The competence of research groups and their capability for development;

- E. Success in applying for funds and grants,
- F. National and international co-operation,
- G. The implementation opportunities for the research results and their importance for the Estonian society,
- H. The correspondence of research and development to the international level.

The Evaluators were asked to give assessments on a four-point scale (Excellent, good, satisfactory, unsatisfactory). In this Report, the Evaluators have in addition made various Recommendations. Both the assessments and recommendations are given in **bold type**.

The rest of this Report is divided into sections describing our general impressions and comments (Section II) then more detailed comments for the different institutes.

I. General Comments

The Evaluators took note of the fact that an assessment of astronomical research had been made by representatives of Swedish institutes in 1992 to the then Estonian Science Fund Council. In addition, at about this time, the United States Naval Research Office made a short report on the Institute of Environmental Physics at Tartu University. The U.S. report was extremely favourable. The Swedish report made several points about Estonian astronomy research, generally recommending that the research carried out be more openly available to the outside, in particular the Western World. One recommendation, for example, was for Estonian researchers to publish papers in the open literature to a greater extent, inevitably meaning in English rather than Estonian or Russian.

It is clear that a great deal has changed since 1992. It was clear to the Evaluators that many of these recommendations had been implemented, and that researchers in the various institutes the Evaluators visited were much more geared to advertising their research by writing papers for international journals. The output from some groups is particularly outstanding – the two astrophysics groups at Tartu Observatory for instance being highly prolific. The Annual Report of Tartu Observatory is also a useful summary of their work. The Internet has grown enormously since 1992 and some groups we visited now have Web Pages that are an attractive way of learning about their work and environment. We did note however that these web sites are a little out of date – **the Evaluators recommend that these are updated at least once a year, with a list of important publications and highlighted research activities**. This will cost the Institutes very little but should be an increasingly effective way of advertising.

The whole funding system has changed since 1992, with the end result being that most researchers now have to “bid” for research funds in a competitive way, these funds including not only the money needed to carry out the research activities but also fundamental items such as the salaries and travel and subsistence expenses of the researchers. **The Evaluators generally applauded this peer-review style of research proposals and recommend that this continue. However, the**

Evaluators thought it was important to maintain some basic funding for the departments in addition to the funds obtained from the bidding process.

There seems to be relatively small amounts of non-Estonian funds coming into the institutes (two exceptions being the International Science Foundation long-term research grant to Dr. Haud's group at Tartu Observatory in 1995 and the Participation of the Institute of Environmental Physics in the 5th Framework Project (P.I. A. Mirme) in 1998). Yet many of the research activities carried out are of very high international standing – examples include the cosmology activities of Prof. J. Einasto at Tartu Observatory and the theoretical work done by Prof. E. Ergma -- so grant proposals by applicants at Estonian astronomy institutes could stand a high chance of success. Information about the many possibilities of outside funding that can be found from the Internet and most likely the Estonian Academy of Sciences can be a source of advice in this respect.

There is a clear commitment to bringing in young people into research, another big change since 1992, though the Evaluators thought that in some cases that this could be emphasized still further. Training young people in astronomy is an extremely important way of helping these people to learn techniques that can be used in a wide variety of different disciplines, not just scientific research but commercial activities like banking, a lesson that is repeatedly learned in EU countries and the U.S. **The Evaluators therefore encourage the Estonian funding authorities to continue funding astronomy research at present levels or higher if possible, as this will prove to be a valuable investment for future generations in Estonian society.**

Cross-fertilisation of research, e.g. by exchange visits, can be an extremely good way to encourage research activities, particularly for younger people. The Evaluators noted that some investigators at the Institutes visited have attended international conferences, though the level seems rather low for some groups. The attendance of students in particular seemed to be very slight, even though many international conferences (like the International Astronomical Union and those organised by the European Space Agency) have “bursaries” that enable financial help in travel and subsistence to students and postdoctoral fellows. In addition, there are national programmes in some EU countries (e.g. the British Council) that offer the possibility of travel funds for limited exchange visits. (Though the British Council in Estonia has not yet given extensively to science projects, this may be because of a relative lack of science proposals.) The Evaluators realize that international visits may contribute somewhat to a “brain drain” of Estonian astronomical expertise, but they thought this would probably be very minor. In general, then, **the Evaluators recommend that more energy be devoted to providing international travel for particularly young researchers.**

The astronomical equipment that the Evaluators visited at Tartu Observatory (1.5m telescope) and Tallinn Observatory (0.5m telescope) seemed to be in good shape apart from lack of regular maintenance (especially the recoating of the mirrors). It was evident that they are being extensively used. However, the highly

motivated and prolific astronomers the Evaluators met would welcome access to the much larger international facilities such as the Nordic Optical Telescope (NOT) and European Southern Observatory (ESO). **We recommend that consideration of membership to these consortia** should be made if and when money becomes available. Estonian astronomy would then really start to make its mark on the international community.

Astronomy does not offer many direct commercial possibilities (though as mentioned above the training of young people in specialized astronomical techniques can be very usefully applied in the commercial world). However, in the experience of the Evaluators, the general public have a considerable interest in astronomical and space science matters as evidenced by recent events such as the appearance of Comet Hale-Bopp and the total solar eclipse in 1999 and the number of “hits” recorded for a variety of astronomical World Wide Web sites. The Evaluators found it very gratifying that the staff at Tartu and Tallinn Observatories open up their facilities in a regular way to the general public for educational purposes. There are even plans for an eventual erection of a planetarium at Tartu. These are excellent ways of promoting public understanding of astronomy and science generally which will help the Estonian people to appreciate why part of the national income is being spent on such specialized subjects. The Evaluators were told that several thousand people visit the two observatories each year, which is very commendable in view of the way the staff have to spend their limited amounts of research time on these activities. **The Evaluators strongly recommend the continuation of these activities as a way of educating Estonian society.**

The Evaluators were concerned at the sometimes poor state of maintenance of equipment which is evidently due to relatively small funding levels in recent years. Particular cases are noted below. This raises health and safety issues which should be of great importance, especially for facilities (the Observatories) which the general public use. **The Evaluators recommend that attention be paid to proper maintenance to these facilities.**

The Evaluators were concerned at the uneven distribution of staff ages at the various institutes – in some cases (e.g. Tallinn Observatory and the gravimetric station at Tallinn) staff who are either nearing retirement age or will be in about 10 years’ time are the only ones looking after facilities. There is an evident need for younger people to be trained up to take over these important facilities – again particular cases are noted below and recommendations made.

The status of Tartu Observatory as an independent research institution was extensively discussed by the Evaluators with staff at the Observatory and the Tartu University. It was clear that the staff of both institutions had differing views. **It was our view that Tartu Observatory should remain as a research institution independent of the University of Tartu.** This is an important point if at some stage in the future Estonia wishes to join international consortia such as

the NOT, ESO and European Space Agency (ESA). In spite of this, teaching and research activities at Tartu University by Observatory staff should be strengthened and formalised.

II. Tartu Observatory

A. Dept. of Cosmology

General Overview

The Department of Cosmology, led by Prof. Jaan Einasto, is divided into three groups, one of Cosmology, one of Physics of Galaxies and one of Data Communication. This latter however is apparently composed by one single person, and no information was provided to evaluate it.

In the period 1995-2000, two PhD Theses (one of which from Georgia) and four Master Theses were supervised. At present, two PhD theses and four Master theses are supervised. Regular lectures and seminars are given. Therefore the interaction with Tartu University seems very good.

The Department has constant collaboration with researchers and institutes of different foreign countries, well reflected for instance by joint authorship in the excellent collection of scientific papers. This international capability is undoubtedly prompted by scientific reputation, but it should found a more formal status with international protocols of agreement. Realistically, one could think of a formal relationships with the group of the other Nordic countries active in Astronomy, to have regular access to the Nordic Optical Telescope (NOT) at La Palma, and perhaps some sort of 'observer status' with the European Southern Observatory (ESO). For instance, it is felt by the reviewers that the Department of Cosmology could be a valid utiliser of the ESO AstroVirTel project. **To this end the Evaluators recommend that the already existing data communication facilities between Estonia and the rest of the world be kept at the forefront of the state of the art.**

Funds for the Department came essentially through grants by the Estonian Science Foundation and by the International Science Foundation. The motivation and utilization of that money seems adequate and good; among the rest, the group could provide several modern computers and travel to major international conferences.

The Cosmology and Physics of Galaxies groups will be evaluated separately in the following.

Group of Cosmology.

There are six research associates (four senior) in the Group, four of them holding a PhD, in addition to Prof. Einasto himself.

The group has a long standing international reputation that goes back to the works initiated by Prof. J. Einasto 30 years ago on the structure of the observable Universe. These works have been greatly extended by the younger collaborators, with the systematic utilization of observational data from various optical, radio and X-rays surveys. More recently, the importance of cosmic microwave radiation fluctuations has been taken into consideration in order to derive the initial power spectrum of matter. The group is therefore already evaluating the possibilities offered by the future European space mission named 'Planck' and preparing its younger members for this great opportunity. The Evaluators were quite impressed by the group's recognition of a regularity in the spatial distribution of rich cluster of galaxies, with a typical 3-D cell size of 120 - 130 h^{-1} Mpc, the work being published in *Nature* in 1997, and given the Estonian Science Award in 1998. The Evaluators were also interested to see a pre-publication issue of an advanced-level book (to be published by Cambridge University Press) about matter distribution in the Universe by one of the group members.

Group of Physics of Galaxies.

Five research associates (four senior, and one having a part time duty as lecturer at the University of Tartu), four holding a PhD, form this group. The group's original contributions to the understanding of the properties of small group of galaxies, of the distribution of interstellar Hydrogen, of the stellar populations, are well represented in the publications. The international collaboration is strong. Some of the work produced by this group deserves a special mention, being utilized by other researchers, for instance the numerical algorithms for the Gaussian deconvolution of two-dimensional data, or the stellar spectral classification needed for calculation of atmospheric refraction.

In summary, the quality of the research carried out by the two groups of the Department, as shown by the amount of literature in international refereed journals, the interaction with the local academic world, and the interaction with the international community, is judged to be **good to excellent.**

Recommendations:

- The average age of the Department is fairly high. The young people who are in the Department should be given immediate opportunities to spend an adequate period of time (2 to 3 years) abroad so that when they return they can inherit the distinguished record of this Department.
- More students from other countries should be hosted.
- An international congress on a suitable cosmological subject should be organized reasonably soon. (The Evaluators noted the more-than-adequate conference facilities at the Observatory.)

A. Dept. of Astrophysics

General overview

The department lead by Dr. Arved Sapar is divided into two subgroups, the group of stellar physics and the group of theoretical astrophysics. In addition there is a group for managing and maintaining the Observatory's telescopes. The total number of the personnel is 18 including two technicians and a scientific secretary. During the period of the evaluation 34 papers were published in international refereed journals (however, one person is the author of 15 of these papers) and about the same number of other papers were published. Dr. Sapar gave a summary of the work within the group and some of the highlights were presented in more detail. Several of the younger students were also present at this occasion. The Evaluators visited the "Stellarium" exhibition and the 1.5m telescope (the only one available to the Tartu astronomers), used exclusively for stellar spectroscopy, was demonstrated. We also inspected the main observatory building with the office facilities and the plate archive from the 1.5m telescope. The total number of ESF grants during the evaluated period was nine with three grants running during the year 2000.

The age of the scientific staff is very high, ranging from 40 to 67, with ten over the age of 55 in the Department of Astrophysics. The number of PhD students is rather low with few examinations in recent years. Several of the staff at Tartu observatory give lectures at Tartu University on a voluntary basis without pay. The office facilities seem adequate as does the computing equipment. The condition of the dome and the telescope is not up to modern standards, in particular the recoating of the mirror is long overdue. Attention should be paid to these points if Tartu Observatory is to remain in the forefront of observational astronomy.

The total number of visitors from the general public, 7000 per year, is commendably high and the informative "Stellarium" exhibition at the Observatory is a very good example of what can be made with very modest funds. Especially recommendable is the annual astronomical almanac with interesting astronomical highlights for the year in question. The number of copies sold gives good evidence of this something that maybe in the future can be turned into a popular astronomical magazine published in Estonian. There is therefore a strong connection with Estonian society in general.

The research carried out in astrophysics covers a large range in both theoretical and observational astronomy. Most of the results are now published in journals with international standards. Given the circumstances for research in astrophysics at Tartu Observatory we rate the astrophysics part of it as **good to excellent**.

Recommendations

The quality of the research is high, and to maintain this the funding must be kept at least at the present level. Some improvements can be made such as strengthening the international collaboration. At present only the Russian 6m telescope at Special Astrophysical Observatory (North Caucasus) is used regularly by staff. We recommend that the Tartu observers make more use of international facilities such as the Nordic Optical Telescope, European Southern Observatory, or other international observatories giving observing time to non-members. This could be done in collaboration with astronomers of the member states. Especially with Nordic astronomers it should be possible to enlarge the collaboration without too much investment of time or money. In case such applications for observing time are successful we recommend that the Estonian astronomers are guaranteed travel money from the Estonian Science Foundation. In the long run an Estonian membership in the NOT and ESO consortia should be considered.

We further recommend that the number of PhD students is increased, in collaboration with the Tartu University and that some modest amounts of money are put at the disposal of these students so they can attend at least one international conference, or summer school, during their PhD studies. Students should be encouraged to apply for graduate student and post-doctoral positions abroad.

B. Dept. of Atmospheric Physics

The Department of Atmospheric Physics, currently headed by Rein Rõõn, is the most heterogeneous department at Tartu Observatory. The department consists of five quite independent groups. Two of the groups have been evaluated already within the “research evaluation of ecology”, October/November 2000, both with “good” results.

The five groups are:

1. Actinomonitoring (Uno Veismann)
2. Energetics of ground surface (Juhan Ross) already evaluated
3. Remote Sensing of Vegetation (Tiit Nilson) already evaluated
4. Climatology (Olavi Kärner)
5. Dynamical Meteorology (Rein Rõõn)

At least one scientist of all the groups gives lectures at Tartu University or the Estonian Marine Academy mostly without pay in order to attract students to their research topics for future enrolment in master or PhD level studies.

Actinomonitoring Group

The group headed by Uno Veismann consists of four scientists with Ph.D. (the youngest of them, Toomas Kübarsepp, only part-time) and one laboratory assistant. Most of the researchers are close to or even past pension age. After the disconnection from the Soviet Space Station missions to which the group contributed very actively and successfully by the development of remote sensing instruments, the scientists reoriented their research to ground based monitoring of ozone related radiation measurements in connection with satellite estimates of ozone by the TOMS instrument. Besides developing and calibrating instruments for monitoring at Tartu Observatory, they also develop instruments to be used by a future national ozone and radiation network to be operated by the Estonian Meteorological and Hydrological Institute, for which the group will do the calibration work. The radiation measurements and the derived ozone column depths are analyzed together with meteorological information in order to allow for predictions of UV radiation and their effects on human health and technical systems.

The results achieved so far are of significance for the international efforts to understand global ozone trends and their regional variation especially in Northern latitudes. Of particular interest is the relation of ozone variability to the different atmospheric modes like the North Atlantic Oscillation (NAO) and the variability of the East Atlantic Jet, which also might shed some light on the nature of global climate variability in general. The future plans of the group point at expanding their activities towards the relation of UV radiation to meteorological parameters but now including aerosols. This will lead naturally to an even more intense collaboration with the group on climatology and also with the group on Environmental Physics at Tartu University. In order to expand the capabilities of the group to compete effectively on the international level, a spectroradiometer for the UV-range and a spectral sunphotometer is urgently needed, the latter especially to include the aerosol impact on radiation.

The group was able to apply successfully for one grant at a time from the Estonian Science Foundation, but no additional research or development money could be achieved on the national and international level, although their co-operation with the Estonian Meteorological and Hydrological Institute and the Estonian Marine Institute contained quite an amount of service provided by the group. Although we recognize the informal co-operation with the Helsinki University of Technology (HUT) due to Toomas Kübarsepp, **we strongly recommend to more actively pursue a participation in UV- and ozone monitoring and research in European scale projects as funded by the EU in the 5th framework programme and maybe follow-ups.**

It seems to us, that the group has not yet recovered from the separation from the former Soviet (now Russian) science programs. The set-up of the laboratory and the measurement instruments absorbed a lot of time, according to the staff the Evaluators met. The group has already published interesting work in national scientific journals, but the senior researchers and the current works of the group is not yet visible on the international level because of the far too low publication record in refereed international scientific journals. Like for the group on climatology the success of this group is hampered by the absence of students on the master and PhD level. We judge the research of the group as **satisfactory**.

Group on Climatology

The Group, headed by Olavi Kärner, consists of only three scientists approaching or past pension age, and one of them only part-time. Olavi Kärner and Sirje Keevallik, are well known in the international atmospheric radiation community and took several positions in relevant science organisations. The group names global change quantification for Estonia on the basis of weather patterns (“Großwetterlagen”) and satellite remote sensing of cloud parameters as their current main goals in the self-evaluation report. The Annual Report 2000 of Tartu Observatory also describes interesting studies on the hydrological links between the surface and atmosphere, especially the influence of snow cover on regional and global climate variability, a topic which becomes increasingly the focus of modern climate research.

The group specifies only one future goal in the development plan, namely the extension of their efforts to use their developed satellite remote sensing and cloud quantification scheme to use satellite data for estimating the terrestrial surface radiation budget globally. This is logical in view of the well-known expertise of the scientist in radiation problems in general and cloud-radiation interaction specifically. It cannot be overlooked, however, that large groups, especially in the US, are also working on this topic. Taken into account, that the group unfortunately was not able to significantly attract students to this topic in the last three years, we doubt that the group will be able to compete effectively in the future. The old idea of atmospheric modes, like the weather pattern described by the “Großwetterlagen” has regained attention in the view of global change prediction, because they provide a means for quantifying nonlinear behaviour of climate subject to external forcings. Regionalisation of the global re-analysis data available from NCAR and ECMWF including satellite estimates of the radiation budget with focus on Estonia might be a promising and attractive goal for the group. The studies on the influence of surface hydrology on climate, which have been pursued in 2000 could be an important contribution to this topic.

The group has been quite successful in getting research grants from the Estonian Science Foundation but no funded participation in international projects has been mentioned. **We strongly encourage the group to seek funding e.g. from the EU 5th framework and follow-ups for their research**, which has a clear European dimension. The group has

strong links with all Estonian groups relevant in atmospheric physics by common grant applications, teaching services and exchanging personnel, namely with the Institute of Environmental Physics at Tartu University, the Estonian Meteorological and Hydrological Institute and the Estonian Marine Academy. Internationally the group cooperates with several German and U.S. American groups mainly by their visiting scientist programs. **We recommend intensifying the contacts in order to enlarge the external funding of the group.** The exceptionally strong engagement of the group in the international BALTEX programme is of high value for the BALTEX community and also considered very important for Estonia.

It should be noted, however, that the group lost of their former visibility in the international science community during the past three years due to too few publications in international refereed journals on atmospheric physics by all three group members. The main reason is possibly that the group was not able to attract enough students to their work. A better formalisation of the relations between Tartu University and Tartu Observatory might be helpful here. Taken all this into account we judge the performance of the group as **satisfactory to good.**

Dynamical Meteorology Group

The group headed by Rein Rõõm is the smallest and youngest by age of the Department of Atmospheric Physics. Compared to the other groups in the Department (which all work on different aspects of radiation in the atmosphere from either the energetic and/or the remote sensing aspect and which also contain monitoring aspects in their work), this group has a pure theoretical orientation and works on dynamic atmospheric modelling including pollution transport.

The scientists of this group contribute significantly to the development of the non-hydrostatic kernel of the future high-resolution version of HIRLAM, the common weather forecast model chain developed by the Scandinavian countries, which is also used by many other European national weather services. Their speciality is the use of pressure for the vertical coordinates in order to circumvent known problems with other (e.g. terrain-following) coordinates, which are currently used by other models like the German Lokal Modell (LM) for the same purpose. Also due to this competition the work of the group is both new and of high quality. The group works on the leading international edge in the field of non-hydrostatic atmospheric modelling, which is documented by several papers in one of the most important journals in meteorology.

The group plans to work also in future along these lines. It also plans to maintain or strengthen its highly developed connections in Europe (e.g. by more active participation in EU-projects) and its currently weak relations to the Estonian Meteorological and Hydrological Institute (this Institute might at a later stage implement their own model chains for regional weather and pollution prediction). We consider this as absolutely the right direction to go; and we believe that the group can play a central role in future

Estonian weather and pollution prediction. The group intends to move formally and physically to Tartu University, Institute of Environmental Physics, in order to establish meteorology in Estonia as part of physics education with a very strong link to mathematics. The group clearly has the necessary competence, which is also demonstrated by the fact that students of mathematics have been attracted to the group. While the Evaluators considered the goal of this intended move to be of high importance, they felt that the loss of the group could significantly weaken the atmospheric physics part of Tartu Observatory.

Apart from three Estonian Science Foundation projects the group also successfully applied for grants from several institutions in Estonia, which clearly demonstrated their ability to transfer theoretical knowledge effectively from research to application. This will give the group very good chances to successfully compete for grants in the 5th Framework of EU funding and follow-ups. Being the only group on dynamical meteorology in Estonia their national co-operation on the research aspects is naturally limited but by far outweighed by their strong international co-operation which is considered excellent. The evaluation committee considers this group as the strongest group of the three groups not yet evaluated; we rate the group as **excellent**.

Recommendations:

1. The group on Actinomonitoring urgently needs a spectroradiometer for the UV-range and a spectral sunphotometer. The latter is especially needed to include the aerosol impact on radiation in their work.
2. The groups on Actinomonitoring and Climatology do not have the critical mass either to reach or to keep an international standing in their research topics. On the other hand, the current research and future plans of both groups demonstrate quite a large synergistic potential, so we recommend to combine both groups into a single group on radiation and climate.

I. University of Tartu

A. Chair of astrophysics, Institute of Theoretical Physics

The Chair includes two permanent positions, Professor E. Ergma and Assistant Professor P. Tenjes, the scientific work of the latter being included in the Tartu Observatory report above (see Section III). In Professor Ergma's group there is at present one graduate student; in addition one graduate and one MSc student have started their thesis work.

Professor Ergma's scientific work concerns stellar evolution and high energy astrophysics, problems like formation of neutron stars and black holes, evolutionary scenarios for binary pulsar systems, especially for a unique millisecond x-ray pulsar system, future plans being to extend the investigations to x-ray astronomy.

Prof Ergma's scientific work is excellent and concentrates on very timely and high-profile problems. Her foreign contacts are good, both with Moscow and western astronomical institutes, and the publication record is very good, especially taking into account her other duties as a Vice-President of Estonian Academy of Science and her work in the Estonian Science Foundation. These positions give her a great responsibility for the development of Estonian astronomy. We feel that she has done this with considerable success, the most important being the grant system supporting especially the young astronomers. We therefore rate her work as **excellent**.

An important task of the Chair of Astrophysics is the teaching of undergraduate and graduate students and organizing the teaching and contacts with students especially at Tartu Observatory. Considerable progress has been achieved in recent years in these contacts but more remains to be done.

Recommendations:

We recommend that Professor Ergma's scientific work and the work for the development of astronomy is strongly supported. The teaching contacts between University and Tartu Observatory should be strengthened to attract more young astronomers to enter graduate work. To help this to happen we propose that the University considers paying teaching fees to Tartu Observatory lecturers. At present, teaching is done on a voluntary basis. Furthermore, all possibilities should be used to offer working possibilities for graduate and especially postdoctoral students to work in foreign institutes, from short summer schools up to longer working periods. This would help to fill the clear lack of younger-generation astronomers in Estonia.

B. Institute of Environmental Physics

The main target of research of the institute under the lead of Hannes Tammet is aerosol research. Within this wide research field the group, having its roots in air electricity, specialised in the very small fraction of aerosol particles, because electrical methods can be used successfully to measure this kind of aerosol. Aerosols not only play an important role in pollution but also becomes increasingly important in climate research. It is well known that aerosols not only influence the Earth radiation budget but also they are the precursors of all clouds. Aerosol size and composition impacts the way clouds develop and interact with

radiation. The importance of aerosols in climate research is completely at variance with our understanding of aerosol formation – which begins with the small particles investigated by the Institute - and its crude implementation in climate models. The Institute has not only developed a unique measurement device, which is able to quantify with a so far unsurpassed integration period and width the size spectrum of the smallest particles. In addition, physical models are developed to simulate aerosol development, which might become part of future generations of climate models.

The research of the institute is performed at a very high level, which is documented by the exceptionally large number of papers in reviewed international journals. The head of the group is a leading scientist in the field. The instrument developed by the Institute, although subject to continuous improvement, is now being built by a private enterprise and already competes successfully on the world market for aerosol measuring devices. The Institute was able to successfully apply for five national research grants on this topics and could even get research and development money from two non-national funds, one of them a participation in an EU 5th framework project. In addition to the small particle fraction aerosol research and development pursued by the head of the Institute and most of his scientific staff (Eduard Tamm, Jaan Salm and Aadu Mirme), aerosol evolution in general and its effects are also studied on regional and global scale and its effects on atmospheric transparency by the senior researcher Hanno Ohvril, who is also informally in charge of teaching administration. He also was able to apply successfully for two national research grants and to get some external money in the frame of co-operative work with the University of Granada, Spain.

There is also a very good and intense co-operation with almost all groups of the Department of Atmospheric Physics of Tartu Observatory, who also contribute very significantly to the quality of teaching (without extra payment) at Tartu University. The Institute of Environmental Physics of the University Tartu and the Department of Atmospheric Physics of Tartu Observatory complement each other in a very efficient and synergistic way. Other external national partners are the Estonian Meteorological and Hydrological Institute (mainly data provision), the Estonian Marine Institute (mainly teaching services) and the Pärnu Institute of Health Resort Treatment and Medical Rehabilitation (investigation of health effects of UV radiation and aerosols). On the international level the institute is collaborating with many Scandinavian and two other European institutes as can be inferred also from co-authored papers.

Finally, we must mention the very strong involvement of the institute in the GLOBE programme, (organized by Ülle Kikas besides her research and teaching work) in which Estonia seems to take the lead in Europe. The GLOBE programme originated in the U.S.A. and promotes environmental observations (and thus the urgently needed interest) in science already on school level. Four national and even one international workshop has been held and organized by the institute. The Evaluators were impressed by the Internet presentation of the data

from the automatic meteorological station. This programme provides an excellent way of involving schoolchildren in Estonia in fostering awareness of environmental issues.

The Evaluators support the plans of the Institute to fill the Open Chair of Dynamical Meteorology. This will provide a thorough physically-based education in meteorology for Estonia in the future.

Overall judgement: **excellent**

II. Tallinn Technical University

A. Tallinn Observatory

General Comments

The present evaluation only deals with the astrophysics parts of the research carried out at Tallinn Technical University and its observatory. The astrophysics division is rather small consisting of P. Kalv (senior researcher), V. Harvig (researcher) and with technical assistance from T. Aas. In addition to the “target money” the research was supported by the Estonian Science Foundation (Automating of photometer and telescope, Automated supernova search). After discussions with the Dean of the Faculty at Tallinn Technical University we met with P. Kalv who gave the background to the present situation with Tallinn Observatory and presented the highlights of his research. The teaching of astronomy at Tallinn Technical University was also discussed. After this we visited the Tallinn Observatory and also met with V. Harvig showing the locations and the actual observing facilities.

The research carried out so far at Tallinn Observatory is of a kind requiring long time series, sometimes of the order of decades before usable results can be published. We were very impressed with the high photometric accuracy obtained during the present observing circumstances as well with the choice of targets of high astrophysical interest. The level of international collaboration is good, as reflected by the publication list of P. Kalv and from what came out through the discussions. The total number of publications from the group is rather small but is correlated to the astrophysical objects requiring very long time series before usable results can be obtained. We rate the quality of the research as between **good and excellent**.

In addition to the research P. Kalv is teaching at the Technical University and he has also supervised two master’s theses during last years. An important contribution is also the admittance of the general public to Tallinn Observatory, about a thousand visitors per

year, giving the possibility of not only describing astronomical highlights but also increasing the general understanding of natural sciences which is crucial for a technical university. We also want to emphasize the nice work put in by Dr Kalv in the impressive recently published booklet on astronomy. It was found during the visit that the observatory building is in very bad shape and also that the telescope mirror was not re-aluminized during the last years.

Recommendations:

Astronomy and astrophysics may play an important part at a technical university giving many possibilities for students to do experiments and building equipments as part of their training. To integrate astrophysics further we recommend that during the first year at the university the students are offered a popular course in astronomy, throughout the whole semester. This could be partly arranged in collaboration with Tartu observatory. We recommend that the programme of P. Kalv is continued because of its high scientific value but this means that the observatory building must be properly repaired. In the total budget of the university this should be possible to solve.

B. Gravimetric Measurement Facility

The gravimetric station in Tallinn is maintained by an assistant (J. Paesalu), with the help of a young BS student and an engineer. According to our information, there are no courses of geophysics in Tallinn (or anywhere else in Estonia), and Mr. Paesalu is charged with general assistance to the laboratories. The Evaluators see this situation as highly unsatisfactory, especially in the view of the merit of the station that should deserve more resources, both of young researchers and of funds.

The committee had the chance to pay a short visit to the station. The gravimetric detector itself is of good quality, and the surrounding environment has been carefully protected by temperature and humidity fluctuations. The data acquisition and reduction instrumentation has been recently modernized, so that all data are stored in PC for quick evaluation and distribution. The Evaluators were able to examine records and analysis to their satisfaction.

The location where the gravimeter was installed was selected long ago with sound scientific criteria, because the foundations are on solid (limestone) rock at the top of a hill overlooking the town, where disturbances (e.g. vehicular traffic) are absent or minimal. The equipment could not be relocated to Tallinn Technical University because the University is built on a much less rigid ground. Furthermore, any change of localization would destroy the highest intrinsic value of this unique data base, consisting of a long uninterrupted series of measurements from the same place. It is therefore essential that this location should be maintained. Nevertheless, the building in which the equipment is housed is in a bad state of repair and it is quite dangerous for one person to use if for

example this person gets into difficulty due to a health emergency. **The Evaluators strongly recommend improving it.**

The lack of adequate manpower and funding, not the intrinsic value of the responsible person, is in the opinion of the Review Committee the main cause for the low rate of publication of results. Mr. Paesalu should receive more attention in the next funding cycle, in order also to allow him to take part in a major international conference. In conclusion, we therefore rate the gravimetric activities at Tallinn University as **good**.

I.

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Tallinn, March 10, 2001

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