Evaluation of Estonian Research

- Condensed Matter Physics -

Report to the Estonian Science Fund Council

by

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NFR Naturvetenskapliga forskningsrådet
Swedish Natural Science Research Council

Foreword

Several Swedish organizations have been asked to take part in a general evaluation of all research performed at academic institutions in Estonia. NFR has agreed to organize the evaluation of Estonian research within the field of natural science. This report has been prepared according to an agreement between the Estonian Science Fund Council and the Swedish Natural Science Research Council (NFR).

During the spring of 1991 Estonian scientists completed reports on their research which were sent to NFR. These reports have subsequently been distributed among 14 Swedish evaluation groups. In total about 40 Swedish scientists are engaged in the evaluations. The groups are making site visits to the Estonian laboratories and institutes during 1991/92 to discuss the research performed, the plans for future activities and to get information about the working conditions, experimental facilities, financial resources etc. Each group has been instructed to produce a report assessing its particular research area.

This report concerns the sub-field of condensed matter physics and will eventually be a part of an extensive report covering all Estonian research in natural science.

The organization of the site visits is done in close cooperation with the Estonian Science Fund Council. Although difficult times prevail in Estonia the site visits performed so far have been successful. The NFR is grateful to the Estonian Science Fund Council for its efforts to handle all practical matters in connection with these visits.

The NFR is also grateful to the Swedish scientists who with enthusiasm and great skill have taken part in the demanding evaluation work.

Finally, the Council wishes to express its sincere hope that this evaluation report will contribute to a further positive development and strengthening of Estonian science.

Carl Nordling
Secretary General

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INTRODUCTION

The Estonian Science Fund Council has instructed Estonian scientists in the field of Condensed Matter Physics to prepare reports concerning their research activities during the last 5 years. These reports were completed during the spring of 1991 and dealt with the following points:

- project leader(s)
- short description of the objectives
- summary of results
- summary of resources
- scientific staff and their qualifications
- list of publications
- dissertations
- scientific meetings organized
- prognosis of the future development of the project

In most cases the reports were accompanied by reprints of scientific publications written in English and Russian.

In July 1991 the reports were sent to NFR and during the autumn the evaluators received the reports. A site visit by the evaluators to the relevant Estonian research institutions was done in the period March 29 - April 2 1992. The Estonian Science Fund Council had appointed Dr Raivo Tamkivi as organizer and contact person for this evaluation.

ACKNOWLEDGEMENTS

The evaluation group gratefully acknowledges the good cooperation with and generous help from Dr Tamkivi.

GENERAL COMMENTS ON CONDENSED MATTER PHYSICS

Condensed matter physics is a large research field and obviously only a small part of this research field can be represented in a country of the size of Estonia. Nevertheless the evaluation group was generally quite impressed by both the quality and the volume of the present research in Estonia. The body of physicists involved in this high-quality research clearly constitutes an Estonian national intellectual asset. High priority must be given to try to keep, cultivate and make good use of this national resource.

The evaluation group recognizes that the existence and intellectual vigour of this body of physicists is threatened by the recent political and economical developments. One threat is the decreasing funding and the brain drain towards Western Europe and U.S.A. Another is that part of the Estonian physics research used to be an integrated part of the physics research of the former Soviet union. Now, when this integrated structure is severed, the Estonian physicists must to higher degree rely on their own research-initiatives and try to develop new research collaborators. In view of this the evaluation group suggests that a serious effort is made to develop stronger links between various parts of the condensed matter research both within Estonia as well as developing stronger contacts with the nordic countries and Western Europe.

A crucial problem is the funding. Here the most impending threat on a short time-scale is the lack of spare parts to the research equipment (notably laser-tubes). High priority must be given to at least partially solve this immediate problem lest a large part of the condensed matter research is suddenly cornered in an impossible situation.

The evaluation group noted that in general the strongest research groups were associated with the Estonian Academy of Sciences whereas the university research was in general somewhat weaker. It was also noted that there were relatively few graduate students involved in the research and that the Academy research groups were relatively weakly involved in the physics education. In the long run more graduate students are needed to prevent a stagnation of the research. In order to achieve this the evaluation group believes it is necessary that the strong research groups form stronger links with the university and with the educational programs in physics.

Research in condensed matter physics has the potential of serving as a growing ground for technical spin off companies. The evaluation group judged the Estonian condensed matter research well suited for this purpose and examples of spin off companies already exist. On the other hand the evaluation group believes that attempts to push the research to hard into serving this purpose is likely to destroy the growing ground. It is extremely important to maintain a vigorous basic research program in condensed matter physics as a prerequisite for possible future spin off companies.

EVALUATION OF RESEARCH GROUPS

Prof. Nikolai Kristoffel
Prof. Vladimir Hizhnyakov
Laboratory of Solid State Theory
Institute of Physics
Estonian Academy of Sciences
Tartu

Solid State Theory

Principal Activities

N Kristoffel and V Hizhnyakov together with coworkers (P Kosnin, A Sherman, O Sild, G Zavt, V Fedosseyev, I Tehver, M Haas, A Pishchev, M Rozman, T Örd, P Rubin, A Shelkan, I Rebane) constitute a large and versatile theory group. One main research line deals with optical effects involving topics like resonance Raman scattering, molecular and vibronic spectra, and emission induced by electromagnetic fields. Another main research line deals with bulk properties in general and involve topics like high-T_c superconductors, structural phase transitions, impurity centers, and energy transport in disordered systems. The theory efforts appear to be well integrated into the experimental activities at the Institute of Physics. The theory group also has close collaboration with groups outside Estonia in particular with groups in Germany.

Evaluation

This is a versatile theory group with the research spanning from good to very good. Hizhnyakov appears to be a particular dynamical and imaginative research leader. A prime merit of the group at present is its versatility and its coupling to the experimental research. The group has not yet made any strong international impact within condensed matter theory but with research leaders like Hizhnyakov it has the potential of doing so in the future.

Recommendations

The group constitutes the backbone of Estonian condensed matter theory. It is essential to keep it alive and keep it from going under-critical both for Estonian condensed matter theory *per se* and for Estonian condensed matter physics at large. The interaction with a versatile theory group is very essential for the Estonian experimental condensed matter physics. One goal for the group should be to develop even closer ties with the experimental research in Estonia. Another goal should be to more decisively break into the international scene of condensed matter theory. As with all of the groups associated with the Estonian Academy of Sciences it is also important to develop closer ties with the educational programs in order to optimize the Estonian physics education and to secure a steady supply of well-educated researchers.

**Prof Cheslav Lushchik, Dr E Feldbach, Dr I Kuusmann, Dr T Kärner,
Dr Alexander Lushchik, Dr V Denks, and Dr Svetlana Zazubovich
Laboratory of Physics of Ionic Crystals
Institute of Physics
Estonian Academy of Sciences
Tartu**

Investigations of Ionic Crystals and High Temperature Superconductors by Spectroscopic Methods

Principal Activities

This laboratory is divided into several subgroups and the research is carried out by 18 senior scientists and 2 post-graduate students. The main theme of the laboratory is studies of the electronic excitations and the processes that govern the deexcitation of excitons in wide band-gap crystals (and high temperature superconductors). The laboratory uses a number of different spectroscopies for the investigations.

Evaluation

The activities as regard the wide-band-gap crystals are of high international standard and the work is performed by enthusiastic and knowledgeable scientists. The results are published in international and national journals at a reasonable rate. The research activities are rated from fair to very good. The work on memory phenomena in photochromic materials (sodalites), presented by Dr V Denks, seemed to be somewhat isolated.

Parts of the work on high temperature superconductors (Feldbach, Kuusmann) appear potentially very interesting. The research performed in the groups of Prof Alexander Lushchik and Dr Svetlana Zazubovich on defects in ionic crystals is very good and internationally competitive.

Recommendations

The work at this laboratory ranges from fair to very good. The evaluation group recommends that this laboratory is given continued support. Here, as at the other laboratories at the Institute of Physics, one major concern is the lack of post-graduate students, overcoming the current difficulties as regard financing and structure it must become a prime task to establish a good common post-graduate program within the Institute of Physics and Tartu University.

Prof Mart Elango, Dr A Ausmees, Dr A Kikas, and Dr Henn Käämbre
Laboratory of X-ray Spectroscopy
Institute of Physics
Estonian Academy of Sciences
Tartu

Exoelectron Emission, Crossluminescence and Energy Transfer in Ionic Solids

Principal Activities

The laboratory led by prof Elango has today a scientific staff of 7 senior scientists and 1 post-graduate student. The activities involve cooperation with different synchrotron radiation laboratories around the world, an active cooperation has e.g. recently been established with the MAX laboratory, Lund University. One major interest of the laboratory today is to understand the processes involved in energy transfer from bulk to surface of ionic crystals subjected to XUV radiation. These investigations are also complemented with computer simulations of the processes. Another important field of research is studies of electron emission associated with recombination of defects in ionic crystals.

Evaluation

The research activities of this laboratory are very good and the results are published in international and national journals. The phenomena studied are quite interesting and the research is competitive on an international level. One concern of the evaluation group is again the lack of post-graduate students in the group, an expressed wish of the leader of the laboratory to engage new students is strongly supported.

Recommendation

The work within this laboratory is of high quality and continued support is well deserved. Especially, it is important that the well established cooperation with foreign synchrotron radiation laboratories can be maintained.

Dr Rein Kink, Dr Ants Lohmus, Dr M Selg, Dr A Stolovich, Dr V Korrovits, and Dr K Kalder
Laboratory of Low-Temperature Physics
Institute of Physics
Estonian Academy of Sciences
Tartu

Laser Spectroscopy at Low and Ultra Low Temperatures

Principal Activities

Today the scientific staff of the low temperature laboratory consists of 8 senior physicists, 2 chemists, 1 theorist and 1 post-graduate student (currently working in Lund). The physical problems addressed in this laboratory follow two main lines: i) Optical spectroscopy at very low temperatures. By utilizing a unique dilution cryostat for optical measurements spectroscopic data can be taken down to temperatures as low as 40 mK. The apparatus has been used to measure optical spectra of laser hole burning in various specimen. Temperature dependent physical phenomena have been shown to occur also down to such low temperatures. ii) VUV spectroscopy at low temperatures of rare gas crystals. Bulk single crystals of rare gases are grown from the liquid phase. A number of properties related to electronic excitations in single crystals of different rare gases have been discovered and investigated. Due to the simplicity of the crystals, the behaviours can often be adequately predicted and reproduced in theoretical models.

Evaluation

The work mentioned above is good/very good, original and internationally competitive. The optical spectroscopy work on high temperature superconductors that was presented contains very interesting parts.

Recommendation

The Laboratory of Low-Temperature Physics works on interesting and challenging physical problems. It has additionally a very innovative atmosphere for the development and design of low temperature instrumentation and cryostats. We recommend continued support at about todays level of this laboratory. The lack of post-graduate students at the Estonian Institutes is evident also for this laboratory.

Dr Ants Lohmus
Laboratory of Low-Temperature Physics
Institute of Physics
Estonian Academy of Sciences
Tartu

Optical Helium Cryostats

Principal Activities

An important development that has been carried out at the Institute of Physics in Tartu is that of cryostats used for optical measurements. The cryostats are developed based on clever technology and have been found to operate very well at temperatures in the mK range. The development of these cryostats have been important to several other projects at the Institute. Also groups in Finland and in Sweden use the cryostats.

Evaluation

The evaluation committee was impressed by the ideas behind the cryostat development and the skills of the researchers and engineers involved in this project. It is also clear that the cryostats are being utilized in scientific projects of very high quality.

Recommendations

It is essential that projects such as this are allowed to be continued. It gives Estonia both scientific equipments that can be used in very basic scientific studies and a possibility of establishing high-tech commercial products which have an international market.

Dr Jaak Kikas, Dr Indrek Renge, Dr Koit Mauring and Dr Artur Suisalu
Laboratory of Laser Spectroscopy
Institute of Physics
Estonian Academy of Sciences
Tartu

High Resolution Optical Spectroscopy of Molecular Impurities in Solids

Principal Activities

The activities in the laboratory of laser spectroscopy, headed by Dr Kikas (who was abroad at the time of the site visit), is involved in studies of low-temperature high-resolution optical spectroscopy of solids predominantly using the spectral hole burning technique. The samples that are studied covers a large range of materials from organic materials to inorganic crystals. In the project that is being conducted by Mauring, Suisalu and Renge the measurements were concentrated towards picosecond spectral fluorescence kinetics on photosynthetic systems including living cells. For example, based on time-resolved spectroscopic data models for the primary energy transfer and trapping in photosynthetic membranes have been developed. The work is carried out in a close cooperation with groups at the State University of Moscow.

Evaluation

The work that is being carried out is of good quality and makes an excellent use of the powerful techniques developed at the Institute of Physics to conduct studies with a high relevance in the biological and bio-physics area.

Recommendations

The work should be allowed to continue on the present level. If an expansion of this area is possible, it should involve engaging students and possible researchers with a strong biological background. This project should be coordinated with the work described on page 16 ("(Sub)picosecond time-resolved spectroscopy of organic and photosynthetic systems")

Dr Kristjan Haller
Laboratory of Laser Spectroscopy
Institute of Physics
Estonian Academy of Sciences
Tartu

Disorder and Phase Transitions in Crystals Studied by Raman Spectroscopy

Principal Activities

The activities in this project are aimed at studying order-disorder transitions, structural instabilities and phase transitions in ferroelectric and molecular crystals. The experimental technique that is used is Raman spectroscopy. In addition to Dr Haller only a graduate student is involved in the project.

Evaluation

Since Dr Haller currently is deputy director of the institute his administrative load is naturally very high and since only one more person is involved in this research it does not at present constitute a major effort of the laboratory. However, in spite of the low man-power that is put into this project it has developed satisfactorily and interesting results are being produced.

Recommendations

If this project, which indeed has interesting potentials, is continued it is a necessity to increase the number of researchers taking part in the work. However, it might be better for the institute if these resources at the moment are devoted to other projects which at present are more the main stream of the laboratory.

Dr Ilmo Sildos and Dr Jaak Kikas
Laboratory of Laser Spectroscopy
Institute of Physics
Estonian Academy of Sciences
Tartu

Spectral Hole Burning and Phonon Propagation in Crystals with Colour Centres

Principal Activities

The work in this project is focused on obtaining a wider application for the spectral hole burning technique by searching for new materials were the spectral holes are stable at higher temperatures. Colour centres in inorganic crystals can be used for this purpose. The group has studied neutron irradiated a-Al2O3 crystals and demonstrated that stable holes can be obtained up to temperatures as high as 600 K. Due to the high Debye temperature diamond crystals are also being studied. Furthermore, the group is also involved in studies of stress induced shifts of the spectral holes.

Evaluation

The work is of very good quality and of course of vital importance for the utilization of spectral hole burning in the, at the institute, suggested applications. However, in addition to producing important results for future applications, the work also results in fundamental materials research of a good and unique quality. The initiated studies of diamond crystals should be promoted and a stronger cooperation with groups involved in diamond thin film fabrication, in Russia or elsewhere, has the perspective of becoming very fruitful.

Recommendations

For the total program on spectral hole burning at the Institute of Physics it is important that these activities, as well as other activities that are aimed at finding new materials with a high temperature spectral hole stability, are allowed to continue.

Dr Arlentin Laisaar
Laboratory of Laser Spectroscopy
Institute of Physics
Estonian Academy of Sciences
Tartu

Optical Spectroscopy at High Pressures

Principal Activities

The group, in which 3 researchers are working, is carrying out spectroscopic investigations of solids under high hydrostatic pressures and low temperatures. The high pressure studies are being carried out in a high-pressure equipment capable of achieving pressures up to 15 kbar. Both impurity centres in ionic crystals and excitons in pure crystals have been studied. Spectral hole burning studies at high pressures have also been carried out. Studies on semiconductors as well as high-T_c materials have been initiated.

Evaluation

The work that is being carried out is of very good quality and the research leader is dynamic and very active.

Recommendations

Since the spectroscopy studies being carried out at high pressures are of a high international standard it is essential that this group can continue to work and expand. An expansion through interaction with groups in Western Europe or elsewhere is to be recommended since there definitely is a need for more extensive high pressure studies.

Prof Peeter Saari, Dr Rein Kaarli, Dr Heiki Sonajalg, and Dr Margus Rätsep
Laboratory of Spectroscopy of Crystals
Institute of Physics
Estonian Academy of Sciences
Tartu

Four-dimensional Holography and Its Application for Ultrafast Optical Data Processing

Principal Activities

The spectral hole burning phenomenon has been suggested to be useful for optical information storage and processing. A concept of time- and space-domain (or 4-D) holography utilizing spectral hole burning had been elaborated by 1985. This project is aimed at achieving understanding of and ability to utilize the 4-D holographic concept and also to exploit the idea to suggest and develop possible applications for optical data processing devices.

Evaluation

This attempt to exploit the spectral hole burning phenomenon in information storage and processing devices is valuable for the institute. The efforts today are mainly directed towards applications of the concept and is rather unique in an international perspective and of good quality. The experimental equipment available to this research group is adequate and competitive today. However, one potential problem that was very evident on visiting this laboratory and that also applies for the Institute of Physics as a whole, is how to find necessary fundings to afford the unavoidable replacement of non-working laser tubes in the future.

Recommendation

The level of the current effort is of reasonable size and deserves continued support at about constant level. A need for new equipment is not urgent at the moment, but the problem of replacing laser tubes will soon appear.

Dr Jaak Aaviksoo
Laboratory of Spectroscopy of Crystals
Institute of Physics
Estonian Academy of Sciences
Tartu

Ultrafast Dynamics of Photoexcitations in Solids

Principal Activities

The activities in this small subgroup, in the Laboratory of Spectroscopy of Crystals, are directed towards exciton energy transfer and relaxation phenomena in molecular solids (anthracene) and semiconductors (III-V and II-VI materials). The group uses time-resolved picosecond spectroscopy to obtain this information. Also quantum structures as well as surface excitonic states are being studied.

Evaluation

The group is dynamic and very good results are being produced. The research leader has good contacts with the Max Planck Institute in Stuttgart, which belongs to the international leading laboratories in the semiconductor area.

Recommendations

Since this is a semiconductor project that has the potential to be in the international forefront in a highly competitive area without extremely large new investments, it is essential that continued support is given. However, since the semiconductor field requires massive capital investments, it is important for this small group that they can continue to interact with groups outside Estonia..

Dr Peeter Kukk and Dr Tonu Pullerits
Laboratory of Spectroscopy of Crystals
Institute of Physics
Estonian Academy of Sciences
Tartu

(Sub)picosecond Time-Resolved Spectroscopy of Organic and Photosynthetic Systems

Principal Activities

This group works on problems related to the photosynthesis by means of laser spectroscopy. By employing (sub)picosecond pulses excitation processes on timescales of the order of 10^{-13} s and longer can be studied, corresponding to the elementary excitation time in the complicated photosynthesis process. The group has active contacts with research groups in e.g. Jyväskylää, Vilnius and Umeå.

Evaluation

The research of this group is interesting and valuable, but it should be more firmly coordinated with the projects on photosynthesis evaluated on page 10.

Recommendation

This project and the work described on page 10 ("High resolution optical spectroscopy of molecular impurities in solids") should be coordinated as one project. The basic recommendations for the latter project apply also for this project.

Prof Karl Rebane and Dr Viktor Palm
Laboratory of Laser Optics
Institute of Physics
Estonian Academy of Sciences
Tartu

Spectral Hole Burning: Optical Dephasing in Glasses, Optical Memories, and Neural Networks

Principal Activities

Spectral hole burning is an Estonian specialty and Rebane and his associates have played a significant role in developing this field. The present project concerns research directed at applying the spectral hole burning technique to optical memories and neural networks. This is an application which, if successfully developed into a competitive system, would have a large technological potential. The group has good international connections.

Evaluation

The idea of applying the spectral hole burning concept to optical memories is certainly interesting and attempts to develop this idea are also made by other groups on the international scene. Rebane and his associates have the advantage of a considerable and fruitful experience within the field and their work is of good quality. However, it probably will require a major research effort to turn it into a competitive technological system. The pay off of such a major effort is, of course, somewhat uncertain.

Recommendations

Estonia should take advantage of its specialty in spectral hole burning and try to develop it further. The present project is an attempt in this direction. It is a somewhat risky project, since the goals might turn out to be impossible to achieve.

Dr Enn Realo, Dr Rein Koch, and Dr Jaak Jogi
Laboratory of Nuclear Spectroscopy
Institute of Physics
Estonian Academy of Sciences
Tartu

Mössbauer Spectra of Solids, Nanosecond Transient Phenomena

Principal Activities

This laboratory employs 4 senior scientists and 1 engineer. At the time of our site visit the experimental equipment was just being reinstalled after restoration of the laboratory space. The current activities include e.g. studies of oriented sintered YBCO with Fe^{57} impurity work on perovskites of type $KMeF_3$ doped with Fe^{57}. Mössbauer spectroscopy with coincidence time-analysis methods is used to study fast transient phenomena between the Mössbauer radiation and the resonant solid, results from which are complementary to e.g. luminescence studies. The group has an active cooperation with Prof Kattila in Helsinki and Prof Smirnoff in Moscow.

Evaluation

The laboratory is an independent part of the Institute. The research performed is of good international quality. The size of the group is small but adequate. One concern is again the lack of post-graduate students in the laboratory.

Recommendations

It is of value to have an active Mössbauer spectroscopy group at the Institute of Physics. The evaluation group hopes that this research team finds possibilities to engage post-graduate students in its work.

Dr Jiirik Aarik, Dr Arnold Rosental, Dr Ahti Niilisk, Dr Jaanus Friedenthal, and Dr I Rammo
Thin Film Technology Group
Institute of Physics and
Tartu University

Investigations of Thin Films and Application of Thin Films in Sensor and Electroluminescence Devices

Principal Activities

The laboratories and researchers of this group are located at both the Institute of Physics in Tartu and at the Tartu University (in the Laboratory of Electroluminescence and Semiconductors). The group is concerned with physical phenomena in thin films and the applications of thin films for sensors and electroluminescence devices. The group has previously also been engaged in studies of compound semiconductors and heterostructures but is today basically involved in studies of oxide and sulfide based thin films. Particularly the group has focussed on utilization of atomic layer epitaxy (ALE) or atomic layer deposition (ALD) for growth of the films. The group is studying the growth kinetics of the films (using, e.g., optical *in situ* techniques), their properties, and the utilization of the films in sensor and electroluminescence devices. The experimental facilities for film analyses include both optical techniques, scanning electron microscopy and scanning tunneling microscopy. Contacts exists with groups involved in ALE research in Finland.

Evaluation

The work carried out by the group is of good quality and has the potential of becoming really internationally competitive. The decision to change from semiconductor materials towards oxide materials was good since it is hard for a relatively small group to be competitive in the semiconductor materials fabrication area where very large financial resources are needed. Furthermore, the efforts of establishing *in situ* optical characterization methods for ALD are very good, taken into account the massive efforts that are being devoted to optical spectroscopy at the Institute of Physics. The evaluation group was also encouraged by the fact that the group was involved in research at both the Institute of Physics and at the University.

Recommendations

The group should be given an increased level of support to keep this work, which indeed also has the potential for industrial spin-offs, going in the directions taken. Since no other groups in Estonia are as deeply involved in thin film science it is also important for the group to keep, and increase, their international contacts. Since there are several internationally competitive groups in the ALE field in Finland it is, first of all, important that the group has the possibility to continue these already initiated contacts.

Prof Lembit Pung, Dr Viktor Seeman, Prof Ando Ots, Prof Kalev Tarkpea, and Prof Aleksander Lushchik
Department of Experimental Physics
Tartu University

Radiation Physics of Dielectrics

Principal Activities

The work within the EPR group is mainly directed towards studies of defects in alkali halides and alkaline-earth oxides and sulphides. Different types of defects are introduced by subjecting the crystals to electromagnetic radiation of selected frequencies and intensities. The properties associated with the specific defects are studied by EPR-spectra combined with optical measurements at the Institute of Physics. An old X-band EPR spectrometer equipped with a helium cryostat is used for the experiments at Tartu University. The work is carried out in close collaboration with the Institute of Physics.

Evaluation

The research efforts within the EPR group is of good quality and competitive at an international level. The work is systematic and creative, a good example of solid fundamental research in solid state physics. The results are published in international journals and the plans for the future are reasonable and thoroughly considered. Due to the efforts of Prof Lushchik, a fruitful cooperation between Tartu University and Institute of Physics has been established within the project. This project may serve as an example of how to increase the cooperation between the University and the Institute of Physics in Tartu.

Recommendations

The evaluation group is concerned about the fact that the research work at Tartu University is currently not supported financially. We find it essential that this research effort can continue at a reasonable level, since it is fundamental work of high quality and it contains an active cooperation between the University and the Institute of Physics. We recommend that this coordinated research effort should be adequately supported.

Prof Aksel Haav and Dr Hugo Mändar
Department of Experimental Physics
Tartu University

X-ray Structural Analyses

Principal Activities

The work of this group, which in addition to the above named researchers also involves one graduate student, is aimed at utilizing X-ray diffraction techniques for materials characterization. Several different materials are being studied, ranging from alkali halides via semiconductors and superconductors to cellulose. The available equipment is of a rather standard type.

Evaluation

The work that is being carried out is of a fair quality, that today unfortunately is non-competitive on an international level. The out-put is also relatively low and predominantly published in Russian.

Recommendations

In order for this group to become competitive on an international level it is important that they concentrate on a few materials systems. Of course, this group also fills a service function to other groups in Tartu and its existence can be motivated based entirely on this fact. However, the committee recommends that the group tries to establish a stronger contact with materials fabrication groups, such as the Thin Film Technology group at the Institute of Physics in Tartu.

Prof M-L Allsalu, Dr V Seeman, and Dr M Danilkin
Department of Analytical Chemistry
and Department of Experimental Physics
Tartu University

Alkaline Earth Sulphides

Principal Activities

This research project concerns studies of defects in Alkaline Earth Sulphides (AES) and involves groups at Tartu University from the departments of Analytical Chemistry and Experimental Physics and one group at the Synchrotron Radiation Laboratory at Moscow State University. Some AES material is to be fabricated at Tartu University and the physical investigations are to be made with EPR spectroscopy and by luminescence studies.

Evaluation

The suggested research regarding the physical properties of the AES materials should fall within the research evaluated under "Radiation Physics of Dielectrics" (see page 20).

Recommendations

The evaluation group suggests that the future work on Alkaline Earth Sulphides is integrated in the ongoing research program on defects, that is carried out in cooperation between Tartu University and Institute of Physics. We also find it important that the described cooperation with the Department of Analytical Chemistry and the contacts with Moscow are maintained.

Prof Ivar Jaek
Department of Experimental Physics
Tartu University

Paleodosimetry

Principal Activities

The work of this group is concerned with thermoluminescence dosimetry and paleodosimetry. The research is largely aimed at developing new methods of paleodosimetry for reliable dating of geological objects.

Comments

The evaluation group finds that the work of this group falls outside the field of solid state physics and thus we choose not to evaluate this research effort.

Dr Valeri Vassiltchenko
Department of Experimental Physics
Tartu University

Electroluminescence Capacitors

Principal Activities

This group, which consists of 5 scientists, is engaged in studies of electroluminescence capacitors. The studies are focused towards relationships between the electrical properties of the devices and the luminescence. The electroluminescence structures that are being studied are obtained from groups in Russia.

Evaluation

The work carried out is unfortunately non-competitive on an international level and is rated as fair. The evaluation group was also disappointed by the total lack of future plans and efforts to obtain a fundamental knowledge that could drive the electroluminescence field forward. The scientific out-put from this group is also low and predominantly published in Russian.

Recommendations

The evaluation group does not recommend that this project is continued in the present direction. If further support should be given to this group they should establish a closer contact with other groups in Estonia that are involved in work related to electroluminescence and they also have to redirect their research to a more scientific profitable route.

Prof Endel Lippmaa and Dr Enno Joon
Laboratory of Chemical Physics
Institute of Chemical and Biological Physics
Estonian Academy of Sciences
Tallinn

Magnetic Resonance and Raman Scattering of High Temperature Superconductors and Related Topics

Principal activities

Prof Lippmaa and his associates have a world-wide reputation in NMR-spectroscopy and have very significantly contributed to the development and refinements of this experimental technique. In the present project (which involves E Lippmaa, E Joon, E Kundla, A Samoson, I Heinmaa) this expertness in the NMR-technique is used to investigate high-temperature superconductors and related materials. The NMR and NQR-techniques is combined with Raman spectroscopy where the group also has considerable expertness. The group has very good international contacts.

Evaluation

This project is very good to excellent. The careful and ingenious studies of high-T_c materials together with the systematic comparisons with possibly related materials contribute in a significant way to this, at present, extremely competitive research field.

Recommendation

This research group clearly deserves to be supported in the fullest. It brings a well deserved international recognition to Estonian physics. It is very essential to keep the group operative by making it possible for and encouraging the young talented researches in the group to continue their research within Estonia. A talented group like this faces the immediate danger of dispersing if strong counter measures are not taken to keep it together.

Prof Endel Lippmaa, Dr Georg Liidja, Dr Urmas Nagel, Dr Girsh Blumberg, Dr Jüri Pahapill, and Dr Jaak Lippma
Laboratory of Chemical Physics
Institute of Chemical and Biological Physics
Estonian Academy of Sciences
Tallinn

Laser Optics and Spectroscopy

Principal Activities

The activities in laser optics and spectroscopy in the laboratory headed by Prof Lippmaa consist of several projects that at first seems rather disperse and unconnected. The five different research projects that were presented to the evaluation group were directed towards spin inversion studies in ionic solids, spin lattice relaxation in solids and hydrogen traps in CaO (Dr Liidja), towards Raman scattering techniques for studying electron-vibrational dynamics in excited electronic states of impurity molecules in ionic crystals (Dr Blumberg), photochemical hole-burning for studying electronic relaxation processes in heme- as well as metal-free proteins (Dr Pahapill) and with picosecond spectroscopy of excitons in II-VI semiconductor crystals (Dr J Lippmaa). In each of the projects only one to three researchers were engaged. In most of these projects there are relative strong connections to several groups in Tartu.

Evaluation

Each of the above projects is of good quality and the researchers engaged in the work are indeed very competent. However, the evaluation group is concerned with the relative disperse nature of the different projects. The overall research directions for the work at the institute are towards high-T_c superconductors and enzymatic catalysis. Unfortunately, it was not clear how all of the presented projects contribute to the latter task. Furthermore, several of the participating researchers have also recently been engaged in a new project on detector development for the Large Hadron Collider (LHC) at CERN. This new engagement and the lack of grants for carrying out research on laser optics and spectroscopy have resulted in a relatively low publication rate the last couple of years.

Recommendations

The research groups definitely needs to be adequate supported such that they can be engaged in laser optic spectroscopy research that is aimed at understanding proteins and enzymes. This is definitely an area in which this research group could make a large impact internationally. Finally, even though detector development for LHC is internationally important we believe such studies might severely hamper the research directed towards laser spectroscopy of materials relevant to proteins and enzymes.

APPENDIX

Background of evaluators

Petter Minnhagen

Born 1946. NORDITA-stipendiate in Copenhagen 1977-80, post doc. at Indiana University 1980-82, NFR special research position in statistical physics 1986, professor of theoretical physics, in particular statistical physics, 1987, goverment professor of theoretical physics at Umea University 1992. He has been particularly interested in the physics of low dimensional systems and superconductivity and is the author of some 60 scientific papers among those a well-known review article about vortex-fluctuations in connection with superfluid and superconducting films. Recently his research has been focused on fluctuation effects in high temperature superconductors. He serves on various national and international committees.

Per Nordblad

Born 1949. He holds a special research position in "Structure and dynamics in magnetic materials" at NFR. Presently he is at Department of Physics at Uppsala University. He has worked in the field of fundamental experimental properties of magnetic materials and superconductors since 1974 and been post doctor at Department of Physics at University of California Santa Barbara 1981-82 and a visiting scientist at Laboratory of Solid State Physics at Universitē Paris-sud, Orsay, several periods in the 1980's. He has published some 80 papers in international journals. His research is today focussed on dynamic phenomena in disordered magnetic materials and high temperature superconductors.

Jan-Eric Sundgren

Born 1951. Professor in "Thin Film Physics" at Department of Physics at Linköping University. He has been working with different aspects of thin films since 1975 and been a visiting professor at Materials Science Dept., University of Illinois, Urbana, USA between 1985 and 1986. He has published more than 100 scientific papers in international journals. He is a member of the editorial board for the journals "CRC Critical Reviews in Solid State and Materials Science", "Surface and Coatings Technology" and "Thin Solid Films". The research as been focussed on understanding relationships between process parameters, structure and properties of thin films grown from the vapour phase. Particular films grown by sputtering and evaporation methods have been utilized. Both pure metal and semiconductor films and compound films, such as nitrides and carbides have been studied. Today the research is concentrated on epitaxial silicon carbide films, growth and physical properties of one-dimensional superlattice structures and studies of the interactions between low-energy ions and growing film surfaces.