09.511 HYS THE MASTER'S PROGRAMMES

Admit it. You are one of those people who want answers. Why? When? How fast? How far? How big? How small? You are – and have always been – fascinated by what can't yet be explained. You are curious and creative. What if satisfying your curiosity could become your job? We believe we have something to offer you. At the Physics Department in Lund, you can continue being curious and creative, and at the same time make a strategic choice for your career.

Physicists in Lund are, for example, studying the smallest parts of matter or the interfaces between living cells and electronics. Their discoveries are fundamental for creating a cleaner environment and treatments for cancer, just to mention a few examples. At the same time, they are working on what they enjoy – solving problems by creating models and performing experiments. In fact, they are simply satisfying their curiosity.

As a Master's student you will become part of a vibrant research community engaged in experiments at large international facilities, state-of-the-art laboratories on site, as well as cutting-edge theoretical studies. Learn more about Physics in Lund on our website www.physics.lu.se

At the back of this brochure you will find information on how to apply to our programmes.

Come to Lund and shape the future, your future.



PHYSICS MATHEMATICAL

Fasten your seat belts – you are about to enter the dynamic borderland between physics and mathematics.

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We offer you a broad education in the fundamentals of theoretical modelling, which is useful in many areas of science and technology. Once you have gained the necessary knowledge in mathematics and physics you are free to choose an area of application. You will be creating models and using them in areas such as chaos, nanoscience or solid state theory, theoretical nuclear physics or even econophysics.

Researchers at Mathematical Physics in Lund are carrying out studies in several areas. In solid state theory and nanophysics we are studying everything from nanoelectronics to the *Bose-Einstein condensate* – a new form of matter at the coldest temperatures in the universe – and the electronic structure of solid bodies. The number of applications is unlimited.

Another area with great future potential is theoretical nuclear physics, where our research has played an important role in describing the structure and dynamics of deformed, rotating nuclei. The atomic nucleus is a fascinating many-body system, which is governed by the laws of quantum mechanics. It also has many simi-



larities to nanostructures consisting of many-particle systems.

A new, dynamic area of physics is chaos theory which, believe it or not, can be applied to the beating of the heart, as well as to microscopic systems governed by the laws of quantum mechanics, quantum chaos.

If you dare take the plunge into the theory of physics, Mathematical Physics in Lund is the place for you. We can offer you a stimulating and creative environment with many intellectual challenges.



ANALYTICAL

As an analytical physicist, you will be familiar with the most important physical analysis tools used in industry, society and in research.

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How much mercury is there in a single hair? How old is that ceramic pitcher found by archaeologists? How are the atoms arranged in a nanostructure or a virus?

The answers to all these questions, and many more, can be found using analytical physics. Such complex problems can be solved by breaking them down to the level where the building blocks of material and their interactions are described by the basic laws of physics. This is the foundation of innovative and knowledge-based development.

You can visualise a complicated molecule using synchrotron radiation at *MAX-lab*, or investigate a crystalline material, not only its surface, but also its inner structure. It is also possible to detect minute amounts of pollution in a tiny environmental sample, or establish the authenticity of a Rembrandt without damaging it. In analytical physics you will learn which method is the most suitable, and develop it further.

Making correct measurements is, however, only half of the picture; it is also important to be able to interpret the results and their consequences, identify sources of error and estimate their size and significance, and then be able to present the conclusions to experts, as well as to the public.

One of the greatest advantages is that you will be able to use your knowledge in advanced technological, biological and pharmaceutical applications in industry, as well as in areas such as environmental management and medicine.



SYNCHROTRON RADIATION

Would you like to do research using the brightest scientific tools and investigate novel materials that may shape tomorrow's technology?

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Researchers in synchrotron radiation in Lund investigate a wide range of materials and processes. As our name implies, the majority of our experiments take place at synchrotron radiation sources: large national or international facilities that provide intense X-rays, called synchrotron radiation. Our work is concentrated at *MAX-lab* in Lund, which attracts top researchers from all over the world.

Nanotechnology is at the heart of our research. As a member of the *Nanometer Structure Consortium* in Lund, we characterise nanostructures down to single atoms – no nanostructure is too small for us.

An important area is nanochemistry or nanocatalysis. You might think this is not a very exciting topic, but imagine this: an improved catalyst that enhances a particular chemical reaction so much that the size of an industrial plant can be reduced by a

factor of 10. Not only that, it would reduce the pollution from the factory by a similar amount. Now, multiply that by hundreds of factories around the world.

Other exciting questions that we are trying to answer are: How fast is a chemical reaction? What causes a molecule to change its shape and, as a consequence, change its behaviour? We are working together with the *Lund Laser Centre* in studying the dynamics of molecules using lasers.

Synchrotron radiation research in Lund is world leading in several areas, and we participate in a number of large pan-European projects. The next generation of synchrotrons is just around the corner, and if you decide to join us, you are likely to be embarking on a long scientific career.





PHYSICS NANO

Are you prepared to enter a different world, one where classical laws do not hold anymore and quantum mechanics rules?

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Would you like to take an atomistic view in order to understand how things work? Or what about developing new biomedical sensors by applying nanotechnology or connecting electronics to living cells?

Nanoscience is one of the most intense areas of research today, and is likely to have an impact on all branches of indus-



try. Imagine air-purifying concrete, cheap and efficient solar cells, a million songs in your iPod, or curing cancer before you feel it.

Nanoscience is about controlling and understanding matter on a scale smaller than a micrometre. One nanometre (nm) is one billionth, or 10⁻⁹ of a metre. Imagine a nanoparticle 10 nm in diameter. The relation between this particle and a football is the same as that between a football and planet Earth.

For the past 15 years, nanoscience and technology research at Lund University has been conducted within the *Nanometer Structure Consortium*, one of the first European nanocentres. The consortium is the main Swedish centre for materials technology, nanoscale physics, nanoelectronics and applications of nanometre structures. Research ranges from the growth, characterisation and basic studies of materials, to the implementation of nanostructures in nanoelectronics and photonics, as well as biomedical applications.

Would you like to work in a truly multidisciplinary environment with many oppor-

tunities to develop your competence and problem-solving skills? If you are into biology and medicine but still like physics and mathematics, or your heart belongs to mathematics and physics but you want to learn more about the life sciences, then Nano Physics could be for you.







COMBUSTION

A short-circuit or a burning candle forgotten – the result can be total destruction; but if we tame fire and control it, we can use its energy.

>> READ MORE

Combustion processes are extremely important in our society. They account for over 85% of the energy used in the world. We need energy to drive cars, to heat and light our homes and to run industries. Unfortunately, combustion brings with it many environmental problems, such as acidification and smog, and



the much-discussed greenhouse effect. We can therefore not simply burn fuels without trying to make the process as efficient and clean as possible. That is why our combustion research is so important.

Combustion processes are



Researchers at Combustion Physics in Lund are developing models that describe the complicated chemistry taking place during combustion. Our most extensive area is that of measurement technology. The advanced techniques we are developing are mostly based on lasers, and we perform world-class research in laser diagnostics for combustion.

The light emitted by lasers can be used, for instance, to determine the concentrations of various compounds in combustion processes or to measure the temperature in a combustion engine. Only when we understand what is happening at the molecular level, can we improve the efficiency of combustion and reduce the amount of pollutants released in exhaust gases.

Knowledge in combustion is useful for many companies within the energy and transport sector, thus courses within this area may prove valuable for your professional career.

If you want to contribute to the knowledge on combustion, then Lund is a good choice. There are already around one hundred researchers working on combustion in Lund, but there is still plenty left to do.

SUBATOMIC PHYSICS

The art of seeing the building blocks of our universe. Think incredibly small, and immensely big.

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Starting at the far end of the scale with galaxies and stars, moving on to objects that we can touch, and then past crystals, molecules and atoms, we arrive in the subatomic world of nuclei and fundamental particles such as leptons and quarks.

Although we think we know most things about the building blocks of matter, we still know little about the fundamental forces holding them together. This lack of knowledge on the subatomic scale is reflected in the macroscopic world, as the hierarchy of matter is closely linked to the evolution of our universe. Many questions remain to be answered!



World-leading research is performed through international collaborations at particle accelerator facilities all over the world, for example, Germany, Switzerland, the United States, and in Sweden, at *MAX-lab* here in Lund. Many of these laboratories have summer schools for Master's students and as part of your thesis work you will have the opportunity to participate in real experiments.

In addition to investigating the basic physics of nuclei and subatomic particles, we also perform research on the applications of nuclear physics, either in other fields of research or for technical applications. This involves the study of nuclear decay and nuclear reactions, with the aid of accelerators and sophisticated detector systems. In Lund the main fields of application are elemental analysis using a so-called micro-beam, and ¹⁴C analysis for medical, pharmaceutical and nuclear energy applications.

If you would like to work in a challenging and international environment, then subatomic physics could be just what you are looking for.



PHOTONICS 8. LASERS

Interested in optics, lasers or spectroscopy? Go for photonics – the science of mastering light.

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Photonics is about generating and controlling photons, including the emission, transmission, amplification, manipulation, detection and utilization of light.

Lasers are often used in photonics applications, and are becoming standard tools in industry and research. They are used in areas as diverse as information and communication, manufacturing, security, space exploration, life sciences and health care.

In the same way that electronics was critical for technological development in the 20th century, photonics will be one of the most important technologies in the 21st century. Scientists, engineers and technicians with training in photonics and related technologies are, and will be, in high demand.

In Lund, we conduct world-leading photonics research in many fields, ranging from basic science and information technology to spectroscopic diagnostics in environment and medicine. Using the lasers at the *High-Power Laser Facility*, unique in Scandinavia, we produce and apply laser pulses of unprecedented short duration and extreme peak intensity.

Welcome to an exciting area in physics leading to careers in research as well as in industry!







ALUMNI

KARIN FRÖJD who is

working on the development of program codes at LOGE AB, a small company started by one of the researchers at the Division of Combustion Physics in Lund. "I have had fantastic benefit of my physics education in my work. It isn't the actual knowledge I gained, as much as the way of thinking. The ability to understand and solve problems is the most important thing I learnt through studying physics in Lund."

KRISTER NIELSEN who is now working for NASA at the Goddard Space Flight Center, outside Washington DC, and is carrying out research on massive stars and their evolution. "The learning environment was great, with good communication between the students and lecturers. The combination of theory and labs was good too, as you could put into practice what you had learnt in the lectures."

ANN PERSSON who lives in the USA and is carrying out research on the thermoelectric properties of nanowires at the University of Oregon. "As a physicist, I feel that I have good opportunities to work with new, exciting things that can help people and society."

JENNY NYGREN who works at FOSS in Denmark, a company that develops high-tech analysis equipment for the food industry. "There was a great feeling of camaraderie, which made it extra fun to study physics. In the mornings we had lectures, and in the afternoon most people stayed on and helped each other with tutorial problems."

HOW TO APPLY

MASTER'S OF SCIENCE IN PHYSICS

You will find information about our programmes on our webpages under edu.physics.lu.se or utbildning.fysik.lu.se. If you are applying from within Sweden, you should turn to www.studera.nu to apply to our programmes.

If you are interested in studying Physics in Lund, we of course welcome you to apply to our **Bachelor programmes** (see our webpage edu.physics.lu.se/bachelor). If you already have a Bachelor's degree, we welcome you to apply to our **Master's programme in Physics**. This leads to the degree of Master's of Science in Physics. We have chosen to keep the whole physics programme together, to increase the freedom of choice and flexibility for the student. Regardless of what direction (see our webpages) you would like to follow you apply to the same "entrance" to the programme. Once you are accepted, you are guaranteed access to all courses you are qualified to take.

WHEN TO APPLY

Formally, the last day to apply to the Master's Programme is:

- April 15 each year for the following fall term, which lasts approximately from September 1 to January 18.
- October 15 each year for the following spring term, which lasts approximately from January 19 to the beginning of June.

If you are from outside the EU/EES we strongly recommend that you apply before February 1, for the fall term, if you don't already have a valid visa for Sweden. We do not recommend students from outside the EU/EES to apply for a spring term, since the time between application deadline and term start is too short.

REQUIREMENTS

You need to have a completed Bachelor of Science (180 ECTS), containing at least 90 ECTS in Physics and Mathematics. (The Physics department reserves the right to evaluate your specific physics courses, to determine if you can follow the Master's programme).

English is the official language for the Master's programme. Therefore, if you apply from outside Sweden, you need to pass an internationally recognized test of English (or have sufficient English in your high school diploma).

If you are enrolled at a university which has an exchange contract with Lund, your best choice is to apply to the Master's programme, or to a set of specific courses, as an exchange student. Contact the International Coordinator of Physics at your university or check our webpage edu.physics.lu.se/ exchange for more information.

WHERE TO SEND THE APPLICATION Send your application form to:

Antagning SE-833 82 Strömsund Sweden

You should also ask your Bachelor University to send official certificates/transcripts <u>directly</u>, in sealed official University envelopes, to:

Antagning Box 24070 SE-104 50 Stockholm Sweden

If you apply as an exchange student, your coordinator will give you more information on how to apply.

FURTHER INFORMATION

Links to application forms, more information on the application procedure and our directions within the Master's programme, you can find on our webpage http://edu.physics.lu.se/masters

or contact our Director of Education in Physics: Tomas.Brage@fysik.lu.se phone: +46 46 222 77 24 (from outside Sweden) 046 222 77 24 (from inside Sweden)

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