PHYSICS

Study at the Johannes Gutenberg University, Mainz







There's only one mind-expanding drug I enjoy, and that's called "Science"! Dr. Sheldon Cooper in "Big Bang Theory"



Why Physics?

What does an insurance assessor have to do with a particle physicist? How does a nanophysicist collaborate in medical diagnostics? What mysteries of the universe are physicists researching with a one-kilometre ice-cube in Antarctica? All these questions are connected. And the reason? In their study courses, physicists don't just learn about physics – a science which describes what happens in nature. They learn how to work effectively with other people in order to master projects as a member of a team. They also learn to analyse facts logically and in this way to find solutions to complex problems. In their scientific work, they create new materials, construct enormous detectors and research secrets buried far out in space. To do this, they collaborate with many experts from other disciplines: with computer scientists, when it has to do with faster IT storage media. With medics when new treatments and diagnostics technologies are being developed. With mathematicians to describe physical effects. And with engineers when constructing giant detectors.

The systematic methods learned to solve problems in study courses are by no means restricted in their application to physical matters: physicists are all-round specialists and are employed in all those sessors working in the insurance field to bankers and industrial consultants and naturally in research and development.

The Johannes Gutenberg University gives its students the best possible preparation for the challenges of the future – not only with a diverse programme of subjects and lectures but with an excellent and unique infrastructure on the campus. As researchers, they will work on some of the world's biggest experiments, for example in their master course, and in experimental associations spanning the globe, they will experiment with CERN in Geneva or assist in the further development of the "IceCube" Neutrino experiment in Antarctica.

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BACHELOR

Why Mainz?

The Johannes Gutenberg University (JGU) in Mainz is backed by over 500 years of history and combines all the advantages of a fully-fledged university with the infrastructure of a university campus in the very centre of a charming, centrally-located city.

Studying with short distances

The JGU is one of the few major universities in Germany with a contiguous campus. For the students, that means shorter walks from one lecture to the next - and they are only a short distance from their professors too.

A fully-fledged university with no study fees

You can study almost any subject at the JGU and – thanks also to the extensive international exchange programme – you can meet people from all over the world.

Mainz makes no charges for study courses. As in many popular university towns, rents are not by any means

The location of this city on the Rhine is perfect. There are ample opportunities for a relaxing barbecue with music, playing sports and meeting other people. Apart from that, with so many students here, there is always a house party somewhere that you can go to.

Nils Brast, Bachelor course student

Germany alone makes Mainz a most attractive place to live. From Mainz central station there are long-distance train connections to all German cities and from Frankfurt Airport,

just 30 km away, you can reach the whole world. Local buses and trains can be used free of charge with the "Semester ticket".

Culture and flair

Mainz, located on the Rhine and with over 210,000 inhabitants, is a city full of life. It was founded way back in Roman times and lies in the middle of wine-growing regions. Science and technological progress have long been associated with the name Mainz – you only have to think of the invention of the printing press by Johannes Gutenberg over 500 years ago.

The university city offers some 40,000 students a wide range of cultural facilities as well as many and varied leisure and sporting activities: There are also plenty of open-air concerts and readings, theatre and cabaret performances and sports events in the football stadium to pass the time.



flair, Mainz combines the quality of life in a smaller city with the dynamism and the variety of facilities expected of a state capital.

With its historical character and cultural

Content of study courses

The aim of the Bachelor and Master courses in Physics is a basic education in Experimental and Theoretical Physics. In your course you can therefore expect progressive lectures, and these will give you a broad view of the main fields covered by Physics and the mathematical and experimental methods required for them. Mainz as a place to study stands out on account of its unusually wide spectrum of specialisation possibilities and the usual facilities are supplemented by

- Tutorials | individual help for those starting out on their studies
- Practice and seminars | room for discussions, independent scientific work, training in lecturing techniques
- Practical Physics training | preparing experiments in the laboratory, handling measuring instruments
- Mathematics bridging courses | support in getting started on courses: alignment of the different aspects of previous knowledge in mathematics

cheap, but living in a hostel or a student community is nevertheless af-

Mainz – in the centre of the Rhine-Main region

fordable.

Its convenient location in the middle of

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Info and dates

Normal length of courses

6 semesters (Bachelor study courses) and 4 semesters (Master study courses)

Conditions of admission

Admission to the course is not restricted, although of course a university entrance qualification is required. Please note that for the Bachelor of Education course, there may be restrictions on admission for other sections of your desired combination.

Periods for submitting applications 06/01 - 09/01 (Winter semester) and 12/01 - 03/01 (Summer semester)

Any more questions?

Our Study Consultants will be pleased to assist you:



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Bachelor of Science

The Physics study course aims to impart fundamental physics and mathematical knowledge; this will involve approaching complex problems creatively and solving them with an analytical way of thinking. Physics students at the JGU benefit particularly from an unusually broad spectrum of research work which gives them the possibility of choosing from over 50 research groups. Even on the BSc course, the students can already take an active part in scientific work, both on the spot as well as at some of the

The Physics course in Mainz offers ingredients which are often mutually exclusive: a wide choice thanks to three institutes and other research institutions directly on the campus – and despite the size, an open community in which you can quickly make friends and good contacts, whether to fellow students, senior years, lecturers or working groups.

Florina Roana Schalamon Bachelor course student

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world's leading research institutes. Many research groups offer paid positions which help students pay their way and which at the same time lift the curtain on the exciting world of science.

The study course "BSc Physics" takes up a total of six semesters (normal course time) and is divided into two phases: the foundation course and the main course.

The foundation course

In the first two semesters you learn the basic contents of Experimental and Theoretical Physics and Mathematics. The first two semesters are to a large extent identical with the study course "Bachelor of Education Physics", to facilitate transition between the two courses.

Main course

From the third to the sixth semester you will extend your knowledge in the main subject areas of physics and from the fourth semester you can select lectures to attend which deal with your own personal main interests. In addition, from the third semester you will carry out practical physics training, to get used to setting up experiments in the laboratory and handling measuring instruments. There will also be inter-disciplinary events (lectures and training).

In the fifth semester you attend a seminar to prepare for your bachelor thesis. The bachelor thesis and the oral finals are scheduled for the sixth semester.

Subsidiary studies

In the context of the bachelor course, alongside the mathematics and physics lectures and seminars, you can also attend those in a subsidiary subject (in Physics often also termed a "non-physics subject"). A choice may be made from the following subjects:



On application, the minor subject can also comprise further lectures and seminars of the Johannes Gutenberg

Semester 1	Semester 2	Semester 3	Semester 4	Semester 5	Semester 6
Experimental Physics 1 + 2 (mechanics & heat; electricity & optics)		Experimental Physics 3 (atomic & quantum physics)	Experimental Physics 4 (scales & structures)	Experimental Physics 5 (selected from atomic, nuclear / particle or solid- state physics)	Experimental Physics 6 (selected from atomic, nuclear / particle or solid- state physics)
Theoretical Physics 1 (Theoretical mechanics)		Theoretical Physics 2 (electrodynamics)	Theoretical Physics 3 (quantum mechanics)	Theoretical Physics 4 (statistical physics)	Theoretical Physics 5 (higher quantum mechanics)
Mathematics 1	Mathematics 2	Mathematics 3	Inter-disciplinary module (e.g. measuring methods)	Inter-disciplinary module (e.g. computers in science)	
	Inter-disciplinary module (optional) (e.g. language course, history of sciences)	Beginners training 1	Beginners training 2	Advanced training 1	Advanced training 2
Subsidiary subject (e.g. chemistry for physicists 1)	Subsidiary subject (e.g. chemistry for physicists 2)			Scientific communication Competency seminar	Bachelor thesis

"Bachelor of Science", study timetable of a start in the winter semester. For a start in the summer semester, the timetable is available on the Internet.



BACHELOR

Just like when I was a kid, studying Physics today still fills me with wonder over the world and the universe. Mainz University offers me the ideal conditions to pursue my passion for research into the laws of nature: the physicists here walk the knife-edge between on the one hand creating good conditions for learning and on the other hand carrying out fascinating research projects.

David Maksimovic, Bachelor course student

University, although as a rule there must be a natural science-mathematical connection.

Bachelor of Education

The study of Education at Mainz University is the foundation stone of a teaching career at grammar schools and is read in combination with at least one other specialist subject. There are also lectures and seminars from the field of educational sciences and teaching methodology which are supported by practical demonstrations and school training.

As a fully-fledged university, the Johannes Gutenberg University offers a very wide spectrum with 22 subject combi-

The teaching course makes it possible for me to pass on my interest and enthusiasm for Physics combined with attractive career prospects. Here in Mainz, at last I have the chance to have my fling in a huge physics collection and actually carry out all those experiments we may only ever have heard of at school.

Florian Bürger, Bachelor course student

nations for the teaching profession. Special timetables ensure that these different subjects can almost all be studied avoid clashes occurring. In the study course for Bache-

lor/Master of Education in Physics the first aim is a deeper understanding of Physics, so that it will later be possible in your own teaching to impart the connections in Physics and with other subjects in a structured manner.

In addition, in methodological events you will be dealing with typical obstacles to comprehension, with the execution of easily-understood demonstration experiments and with how schoolchildren in class can themselves carry out experiments.

The course is particularly noteworthy on account of the special individual care provided for the students and its great practical relevance:

- ▶ in-school training and visits from classes of schoolchildren to lectures
- **instruction** in practical teaching methodology by grammar school teachers on part-time secondment
- innovative lecture and seminar formats given by course seminar tutors
- experimenting together with schoolchildren "Versuch's mal", "Master Classes in Particle Physics" and the school laboratory.

The studies are divided into a foundation course and a main course and will normally last six semesters.

Foundation course

The first two semesters of the Physics education study course are largely identical to the study course "Bachelor of Science Physics". This facilitates transition between the two courses.

Even on the BSc course, students can already take an active part in scientific work, both on the spot as well as at some of the world's leading research institutes. Many research groups offer work paid by the hour, to "student assistants", which at the same time lifts the curtain on the exciting world of science.

For me, what counts most in studying in Mainz is that teaching methodology is regarded as so important. Another thing is that there is excellent co-operation with alumni, so that you're never short of someone to contact when you have questions after completing your studies. There's a grill party every semester, and all the current and for- \mathbf{x} mer teaching course students are invited.

Maren Grasemann, Bachelor course student

Main course



From the third to the sixth semester you will learn the fundamental principles of Theoretical Physics and extend your knowledge of Experimental Physics. In supervised training, you will practise setting up experiments in the laboratory and handling measuring instruments. The main course also includes teaching methodology.

Semester 1	Semester 2	Semester 3	Semester 4	Semester 5	Semester 6
Experimental Physics 1	Experimental Physics 2	Experimental basic training 1	Experimental basic training 2	Experimental Physics 3	Basic Physics methodo- logy and teach-and-learn laboratory
Mathematics calculation methods 1	Mathematics calculation methods 2	Second subject	Theoretical Physics 1	Demonstration training 1	
Second subject	Second subject	Second subject	Second subject	Second subject	Bachelor thesis
Second subject	Teaching methodology consolidation (part 1 and part 2)		Second subject	Second subject	
Educational Science 1		Educational Science 2		Educational Science 3	

"Bachelor of Education", study timetable of a start in the winter semester. For a start in the summer semester, the timetable is available on the Internet.

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School training

In the course of your studies, you will undergo four periods of training: two orientation training courses and one consolidation course in the Bachelor and a specialist training in the Master course.

When Physics has been chosen as the first of the two specialist subjects, the bachelor thesis and the oral finals are scheduled for the sixth semester.

Master of Science



The "Master of Science Physics" course in Mainz is offered exclusively in English commencing with the winter semester 2016/17. This will benefit not only

I set great store by the large number of support programmes and the Cluster of Excellence in Physics, which made it possible for me to stay in Paris during my Bachelor studies and to make a visit to the impressive Gran-Sasso laboratory in Italy. I opted to study for my masters in Mainz because I want to continue to benefit from the unique support and course options available.

Carina Kießling Master course student

international students: for German speakers this will mean that their value on the international jobs market is greatly enhanced. In addition, the majority of specialist literature in physics is published in English.

During the Master course, students in Mainz benefit from a range of unique programmes which are offered by the Graduate School MAINZ the PRISMA Cluster of Excellence, Graduate College and the

nearby Max-Planck-Institute for Chemistry and Polymer Research. Thus there are many potential contacts with the leading Universities and research institutions abroad. Students can also stay abroad in the context of various international exchange programmes actively promoted and supported financially.

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Structure of the course

During the first two semesters you will consolidate the basic knowledge you acquired in the Bachelor course in Experimental and Theoretical Physics. There are also two seminars, two periods of training and two special lectures. In the following research phase, from the third semester, there are two seminars devoted to special knowledge and methods for scientific preparation for your master thesis. The master thesis and oral finals are scheduled for the fourth semester.

Consolidation phase (Semesters 1 + 2)

- Consolidation in Experimental and Theoretical Physics (lectures and practical work)
- Special lectures and seminars
- Advanced training periods

Research phase (Semesters 3 + 4)

- Specialisation and methods (seminars)
- Master thesis and oral finals (colloquium)

Master of Education

Entry qualification for the "Master of Education" is successful completion of the "Bachelor of Education" course with the same combination of specialisations.

Structure of the course

The teaching study course "Master of Education Physics" is made up of Physics as a subject and another science, including relevant teaching methodology; there is also the subject of teaching sciences. The course normally lasts four semesters.

Provided Physics is selected as the first specialisation, the master thesis and the oral final examination in this subject will be scheduled for the fourth semester.

Consolidation module (Semesters 1 + 2)

Consolidation in Experimental and Theoretical Physics (lectures and practical work)

Teaching methodology module (Semesters 1 + 2)

 Developing theories and methodological research, basic experiments in physics teaching, possibilities of experimental specialist work (lecture, training period and main seminar)

Advanced training period (Semester 3)

Selected experiments in Atomic and Molecular Physics, Molecular Spectroscopy, Solid-state Physics, Nuclear Physics, Optics and measuring techniques

Inter-disciplinary concepts and applications (Semester 4)

- Cross-connections between sub-sections in physics
 - and other sciences
- Structures and concepts
- Applied and Technical Physics

I think too many people have a negative im-pression of Physics. What I want to do in the future is help my students to view Physics in a positive light. And the wide range of projects for all schoolchildren at Mainz university has given me lots of ideas how to do that in future.

Frederick Krämer. Master course studen



Mainz – top research

For bachelor and master theses and doctorates in Physics. the Johannes Gutenberg University offers a highly diverse and top guality range of research programmes which are centred on the fields of Astro-particle and Particle Physics, Nuclear Physics, Materials Science, Quantum Optics and Magnetism. In the "Nature Index Ranking 2016", Mainz University achieved very good results especially in Physics and reached the Top 5 in the ratings of German research colleges and indeed was placed 69th in the global listings.

This strength in research makes it possible to attract a great deal of sponsorship, among others in connection with the Cluster of Excellence "Precision Physics, Fundamental Interactions and Structure of Matter (PRIS-MA)" and also the graduate school "MAterials science IN mainZ" (MAINZ). For the students, this results in first class equipment and infrastructure.

Materials Science and Magnetism

To understand and manipulate Magnetism at a microscopic level offers unique opportunities, including those relating to future data-storage technologies. Some of the questions arising are how long the magnetic reversal processes take, how small a magnetic area ("domain") can be, or what properties new types of materials have. For this purpose, researchers in Mainz are for example investigating electrons which can be emitted from materials on exaltation by laser pulses, construct new, high-definition electron microscopes and create nano-structures in special designs.

The subjects we cover



Particle and Astro-particle Physics, Nuclear Physics and the Theory of Relativity

How exactly do the processes function in nuclear fusion in stars? What is dark matter and how is it supposed to have shaped the development of the universe? These are just some of the questions on which the researchers in Mainz are working. They

For me, the fascinating thing about my research is the connection between smallest and largest: We work with microscopic particles in the accelerator, perform experiments and with them we answer the exciting questions surrounding the Big Bang and the creation of the stars or the riddle of the mysterious dark matter.

Prof. Dr. Concettina Sfienti Institute for Nuclear Physics

are all taking part in major international projects for this, such as the ATLAS experiment at the CFRN research centre in Geneva. where the Higgs-Boson was discovered. Or the IceCube experiment in Antarctica, where cosmic neutrinos are detected. For these challenging experiments, the researchers develop hardware and software, analyse data and work on new theoretical models.



Quantum Optics and Laser Spectroscopy

In Quantum Optics researchers use laser radiation to align atoms. They investigate gases for instance at a temperature close to absolute zero or trap individual ions or protons by particle traps. This accentuates their quantum mechanical properties and as strange as it may sound, the atoms can then be in two places at once. These experiments are decisive steps on the way to developing quantum computers or bug proof quantum communication systems.

Physicists continue trying to answer fundamental questions such as whether two bodies fall to the ground at the same speed and send experiments out into space to find out. Or they use ultra-precise measuring instruments to seek out on the ground the rarest elements on our planet.

RESEARCH



Our group develops new materials, predicts new phenomena and establishes physical understanding to prepare the way for the technology of the future. We no longer look for materials which possess specific properties. Instead we think out properties and phenomena we would like to see, then we create these materials ourselves. In a way, you might say we are using 3-D printing in a quantum world.

Prof. Dr. Jairo Sinova **INSPIRE Group, Institute for Physics**





Always discovering something new, carrying out experiments using the most extreme technology available, to get to understand a tiny corner of the world and share my enthusiasm with others: that's why I became a physicist. What particularly fascinates me in my daily work is the seemingly limitless attributes of quantum mechanics, which we can actually observe and measure in our laboratory.

Prof. Dr. Patrick Windpassinger QUANTUM Group, Institute for Physics

Great science ...

MAMI and MESA

The particle accelerator "MAinzer MIkrotron" (MAMI) makes it possible for researchers to investigate the structure of matter. A new accelerator – "Mainz Energyrecovering Superconducting Accelerator" (MESA) - is currently being constructed. This will make it possible to identify the structure of compound particles, The radius of the proton, which has given rise to many puzzles in recent years, will be measured here. MESA will also contribute to the search for dark photons, whose existence has recently been predicted by theoretical physicists.





TRIGA

The research reactor "TRIGA" in Mainz is a nuclear reactor in the grounds of the Johannes Gutenberg University. With the help of the reactor, scientists investigate exciting questions in both the physics and chemistry fields.

Used in fundamental research, the reactor produces "ultra-cold neutrons" - these are neutrons travelling at a comparatively low speed of about 5 m/s. One of the tasks carried out by TRIGA is determining the life span of these neutrons with hitherto unmatched accuracy.

TRIGA is an outstanding example of inter-disciplinary cooperation: researchers from the chemistry, physics and other specialised fields work together here to obtain new findinas.

... and powerful connections

MITP and SPICE

MITP, the "Mainz Institute for Theoretical Physics", and SPICE, the "Spin Phenomena Interdisciplinary CEnter", are known throughout the world as two centres for promoting scientific exchange visits.

It is the vision of both these centres to bring together scientists at conferences, workshops and meetings in Mainz and in this way to promote exchange of ideas. Discussions and lectures provide food for thought to progress one's own research.

The workshops organised cover a very wide variety of subjects, ranging from quantum theory and gravitation to spintronics and cosmology.



nity.

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RESEARCH

The research background

The researchers in Mainz have access to an outstanding infrastructure on the campus and in its immediate vici-

On the campus itself, our own particle accelerator MAMI, soon to be joined by MESA, and the reactor TRIGA offer unique possibilities. The scientists are moreover members of world-wide associations and undertake research in major projects such as the ATLAS detector at the CERN research centre in Geneva or the IceCube Experiment in Antarctica.

In Mainz itself, there are many networking and research possibilities too, as well as numerous career opportunities because of the number of institutes in the city.

Helmholtz-Institute Mainz (HIM)

Structure, symmetry and stability of matter and antimatter

Max-Planck-Institute for Polymer Research

Manufacture and characterisation of polymers and investigation of their physical and chemical properties

► Max Planck Institute for Chemistry

Understanding the chemical processes in the earth's system from a molecular to a global scale

Fraunhofer ICT-IMM

Energy and chemical technology and analysis systems and sensors

Career prospects

the physicist has

not only learned

"pure Physics",

but also how to

solve complex pro-

blems with an ana-

lytical and systematic

They can score in all

those places where cri-

tical consideration and

creative development

of new concepts are

required in addition to

mere action. That's why

approach.



And when you have finished your studies? There are many openings in the jobs market: physicists are not restricted to a particular sector, but are valuable members of the workforce in a great variety of different fields. This is because

I am working at Siemens on the development of electric motors, which are projected to find new types of application in avionics. They have to be ultra-light, extremely efficient and especially powerful. My particular task is to identify the limits of today's concepts and to incorporate new technologies in the development. To realise this technology transfer, I need to collaborate with our own research departments, other universities and external partners. 99

Dr. Florian Schulz, Siemens Mainz University graduate

- mostly in teams together with experts from other disciplines.

The physics course certainly prepares the student for a career in research and development, but it is just as clearly an ideal springboard for demanding careers in commerce and industry.

publicly-owned organisations and international concerns

To support the career orientation of its students, even during the courses the Johannes Gutenberg University offers an insight in different ways into various fields of activity. As one example, mentoring programmes permit





The best decision I could have made after passing my university entrance exam was to study Physics – even though the course was a tough challenge. I'd certainly do it again. To understand what keeps the earth together and to pass on 99 this understanding to young people: for me personally, that's a reward in itself every day.

Kerstin Müllers, teacher at the Gustav-Heinemann School, Rüsselsheim Mainz University graduate

> close contact at an early stage between students and graduates active in a variety of sectors.

> In schools, physicists are always in demand; there are few careers with such an influence on the future as that of a teacher. Teachers should not merely be confident in their subject, but also ideally have an ability to encourage those they teach and be understanding as well. These characteristics are enormously important, especially in the natural sciences. Demand is high for gualified teachers in Physics to open the door on the exciting cosmos of matter and antimatter to schoolchildren and to prepare the way forward for the potential scientists of tomorrow.

they don't only work in university research and develop-

ment but in many branches of electrical and computer

technology, in the optics industry and in the semicon-

ductor industry, medical technology, machinery and ve-

hicle construction. They are also employed in sectors far

removed from technology, such as banks and insurance

companies, in patent matters, scientific journalism, busi-

ness consultancy, politics and management as well as in

Useful links and info

Still not sure if Physics is right for you?

- Online study selection assistant www.studium.fb08.uni-mainz.de/physik/ studieninteressierte/osa
- School projects www.schule.physik.uni-mainz.de
- Taster days www.studium.uni-mainz.de/schnuppertage

Plan your course:

Studying Physics in Mainz www.studium.fb08.uni-mainz.de/physik

Here you will find further information on the modules and courses in the download centre.

Get some good advice

- Study course consultancy www.studium.fb08.uni-mainz.de/physik/ studienfachberatung
- Studies office www.studium.fb08.uni-mainz.de/physik/ studienbuero
- Students' Council Physics / Meteorology fachschaft.physik.uni-mainz.de
- Teachers Training Centre www.zfl.uni-mainz.de
- University Examination Office for Teaching Courses www.hpl.uni-mainz.de

CAREER PROSPECTS

Mentoring

a wide-ranging mentoring programme for supporting the choice of study course and to support students on their course.

The Ada Lovelace Project has the aim of encouraging girls and young women to take up the natural sciences, mathematics and computer science, to look after students in their study courses and to support young sci-



For young up-and-coming scientists, the Ada Lovelace Project offers support – throughout the schooldays and beyond!

For schoolchildren and students, Mainz University offers entists with career development during their doctorate. The Ada Lovelace Programme offers specific content for the researcher of tomorrow.

For schoolgirls

- ▶ Girls' Day at the Uni Mainz: on the campus, schoolgirls can find out all about the world of natural sciences
- MINT in MAINZ: study orientation and school-girl mentoring for senior girls in co-operation with Mainz University of Applied Sciences
- Career orientation for schoolgirls at middle school

For female students

- participation in our first-year-student mentoring
- Co-operation: MINT students take care of first year female students and enthusiastic schoolgirls in MINT workshops
- Further education for MINT students

In addition we offer student teachers

- Orientation practical training II at one of our partner schools: independent conception, planning and execution of a ten-hour teaching module
- Accompanying seminar programme

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C The fairest thing we can experience is the mysterious. It is the fundamental emotion which stands at the cradle of true art and science. **S** Albert Einstein (1870-1955)



Learn more: www.studium.fb08.uni-mainz.de



