UniverseNews

Excellence Cluster Universe | Issue 2/2014

Details of the readout electronics of the time projection chamber of EXO-200, Photo: EXO-200 Collaboration

New high-precision measurement with the experiment EXO-200

No evidence of the double nature of neutrinos

Munich Institute for Astro- and Particle Physics (MIAPP)

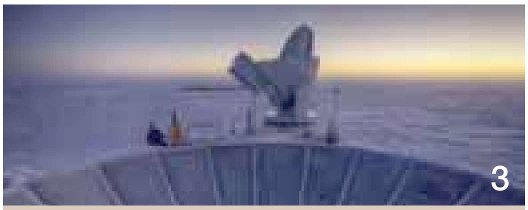
Focal point for international cutting-edge research

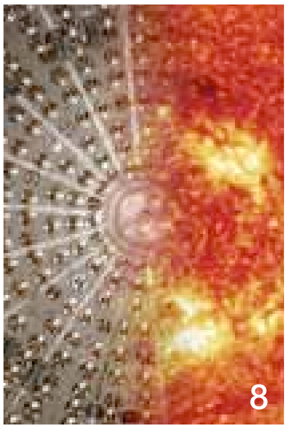
Dear readers,

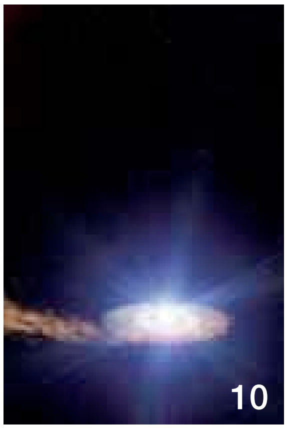
competition and cooperation, both can advance knowledge. Two examples: In a sense, the teams of BICEP2 and Planck pursue very different scientific objectives. But presently, they have put their knowledge together because it is the only way to find an answer to the question: Did the BICEP2 telescope observe gravitational waves – or just dust? (page 3).

The scientists of the experiments Gerda (page 7) and EXO 200 are working on the same problem but with different experimental approaches. Both are in search of the double nature of neutrinos and try to track a very rare radioactive decay. The most precise measurement of this decay has recently been published by the EXO-200 team (page 9). But the actual question is still open: Are neutrinos Majorana particles?

Petra Riedel, PR Manager







Review

Photos: Petra Riedel/EXC (2), Beate Riedel

MIAPP Kick-off
25 May 2014

After two years of preparation, the new Munich Institute for Astro- and Particle Physics (MIAPP) launched its first four-week workshop on 25 May. After a welcome by MIAPP director Prof. Rolf-Peter Kudritzki (photo) the program started with a first highlight: the opening lecture of Nobel Prize laureate Prof. Adam G. Riess. At the inauguration of the new international visiting research center on 11 June, the Nobel Prize colleague of Adam G. Riess, Prof. Brian P. Schmidt, held a lecture at the TUM Institute for Advanced Study with 80 invited guests in attendance.

Café & Kosmos Matinee
6 July 2014

Following the invitation of the artist Ugo Dossi, the science café series Café & Kosmos made its first stopover outside of Munich. In the studio Dossi in Murnau at the foothill of the Bavarian Alps, Prof. Andreas Burkert (LMU) (photo) presented new observations of the small gas cloud G2 on its way to the black hole of our galaxy – a unique event that is currently tracked by astrophysicists with great fascination. In a wonderful studio setting, accompanied by fine aperitifs, the audience and the physicist also discussed the many similarities between art and science.

Girls and Technology
Summer holiday 2014

As a tradition, the Excellence Cluster Universe participated in the Summer Program for girls at the TUM. In the workshop "Our star, the sun" (31 July – 1 August), guided by Petra Riedel, 10- to 12-year-old pupils got to know our solar system in more detail. Dr. Eliane Epple (TUM) offered an "Introduction into programming" (September 4 – 5). Finally, the PhD students Karina Voggel and Roxana Chira (both ESO) led the workshop "The simulated universe" and demonstrated the group of 14- to 16-year-olds how exciting it can be to let galaxies collide (September 10 – 12) (photo).

Doubts over the results of the BICEP2 collaboration

Much ado about dust?

If a physics announcement makes the evening news, it must be an epoch-making discovery. And initially, it looked like that in March of this year, when an American team of scientists reported to have discovered gravitational waves in the cosmic microwave background for the first time ever. Critical colleagues believe, however, that the signal could have a different cause and could be generated, at least partly, by the galactic dust in the Milky Way. This is also implied by a new publication of the Planck collaboration.

So far, the cosmic inflation is only a theory: It states that a split second after the Big Bang and only for a tiny moment, the universe expanded faster than with the speed of light, thereby increasing in size by at least a factor of 10^{26}. This fantastic assumption could explain some of the crucial properties of our universe, but evidence is lacking. However, according to cosmologists, the presence of a particular swirly pattern in the polarization of the cosmic microwave background would be a strong indicator. If a cosmic inflation had occurred, the tiny gravitational waves caused by the Big Bang would have been pulled apart strongly during the inflation phase and thus should be preserved in the microwave background until nowadays.

The 512 detectors of the South Pole Telescope "Background Imaging for Cosmic Extragalactic Polarization" (BICEP2) have been looking for that swirly pattern for more than two years, mapping the microwave radiation with a frequency of 150 GHz coming towards the earth from a 380 square degrees spot in the sky. The signal should be extremely weak, if measurable at all. Therefore, the location and the spot in the sky have been carefully chosen: far away from the galactic plane of the Milky Way, clear and free of atmospheric disturbances. If anything, the scientists would be able to prove the distortion of space-time postulated by Einstein from this place on the earth. And at first, it looked as if the BICEP2 collaboration had been successful: In March, after two years of data analysis, the researchers broke the news that they had discovered the long-sought evidence and thus to have confirmed the inflation theory.

But meanwhile, international colleagues have doubts whether the conclusions drawn from the measurements are accurate. In May 2014, the Excellence Cluster Universe invited its member Prof. Viatcheslav Mukhanov from the Ludwig-Maximilians-Universtität Munich to hold a public lecture. The internationally renowned cosmologist referred to tensions between the theory and the BICEP2 results. But what might be the problem?

Very likely, the problem is caused by interstellar dust in our galaxy. "The thermal radiation from dust particles that align in galactic magnetic fields is polarized", says Prof. Hans Böhringer from the Max Planck Institute for Extraterrestrial Physics, who is also a member of the Excellence Cluster Universe. "Since the galactic magnetic fields themselves are swirled, it is not surprising that the resulting polarization pattern contains vortices."

Apparently, the interpretation of the BICEP2 data strongly depends on how much dust is allocated to that 380 square degrees spot. The collaboration led by John Kovac only used very limited own data to estimate the dust contribution. The team had to rely on theoretical models as well as results from other experiments. Since June 2014, the BICEP2 results are published in Physical Review Letters where the scientists present their results more cautiously. The scientists state that their "models are not sufficiently constrained by external public data to exclude the possibility of dust emission bright enough to explain the entire excess signal".

A new publication of the Planck collaboration from September 2014 confirmed that the dust is not a negligible quantity: "We can say, that the detected spiral pattern in large parts arises from dust particles rotating in the galactic magnetic fields", says PD Dr. Torsten Enßlin from the Max Planck Institute for Astrophysics (MPA), who heads the Planck team at MPA and is a member of the Excellence Cluster Universe. "Whether the BICEP2 telescope has really observed signs of gravitational waves, is open." Both collaborations are now working together to jointly analyse their data. "In the microwave range, galactic astrophysics and cosmology meet each other, and experts from both are needed to understand the data," says Torsten Enßlin. It remains to be seen whether the news from March was more than much ado about dust. *Petra Riedel*

Photos: Steffen Richter, Harvard University

Sunset behind the BICEP2 telescope: Very likely, the galactic dust in the Milky Way had great influence on the measurement.

Enough time for discussion was provided for the third program "Challenges, Innovations and Developments in Precision Calculations for the LHC".

The first season of the Munich Institute for Astro- and Particle Physics (MIAPP)

Four successful programs

For the first time, high-profile international researchers met at the Munich Institute for Astro- and Particle Physics (MIAPP) in May 2014. The new international visiting research center was founded by the Excellence Cluster Universe and organizes four-week programs on cutting-edge research topics in the field of astrophysics, cosmology, particle and nuclear physics. Recently, the fourth and final program of this year came to an end. The final verdict: the new institute is considered a great success.

"Aspen is good, Garching is better", that's how Prof. Brian P. Schmidt praised the Munich Institute for Astro- and Particle Physics (MIAPP) in advance. The Nobel Prize laureate and scientist at the Australian National University was one of the hosts of the first MIAPP program "Extragalactic Distance Scale". Together with his Nobel Prize laureate colleague Prof. Adam G. Riess from the Space Telescope Science Institute, Baltimore, USA, and other international renowned astrophysics, they were working on an ambitious goal: From 25 May to 20 June the physicists tried to develop a strategy to reducing the Hubble constant deviation to just one percent over the course of the next ten years.

"The different approaches were discussed heatedly but very constructive and in a very cooperative atmosphere", says Prof. Rolf-Peter Kudritzki (University of Hawaii/LMU), MIAPP director and one of the coordinators of the first program. "I am sure that the results of the discussion will have an impact on further studies."

Time for discussion

The second program, "Neutrinos in Astro- and Particle Physics" from 30 June to 25 July, received a very positive feedback, also. Currently, as a result of the four-week meeting, a publication on sterile neutrinos is being prepared. The many facets of the field were discussed in "Challenges, Innovations and Developments in Precision Calculations for the Large Hadron Collider" (28 July – 22 August). "The scientists especially appreciated that the program was not packed with lectures, so that there was a lot of time for discussions and work in small groups", says Dr. Gudrun Heinrich from the Max Planck Institute for Physics and one of the coordinators of the third MIAPP program. Finally, the first MIAPP season was concluded by the four-week meeting of international experts on "Cosmology after Planck" (25 August – 19 September).

The four programs were rated as an outstanding success by all participants. The special MIAPP format, which provides plenty of time for scientific cooperation, discussion and development of new projects, was very well received. Participants were enthusiastic about how scientifically stimulating their meeting proved to be. For the four programs of the year 2014, a total of 222 scientists from 24 countries were invited, 87 of them from Germany. The application deadline for the first four of six programs of the year 2015 has expired, and the registration numbers exceed those of 2014. It looks as if the Munich Institute for Astro- and Particle Physics is well on its way to get established as the meeting place for international top researchers.

Photos: MIPP: Wenzel Schürmann/TUM

The participants of the first MIAPP program "Extragalactic Distance Scale" together with the four coordinators (first row, from left) Prof. Lucas Macri (University of Texas, USA), Prof. Wolfgang Hillebrandt (Max Planck Institute for Astrophysics), Prof. Rolf-Peter Kudritzki (University of Hawaii/LMU) and Prof. Wolfgang Gieren (Universidad de Concepción, Chile)

MIAPP Programs 2015

2 – 27 February 2015

Dark Matter: Astrophysical Probes, Laboratory Tests, Theory Aspects

4 – 29 May 2015

The new Milky Way

1 – 26 June 2015

Indirect Searches for New Physics in the LHC and Flavour Precision Era

29 June – 24 July 2015

Anticipating 14 TeV: Insights into Matter from LHC and Beyond

27 July – 21 August 2015

Star Formation History of the Universe
Closing date: 26 October 2014

24 August – 18 September 2015

The many faces of Neutron Stars
Closing date: 23 November 2014

The hosts of the second MIAPP program focused on "Neutrinos in Astro- und Particle Physics".

International experts were working on the "Cosmology after Planck" as part of the fourth MIAPP program.

Photos: LNGS-INFN, CRESST-Kollaboration, Sabine Kaps/EXC (2), Petra Riedel/EXC

The Gran Sasso underground laboratory: Located 1,400 meters below the Corno Grande in the Italian region of Abruzzi, there are three halls where a total of 15 experiments are housed, among them Borexino, Gerda and CRESST.

The Gran Sasso underground laboratory and the experiments Borexino, Gerda and CRESST

First exit on the right

The world's largest underground laboratory for particle and astroparticle physicists is about 120 kilometers away from Rome in the highest mountains of the Italian peninsula. The Gran Sasso massif is traversed by a 10-kilometer-long tunnel, a turnoff in the middle leads towards the Labori Nazionali del Gran Sasso. The laboratory is almost completely shielded against the particle showers from space. Thus, it's the ideal place to look for the rarest events in our universe.

The Gran Sasso underground laboratory is comprised of three large experimental halls, each about 100 meters long, 20 meters wide and 18 meters high, connected by supply tunnels, with a total volume of 180,000 cubic meters. But the size is not its most important feature. More important is the almost complete absence of cosmic "noise", the permanent shower of particles from space, that makes the laboratory so important for astroparticle and particle physicists. There are 1,400 meters of rock above the halls, so that the cosmic particle flux is about a million times smaller than at the Earth's surface. Additionally, the radioactivity is reduced by a factor of 1,000: For the Gran Sasso massif consists of dolomite, a rock that contains little uranium and thorium, the two main natural radioactive elements in the Earth's mantle. These properties make the laboratory ideal for physicists to search for the most difficult-to-detect phenomena in the universe. Currently, at Gran Sasso there are a total of 15 experiments running, used by more than 900 scientists from 27 countries.

Researchers from the Excellence Cluster Universe are involved in the following three experiments at Gran Sasso underground laboratory:

Borexino

The Borexino experiment (Hall C) consists of a huge dome with 18 meters in diameter, containing a stainless steel sphere with a liquid scintillator for the detection of neutrinos. To further shield the detector, the sphere is placed within a tank with ultra-pure water. Borexino has started operation in 2007. The primary aim of the experiment is the exploration of solar neutrinos of low energy, but also of neutrinos from radioactive decay in the Earth and other phenomena. Just recently, the Borexino Collaboration published the first direct observation of the creation of solar energy (see page 7).

Gerda

The scientists of the Gerda experiment (Hall A) are looking for the neutrinoless double beta decay in the germanium isotope Ge-76. For this purpose, they operate 13 detectors the size of a tin can and weighting two kilograms, placed in the middle of a gigantic "thermos flask". The flask is filled with high-purity liquid argon, lined with high-purity copper and placed within a tank with ten meters in diameter filled with ultra-pure water. Last year, the Gerda Collaboration released a new world's best lower limit for the half-life of the neutrinoless double beta decay of 2.1×10^{25} years (see Universe News 2/2013).

CRESST

With the CRESST experiment (Cryogenic Rare Event Search with Superconducting Thermometers) (Hall A), the physicists aim at directly detecting dark matter. The detector is optimized for the search of WIMPs (Weakly Interacting Massive Particles), one of the dark matter candidates under discussion. Highly pure crystals are used as Low Temperature Detectors. Incident particles are detected via the light and the heat they produce within the crystal. Possible WIMP candidate events within a first measurement have been ruled out by other experiments. Since July 2013 a new measurement campaign is running.

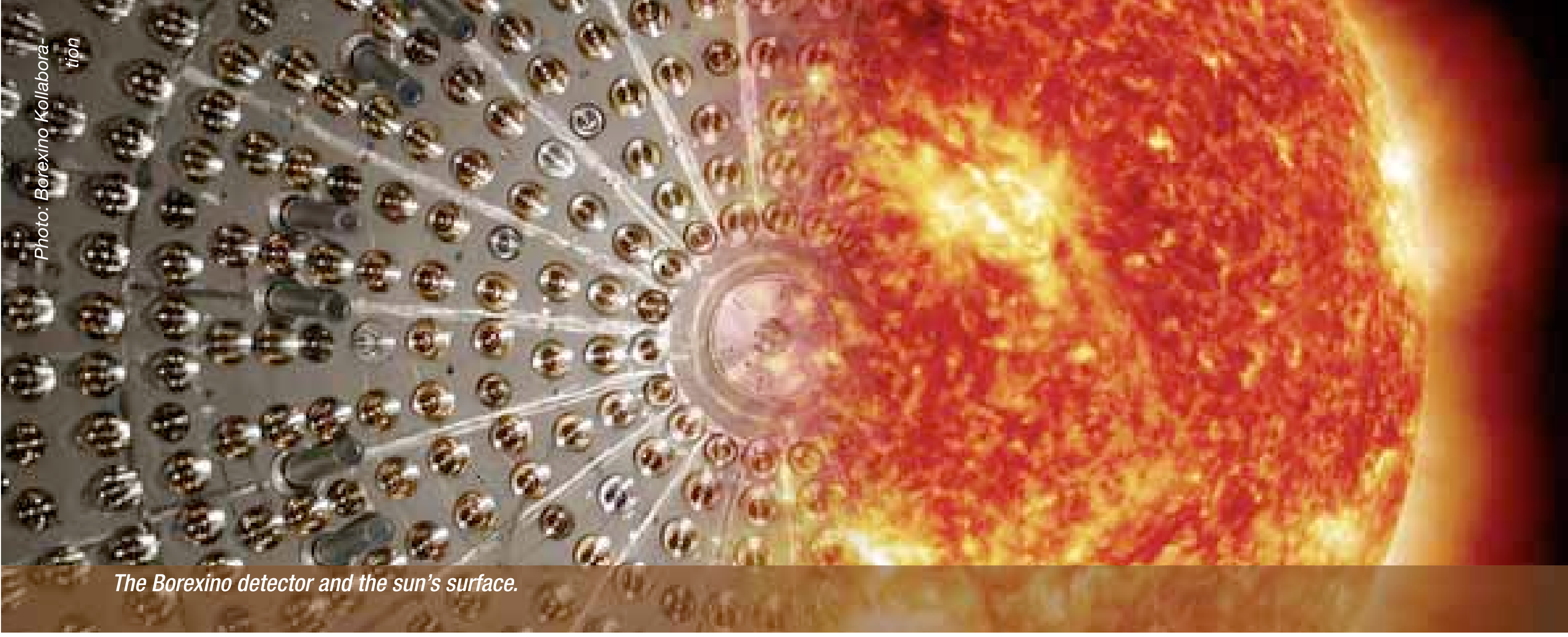


Photo: Borexino Kollaboration

The Borexino detector and the sun's surface.

Improved technology enables the measurement of solar neutrinos

Physicists observe the creation of solar energy for the first time ever

For the first time in the history of solar research, scientists have successfully measured solar energy at the instant of creation inside the sun. In the Gran Sasso underground laboratory, physicists of the Borexino Collaboration are for the first time ever directly observing the neutrinos created during the fusion of two hydrogen nuclei and the resultant production of heavy hydrogen. The researchers, including physicists from the Technische Universität München (TUM), are presenting their results in "nature".

15 million degrees Celsius – that is the temperature deep inside our sun. Various fusion reactions take place there. 99 percent of the energy is created in a fusion cycle that starts with two hydrogen atoms fusing into a single atomic nucleus of heavy hydrogen. The energy that lets the sun shine (solar radiation) is released in this cycle. In addition, electrically neutral particles called neutrinos are created.

A hundred thousand years

Previous analyses of solar energy built on measurements of solar radiation. On average, however, this takes over one hundred thousand years to find its way to the surface from the sun's dense core. Thus, the values correspond to the energy that was released over a hundred thousand years ago inside the sun.

Neutrinos behave in a completely different manner: As electrically neutral elementary particles, neutrinos hardly interact with other matter, allowing them to move freely. They thus leave the interior of the sun within seconds of their creation and reach the Earth in only eight minutes – more or less at the speed of light.

However, the same properties that enable neutrinos escape from the interior of the sun so quickly, also make these particles from the decisive nuclear reactions in the sun extremely difficult to measure. "The published observation was possible only because Borexino is the most sensitive detector worldwide and we were able to massively reduce noise from radiation and other cosmic particles," says Prof. Stefan Schönert. "In addition to solar neutrinos, we can also observe neutrinos from the interior of the Earth and use them to test geophysical models," adds Prof. Lothar Oberauer. Both scientists work at the TUM Chair for Experimental Physics and Astroparticle Physics.

Unchanged for ages

These results provide, for the first time, experimental proof that the energy released from inside the sun has remained unchanged for a very long time. To this end the researchers compared the present values of solar energy measured using the new method with the solar energy from over one hundred thousand years ago measured via the radiation. The result of the comparison correlates well with current theoretical models of the sun.

The scientists of the Borexino Collaboration have further ambitious plans: In the next four years they hope to improve the previously made measurements and to carry out new neutrino observations. One experiment in particular is currently in preparation to search for new particles – so-called sterile neutrinos. Their existence would have fundamental repercussions for particle physics, astrophysics and cosmology.

The Borexino experiment is installed in the Italian Gran Sasso underground laboratory approximately 1,400 meters beneath the surface of the Earth and serves primarily for the observation of neutrinos. Borexino is a cooperation of scientists from Italy, Germany, France, Poland, USA and Russia. Germany is represented with groups from TUM, the Max Planck Institute for Nuclear Physics in Heidelberg, the Universities of Mainz and Hamburg and TU Dresden. One of the authors and co-initiator of the Borexino experiment is TUM Professor Emeritus Franz von Feilitzsch, who founded the Collaborative Research Center "Astrophysics" in 1994 in which the Borexino experiment assumed a central role.

The Majorana nature of neutrinos and the neutrinoless double beta decay

No evidence of the double nature of neutrinos

After two years of searching for a special radioactive decay that would provide an indication of new physics beyond the Standard Model, an experiment deep under ground near Carlsbad (New Mexico, USA) has so far found no evidence of its existence. If this decay indeed exists, its half-life must be more than a million-billion times longer than the age of the universe.

Neutrinos are tiny, neutral elementary particles that, contrary to the Standard Model of physics, have been proven to have mass. One possible explanation for this mass could be that neutrinos are their own antiparticles, so-called Majorana particles.

Though experimental evidence for this is still lacking, many theoretical extensions of the Standard Model of physics predict the Majorana nature of neutrinos. If this hypothesis proves to be true, many previously unanswered questions about the origin of our universe and the origin of matter could be answered.

650 meters of shielding

In the EXO-200 experiment (Enriched Xenon Observatory), which is operated near the provincial town of Carlsbad in the US state of New Mexico, physicists from the research group of Prof. Peter Fierlinger of the Excellence Cluster Universe at the Technische Universität München are major contributors to this experiment.

The most sensitive method to experimentally verify the Majorana question is the search for a process called neutrinoless double-beta decay. This process is a special radioactive decay that may only occur if neutrinos are their own antiparticles.

Unprecedented accuracy

The EXO-200 experiment has searched for these decays over several years. From the fact that not one of these decays has been detected, the scientists can now deduce a lower limit for the half-life of the decay of at least 10^{25} years – around one million-billion years more than the age of the universe.

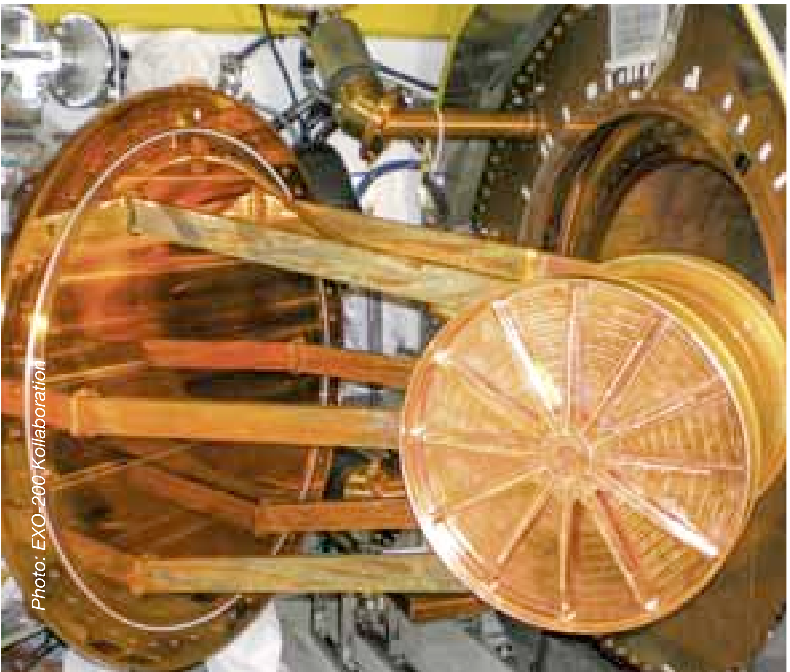
“Although this measurement attains unprecedented accuracy, the question about the nature of neutrinos can still not be answered,” says Dr. Michael Marino, member of the research group of Peter Fierlinger and responsible for the analysis of the now published data. “That’s why this open issue remains one of the most exciting questions in physics.”

This result demonstrates the high sensitivity of the detector and also the future potential of this method. Hence the EXO-200 measurements are also the basis for a much larger future experiment that finally could confirm or refute the Majorana nature of neutrinos.

International cooperation

The EXO-200 experiment uses 200 kilograms liquid xenon that was enriched to 80.6 percent of Xe-36 in Russian centrifuges. Xe-36 is an isotope that is allowed by theory to undergo neutrinoless double beta decay. The experiment’s location in the Waste Isolation Pilot Plant (WIPP) 650 meters below ground provides shielding against radioactive decays and cosmic radiation. Efforts are underway for a ton-scale experiment with the goal of probing new physics.

EXO-200 is a collaboration of research groups from Canada, Switzerland, South Korea, Russia and the USA; the Technische Universität München is the only German partner.



Inserting the Time Projection Chamber (TPC) into the cryostat.

One half of the TPC in the clean room, during construction.

Photo: European Space Agency and Justyn R. Maund (University of Cambridge)

Supernova Type Ia: The star gives off matter to its companion, a white dwarf. If the mass of the white dwarf exceeds a certain limit, an explosion ignites.

Unexpected observation at the end of life of a dwarf star

Igniting a supernova explosion

High-energy observations with the INTEGRAL space observatory have revealed a surprising signal of gamma rays from the surface of material ejected by a recent supernova explosion. This result challenges the prevailing explosion model for supernovae, indicating that such energetic events might be ignited from the outside as well – rather than from the exploding dwarf star's centre.

In January, a supernova explosion was reported in a nearby starburst galaxy, called M82. Just two weeks later, astronomers were able to take data with the INTEGRAL space telescope, revealing two characteristic gamma ray lines from a radioactive nickel isotope (Ni-56).

Supernovae are giant nuclear fusion furnaces, and the atomic nuclei of nickel are believed to be the main product of nuclear fusion inside the supernova. Presumably this radioactive element is created mainly in the centre of the exploding white dwarf star and therefore occulted from direct observation. As the explosion dilutes the entire stellar material, the outer layers get more and more transparent, and after several weeks to months also gamma rays from the nickel decay chain are expected to be accessible to observation.

As the astronomers scrutinized the new data, however, they found traces of the decay of radioactive nickel just 15 days after the presumable explosion date. This implies that the observed material was near the surface of the explosion, which was a surprise.

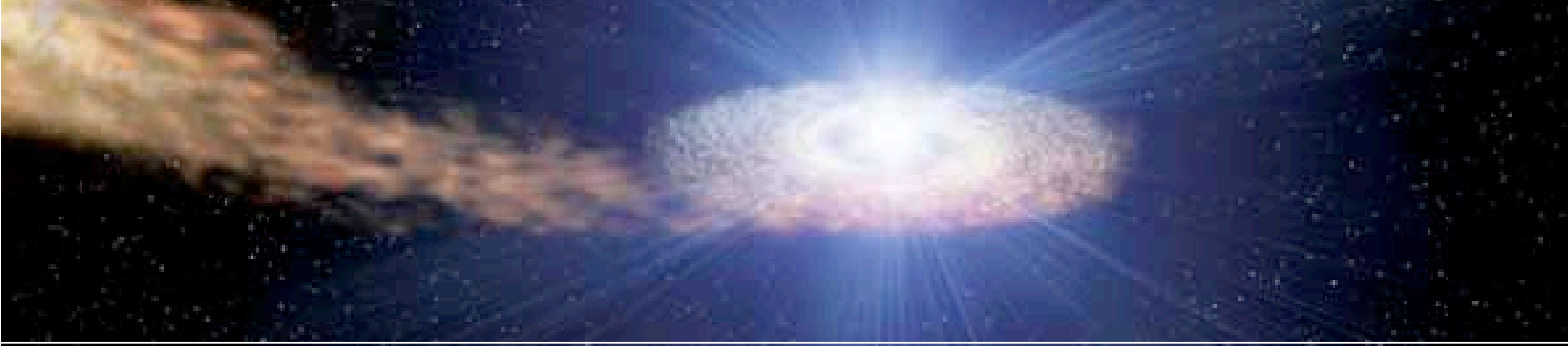
"We know that the supernova burns an entire white dwarf star within a second, but we are not sure how the explosion is ignited in the first place", explains Wolfgang Hillebrandt from the Max Planck Institute for Astrophysics (MPA) and member of the Excellence Cluster Universe. "A companion star's action seems required", he continues, "and for a while, we believed that only those white dwarfs explode, which are loaded with material from the companion star until they reach a critical limiting mass". But then, the explosion would be ignited in the core of the white dwarf, and no nuclear fusion products should be seen on the outside.

"We were puzzled by this surprising signal ourselves, for quite a while", says Roland Diehl from the Max Planck Institute for Extraterrestrial Physics (MPE) who is Principal Investigator of the INTEGRAL spectrometer instrument and, as well as Hillebrandt, member of the Excellence Cluster Universe. "But we could not find anything wrong, rather the gamma ray lines from Ni-56 faded away as expected after a few days, and clearly came from the direction of the supernova", he explains the outcome of their analysis of the observations. At MPE, an expert analysis team has been developing special methods for high-resolution spectroscopy of gamma ray lines for many years. These have been successfully applied to the study of nucleosynthesis throughout our Galaxy, as well as for the Cassiopeia A supernova remnant – and now to the recent supernova observations.

Diehl, Hillebrandt and their colleagues had argued over the result for a while, challenging the methods of data analysis as well as ideas about supernova explosion scenarios. They now report their finding, supported by statistical arguments and descriptions of their methods to help scientists judge this important discovery. They conclude that those gamma rays shed new light on how a binary companion's material flow can ignite such a supernova from outside, and without demand for exceeding a critical mass limit for white dwarf stars.

From the early appearance of the nickel gamma rays it seems that some modest amount of outer material accreted from the companion star ignited, and was processed to fusion ashes including the observed nickel. This primary explosion then must have triggered the main supernova, which was also observed with a variety of telescopes at many other wavelength bands, and appears as a rather normal supernova in these observations.

Gamma rays from radioactive decay directly trace nuclear fusion ashes, and thus make a unique contribution to what we can learn about such explosions. The scenario that the astrophysicists describe ties in with recent belief that rather rapid material flows such as they occur in merging white dwarfs may often be the origins of supernovae of this type.



Interview with Dr. Jaideep Singh on his year as scientist in Germany

"For me, that's completely crazy!"

The American experimental physicist Dr. Jaideep Singh owns about 3,000 physics textbooks, some endurance in the laboratory and a good sense of humour. As a Fellow, he spent one year at the Excellence Cluster Universe where he examined fundamental symmetries in atomic nuclei. Since August, he is back in the USA as Assistant Professor at Michigan State University. An interview on the mentality of American students, the German eight-hour day and the life of a vegetarian in Munich left with cheese bread and cheese spaetzle. *Interview: Petra Riedel*

I would like to ask you about the differences between USA and Germany you noticed during your stay here. To begin with: What did you strike most when you first came?

Jaideep Singh: It's very different! Before I came, I bought every book you can buy on Kindle for learning about the German culture. One interesting thing I found to be very true is that Germans are very direct. In some cases, it can be very efficient, in other cases, from an American point of view, it seems to be rude whereas it's just part of the national culture. Because I read about it beforehand, I was prepared.

Did you get used to it?

Yes. Now when I go back to the US, people tell me my personality has changed. So that's kind of funny.

You have been working with a lot of students. Did you notice any differences?

The students take a more professional attitude towards their studies in Germany. In the US, the mentality is very different. As an example: When I worked in the lab at Argonne National Laboratory, I had to give the big picture: I had to explain everything, tell them, why they have to do the task, how it fits in everything, and why we can't move forward in the project, when the task is not done. At the beginning, I tried to do the same thing here, but the students found it very annoying that I was wasting their time. They just wanted to know what they had to do. And they did it.

Did you realize any differences between the universities you got to know in the USA and in Germany?

They are very similar. For me, the big difference is a university setting versus a national lab setting. At a national laboratory, there are more resources. In my old group at Argonne National Laboratory, we had two engineers who designed everything for us. In a university setting, this normally doesn't exist. You have to do a lot of design work yourself. The other difference: In a university setting a lot of students do the work, in a national lab there usually are much fewer students. I like that, because I still like to play in the lab. But I'm afraid that this becomes less and less in time.

You really seem to love the lab. Your German colleagues told me that once they had to gently remove you from your experiments at the research neutron source in Garching, the FRM II, after 24 hours.

That story reminds me of another difference: I asked the security guard at the FRM II: What's the normal working style here? He said: Eight hours work per day, only during the week, not on the weekend. For me, that's completely crazy. Eight hours is maybe the length of time in which you can get your experiment ready to start taking data. Maybe I have just bad luck in the lab, but nothing is ever ready in eight hours. You have to keep working until your experiment is ready, or you find a natural stopping point, and if it's five hours, that's great. If it's 18 hours, well, that's life.

Are you a perfectionist? Perfectionists usually can't stop.

Not at all. In this particular case we had a long run plan for two weeks and I promised our collaborators that certain things are done before they come. But it took quite a long time before everything had been put together. At the end, when I was almost finished, they took me away from the lab. In the US my colleagues wouldn't have done that.

Why not?

First of all, no one would tell me that eight hours is a reasonable amount of time to work. But that's actually a very unhealthy part of the American culture. Another interesting difference: If one sees you working for a very long time in the USA, one would think: what a very dedicated, hard-working person. In Germany, one would rather think, that I don't know what's important in life and that I don't have an appropriate work life balance. Secondly, that I am a very lazy and inefficient worker who couldn't get his work done within eight hours. But those rules don't apply to a scientist! If your equipment is broken, you just have to stick with it until it's fixed.

Is there any difference in how large-scale research facilities work? You know Argonne National Laboratory, in Munich you have been working at the FRM II.

They are very similar. For large-scale research activities, you are part of a bigger project and your activities have to coordinate with other people's activities. The only rational, efficient way to do this is fit in with the system. You have to learn to be patient. There is no instant gratification.

You have an amazing hobby: You are an award-winning collector of physics textbooks with about 3,000 books. You have also textbooks from German physicists like Heisenberg, Planck or Sommerfeld. Did you notice any striking differences in the nationalities' approach to the same physics topic?

Oh yes! Americans tend to be very intuitive and hand-wavy, the best example of which is Feynman's own three volumes "Lectures on Physics". On the other hand, the French are very formal and bring a refreshing amount of rigor. The British are also formal and very mathematical, such as Paul Dirac's "The Principles of Quantum Mechanics". Whereas the Russians tend to be very terse and dense. But this may be an unfair stereotype famously attributable solely to Lev

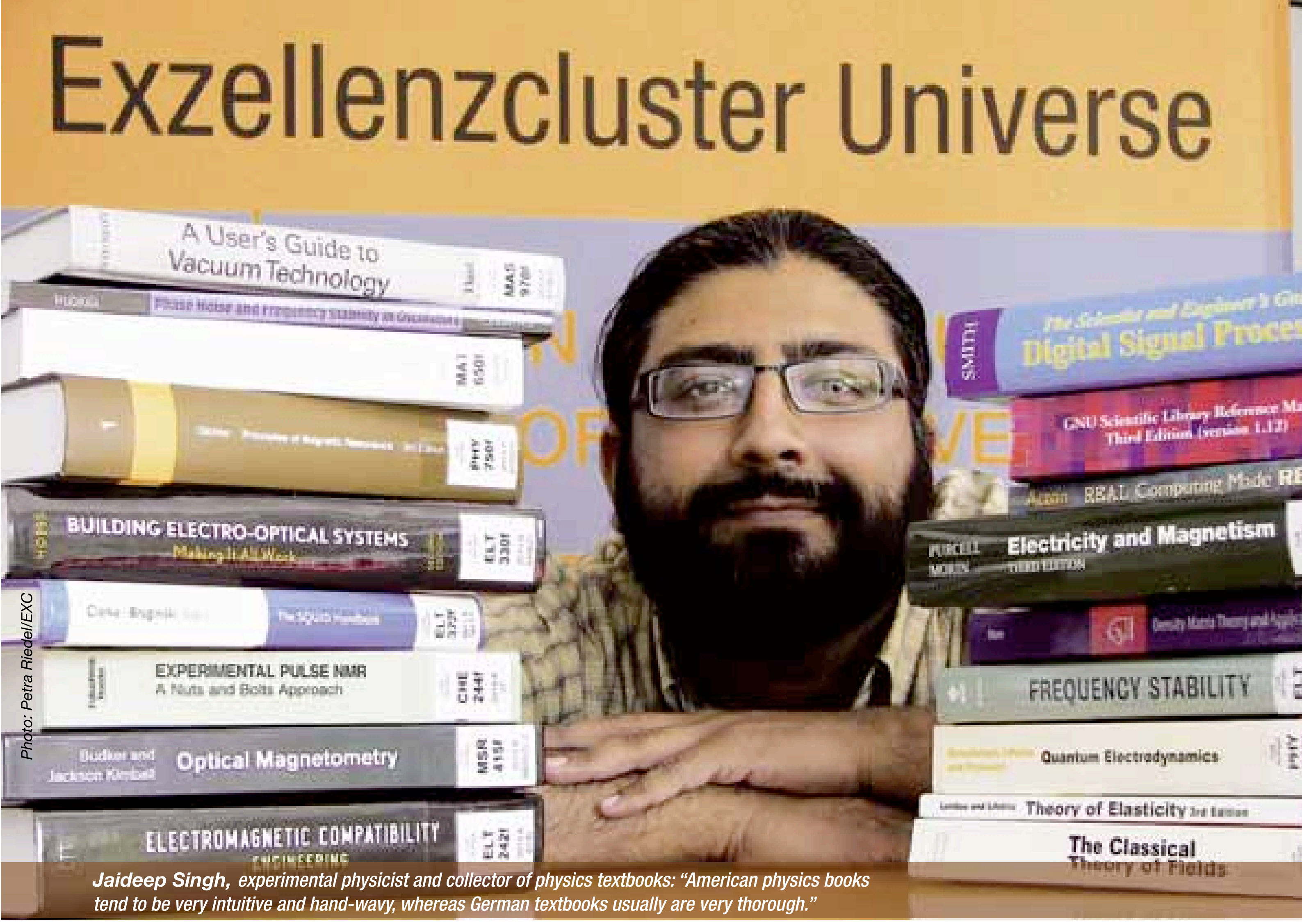


Photo: Petra Riedel/EXC

***Jaideep Singh,** experimental physicist and collector of physics textbooks: "American physics books tend to be very intuitive and hand-wavy, whereas German textbooks usually are very thorough."*

Landau and E.M. Lifshitz's classic ten volumes "Course of Theoretical Physics". German textbooks tend to be a good mixture of all of those qualities as well as being very thorough, which is represented well by Arnold Sommerfeld's six volumes "Lectures On Theoretical Physics".

Where are your books now?

At the moment, they are at my old lab in Argonne. I made them promise that I wouldn't throw them away or lose them or anything. For my new job at Michigan State University, I negotiated that they will move my books for me and I will have an office with enough shelves for my textbooks. I'm really looking forward to happily meeting them all again in Michigan.

Finally, what do you think of the German food and the German language?

The German language is quite tough. And it got even more complicated because at the beginning, there were many words that I thought I recognized from English, but they don't really mean the same.

An example?

There is a prefix on many signs that says "NOT". For me, it was very natural to think that like "Notausgang" the signs say: Do not go there. And definitely, in an emergency, I should not use that exit! But that was misleading and gave me a false confidence at the beginning. Because of that, it was harder than I initially had thought. On the other hand, it seems to me that there are fewer exceptions in the German language. The grammar seems to be very logical and rational.

What about German food?

I am a vegetarian. Before I came here, everyone joked that I will drink beer and eat bread and cheese all the time. That was approximately true, but different than what I had imagined. Thinking of the American bread and cheese sandwich, with this white bread and this very thin and low quality cheese, made me very sad when I came here. But the bread and cheese you get here are absolutely fantastic! If you eat this all the time, it's not bad. And I like cheese spaetzle, that's my favourite dish here.

Anything you will miss?

The bakeries and Spezi, Paulaner Spezi to be precise. I will miss them a lot.

Dr. Jaideep Singh was born in India and, as a child, moved with his family to the USA. He studied physics at the California Institute of Technology (Caltech) and received his PhD in 2010 from the University of Virginia. After that, he spent two years as a postdoc at Argonne National Laboratory, before he worked for a year at the Excellence Cluster Universe in the research group of Prof. Peter Fierlinger. His research interests include tests of fundamental symmetries, low energy searches of physics beyond the Standard Model and studies of rare nuclear reactions. A particular emphasis lays on creating, manipulating, and detecting spin-polarized nuclei.
Since August 2014, Jaideep Singh is Assistant Professor at Michigan State University leading his own research group, and will be also deploying the new Facility for Rare Isotope Beams (FRIB) once it is online.

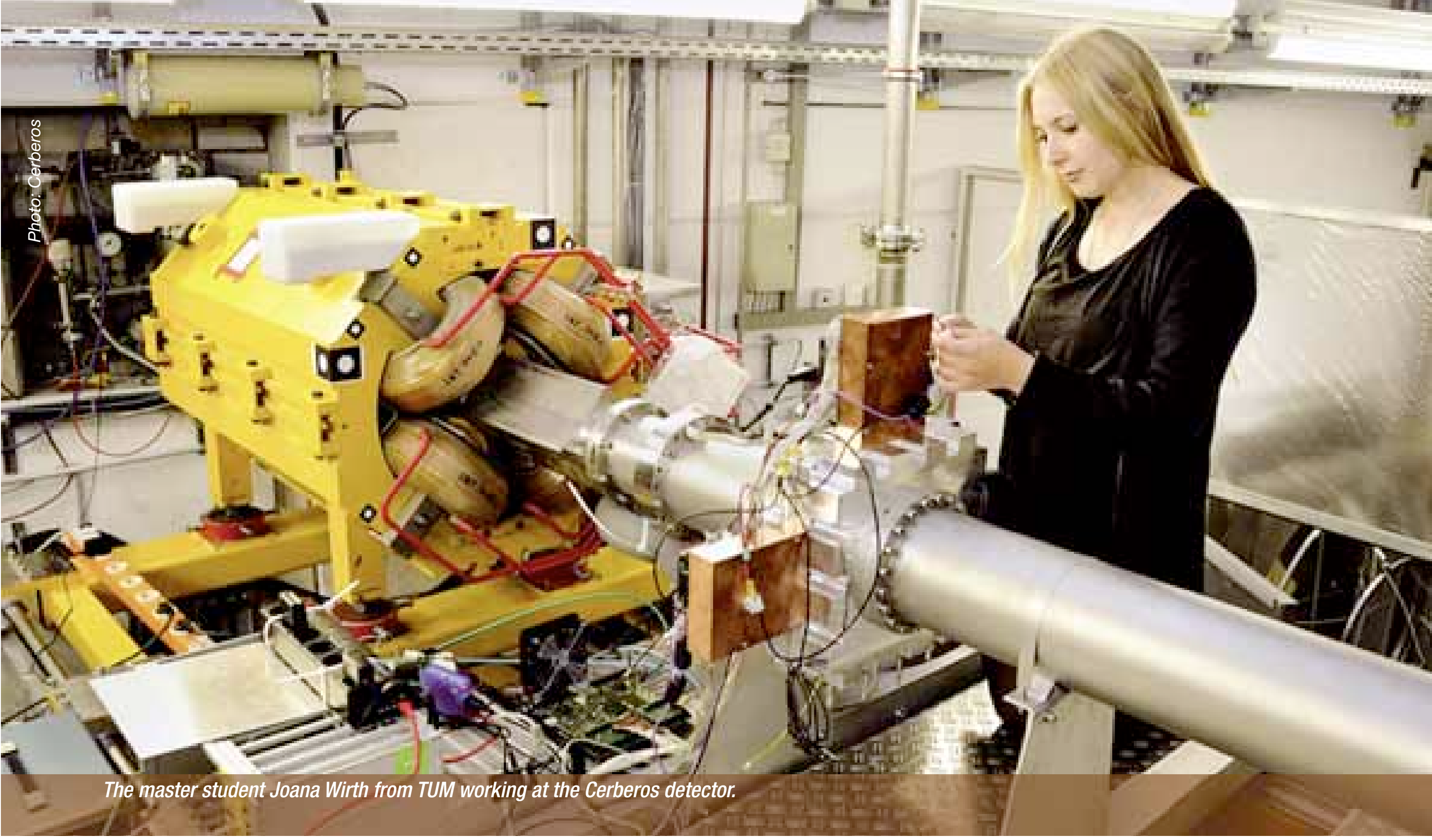


Photo: Cerberos

The master student Joana Wirth from TUM working at the Cerberos detector.

New measuring system at GSI Darmstadt

First use of Cerberos detector

In May 2014, the measuring system Cerberos was put into operation at the GSI Helmholtzzentrum für Schwerionenforschung. During the on-going beam time, the detector is analyzing the pions produced in the GSI accelerator facility, for the first time. The research group of Prof. Laura Fabbietti from the Technische Universität München (TUM) made significant contributions to the development and construction of Cerberos.

In order to study the properties of the components of atomic nuclei, i.e. the protons and neutrons, ions are fired at each other with nearly the speed of light at the GSI in Darmstadt. If the nuclei collide head-on, a new joint system with increased density emerges for a short moment, and quark and anti-quark particles are combined to new particles, the mesons. The physicists are particularly interested in the lightest group of mesons, the pions. These particles can only be produced in laboratories and do not exist on earth naturally. To better understand the pion's properties is the aim of the research group of Prof. Laura Fabbietti (TUM), who is also Principal Investigator at the Excellence Cluster Universe.

Highest accuracy needed

For the production of pions scientists accelerate nitrogen ions with the GSI accelerator and let it bounce on long rods made of beryllium. Then, the pions are sorted using magnets, bundled and then made to collide with other particles, thereby creating new, even rarer particles containing strange quarks. “To investigate these new particles, it is crucial to know the pion's momentum with highest accuracy possible”, says Laura Fabbietti. This is the purpose of Cerberos. After three years of work, the new measurement system went into operation in May 2014. The special feature of Cerberos is a novel microchip, which decides whether a collision event is interesting and will be recorded or not. Additionally, the detector is endowed with a particularly fast and precise readout component. The new system was developed and commissioned by researchers at the GSI in collaboration with various universities. From Laura Fabbietti's research group at the TUM the postdoc Dr. Ludwig Maier, the PhD student Rafal Lalik and the master student Joana Wirth made essential contributions. The name Cerberos was chosen because the new measurement system at GSI is located in front of the HADES (High Acceptance Di-Electron Spectrometer) detector. Hades is the ancient Greek god of the underworld, while the three-headed hellhound Cerberus guards the entrance of the underworld to prevent the dead from escaping and the living from entering.

International interest

After the first successful measurements in May, Cerberos is currently used in on-going experiments. The concept of a self-triggering readout electronic is not limited to the study of pions. In the future, parts of the system can also be used in the international accelerator facility FAIR (Facility for Antiproton and Ion Research), which is currently being built in Darmstadt, for example in the experiments PANDA and CBM. Research facilities in Russia and Japan have already shown interest in Cerberos, also.

Scientific & Public Events

Preview

Within the next couple of months, the Excellence Cluster Universe will organize numerous scientific and public events. The highlighted conferences and workshops are primarily addressing experts, teacher trainings are marked with "L", all other events are aimed at the interested public.

22. - 24.09.2014, 10:15 - 15:15		PhD Lectures with Prof. Stephan Paul (TUM): Introductory Course on Particle and Nuclear Physics	Excellence Cluster Universe, Boltzmannstr. 2 (MIAPP building, seminar room), Garching
23.09.2014, 19:00		Café & Kosmos: Prof. Dr. Gerhard Haerendel (MPE): "Raumsonde Rosetta – Verabredung mit einem Kometen"	Ampere/Muffatwerk, Zellstr. 4, Munich
26.09.2014, 14:00 - 18:15	L	Teacher training "Variabilitätsphänome im Kosmos" within the framework of the annual meeting of the German Astronomical Society	University Bamberg, Markusstr. 8a (seminar room MG1/02.06), Bamberg
29.09. - 01.10.2014, 10:15 - 15:15		PhD Lectures with Prof. Andreas Burkert (LMU): Introductory Course on Astrophysics and Cosmology	Excellence Cluster Universe, Boltzmannstr. 2 (MIAPP building, seminar room), Garching
07.10.2014, 9:00 - 17:00	L	Teacher training "Aspekte der modernen Kosmologie" www.universe-cluster.de/lehrerfortbildungkosmologie	Deutsches Museum, Museumsinsel 1, Munich
08.10.2014, 16:30 - 17:30		Semester's start of the Universe Colloquium followed by wine & cheese for topics see www.universe-cluster.de	Excellence Cluster Universe, Boltzmannstr. 2 (seminar room basement), Garching
08.10.2014, 19:00		Wissenschaft für jedermann: Prof. Dr. Klaus Blaum (MPI for Nuclear Physics, Heidelberg): "Vom Elektron und Proton zum kosmischen Antimaterie-Rätsel"	Deutsches Museum, Museumsinsel 1 (Hall of fame), Munich
09.10.2014, 9:00 - 18:00	L	Teacher training "Relativitätstheorie" www.universe-cluster.de/lehrerfortbildungrelativitaetstheorie	Excellence Cluster Universe, Boltzmannstr. 2 (seminar room basement), Garching
11.10.2014, 11:00 - 18:00		Open day Campus Garching www.forschung-garching.de	Campus Garching
15.10.2014, 19:00		Wissenschaft für jedermann Prof. Helmut Dosch (DESY): "2014 – Odyssee im Nanokosmos"	Deutsches Museum, Museumsinsel 1 (Hall of fame), Munich
21.10.2014, 19:00		Café & Kosmos: Florian Reindl (MPP): "CRESST – Licht ins Dunkel der Materie" for further dates see www.cafe-und-kosmos.de	Muffatcafé/Muffatwerk, Zellstr. 4, Munich
03. - 05.11.2014		Interdisciplinary Workshop on Statistical and Analysis Methods in Nuclear, Particle and Astrophysics www.universe-cluster.de/trento2014	European Center for Theoretical Studies in Nuclear Physics and Related Areas, Villazona, Italy
19.11. 2014, 19:00		Wissenschaft für jedermann PD Dr. Torsten Enßlin (MPA): "Vom Anfang der Zeit – unser Kosmos im Mikrowellenlicht"	Deutsches Museum, Museumsinsel 1 (Hall of fame), Munich
26.11.2014, 19:00		Wissenschaft für jedermann Prof. René Reifarth (Uni Frankfurt): "Nukleare Uhren und das Alter des Universums"	Deutsches Museum, Museumsinsel 1 (Hall of fame), Munich
01. - 04.12.2014		Science Week of the Excellence Cluster Universe www.universe-cluster.de/scienceweek2014	MPI for Astrophysics, Karl-Schwarzschild-Str. 1 (seminar room E.0.11), Garching

Prof. Dr. Paola Caselli,
director of the Max Planck Institute for Extraterrestrial Physics since 1 April 2014, is also a new Principal Investigator and a new member of the Excellence Cluster Universe. After working for the Harvard-Smithsonian Center for Astrophysics, among others, Paola Caselli last held a position in the Astrophysics Group at the University of Leeds, UK. Her scientific focus is on astrochemistry, stars and planets, molecular astrophysics and astrobiology.

Dr. Andreas Kronfeld,
was awarded a TUM-IAS Hans Fischer Senior Fellowship for the research project "Interaction of effective quantum field theory and numerical lattice gauge theory" together with Prof. Nora Brambilla. Andreas Kronfeld is a theoretical physicist at Fermilab, USA. Nora Brambilla heads the research group "Theoretical Particle and Nuclear Physics" at the Physics Department of the TUM and is a Principal Investigator of the Excellence Cluster Universe.

Dr. Jens Jasche,
is a new Fellow at the Excellence Cluster Universe, since 1 October 2014. After studying physics at the Leibniz University of Hannover, he received his doctorate in 2010 from the Max Planck Institute for Astrophysics, supervised by Prof. Simon White. After that, he held a Feodor-Lynen Research Fellowship at the Institut d'Astrophysique, Paris. The theoretical cosmologist is engaged in simulating the large-scale structures of the universe.

Dr. Xavier Defay,
will join the Excellence Cluster Universe as a Fellow on 1 November 2014. The astroparticle physicist concentrates on neutrinos and the direct search for dark matter. As an experimenter, he is an expert for cryogenic detectors. He studied physics at the universities of Montpellier and Clermont and received his doctorate in 2008 from the CSNSM in Orsay, France. Most recently, he was a postdoc at the University of Wisconsin, Madison, USA.

Photos: privat (3), Reidar Hahn/Fermilab

IMPRINT

Editors: Petra Riedel, Dr. Andreas Müller, Sabine Kaps

Translations: Petra Riedel, Sabine Kaps, Patrick Regan

Layout: Sabine Kwauka

Printing: flyeralarm GmbH, Alfred-Nobel-Str. 18, D-97080 Würzburg

Subscribe: www.universe-cluster.de/newsletter

Unsubscribe: E-Mail to presse@universe-cluster.de, body text "unsubscribe ucnews"

The newsletter is distributed three times a year by the Excellence Cluster Universe, Technische Universität München, Boltzmannstr. 2, D-85748 Garching, Tel. +49.89.35831-7100, Fax: +49.89.3299-4002, E-Mail: info@universe-cluster.de, www.universe-cluster.de

Coordinators: Prof. Stephan Paul (TUM), Prof. Andreas Burkert (LMU)

The Excellence Cluster Universe is supported by the German Excellence Initiative.

Max-Planck-Institut für Physik