NEWSLetter
Excellence Cluster Universe

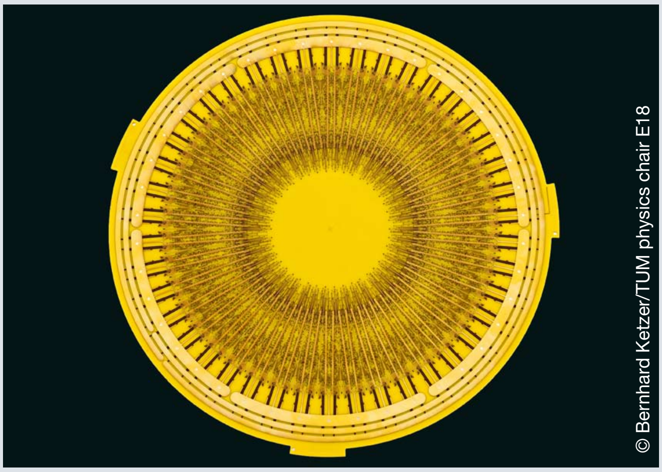
Issue 3 August 2009

Dear Readers,

the past weeks were in the sign of the moon. 40 years after Apollo 11 and two astronauts touched our satellite's surface the event was celebrated with anniversary parties, TV programs, newspaper articles, blogs and twitter entries - and it was a hightime for recollections. Of course it was also a perfect occasion to warm up the old conspiracy theory about the moon landing being just a studio fake ... While NASA plans a new lunar mission with the aim of a long term human presence on the moon, astronaut Buzz Aldrin has different ideas in mind: "Our next generation must think boldly in terms of a goal for the space program: Mars for America's future. I am not suggesting a few visits to plant flags and do photo ops but a journey to make the first homestead in space: an American colony on a new world" he said in an interview with the Washington Post. Let's wait and see!

Barbara Wankerl, PR Manager

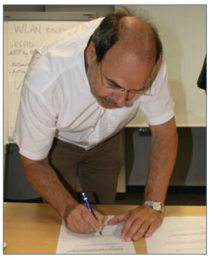
PICTURE OF THE MONTH



Look inside of PANDA
The readout plane of the detector prototype for the PANDA experiment at the GSI was designed to explore the strong interaction, one of the four fundamental forces in the Universe. The plane was built by Martin Berger in a joint project of two teams at the Cluster: the Junior Research Group "Dense and Strange Hadronic Matter" and a group at the TUM physics chair E18.

HIGHLIGHTS

LOFAR: A new perspective of the Universe



Cluster coordinator Stephan Paul signs the GLOW membership agreement

The Excellence Cluster Universe has joined the German consortium for the LOFAR (LOw Frequency ARray) telescope. The agreement for membership was signed on 3 July 2009 at the meeting of the German Long Wavelength Consortium (GLOW). The digital radio telescope is designed to explore the sky using long radiowaves between 1,25 and ten meters – the wavelength broadcasting stations usually operate in. The LOFAR contribution will help Cluster scientists to gain additional clues for their research on the development of galaxies and black holes over billions of years. One source of radio waves in the Universe are fast moving electrons in weak magnetic fields. Hence researchers will be able to observe cosmic magnetic fields in our Milky way as well as in galaxies, galaxy clusters and in stellar and galactical jets produced by active black holes.

The antenna field in Unterweilenbach amidst summer vegetation

„With our affiliation to GLOW we get the opportunity to examine a part of the Universe which up to now has been virtually unexplored,“ explains astrophysicist Dr. Andrea Merloni, a researcher in the Universe Cluster and initiator of the GLOW membership.

The LOFAR project was started in 2005 by the ASTRON institute with support of the Dutch government. The core station of the antenna fields is located in Exloo with 54 additional sites arranged in a spiral pattern throughout the Netherlands. In order to achieve an angle resolution of more than 1 arcsecond, LOFAR stations are also being constructed in Germany, Great Britain, France, Italy and Sweden. After completion of the test phase, the first scientific data are expected by the end of 2010 when all the planned European antenna fields have gone into operation; but the first results do already show glimpses of a promising future.

At the moment there are four stations in Germany participating in the test: in Effelsberg, Tautenburg, Potsdam, and in Unterweilenbach, located about 60 kilometers northeast of Garching. The last-mentioned antenna field is run by the Max-

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Data collection at the Unterweilenbach antenna station

Planck Institute for Astrophysics, a partner institution of the Universe Cluster. Once all stations are online, LOFAR will be the largest telescope array in the world networked via data lines.

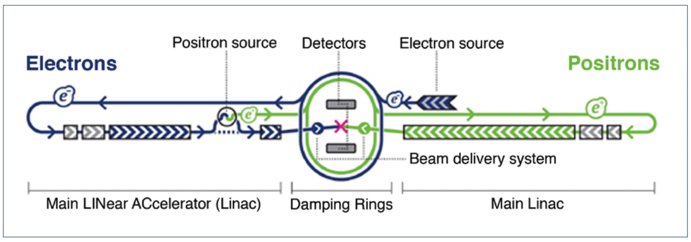
The purely digital concept of LOFAR is simple and complex at the same time. The idea is to build different remote sites with many radio antennae – without any motors or moveable parts as required in classical parabolic radiotelescopes. Each station will be equipped with two different antennna types. The low-band antennae receive signals between 30 to 80 megahertz whereas the high-band antennae work in the range of 110 to 240 megahertz. Data of all stations in Europe will be collected by an IBM BlueGene/L super computer located at the University of Groningen processing them to images that will be sent back on the associated work groups.

„The LOFAR telescope not only represents a completely new technological concept, but will also open a wavelength range so far ‘neglected’ by astronomers”, says Merloni. “Besides the main key science projects planned for LOFAR, we should be ready for unexpected new results and discoveries: It will be exciting!”

www.lofar.org | www.lofar.de

Search for the best technology for the ILC

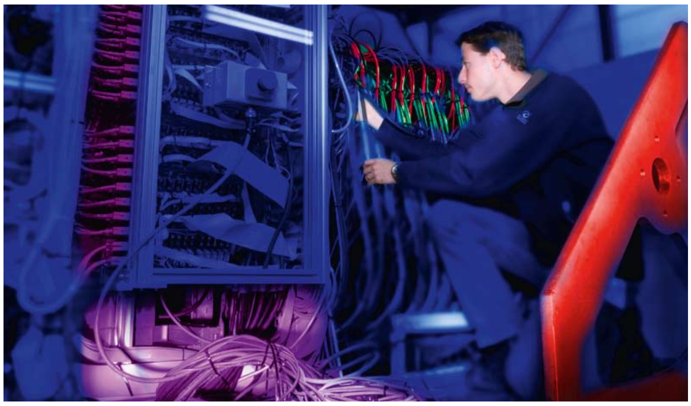
Even though the Large Hadron Collider (LHC) at CERN has not been operating yet, international scientists are already working on a complementary collider: the so called International Linear Collider (ILC). This electron-positron collider will be able to follow up the



A schematic layout of the International Linear Collider

discoveries at the LHC with high precision measurements necessary to for full understanding of the new physics at the terascale. It is expected to provide answers to the questions about the nature of matter, energy, space and time as well as dark matter, dark energy and the existence of extra-dimensions. Since the ILC will collide elementary particles, electrons and positrons, and not protons, composite particles with a rich substructure, like the LHC, the background of the measurements will be much reduced. This allows precise measurements of the properties of new particles created in these collisions. Thus, the LHC with its high energies and the ILC with its precision complement each other in an ideal way: They have different potentials, analyzing different aspects of the same problem. A decision on the construction and the exact parameters of the ILC will be taken once first LHC results are available.

The research and development for detector systems at this future accelerator is already in full swing. Now scientists of the CALICE (Calorimeter for the Linear Collider Experiment) collaboration just have finished successfully testing the first prototype particle flow hadronic calorimeter at the test beam facility at Fermilab. Calorimeters measure the energy of particles by absorbing them, and are a crucial part of every high energy physics detector system. For the ILC, a new concept called “Particle Flow” has been developed. This promises major improvements in the energy resolution for jets, sprays of particles that originate from a highly energetic quark or gluon created in the collision. “The key idea is to measure every single particle in a jet, not just the overall energy deposited in the detectors. However, this requires highly segmented detectors, for the calorimeter system in particular” explains Frank Simon, Junior Research Group Leader at the Universe Cluster and member of the CALICE collaboration.



Frank Simon works on the CALICE analog hadron calorimeter at Fermilab’s Meson Test Beam Facility

About 280 scientists from 12 countries are currently involved in the CALICE collaboration with the aim of developing this highly granular imaging calorimetry. “The goal of the CALICE collaboration is to evaluate the different ideas for particle flow algorithm calorimetry at the ILC,” says Simon. The collaboration will study the technical data from tests of all the different technologies in order to demonstrate the validity of the various techniques and determine which modules perform best in providing precise measurements of hadronic showers. The first prototype that has now completed its testing phase consists of layers of small plastic scintillator tiles, which produce flashes of light when particles go through them, sandwiched between steel absorber plates. The scintillator tiles themselves were read out with novel light sensors, so called Silicon Photomultipliers, which are also studied in Frank Simon’s group in cooperation with the semi-conductor laboratory HLL. The next prototype hadron calorimeter, using resistive plate chambers which

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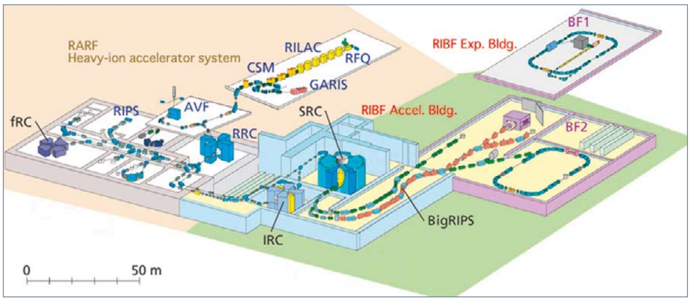
detect the charge produced by throughgoing particles in the same steel structure, is currently under construction at Argonne National Laboratory. For the scintillator tile calorimeter, the design work for a technical prototype, a detector that fulfills the requirements for a real high energy physics experiment in terms of mechanical structure and readout electronics, has already started.

In addition to the evaluation of different detector concepts for the ILC, the CALICE data also provides important information about the structure of hadronic showers with unprecedented precision. This helps to improve the computer models used to simulate the interactions of particles with matter, which are also crucial for the analysis of the data taken at the LHC and other particle physics experiments.

High-intensity accelerator RIBF produces first results

New findings in nuclear physics are essential to gain a better understanding of the Universe and the generation of heavy chemical elements. The Excellence Cluster Universe is involved in leading national and international experiments exploring the structure and dynamics of atomic nuclei.



The RBIF factory project: Beams from the Riken Ring Cyclotron (RRC) are further accelerated by the two cyclotrons fRC and IRC. Heavy-ion beams of 100 kW are procuced by the Superconducting Ring Cyclotron (SRC). Unknown RI beams are created by applying these heavy-ion beams to target atomic nuclei using supterconducting magnets (BigRIPS), and their properties are studied.

The first experiment using secondary radioactive ions from the new Radioactive Isotope Beam Factory (RIBF) in Japan resulted in finding a highly deformed shape in a neutron-rich isotope of Neon. The experiment and the subsequent publication in Physical Review Letters 103 (2009, 032501) were brought about with the contribution of the TUM physics chair E12 and the Cluster's Research Area „Heavy Elements“ led by Reiner Krücken.

RIBF at the RIKEN Nishina Center for Accelerator-Based science (RNC) is based on a new cyclotron accelerator producing a beam 100 times stronger than any other in the world. It started operation in 2007 and the first experiments were performed in late 2008. The international team could show that a neutron-rich isotope of neon has a highly deformed shape despite its 22 neutrons, which should favor a spherical shape, and therefore lies in a mysterious region of the nuclear chart known as the ‚Island of Inversion‘. The beam used fired at 60 per cent the speed of light and has enabled the exploration of the region where standard concepts of nuclear physics break down.

In two earlier experiments at the accelerator facility of the GSI Helmholtzzentrum für Schwerionenforschung teams lead by Cluster scientists were able to provide evidence for new magic numbers in atomic nuclei. Apparently, there are new magic shell closures at the limit of nuclear existence in the neutron-rich isotope oxygen-24 with 8 protons (a classic magic number) and 16 neutrons (a new magic number), in the neutron-rich nucleus calcium-54 with 20 protons (another classic magic number) and 34 neutrons (a new magic number). These results could help to gain better understanding of neutron-rich environments such as neutron stars and supernovae.

Call for new project proposals

As in the previous year, the Excellence Cluster Universe will allocate additional grants for new research projects. The call for proposals is now open to all Cluster scientists. The timeline for submitting the proposals is 21 August 2009. Says Stephan Paul, the coordinator of the Universe Cluster: “Last year we provided an amount of more than 1 million Euros for additional scientific projects. We hope that this year's call will result in equally innovative project ideas as in 2008!” One of the projects funded in 2008 is the design of a prototype of a Time Projection Chamber with GEM read-out that will be used to investigate the strong interaction in the PANDA experiment (see page 1). Another example is the development of silicon photo multipliers, that build the core technology for the future hadron collider ILC (see page 2).

New international partnerships

In the past weeks, the Excellence Cluster Universe has embarked upon official collaborations with renowned research institutions. To boost the new cooperations and to intensify mutual exchange with all partners a special fund for Cluster scientists has been created.

Argonne NATIONAL LABORATORY

The collaboration with the Argonne National Laboratory (ANL), Chicago will cover the field of fundamental physics. On a joint workshop in May 2009 representatives of the two research centers identified four initial research issues: Explosive nucleosynthesis, high-energy astrophysics, the test of fundamental symmetries in the Universe and the inner structure of hadrons. The cooperation extends to both theoretical and experimental groups in the Cluster and the ANL. Further, Cluster scientists will benefit from access to both experimental as well as computational facilities at the ANL.

JINA

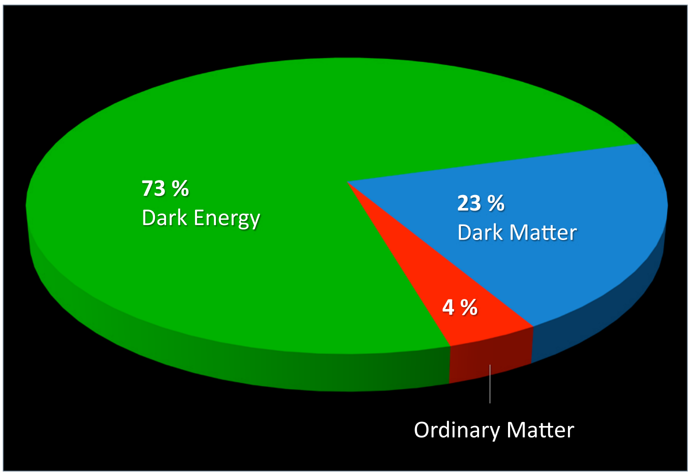
Just recently the Universe Cluster and the Joint Institute of Nuclear Astrophysics (JINA) have confirmed their co-operation by signing a Letter of Understanding. The two institutions intend to start an active collaboration between selected research groups and to establish a closer communication by exchanges of scientists, postdocs and students as well as joint workshops and schools.

PORTRAIT OF THE MONTH

This article marks the beginning of a new series of articles. From now on, we will be introducing our readers to one of a total of ten groups of young scientists at the Cluster. These work groups, also known as „Junior Research Groups"or JRGs for short, are the heart of the Cluster. Young professors build new teams which do research on different topics concerning the history of our Universe. Through networking with other JRGs in the Cluster, they gain new perspectives and innovative approaches for their research work.

In search of the cosmic motor

It can be dizzying talking to Prof. Dr. Weller – he explains that the Universe is constantly expanding but not at a constant speed as one could expect it to, but increasingly faster. At some point the galaxies will therefore move unimaginably far away from one another. In order to do this, the Universe requires a motor. In technical jargon this motor is referred to as „dark energy". According to what we know today dark energy makes up close to 75 per cent of the Universe.

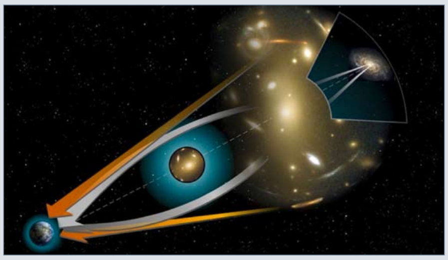


The distribution of energy in the Universe: Ordinary, visible matter accounts for only 4 per cent - the rest is made up of 'dark components'.

As early as in the first half of the 20th century the American astronomer Edwin Hubble found out that all galaxies move apart from one another – their spectra displayed a shift in the red wavelength range. The final evidence of the accelerated expansion we owe to supernovae of the type Ia: These stellar explosions follow a specific pattern, from which their luminosity can be measured. As a result of this property scientists can use them as cosmic „measuring staffs": They simply compare their actual (absolute) brightness with the apparent brightness measured on earth and can thus calculate how distant they are. With the help of these standard candles and the redshift of galaxies, scientists were able to prove beyond a doubt towards the end of the 90s that the Universe is expanding at an ever accelerating rate.

Since this breakthrough scientists have been working on different models for explanation of this phenomenon. Weller wants to make his contribution towards testing the different scenarios for their validity with his group.

Junior Research Group: Observational Astrophysics



The Group has been led by Prof. Dr. Jochen Weller (39) since October 2008. Weller previously performed research and lectured at the Department of Physics and Astronomy at University College London. Dr. Virginia Corless and Dr. Ralf Kelzenberg are the first two post-docs in the team.

Research Goals

- Study of the accelerated expansion of the Universe with different astrophysical tests
- Galaxy clusters as witnesses of the cosmological history
- Structure formation in the Universe

Collaborations

- Planck Mission: Study of the Cosmic Microwave Background (CMB)
- EUCLID Mission: Mapping the geometry of the dark Universe
- Dark Energy Survey (DES)
- Hobby-Eberly Telescope Dark Energy Experiment (HETDEX),
- Low Frequency Array (LOFAR) telescope

Results so far

- Restriction of models of dark energy and modified gravity with the help of weak gravitational lenses
- New statistical methods to use galaxy clusters for cosmological studies
- Development of new parameters of the reionisation for the Planck satellite

„The simplest form of dark energy is the cosmological constant of Albert Einstein formulated in his General Theory of Relativity," Weller says. With his field equations he showed that the space is warped by matter, that is, dented – and that these dents cause gravity. „However Einstein's theory was based on the premise that we live in a stationary and unchanging Universe. He made use of a mathematical trick, so that his newly formulated equations worked: He introduced the cosmological constant," Weller explains.

As we already know in the meantime the cosmological constant is only conditionally qualified as a candidate for the dark energy. „In order for very complex processes to be described directly after the big bang, the cosmological constant would have to be about 120 orders of magnitude larger than it is believed to be today according to the current level of knowledge ." Particle physicists in particular reckon that a vacuum energy is driving the cosmos apart. According to this theory the assumed empty space in the Universe is filled with energy. However the calculated energy is many times greater than the measured value for the dark energy.

Another possible explanation is provided by the so-called "quintessence", which assumes an additional fifth force to the known four interactions in Nature. This form of dark energy would change dynamically with time.

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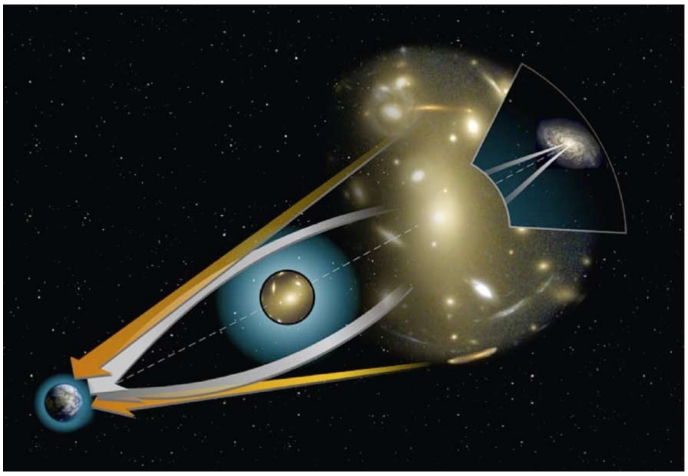
In addition there is still the possibility of a theory of „modified gravity“, which does without dark energy altogether. Weller: „The supporters of this model assume that the laws of gravity discovered by Einstein no longer apply in the case of great distances. For this reason there ought to be a second different gravitational force, with which events occurring very far away in time and space can be explained.“

With their astrophysical research Weller's group is working on defining observable values, with which the dark energy or, as the case may be, modified gravity can be verified. For this purpose the group is taking an indirect route: They are studying the dark matter, the second unknown component in the Universe, which comprises 23 percent. Dark matter is capable of distorting the shape of galaxies with its own gravity.



Light paths deflected by the presence of mass underlie the principle of 'Weak Gravitational Lensing'

„For our studies we use the weak gravitational lens effect,“ Weller explains. „Matter not only deflects massive objects, but also rays of light. This means that one can deduce specific spatial structures from the picture of a galaxy distorted by dark matter.“ The researchers know which topographies form with the existence of the dark energy or, as the case may be, the modified gravity. For this reason, they hope to find clarity through their observations: Whether our cosmic motor is driven by dark energy – or whether we must broaden our understanding of gravity.

At the Garching research campus Weller has the best preconditions for his projects. He works together closely with his JRG colleague Stefan Hofmann, who is examining the theoretical aspects of dark energy as particle physicist. „Furthermore,“ he concludes, „the Cluster links scientists of the University Observatory, the Max Planck Institute for Astrophysics and for Extraterrestrial Physics, and ESO.“ Several of these institutes are significantly involved in the construction of astrophysical instruments, with which Weller's team will perform research, for example, the Dark Energy Survey (DES) and HETDEX.

EVENTS

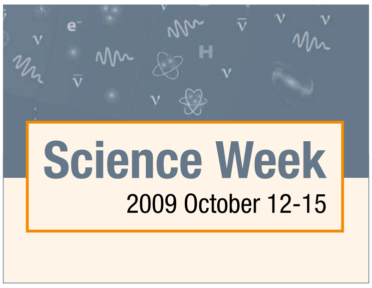
Teacher Training in cooperation with TUMLab

On 30 July 2009 the Excellence Cluster Universe has held its second annual teacher training on astrophysics and particle physics. As last year's participants recommended to offer more "hands-on"-suggestions and materials to be used directly in school lessons, this year's event was divided into a theoretical and an experimental part.

This was possible due to a cooperation with the TUMLab at the Deutsches Museum: The first half of the training was dedicated to a general overview on particle- and astrophysics, given by Dr. Andreas Müller and Dr. Frank Simon from the Universe Cluster. In the afternoon the 34 participants benefitted from exercises and demonstrations at the TUMLab.

Again, the Cosmology training was a big success: the attending teachers gave a very positive feedback on the teaching program and the useful practical examples.

Science Week from 12 to 15 October 2009

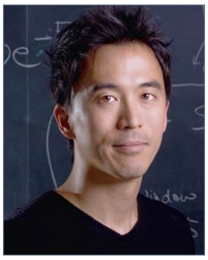


For the third time, the Cluster hosts its annual ‚Science Week‘. From 12 to 15 October 2009 Cluster scientists and invited guests will present their current research work in the fields of astrophysics, particle and nuclear physics. The Science Week is an interdisciplinary event and addresses internal as well external scientists who want to gain insight into the current state of all Cluster research areas - covering all epochs of the Universe. This year's Science Week will be hosted by the Max-Planck-Institut für Plasmaphysik (IPP), one of the partners in the Universe Cluster.

One of the highlights will be an evening talk by Scott Tremaine on Tuesday, 13 October 2009. The renowned astrophycisist is a professor at the Institute for Advanced Studies in Princeton, USA. His research interests are directed towards understanding the dynamics of a broad range of astrophysical systems, including protoplanetary disks, planetary rings, planetary systems, comets, black holes, galaxies and clusters of galaxies.

PEOPLE

Interview with Alan A. Chen – new long-term guest at the Excellence Cluster Universe



Alan Chen

On 1 July, Alan A. Chen, Associate Professor at the McMaster University in Ontario, Canada, arrived as a long-term guest at the Excellence Cluster Universe. Here, he will be part of Research Area G and thus focus on the question how the Universe was enriched with heavy elements.

Asked about his first impression of the Cluster, Alan answered with a smile: “Better coffee than back home”. Since he will stay for a year, he will have enough opportunity to enjoy the Cluster-coffee.

You just arrived at the Cluster. What are your first impressions?

The proximity and connections to several world-class institutes and departments, such as the Max-Planck Institutes, ESO, and TUM- and LMU-Physics are impressive. And besides the coffee, I enjoy the large number of interesting seminars on various topics in any given week, which is certainly a testament to the high volume of scientific activity and exchange going on around here.

What are your expectations and what do you hope to achieve within the next year?

I expect to develop new research ideas and form new partnerships and collaborations, not only for projects in the coming year, but also for my research program in the longer term. In the near future, I’ll be proposing and executing experiments using the unique local facilities and the MLL tandem accelerator, and collaborating with the TUM nuclear astrophysics group on other projects both here and at other labs, such as GSI and CERN; all of these experiments aim at elucidating outstanding questions regarding the energy generation and element synthesis in stars, and some will involve developing new experimental techniques.

I will also be joining an exciting ongoing Cluster effort toward improving our understanding of supernova explosions, through studying the synthesis of signature isotopes, such as Titanium-44. This work brings together various research teams within the Cluster in theoretical/computational and observational astrophysics, and experimental nuclear astrophysics. One of the goals will be to assess the impact of important nuclear reaction rates in the element synthesis, thereby motivating future experiments in this research area.

Beside the Campus Garching, have you already had the chance to explore the Munich area?

After I decided to come to the Cluster for my sabbatical leave, I discovered that Munich is near the Bavarian Alps, which in turn offers many fun opportunities for an outdoor enthusiast like me. In my first week here, I paid the Landkreis München a couple of visits, and so I had a chance to check out a bit of Munich. It strikes me as an exciting city – very culturally and historically rich – and so I look forward to exploring more during my stay.

What do you miss the most in Munich?

I have yet to try the Chinese cuisine here in Munich, but my gut instinct (and some of my Cluster colleagues) tells me that it won’t be as good as that of the Toronto area in Canada. Nevertheless, who knows, I might get positively surprised!

And so far what did surprise you in a positive way?

I’ve definitely been pleasantly surprised by the local folks’ patience with my complete lack of proficiency with the German language. I’m gradually remedying this problem, but progress has been slow, shall we say. In the interim, it’s been very helpful to communicate in English and I’ve certainly appreciated that people have been so accommodating.

LINK

Pink Floyd and the moon landing

Asked by the Guardian what he was doing during Apollo 11’s flight to the moon, Pink Floyd’s David Gilmore answered that he was performing in a live jam session during the BBC live coverage of the landing. The jam piece, called “Moonhead”, has now been saved from oblivion - thanks youtube. Obviously a fan used the bootlegged recording with images of the apollo 17 mission. The whole story can be found in a blog of the New York Post:
http://thelede.blogs.nytimes.com/2009/07/20/pink-floyds-moon-landing-jam-session/

Welcome to the Cluster!

Professors: Prof. Dr. Joseph Mohr (14 September 2009)
Postdocs: Dr. Gurvan Bazin (14 September 2009) ++ Dr. Alexey Voevodkin (14 September 2009)
Guests: Prof. Toshimitzu Yamazaki (University of Tokyo, 25 July 2009 - 24 August 2009) ++ Prof. Dr. Michael Paul (Racah Inst. Israel, 01 October 2009 - 31 December 2009) ++ Prof. Dr. Marco Maggiora (INFN Torino, 04 - 07 August 2009) ++ Dr. Tamas Szucs (HAS-ATOMKI, Hungary, 09 - 11 September 2009)
Other: Michael Novotny (Technician, 01 September 2009)

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Contribution: Alexandra Wolfelsperger

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