NEWSLetter

Excellence Cluster Universe

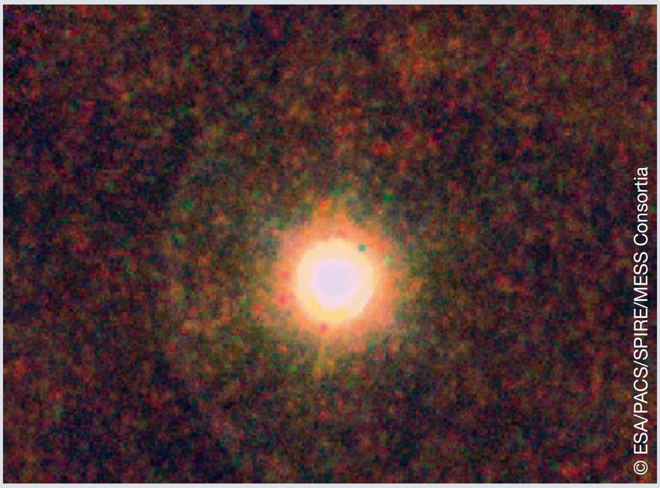
Issue 3 / 2010

Dear Readers,

With the first leaves turning yellow the event season starts. The fall events are heralded by the annual meeting of the Astronomische Gesellschaft from 13 to 17 September 2010 in Bonn. A few weeks later, from 11 to 14 October, the Universe Cluster invites its community to join the Science Week: four days to learn about the research results achieved in the past year – and projects to be embarked upon in the future (p. 3). And from 4 to 7 November, Munich will be hosting the 14th edition of the "Deutsche Physikerinnentagung", a large conference offering a platform for women physicists – and scientists to-be (p. 4). In our "Portrait" series we introduce Stefan Hofmann's group looking at the Dark Universe from a theoretical perspective. And last but not least there's an important new entry to announce: We would like to welcome Dr. Birgit Schaffhauser who has joined the Universe Cluster as our new General Manager!

Barbara Wankerl, PR Manager

PICTURE OF THE MONTH



Space Observatory Herschel finds warm water on red giant star

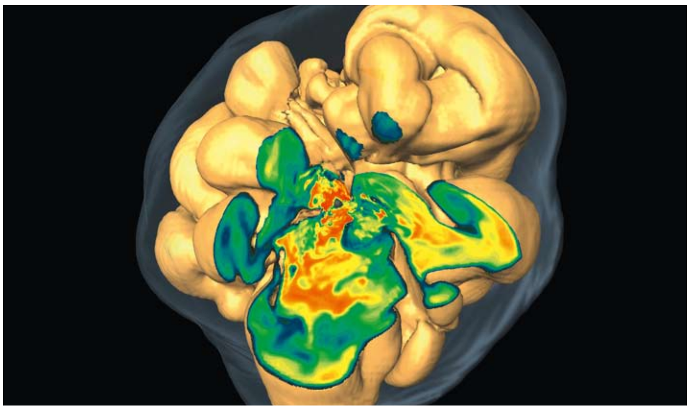
Astronomers have observed water vapor in the atmosphere of a red giant carbon star – somewhere thought impossible before. The scientists used data from different instrument including PACS, developed under the lead of the MPE. Thereby, they not only detected water vapor by its "wavelength fingerprint" but could also measure its temperature.

RESEARCH

Supernova in Three Dimensions

3D is in vogue – not only in Hollywood's film industry. Scientists at the Max Planck Institute for Astrophysics carried out the first fully three-dimensional computer simulations of a supernova. Other than in blockbuster "Avatar", where 3D merely implies the adding of a visual effect, three-dimensional supernova images contain important information for scientists. The new simulations will help them to better understand the physical processes in stellar explosions. Scientists also hope for further insight to the origin of heavy chemical elements in the Universe – an issue also addressed by scientists in Research Area G (Heavy Elements) in the Cluster.

Although supernovae have been studied theoretically via computer models for several decades, the physical processes that occur



Three-dimensional explosion simulation about 0.5 seconds after core bounce.

during the blasts are so complex that astrophysicists can simulate only parts of the process. Simulations have only been performed in one or two dimensions so far. Massive stars end their lives in gigantic explosions which for a short time can shine brighter than a whole galaxy. The hot gaseous remnants of supernovae belong to the most spectacular objects in the Universe. However, unlike the progenitor star, the shape of the supernova debris is not symmetric. It displays filaments of different sizes, dense clumps as well as areas of low concentration of matter. This inhomogeneous, aspherical structure is considered to be rooted in the mechanism of the supernova blast.

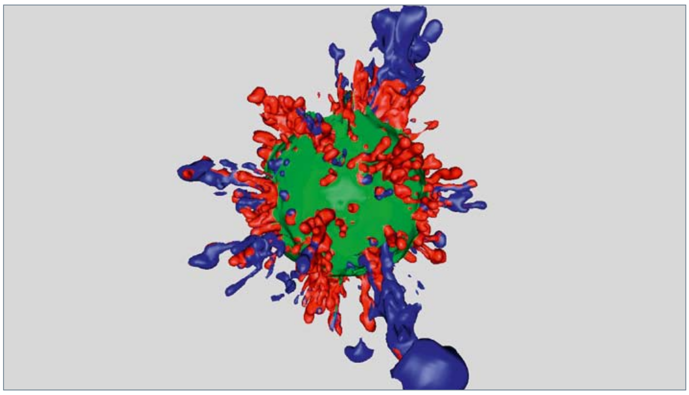
Recent two-dimensional simulations indicate that neutrinos, a mysterious category of elementary particles, play an eminent role in the explosion. They transport energy from the core to the outer layers of the star. Even though the exact process is not completely understood, scientists have discovered through their models that the neutrino-triggered energy transfer causes convection streams. This process can be compared to a stew boiling on the stove. Matter and gas start to move incontrollably at ever higher oscillations eventually causing the asymmetrical explosion.

While the great energy of the outburst makes stellar explosions visible far out into the Universe, they are relatively rare. In a galaxy the size of our Milky Way, on average a supernova will occur once every 50 years. About twenty years ago, a supernova could even be seen with the naked eye: SN 1987A in the Large Magellanic Cloud, our neighboring galaxy. This relative proximity of ”only“ about 170 000 light years away allowed many detailed observations.

SN 1987A turned out to be a core-collapse supernova, a so-called Type II event. It occurs when a massive star at least nine times heavier than our sun has burned almost all its fuel. The fusion engine in the center of the star begins to stutter, triggering an internal collapse and thus a violent explosion of the entire star. SN 1987A is probably the best studied supernova. Still it is a great challenge to develop and refine models of what was happening inside the dying star. The current 3D simulations represent an important milestone in these studies.

One of the unexpected discoveries in SN 1987A was that nickel and iron, heavy elements that are formed near the center of the explosion. These are building big clumps that migrate outwards to penetrate into the hydrogen shell of the disrupted star. Scientists observed that nickel “bullets” propagated at velocities of thousands of kilometers per second, much faster than the surrounding hydrogen and much faster than predicted by simple hydrodynamic calculations in one dimension.

The new computer models simulate the complete burst in all three dimensions, from the first milliseconds after the explosion is triggered at the core to a time three hours later, when the shock breaks out of the progenitor star. ”We found substantial deviations in our 3D models compared to previous work in 2D.“ says Nicolay Hammer, the lead author of the paper, ”Especially the growth of instabilities and the propagation of clumps differ. These are not just minor variations; this effect determines the long-time evolution and the extent of mixing and observable appearance of core-collapse supernovae.“ In the 3D-simulations, metal-rich clumps have much higher velocities than in the 2D case. These ”bullets“ expand much more rapidly, overtaking material from the outer



This snap-shot shows the outward mixing of certain elements in the supernova explosion after 2.5 hours, when the shock has broken out of the stellar surface. The surfaces denote the radially outermost locations of carbon (green), oxygen (red), and nickel (blue) with a constant mass fraction.

layers. This makes them, their distribution and masses a good probe for the non-spherical beginning of the explosion.”With a simple analytic model we were able to demonstrate that the different geometry of the bullets can explain the differences observed in our simulations,“ explains co-author and Cluster member Thomas Janka. The authors hope that in comparison to observations, their models will help us to understand how stellar explosions start and what causes them. The investigation of a wider variety of progenitor stars and initial conditions will therefore be the focus of future simulation work. In particular, a detailed model that reproduces all observational features of SN 1987A still remains a challenge.

Original publication

N.J. Hammer, H.-Th. Janka, E. Müller, “Three-dimensional simulations of mixing instabilities in supernova explosions”, The Astrophysical Journal 714 (2010) 1371-1385

EVENTS

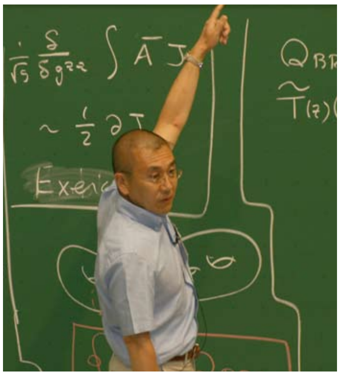
Summer and Strings in Garching

An atmosphere of intense concentration pervades lecture hall 1 of the TUM Physics Department. Row upon row of formulas is written on the blackboard: Professor Barton Zwiebach, an internationally renowned expert in the field of string theory, is holding a lecture on the world of particle strings and D-branes. Professor Zwiebach’s audience are the participants of the summer school course “String and Fundamental Physics (SFP)”.

Highly focussed: students following a lecture at the summer school

The course took place from 26 July to 6 August and was organized by scientists from the Excellence Cluster Universe and of the Arnold-Sommerfeld Zentrum (ASC) for Theoretical Physics at the LMU. One glance at the list of participants proves that this school was special: The young scientists came from many different countries throughout the world, e.g the USA, Russia, India, Iran and Argentina. Professor Ilka Brunner explained, “It was important to us to attract top scientists as lecturers. At the same time it was intended that as many young and talented people as possible from all over the world profit from the lectures and expertise at first hand. For this reason we’ve launched a special funding program for students from less economically developed countries.” Of the 160 students from 35 countries, a total of 37 participants received full scholarships.

Maria Platonova from Moscow praised the organization and the quality of the training: “I’m finding my way around here very easily and the level of the lectures is just right.“ Alexander Krikun, from Moscow as well, added, “The mixture suits: We work with a high level of concentration but have enough breaks in order to relax and enjoy city life in Munich." Alessandra Cagnazzo and Francesca Catino from Padua liked the fact that the lectures are held without slide presentations: "The lecturers develop the content on the blackboard, so that we have no trouble following the individual work steps."



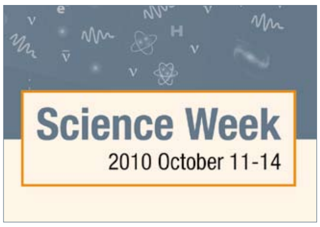
Hirosi Ooguri

Barton Zwiebach

The first week of school was dedicated to the basics. The lecture series for advanced topics followed in the second week. The organisers succeeded in engaging the professors Atish Dabholkar of the LPTHE in France, Hirosi Ooguri of the IPMU in Japan and Caltech, as well as Dam Thanh Son of Washington University, in addition to Barton Zwiebach from MIT.

The variety of topics and the choice of lecturers were well received by the participants: Nkululeko Nokwara from Zimbabwe, who studies in South Africa, was impressed by Dam Than Son: "It's fascinating, how well this scientist masters his area of expertise, 'applied holography', the field that I'm currently doing my doctorate in." There were lively discussions during and after the lectures and tutorials. "It was nice to see how intensely the students dealt with the subject areas," co-organiser Dr. Marco Baumgartl explained. "The lecturers were impressed by the students' dedication and enthusiasm. And as organisers we are proud of Hirosi Ooguri saying we had done a great service to the community."

Cluster hosts its fourth Science Week



From Monday 11 October until Thursday 14 October 2010 the Excellence Cluster Universe will host its fourth Science Week. The event will take place at the lecture hall of the Max Planck Institute for Plasma Physics (IPP).

The aim of this annual meeting is to support the scientific exchange between the different communities of the Cluster. Several topical talks, for example on Cosmic Microwave Background, Dark Energy and Dark Matter, String Theory or Neutrino Physics will summarize the main research issues of the Cluster. Concluding the event on Thursday, 14 October, each Research Area of the Cluster will give an overview of their specific research projects. Furthermore, the winners of this year's PhD award, Jens Jasche (theory) and Thomas Krühler (experiment) will receive their prizes and introduce their PhD theses. Other subjects of the Science Week include a reception with poster session on the first evening of the conference. On the last day, a general meeting for all Cluster members will take place. During this meeting the Cluster coordinators will give insight into the current status of the Cluster.

In addition, on Tuesday, 12 October, there will be a public talk by Professor Simon White, director of the Max Planck Institute for Astrophysics. Title and venue will be announced.

More information and program:
http://www.universe-cluster.de/scienceweek2010

Day of Astronomy in the Deutsches Museum

On Sunday, 17 October 2010, the Excellence Cluster Universe will again co-organise the annual "Day of Astronomy" at the Deutsches Museum Munich. This year, Cluster scientists will guide visitors through the Cluster's new exhibition "Evolution of the Universe" in the astronomy department. Every hour between 11am and 3pm visitors will have the chance to follow Cluster scientists on a time travel, starting with the Big Bang and ending with an outlook on how the Universe might evolve in the future. The Cluster will also offer guided tours through the exhibition rooms of nuclear physics. This tour was already offered last year and attracted numerous visitors.

The detailed program will be published soon at
http://www.universe-cluster.de and http://www.deutsches-museum.de.

Münchner Wissenschaftstage: Energy from the Universe

The Excellence Cluster Universe will take part in the 10th Münchner Wissenschaftstage (Munich Days of Science) taking place from 23 to 26 October 2010. This year's topic "Energy: Fundament for the Life-engine of the Future" will present the various forms of energy to the public. Main venue will be the Ludwig-Maximilians University (LMU).

Several information stands, talks, workshops and guided tours will support the exchange between science and public. The Cluster's information stand in the entrance hall of LMU's main building will inform the public about the "Sun and Stars: The Natural Energy Source in the Universe". Through hands-on experiments and conversations with Cluster scientists, visitors will gain insight into the possible exploitation of stellar and solar energy and the influence of solar activity on our climate.

More information: http://www.muenchner-wissenschaftstage.de/2010

German Women Physicists Conference

The 14th German Women Physicists Conference will take place from 4 to 7 November 2010 in Munich, one of the organising institutions being the Excellence Cluster Universe. This year's conference will be held under the auspices of Prof. Dr. Annette Schavan, the German Federal Minister of Education and Research.

This conference is a platform for woman physicists to present their achievements in physics to a wide audience and to show the broad range of their research fields. The event is primarily aimed at both male and female physicists. Besides, it is also open to all those who are generally interested in physical topics. The conference offers a diverse program with scientific and socio-political lectures. Impulses from the professional world, as well as contributions as to questions on career planning round off the programme.

In addition, the women participants have sufficient opportunity for technical and scientific exchange during a panel discussion and various poster sessions. The organizers are also arranging a conference dinner and a leisure programme including a guided tour of Munich and visits to exhibitions, so that the participants will have plenty of time to network. Female students may not only participate in the regular meeting but also in a special programme which is intended to arouse and develop their interest in physics. Interested parties can register their own lectures until 13 September 2010.

The event is organised by the Deutsche Physikalische Gesellschaft (German Physical Society) and the Arbeitskreis Chancengleichheit (Study Group for Equal Opportunities). Further organising institutions include the Ludwig-Maximilians-Universität (LMU) and the Technische Universität München (TUM), the Max Planck Institutes for Astrophysics, Extraterrestrial Physics, Physics, Plasma Physics and Quantum Optics, as well as the Excellence Clusters "Munich Center for Advanced Photonics (MAP)" and "Nanosystems Initiative Munich (NIM)".

More information: http://www.physikerinnentagung.de.

PORTRAIT

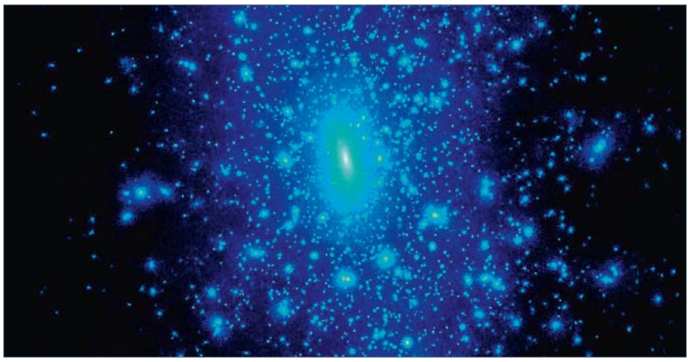
The Dark Side of the Universe

Dark matter - dark energy! There's not a single cosmologist who can avoid these terms nowadays. It's no wonder as scientists are indeed convinced that these "dark" entities virtually dominate our Universe completely. It goes without saying that the Excellence Cluster Universe provides top-class research on the dark side of the Universe.

A few issues ago we introduced Prof. Jochen Weller's work group here. This group has made it their task to reveal the dark Universe using the methods of astronomical observation. To a certain extent Prof. Stefan Hofmann and his Junior Research Group Particle Physics and the Early Universe from the theoretical physics fraction is the counterpart of Weller's Group in the Cluster.

It is actually quite simple to explain what cosmologists refer to when they are talking about the "dark Universe": They mean the 96% of the Universe, whose nature and composition are completely unknown. According to today's perception, 73% of the world exists as a form of energy which is driving the Universe apart at a constantly accelerating speed. Researchers can deduce the existence of the accelerating cosmic expansion from the observation of distant supernovae. Cosmologists assume that the cause of this strange expansion behaviour has to do with the dark energy. As one can imagine, the nature of this energy is still completely in the dark. Nothing is known about its origin or about its composition. A convincing theory has yet to be found.

Alright, 73% is dark energy but what about the rest? Matter. Here however we are faced with a problem as well: Only about 15% of the matter is in a form that is known and understood by physicists. In contrast 85% is completely unknown. One of the greatest challenges of modern physics involves the deciphering of these



This computer-generated image shows the simulated distribution of dark matter in a galaxy cluster. The clumps are locations where galaxies form.

unknown "dark" forms of matter and energy. In Prof. Stefan Hofmann's work group no-one has heard of measuring instruments or telescopes. Research is performed solely on paper and by computer. "The dark side of the Universe is so interesting because it provides clear evidence of physics beyond the standard model of particle physics and cosmology", Hofmann explains. Dark matter in particular is an excellent example of the interaction of microscopic physics and cosmology. Depending on how the mysterious matter is composed and what interactions it is subject to, this would lead to completely different effects on the formation of cosmological structures such as galaxies and superclusters.

From the researchers' points of view, the dark energy is afflicted by a sheer legendary flaw: In no other area of physics is the gap between the results of theory and actual measurement as great as here: The value of the theoretically required density of the dark energy lies at a ludicrous factor of about 10^{120} above the actually measured value. An answer to the riddle does not seem to be in sight. In the meantime Hofmann and his group are attempting to track down the riddle of quantum mechanical vacuum energy, which has always been referred to in connection with dark energy. "We have to ask ourselves whether we've understood the vacuum energy of the standard model of particle physics and its impact on spacetime", Hofmann substantiates his ambitions in this area.

During their studies Stefan Hofmann and his staff do indeed leave well worn paths. "A large part of my group is concerned with the question as to how gravitation could look on cosmological scales at all and as a matter of principle". This also involves even questioning the universal validity of Einstein's general theory of relativity. Hofmann refers to a "possible deformability of the theory of great scales".

The euphoria surrounding the famous Higgs particle, which is currently being searched for with the help of the Large Hadron Collider (LHC) at CERN, also has Hofmann's work group in its grip albeit in a very special way. The standard model of particle physics needs the Higgs in order to explain why the matter particles possess mass. Just as all particles, the Higgs has a dual nature and can also be explained as a field or scalar. Scientists are now speculating that the Higgs field could interact with an additional field, the so-called phion. This new interaction is also known as the Higgs portal. In this model, the suggested phion could be both dark matter and dark energy. Thus cosmologists would have solved the complex of problems posed by the dark Universe very elegantly.

As one can see, the dark side of the cosmos still leaves a lot of room for discussion and new theories. Exchanges with colleagues at conferences thus play an important role in the daily routine of cosmology. In spring 2010 Hofmann's work group held a very successful workshop. The leading experts in the areas of string theory, effective field theories and mathematical physics gathered at this workshop in order to discuss the current trends in gravitation and quantum gravity. Researchers from Bonn, Sweden, Denmark, France and the USA are among Prof. Hoffman's collaboration partners. In addition Hofmann also worked closely with his colleague Jochen Weller from the field of astronomy. This is because all these scientists have one thing in common: the will to decipher the hidden 96% of the Universe.

Junior Research Group: Particle Physics and the Early Universe


Prof. Dr. Stefan Hofmann has started his group in early 2009. He and his co-workers focus on research aspects related to particle physics in the early Universe, investigating the nature of dark matter and dark energy in particular. His group "Particle Physics and the Early Universe" includes 12 postdocs, PhD students as well as diploma and master students. Within the Universe Clusters, Hofmann closely collaborates with Prof. Dr. Ilka Brunner (Extra Dimensions in Particle Physics and Cosmology) and Prof. Dr. Jochen Weller (Observational Astrophysics).

Before joining the Excellence Cluster Universe, Stefan Hofmann was an assistant professor with the renowned Nordic Institute for Theoretical Physics and the Royal Institute of Technology in Stockholm, Sweden. Prior to that he was a research fellow at the Perimeter Institute for Theoretical Physics in Ontario, Canada and at the Stockholm University.

Current Research Activities:
Stefan Hofmann's group is studying cosmological models including

- Consistent Deformations of Einstein's Gravitation Theory at Cosmolological Scales
- Separate Universes and Primordial Black Holes
- Cosmological Structure Building by the Higgs Portal

(Inter)national Collaborations:

- Stockholm University: Prof. Ariel Goobar (observational cosmology), Prof. Fawad Hassan (String Theory), Mikael Strauss (theoretical cosmology)
- Universität Bonn: Dr. Kerstin Paech, Prof. Marek Kowalski (observational cosmology)
- University of Southern Denmark: Prof. Dennis D. Dietrich (particle physics/phenomenology)
- University of Pennsylvania, USA: Prof. Justin Khoury (theoretical cosmology)
- APC Paris: Prof. Cedric Deffayet (theoretical physics)
- Ecole Polytechnique Federale de Lausanne: Dr. Yannis Burnier (thermical field theory)
- McGill University, Canada: Prof. Robert Brandenberger (theoretical cosmology)

PEOPLE

Cluster Awards Promotional Theses

Jens Jasche

For the third time, the Exellence Cluster Universe has awarded two outstanding dissertations in the fields of astro-, nuclear and particle physics. The "Universe Awards" were given to Dr. Jens Jasche from the Max Planck Institute for Astrophysics and to Dr. Thomas Krühler from the Max Planck Institute for Extraterrestrial Physics. The prize is worth 4 000 euros and is endowed to a dissertation in the categories "experiment" and "theory", respectively. Although the quality of promotional theses presented was very high, the committee identified two clear winners for the year 2010.

Both scientists will present their dissertions at the Universe Cluster's Science Week from 11-14 October 2010. The winner in the category "Theory" is Jens Jasche who was awarded for his dissertation "Bayesian Methods for Analyzing the Large Scale Structure of the Universe". In his work, he developed innovative statistical methods which allow the use of the distribution of galaxies in the cosmos to draw conclusions on the density distribution of matter in the early Universe. According to today's knowledge tiny quantum fluctuations that occur during the inflation phase shortly after the Big Bang are the reason for the web-like dispersion of galaxies observed today. In his laudatio, commitee member Prof. Dr. Peter Ring emphasized that the methods developed by Jens Jasche "set a new standard for the analysis of galaxy catalogs." He concluded that Jasche's work had blazed the trail for future analyses using this kind of data-sets.

Thomas Krühler

Thomas Krühler was awarded for his experimental work on “Advanced Photometric Studies of Gamma-Ray Burst Afterglows”. In his dissertation he investigated the afterglows of Gamma-Ray Bursts (GRBs). These extremely bright objects are studied intensively by astromers, as they can be observed in the early Universe. They provide insight into the first generations of stars.

The laudatio of Prof. Dr. Klaus Schreckenbach praises Thomas Krühler’s thesis for the “comprehensive insight into the phenomena and current interpretations of the GRBs.” At the beginning of his diploma work Krühler participated in the development and commissioning of the GROND detector at the La Silla observatory in Chile. While working on his dissertation Thomas Krühler spent several months at the observatory and developed new routines to evaluate the afterglow.

Interview with Nora Brambilla

Nora Brambilla

Nora Brambilla has been a professor at the Technische Universität since fall 2008. As a theoretical physicist working in the field of particle and nuclear physics, she closely collaborates with other scientists in the Universe Cluster. She is a renowned expert in the area of effective field theories (EFT) to better understand the dynamics of the “strong interaction”. This fundamental force acts upon quarks and gluons and binds them together to form neutrons and protons, for example, the building blocks of atomic nuclei. Currently, Nora Brambilla is chairing the EuroFlavour 2010, the final workshop of the FLAVIAnet European Network.

Can you please describe your research to us?

Our group is looking deep inside the structure of hadrons such as protons and neutrons. These are formed by quarks, elementary particles that are glued together by the strong interaction. This force is very interesting to us: According to our knowledge quarks never exist alone but are “confined” to group constellations of two or three, the reason being the strong interaction. They can be released at high temperature and high energy conditions similar to those existing microseconds after the Big Bang and those currently being recreated in the lab in heavy ions experiments. The exploration of these confinement/deconfinement properties will allow us to better understand the formation and nature of matter in the Universe. The interactions between quarks are described by a field theory called quantumchromodynamics – QCD for short. QCD is an extremely rich theory.

What role do EFT play in it?

To describe physical systems existing in nature it makes sense to formulate EFT which help to simplify the problem and make model independent predictions. You might consider EFT as a sort of magnifying glass that focuses on physical phenomena occurring within a chosen length or energy range. The results of our calculations build the fundament for our colleagues in experimental physics to interpret the experimental data collected at the particle accelerators.

Can you please give some examples of experiments for which your research is relevant for?

The results of my research are relevant for the experiments going on at Tevatron at Fermilab and LHC at CERN, B-factories like KEK in Japan, Tau-charm factories like IHEP in China and the FAIR experimental facility at the GSI Helmholtzzentrum. In fact, it has always been important to me to bring the theoretical and the experimental communities together. To foster communication and collaboration between these groups, I founded the Quarkonium Working Group (QWP) back in 2002. This group meets regularly and involves more 100 theorists and experimentalists of research institutions all over the world. Several publications originated from this cooperation, one of them being the CERN Yellow Report on Heavy Quarkonium Physics in 2005.

Your last position before joining TUM was at the University of Milan. Have you always worked in academics?

Actually not, I spent a year in industry. In 2001, I joined the Philips Research Laboratories in Aachen. I worked on the development of small internal antennas with large bandwith for mobile communication and achieved several patents. It was very pleasant and interesting working at Philips. I had the impression of being right at the center of the technological innovation and there were many interesting problems to be solved.

People often see Munich as the most Northern City of Italy. You’re Italian, how do you see it?

Well, there are a lot of my compatriots visiting or living in Munich, so sometimes it feels rather Italian. It is a very serene city, so in some aspects it actually strikes me as being more Italian than Milan, the place I come from.

Welcome to the Cluster!

Visiting Scientists: Prof. Yukinari Sumino (Tohuku University, 6 - 14 September) ++ Prof. Chung Suh-Urk (Brookhaven National Lab, October 2010) ++ Prof. Kenneth C. Freeman (Mt Stromlo Observatory, Australian National University, 7 November - 8 December) Prof. Luca Amendola (Universität Heidelberg, 11 - 19 November) ++ Prof. Samoil Bilenky (Joint Institute for Nuclear Research, 1 October - 31 March)

Research Fellows: Dr. Antonio Palazzo (13 September 2010) ++ Dr. Erandy Ramirez (27 September 2010) ++ Dr. Louise Oakes (1 October 2010)

Realisation: Ulrike Ollinger (Layout) · Barbara Wankerl (Conception & Text)

Contribution: Dr. Helmut Hetznecker, Dr. Hans-Thomas Janka, Alexandra Wolfelsperger

Image credits: Page 1: (1) ESA/PACS/SPIRE/MESS Consortia, (2) MPA; Page 2: (1) MPA, (2) UC; Page 3: (1-2) UC, (2); Page 4: (1) Simulation was performed by Stefan Gottloeber (AIP, Potsdam), Anatoly Klypin (NMSU), Andrey Kravtsov (U.Chicago), Visualization by Andrey Kravtsov; Page 5: (1) UC, (2) NASA/CXC/Rutgers/J.Warren & J.Hughes et al., (3) 2006 H.-A. Arnolds/MPA; Page 6: (1) MPE, (2) UC

Subscribe to this newsletter at *http://www.Universe-cluster.de/about-us/newsletter*

Unsubscribe from this newsletter by sending an email with “unsubscribe ucnews” in the body text to dlmanager@ph.tum.de.

This newsletter is distributed bimonthly by the **Excellence Cluster Universe**
Technische Universität München, Boltzmannstr. 2, D-85748 Garching, Fon: +49.89.35831-7100, Fax: +49.89.3299-4002, E-mail: info@universe-cluster.de, www.universe-cluster.de
Directors: Prof. Dr. Stephan Paul (TUM), Prof. Dr. Andreas Burkert (LMU)
The Excellence Cluster Universe is supported by the German Excellence Initiative