NEWSLetter
Excellence Cluster Universe

Issue 2 / 2010

Dear Readers,

summer is here and with the heat there is a rising probability for thunderstorms. As we've learnt recently storms also occur on the "hot Jupiter" exoplanet — compared to these, one should stop calling thunder and lightning on our planet "bad weather".

There is more summer news to tell: In its report "Science Tourism", the Science Magazine has recommended our exhibition in the Deutsches Museum to its readers. And a couple of days ago, Cluster coordinator Prof. Stephan Paul was awarded the order of the Federal Republic of Germany for his committment to science — congratulations!

Besides, we've opened our Café & Kosmos event in Munich City: Once a month we invite the public to discuss current research topics with a scientist of MPA, MPE, MPP, ESO or the Cluster.

I wish you a pleasant holiday season!

Barbara Wankerl, PR Manager

PICTURE OF THE MONTH

Planet with superstorm

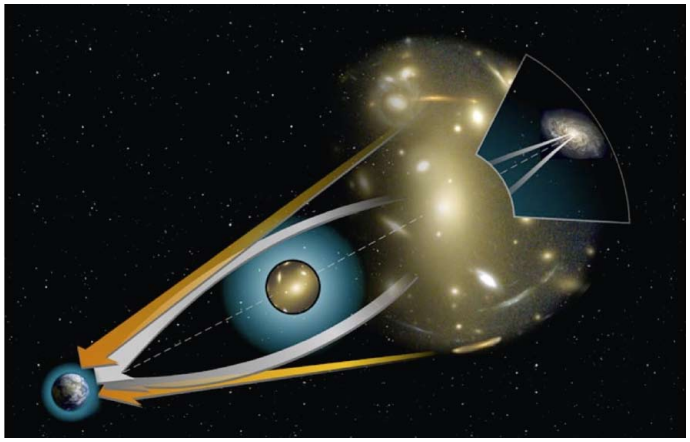
Astronomers have measured a superstorm for the first time in the atmosphere of an exoplanet, the well-studied "hot Jupiter" HD209458b. The very high-precision observations of carbon monoxide gas show that it is streaming at enormous speed from the extremely hot day side to the cooler night side of the planet. This artist's impression shows the Jupiter-like transiting planet around its solar-like host star.

RESEARCH

In Search of the Expansion Engine of the Universe

The Universe of the future will be a dark and lonely place: A hitherto unknown phenomenon ensures that space and the galaxies are drifting farther and farther apart from one another and are doing so at an ever accelerating pace. In 1998 scientists found convincing evidence of the accelerated expansion through the observation of supernovae. Since then cosmologists have been studying the nature of the driving force of the Universe.

One of several explanatory models is based on the premise that Dark Energy exists, which continuously inflates the Universe like gas. The cosmological constant „lambda" in Albert Einstein's general theory of relativity is considered a special case of Dark Energy: Einstein had inserted the constant into his equations in order to support his premise of a stationary Universe mathematically. In addition, there is yet another school of thought which assumes that Einstein's theory of relativity is no longer valid in the case of very large distances. For this reason, Einstein's theory must be modified.



Scheme of the weak gravitional lensing effect

Nevertheless, let's stay with Dark Energy for the time being. For a better understanding of Dark Energy scientists are studying the large-scale structure of the Universe. This plays a role for cosmologists similar to the role of fossils for evolution researchers: The history of the Universe's expansion can be deduced from the distribution of matter and to what extent Dark Energy played a role.

As the largest fraction of matter does not emit light, but is dark, cosmologists make use of an indirect method of providing evidence: the gravitational lensing effect. One speaks of a gravitational lens when the light emitted from distant galaxies is bent by means of unevenly distributed matter in the Universe. It is possible to draw conclusions as to the structures from the size of this very weak distortion of the light.

In order to gain a statistically relevant data set from the gravitational lenses, cosmologists are studying hundreds of thousands of galaxies. Large-scale sky surveys supply the data for this research, in which the scientists of Prof. Dr. Jochen Weller's research group „Observational Astrophysics" at the Excellence Cluster Universe are also involved. In these surveys scientists are endeavouring to study ever larger regions of the cosmos. This research can be performed successfully with increas-

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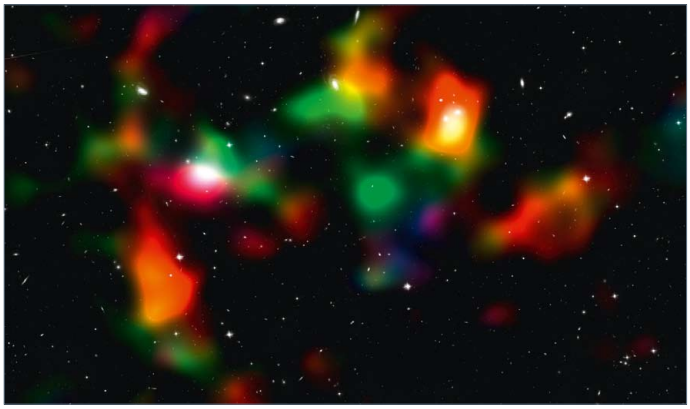
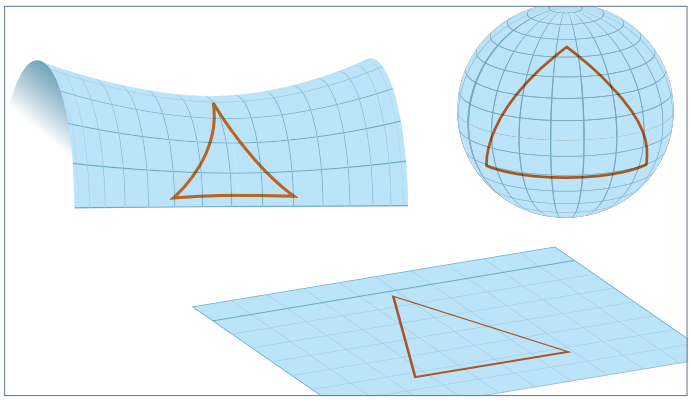
ingly sophisticated instruments. Two international collaborations are currently working on instruments which can scan huge space panoramas. The Dark Energy Survey (DES) and EUCLID initiatives will cover huge cosmic panoramas of 4,000 and 20,000 square degrees respectively. In the DES, scientists can scan 10 percent and with EUCLID even up to 50 percent of the sky. The Universe Cluster is participating in both large-scale projects.

In a recently released study Dr. Martin Kilbinger of the Cluster examined the so-called COSMOS field by means of the Hubble Space Telescope, which is operated by NASA and ESA. The COSMOS field only just makes up 0.004 percent of the sky with 1.6 square degrees. As these observations are not disturbed by the earth's atmosphere, they deliver excellent photographs of even small and dim galaxies. The Dark Energy makes itself apparent in two different ways in terms of the formation of structure in space: On the one hand it influences the formation of structures directly and on the other it also determines the spatial curvature and geometry of the Universe. With the measurements from the COSMOS field both effects could be taken into account. This enabled scientists to draw conclusions as to the characteristics of Dark Energy and thus test different theoretical models.



Reconstructed distrubution of matter in the COSMOS field. The red strucutures show matter at a red shift of z=1, representing a distance of 10 billon light years, when the Universe was half as old as today (13 billion years). Green: z = 0,5; blue: z=0,3.

Furthermore the group is also involved in observations with the Planck satellite, which images the cosmic microwave background radiation (CMB), whose minimal temperature fluctuations likewise provide information on Dark Energy. Kilbinger also applies



Different models for the spatial curvature of the Universe: Today's insights indicate a flat Universe as seen in the figure below.

combined measuring methods: In another approach he combines CMB data, supernovae and measurements of so-called baryonic acoustic oscillations (BAO). The existing density fluctuations in the early Universe propagate as sound waves after the formation of matter. Today you will find the highest density of matter at the peaks of these waves. Kilbinger developed optimised statistical procedures, with which he evaluated the combined CMB, supernova and BAO measurements. With these data he provided yet another indication that we are dealing with a flat Universe rather than a curved one. A statement as to how the cosmological constant lambda compares to models of Dark Energy is still not possible on the basis of current data.

The question as to whether the Dark Energy really exists or whether we have to revise what we know about gravitation still cannot be answered. The latest results of an international research group provide evidence thereof. The team studied gravitational lensing signals, as well as the distribution of galaxies and their speed, in order to gain a more accurate picture of the distribution of matter. For this purpose the scientists made use of the observation data of 70,000 galaxies, which were gathered in the Sloan Digital Sky Survey. This survey covered an eighth of the sky. It is the largest optical cosmological survey up to now. Scientists were able to collect the galaxy light from the era 3.5 billion years ago. At that time the Universe had reached 77 percent of its expansion today and was already in the state of accelerated expansion. Upshot of this study: Einstein's theory of relativity is compatible and easily fits in with the results of the surveys without any problem. The current score is therefore (still) 1:0 for Dark Energy.

EVENTS

Teacher Training „Aspects of Modern Cosmology"

The Excellence Cluster Universe will hold its annual teacher training „Aspects of Modern Cosmology" for the third time on 29 July 2010. The course will take place again this year at the Deutsches Museum. The Cluster scientists Dr. Frank Simon and Dr. Andreas Müller will discuss the topics „Big Bang, Particles and Forces", as well as „Galaxies, Black Holes and Cosmology" in two lectures. Following the lectures participants are invited to a guided tour of the special exhibition „Evolution of the Universe", which was planned and initiated by the Excellence Cluster Universe. The topics of the teacher training are geared to the Bavarian curriculum for the 10th year of secondary school.

Registration: http://fortbildung.schule.bayern.de/

Programm: http://www.universe-cluster.de/fileadmin/user_upload/Bildmaterial/Events/Lehrerfortbildung/Lehrerfortbildung_2010.pdf

Summer School on „Strings“

The string theory is the main focus of a course with outstanding lecturers which is being coordinated by scientists at the Excellence Cluster Universe. The course will be held from 25 July to 6 August 2010 at the research center in Munich/Garching. It is intended for young researchers and doctoral candidates working in the field of theoretical high energy physics, particularly in the area of string theory. At the same time the organizers are placing great emphasis on the advancement of scientists from less economically developed countries: Approximately 35 participants will receive a full scholarship. The summer course is promoted by the Deutscher Akademischer Austauschdienst (DAAD, German Academic Exchange Service) and the German Federal Foreign Office.

Professor Ilka Brunner and Dr. Marco Baumgartl of the junior research group „Extra Dimensions in Particle Physics and Cosmology“ at the Cluster, as well as Dr. Michael Haack, scientific coordinator at the Arnold Sommerfeld Center are organizing the summer course. The team was able to attract renowned scientists from international research institutes to hold lectures at the summer school. “We are pleased that top scientists like Hirosi Ooguri and Barton Zwiebach, who recently brought out an excellent book on the string theory, have accepted our invitation and made themselves available as lecturers”, says Ilka Brunner. Marco Baumgartl adds: „This summer school for theoretical high energy physics is expressly committed to sponsoring students from less economically developed countries. We are offering talented young people the chance to broaden their scientific knowledge at an international level despite financial restrictions in their home countries and to create networks. Both sides will profit from knowledge transfer.“

More information at www.universe-cluster.de/sfp10

Café & Kosmos brings the Universe to the Pub

Munich and its surroundings belong to the most important scientific regions of Germany. In astronomy and astrophysics alone, there are no less than five great research institutes and organisations, as well as several other research groups, which try, in different and complementary ways, to understand the Universe.

With the idea of “Café & Kosmos”, the Excellence Cluster Universe and its partners bring researchers and non-scientists together, and to do so where people live: in the centre of the city of Munich, and in a pub, a place where communication traditionally takes place: people meet, share their thoughts, discuss business, and debate about big and small things. With Café & Kosmos, we want to give people the chance to speak with scientists about fascinating scientific themes.

The first Café & Kosmos took place on 31 May 2010, opening the stage for Stefan Stonjek from the Max-Planck-Institute for Physics and his subject “The Big Bang in the Tunnel”. All plush seats in the Café Jasmin were occupied when Stefan Stonjek explained how scientists at the LHC and ATLAS particle detector work on answering fundamental research questions like the nature of dark matter or the existence of the Higgs particle. The feedback of the 80 guests was unanimously positive. They very much liked the idea to bring research from the labs to Munich City - and virtually bombarded the scientists with their questions.

Café and Kosmos opens every first monday of the month. The next discussion takes place on 5 July 2010: Astrophysicist Markus Kissler-Patig from ESO will deal with the intriguing question: “Are we alone in the Universe?” The event will start at 7 pm at the Café Jasmin (Steinheilstr. 20, München). Access is free.

More information at www.universe-cluster.de

Science Lounge and Magic Tours through the Universe

The magician Thomas Fraps “explains” the String Theory

On the Saturday evening of 15 May, around 10,000 visitors came to the Garching Research Center: Between 6 pm and midnight, several departments and institutions of the Technical University and the Max Planck Institute for Plasmaphysics opened their doors for the “Long night of Sciences”.

Again, the Excellence Cluster Universe participated with a varied program, this time at the newly opened Excellence Center on Boltzmannstraße 17. Besides the Universe Cluster, the Excellence Clusters NIM and MAP, as well as other research institutions presented themselves at this venue.

In the course of this evening, the physicist and magician Thomas Fraps took the guests three times on a tour through the magical Universe. In between the program highlights, scientists answered questions and explained their research work. In the Science Lounge, scientists discussed their research issues with the audience, making it a successful test run for the “Café & Kosmos” (s. article above). Almost the whole evening, the building was so crowded that visitors had to squeeze into every corner of it.

PEOPLE

Order of the Federal Republic of Germany for Prof. Stephan Paul

Stephan Paul receives the award from minister Wolfgang Heubisch

The speaker of the Excellence Cluster "Origin and Structure of the Universe" was awarded the order of the Federal Republic of Germany at the end of June 2010. Prof. Dr. Stephan Paul was presented with the award by the Bavarian Minister of Science Dr. Wolfgang Heubisch. In the honorific speech the outstanding achievements of Stephan Paul were honoured, which he has attained in different scientific institutions and as initiator and leader of the Universe Cluster. He has "rendered outstanding services to science and research and thus to the common good in an exemplary manner."

Stephan Paul has made a name for himself particularly in hadron physics and in the field of particle physics with neutrons. He was born in Bonn and has held the Chair for Experimental Physics (E18) at the Technische Universität München since 1997. Since 2006, he has been the speaker of the Excellence Cluster Universe, a project he initiated along with Prof. Dr. Andreas Burkert of the Ludwig-Maximilian University (LMU) within the framework of the Excellence Initiative.

Interview with Jochen Schieck

Jochen Schieck

On 1 April 2010 the Excellence Cluster Universe has started a new Junior Research Group (JRG) for experimental particle physics. Under the leadership of Prof. Dr. Jochen Schieck, the group will study the properties of heavy quarks.

Two major international projects are the main focus of the new JRG: Firstly, the ATLAS detector of the Large Hadron Collider (LHC) at CERN. Schieck's group works particularly in the area of the interpretation of data from the inner detector (ID), the tracker of the ATLAS experiment. The second project is the development of the Belle II detector at the "High Energy Accelerator Research Organisation" KEK (High Energy Accelerator Research Organization) in Japan. This spectrometer is used in the study of B physics, especially CP violation in B mesons.

The main focus of your research work has been at CERN and KEK. Are there any affiliated experiments which you work on in Garching?

The experiments are taking place in Switzerland and in Japan. However, the Belle-II detector is currently being built and for this we will perform some research and development work here in Munich. We will set up a small test system to develop the power supply for the Belle-II Pixel detector. After the development of this we plan to produce the complete power supply system, which will be then shipped to Japan.

Has your Junior Research Group already been fully set up?

Not yet, but we are steadily increasing – the group currently has three scientists, but I expect some people to join during the next months. The next person will arrive as early as in July.

What do you aim to achieve within the next few years?

I have two major goals which I follow up. I would like to perform first analyses with data from the ATLAS detector and I would like to contribute to the construction of the Belle-II pixel detector. I took part in the production and commissioning of the ATLAS inner detector during the last years and I am looking forward very much to use this detector to perform physics studies. Ultimately I would like to measure possible asymmetries in a certain decay of the B meson. The standard model tells us that there shouldn't be any – a discovery of one would be a hint for new physics.

How can the collaborations within the Excellence Clusters Universe support your research work?

We are an experimental group and we build detectors and analyse data – for the interpretation of the data we need a close collaboration with theorists. Within the Cluster there are a couple of excellent scientists working on the same subject from a theoretical perspective. We are already exchanging ideas.

Welcome to the Cluster!

Postdocs: Dr. Gerd Petzoldt (1 June 2010) ++ Dr. Tommaso Giannantonio (1 July 2010) ++ Pavel Reznicek (1 July 2010) ++ Alexandro Saro (1 September 2010)

Guests: Prof. Jihn E. Kim (Seoul National University, 23 June - 4 July) ++ Dr. Moshe Elitzur (University of Kentucky, 28 June - 2 July) ++ Dr. Francesca Civano (CfA Harvard Smithsonian Center for Astrophysics, 29 June - 7 July) ++ Prof. Paul Garrett (University of Guelph, 1 July - 31 December) ++ Prof. Hiroshi Toki (RCNP, Osaka University, 1 July - 31 July) ++ Prof. Felipe Llanes Estrada (Universidad Complutense de Madrid, 6 July - 29 July) ++ Prof. Marco Maggiora (University of Turin, 19 July - 23 July) ++ Prof. Subhabrata Majumdar (Tata Institute for Fundamental Research, 1 August - 30 October) ++ Prof. Neda Sadooghi (Sharif University of Technology, 1 September - 31 December)

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The Excellence Cluster Universe is supported by the German Excellence Initiative