

62nd Lindau Nobel Laureate Meeting

PRESS RELEASE

Dark Matter for Bright Minds

- *Physics Nobel Laureate 2011, Brian Schmidt, to open the scientific programme*
- *Gazing at the stars offers a glimpse of the past*
- *The universe is accelerating*
- *Young researchers from 69 countries reflect on the composition of the universe*

Lindau, 13 June 2012. Almost two thirds of our universe is made up of dark energy. It is invisibly interwoven with the empty space, and forces the universe to expand at an ever-increasing speed. This discovery, which two teams published simultaneously in 1998, was nothing short of a sensation. Nobody yet knows what is behind dark energy. **Brian Schmidt** does not know either. However, the Australian astronomer is one of those who discovered it, together with Saul Perlmutter and Adam Riess. The three scientists were jointly awarded the Nobel Prize in Physics in 2011 for this discovery. "Observations, and the Standard Model of Cosmology" is the title of Schmidt's lecture, which will open the scientific programme of the 62nd Lindau Nobel Laureate Meeting on 2 July, where 27 Nobel Laureates and more than 580 young scientists from all over the globe will participate in. The meeting is devoted to physics this year.

Evidence of Exploding Stars

Brian Schmidt's success is based on his amazement at observations which contradict the hypothesis of his own research project and his ability to draw the correct conclusions from it. His High-z Supernova Search Team based in Weston Creek, Australia, aimed to measure the slowdown of the expansion of the universe, as did Saul Perlmutter's competing Supernova Cosmology Project at the University of California in Berkeley. The billions of galaxies in the universe are moving away from each other, as Edwin Hubble proved back in 1929.

This led astronomers to conclude that either this expansion would continue indefinitely with uniform speed, or the gravitational force would gain the upper hand one day and gradually turn the expansion of the universe into its opposite - just as a ball thrown into the air rises more and more slowly in order to then fall back to Earth. Since the early 1990s it has been possible to check these assumptions empirically. This is thanks to the advances made in data processing and the digital acquisition and processing of images (Nobel Prize in Physics in 2009), on the one hand, and also to the fact that astronomy had succeeded in finding reliable distance indicators in the depths of the universe: type 1a supernovae.

When a star is burned out and its time has come, it explodes in a supernova. Type 1a supernovae are particularly interesting for astronomers. They only arise in binary systems in which one star is a white dwarf and the other a red giant that is in a phase of expansion. The red giant's mass flows to the white dwarf until this star reaches its maximum mass limit, which was already predicted by Chandrasekhar Subrahmanyan at the end of the 1930s; he was awarded the 1983 Nobel Prize for it. Consequently, the white dwarf explodes in a type 1a supernova. As the brightness of these explosions is physically always the same, observing the apparent brightness of supernovae allows astronomers to deduce their distance. A supernova occurs in every galaxy approximately once every 500 years. The gigantic universe has around ten type 1a supernovae every minute, however. One incredible feat achieved by the 2011 Laureates was detecting these supernovae at a distance of more than five billion light years, estimating their age, subtracting their signals from the vast quantity of digital data in order to record their luminosity. The other one was to not cast doubt on their own results: "Adam, did you do wrong?" Schmidt asked his colleague Adam Riess, when the latter showed him a diagram of his first measurements.

Stronger than Gravity

According to the data, five supernovae not only shone less and less brightly during the observation time, they also lost more luminosity than expected. Embedded in their galaxies, they were obviously moving away from their observer with increasing speed - the universe was accelerating its expansion. Further observations confirmed this surprising finding, which was also found in parallel by Saul Perlmutter's team. Both groups of researchers based their concurring results on the analysis of a total of 50 type 1a supernovae. Experts in the field, who knew that both teams had been competing with each other for many years and would have loved to refute the other group's findings, took this as proof of the credibility of the astounding findings:

the universe is accelerating, because with the dark energy there is a force that counteracts gravitation.

Most physicists consider the source of the dark energy to be the vacuum, because it is here that matter and energy continuously convert into each other at almost infinite speed - as the laws of quantum physics suggest. The energy which the vacuum can theoretically obtain through these fluctuations is less than the dark energy by the unimaginably large factor of 10 to the power of 122, however. Where are the gaps between theory and observation? Does the dark energy - albeit with opposite sign - correspond to the cosmological constant that Einstein had introduced into his equations, in order to not have to abandon his belief in a static universe? Or is it not constant at all, but originates from temporary force fields? If, as some theoreticians believe, the early universe experienced a sudden expansion resulting in an enormous, temporary increase in its energy density - could something similar be occurring now? And could this explain dark energy? These questions revolve around the greatest physics mystery facing us today. The fine line between speculation and science which they reveal is what makes them so fascinating for a dialogue between young scientists and Nobel Laureates.

The Radiating Beginning of the World

The deeper astronomers look into space, the deeper they delve into its past as well. The explosions, whose light Brian Schmidt and his co-laureates recorded and investigated, occurred many billions of years ago. With telescopes stationed on earth, astronomers can cover just over 60 % of the time axis from our present to the Big Bang; they cannot thereby reach the birth of our universe 13.7 billion years ago. To do this, they would need a technology outside earth's absorbing atmosphere that is able to detect the first rays of light announcing the formation of the world. These technological requirements were realized by the American space agency NASA with its Cosmic Background Explorer (COBE) satellite, a project headed by **John Mather** and **George Smoot**. Only nine minutes after it had been launched into space in November 1989, the satellite was already sending its first images back to Earth. And they were an accurate confirmation of the COBE mission's starting hypothesis: if the universe was formed in a Big Bang from an infinitely dense and hot point, then it initially contained perfect radiation, whose wavelength depended only on the temperature from a raging sea of energy, some of which gradually converted into matter. A remnant of this radiation remains, dramatically cooled, to this day, however, and its cosmic noise bears witness to the beginning of the world, like a shell from the ocean. If this assumption is correct, then this cosmic background noise must not be completely uniform

(isotropic), but must exhibit tiny direction-dependent temperature differences, so that the formation of heaps of matter, i.e. galaxies, from the energy field can be explained.

The analysis of the COBE data did indeed show that tiny variations in the background radiation can be measured which show where heaps of matter started to form at the beginning of time. The results of the COBE mission are deemed to be proof of the Big Bang model and led to John Mather and George Smoot being awarded the Nobel Prize in Physics in 2006.

John Mather will provide an overview of current developments in space-based and ground-based telescopes in his Lindau lecture “Seeing farther with new telescopes”. George Smoot, in his lecture entitled “Mapping the Universe in Space and Time”, will look at the data that those telescopes provide, and discuss which insights they can be expected to provide in the near future. The fact that both will speak directly after Brian Schmidt on 2 July is also a sign of their scientific connection: It was precision measurements of the cosmic background radiation which, during the past decade, have confirmed the discovery that our universe is expanding at an ever-increasing rate.

Further Information

The programme of the 62nd Lindau Nobel Laureate Meeting, background information regarding the participating Laureates, and abstracts/summaries of their talks are available in the Lindau Mediatheque: www.mediatheque.lindau-nobel.org/#/Meeting?id=284. It also comprises audio recordings and videos of the lectures of Nobel Laureates from more than 60 years of history of the Lindau Meetings. With supplementary background information, photos, links to related contents and didactically edited “mini lectures”, the Lindau Mediatheque is interesting for researchers, those interested in science, journalists and teachers alike.

Topic cluster of all mediatheque contents on cosmology:

<http://www.mediatheque.lindau-nobel.org/#/TopicCluster?id=3>

Profiles of the Nobel Laureates with background information in the Lindau Mediatheque:

Brian Schmidt (Physics, 2011): <http://www.mediatheque.lindau-nobel.org/#/Laureate?id=18261>

George Smoot (Physics, 2006): <http://www.mediatheque.lindau-nobel.org/#/Laureate?id=6951>

John Mather (Physics, 2006): <http://www.mediatheque.lindau-nobel.org/#/Laureate?id=6884>

Official Nobel Prize award reasoning for the Laureates mentioned above:

- Brian Schmidt, Saul Perlmutter and Adam Riess were jointly awarded the 2011 Nobel Prize in Physics for their discovery of the accelerating expansion of the Universe through observations of distant supernovae.
- John Mather and George Smoot were jointly awarded the 2006 Nobel Prize in Physics for their discovery of the blackbody form and anisotropy of the cosmic microwave background radiation.

The Lindau Nobel Laureate Meetings

27 Nobel Laureates and more than 580 young scientists from 69 countries will participate in the 62nd Lindau Nobel Laureate Meeting (Physics) from 1 to 6 July 2012. The topics include cosmology, particle physics, the challenges of a sustainable energy supply and the climate issue. The Lindau Nobel Laureate Meetings have been taking place every year since 1951. They are organised by the Council for the Lindau Nobel Laureate Meetings e.V. established in 1954 and the Foundation Lindau Nobelprizewinners Meetings at Lake Constance established in 2000. More than 250 Nobel Laureates are Members of the Founders Assembly.

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