



69<sup>th</sup> Lindau Nobel Laureate Meeting  
Annual Report 2019



LINDAU  
NOBEL LAUREATE  
MEETINGS

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# Changing the World for the Better

Greeting by Countess Bettina Bernadotte and Jürgen Kluge

This summer, 39 Nobel Laureates and around 580 young scientists from 89 countries joined the 69<sup>th</sup> Lindau Nobel Laureate Meeting. Never before have so many countries been represented in this week of exchange. Although very diverse in their backgrounds, all these great scientists from around the world have one thing in common: their passion for physics.

In his opening lecture, Nobel Laureate Brian Schmidt discussed how the responsibility to improve society should shape every scientist's motivation for their work. The aspiration to change the world for the better emerged as a key theme of this year's meeting. Related issues were discussed during the opening lecture, in a multitude of sessions throughout the week and again during the closing panel discussion entitled 'How Can Science Change the World for the Better?'. The 'Lindau Spirit' embraced in this way an attitude of challenging one another to, in our actions, go further than what we have achieved thus far, recognising that every single person is an important protagonist of our world's future. We should all stand shoulder to shoulder with our colleagues, friends and fellow citizens and look in the same direction: towards solutions for the challenges that we face as a global society – and take action accordingly.

The new Lindau Nobel Laureate Pier is an exciting new physical representation of the laureates that have attended the Lindau Meetings. Around 400 Nobel Laureates have participated in our meetings since 1951. The pier was built in their honour, and its opening marked a highlight of this year's meeting. The guardrails of the pier not only bear the laureate's name, the year of the award and the discipline but also the year of the first visit to the Lindau Meeting. With 1,000 individual metal bars, there is enough space for future Nobel Laureates, who will attend in the years to come. And in the next years and decades, people will remember the laureates and their contributions to science and humankind, while strolling along the pier. We are grateful to the Beisheim Stiftung for the funding as well as Lord Mayor Gerhard Ecker and the City of Lindau for the cooperation that enabled us to realise both the Lindau Science Trail and the Lindau Nobel Laureate Pier.

One of the guardrails of the pier also bears the name of Nobel Laureate Elizabeth Blackburn. In her opening lecture in 2018, she made a compelling appeal proposing to create a 'Lindau Declaration' for the 70<sup>th</sup> Lindau Meeting in 2020. She called for a new approach to global, sustainable, cooperative open science, since the problems currently facing humanity cannot be solved on a national basis anymore. Climate crisis, emerging infectious diseases and the need for alternative energy sources are only some of the pressing issues of our time that require global answers.

Since then, Elizabeth Blackburn and we at Lindau have written a first draft of the Lindau Declaration 2020. While it was formulated with basic research as its primary focus, its principles and goals can apply to all types of science. Now, it is open for debate, changes and amendments until the end of 2019. Everyone is invited to contribute to this project online at [lindaudeclaration.org](http://lindaudeclaration.org). It will be officially signed by Nobel Laureates and published during the interdisciplinary Lindau Meeting in 2020. This is the chance to spread the Lindau Spirit into the world and to make a change beyond our meeting in Lindau.

The core of the Lindau Meetings always was, and still is, to connect. In 1951, the idea of two doctors from Lindau became reality. They had the vision of connecting European scientists again, after years of separation during World War II. Together with Count Lennart Bernadotte from Mainau Island, Franz Karl Hein and Gustav Wilhelm Parade initiated the first 'European Meeting of Nobel Laureates' with seven Nobel Laureates. Only two years later, the first students were invited to join.

The founders wanted to establish a place of scientific as well as personal exchange between the Nobel Laureates and young scientists. They wanted people to be connected. Nearly 70 years later, this is still our aspiration. Not only to connect the right thoughts and concepts in order to foster new scientific discoveries. But above all to connect people, for the purpose of multiplying knowledge all over the globe.

*“We should all look towards solutions for the challenges that we face as a global society – and take action accordingly.”*

Countess Bettina Bernadotte and Jürgen Kluge



Lindau should encourage everybody to debate, to exchange views, to discuss facts, scientific behaviour as well as personal beliefs and to learn from each other. We hope young scientists took the chance to chat with a Nobel Laureate during a breakfast, lunch, walk, dinner, or whenever there was the chance. We hope they experienced the special 'Lindau Spirit' as more than 33,000 Lindau Alumni have before them. And, ultimately, we hope that as well as feeling educated and inspired, they feel first and foremost connected.

» Countess Bettina Bernadotte af Wisborg  
President of the Council for the Lindau Nobel Laureate Meetings

Jürgen Kluge  
Chairman of the Board of Directors of the Foundation Lindau  
Nobel Laureate Meetings



*“This is what we work for: we want to see the sparkle in the eyes of the young scientists and the Nobel Laureates.”*

Countess Bettina Bernadotte, President of the Council for the Lindau Nobel Laureate Meetings

Rainer Weiss and young scientists taking a break during the Science Walk





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## Big Questions for Society, Big Questions for Research

Nobel Laureate Brian Schmidt gave the keynote lecture during the opening ceremony of the 69<sup>th</sup> Lindau Nobel Laureate Meeting. He stressed the potential for science to solve the challenges of our time and encouraged all scientists to become active members of society.

Here in Lindau, it's a good opportunity to think about the world around us as it presents itself in 2019. We certainly live in the apocryphal "interesting times". This well-worn phrase has been said many times before – but not all times are equally interesting.

Will our years look like the rise of Sumer, the age of the Egyptian pharaohs, Athenian Greece, the Glories of Rome, the Han dynasty, the Renaissance, the Industrial Revolution? Or, less happily, will they look like the Three Kingdoms War, the Fall of Rome, the Ottoman Wars, World Wars I and II?

Only time will tell, but we are entering what seems to be, for me, the most interesting time for humanity since World War II and the early Cold War. The pace of technological change is staggering, and this is accompanied by a new social and political uncertainty and global instabilities that have not been present in my lifetime.

But we are also lucky enough to live in a time of hope and progress. Human longevity has moved quickly up from 30 years less than a 100 years ago, to greater than 71 years. The fraction of the world living in extreme poverty is dropping precipitously, from 35% in 1990 to less than 11% in 2013.

We live in a time where every human on planet earth will soon be able to engage with the rest of the world – digitally, by mass transit and by trade. We have developed physics to allow us to manipulate the world at the quantum level, and to understand the Universe on the largest scales. We have beginnings of artificial intelligence, we are recording data on unimaginable scales and new technologies that in theory should help each of us to be orders of magnitude more productive than in the past. In my home of Australia, we can now build a solar power station that delivers power three times cheaper than can be with a new coal station. But remarkably, we are still debating what type of power plant should be built. There are issues around storage, but also issues around politics.

This is important because humanity is affecting our planet – we live in the Anthropocene epoch. We live in a time where our use of the Earth's resources is not sustainable over the current human lifetime. I used to talk about my grandchildren, I now talk about me. We live in a time where the rapid rise of prosperity for all – especially amongst some of the haves in developed economies – has slowed for the first time since World War II; where democracies struggle against the rise of populism and the abundance of information, some true and some false; while autocracies are able to double down with AI and data to increase their powers through the control of information. We live in a time where everyone finally has a voice, thanks to the internet – but it is hard to hear what is important amid the deafening collective noise.

So, in these times, humanity faces a choice. Either we choose to power through the Anthropocene with knowledge, technology and human organisation creating a more prosperous world for all, one that is able to thrive on earth in a sustainable prosperity.

Or we see ourselves fall into conflict, where the haves and have nots fight over the finite resources of earth. Where everyone finds themselves less prosperous, less secure and ultimately, less happy. This second way has no winners.

Sobering words! But there is hope – and the hope is here in this room. There is nothing that lies before us that is not solvable. While the solutions involve ideas not yet had, and technologies not yet invented, the next generation of scientists spread around the world, rather than in just a few places – and that is all of you – will have the knowledge and tools to create the solutions. You have the ability to make sure they apply to everyone from all societies and backgrounds.

Now this isn't something we can wait for permission to do from the political forces which are distorting our current world. It is the role of us scientists – young and old – to challenge orthodoxy and to think big. We can do things differently, and

*“Science works because it is contestable and testable. And it works best when it is completely open and transparent.”*

Brian Schmidt



lead the way, continue to make progress so that when the political world clears its mind, and is ready to take action, we will have the answers.

Today I want to hopefully give each of you confidence about your part in this collective endeavour. But I also want to endow on you a sense of responsibility. An obligation to act for the good of all, and in a way that maximises the speed of progress, unhindered by short-term thinking. In the world today, it is so easy for the community and politicians who serve our community, to think that science is somehow not that important. The

fruits of our endeavours are so ubiquitous, they are now part of the fabric of humanity – easily taken for granted. [...]

Humans have been able to make progress because we are efficiently able to learn from each other, our breakthroughs and our mistakes are shared. Let's just look at the accelerating Universe: if I look at all of the authors whom we cited in our 1998 paper announcing the evidence for an accelerating universe, it was about 10% of all practicing astronomers in the world. If we were to take the papers we cited, and the papers they cited – we would cover over half of all astronomers. A single discovery – and

*“In 2019, we MUST make a difference.  
The world is waiting.”*

Brian Schmidt



Brian Schmidt with young scientists at #LINO19

only a single degree of separation between our paper and half of all practicing astronomers of the day. We are completely interdependent to do our work.

So it is easy to feel isolated in research, that somehow your little piece doesn't matter. But more often than not it does – or it will – but in ways that you simply cannot predict in advance. [...]

Science works because it is contestable and testable. And it works best when it is completely open and transparent. Have a thought about that Lindau Declaration document. Have it not be the Nobel Laureates' document, have it be this community's document. I routinely see scientists become highly secretive because they are paranoid that their ideas will be stolen. The basis of science is your ideas need to be shared. I don't hire people because of the number of ideas they have and kept in their head. I hire people because of the number of ideas that they have that are taken up and used around the world.

So yes – some prudence to make sure you get credit for your ideas, but then be open and share everything. Make sure people can use your ideas to further their work, don't hinder them because you have a paper you might want to write sometime in the future.

Ask yourself the following question. When I publish a result, can it be easily reproduced by someone else in the field? Have I made my data available, have I made my methods clear? I'm quite an evangelist on this, I personally think each of us should share our computer code, datafiles, everything so to maximise the velocity at which science can travel. If everyone did it we would all be so much better off! Have confidence that in sharing, you will be better off.

Each of us needs to beware of our own human psychology. When you lead a university as I do now, you get the opportunity to meet thousands of highly talented people across all disciplines. And I am surprised by exactly how irrational even the smartest of scientists can be.

You as scientists, I hope, share the value to defend truth as a core value of our discipline. Yet, I continually see scientists around the world defending their own work or people who agree with them like a lawyer (who after all are required to defend in the face of all evidence), rather than with an open mind, receptive of possible short-comings. Indeed, as humans have done for our entire existence, we form tribes which we trust and defend. We use, as Nobel Prize Economist Daniel Kahneman wrote about in 'Thinking, Fast and Slow', our fast-thinking brain where we trust what is familiar with us, rather than engaging our rationality. And this fast way of thinking affects each of us all the time.

Last year, the Hubble Space Telescope for the first time allocated telescope time using a system where the people who allocated the time did not know the names of who was proposing. And for the first time ever, the success rate for women and men was more or less the same. [...] The biases that caused women to not be allocated telescope time before at the same rate are indicative of biases that cut across all sorts of variables. It shows just how hard it is to be fully rational. We do better when we try to engage our slow-thinking, rational brain – but be aware of your own limitations to being perfect.

But also be aware how the average person's brain works, too. I find it beyond frustrating that the scientific evidence is so easily discarded for things like vaccination and climate change by so many, including the US president. Part of me realises this is because people now have access to counter information (largely based on the internet) that fits their own prior belief. But unfortunately, our brains are naturally wired to believe what we believe, and to double down on our beliefs when we are attacked.

Shouting at President Trump is not going to make him or the voters who support him change their minds, in fact it is counterproductive. We need to somehow bring all of society into our tribe, where we, science and evidence are once again highly trusted. Each of us have a role to play. Get out, tell your stories

of science, bring young and old into your world – don't tell them they are idiots when they disagree with you. Listen to their questions with an open mind, be respectful. By the way, do the same thing when dealing with your scientific colleagues as well.

Research is a broad church. We need the curiosity-driven research to explore our Universe in all of its many facets. It is from this fountain of knowledge new solutions – revolutions – can emerge. I urge each of you to defend the importance of this aspect of science in your own country – no matter how rich or poor. It is the foundation of the research ecosystem.

But we also need research to translate that knowledge, when appropriate, to real-world solutions. Places where academic research and industry work hand-in-hand at first, eventually handing off to industry to create the products and services that deliver prosperity to the world. All too often, I see people who work on fundamental research look down on the translational and industrial research. All research is important, it is all equally dignified, and none of us should be scared to bounce between fundamental and applied research, as opportunities emerge. And people like me, who run universities, will increasingly support these opportunities. [...]

So as I finish my talk, I ask each of you to embrace your privileged role as one of the world's most educated citizens. Make sure your work, as much of it as possible, is available for fellow scientists to amplify. Always make sure you are working to push the boundaries of knowledge, rather than defending your view of the world. And bring the world with you. Know your own biases, be inclusive, show patience and respect to everyone around you – from young children you might meet visiting a kindergarten, to the leader of your country. If we all do this, we can make a difference. And in 2019, we MUST make a difference. The world is waiting.

 A video of Brian Schmidt's full speech is available in the mediatheque.



# Lindau Declaration 2020 – Guidelines Towards New Ways in Science

At #LINO18 Nobel Laureate Elizabeth Blackburn suggested the initiative for a Lindau Declaration 2020, including guidelines for a new approach to global, sustainable, cooperative open science. These guidelines are now open for debate, changes and amendments and will be signed at the 70<sup>th</sup> Lindau Meeting.

Elizabeth Blackburn's initiative for a Lindau Declaration on Sustainable Cooperative Open Science was a call to widely support new ways in science. While it was formulated with basic research as its primary focus, its principles and goals shall apply to all types of science. The initiative draws upon, refers to and supports various already existing projects and activities. The motivation and goals of this initiative have been described by Elizabeth Blackburn during the 68<sup>th</sup> Lindau Nobel Laureate Meeting:

“Over the past century, industrialised nations around the world have built robust government-funded national research enterprises. Each of these organisations has advanced science by infusing the universal human impulse for discovery with national or regional pride.

Despite the unarguable success of the nationally focused model of science that has dominated the past hundred years, the truly vexing problems now facing humanity – such as environmental degradation; the global climate crisis and its effects on health; emerging infectious diseases and pandemics; and the need for alternative energy sources – call for building something new: a global framework to support fundamental scientific research.

An inspiring model of international commitment for the common benefit already exists in the Paris Agreement for climate change mitigation. The 2015 agreement, which recognises global climate change as one of the most daunting challenges faced by humankind, has the signatures of 194 nations plus the European Union, and lays out commitments to support the collective actions needed for long-term global benefit. Though the Paris Agreement has been subject to criticism that it is based on aspirations rather than mandates, it is nonetheless an unprecedented achievement in global cooperation toward a shared and urgent goal and a powerful example of what humanity can achieve through inclusive, careful negotiations conducted in good faith.

By implementing the equivalent of a Paris Agreement for long-term, cooperative, international support of scientific research –

to complement the nation-based organisations that have served us so well – we can better embrace far-sighted, strategic scientific planning.

Arming the world with collectively acquired new scientific knowledge would allow us to anticipate crises that ultimately affect us all, freeing us from the reactive stances we so frequently must adopt in response to unexpected challenges.

A global model would also provide the means to build a sustainable source of funding and freely shared scientific tools. When fiscal resources for science are bound up in national politics, year-to-year funding proposals can be unpredictable and even capricious.

The Paris Agreement crucially includes robust funding to achieve its objectives, via a Green Climate Fund that has so far attracted more than \$10 billion in pledges. Notably, these pledges have come not just from affluent, highly industrialised countries but also from a diverse range of nations, including Mexico, Indonesia and Vietnam.

The current concentration of scientific activity in a small number of rich nations excludes the perspectives and talents of millions who stand ready to contribute to science. By actively sharing technology and data through a global framework and by building on current momentum to open the scientific publishing process to all, we can greatly accelerate the pace of discovery and increase the diversity and richness of the research we pursue. I have presented preliminary ideas on a global science framework at several international forums and received an enthusiastic response. It is my hope that young scientists and future scientists just coming of age can imagine, and eventually realise, a global pact for science – a science based on shared goals and guidelines, transparency and strategic, long-range thinking. We would all stand to benefit.”

The guidelines currently consist of the following ten goals that shall be refined and complemented in discussion during the next months:

## Goal 1

### Cooperate Globally on Global Problems

The vast majority of the most pressing problems of today are of global nature: They affect large parts of the world's population, they do not stop at borders and they cannot be solved alone.

Therefore, scientists, funders and politicians must cooperate globally to increase efficiency, speed and effectiveness. While the creative benefits of differing approaches and the stimulus of competition are to be acknowledged, inefficiency by unnecessary parallelism or obstruction must be avoided.

## Goal 2

### Share Knowledge

Knowledge becomes most powerful when it is shared with others. By sharing information, progress can be achieved faster and more efficiently. This includes sharing information about failures.

Thus, all scientific results and data shall be made openly available. Modern technologies (e.g. blockchain archives) allow for systems that can guarantee correct attribution of ideas to their inventors.

## Goal 3

### Publish Results Open Access

Scientific results shall be published in an open access mode. Many approaches such as open access journals or pre-print archives as well as new initiatives already exist. While it is not yet clear which modes and models will ultimately succeed, it remains a requirement that all relevant scientific findings must be published in an open access mode.

## Goal 4

### Publish Data to Repositories

Publishing is not limited to scientific findings. Any kind of data found, generated or used shall also be archived in appropriate data repositories. As this means storing vast amounts of data, the technological and administrative infrastructure must be



Elizabeth Blackburn

continuously improved and adapted to guarantee safe and secure long-term storage. The publication of data, formulas, algorithms and other background used to generate findings will become a new requirement of scientific publishing. All scientific content shall be preserved, connected and versioned to foster discovery, accumulation of evidence but also respect for uncertainty.

*“It is my hope that young scientists can imagine, and eventually realise, a global pact for science – a science based on shared goals and resources, transparency and strategic, long-range thinking.”*

Elizabeth Blackburn



**Goal 5**  
**Work Transparent and Truthful**  
 Research must be transparent and truthful:

First, in methodology, data and findings, meaning that these have to be performed and documented in the most precise and comprehensible way.

Second, in communication and collaboration, meaning that relevant findings shall be communicated and provided to others in a precise, timely and constructive manner.

Third, in disclosure of funding, affiliations and political or ideological motivations, meaning that all motivations outside a pure scientific interest shall be communicated openly.

**Goal 6**  
**Change Reward Systems**  
 Currently, working along the outlined standards and investing in transparency, openness, accessibility etc. is not appropriately rewarded, especially not when it takes capacity from traditional main goals. For the future, implementation and adherence to the aforementioned practices must be awarded, e.g. in reviewing

and job employment selections. Evaluations of scientists shall be based on both the relevance of their discoveries and the process by which they were discovered, not on where those results are published. Credit will also be given for generating useful data, authoring code or creating resources that can be reused by others.

**Goal 7**  
**Support Talent Worldwide**  
 Scientific talent exists in all parts of the world and all parts of society. All work and research environments as well as all structures related to that shall support scientific talent regardless of its background in a diverse and non-discriminative manner. Equal access and opportunities shall be provided wherever possible.

**Goal 8**  
**Communicate to Society**  
 Science has a distinct responsibility to communicate its procedures and results to society. Not only is most basic research funded by tax-payers money. Research and its application do also always influence people's lives. Particularly in cases of world-wide relevance such as climate change, proper communication becomes an important duty.

The science community must also constructively work on providing usable information to the decision-making process in politics, society, industry and other areas.

**Goal 9**  
**Engage in Education**  
 While research is at the core of the scientific discovery process, engaging in the education of the next generation is equally crucial.

Enabling and supporting aspiring young pupils, students and scientists ensures a sustainable process of mutual learning and empowers the subsequent cohort of researchers.

Engaging in education can take multiple forms, from classroom lectures to mentoring, from cooperative lab-work to off-campus activities.

**Goal 10**  
**Ensure Global Funding**  
 Basic research requires reliable funding, even more so than other forms of science, such as industry research. In almost all cases, insights from basic research, or even blue-sky research, lay the ground for inventions and products that directly benefit people.

This goal specifically calls upon governments, funding agencies, science-promoting foundations, supranational organisations and other institutions to collaborate and actively engage in ensuring reliable long-term funding, with a focus on global, imminent problems rather than national agendas.

» Everyone is invited to join the discussion and contribute ideas and suggestions for the declaration's guidelines at [www.lindadeclaration.org](http://www.lindadeclaration.org) by the end of 2019.



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## Facing the Challenges of Our Time

In her speech held during the opening ceremony of the 69<sup>th</sup> Lindau Nobel Laureate Meeting, German Federal Minister of Education and Research Anja Karliczek stressed the relevance of the Lindau Meetings as a platform for international scientific exchange and issued a call for more academic freedom.

I was thrilled when I saw the numbers for the 2019 Lindau Nobel Laureate Meeting: Well over 500 young scientists have come to Lindau this year from 89 countries! So basically, almost the entire global community is represented here at Lake Constance. That's fantastic!

It also shows that the annual Lindau Meeting is a very special format. It is an international forum of encounter, a forum that is unique in the world. Here at Lindau, we are not only building bridges between nations, but also forming networks across generations. Where else could young scientists and students enjoy such close exchanges with Nobel Laureates? Where else is it so easy to make such contacts? [...]

It is the opportunity to make people-to-people contacts and discuss challenging topics for the world today face-to-face that makes the Lindau Nobel Laureate Meetings such a unique and successful event.

As the Federal Government, we attach great importance to sending out a strong signal from time to time. This is why we keep supporting these meetings year upon year – and are happy to do so. The Lindau Meetings are a beacon of excellence and showcase the German science and research landscape. Our support emphasises just how much importance we attach to research and internationalisation – and how much we rely on cooperating with scientists and researchers to make the best of the great changes happening on our planet.

These changes are big and consequential. So it requires joint global efforts to address them. I am deeply convinced that we can find effective global solutions if we bring together the perspectives and research results of scientists from various countries. [...]

Globalisation and digital technology are revolutionising the way we live and work. They are also mutually reinforcing. We are all faced with the challenge of this development – every country, every system, every individual. As the current driver

of innovation, artificial intelligence plays a central role in this context. Quantum technologies will be the next step. Many of you are physicists and know what this means.

But there is one topic that is now more important to us than any other and that is climate change. The 2015 Paris Agreement was a real breakthrough. It was an agreement based on research results. It is no coincidence that it was so highly acclaimed, because it is in fact true that the next ten years will be decisive. The melting of the Arctic ice shield is evidence of dramatic developments that are threatening our livelihoods in the long term. This is why we must make sure that we mitigate climate change. [...]

The 2019 Lindau Nobel Laureate Meeting is dedicated to physics. Basic physical research helps us to gain a better understanding of our world and the universe. There are several prize-winning researchers gathered here in Lindau whose discoveries in cosmology, laser physics and research on gravitational waves have provided humankind with game-changing new insights. We very much hope that they will continue to make further discoveries in the future.

At the same time, basic physical research is also one of the key motors of innovation today. Let's take laser physics as an example: laser tweezers revolutionised medical care. They made it possible to use microscopic fingers to trap and examine objects such as bacteria or viruses. Already now, laser tweezers help us to broaden our knowledge base in the fight against cancer – and thus to save lives.

Laser tweezers and other innovations directly benefit the people. They show that science and research improve the lives of all of us. It is especially in today's times where nationalism and populism are on the rise around the world, that we need strong and independent science. This means in particular exchange across borders and cultures. Science and research thrive on cooperation, curiosity and open-mindedness – always with the aim of generating new findings to achieve progress.

*“The freedom of science and research is a precondition for producing research results that benefit all of humankind as well as the entire planet.”*

Anja Karliczek

In this context, it is essential that we create an environment characterised by academic freedom. The freedom of science and research is a precondition for producing research results that benefit all of humankind as well as the entire planet. It is this freedom alone that enables researchers and academics to let themselves be guided not by their own interests, but by the challenges that concern all of us. [...]

The Lindau Meetings are an expression of a spirit that we need now more than ever: the meeting brings together researchers, who are aware of their social responsibility and get actively engaged in debates and discussions. To give you just one example: in the 2015 Mainau Declaration, you called upon us policy-makers to strengthen our commitment to climate change mitigation. I quote: “If left unchecked, our ever-increasing demand for food, water, and energy will eventually overwhelm the Earth's ability to satisfy humanity's needs, and will lead to wholesale human tragedy.”

This quote embodies the Lindau Spirit. And it is precisely this spirit that we admire about the Lindau Nobel Laureate Meetings. They provide an important impetus for the whole of society. On this note, I wish all of you a good start to the 2019 meeting, inspiring discussions and a successful conference!



A video of the speech is available in the mediatheque.





# 69

## A Showcase of Physics

The scientific chairpersons of the 69<sup>th</sup> Lindau Nobel Laureate Meeting, Rainer Blatt and Lars Bergström, reflect on the diverse programme of this year's meeting and share some of their personal highlights.



Rainer Blatt

The 69<sup>th</sup> Lindau Nobel Laureate Meeting 2019, devoted to physics, was graced with the presence of 39 Nobel Laureates in physics and other disciplines, who, together with 580 enthusiastic young scientists from a record 89 countries contributed to a vibrant atmosphere. A defining characteristic of the meeting was the frequent highlighting of the importance of physics to society and its interface with other disciplines.

The tone of #LINO19 was set in a keynote address by Brian Schmidt, who was awarded the physics prize in 2011 for his fundamental research into supernova cosmology and the accelerating universe. Schmidt pointed out many acute problems that face humanity, not least the changing climate, but painted an optimistic picture about the role of science in finding tools to combat these problems – once politicians make up their minds to use them! He also reminded his listeners about the

important role of basic science and that occasionally there is a long time between basic discoveries and applications. He described his smartphone as a very good example of something that incorporates many discoveries in basic physics that have now, after in some cases decades, reached a level of sophistication where they can be combined together in an important application for society. In this vein, the final panel discussion on Mainau Island was devoted to the question 'How can Science Change the World for the Better?'; Brian Schmidt was joined by, among others, 1997 physics laureate Steven Chu. Again, the tone was hopeful about the role of science in solving the many issues currently facing society. However, profound problems like overpopulation and unequal distribution of wealth necessitate sustainable solutions that will require politics and science to collaborate.

The interactions between laureates and young scientists in this year's Lindau Meeting took a variety of different forms, from traditional lectures to more open-format Agora Talks, Science Walks, Laureate Lunches, Master Classes, and of course the important face-to-face Open Exchange meetings between young scientists and Nobel Laureates in the afternoons. Together with other interactive sessions, these formats promote one of the most important aims of the meeting, namely, to foster inspiring connections between people.

For the lectures, priority was given to recently honoured Nobel Laureates and first-time visitors of the Lindau Meetings. The first lecture was given by 2018 laureate Donna Strickland, who gave an inspirational account of how she made her discovery on fast-pulsed and powerful lasers already as a graduate student – something that certainly caught the attention of the young scientists. Her collaborator and Nobel Laureate Gérard Mourou followed her and gave a more general review about the possibilities of modern laser technology.

In May 2019, the new international system of units was officially introduced, the biggest innovation to our metric system since the French Revolution. In an Agora Talk, Bill Phillips gave an

overview of the new definitions for the kilogramme, ampere, kelvin and mole in lively interaction with the young scientists. Klaus von Klitzing sketched the development of the new kilogramme based on the Josephson and von Klitzing constants.

The physics of our cosmos, with the fascinating enigmas of dark energy and dark matter, was the subject of an afternoon panel discussion with laureates David Gross, Adam Riess, Brian Schmidt and George Smoot and young scientist Kirsten Hall.

The audience was also given an insight into one of the most interesting current controversies in the standard model of cosmology: Adam Riess gave a very convincing talk about how he and his group has measured a value for today's expansion rate, the so-called Hubble constant, which is considerably higher than what is measured using the microwave background radiation. It is fascinating to speculate that this may tell us something new about the workings of the universe.

For the first time, the Nobel Laureates in Physics 2017, Michael Kosterlitz and F. Duncan M. Haldane, attended a Lindau Meeting and presented their award-winning research in a compelling and clear way to the appreciative audience of young scientists. Also for the first time in Lindau, laureates Konstantin Novoselov (Nobel Prize 2010) and Wolfgang Ketterle (2001) presented the work for which they were awarded the prize and talked about some of their current research. The final talk of the meeting was given by Claude Cohen-Tannoudji (1997), who talked about his life-long research at the École Normale Supérieure, which laid many of the foundations in quantum mechanics and quantum optics.

With its varied programme, ranging from the work of the most recent laureates over new developments and current topics in physics to reviews covering the history and the development of physics, the meeting was a fascinating showcase for the young scientists and will surely remain long in the memory of all participants.



Lars Bergström

» Scientific Chairpersons #LINO19  
Lars Bergström  
Member of the Royal Swedish Academy of Sciences  
Member of the Board of the Nobel Foundation (2011–2017)  
Secretary of the Nobel Committee for Physics (2004–2015)  
Professor of Theoretical Physics, Stockholm University, Sweden

Rainer Blatt  
Member of the Austrian Academy of Sciences  
Professor of Experimental Physics, University of Innsbruck, Austria  
Scientific Director, Institute for Quantum Optics and Quantum Information, Austrian Academy of Sciences





*“The Lindau Nobel Laureate Pier is a tribute to the unique bond between Nobel Laureates from around the world and the city of Lindau. We hope that it will motivate young people to discover the beauty of science.”*

Fredy Raas, Chairman of the Board, Beisheim Stiftung



# The Lindau Nobel Laureate Pier

The inauguration of the new Lindau Nobel Laureate Pier was one of the highlights of the 69<sup>th</sup> Lindau Meeting. In the presence of laureates, young scientists and guests, the pier was handed over to the City of Lindau and officially opened to the public.



The Lindau Nobel Laureate Pier honours the more than 400 Nobel Laureates who have participated in the Lindau Meetings since 1951. Its guardrails bear the names and disciplines of the laureates as well as the year of the award and the year of their first meeting participation. In total, the pier has more than 1,000 individual metal bars – sufficient for the names of future Nobel Laureates who will participate in the Lindau Meetings to come.

During the official inauguration of the pier, the final metal bar with the name of Donna Strickland, 2018 Nobel Laureate in Physics, was inserted into the guardrail. Thus, the pier was symbolically completed and handed over to the public. “In the future,” said Countess Bettina Bernadotte during the ceremony, “people will remember the laureates’ names and their outstanding achievements for science and humankind while strolling along the Nobel Pier.”

The Lindau Nobel Laureate Pier could be realised thanks to the support of the Beisheim Stiftung and the City of Lindau. The pier now constitutes the central station of the Lindau Science Trail. A knowledge pylon at the entrance to the pier portrays the history of the Nobel Prize.

The official inauguration of the Lindau Nobel Laureate Pier: Hugo Trütsch, Member of the Board, Beisheim Stiftung, Jürgen Kluge, Annette Heuser, Managing Director, Beisheim Stiftung, Nobel Laureates Donna Strickland and Gérard Mourou, Countess Bettina Bernadotte, Bernd Sibler, Bavarian State Minister of Science and the Arts, Fredy Raas, Chairman of the Board, Beisheim Stiftung, Niklas Manhart, Beisheim Stiftung

Donna Strickland with the metal bar bearing her name





# Opening Day

## » Opening Ceremony

### Welcome & Interview

Countess Bettina Bernadotte, President, Council for the Lindau Nobel Laureate Meetings

### Greetings from Stockholm

Lars Bergström, Member of the Board of the Nobel Foundation (2011–17), Secretary of the Nobel Committee for Physics (2004–15), Sweden

### Address

Anja Karliczek, Federal Minister of Education and Research, Germany

### Opening Speech

**BIG QUESTIONS FOR SOCIETY, BIG QUESTIONS FOR RESEARCH**  
Brian P. Schmidt, Nobel Laureate in Physics 2011, Vice-Chancellor, The Australian National University, Australia

### Interview

– Lars Bergström, Scientific Chairperson, 69<sup>th</sup> Lindau Nobel Laureate Meeting  
– Rainer Blatt, Scientific Chairperson, 69<sup>th</sup> Lindau Nobel Laureate Meeting

### Master of Ceremonies

Adriana Marais, Director, Foundation for Space Development, Lindau Alumna 2016, South Africa

## » Reception and Concert

hosted by the Federal Ministry of Education, Science and Research, Austria

### Welcome Address

Barbara Weitgruber, Director General for Scientific Research and International Relations, Federal Ministry of Education, Science and Research, Austria

### Ensemble of the Vienna Philharmonic Orchestra

## » Foundation Dinner

hosted by the Foundation Lindau Nobel Laureate Meetings

### Welcome Address

Jürgen Kluge, Chairman of the Board of Directors, Foundation Lindau Nobel Laureate Meetings



Countess Bettina Bernadotte



Presentation of the opening film



Barbara Weitgruber



Jürgen Kluge addressing the guests at the Foundation Dinner



Scientific Chairpersons Lars Bergström and Rainer Blatt with Adriana Marais



The Nobel Laureates waving to the audience



Ensemble of the Vienna Philharmonic Orchestra



Group photo of the attending Nobel Laureates



# 69 Nobel Laureates



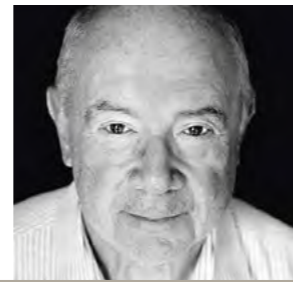
**J. Georg Bednorz**  
**Nationality:** Germany  
**Nobel Prize:** Physics  
**Year:** 1987  
**Prize Motivation:** “for their important break-through in the discovery of superconductivity in ceramic materials”



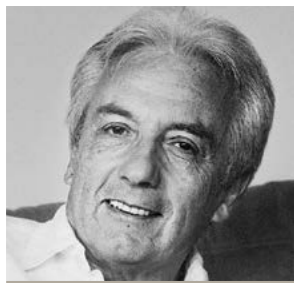
**Steven Chu**  
**Nationality:** USA  
**Nobel Prize:** Physics  
**Year:** 1997  
**Prize Motivation:** “for development of methods to cool and trap atoms with laser light”



**Claude Cohen-Tannoudji**  
**Nationality:** France  
**Nobel Prize:** Physics  
**Year:** 1997  
**Prize Motivation:** “for development of methods to cool and trap atoms with laser light”



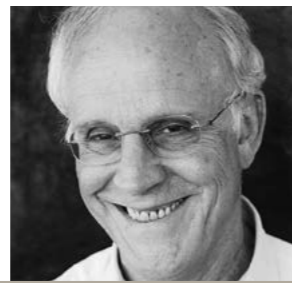
**Johann Deisenhofer**  
**Nationality:** Germany  
**Nobel Prize:** Chemistry  
**Year:** 1988  
**Prize Motivation:** “for the determination of the three-dimensional structure of a photosynthetic reaction centre”



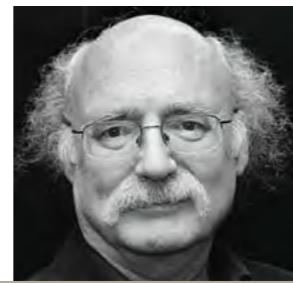
**Albert Fert**  
**Nationality:** France  
**Nobel Prize:** Physics  
**Year:** 2007  
**Prize Motivation:** “for the discovery of Giant Magnetoresistance”



**Joachim Frank**  
**Nationality:** Germany/USA  
**Nobel Prize:** Chemistry  
**Year:** 2017  
**Prize Motivation:** “for developing cryo-electron microscopy for the high-resolution structure determination of biomolecules in solution”



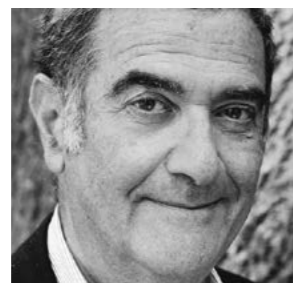
**David J. Gross**  
**Nationality:** United States  
**Nobel Prize:** Physics  
**Year:** 2004  
**Prize Motivation:** “for the discovery of asymptotic freedom in the theory of the strong interaction”



**F. Duncan M. Haldane**  
**Nationality:** United Kingdom  
**Nobel Prize:** Physics  
**Year:** 2016  
**Prize Motivation:** “for theoretical discoveries of topological phase transitions and topological phases of matter”



**Theodor W. Hänsch**  
**Nationality:** Germany  
**Nobel Prize:** Physics  
**Year:** 2005  
**Prize Motivation:** “for their contributions to the development of laser-based precision spectroscopy, including their optical frequency comb technique”



**Serge Haroche**  
**Nationality:** France  
**Nobel Prize:** Physics  
**Year:** 2012  
**Prize Motivation:** “for ground-breaking experimental methods that enable measuring and manipulation of individual quantum systems”



**Harald zur Hausen**  
**Nationality:** Germany  
**Nobel Prize:** Physiology or Medicine  
**Year:** 2008  
**Prize Motivation:** “for his discovery of human papilloma viruses causing cervical cancer”



**Stefan W. Hell**  
**Nationality:** Germany  
**Nobel Prize:** Chemistry  
**Year:** 2014  
**Prize Motivation:** “for the development of super-resolved fluorescence microscopy”

## Laureates at #LINO19

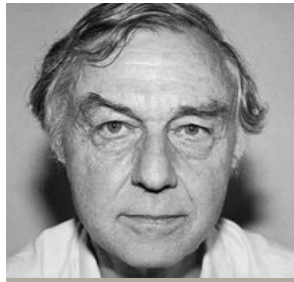


## RECORDS

- Most Participations**
1. Robert Huber (23)
  2. Hartmut Michel (22)
  3. Klaus von Klitzing (16)

- First Participations**
- F. Duncan M. Haldane
  - Tawakkol Karman
  - Wolfgang Ketterle
  - J. Michael Kosterlitz
  - G rard A. Mourou
  - Sir Konstantin S. Novoselov
  - Adam G. Riess
  - Donna Strickland
  - Joseph H. Taylor
  - Rainer Weiss

**Earliest Award**  
 Brian D. Josephson (1973)



**Robert Huber**  
**Nationality:** Germany  
**Nobel Prize:** Chemistry  
**Year:** 1988  
**Prize Motivation:** “for the determination of the three-dimensional structure of a photosynthetic reaction centre”



**Brian D. Josephson**  
**Nationality:** United Kingdom  
**Nobel Prize:** Physics  
**Year:** 1973  
**Prize Motivation:** “for theoretical predictions of the properties of a supercurrent through a tunnel barrier, in particular those phenomena which are generally known as the Josephson effects”



**Takaaki Kajita**  
**Nationality:** Japan  
**Nobel Prize:** Physics  
**Year:** 2015  
**Prize Motivation:** “for the discovery of neutrino oscillations, which shows that neutrinos have mass”



**Tawakkol Karman**  
**Nationality:** Yemen  
**Nobel Prize:** Peace  
**Year:** 2011  
**Prize Motivation:** “for their non-violent struggle for the safety of women and for women’s rights to full participation in peace-building work”



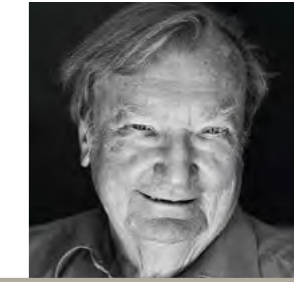
**Sir Konstantin S. Novoselov**  
**Nationality:** Russia/United Kingdom  
**Nobel Prize:** Physics  
**Year:** 2010  
**Prize Motivation:** “for groundbreaking experiments regarding the two-dimensional material graphene”



**William D. Phillips**  
**Nationality:** USA  
**Nobel Prize:** Physics  
**Year:** 1997  
**Prize Motivation:** “for development of methods to cool and trap atoms with laser light”



**Adam G. Riess**  
**Nationality:** USA  
**Nobel Prize:** Physics  
**Year:** 2011  
**Prize Motivation:** “for the discovery of the accelerating expansion of the Universe through observations of distant supernovae”



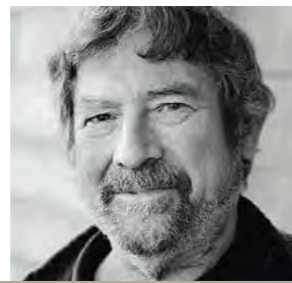
**Carlo Rubbia**  
**Nationality:** Italy  
**Nobel Prize:** Physics  
**Year:** 1984  
**Prize Motivation:** “for decisive contributions to the large project, which led to the discovery of the field particles W and Z, communicators of weak interaction”



**Wolfgang Ketterle**  
**Nationality:** Germany  
**Nobel Prize:** Physics  
**Year:** 2001  
**Prize Motivation:** “for the achievement of Bose-Einstein condensation in dilute gases of alkali atoms, and for early fundamental studies of the properties of the condensates”



**Klaus von Klitzing**  
**Nationality:** Germany  
**Nobel Prize:** Physics  
**Year:** 1985  
**Prize Motivation:** “for the discovery of the quantised Hall effect”



**J. Michael Kosterlitz**  
**Nationality:** United Kingdom/USA  
**Nobel Prize:** Physics  
**Year:** 2016  
**Prize Motivation:** “for theoretical discoveries of topological phase transitions and topological phases of matter”



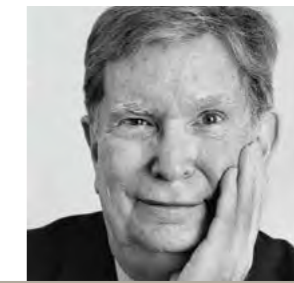
**John C. Mather**  
**Nationality:** USA  
**Nobel Prize:** Physics  
**Year:** 2006  
**Prize Motivation:** “for their discovery of the blackbody form and anisotropy of the cosmic microwave background radiation”



**Brian P. Schmidt**  
**Nationality:** Australia/USA  
**Nobel Prize:** Physics  
**Year:** 2011  
**Prize Motivation:** “for the discovery of the accelerating expansion of the Universe through observations of distant supernovae”



**Dan Shechtman**  
**Nationality:** Israel  
**Nobel Prize:** Chemistry  
**Year:** 2011  
**Prize Motivation:** “for the discovery of quasicrystals”



**George F. Smoot**  
**Nationality:** USA  
**Nobel Prize:** Physics  
**Year:** 2006  
**Prize Motivation:** “for the discovery of the blackbody form and anisotropy of the cosmic microwave background radiation”



**Donna Strickland**  
**Nationality:** Canada  
**Nobel Prize:** Physics  
**Year:** 2018  
**Prize Motivation:** “for their method of generating high-intensity, ultra-short optical pulses”



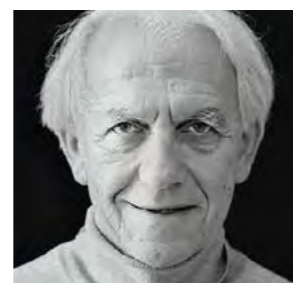
**Arthur B. McDonald**  
**Nationality:** Canada  
**Nobel Prize:** Physics  
**Year:** 2015  
**Prize Motivation:** “for the discovery of neutrino oscillations, which shows that neutrinos have mass”



**Hartmut Michel**  
**Nationality:** Germany  
**Nobel Prize:** Chemistry  
**Year:** 1988  
**Prize Motivation:** “for the determination of the three-dimensional structure of a photosynthetic reaction centre”



**William E. Moerner**  
**Nationality:** USA  
**Nobel Prize:** Chemistry  
**Year:** 2014  
**Prize Motivation:** “for the development of super-resolved fluorescence microscopy”



**Gérard A. Mourou**  
**Nationality:** France  
**Nobel Prize:** Physics  
**Year:** 2018  
**Prize Motivation:** “for their method of generating high-intensity, ultra-short optical pulses”



**Joseph H. Taylor**  
**Nationality:** USA  
**Nobel Prize:** Physics  
**Year:** 1993  
**Prize Motivation:** “for the discovery of a new type of pulsar, a discovery that has opened up new possibilities for the study of gravitation”



**Martinus J.G. Veltman**  
**Nationality:** Netherlands  
**Nobel Prize:** Physics  
**Year:** 1999  
**Prize Motivation:** “for elucidating the quantum structure of electroweak interactions in physics”

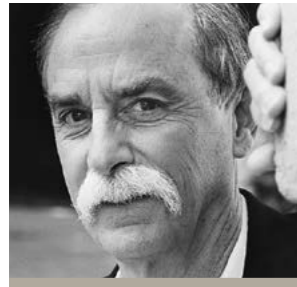


**Rainer Weiss**  
**Nationality:** USA  
**Nobel Prize:** Physics  
**Year:** 2017  
**Prize Motivation:** “for decisive contributions to the LIGO detector and the observation of gravitational waves”



**Carl E. Wieman**  
**Nationality:** United States  
**Nobel Prize:** Physics  
**Year:** 2001  
**Prize Motivation:** “for the achievement of Bose-Einstein condensation in dilute gases of alkali atoms, and for early fundamental studies of the properties of the condensates”





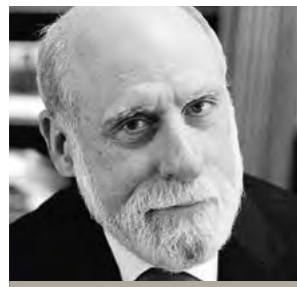
**David J. Wineland**  
**Nationality:** United States  
**Nobel Prize:** Physics  
**Year:** 2012  
**Prize Motivation:** "for ground-breaking experimental methods that enable measuring and manipulation of individual quantum systems"



**Kurt Wüthrich**  
**Nationality:** Switzerland  
**Nobel Prize:** Chemistry  
**Year:** 2002  
**Prize Motivation:** "for his development of nuclear magnetic resonance spectroscopy for determining the three-dimensional structure of biological macromolecules in solution"



**Ada E. Yonath**  
**Nationality:** Israel  
**Nobel Prize:** Chemistry  
**Year:** 2009  
**Prize Motivation:** "for studies of the structure and function of the ribosome"



**Vinton G. Cerf**  
**Nationality:** USA  
**Award:** ACM A.M. Turing Award  
**Year:** 2004  
**Prize Motivation:** "for pioneering work on internetworking, including the design and implementation of the Internet's basic communications protocols, TCP/IP, and for inspired leadership in networking"



**Martin E. Hellman**  
**Nationality:** USA  
**Award:** ACM A.M. Turing Award  
**Year:** 2015  
**Prize Motivation:** "for inventing and promulgating both asymmetric public-key cryptography, including its application to digital signatures, and a practical cryptographic key-exchange method"

» All portraits taken from the photo series 'Nobel Laureates photographed by Peter Badge'. For more information see p. 99.

» The mediatheque contains profiles of almost 500 Nobel Laureates.

## Young Scientists at #LINO19

# 580

from  

# 89

 countries

MOST REPRESENTED NATIONS



## GENDER BALANCE

♂ 65%    ♀ 35%

# AGE

Oldest 35 years    Youngest 19 years    Average 28 years

## ACADEMIC DEGREES



**12%**  
Undergraduate



**38%**  
Master/Diploma



**50%**  
PhD



# Academic Partners

To ensure the scientific excellence of participants, the Lindau Nobel Laureate Meetings maintain a strong global network of more than 200 academic partner institutions. World-renowned science and research bodies both from the public and private sectors are entitled to nominate young scientists for participation in the Lindau Meetings.

Nominating partners include academies of sciences, leading universities, research institutions, foundations and innovative enterprises throughout the world.

For the 69<sup>th</sup> Lindau Nobel Laureate Meeting, 180 academic partners received the call for nomination of young scientists, and 161 of them participated in nominations.

Generally, young scientists are nominated by official academic partner institutions and apply through them. In exceptional cases, applications can be submitted directly to the Council via Open Application, for example, when an applicant studies or works in a country where the Lindau Meetings do not yet have an academic partner.

The partner network is continuously being expanded by means of memoranda of understanding (MoU). In these, both the Lindau Meetings and their partners commit themselves to the interconnection and promotion of aspiring young scientists and thus to spreading Lindau's 'Mission Education' worldwide.

New memorandum of understanding with Honoris United Universities: Jürgen Kluge, Countess Bettina Bernadotte, Laura Kakon, Chief Marketing Officer (Honoris), Hassan Filali, CEO in Morocco (Honoris), Luis Lopez, CEO (Honoris)



## Partnerships 2019

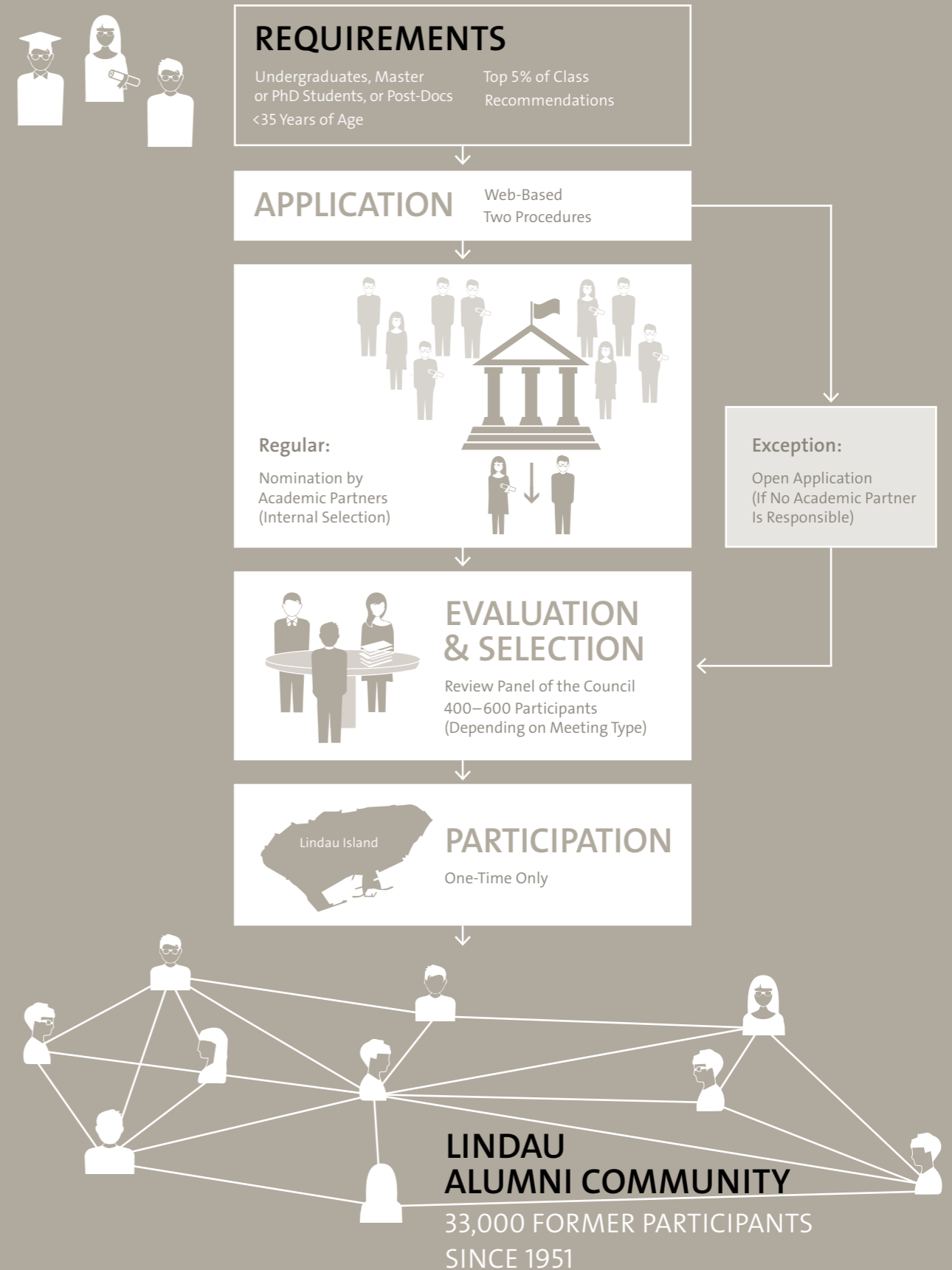
In 2019, official partnerships with the following international institutions have been established or renewed:

- Australian Academy of Science
- Austrian Federal Ministry of Education, Science and Research
- University of Nicosia, Cyprus
- University of Iceland and The Icelandic Centre for Research
- Ministry of Research, Technology and Higher Education of the Republic of Indonesia
- Irish Research Council
- American University of Beirut, Lebanon
- Lithuanian Academy of Sciences and Arts
- Ministry of Education of the Republic of the Union of Myanmar
- Calouste Gulbenkian Foundation
- National Research Foundation, Singapore
- Slovenian Academy of Sciences and Arts
- Ragnar Söderberg Foundation
- Honoris United Universities
- University of California, USA
- European Organization for Nuclear Research

MoU with the Ministry of Research, Technology and Higher Education of the Republic of Indonesia (MoRTHE): Nikolaus Turner, Arif Havas Oegroseno, Ambassador of Indonesia to Germany, Ainun Na'im, Secretary General MoRTHE



# Application Process





# Nominating Institutions

» With Accepted Candidates at #LINO19

Academia Sinica  
 Académie Nationale des Sciences et Techniques du Sénégal  
 Academy of Science of South Africa (ASSAf)  
 Academy of Sciences Malaysia  
 acatech – National Academy of Science and Engineering, Germany  
 African Academy of Sciences  
 Alexander S. Onassis Public Benefit Foundation  
 Alexander von Humboldt Foundation  
 American University of Beirut, Lebanon  
 Australian Academy of Science  
 Austrian Academy of Sciences  
 Bangladesh Academy of Sciences  
 Bavarian Academy of Sciences and Humanities, Germany  
 Brazilian Academy of Sciences  
 Bulgarian Academy of Sciences  
 Canadian Institutes of Health Research (CIHR)  
 Carl von Ossietzky University of Oldenburg, Germany  
 CERN European Organization for Nuclear Research  
 Chemnitz University of Technology, Germany  
 Columbus Association  
 Croucher Foundation  
 Czech Academy of Sciences  
 Danish Council for Independent Research  
 Department of Science & Technology, Government of India  
 Elite Network of Bavaria  
 Else Kröner-Fresenius-Stiftung  
 Estonian Academy of Sciences  
 European Commission  
 European Molecular Biology Organization (EMBO)  
 Foundation for Polish Science  
 Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e.V.  
 French National Centre for Scientific Research  
 Fund for Scientific Research, Belgium  
 Georg-August-Universität Göttingen, Germany  
 German Academic Exchange Service (DAAD)  
 German Academic Scholarship Foundation  
 German Aerospace Center

German National Academy of Sciences Leopoldina  
 Global Young Academy  
 Goethe University Frankfurt, Germany  
 Göttingen Graduate School for Neurosciences, Biophysics, and Molecular Biosciences, Germany  
 Graphene Flagship  
 Heidelberg University, Germany  
 Helmholtz Association of German Research Centres  
 Human Frontier Science Program  
 Humboldt-Universität zu Berlin, Germany  
 Hungarian Academy of Sciences  
 ICREA – Catalan Institution for Research and Advanced Studies, Spain  
 Internationale Bodensee-Hochschule  
 Irish Research Council  
 Jacobs University Bremen gGmbH, Germany  
 Japan Society for the Promotion of Science  
 Johannes Gutenberg University Mainz, Germany  
 Julius-Maximilians-Universität Würzburg, Germany  
 Karlsruhe Institute of Technology, Germany  
 King Abdullah University of Science and Technology, Saudi Arabia  
 Körber Foundation  
 Leibniz Association  
 Leipzig University, Germany

Renewal of the memorandum of understanding with Australia:  
 Jürgen Kluge, Countess Bettina Bernadotte, Chennupati Jagadish,  
 Distinguished Professor, The Australian National University



Ludwig-Maximilians-Universität München, Germany  
 Luxembourg National Research Fund  
 Max Planck Institute for Biophysical Chemistry, Germany  
 Max Planck Society  
 Mexican Academy of Sciences  
 Ministry of Education and Human Resources, Tertiary Education and Scientific Research, Mauritius  
 Ministry of Education of the Republic of the Union of Myanmar  
 Mongolian Academy of Sciences  
 National Academy of Sciences of the Republic of Armenia  
 National Academy of Sciences of Uruguay  
 National Research Foundation, Singapore  
 National Science and Technology Development Agency, Thailand  
 Oak Ridge Associated Universities (ORAU), USA  
 OIC Standing Committee on Scientific and Technological Cooperation (COMSTECH)  
 Otto von Guericke University Magdeburg, Germany  
 Paderborn University, Germany  
 Pakistan Institute of Engineering and Applied Sciences  
 Ragnar Söderberg Foundation  
 Research Foundation – Flanders (FWO)  
 Royal Netherlands Academy of Arts and Sciences  
 Sharif University of Technology, Iran  
 Sino-German Center for Research Promotion, China  
 St Petersburg University, Russia  
 Swiss Academy of Sciences (SCNAT)  
 Technical University of Munich, Germany  
 Technische Universität Berlin, Germany  
 Technische Universität Braunschweig, Germany  
 The Council of Finnish Academies  
 The Korean Academy of Science and Technology  
 The Lithuanian Academy of Sciences  
 The Norwegian Academy of Science and Letters  
 The Research Council, Oman  
 The Royal Society  
 The Russian Rectors' Union  
 The Slovenian Academy of Sciences and Arts  
 TU Dortmund University, Germany

TÜBİTAK, Turkey  
 TWAS – The World Academy of Sciences  
 Universidad de los Andes, Colombia  
 Universität Hamburg, Germany  
 Universität Regensburg, Germany  
 Universität zu Lübeck, Germany  
 University of Augsburg, Germany  
 University of Bayreuth, Germany  
 University of Bonn, Germany  
 University of Duisburg-Essen, Germany  
 University of Kassel, Germany  
 University of Konstanz – Zukunftskolleg, Germany  
 University of Liechtenstein  
 University of Malta  
 University of Münster, Germany  
 University of Rostock, Germany  
 University of Siegen, Germany  
 University of Tübingen, Germany  
 Volkswagen Foundation  
 Weizmann Institute of Science, Israel

» The nomination process in Germany was conducted in cooperation with the Mathematisch-Naturwissenschaftlicher Fakultätentag (MNFT) and the German Physical Society (DPG).

Sivaji Chadaram, Department of Science & Technology, Government of India, and Noriyoshi Masuko, Senior Managing Director, Japan Society for the Promotion of Science







# Controlling Frequency Correlations and Biphoton Statistics in a Semiconductor Photonic Chip

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## Integrated AlGaAs source of photon pairs

Type II Spontaneous Parametric Down Conversion

Counter-propagating phase-matching

$$k_p \sin \theta = k_s - k_i$$
$$\text{I) } \omega_p \sin \theta = n_{TE} \omega_s - n_{TM} \omega_i$$
$$\text{II) } \omega_p \sin \theta = n_{TM} \omega_s - n_{TE} \omega_i$$

Why AlGaAs?

- room temperature
- telecom wavelength
- direct band-gap (electrical injection)

## Quantum frequency correlations control

Biphoton wavefunction

JSI measurement via Stimulated Emission Tomography

Beam waist

Correlated JSI

Uncorrelated JSI

Anti-correlated JSI

## Biphoton exchange statistics control

Joint Spectral Amplitude

Chronocyclic Wigner function  $W$

Hong-Ou-Mandel

Schrödinger's

### Fostering Intergenerational Dialogue

Saverio Francesconi from the Université Paris Diderot, France, presenting his poster to Astrid Weidt, Leibniz Institute of Surface Engineering, Germany, and a future young scientist

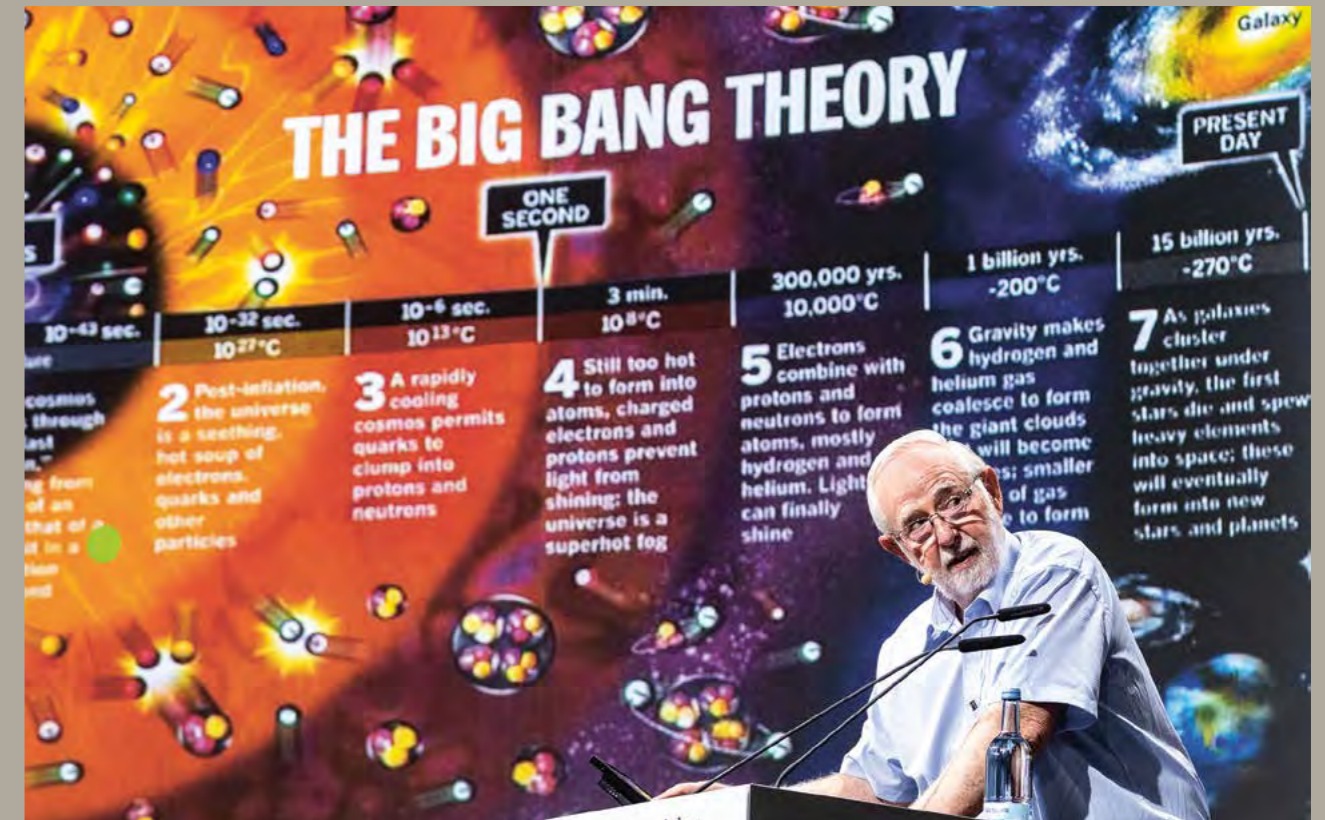


# Scientific Programme

» Lectures (in Alphabetical Order)

Joachim Frank	Visualising Short-Lived States of Biological Molecules by Cryo-Electron Microscopy
David J. Gross	The Future of Fundamental Physics
F. Duncan M. Haldane	Entanglement and Topological Quantum Matter
Theodor W. Hänsch	Laser Spectroscopy of Hydrogen and the Proton Radius Puzzle
Takaaki Kajita	Oscillation of Atmospheric Neutrinos
Wolfgang Ketterle	New Forms of Matter Near Absolute Zero Temperature
Klaus von Klitzing	Quantum Hall Effect and the New SI System
J. Michael Kosterlitz	Creating New Scientific Knowledge
Arthur B. McDonald	Direct Detection of Dark Matter With Liquid Argon
Gérard Mourou	Passion for Extreme Light
Sir Konstantin S. Novoselov	Materials of the Future
Adam G. Riess	The Expansion of the Universe, Faster Than We Thought
Carlo Rubbia	Further Searches of the Higgs Scalar Sector
Dan Shechtman	Scientific Blunder
Donna Strickland	From Nonlinear Optics to High-Intensity Laser Physics
Joseph H. Taylor	The Long Tortuous Path to Gravitational Waves
Rainer Weiss	Gravitational Wave Astronomy
Kurt Wüthrich	NMR – From Physics to Biology and Medical Diagnosis
Ada E. Yonath	The Ribosome – a Connection Between the Prebiotic Origin of Life and Next Generation Antibiotics

» Along with approximately 900 videos, lectures from #LINO19 can be watched in the mediatheque.



Arthur B. McDonald

Takaaki Kajita



Theodor W. Hänsch





## » Heidelberg Lecture

The Heidelberg Laureate Forum (HLF) was founded in 2013 by Klaus Tschira after the model of the Lindau Nobel Laureate Meetings. Tschira, who died in 2015, was one of the most committed supporters of the Lindau Meetings and member of the Honorary Senate of the Foundation. His experience of the Lindau Meetings spawned the idea of creating something similar for mathematics and computer science; thus, the HLF dedicates its meetings to prize-winning and aspiring young scientists from these disciplines. To emphasise these close links and the outstanding partnership, Lindau hosts Heidelberg Lectures every year, and Lindau Lectures are part of the programme of every HLF.

Already for the fourth time at #LINO19, a laureate from computer science or mathematics was invited to give a lecture on a topic of their current or past research. In this year's Heidelberg Lecture, Martin E. Hellman, known for his contribution to public key cryptography, shared eight lessons he learned in his (scientific) life.

**THE TECHNOLOGICAL IMPERATIVE FOR ETHICAL EVOLUTION**  
Martin E. Hellman, ACM A.M. Turing Award 2015,  
Stanford University, USA

Martin E. Hellman



## » Life Lecture

At past Lindau Meetings, several Nobel Laureates have given inspiring lectures with considerable insights into their own scientific paths, including helpful and practical hints for academic careers. Particular highlights – to be watched in the mediatheque – are among others the lectures by Christian de Duve, Oliver Smithies and Sir Harold Kroto.

To officially implement this session type, the 'Life Lecture' became part of the meeting programme in 2018. The format allows a laureate to reflect on his or her life inside and outside of academia and provides rare and personal insights. The Life Lecture is designed to motivate and inspire the young audience and numbers among the emotional highlights of the Lindau Meetings' lecture programme.

In this year's Life Lecture, Nobel Laureate Claude Cohen-Tannoudji provided 'A Brief Description of My Personal and Scientific Itinerary'. The audience was introduced to several companions of Claude Cohen-Tannoudji (family, professors, students) who shaped him as a person and as a scientist. He also emphasised that (school) education is a pillar of society and that his main aim in life is to share the values taught by his companions with the next generation.

**A BRIEF DESCRIPTION OF MY PERSONAL AND SCIENTIFIC ITINERARY**  
Claude Cohen-Tannoudji, Laboratoire Kastler Brossel, France

Claude Cohen-Tannoudji



# Programme Structure #LINO19

	Sunday, 30 June	Monday, 1 July	Tuesday, 2 July	Wednesday, 3 July	Thursday, 4 July	Friday, 5 July
07		Partner Breakfast hosted by South Africa	Morning Workout	Partner Breakfast hosted by Mars, Inc. / Rolex SA	Morning Workout	Science Breakfast hosted by Council for the Lindau Nobel Laureate Meetings
08					Partner Breakfast hosted by Austria	Morning Workout
09		Lecture Strickland	Lecture Kajita	Lecture Kosterlitz	Lecture Ketterle	Social Event Baden-Württemberg Boat Trip to Mainau Island hosted by the State of Baden-Württemberg
10	Registration 10 - 20 hrs	Lecture Mourou	Lecture McDonald	Lecture Haldane	Lecture Hänsch	
11		Break	Break	Break	Break	
12		Agora Talks Moerner Phillips	Agora Talks Bednorz Haroche & Wineland	Agora Talks Josephson Veltman	Agora Talk Deisenhofer Huber	Interview Tawakkol Karman Panel Discussion How Can Science Change the World for the Better?
13		Break	Break	Break	Break	
14		Agora Talks Hell Wieman	Agora Talks Chu Mather & Smoot	Lecture Rubbia	Agora Talks zur Hausen Michel	
15		Break	Break	Lecture Gross	Lecture Shechtman	Social Event Science Picnic on the Aboretum Lawn hosted by Ministry of Science, Education and the Arts, State of Baden-Württemberg
16		Lecture Novoselov	Lecture Taylor	Lecture Wüthrich	Lecture von Klitzing	
17		Lecture Yonath	Lecture Weiss	Lunch Break	Life Lecture Cohen-Tannoudji	
18		Lecture Frank	Lecture Riess	Laureate Lunches	Poster Session	Farewell Ceremony
19		Lunch Break	Lunch Break	Laureate Lunches	Poster Session	
20	Social Event Opening Ceremony Opening Lecture: Schmidt	Open Exchange	Panel Discussion The Dark Side of the Universe	Panel Discussion Student, Postdoc, and Then? – Aiming for a Career in Science	Open Exchange	
21		Science Walks			Science Walks	Social Event Baden-Württemberg Boat Trip to Lindau hosted by the State of Baden-Württemberg
22	Social Event Opening Concert					
23		Poster Flashes by up to 30 selected young scientists	Open Exchange	Master Classes Haroche & Wineland Schmidt	Break	
24			Open Exchange	Master Classes Fert Wieman		
25						
26	Social Event Dinners at various locations	Social Event International Get-Together hosted by South Africa	Social Event Grill & Chill hosted by Council & Foundation	Heidelberg Lecture Hellman	Social Event Bavarian Evening hosted by Free State of Bavaria	
27			or	Dinner		
28			Partner Event Academic Dinners			
29						
30						



» Agora Talks (in Alphabetical Order)

J. Georg Bednorz	Career Planning in Science – Dreaming Allowed? Moderator: Laura Sprechmann, Acting CEO, Nobel Media, Sweden
Steven Chu	Non-Thermal Equilibrium Transport by Dynein Molecular Motors in Live Neurons, and Breakthroughs in Linear and Non-Linear Ultrasound Imaging Moderator: Adam Smith, Chief Scientific Officer, Nobel Media, Sweden
Johann Deisenhofer	Photosynthesis – Structural Biology and Evolution Moderator: Paul Kennedy, Academy of Science of South Africa
Serge Haroche & David J. Wineland	Future Quantum Technologies Moderator: Günter Werth, Johannes Gutenberg University Mainz, Germany
Harald zur Hausen	Bovine Origin of Infections Linked to Colon and Breast Cancers Moderator: Alaina Levine, President, Quantum Success Solutions, USA
Stefan W. Hell	Reaching Molecular Size Resolution in Lens-Based Microscopy: the Diffraction Limit Blown Away Moderator: Anna Sjöström-Douagi, Vice President Science & Programs, Nobel Prize Museum, Sweden
Robert Huber	Proteases for Drug Design and Development, My Experience Moderator: Tobias Maier, Deputy Director, National Institute for Science Communication (NaWik), Germany
Brian D. Josephson	Will Twenty-First Century Physics Need Biology? Moderator: Burkhard Fricke, former Vice-President, Council for the Lindau Nobel Laureate Meetings, Germany
John C. Mather & George F. Smoot	From the Big Bang to Intelligent Life Moderator: Lars Bergström, Scientific Chairperson, 69 <sup>th</sup> Lindau Nobel Laureate Meeting
Hartmut Michel	Structures of Terminal Oxidases: A Comparison of Structure Determinations by X-Ray Crystallography and Electron Microscopy Moderator: Tobias Maier, Deputy Director, National Institute for Science Communication (NaWik), Germany
William E. Moerner	What Can You Learn From Single Molecules, Even When Trapped Without Optical Forces? Moderator: Günter Werth, Johannes Gutenberg University Mainz, Germany
William D. Phillips	The New International System of Units: Our Metric System is Experiencing its Greatest Revolution Since the French Revolution Moderator: Rainer Blatt, Scientific Chairperson, 69 <sup>th</sup> Lindau Nobel Laureate Meeting
Martinus J.G. Veltman	The Future of Particle Physics Moderator: Rolf-Dieter Heuer, President, SESAME Council, Germany
Carl E. Wieman	Taking a Scientific Approach to Physics Teaching and Learning Moderator: Laura Sprechmann, Acting CEO, Nobel Media, Sweden



William E. Moerner



Agora Talk with Serge Haroche and David Wineland, moderated by Günter Werth

Audience at Stefan Hell's Agora Talk



George Smoot and John Mather



Martinus Veltman and moderator Rolf-Dieter Heuer





## » Panel Discussions

### THE DARK SIDE OF THE UNIVERSE

**Panellists**

- David J. Gross, Kavli Institute for Theoretical Physics, University of California, Santa Barbara, USA
- Kirsten Hall, Department of Physics and Astronomy, Johns Hopkins University, USA
- Adam G. Riess, Department of Physics and Astronomy, Johns Hopkins University, USA
- Brian P. Schmidt, The Australian National University, Australia
- George F. Smoot, Lawrence Berkeley National Laboratory, University of California, USA

**Moderator**

Jan-Martin Wiarda, Journalist for Education and Research, Germany

### STUDENT, POSTDOC, AND THEN? – AIMING FOR A CAREER IN SCIENCE

**Panellists**

- Niamh Kavanagh, University College Cork, Ireland
- Wolfgang Ketterle, Research Laboratory for Electronics, MIT Massachusetts Institute of Technology, USA
- William D. Phillips, Laser Cooling and Trapping Group, National Institute of Standards and Technology (NIST), USA
- Donna Strickland, Department of Physics and Astronomy, University of Waterloo, Canada
- Maria Żurek, Lawrence Berkeley National Laboratory, USA

**Moderator**

Alaina Levine, President, Quantum Success Solutions, USA

### HOW CAN SCIENCE CHANGE THE WORLD FOR THE BETTER?

**Panellists**

- Vinton Cerf, VP and Chief Internet Evangelist, Google, Inc., USA
- Steven Chu, Physics Department, Stanford University, USA
- Tim Luce, Head of the Science & Operations Department, ITER, France
- Adriana Marais, Director, Foundation for Space Development, South Africa
- Brian P. Schmidt, The Australian National University, Australia

**Moderator**

Karan Khemka, Director in Global Education Companies and Institutions, Singapore & United Kingdom

Panel discussion on 'How Can Science Change the World for the Better?' with Vinton Cerf and Adriana Marais



Steven Chu



'The Dark Side of the Universe' with Jan-Martin Wiarda, Kirsten Hall and Brian P. Schmidt



Adam G. Riess and David J. Gross

Panel discussion on careers in science: Alaina Levine, Maria Żurek, Wolfgang Ketterle, Donna Strickland, William D. Phillips and Niamh Kavanagh





## » Poster Presentations

Poster Presentations allow young scientists to present their research to fellow young scientists and Nobel Laureates. Three hundred young scientists applied for this opportunity – 30 have been chosen by Lindau Alumni peer reviewers. These 30 were also invited to pitch their posters during the two-minute Poster Flashes before they were then exhibited in the Inselhalle to stimulate discussions between participants.

For the first time, a further 70 young scientists had the chance to show their posters in a digital format during the meeting week. In total, this enabled 100 young scientists to present their highly diverse research posters at #LINO19. Among others, the following topics have been covered:

- Quantum Physics
- Astrophysics
- Material Sciences
- Solid-State Physics

Young scientists discuss during the Poster Session at #LINO19.



Two young scientists use the new e-poster format for discussion.



The 30 posters selected for the traditional poster session were also eligible for the poster prize. In a public vote, the participating Nobel Laureates and young scientists voted for five posters which took the top three places.

### The Winners

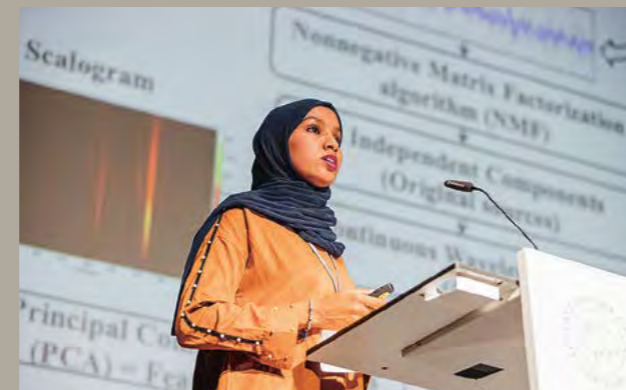
#### 1<sup>st</sup> Place

**Vanessa Graber** – McGill Space Institute, McGill University, Canada for her poster  
**PROBING NEUTRON STAR ASTROPHYSICS WITH LABORATORY EXPERIMENTS**

#### 1<sup>st</sup> Place

**An Pan** – Xi'an Institute of Optics and Precision Mechanics, Chinese Academy of Sciences, China for his poster  
**FOURIER PTYCHOGRAPHIC MICROSCOPY: BREAK THE LIMITATION OF CONVENTIONAL MICROSCOPY**

Hanane Arahmane pitching her poster in a Poster Flash



Vanessa Graber presenting her prize-winning poster



#### 2<sup>nd</sup> Place

**Aonan Zhang** – College of Engineering and Applied Sciences, Nanjing University, China for his poster  
**QUANTUM AND CLASSICAL BEHAVIOURS IN CONTEXTUALITY TESTS**

#### 3<sup>rd</sup> Place

**Gavin Macauley** – School of Physics and Astronomy, University of Glasgow, United Kingdom for his poster  
**ICE-RULE MADE MANIFOLD: PHASE TRANSITIONS AND TOPOLOGICAL DEFECTS IN 2-D ARTIFICIAL SPIN SYSTEMS**

#### 3<sup>rd</sup> Place

**Fabian Mooshammer** – University of Regensburg, Germany for his poster  
**QUANTUM MATERIALS ON THE FEMTOSECOND AND NANOMETER SCALE**



Markus Parzefall from the ETH Zurich in front of his poster

Scientific chairpersons Rainer Blatt and Lars Bergström framing the poster prize winners Fabian Mooshammer, Gavin Macauley, An Pan, Aonan Zhang and Vanessa Graber





» Master Classes



Albert Fert giving feedback on Kai Litzius' presentation

**TOPOLOGY & PHYSICS: TOPOLOGICAL MATERIALS, SKYRMIONS**  
chaired by Albert Fert

**Speakers**

- Edoardo Albisetti, Politecnico di Milano, Italy
- Kai Litzius, Massachusetts Institute of Technology (MIT), USA
- Helena Reichlová, Technische Universität Dresden, Germany



Sébastien Philippe

**TEACHING PHYSICS**  
chaired by Carl E. Wieman

**Speakers**

- Sarah Guerin, Bernal Institute, University of Limerick, Ireland
- Sébastien Philippe, Harvard University, USA
- Philine van Vliet, University of Amsterdam, Netherlands



Guoji Zheng

**MANIPULATION OF INDIVIDUAL QUANTUM SYSTEMS**  
chaired by Serge Haroche and David J. Wineland

**Speakers**

- Jan Goetz, Aalto University, Finland
- Elena Jordan, National Institute of Standards and Technology (NIST), USA
- Aishwarya Kumar, The Pennsylvania State University, USA
- Guoji Zheng, Delft University of Technology, Netherlands



Marilyn Cruces presenting her research

**THE TRANSIENT UNIVERSE**  
chaired by Brian P. Schmidt

**Speakers**

- Vivien Bonvin, École Polytechnique Fédérale de Lausanne (EPFL), Switzerland
- Marilyn Cruces, Max Planck Institute for Radio Astronomy, Germany
- Hester Schutte, Northwest University, USA
- Sebastian Völkel, University of Tübingen, Germany

Intense discussions at the Master Class of Carl Wieman



Workshop atmosphere at Brian P. Schmidt's Master Class





## » Science Breakfast

The Science Breakfast hosted by the Lindau Nobel Laureate Meetings offered the chance to start the meeting day with a stimulating discussion. The scientific input by a panel at the beginning of the breakfast and ice-breaker questions led to diverse discussions on material sciences, new technologies, science policy and society. Hence, the Science Breakfast topic at #LINO19 – Graphene – illustrated how complex the relation between academia, technology and society can be.

**GRAPHENE**  
hosted by the Lindau Nobel Laureate Meetings

### Panellists

- Jari Kinaret, Director, Graphene Flagship, Chalmers University of Technology, Sweden
- Klaus von Klitzing, Max Planck Institute for Solid State Research, Germany
- Sir Konstantin S. Novoselov, University of Manchester, United Kingdom/National University of Singapore

### Moderator

Adam Smith, Chief Scientific Officer, Nobel Media AB, Sweden

Konstantin Novoselov presenting the Graphene Flagship project



Jari Kinaret in discussion with young scientists over breakfast



Klaus von Klitzing, Jari Kinaret and Konstantin Novoselov



Science Breakfast in the foyer of the Inselhalle



## » Partner Breakfasts

**GLOBAL SCIENCE IN REACHING FOR THE STARS**  
hosted by South Africa

### Panellists

- Frank Bradley, Senior Developer – Project Lead, South African Radio Astronomical Observatory, South Africa
- Thebe Medupe, Deputy Dean, Community Engagement and Stakeholder Relations, North West University, South Africa
- Brian P. Schmidt, The Australian National University, Australia
- Buyisiwe Sondezi, Lecturer in Physics, University of Johannesburg, South Africa

### Moderator

Beverley Damonse, Group Executive, Science Engagement and Corporate Relations, National Research Foundation, South Africa

Buyisiwe Sondezi and Frank Bradley



Panel and audience at the Partner Breakfast



**EXCELLENCE IN SCIENCE AND EXPLORATION**  
hosted by Rolex SA

### Panellists

- John C. Mather, Goddard Space Flight Center, NASA, USA
- Andrew McGonigle, Department of Geography, The University of Sheffield, United Kingdom

### Moderator

Francesco Raeli, Rolex SA

Francesco Raeli and John Mather



Andrew McGonigle





» Partner Breakfasts

**PHYSICS, OCEANS AND OUR FUTURE**  
hosted by Mars, Incorporated

**Panellists**

- Levke Caesar, Potsdam Institute of Climate Impact Research, Germany
- Sylvia Earle, Marine Biologist, Explorer, Author and Lecturer, USA
- Donna Strickland, Department of Physics and Astronomy, University of Waterloo, Canada

**Moderator**

Meeri Kim, science journalist, USA

Meeri Kim, Donna Strickland, Levke Caesar and Sylvia Earle



Levke Caesar in discussion with other participants



**BIG SCIENCE: IS THERE STILL ROOM FOR THE ONE BRIGHT IDEA?**  
hosted by the Austrian Federal Ministry of Education, Science and Research

**Panellists**

- Rebecca Meißner, Institute for Ion Physics and Applied Physics, University of Innsbruck, Austria
- Rainer Weiss, LIGO MIT, USA

**Moderator**

Olaf Reimer, Institute for Astro- and Particle Physics, University of Innsbruck, Austria

Rainer Weiss and Olaf Reimer talking to young scientists



Rebecca Meißner



# Sessions of the Scientific Programme of #LINO19

**5 BREAKFAST SESSIONS**  
Early Morning Discussions  
4 Partner & 1 Science Breakfast  
Presented by Partners and the Lindau Meetings

**AGORA TALKS**  
Laureates Interact During Presentation  
Moderator Leads Q&A from the Audience  
Flexible and Interactive

**14**

**PANEL DISCUSSIONS**  
Topical and Relevant Issues  
Discussions Involving the Audience

**3**

**19 LECTURES**  
By Nobel Laureates  
Free Choice of Topics

**MASTER CLASSES**  
Young Scientists Showcase Their Research  
Nobel Laureates Give Advice

**4**

**34 OPEN EXCHANGES**  
Time for Q&A  
Informal Atmosphere

**3 POSTER SESSIONS**  
Young Scientists Present Posters  
Nobel Laureates and Young Scientists Vote for the Winners

**30 POSTER FLASHES**  
Two-Minute Presentations  
One Session



# 69 Innovation Forum

The Innovation Forums were established in 2010 upon the initiative of Nobel Laureate Martin Chalfie. Their aim is to bring together top-level scientists and business executives for an informal exchange on current problems and solutions for tomorrow.

The Innovation Forum of the 69<sup>th</sup> Lindau Nobel Laureate Meeting featured some innovations in its own format: a new venue, a new programme structure and an increased exchange between the participants.

Thematically, the Innovation Forum explored the second quantum revolution, and shed some light on the question of whether it is hype or reality.

In the early 20<sup>th</sup> century, Albert Einstein, Werner Heisenberg, Erwin Schrödinger, Nils Bohr, John von Neumann and many others developed the theoretical framework of quantum mechanics, which turned out to be an extremely useful description for the outcome of experiments, though based on axioms to account for the observed quantum phenomena. Subsequent applications based on and making deliberate use of quantum properties, such as wave-particle duality, the uncertainty principle and the probabilistic description of measurements allowed for the development of modern devices, such as lasers, transistors, magnetic resonance imaging and many more – a development often termed the first quantum revolution.

In the last decades of the 20<sup>th</sup> century, creating and mastering the manipulation of superpositions and entanglement became routinely feasible. An enhanced understanding of these phenomena enabled scientists to develop new technologies facilitating nonlocal operations useful for communication purposes

Serge Haroche, Heike Riel, Andreas Wallraff, Chris Monroe



and enhanced metrology tasks. Quantum protocols, such as teleportation, quantum key distribution and entanglement swapping have enabled the development of completely new communication tools. The creation and manipulation of highly non-classical entangled states allow for enhanced precision measurements and even new computational methods.

This development is often referred to as the second quantum revolution, since the newly available quantum control holds the potential to revolutionise a number of different technology fields. Quantum technologies promise secure communication via quantum cryptography as well as quantum simulators and quantum computers, which have the potential to help solve problems that are currently intractable, possibly leading to revolutionary materials and chemical processes.

Over the last years, this has led to worldwide research efforts to further understand these quantum phenomena for technical applications. Big technology leaders currently make huge investments in the quest for quantum technologies. More than a hundred start-up companies have been established globally during the last few years, striving for innovative quantum protocols and quantum devices. Governments worldwide recognise the emerging fields as future strategic key technologies and invest huge amounts of money.

The race for new quantum technologies is on. However, what can we actually expect as an outcome of this? Which promises are merely hype, and which envisioned goals will lead to real innovations? Which quantum technologies will become relevant for industry and consumers, and when will they become available? These were some of the questions discussed at the 12<sup>th</sup> Lindau Innovation Forum.

Jan-Martin Wiarda, Martin Hellman, Jianwei Pan, Gregoire Ribordy



**Session I: Quantum Communication**  
**QUANTUM COMMUNICATION: PAST, PRESENT AND FUTURE**  
 Jianwei Pan, University of Science and Technology of China

**QUANTUM COMMUNICATIONS IN THE REAL WORLD**  
 Gregoire Ribordy, ID Quantique SA, Switzerland

**Discussion Moderator**  
 Martin Hellman, Jianwei Pan, Gregoire Ribordy

**Moderator**  
 Jan-Martin Wiarda, Journalist for Education and Research, Germany

**Session II: Quantum Metrology and Sensing**  
**QUANTUM SENSING: NEW PARADIGMS FOR PRECISION MEASUREMENTS**  
 Jörg Wrachtrup, University of Stuttgart, Germany

**QUANTUM SENSORS AT BOSCH**  
 Thomas Strohm, Robert Bosch GmbH, Germany

**Discussion**  
 David Wineland, Jörg Wrachtrup, Thomas Strohm

**Moderator**  
 Jan-Martin Wiarda

David Wineland, Jörg Wrachtrup, Thomas Strohm



**Session III: Quantum Computation & Simulation**  
**QUANTUM COMPUTING WITH SUPERCONDUCTING CIRCUITS**  
 Andreas Wallraff, ETH Zurich, Switzerland

**QUANTUM COMPUTING WITH ATOMS: FROM RESEARCH TO ENGINEERING**  
 Chris Monroe, Joint Quantum Institute & IonQ, USA

**QUANTUM COMPUTING – TOWARDS APPLICATIONS**  
 Heike Riel, IBM Research – Zurich, Switzerland

**Discussion**  
 Serge Haroche, Andreas Wallraff, Chris Monroe, Heike Riel

**Moderator**  
 Jan-Martin Wiarda

Chris Monroe





# Impressions

Young scientist Noelia Fernández giving a presentation during the Poster Flashes



Johann Deisenhofer in discussion with young scientists



Hartmut Michel during his Agora Talk



Agora Talk with Brian Josephson

Carlo Rubbia





# Social Programme

## » Summer Festival of Science

hosted by the German Federal Minister of Education and Research Anja Karliczek

Reception at Eilguthalle, Lindau

### Welcome Addresses

- Anja Karliczek, Federal Minister of Education and Research
- Countess Bettina Bernadotte

Dinner at Eilguthalle, Lindau



Countess Bettina Bernadotte, Anja Karliczek and Brian Schmidt

Countess Bettina Bernadotte and Jürgen Kluge welcoming Anja Karliczek



Anja Karliczek and Jörg Hacker, President of the German National Academy of Sciences Leopoldina



## » International Day

hosted by South Africa

### PARTNER BREAKFAST:

GLOBAL SCIENCE IN REACHING FOR THE STARS

hosted by South Africa (see pp. 72/73 for more details)

### INTERNATIONAL GET-TOGETHER

hosted by South Africa

### Musical Greeting

Marimboz

### Welcome

Countess Bettina Bernadotte

### Welcome Address

Bheki Hadebe, Director, High End Skills, Department of Science and Technology, South Africa

### Moderator

Himla Soodyall, Chief Executive Officer, Academy of Science of South Africa (ASSAf)

### Cultural Performance

Nomfusi

Bheki Hadebe



Himla Soodyall





## » Bavarian Evening

hosted by the Free State of Bavaria

**Welcome Address**  
Countess Bettina Bernadotte

**Words of Welcome**  
Bernd Sibler, Bavarian State Minister of Science and the Arts, Germany

**Traditional Bavarian Music & Folk Dance**  
– Alphorngruppe Ebratshofen  
– Die 4 Hinterberger Musikanten, Bavarian folk musicians, and performers in traditional attire



Countess Bettina Bernadotte and Bernd Sibler presenting a meeting bag

#LINO19 participants in traditional attire



## » Baden-Württemberg Boat Trip

hosted by the State of Baden-Württemberg

**Welcome Address**  
Ulrich Steinbach, Deputy Minister of Science, Research and the Arts, Baden-Württemberg, Germany

**Exhibition**  
Presentations by selected research institutions and projects of Baden-Württemberg

**Poster Awards Ceremony**  
Winners of the #LINO19 Poster Sessions (see pp. 46/47 for details)

**Science Picnic**  
hosted by the Ministry of Science, Research and the Arts, Baden-Württemberg

Nobel Laureate Gérard Mourou visiting the exhibition by research institutions from Baden-Württemberg



Ulrich Steinbach welcoming the guests

Science Picnic





## » Science Walks

During a Science Walk, Nobel Laureates spend their time exploring picturesque spots in Lindau and its surroundings together with ten young scientists. It is yet another opportunity for informal discussions. A total of 17 walks were organised, taking place on two different days.

Joachim Frank	John C. Mather
David J. Gross	Arthur B. McDonald
F. Duncan M. Haldane	William E. Moerner
Stefan W. Hell	William D. Phillips
Brian D. Josephson	Adam G. Riess
Takaaki Kajita	Donna Strickland
Wolfgang Ketterle	Joseph H. Taylor
Klaus von Klitzing	Rainer Weiss
J. Michael Kosterlitz	

Science Walk with J. Michael Kosterlitz



Science Walk with Wolfgang Ketterle



## » Laureate Lunches

During a Laureate Lunch, one Nobel Laureate sits together with up to ten young scientists at a local restaurant in Lindau to talk informally over lunch. Almost all participating laureates took part in this format.

Ada E. Yonath with young scientists during a Laureate Lunch



Laureate Lunch with J. Georg Bednorz



## » Grill & Chill

upon invitation of the Lindau Nobel Laureate Meetings in cooperation with the City of Lindau

### Welcome Addresses

- Gerhard Ecker, Lord Mayor of Lindau
- Countess Bettina Bernadotte

### Donations

The proceeds and donations were divided among two institutions for projects in the Lindau region: Mentor Stiftung Deutschland and the Degermoos marshland renaturation project.

### Support

- Continental AG
- Stadtwerke Lindau

Thomas Gläßer, Stadtwerke Lindau, Countess Bettina Bernadotte, Lord Mayor Gerhard Ecker and Norbert Hammerschmidt, Continental AG



## » Academic Partner Dinners

### Hosts

- Academy of Science of South Africa (ASSAf)
- Alexander von Humboldt Foundation
- Australian Academy of Science
- Austrian Federal Ministry of Education, Science and Research
- Bayer AG
- Continental AG
- Dieter Schwarz Stiftung gGmbH
- Elite Network of Bavaria
- German Academic Exchange Service (DAAD)
- Helmholtz Association of German Research Centres
- Mars, Incorporated
- Max Planck Society
- Oak Ridge Associated Universities (ORAU), USA
- Wilhelm und Else Heraeus-Stiftung

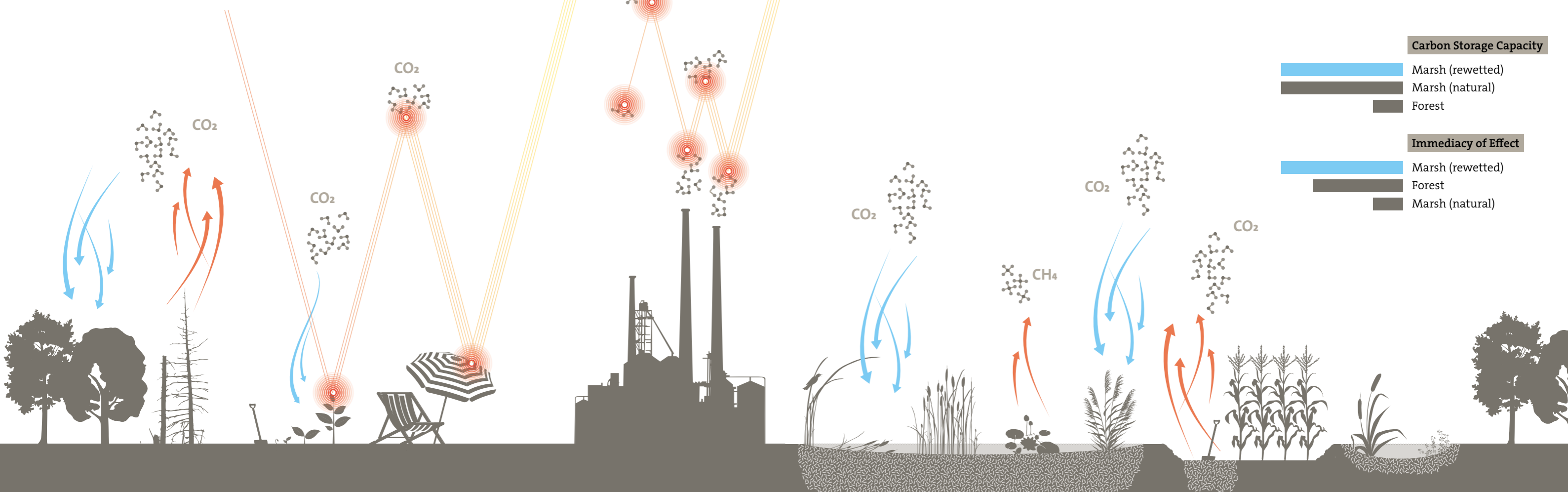
Joachim Treusch, Lindau Alumnus and CEO of the Wilhelm und Else Heraeus-Stiftung, welcoming the fellows of the foundation





# Marshland Renaturation

Since 2018, the Lindau Nobel Laureate Meetings have supported the local Degermoos marshland renaturation project to help offset the carbon emissions generated by the meetings and the participants' travel. But how does marshland renaturation work, and why is it the method of choice?



In intact ecosystems, CO<sub>2</sub> is captured and carbon is stored in vegetation and soil. When plants lose their leaves or die and are decomposed, CO<sub>2</sub> is released back into the atmosphere.

Planting new trees or regrowing forests captures CO<sub>2</sub> which is used by plants for their growth. Carbon can be stored for decades or centuries in the tree's biomass.

The presence of and release of CO<sub>2</sub> into the atmosphere is actually important – it helps regulate the temperature by absorbing and trapping heat radiation.

However, our industries, transportation and agriculture produce too much CO<sub>2</sub>, too quickly. Our planet is heating up, with many negative and unpredictable consequences.

In marshes, water blocks oxygen from the layers below, creating an oxygen-poor environment. Under these conditions, dead biomass is turned into peat, which can store carbon for a long time.

However, marshes also produce potent greenhouse gases like methane (CH<sub>4</sub>). This, in combination with the carbon storage, make marshes in a natural, balanced state more or less climate-neutral.

Turning marshes into farmland is detrimental for the climate, as it releases large amounts of carbon previously stored as CO<sub>2</sub>. Rewetting and renaturing marshlands stops and slowly reverses this process.

Marshes store vast amounts of carbon for a very long time, but the growth process is slow. Renaturing marshes is comparably fast and effective. Planting trees is fastest, but the capacity (per hectare) is lower.

Carbon Storage Capacity	
	Marsh (rewetted)
	Marsh (natural)
	Forest
Immediacy of Effect	
	Marsh (rewetted)
	Forest
	Marsh (natural)



*“One of the things that I love so much about Lindau is that I’m constantly having conversations with young people and learning new stuff at the same time that I’m telling them things that I do.”*

William D. Phillips, Nobel Laureate in Physics 1997





# 69

## A Week on Mount Olympus

G rard Mourou, Nobel Laureate in Physics 2018, visited Lindau for the first time this summer. In a personal review, he reflects on his experiences at the 69<sup>th</sup> Lindau Nobel Laureate Meeting and shares his impressions on being at the summit of science.



*“What an immense privilege to bathe in this environment, where every scientist had contributed in a major way to advancing society.”*

G rard Mourou

My week in the little town of Lindau on the shores of Lake Constance in Bavaria, Germany, was an unforgettable scientific experience. I will cherish my memories of this wonderful place and of the inspiring encounters with other laureates and young scientists.

Together with 39 Nobel Laureates, I met with 580 young scientists from around the world. All who I had the pleasure of encountering personally were passionate about knowledge and wanted to know more about the physical sciences as well as a career in academia. I felt like I had reached the Mount Olympus of science.

What an immense privilege it was to bathe in this environment, where every scientist had contributed in a major way to advancing society through seminal discoveries or inventions. What a pleasure to take part and observe the intense, fruitful interactions between the Nobel Laureates themselves and of course between the laureates and the future generation of scientists, who were eager to learn from the laureates and hear their advice.

A relaxed atmosphere was vital for encouraging effective communication between young scientists and laureates. We broke the ice with scientific round table discussions, Master Classes and even a bit of a bop on the dance floor at the International Get-Together on the evening of the second meeting day. The array of various activities ranged from formal lectures delivered by some of the attending laureates to casual lunch breaks and Science Walks with one laureate accompanied by ten young scientists through the picturesque scenery in and around Lindau. In general, there were so many possibilities for intense personal and scientific exchange. My own highlights are discussions about the creation of the Universe and of particles: this switch from the simple to the complex in an attempt to answer the big question of whether life is unique or inevitable was a definite high point of the conference.


In such a relaxed atmosphere, the discussions were not unlike those you might have encountered if you happened upon Aristotle



G rard Mourou with young scientist Tarnem Afify

walking with his Peripatetic disciples or Goethe holding forth on nature. The high point of the week was when the conference decamped to the amazingly beautiful Mainau Island, where we heard the Yemeni Nobel Peace Laureate Tawakkol Karman speak movingly about the fight for democracy and human rights in her homeland. This was followed by a discussion entitled “How Can Science Change the World for the Better?” and a grand Science Picnic in the park of the small island – another opportunity to talk about scientific careers and research ethics with the meeting participants.

Although my Lindau experience is already now several months in the past, I have indelible memories of the week on this ‘Mount Olympus’, where every morning began with a long swim in the wonderfully calm lake before breakfast, with only the wild ducks and moorhens for company. Then came breakfast with a view over the lake, before I hurried back to join my colleagues and continue sorting out the world!

 A video of G rard Mourou’s first Lindau lecture ‘Passion for Extreme Light’ can be watched in the mediatheque.



# 69

## Eight Lessons from the 69<sup>th</sup> Lindau Meeting

#LINO19 young scientist Samer Kurdi is an experimental physicist and material scientist currently working on his PhD at the University of Cambridge. In his reflections on the 69<sup>th</sup> Lindau Meeting, he highlights eight key lessons that he has learnt in Lindau.

Samer Kurdi



July 2019 was the 100<sup>th</sup> anniversary of the total solar eclipse that proved Albert Einstein's general theory of relativity, the 50<sup>th</sup> anniversary of the moon landing and the coming together of 580 young scientists from 89 countries, joining 39 Nobel Laureates during the 69<sup>th</sup> Lindau Nobel Laureate Meeting. Each of these numbers represents something significant, and the people who make up the numbers even more so.

### Diverse, Interdisciplinary, International

In my professional scientific journey, I have lived and worked in seven countries. I was born in Jordan, and raised from

the age of seven in Canada, but until the age of 24 I had not left North America apart from to return to Jordan. I then moved to France, Germany and the UK, and have had the opportunity to work in Japan, Tanzania and Italy. Learning from and working with people from multiple countries, cultures and disciplines has opened my eyes to how various perspectives could lead to much better ideas.

I was inspired to see Ada Yonath using her presentation to highlight each person on her team and the contribution they make to the overall research success. She emphasised the importance of her family, the women in her life and her grandchildren, sending a strong message that although men have dominated the field of scientific study and it is steeped in a patriarchal bias historically, women can – and must – be part of this story now and in the future.

**The Struggle Is Part of the Process – Perseverance Required**  
In the case of most Nobel Laureates I met, their journeys were not easy, and their struggles were part of their success. Each had their own tales of sleepless nights, lack of respect or support from colleagues and networks and naysayers challenging their theories. However, their hard work and determination paid off – with their work being recognised at the highest level in the scientific field.

For the 580 young scientists at #LINO19, myself included, this came as a welcome reassurance. There are many times on a regular basis in this field where you wonder if your work is good enough and if you are doing the right thing – it was positive encouragement to hear that you CAN fail. That you CAN struggle. And you can ultimately succeed.

### Career Paths Are Not Linear

On the panel discussion 'Student, Post-Doc, and then? Aiming for a Career in Science', three Nobel Laureates and two young scientists shared their stories, and it was clear that they had all taken different paths to achieve their goal. For example, Wolfgang Ketterle shared his experience as

*“Nature is complex and our imagination doesn't take us that far, so we need to keep dreaming and be curious.”*

John C. Mather

a “zig zag” – going from PhD to three different post-docs in three different fields, before ending up at the Massachusetts Institute of Technology (MIT).

Bill Phillips always wanted to be a scientist. He described the two main chapters of his thesis as completely different – one on precision and one on lasers. Based on the chapter on precision, he ended up at the National Bureau of Standards but his lasers knowledge was important for that role – showing how no knowledge is wasted, and that the coming together of opportunity and learnings can open new doors in your career.

### Learn Something New and Have Fun Doing It

Every Nobel Laureate I encountered – whether it was on a panel, giving a presentation, over breakfast or during a Science Walk – was passionate about his or her work, field of research and science as a whole. To me, this means that to be curious and open-minded, and to work where your passion lies, is ultimately where your strength and success will come from.

### Challenging the Status Quo

Throughout the week, many of the founders of the quantum revolution said there are a number of theories that were proven to be wrong, and statements that have subsequently been challenged; Einstein doubted his prediction of gravitational waves, which was subsequently detected by LIGO. Schrödinger even stated in 1952 that “We never experiment with just one electron or atom or small molecule”, which is now very common.

Challenging the status quo evolves scientific theories and practices, and these evolutions require an individual, team or research group to stand firm in their beliefs and work, regardless of existing understanding.

### 95% Luck, 5% Smarts

Many Nobel Laureates attributed their success to luck, discussing “being in the right place at the right time”. However, they adapted to new situations, said “yes” to new opportunities, accepted help when offered and asked questions to seek out

new information. J. Michael Kosterlitz in his lecture 'Creating New Scientific Knowledge' explained that it was also luck – and failure – that led him to receive the Nobel Prize; he initially failed in high energy physics. Every time he wanted to prove a mathematical model or theory, someone else did it first. His answer to this was to ask people to suggest problems for him to solve, and he came across David J. Thouless – initially, he did not fully understand what Thouless was discussing, but eventually was able to learn from him by asking questions, and contribute to the topological states prediction, leading them both to a Nobel Prize.

### Science Can Change the World for the Better!

The opening lecture by Brian Schmidt was entitled 'Big Questions for Society, Big Questions for Research', and it stayed with me throughout the week.

Schmidt spoke of political instability and uncertainties, technological advancement at an unprecedented scale and unsustainable use of the Earth's resources. He emphasised that the 580 young scientists from 89 different countries can work together, participate in areas outside of our existing fields, and use the scientific framework to make a positive impact on the world.

### Everybody Loves a Quote

During the 69<sup>th</sup> Lindau Meeting, many quotes have been shared formally and informally, so it seemed apt that I end this article with just one more that was told by John C. Mather: “Nature is complex and our imagination doesn't take us that far, so we need to keep dreaming and be curious.”



Samer Kurdi's article as well as the #LINO19 reviews by other young scientists are available on our blog: [www.lindau-nobel.org/blog/](http://www.lindau-nobel.org/blog/)



# 69

## Intersection of Science and Society – The Lindau Experience

South Africa hosted the International Day at the 69<sup>th</sup> Lindau Nobel Laureate Meeting. Himla Soodyall, Executive Officer of the Academy of Science of South Africa, gives a personal account of her week in Lindau and explains why it was a ‘Wow!’ moment in her life.

Himla Soodyall



After months of preparations, the time had come for South Africa to host the International Get-Together on 1 July 2019. Soon after my arrival at the Inselhalle in Lindau, I was hooked up to a microphone and headgear and guided through the process for transition between the line-up of events for the evening. A room which had previously served as an auditorium for the lectures by Nobel Laureates was now transformed with the bright colours of the South Africa table settings and decorations, affirming the richness of South Africa’s cultural heritage.

Promptly at 19.00 hrs the vibrant sounds of the marimba drums, singing and clapping filled the entrance hall. The Marimboz band and Xhosa dancers performed energetically and drew the attention of the spectators, including me, to the dance floor. I have a love for marimba-style music and allowed myself to be drawn into the spirit of celebration. After all, we had a lot to celebrate. It was our moment to bring South African hospitality to the world-stage – and where better to do this, than in Lindau, among Nobel Laureates, the world’s most accomplished academic achievers, and to have an opportunity to showcase South African science.

*“To be in a room with Nobel Laureates and other scientists from the same discipline really is what I call that ‘Wow!’ moment.”*

Himla Soodyall

After welcoming all the guests to the evening, I shared with the audience that exactly four years ago today, the Academy of Science of South Africa (ASSAf) signed a memorandum of understanding (MoU) to be part of the Lindau Meetings family. Hosting the International Get-Together was a momentous occasion for South Africa. The house was entertained by Nomfusi – a young female artist who brought the sounds of South Africa to the stage and it was difficult to get people off the dance floor to follow the programme. For the first time in the history of the Lindau Meetings, dancing preceded the dinner.

Bheki Hadebe, who represented the Department of Science and Innovation (DSI) at the meeting, reminded us in his address at the dinner that “physics research in South Africa dates back to the astronomical observations of Sir John Herschel at the Royal Observatory in Cape Town in the 1830s. On the international scene, South Africa was a founding member of the International Union of Pure and Applied Physics (IUPAP) in 1923. The South African Institute of Physics (SAIP) was established in 1955. Even during the apartheid era, SAIP membership was open to all races and genders and its constitution never differentiated on these attributes.”

Between 2012 and 2018, 50 young South African scholars had participated in the Lindau Meetings. I had the privilege of meeting some of the Lindau Alumni, together with the 20 young scientists who we selected to attend #LINO19. From the alumni I heard stories of how the Lindau experience had empowered them to advance their own careers. ASSAf, in partnership with the DSI, is going to produce a publication capturing these stories in the next year.

ASSAf also hosted a panel discussion over breakfast on the morning of 1 July 2019 showcasing astronomy projects like the MeerKAT, South African Large Telescope (SALT) and the Square Kilometer Array (SKA). The panel was chaired by Beverley Damonse from the National Research Foundation with panellists Buyiswe Sondezi, University of Johannesburg, Bradley Frank from the South African Radio Astronomical Observatory, Thebe Medupe, North-West University and Nobel Laureate Brian Schmidt.

Damonse captured the essence of what the International Day meant to South Africa, commenting that hosting “was a really important opportunity for us to show the global community how seriously we take science, technology, and innovation. We need to continue to make our voice heard in these global conversations.”

Over the rest of the week, the South African delegation was treated to all that the meeting could offer – excellent presentations, engagement with Nobel Laureates, discussing their research and interests with fellow young scientists from all over the world and networking. We had an opportunity to dine with Nobel Laureate Donna Strickland one evening and participated at the various events with the best of the best with mutual respect.

Personally, the Lindau experience was a ‘W.O.W.’ moment in my own journey:

‘W’: wonderful showcase for science and the way science is integrated into our daily lives without us truly appreciating the work that goes on behind the scenes.

‘O’: opportunity – to meet ordinary people who have made extraordinary contributions to science in the world of physics, chemistry and biology and who unstintingly work to improve the world for future generations. More importantly – the opportunity to be the first country from Africa to host such an occasion.

‘W’: willingness to share experiences, tell stories and to inspire.

A quote from the late former President Nelson Mandela aptly summarises what the Lindau Nobel Laureate Meetings epitomise: “Young people must take it upon themselves to ensure that they receive the highest education possible so that they can represent us well in the future as future leaders.”



# Impressions

Dan Shechtman in discussion with young scientists



Get-together outdoors



Joseph Taylor and young scientists exploring the Lindau Science Trail



Morning workout at #LINO19



# Don't Lecture Me!

Nobel Laureate Carl Wieman and several education practitioners and educators discussed the educational technique of active learning during the 69<sup>th</sup> Lindau Nobel Laureate Meeting. The results are available as a video and as an article in Nature Outlook.



Traditionally, every Nobel Laureate may give a lecture on a topic of his or her choice at a Lindau Meeting. There are, however, also very many occasions for small group discussions and social interaction. We asked all Nobel Laureates for ideas on how to improve the programme, and Carl E. Wieman made the most radical suggestion: Get rid of all lectures. Next year, more than 60 Nobel laureates will come to Lindau – and none of them should be allowed to give a lecture?

This idea of Wieman can be easily understood in the context of the decades of research that he has undertaken into how to teach (physics) most effectively. Some of the most eye-catching results were published in the seminal Science journal article 'Improved learning in a large-enrolment physics class'. So how does active learning work – and is it really better than currently used methods? What are its strengths, what are its weaknesses?

Carl Wieman is quick to point out that he neither invented active learning nor has he developed a special 'Wieman method'.

Rather, the technique is used by people across the world and it has been described in a large number of studies and publications.

Simply put, the idea behind active learning is that the brain needs to exercise continuously to form new neural connections, which strengthen decision-making and in doing so rewire the brain. Passively listening to lectures does not help the brain to exercise, actively thinking about right or wrong explanations and paths to follow does.

In science and engineering fields, decisions to be exercised and made are usually: What concepts and models are relevant? What information is relevant, irrelevant or needed? What approximations are appropriate? What method(s) can be used to pursue potential solutions? What criteria can be used to test results? Wieman also claims that active learning works equally well in non-STEM disciplines.

Active learning methods have been implemented in various departments and courses, including the Science Education Initiative headed by Wieman at the University of British Columbia, Canada. The vast majority of active learning cases have involved implementation at the (undergraduate) university level in the United States – so the obvious questions are a) is the approach applicable to other levels, and b) is it transferable to other countries and cultures?

Wieman tells the anecdote of how he once explained his method at the University of Tokyo, and all faculty members told him that this would never work in Japan because of cultural differences. However, when he was talking directly to and with the students they very actively engaged in the discussion and did not hesitate at all to engage in active learning. It seems that even though teaching practices may vary widely around the world, learning may be more universal. "It is all about changing the norms of the classroom", concludes Wieman.

As for earlier stages of education, such as kindergarten or elementary school, he admits that not a lot of research data are

*"This method is better for all students with a human brain."*

Carl E. Wieman

available and that active learning definitely becomes more difficult to measure because there are many more factors in play and environments are not as controllable as those in a university setting. The cognitive and neural mechanisms of active learning should, however, apply equally to all ages in principle.

John Rogers, dean of studies at Phillips Academy Andover, USA, notes that some version of active learning is absolutely the norm at institutions like the one he is teaching at, and teachers no longer just practice lecture-style instruction and set tests. But is that also the norm at public schools and regular universities? In any case, Carl Wieman claims that it is not a question of money. Active learning requires some extra training for the teachers, but does not cost more money or require more time than traditional teaching. It also works with large class sizes up to several hundred students. Further, all educators who have been trained in active learning prefer the method to their previous approach.

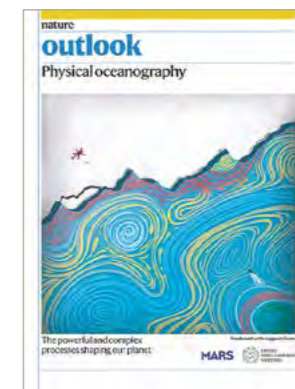
Leslie Medema, head of the Green School in Bali, has a lot of practical experience with active learning. At her institution, teachers and students jointly decide what and how they are learning. But she reminds us that not all students are the same, and that some are more introvert than others and need other ways of being taught. "For a majority of students, active learning is probably most powerful, but we can't forget about those of us who sat in that back row", says Medema.

Additionally, Wieman points to the issue of measuring the quality of teaching overall: "Right now, the evaluation of teaching is extremely, to put it diplomatically, terrible." "Without a good assessment, we can't really measure if we are doing what we are trying to do", adds John Rogers. But Michael Schratz, professor of education at Innsbruck University, Austria, emphasises another point: "If you only use evaluation sheets, what evidence is that? It is an immediate impression, but it is not about the sustainability of knowledge, and this is what matters." Carl Wieman agrees because he has done some research spanning

a two-year period (where students taught with active learning methods still perform better). However, studying the long-term effects of teaching methods is very complicated.

What we need to learn has dramatically changed over the past couple of hundred years, from algebra and writing to very complex and extensive topics that are currently taught at universities. The question remains: Why have teaching methods not changed accordingly to adapt to this new complexity?

» The full article is part of the Nature Outlook on #LINO19. Since 2010, the Lindau Nobel Laureate Meetings have been featured in Nature Outlook. The 2019 edition on 'Physical Oceanography' was published on 14 November 2019 and is available digitally at nature.com and scientificamerican.com. The supplements could be produced thanks to the support of Mars, Incorporated.



» Three videos on active learning, including 'Don't Lecture Me!' are available in the mediatheque or at lindau-nobel.org.



# 69

## Illuminate the Dark Side of the Universe

Nobel Laureate Adam Riess and fellow astrophysicists tackled some of the biggest questions in cosmology on the Tuesday of #LINO19. Science writer Benjamin Skuse sums up current research topics and reflects on the lively discussions.

Nobel Laureate Adam Riess had a busy third day at the 69<sup>th</sup> Lindau Nobel Laureate Meeting, presenting a lecture, debating in a panel session and meeting for an open exchange with young scientists. He was in-demand not only because he was visiting the Lindau Meetings for the first time, but also because his work tackles cosmological questions we have all asked at some point in our lives. When was the universe created? How will it end? And what is it made of?

Riess' Nobel-winning research, shared with Saul Perlmutter and Brian Schmidt, provided strong evidence for an answer to the second question. To get there, the researchers focused on measurements of one of the most important parameters in cosmology – the Hubble constant. The Hubble constant gives the rate at which the universe is expanding today from the Big Bang.

Scientists already knew the Hubble constant was not constant (in time at least, it is however the same and therefore constant throughout space). In the distant past, the universe's expansion rate was much larger, and then it shrank as the universe expanded.

It was therefore a complete surprise when Riess and Schmidt, and Perlmutter independently, revealed that the universe's expansion is actually accelerating and therefore that its ultimate fate is to keep on expanding forever. "This was tremendously exciting, shocking, disturbing, revolutionary... any adjective you can throw at it," he recalled. "But it doesn't really answer the big question: why is the universe's expansion accelerating?"

Riess' current work may shed light on this question, and again studies revolve around the Hubble constant. Recently, Riess and colleagues from the SHOES (Supernovae Ho for the Equation of State) collaboration measured the Hubble constant to be 74 km/s/Mpc, with a precision of 1.9%.

To get to such a level of accuracy, Riess explained that his team had to build a strong 'cosmic distance ladder'. This entailed

measuring accurate distances to nearby galaxies and then moving to galaxies farther and farther away. For relatively nearby galaxies, the team used standard candles called Cepheid variables, common stars that pulsate at predictable rates that indicate their intrinsic brightness. For those farther away, they could also use much brighter but rarer cosmic yardsticks: exploding stars called Type Ia supernovae. By comparing these distances to measurements of an entire galaxy's light, they could then calculate how fast the cosmos is expanding: the Hubble constant.

Yet despite its accuracy, this value surprisingly doesn't match with the one derived from another key technique for calculating the universe's expansion rate. ESA's Planck satellite, which maps the cosmic microwave background – the relic afterglow from the Big Bang – was used by researchers including Nobel Laureate George Smoot to calculate how fast the universe was expanding when it was just 380,000 years old. They extrapolated this value forward to today and came to a Hubble constant value of 67 km/s/Mpc.

This mismatch presents a big problem for the current model of the universe, known as  $\Lambda$ CDM. "If we have reached a point of confirmation of this discrepancy, then we have to imagine new physics in  $\Lambda$ CDM," Riess said.

Riess only hinted at what this new physics could be during his lecture, making the subsequent panel discussion (ominously titled 'The Dark Side of the Universe') in which some of these possibilities were explored all the more eagerly anticipated. The discussion focused exclusively on dark matter and dark energy, that together are thought to make up 95% of the universe. Dark energy is perhaps the more mysterious of the two. It is an unknown phenomenon expanding space everywhere and making the universe balloon at an ever-faster rate.

In 1997, Schmidt and Riess invoked dark energy to help explain their results: "We knew the only easy way to make the universe accelerate was some form of what would eventually be called


dark energy, commonly referred to as the cosmological constant," Schmidt said.

Adding a cosmological constant essentially has an anti-gravity effect on the universe, allowing it to push itself apart when it should be slowing down. What this anti-gravity effect is, however, remains a complete mystery. At least, a mystery to most: "I really don't like the term dark energy", said Nobel Laureate David Gross. "It isn't dark, it isn't mysterious – it's the only form of energy and pressure that looks the same to all observers."

While dark energy is expanding space everywhere, dark matter – the second mystery – has an opposite binding effect on matter in the universe. It is an invisible substance forming a universal cosmic web. This cosmic web is thought to help form galaxies and prevent them from spinning apart.

Like Gross on dark energy, Riess was keen to downplay dark matter's dark credentials: "One of my favourite observations is of the Bullet Cluster where you see two clusters of galaxies pass through each other in a collision", he said. "Luminous matter is shocked and heated and left behind a little bit, and the dark matter separates and moves on, and you can actually see it." But he added: "Our current descriptions of dark matter and dark energy are very phenomenological... that's not a complete description of their physics."

So, although these two dark constituents of the universe may not be as dark as we thought, there is still an awful lot to learn about them – a good reason for young scientists attending the 2019 Lindau Meeting to illuminate the dark side of the universe.

 Videos of Adam Riess' lecture and the panel discussion can be watched in the mediatheque.

Adam Riess





# 69

## Fighting for Democracy and Human Rights in Yemen

Yemeni Nobel Peace Laureate Tawakkol Karman inspired the #LINO19 participants with her attendance at the conclusion of the Lindau Nobel Laureate Meeting on Mainau Island. Science writer Meeri Kim on Karman's life and her struggles for peace and democracy.

Tawakkol Karman



Every year, on the final day of the Lindau Meeting, the young scientists are treated to a boat trip to beautiful Mainau Island. Located in the southwest German state of Baden-Württemberg, Mainau lies just off the shores of Lake Constance and is home to several lush gardens, a Baroque palace and an arboretum. It is also the home of the Bernadotte family.

Amidst these beautiful surroundings, the spirit and energy of #LINO19 continued to rise high during an inspirational public interview with Nobel Peace Laureate Tawakkol Karman. She garnered international attention after playing a key role

in the 2011 pro-democracy youth uprising in her home country of Yemen, which was under the dictatorial regime of President Ali Abdullah Saleh at the time. Later that year, Karman became the first Arab woman and second Muslim woman – as well as the youngest recipient at the time, at 32 – to receive the Nobel Peace Prize.

In conversation with Adam Smith, Chief Scientific Officer of Nobel Media, Karman discussed her ongoing promotion of democracy and human rights in Yemen, the country's current humanitarian crisis, and what might be done about it.

*“When they arrested me they made my voice stronger, and they gave me more power inside Yemen and outside Yemen.”*

Tawakkol Karman

“I am really so proud to be with you here, along with these huge scientists...who changed the world, and my great colleagues – and I am so proud to say they are my colleagues –, and also you as the young people who will be the next Nobel Laureates and the next leaders of the world,” said Karman to the audience.

From a young age, Karman recognised the power of speaking out against political oppression. She organised several student rallies in Sana'a, the largest city in Yemen, while earning her degree in political science from Sana'a University. Later, she used journalism as a gateway to activism, writing candidly about the regime's injustices and civil rights violations, despite Yemen's severe restrictions on press freedom. In 2005, she co-founded the group Women Journalists Without Chains to promote freedom of expression and democratic rights.

Karman credits her father, a lawyer and politician, as an early influence on her strong character and boundless courage: “Since I was a child, the first question I was asking my father was ‘What can I do for my country?’ I was never asking, what can you do or what can the government do,” she said. “Always, he told me to be responsible, to carry the initiative, to do something and also to be in the front line.”

From 2005 to 2010, she regularly led demonstrations and sit-ins in Tahrir Square. Many thought she would get bored and eventually give up, but the situation suddenly swung in her favour in late 2010, when the Arab Spring began to sweep across the Middle East from Tunisia. She gained prominence in her country as a leadership figure, becoming known as the ‘Mother of the Revolution’ and paving the way for the participation of women in peace-building work.

However, with her struggle for democracy has come an arrest, threats on her three children's lives, and even an attempted assassination. Her opponents have tried everything to scare her into compliance, but without as much as an inch of success. “When they arrested me, they made me stronger than before. When I was weak, I was a little afraid because they can reach

me and my kids,” she said. “But when they arrested me – and they were so stupid when they did that – they made my voice stronger, and they gave me more power inside Yemen and outside Yemen.”

Although President Saleh finally resigned in 2012 after the Yemeni revolution, Karman's mission is far from over. Her country is currently suffering through what the United Nations has called “the world's worst man-made humanitarian disaster.” Yemen is in the midst of a civil war, now in its fourth year, that has left 24 million people – an estimated 80 percent of the entire population – in desperate need of aid or protection. Civilians are being injured or killed at an alarming rate, and millions more are malnourished, homeless, or sick with cholera.

But Karman and the Yemeni people haven't lost hope. She noted that Yemen has endured almost 5,000 years of civilisation and is a country with a rich history of democracy. They have much to be proud of, despite the hardships they currently face, including natural resources, stunning lands and an incredibly resilient people.

“If I speak about the Yemen of my childhood, it is the same Yemen that I am living in now because I never left...The Yemen in my mind is the great Yemen,” said Karman. “The most important thing that we have is a great people, a very strong people who want to change their situation and who made the greatest peaceful revolution against the dictator Ali Abdullah Saleh.”

 A video of the interview with Tawakkol Karman is available in the mediatheque.



# Inspired by the Interdisciplinarity of Science

Quazi Rushnan Islam is a young scientist from the University of Dhaka, Bangladesh. Her research aims to increase the efficiency of conventional silicon-based solar cells. Science writer Ulrike Böhm interviewed her about her career, her advice for other women in research and her experience at #LINO19.



Quazi Rushnan Islam

Ulrike Böhm: What inspired you to pursue a career in science?

Quazi Rushnan Islam: When discussing the applications of electromagnetism, my high school teacher told me to investigate the physics behind a credit card swipe. On a mission, I went home and started researching the topic. I was awestruck by the fact that the technology behind the black magnetic stripe on a credit card was derived from basic principles I learned in class! I was amazed by the impact this intricate fusion of physics

and engineering has had on the way we transact money. From then on, whenever my dad paid the restaurant bill, rather than fighting over the last piece of pizza, I would stare at the card reader slot and visualise all the imaginary flux lines around the black stripe. From that moment on, I knew science was for me.

UB: What is the coolest project you have worked on and why?

QRI: In my junior year, I had the opportunity to take part in the Student Small Satellite (SSS) project directed by the Asia Pacific Space Organization (APSCO). The three year-long project is a collaboration between eight countries aimed to give students hands-on experience in satellite engineering. The project aspires to launch one microsatellite and two cubesats in 2020. During the summer camps hosted in Beihang University, China, and Middle Eastern Technical University, Turkey, I worked on activities with students of different academic backgrounds. Such an experience helped me appreciate the advantages of working in an interdisciplinary environment; every individual can add a different perspective when problem-solving. For example, when designing a solar panel for a particular satellite mission, I would have to ask a variety of questions: How much solar radiation would the satellite receive at the particular orbit height? How long will it be in the shadow? How much power will be consumed by the different subsystems? What kind of radiation hardness will be required of the solar cell material? How will I protect the panels from the debris in space? This kind of questioning helped me see that an informed decision can only be made if interdisciplinary participation is fostered. The successful launch of the three satellites next year would mean that every scientist and engineer correctly applied their knowledge in this cool scientific concerto!

UB: What advice do you have for other women interested in science?

QRI: Never feel that having a happy family and a fulfilling career are mutually exclusive. There are countless women who

*“To me, every coffee table was hosting a unique mini-international conference on interdisciplinary research.”*

Quazi Rushnan Islam

balance work and life and still make time for themselves too. Hence, all you need is will power. Also, as a consequence of being offered a rare chance to conduct research at a prestigious institution, many will question whether or not you are deserving of the offer – many will attribute it to being given special treatment for being a woman in the STEM field. However, such questions will become irrelevant when the results of your research are made apparent. Therefore, focus on doing excellent work that advances the field instead of giving weight to peripheral concerns.

UB: In your opinion, what will be the next great breakthrough in physics?

QRI: I am excited to see how the concepts of nanophotonics will revolutionise the solar cell industry. I cannot wait to see the day when solar cell efficiencies skyrocket to the point that non-renewables do not stand a chance when it comes to costs. I hope to be a part of that revolution.

UB: What should be done to increase the number of female scientists and female professors?

QRI: I think there should be more opportunities for female students to connect with senior women mentors working in science. An encouraging phone conversation or talk with a student can help get rid of insecurities. Believe me, you never know what kind of impact someone’s story can have on a younger person walking down a similar path.

UB: What were your highlights of #LINO19?

QRI: I absolutely loved the Open Exchanges with the Nobel Laureates. When a Nobel Prize is awarded, we are mainly informed about the science behind the discovery. However, at the Open Exchanges, I got the opportunity to know the minute details of the countless struggles behind the journey to that discovery. I especially enjoyed asking endless questions at the Open Exchange with Nobel Laureate Donna Strickland –

George Smoot and Quazi Rushnan Islam



to hear about her struggles during her PhD and later in her work life was both heartening and eye-opening. Every person in the room, including me, could relate to the difficulties she had faced.

Furthermore, the random conversations with other young scientists over coffee at the Inselhalle were most enjoyable. In just a few minutes, I learned about the different research cultures in various countries alongside learning about ongoing research projects in biology, chemistry and astrophysics conducted by the young scientists. To me, every coffee table was hosting a unique mini-international conference on interdisciplinary research. I believe you can only get such a rich and diversified environment at Lindau!

» This interview is part of a series of the ‘Women in Research’ blog by biophysicist Ulrike Böhm. The aim of the blog is to increase the visibility of women in science.

» Quazi Rushnan Islam explains her research on solar cell technology in a short video that can be watched on the Lindau Meetings’ YouTube channel.



# 69

## A Bit(e) of Science: The Grill & Chill at #LINO19

At the Grill & Chill at #LINO19, Nobel Laureates, young scientists and citizens of Lindau gathered in an informal, inclusive and culturally diverse atmosphere. Science communicator Andrei Mihai shares his impressions of this get-together.

The 2019 Grill & Chill



Few things are constant in life, and food is most certainly one of them. At the 2019 Lindau Nobel Laureate Meeting citizens of Lindau and meeting participants – including Nobel Laureates as well as young scientists – gathered in lovely Toskanapark for one of the simplest pleasures of life: a barbecue.

The symbolism is remarkable. You usually have a barbecue with your friends and family – and at the Grill & Chill, the crowd felt just like one big group of friends. You could talk to anyone about anything, everything was informal, casual and fun.

This atmosphere of internationality and tolerance is also supported by the host families programme in Lindau. For eleven years already, volunteer host families from Lindau and the surrounding areas have welcomed young scientists from all over the world. This programme allows young scientists to experience Lindau, its people and its culture first-hand, often creating long-lasting friendships. Brigitte Trojan and Hans Schweickert, who have been hosting young scientists for eight years, say they love this opportunity. They are also happy to stay in touch with their guests after the meeting (take note, young scientists).

Degermoos marshland



“You never know who you will get, it’s like a Christmas gift,” Brigitte says. “I am so happy when they write a letter to us, but I understand they are very busy doing science,” she adds in a heartwarming manner.

Across the table, a couple of Afghani refugees don’t speak English, but they converse in perfect German. They’ve been in Lindau for a few years and they love it. Their three-year-old daughter speaks German as a native language. She’d rather play than eat, spreading contagious energy as she runs around.

Meanwhile, other people were more interested in the food. Barbecuing for a thousand people is no easy feat, and the queues snaked around the wooden benches. Some went straight for the Bratwurst, others preferred to have a drink and wait until the queue was smaller. Although it’s safe to say that most people in Lindau are aware of the Lindau Nobel Laureate Meetings, many guests were participating in the Grill & Chill for the first time. It was a great opportunity to spread the word about the meeting and further propagate its message. This was not without effect, and it wasn’t long before children at the event were asking questions about what it’s like to be a scientist and what they need to do in order to become one. Who knew a barbecue can be so good at getting children interested in science?

Close by, Nobel Laureates such as F. Duncan Haldane, Bill Phillips, Serge Haroche and their families were also enjoying the atmosphere. It’s not every day that you get to crack jokes and discuss with Nobel Laureates in an informal way, but this is exactly what makes it so special: everyone is engaging with everyone, and this is what we need more of in the world – particularly in today’s context. In the age of rising nationalism, where research and expertise are sometimes cast aside by populism, showing the world that scientists are just as good-natured and human as everyone else is an important matter. At #LINO19, that’s exactly what’s happening: the human side of science shows up.

All around the park, conversations flowed like water. The interesting part is that the more people talked, the more they came back to common themes like science, culture, society as a whole – a great reminder that our similarities are much larger than our differences. People were acutely aware of rising populism and disinformation and wanted to combat these trends, something which was uplifting. Again, food was a great unifier: what better way to bring people together?

In true Lindau Spirit, sustainability was an important topic, and that was clearly visible at this social gathering. There was no plastic in sight, and waste was kept to a minimum. The food options also reflected this: aside from the traditional Bratwurst and Steak, there were also delicious vegetarian options and salads. The money raised from tickets at the event was rounded up by the organisers and donated to the Mentor Foundation Germany for workshops with students at local schools in Lindau as well as the Degermoos marshland renaturation project – which is a great way to offset the CO<sub>2</sub> emissions produced by meeting participants traveling to Lindau (see pp. 64/65).

All in all, it was a delightful and very useful evening. As they say: a small grill for scientists, but a giant grill for science.





*"I have never interacted with so many international scientists in one space; that's the best thing that has ever happened in my scientific career and it's a memory I will keep for my whole life."*

Katekani Shingange, #LINO19 participant, Council for Scientific and Industrial Research, South Africa

Picture of the International Get-Together, hosted by South Africa



# Inspiring Lindau

## » Explaining the Nobel Prizes

It has become a tradition at the beginning of a new year that the Lindau Nobel Laureate Meetings invite citizens of Lindau to a lecture programme and subsequent reception to celebrate the awarding of the latest Nobel Prizes. In January 2019, two scientific chairmen and two Lindau Alumni gave accessible and entertaining presentations to explain the research findings of the laureates awarded with the Nobel Prize in 2018.

### Presentations

#### THE NOBEL PRIZE IN PHYSIOLOGY OR MEDICINE: JAMES P. ALLISON AND TASUKU HONJO

Henriette Uhlenhaut, Lindau Alumna of the 64<sup>th</sup> Lindau Nobel Laureate Meeting in 2014, professor at the Technical University of Munich, Germany

Wolfgang Lubitz



Henriette Uhlenhaut



#### THE NOBEL PRIZE IN CHEMISTRY: FRANCES H. ARNOLD, GEORGE P. SMITH AND SIR GREGORY P. WINTER

Wolfgang Lubitz, Vice-President of the Council and scientific co-chair of the Lindau Meetings dedicated to chemistry, Director emeritus of the Max Planck Institute for Chemical Energy Conversion, Germany

#### THE SVERIGES RIKSBANK PRIZE IN ECONOMIC SCIENCES IN MEMORY OF ALFRED NOBEL: WILLIAM D. NORDHAUS AND PAUL M. ROMER

Andreas Brunhart, Lindau Alumnus of the 5<sup>th</sup> Lindau Meeting on Economic Sciences in 2014, Head of Research Economics, Liechtenstein Institute

#### THE NOBEL PRIZE IN PHYSICS: ARTHUR ASHKIN, GÉRARD MOUROU AND DONNA STRICKLAND

Rainer Blatt, Member of the Council and scientific co-chair of the Lindau Meetings dedicated to physics, Professor of Experimental Physics at the University of Innsbruck and Scientific Director of the Institute for Quantum Optics and Quantum Information (IQOQI) of the Austrian Academy of Science

### Moderator

Hendrik Groth, Editor-in-Chief, Schwäbische Zeitung

### Partners

City of Lindau  
Schwäbische Zeitung/Lindauer Zeitung  
Sparkasse Memmingen-Lindau-Mindelheim

Andreas Brunhart



## » Time, Einstein, and the Coolest Stuff in the Universe

For this year's Lindau Meeting, 1997 Nobel Laureate in Physics William D. Phillips relocated his laboratory from Maryland (USA) to the Lindau City Theatre for one day. During his live experiment 'Time, Einstein, and the Coolest Stuff in the Universe', Phillips explained basic phenomena in physics as well as his own scientific research in an entertaining and understandable way: What is time? How to explain Einstein's theory of relativity? How does laser cooling work? These and other questions were the focus of a lively presentation.

The event took place on Friday evening before the official opening of the 69<sup>th</sup> Lindau Nobel Laureate Meeting and was especially aimed at interested citizens of Lindau. More than 500 people attended the live experiment and greatly enjoyed the laureate's engaging presentation and his personable manner. At the end of the performance, Phillips answered questions from the audience.

### Presentation

William D. Phillips, Group Leader of the Laser Cooling and Trapping Group at the National Institute of Standards and Technology (NIST), USA

### Moderator

Rainer Blatt, Member of the Council and scientific co-chair of the Lindau Meetings dedicated to physics, Professor of Experimental Physics at the University of Innsbruck and Scientific Director of the Institute for Quantum Optics and Quantum Information (IQOQI) of the Austrian Academy of Science

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Schwäbische Zeitung/Lindauer Zeitung

➤ A video of the life experiment with Bill Phillips can be watched in the mediatheque.





## » Voyager 3

In 1977, NASA sent two identical phonograph records into the Universe on board of the interstellar spacecrafts Voyager 1 and Voyager 2. The 'Voyager Golden Records' contain the compressed knowledge of humankind in the form of images and sounds from the Earth as well as multilingual greetings and musical pieces. The records are meant to reflect the diversity of life and were intended to function as messages for any intelligent extra-terrestrial beings that may find them in the vastness of the Universe.

Which content could be sent today into space on an updated version of the Golden Record, nearly 40 years after the Voyager programme? This question was in the centre of attention during the musical soiree 'Voyager 3' on the final day of the 69<sup>th</sup> Lindau Nobel Laureate Meeting. John C. Mather, 2006 Nobel Laureate in Physics, and German songwriter Gisbert zu Knyphausen nominated, discussed and played their personal favourites for a 'Golden Record Update 2020' together with Swiss musicians Michael Flury und Hank Shizzoe. The evening was open to the public and organised by the Zeughaus Lindau e.V. in cooperation with the Lindau Nobel Laureate Meetings.

### Panelists

- John C. Mather, Senior Scientist at NASA Goddard Space Flight Center, USA
- Gisbert zu Knyphausen, German songwriter and singer
- Michael Flury, Swiss musician and producer
- Hank Shizzoe, Swiss musician and songwriter

### Direction

Verena Regensburger, freelance theatre director

➤ A recording of the Voyager 3 event with John C. Mather is available in the mediatheque.

Hank Shizzoe, John C. Mather, Gisbert zu Knyphausen, Michael Flury



## Queen Silvia in Lindau

The Lindau Nobel Laureate Meetings were honoured to welcome Her Majesty Queen Silvia of Sweden to their premises in Lindau in September 2019. During her visit, the Queen received an introduction to the mission of the annual Lindau Meetings, the unique 'Lindau Spirit' and signed the guest book of the meetings. Queen Silvia was accompanied by Countess Bettina Bernadotte whose roots are in the Swedish Royal Family – her late father Count Lennart Bernadotte, Co-founder of the Lindau Meetings in 1951 and Honorary President of the Council for the Lindau Nobel Laureate Meetings, was the grandson of the later King Gustav V of Sweden who presented the first Nobel Prizes in 1901.

The visit of Queen Silvia took place as part of the 25<sup>th</sup> anniversary of Mentor International. The foundation, which was established by Queen Silvia in 1994, organises workshops and mentoring projects to promote and inspire students. Countess Bettina Bernadotte is the chair of Mentor Foundation Germany. The Lindau Meetings support the foundation through the donations of the annual Grill & Chill event that takes place during the meeting (see pp. 84/85). The donations will be used for projects at schools in Lindau.



Queen Silvia signing the guest book of the Lindau Meetings

» Every year, the donations of the annual Grill & Chill event during the Lindau Meeting are contributed to support projects in the Lindau region. In 2019, the donations were given to the nature conservation project Degermoos (see pp. 64/65) and to Mentor.

Queen Silvia on a guided tour through the Lennart-Bernadotte-Haus





# Impressions

Wolfgang Ketterle and Steven Chu



Stefan Hell



Konstantin Novoselov in exchange with young scientists



Harald zur Hausen during his Laureate Lunch

Coffee break with F. Duncan M. Haldane






# Keeping the ‘Lindau Spirit’

## » Lindau Alumni Network

Attending a Lindau Nobel Laureate Meeting is a once-in-a-lifetime experience for young scientists and young economists that hopefully has a lifelong impact. Lindau Alumni share memories and motivation created by the unique ‘Lindau Spirit’. The alumni initiative of the Lindau Meetings aims to strengthen this community by identifying existing connections and retying loose ends. The connecting centrepiece of this effort is an online social platform: the Lindau Alumni Network.

Launched in 2017 and extensively updated in 2018, the Lindau Alumni Network aims to create a digital space for Lindau Alumni. In addition to a growing database, this online community includes tools that enable users worldwide to share their work, swap stories and find Lindau Alumni events. The Lindau Alumni Network is a further way to educate, inspire and connect.

The Lindau Meetings express their sincere gratitude to the German Federal Ministry of Education and Research for supporting the project. All former and future participants are invited to join this community and to enrich it with their own ideas and perspectives.

 Log in to the Lindau Alumni Network at [lindau-alumni-network.org](http://lindau-alumni-network.org)



## » Lindau Alumni Events

The Lindau Alumni initiative aims to extend the ‘Lindau Spirit’ beyond the boundaries of a weeklong conference. In addition to events organised by the Executive Secretariat in Lindau, meetups and workshops organised on the initiative of Lindau Alumni are an exciting addition to the Lindau Alumni community.

The highlight of the year for the Lindau Alumni initiative was the tour of NASA’s Goddard Space Flight Center (see p. 96). The series of webinars for Lindau Alumni produced by the Lindau Meetings with Alaina Levine has been continued. In April, Lindau Alumni in all career stages received advice on how to establish and leverage a mentoring relationship.

In September 2019, a Lindau Alumni Retreat took place in Heidelberg, Germany, with 13 alumni from the USA, Australia, Germany, Brazil, Romania and Norway. The group discussed research as well as equality in science, open science and mental health in academia. Moreover, Nobel Laureate Harald zur Hausen gave a lecture about his research on nutritional infections as risk factors for human cancers. The retreat was initiated and organised by 2018 Lindau Alumna Tanja Bhuiyan and colleagues.

The Lindau Nobel Laureate Meetings encourage alumni to engage in science outreach projects and in the future will continue to offer member-exclusive opportunities and events as well as seek to support Lindau Alumni in local initiatives.


Nobel Laureate Harald zur Hausen and Lindau Alumni during the Lindau Alumni Retreat



## » Lindau Alumni Peer Review

In 2019, young scientists again had the opportunity to present their research to the Nobel Laureates and the Lindau community in the form of Master Classes and Poster Sessions. As part of their application for these additional formats, young scientists handed in about 430 abstracts in 2019. Continuing a collaboration that started last year, former participants got involved and acted as peer reviewers in the review process for the poster sessions and master classes. Lindau Alumni are closely connected to current, cutting-edge research, have already experienced the Lindau Meetings and are in a unique position to review the work of the new young scientists.

More than 40 Lindau Alumni volunteered to become peer reviewers and as such were actively involved in the meeting this year. We would like to thank all Lindau Alumni reviewers for volunteering their time and expertise and thereby giving back to the Lindau Meetings community. We are looking forward to continuing this successful cooperative effort for the upcoming interdisciplinary 70<sup>th</sup> Lindau Nobel Laureate Meeting and the 7<sup>th</sup> Lindau Meeting on Economic Sciences.

 To find out more about volunteering as a reviewer or to suggest other Lindau Alumni projects, write to [alumni@lindau-nobel.org](mailto:alumni@lindau-nobel.org).

Poster Session at #LINO19





# Lindau in Washington

## » Visit to NASA Goddard Space Flight Center

On 15 February 2019, a group of Lindau Alumni visited NASA Goddard Space Flight Center. The NASA facility in Greenbelt, Maryland, on the outskirts of Washington, D.C., is the place where the COBE (Cosmic Background Explorer) satellite mission was developed and is the home of the Hubble Space Telescope, the James Webb Space Telescope and the future Wide Field Infrared Survey Telescope (WFIRST) missions. Guide for this exceptional event was Nobel Laureate John C. Mather, who received the 2006 Nobel Prize in Physics for his measurements of cosmic microwave background radiation – work he conducted at the Goddard Center with the COBE satellite data.

Nobel Laureate John Mather (centre) and the group in front of the Space Environment Simulator



James Jeletic, Hubble Deputy Project Manager, giving an introduction to the Hubble Space Telescope



John Mather and colleagues showed the group part of the campus, including the Space Environment Simulator, a huge vacuum chamber that can be heated and cooled to test whether equipment can withstand the extreme conditions of space, and a large clean room where components are assembled under sterile conditions. Many Lindau Alumni were particularly impressed by the Hubble Space Telescope's mission control centre. NASA's longest and most successful mission, the telescope is the size of a school bus, is in orbit close to 600 kilometres above the Earth and can be navigated to image objects with such accuracy that it deviates less than a hair's width at a mile's distance. The navigation takes place in a small room that our alumni were allowed to see and explore.

The diverse group of Lindau Alumni from different disciplines, some of whom had travelled from as far away as Germany, Norway and the United Kingdom, also had lunch with John Mather. The visit to NASA Goddard Space Flight Center certainly was the highlight of the year for the Lindau Alumni initiative, whose goal is to extend the 'Lindau Spirit' beyond the boundaries of a weeklong conference.

➤ Find a full recap of the visit to the NASA Goddard Space Flight Center by Lindau Alumna Orsolya Symmons in the Lindau Alumni Network: [www.lindau-alumni-network.org](http://www.lindau-alumni-network.org).

John Mather explains an element of the WFIRST.



## » AAAS 2019 Annual Meeting

The Lindau Nobel Laureate Meetings participated in the American Association for the Advancement of Science (AAAS) 2019 Annual Meeting, which took place 4–17 February 2019 in Washington, D.C.

At a joint booth of the Lindau Meetings and the Heidelberg Laureate Forum Foundation, young scientists received information about participating in the two meetings. Representatives of research institutions and universities could learn more about the global academic partner network, and media representatives were provided with information on covering the meetings.

The theme of the AAAS Annual Meeting was 'Science Transcending Boundaries'. Attendees vigorously debated science's role in society, the importance of fundamental research and international collaboration, especially in the face of global challenges.

Peter Badge, Nikolaus Turner and Lindau Alumna Tolani Olonisakin at the booth of the Lindau Meetings



Jan-Eric Paquet, Director-General for Research and Innovation, European Commission, and Nikolaus Turner



## » Lunch at the German Embassy

On Wednesday, 13 February 2019, the German Embassy in Washington, D.C., invited a select group to a business lunch at the residence of German ambassador Emily Haber on behalf of the Lindau Nobel Laureate Meetings. Guests had the opportunity to meet Nobel Laureates John C. Mather and William D. Phillips and learn more about the Lindau Meetings. The two laureates as well as Lindau Alumnae Martine Abboud, Yeka Aponte and Valerie Darcey acted as perfect advocates for our mission.

During the small gathering for potential partners and supporters on the eve of the AAAS Annual Meeting, Nobel Laureate Bill Phillips appealed for the transcending of boundaries: "The fantastic thing about science is that it has no borders, and anybody who wants to build walls definitely goes in the wrong direction!"

German Ambassador Emily Haber and Lindau Alumnae Valerie Darcey, Martine Abboud and Yeka Aponte





# Sketches of Science

Why not ask Nobel Laureates to make a sketch of the discovery for which they received the Nobel Prize – and then ask them to present their artwork to the camera? This is exactly what German photographer Volker Steger did to create the exhibition 'Sketches of Science' which is an ongoing project of the Foundation Lindau Nobel Laureate Meetings.

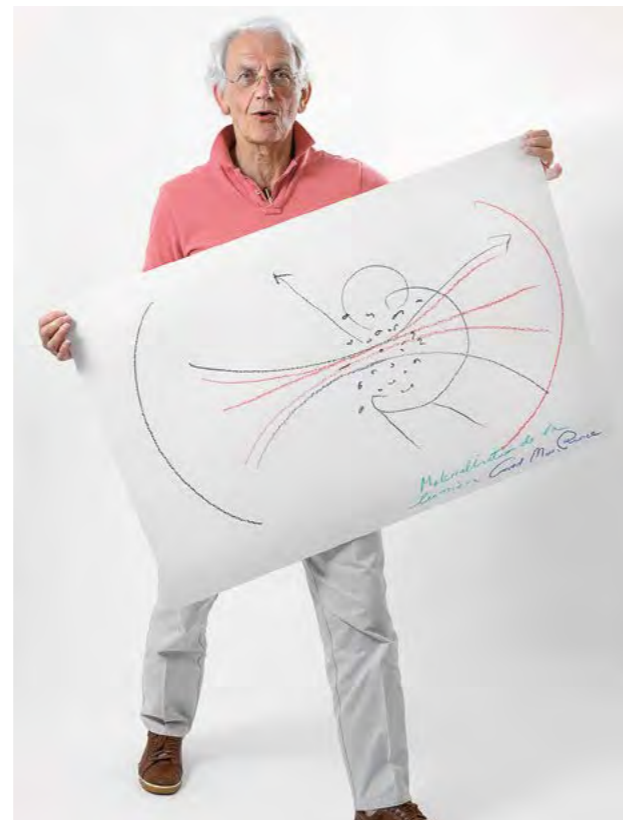
In his photo series, Volker Steger shows a different angle on the people behind the Nobel Prizes. He captures the spontaneity and creativity of Nobel Laureates; the pictures express the enthusiasm of scientists and researchers for their work.

An exhibition of 50 photos of the series was launched at the Nobel Museum in Stockholm in June 2012 and has been on tour around the globe ever since. The following countries have hosted 'Sketches of Science' so far: Germany, Japan, Malaysia, the Russian Federation, Singapore, South Korea, Sweden and the United States.

**Project Partner**  
Nobel Prize Museum, Stockholm

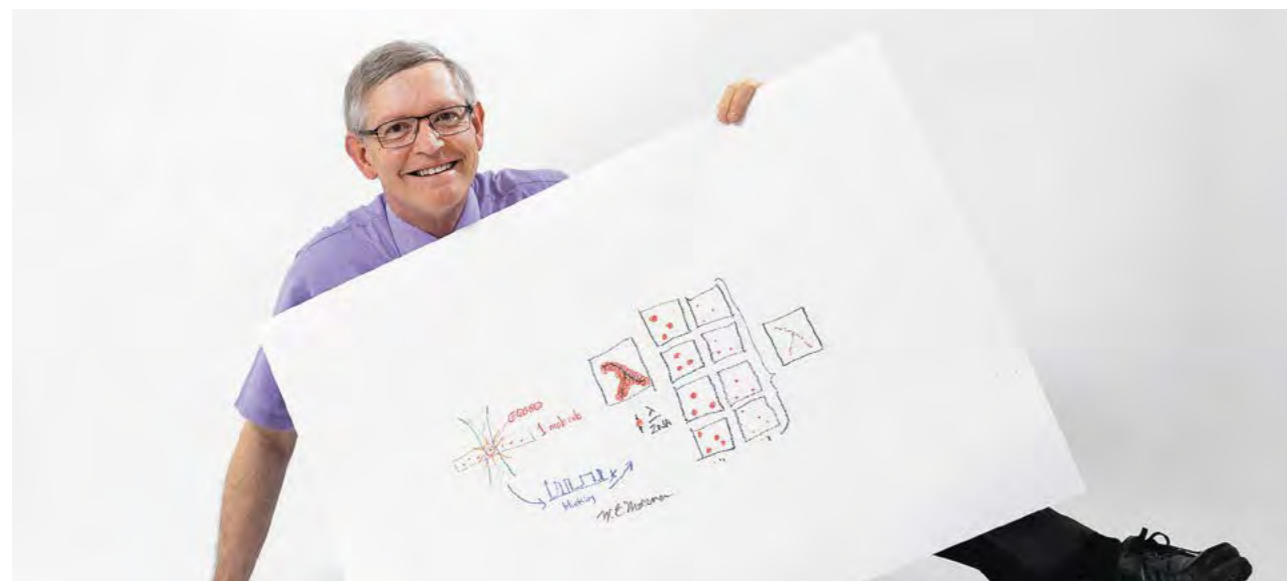
**Principal Funder**  
Klaus Tschira Foundation

 An artbook with a wide selection of sketches is available for download in the mediatheque.



Gérard Mourou and his Sketch of Science at #LINO19

William E. Moerner drew the function of super-resolved fluorescence microscopy at #LINO19.

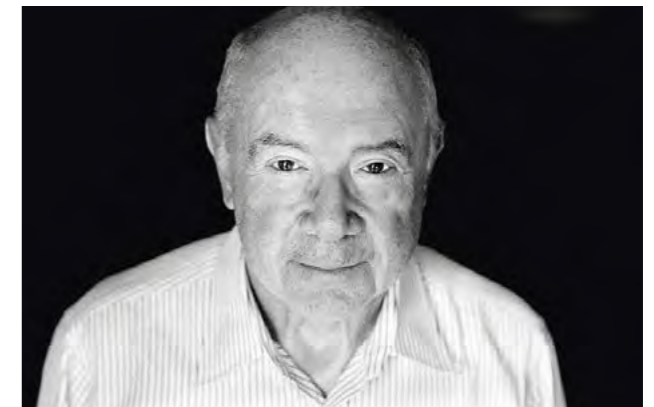


# Nobel Heroes

Since 2000, German photographer Peter Badge has been traveling around the globe on an ambitious mission: to take a picture of every living Nobel Laureate. As part of this long-term project, more than 400 laureates have already been photographed, plenty of them during the Lindau Meetings. Each portrait in this remarkable array of black-and-white photographs reveals a haunting, authentic and fascinating impression of the laureate's unique personality and serves to highlight their scientific, literary or humanitarian achievements.

In 2019, an exhibition of Nobel Laureates photographed by Peter Badge took place at the residence of the Swedish Ambassador, Håkan Juholt, in Reykjavík, Iceland. As welcomed guest of honour, HRH Victoria, Crown Princess of Sweden, was one of the first visitors of the exhibition. Only a few weeks after Her Majesty Queen Silvia of Sweden took a closer look at the permanent exhibition of Badge's photos in the Lennart-Bernadotte-Haus in Lindau (p. 91), her daughter Crown Princess Victoria also had the chance to enjoy a selected number of portraits, including all Swedish laureates, in Reykjavík.

Beyond that, a selection of portraits as well as the coffee table book 'Nobel Heroes' were presented in various locations worldwide, e.g. at the annual meeting of the American Association for the Advancement of Science (AAAS) in Washington, USA.



Johann Deisenhofer photographed by Peter Badge during #LINO19

**Exhibitions 2019**  
Reykjavík, Iceland  
Residence of the Swedish Ambassador  
12 October 2019–12 December 2019

**Project Partner**  
Klaus Tschira Foundation

HRH Victoria, Crown Princess of Sweden, guided through the exhibition in the Swedish Embassy in Reykjavik by Peter Badge





*"Sometimes science can be quite a lonely space.  
But it's not lonely in Lindau."*

Niamh Kavanagh, #LINO19 participant, Tyndall National Institute, Ireland

#LINO19 participants celebrating diversity in STEM on Mainau Island





# The Mediatheque

## » New Content 2019

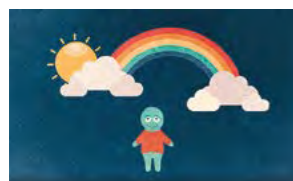
The mediatheque is a unique treasure trove packed with lectures dating back to 1952. Talks from the likes of Nils Bohr, Werner Heisenberg and Dorothy Crowfoot Hodgkin are available as well as the latest lectures from Gérard Morou, Sir Konstantin S. Novoselov and Adam G. Riess from #LINO19. Also, all panel discussions and many Agora Talks have been added. This year, new Mini Lectures and Topic Clusters were created based on the growing collection of video material from the meetings.



### MINI LECTURE: SI SYSTEM

The discoveries of Klaus von Klitzing and Brian D. Josephson that led to their respective Nobel Prizes are also the basis for the redefinition of the

International System of Units. This Mini Lecture shows how and explains why the unit system was redefined.



### MINI LECTURE: LIGHT AND OPTICS

The nature of light is as diverse as its uses. This five-part Mini Lecture explains the dualism of wave and particle and

discusses how the different spectral ranges of light have found their applications in science, medical treatments and everyday life.



### TOPIC CLUSTER ON VIRUSES

The ongoing debate on vaccinations makes the topic cluster on viruses and their nature timely and topical. Utilising historical and more

recent lectures by Nobel Laureates like Françoise Barré-Sinoussi, this cluster gives further insights in this topic and research field.



### TOPIC CLUSTER ON NOBEL FAMILIES

The question whether Nobel Prizes run in families does not just encompass the Curies but also laboratories and

experiments which have led to several Nobel Prizes. True to the proverb 'standing on the shoulders of giants', we trace the history of Nobel Prizes, their recipients and their advisors.

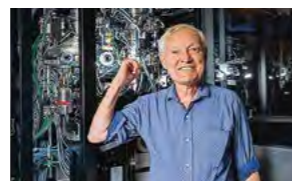
Our Nobel Lab 360° series is particularly interesting for those curious about what the working group and the lab of a Nobel Laureate looks like. The constantly updated mediatheque aims to serve people fascinated by science as well as (young) scientists as a platform for learning and as a space to discover new topics of different disciplines.



### NOBEL LAB 360°: MAY-BRITT AND EDVARD MOSER

Edvard I. Moser and May-Britt Moser received the 2014 Nobel Prize in Physiology or Medicine together with

John O'Keefe "for their discoveries of cells that constitute a positioning system in the brain." Here, they give us a glimpse into their lab at the Kavli Institute for Systems Neuroscience.



### NOBEL LAB 360°: Joachim Frank

Joachim Frank received the 2017 Nobel Prize in Chemistry "for developing cryo-electron microscopy for the high-resolution structure determination of biomolecules in solution". Visit his Nobel Lab to

discover more about Frank's research focus, lab workspace and experimental procedures.



### WEBINARS

The Lindau Meetings host webinars for Lindau Alumni in periodical intervals. These webinars address questions many scientists

encounter: how to find your career path, communicating with the media, networking at conferences etc. Recordings of past webinars are available in the mediatheque.



Recently added to the collection of virtual lab tours: the Nobel Lab 360° of May-Britt and Edvard I. Moser

[mediatheque.lindau-nobel.org](https://mediatheque.lindau-nobel.org)



# Educational Outreach

## » Educational Section Mediatheque

The mediatheque aims to serve as a unique learning infrastructure and research resource for scientists, teachers, students and audiences generally interested in science. Much of the material in the mediatheque is well-suited for use in schools. To meet the rising demand for teaching and didactic material, the Lindau Nobel Laureate Meetings keep expanding this educational section based on the discoveries of Nobel Laureates.

### Teaching Guides

So far, 18 teaching guides have been published covering socio-economic topics as well as various topics in chemistry, physics and medicine. This year, the teaching guide library gained six new lessons. These have been developed in collaboration with Lehrer-Online, one of the leading and most renowned providers of learning materials in German-speaking countries. Each unit consists of a precise lesson design proposal, worksheets and other training materials.

The teaching guides are based on and include mediatheque content: Mini Lectures, Topic Clusters, Nobel Labs 360° and Nobel Posters. This allows for a multimedia approach in schools and lets students and their teachers explore the various topics.

### Didactic Filter

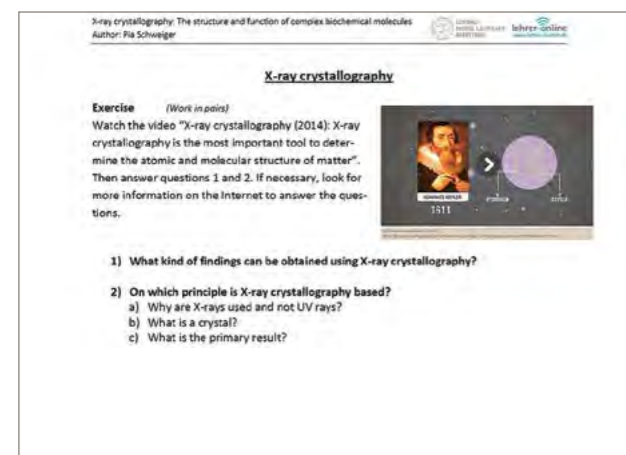
As an additional feature particularly for German and Austrian educators, the didactic filter aligns the contents of the Mini Lectures, the Nobel Labs 360° and the Topic Clusters to curricula of the federal states of Germany and Austria. The content can be filtered according to country, state, subject and level.

### Nobel Posters

Every year, the Swedish Royal Academy of Science and the Karolinska Institute publish posters explaining the discoveries of the Nobel Laureates in Swedish and English. These posters are presented during the Nobel Week in December. The Lindau Nobel Laureate Meetings with the support of the Christa and Hermann Laur-Stiftung translated the posters for the 2018 Nobel Prizes into German and distributed them among secondary schools in Germany, Austria and Switzerland.

Teaching guides and Nobel Posters are available for download in the educational section of the mediatheque.

Teaching Guide on x-ray crystallography in cooperation with Lehrer-Online



The poster explains the Nobel Prize in Physics 2018. Two of the three Nobel Laureates, Gérard Mourou and Donna Strickland, attended #LINO19.



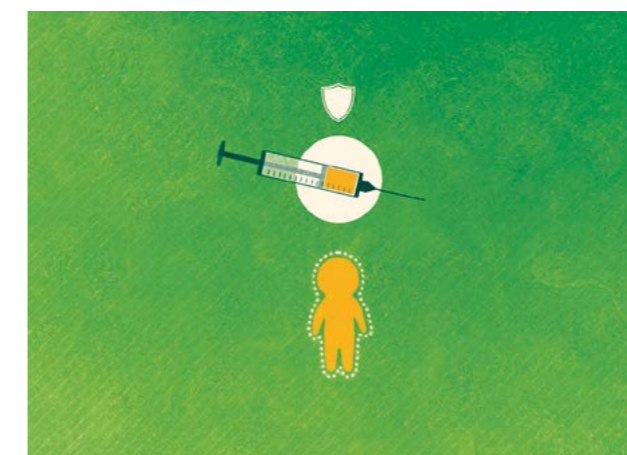
## » Cooperations

The Lindau Nobel Laureate Meetings aim to share the fascination with science and the archived knowledge that is represented by the mediatheque with a larger community, including schools, universities and the general public. This goal can only be achieved by cooperating with other educational content providers. In 2019, the Lindau Meetings extended their cooperation with new partners to reach an even wider audience within the educational sector.

### Cooperation With the German National Library of Science and Technology (TIB)

As part of the Leibniz Association, the German National Library of Science and Technology (TIB) is the leading centre for the digitalisation of scientific and technological content in Germany. Thanks to a cooperation with the TIB, the Lindau Meetings will make historical lectures by Nobel Laureates from 1952 up to today available to a broader audience. The ability of the TIB to catalogue film material and generate transcripts of the respective lectures will help to make the lecture content more easily searchable and accessible to scientists, students and the general public.

One of the most viewed educational materials on the partners' websites was the Mini Lecture on Immunisation.

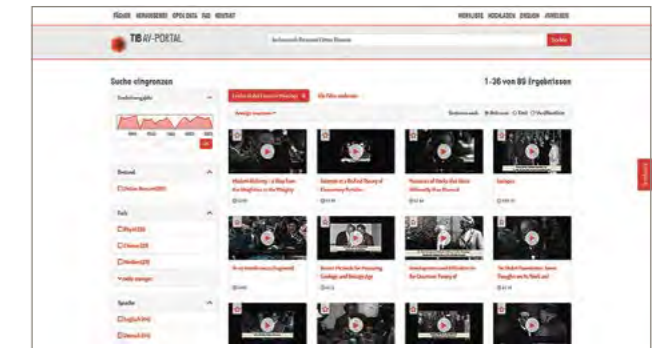


### Cooperation With Educational Content Providers

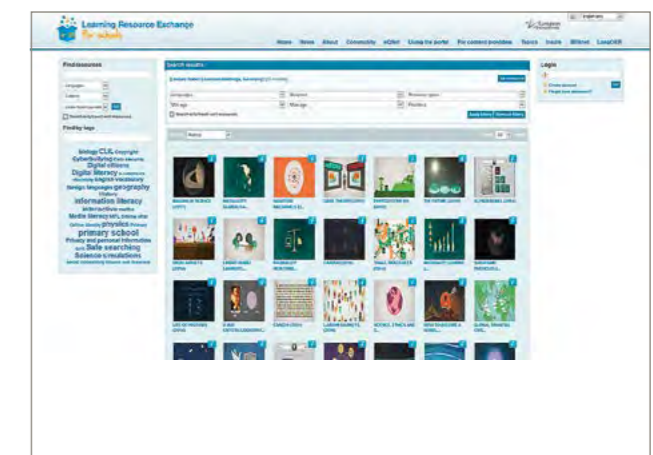
With the aim of imparting and further disseminating scientific information by and about Nobel Laureates, the Lindau Meetings embarked on a strategy to collaborate with non-profit providers of digital educational content, mainly public providers of didactic material for teachers. A selection of videos from the mediatheque that are particularly suitable for use in classrooms can be accessed from the partner's media portal.

A full list of partners can be found in the educational section of the mediatheque.

Videos of historical lectures held in Lindau on the TIB platform



Mini Lectures on the Learning Resource Exchange website



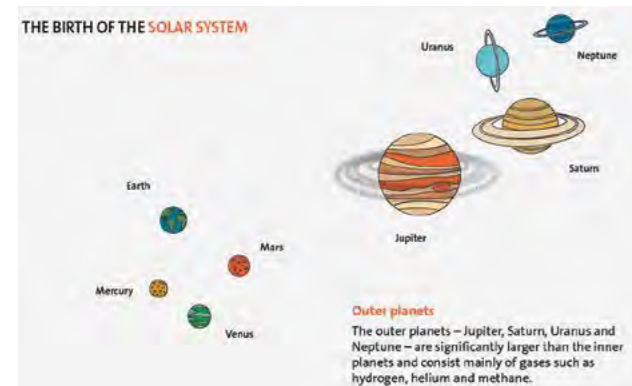


# The Lindau Science Trail

The Lindau Science Trail opened in 2017 and consists of a total of 20 knowledge pylons. Fifteen of them are located on the island of Lindau, two pylons are on the mainland of Lindau and three on Mainau Island. At the pylons, visitors can learn more about the everyday applications of scientific phenomena that have been honoured with the Nobel Prize.

The pylons cover the three natural science disciplines – physics, chemistry and physiology or medicine – as well as economic sciences, peace and literature. One pylon at the Lennart-Bernadotte-Haus in Lindau gives insights into the longstanding history of the Lindau Nobel Laureate Meetings. Since 2019, a pylon at the new Lindau Nobel Laureate Pier provides interesting facts about the Nobel Prize. All information is available in English as well as in German.

Participants of 'Teaching Spirit' exploring the Lindau Science Trail during #LINO19



## Guided Tours

With a special children's section on every pylon, the trail invites students and schools to discover the exciting world of science. Guided tours around the trail can be booked as part of school trips to Lindau.

## Mobile App

A mobile app expands the Lindau Science Trail on-site: by means of augmented reality functions, one can meet virtual Nobel Laureates at various places in Lindau. They describe why they received the Nobel Prize and explain more about their research. With numerous quiz questions, the app also allows users to test their freshly acquired knowledge on a Science Rallye.

## Virtual Science Trail

The web-based Virtual Science Trail takes users on a virtual walk through the existing science trail – irrespective of space and time. The pylons can be easily located through a vivid online map containing site pins to access any chosen pylon. Impressive panoramic images enriched with multimedia elements ensure a truly immersive navigation experience. The Virtual Science Trail, available in both German and English, reaches out to an even wider audience as the trail can be explored from afar.

The Lindau Science Trail could be realised thanks to the support of the Beisheim Stiftung and the City of Lindau.

 The Virtual Science Trail can be accessed at [www.wissenspfad.de](http://www.wissenspfad.de).

The new knowledge pylon at the Lindau Nobel Laureate Pier provides interesting facts about the Nobel Prize.



# Engaging Future Generations

## » School Visit

To inspire the younger generation and to actively involve local students in the Lindau Nobel Laureate Meetings, the Council organises a visit of a local school for one of the participating Nobel Laureates every year. The school visit is part of the Lindau Meetings' 'Mission Education'.

During #LINO19, Klaus von Klitzing, 1985 Nobel Laureate in Physics, visited the Valentin-Heider Gymnasium in Lindau to give a captivating talk about science and research. Von Klitzing explained the definition of the kilogramme that was revised in May 2019 together with the other six base units – the second, the meter, the ampere, the kelvin, the mole and the candela. He also introduced metrology, the science of measurement, by emphasising the importance of natural constants in the past as well as in the present.

The detailed lecture was followed by a lively exchange with the students, in which von Klitzing provided insights into his personal background, his research and career path. Spending nearly two hours with Klaus von Klitzing, the high school students grasped a little of the Lindau Spirit and the world of science.

Klaus von Klitzing explaining his research to high school students



## » Teaching Spirit

Scientific curiosity and a passion for research can be instilled at a young age in children, especially when teachers go above and beyond in sharing that passion with their students. Therefore, every year the Lindau Nobel Laureate Meetings invite a select number of excellent teachers to honour their educational performance and dedication and to provide them with new impulses for their work.

Twenty dedicated physics teachers from Germany, Austria and Switzerland were invited to take part in two days of the 69<sup>th</sup> Lindau Nobel Laureate Meeting. Their programme included lectures, panel discussions and a workshop organised jointly with the Ludwig-Maximilians-Universität München (LMU). During a lunch with several Nobel Laureates, the Bavarian Evening and the Baden-Württemberg Boat Trip to Mainau Island they also had the opportunity to mingle with the participants of #LINO19.

Teaching Spirit participants during physics experiments at #LINO19





# Impressions

Baden-Württemberg Boat Trip to Mainau Island



Robert Huber and his wife on their way to the opening concert



Young scientists in the Lindau city centre

Young scientists and Nobel Laureates partying at the International Get-Together





# Communications

## » Media Representatives

Media representatives from outlets such as Times Higher Education, Scientific American, La Nación, FAZ, YTN Science Korea, Focus, Nature, Physics World and many others from all around the world were present at #LiNO19.

About 100 journalists and communications professionals from 20 countries used the unique opportunity of a Lindau Meeting to engage with Nobel Laureates and young scientists and to gather material on interesting topics from science and research. Members of the media were able to attend the various lectures, Agora Talks, panel discussions, special press events as well as highlights of the social programme. As usual, the Lindau Meetings assisted with organising interviews with the participants.

Continuing the efforts of the last few years, the Lindau Meetings provided travel grants to outstanding science journalists from more remote countries.

Two of Germany's most renowned dailies, Frankfurter Allgemeine Zeitung (left) and Süddeutsche Zeitung, covered #LiNO19 in editorial supplements.



Journalists discuss with the panellists during the Press Talk.



## » Media Partnerships

The Lindau Meetings nurture long-term relationships with a number of premier media partners. The following partners played a key role in covering the Lindau Meetings:

- Bayerischer Rundfunk & ARD-alpha
- Deutsche Welle
- Nature Publishing Group
- Schwäbische Zeitung with Lindauer Zeitung

Representatives of several German public broadcasting stations taped segments showcasing the special interactions during the meeting week. For the Bavarian news format Rundschau, Nobel Laureate Klaus von Klitzing and young scientist Jana Lasser met and talked about their work. Germany's national public educational TV station ARD-alpha met young scientist Nelson Darkwah Oppong in his lab at the Ludwig-Maximilians-Universität München and accompanied him on his Science Walk with Nobel Laureate Bill Phillips.

Young scientist Nelson Darkwah Appong being interviewed for ARD-alpha/ Bayerischer Rundfunk



## » Press Talk

### THE END OF INTERNATIONAL COLLABORATIONS IN SCIENCE? HOW NATIONALISM THREATENS AN OPEN SCIENTIFIC WORLD

Today, international collaborations are common and foster advances in fundamental research. Large multinational projects such as CERN, ITER, ESO, SKA etc. are good examples of an open society, where partnerships without barriers are normal and not something extraordinary. At the 69<sup>th</sup> Lindau Meeting, accredited journalists were invited to join a panel discussion on the pressing question of whether the recent rise in nationalist movements globally has an impact on this kind of international scientific cooperation. Nobel Laureate Konstantin Novoselov debated with Rolf-Dieter Heuer and young scientists Lakshmi Balasubramaniam and Henry Enniful on the degree to which developments like Brexit will have an impact on large-scale international scientific collaboration.

#### Panellists

- Lakshmi Balasubramaniam, Institut Jacques Monod, Université Paris Diderot, France
- Henry Enniful, Felix Bloch Institute for Solid State Physics, Leipzig University, Germany
- Rolf-Dieter Heuer, President of the SESAME Council and former Director-General of the European Organization for Nuclear Research (CERN), Germany
- Konstantin Novoselov, Nobel Laureate in Physics (2010), University of Manchester, United Kingdom, and National University of Singapore

#### Moderator

Lea Albrecht, science journalist, Deutsche Welle, Germany

Young scientist Henry Enniful with Rolf-Dieter Heuer



## » Press Conference

### LASER PHYSICS

with the 2018 Nobel Laureates in Physics Gérard Mourou and Donna Strickland

With their invention of the method of chirped pulse amplification (CPA), Gérard Mourou and Donna Strickland could produce high-intensity, ultra-short laser pulses which led to many advances in high-precision machining. During a press conference for accredited journalists and media representative, Mourou and Strickland answered questions on this invention and a broad field of other topics, ranging from the accidental discovery of CPA's use as a tool in medicine to the importance of women in research and the implications of their newfound Nobel fame.

#### Moderator

Alaina Levine, President, Quantum Success Solutions, USA

Nobel Laureates Donna Strickland and Gérard Mourou with Alaina Levine



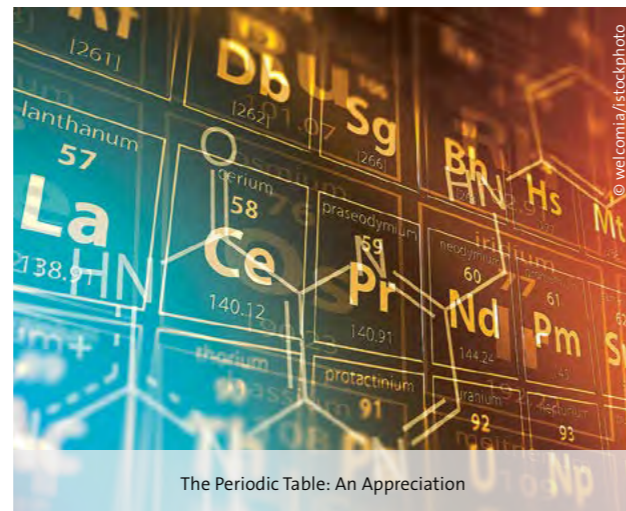


# The Lindau Meetings Online

## » Blog

The blog of the Lindau Nobel Laureate Meetings features background stories on the Lindau Meetings, interviews with participants as well as research news and science history targeted at a broad audience. Over the years, science writers, young scientists, Lindau Alumni and Nobel Laureates have contributed and helped turn the blog into the central online platform and content hub of the Lindau Meetings.

➤ This is just a small selection of the topics covered in 2019. For more please visit [lindau-nobel.org/blog](http://lindau-nobel.org/blog)



## » Social Media

Connecting people to share ideas has always been part of the Lindau Meetings' mission. In 2019, the 'Lindau Spirit' was once again present on social media.

### Facebook

The official Facebook page of the Lindau Nobel Laureate Meetings reaches more than 15,000 followers. We update our community on news from Lindau, share our own and our partners' content and engage in vivid discussions on science-related topics. During the meeting week, science comedian Brian Malow posted interviews with young scientists as popular Facebook Live videos.

### Twitter

During the meeting, participants, Lindau Alumni and users at home engaged on Twitter using the hashtag #LINO19 and created a digital space for discussion, insightful comments and observations on the social programme. The hashtag #LINO19 trended in Germany on the first day of the meeting. Throughout the year, we share news, videos and other related content with our engaged followers.

### YouTube

Like last year, a number of short interviews with Nobel Laureates and young scientists were produced by UK-based Econ Films and have been added to the Lindau Meetings' YouTube channel, including a discussion between Nobel Laureate Brian Schmidt and members of Fridays for Future Lindau. The Mini Lectures we released this year are also available on YouTube, a medium widely used by a younger audience.

### LinkedIn

The Lindau Meetings are also present on LinkedIn. Since last year, we've been using the networking community for professionals to create and nurture relationships with partners and friends of Lindau. LinkedIn is a particularly ideal platform to reconnect with Lindau Alumni and to refer them to the Lindau Alumni Network.

### Instagram

A growing audience engages with us on Instagram, sharing photographic highlights from the Lindau Meetings as posts and interactive Instagram stories, especially during the meeting week. Throughout the year, we share visual highlights of the meeting as well as news on our outreach activities and other digital content.

### Flickr

Hundreds of pictures from past Lindau Meetings are accessible to everyone on our Flickr page, be it to relive memories of their meeting participation or to find high-quality pictures for reports on the Lindau Meetings. Editorial use is free, but the copyrights must be acknowledged accordingly.

### Meeting App

The official meeting app has become an established digital extension of the meeting programme. All participants could download the app onto their iOS and Android devices, create their own personal timetables, submit questions for the panel discussions and stay in the loop on all relevant, up-to-date information on the programme sessions.

The official hashtag #LINO19 was prominently featured onstage.





# Video Coverage

## » Interviews

For the 69<sup>th</sup> Lindau Nobel Laureate Meeting, we continued our collaboration with London-based Econ Films to produce a series of short interviews during the meeting week. The videos feature Nobel Laureates, young scientists and guests alike. The topics of the interviews vary, from intergenerational advice and nationalism's effect on science to 3D printing on a nano-scale and confidence in your scientific work. The interviews were distributed through social media.

➤ All interviews are available on the Lindau Meetings' YouTube channel.



Adam Riess and Vivien Bonvin in conversation



Brian Schmidt and Fridays for Future Lindau

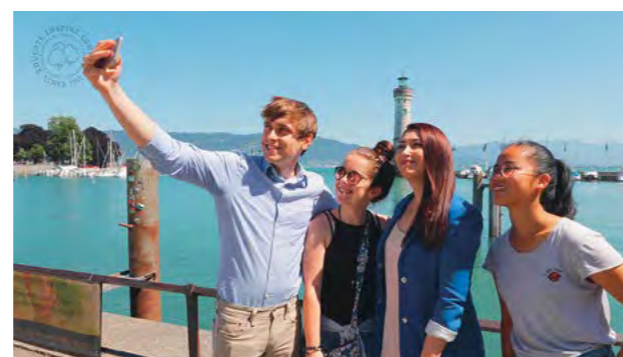
## » The Spirit of Connection

Two new short films, produced during the 69<sup>th</sup> Lindau Nobel Laureate Meeting, showcase the unique Lindau Spirit. 'The Spirit of Connection' highlights the connections made during the meeting week, using statements by Nobel Laureates, young scientists, Lindau Alumni and representatives of our supporters and partners. In 'A Young Scientist's Journey', the viewer accompanies Margoth Córdova Castro as she travels from London to Lindau, meets fellow young scientists and Nobel Laureates and experiences the meeting week.

➤ Both films are available on our YouTube page and our social media profiles.



'The Spirit of Connection'



'A Young Scientist's Journey'

## » Live Videos

Science writer and comedian Brian Malow attended the 69<sup>th</sup> Lindau Nobel Laureate Meeting and, for the third year in a row, recorded videos live on Facebook with young scientists, talking about their work, their background and their Lindau experience. The Facebook Live videos gathered up to 8,000 views.

➤ You can find all #LINO19 Facebook Live videos on the Lindau Meetings' Facebook page.



Brian talks to young scientists Kirti and Lakshmi.



Young scientist Samuel Hinton with Brian Malow live on Facebook

## » Golden Record of Science

The Lindau Meetings continued the collaboration with a production team from the Filmakademie Baden-Württemberg to create a new opening video for the 69<sup>th</sup> Lindau Nobel Laureate Meeting, taking a humorous, fictional interstellar view on the Lindau Meetings' community in three chapters. The film was shot at Haus der Astronomie in Heidelberg, Germany.

➤ Find the opening videos in our mediatheque.



Opening Film #LINO19



Opening Film #LINO19





*"Lindau connects scientists with diverse experiences and an immense passion for science. I left with a spirit full of energy and renewed curiosity."*

Latifah Al-Maghrabi, #LINO19 participant, King Abdullah University of Science and Technology, Saudi Arabia

Baden-Württemberg Boat Trip to Mainau Island



# The Council and the Foundation

## » The Council

The Council for the Lindau Nobel Laureate Meetings was founded in 1954, three years after the first Lindau Meeting, to secure their existence and shape their future development. Count Lennart Bernadotte, one of the three founders of the meetings, became the first president of the Council. He was followed by his wife Countess Sonja in 2004 and then by his daughter Countess Bettina in 2008, who still chairs the Council.

The purpose of the non-profit Council is to organise the annual meetings. This includes the establishment and maintenance of close relations with scientific partners worldwide. The Council maintains an executive secretariat at Lindau.

### Honorary President

Count Lennart Bernadotte af Wisborg †

### Board

Countess Bettina Bernadotte af Wisborg  
President

Wolfgang Lubitz  
Vice-President

Helga Nowotny  
Vice-President

Nikolaus Turner  
Treasurer

### Members

Rainer Blatt  
Thomas Ellerbeck (Spokesman)  
Klas Kärre  
Stefan H. E. Kaufmann  
Jürgen Kluge  
Heiner Linke  
Hartmut Michel  
Torsten Persson  
Reinhard Pöllath  
Klaus Schmidt

### Corresponding Members

Lars Bergström  
Astrid Gräslund  
Hans Jörnvall  
Sten Orrenius

### Permanent Guests

Gerhard Ecker  
Urs Schwager

Council meeting in Munich in March 2019: Countess Bettina Bernadotte, Wolfgang Lubitz, Jürgen Kluge, Lars Bergström and Rainer Blatt



## » The Foundation

The Foundation Lindau Nobel Laureate Meetings was established in the year 2000 by 50 Nobel Laureates. To date, 343 Nobel Laureates are members of its Founders Assembly (pp. 120/121).

The Foundation's general objective is to promote science, research and related societal activities. In particular, its main purpose is to ensure the continuance and further development of the Lindau Meetings. This includes the support of outreach projects and initiatives.

The Foundation is registered on Mainau Island. In the interest of a close collaboration with the Council, the office of the Foundation is also based in Lindau.

### Honorary Presidents

Count Lennart Bernadotte af Wisborg †  
Roman Herzog †

### Honorary Chairman

Wolfgang Schürer

### Board of Directors

Jürgen Kluge  
Chairman

Nikolaus Turner  
Managing Director

Countess Bettina Bernadotte af Wisborg  
Thomas Ellerbeck  
Reinhard Pöllath

Thomas Ellerbeck, Reinhard Pöllath, Jürgen Kluge, Countess Bettina Bernadotte, Nikolaus Turner





# Founders Assembly

The Foundation Lindau Nobel Laureate Meetings was established in 2000 by 50 Nobel Laureates, the Bernadotte family and Council members. Through their membership in the Founders Assembly, Nobel Laureates demonstrate their strong support of the Lindau Meetings. As of September 2019, 343 Nobel Laureates constitute the assembly.

Alexei Abrikosov	Jimmy Carter
Peter Agre	Thomas R. Cech
Martti Ahtisaari	Martin Chalfie
Isamu Akasaki	Georges Charpak
George A. Akerlof	Yves Chauvin
Svetlana Alexievich	Steven Chu
Zhores Alferov	Aaron Ciechanover
Maurice Allais	Ronald H. Coase
James P. Allison	Stanley Cohen
Sidney Altman	Claude Cohen-Tannoudji
Hiroshi Amano	Leon Cooper
Philip W. Anderson	Elias J. Corey
Werner Arber	John Warcup Cornforth
Frances H. Arnold	Mairead Corrigan Maguire
Kenneth J. Arrow	James W. Cronin
Arthur Ashkin	Paul J. Crutzen
Robert J. Aumann	Robert F. Curl jr.
Richard Axel	Angus Deaton
Julius Axelrod	Hans G. Dehmelt
David Baltimore	Johann Deisenhofer
Barry C. Barish	Peter A. Diamond
Francoise Barré-Sinoussi	Peter C. Doherty
Gary S. Becker	Renato Dulbecco
J. Georg Bednorz	Christian de Duve
Baruj Benacerraf	Gerald Edelman
Paul Berg	Manfred Eigen
Hans A. Bethe	Robert Engle
Eric Betzig	François Englert
Bruce A. Beutler	Richard R. Ernst
Gerd Binnig	Gerhard Ertl
J. Michael Bishop	Leo Esaki
James Black	Martin J. Evans
Elizabeth H. Blackburn	Eugene F. Fama
Günter Blobel	John B. Fenn
Nicolaas Bloembergen	Bernhard L. Feringa
Baruch S. Blumberg	Albert Fert
Paul D. Boyer	Edmond Fischer
Sydney Brenner	Ernst Otto Fischer
James M. Buchanan	Robert W. Fogel
Linda Buck	Joachim Frank
William Campbell	Jerome Friedman
Mario R. Capecchi	Milton Friedman

Robert F. Furchgott
D. Caletan Gajdusek
Andre Geim
Murray Gell-Mann
Riccardo Giacconi
Ivar Giaever
Walter Gilbert
Alfred G. Gilman
Vitaly L. Ginzburg
Donald Glaser
Sheldon L. Glashow
Roy J. Glauber
Joseph L. Goldstein
Mikhail Gorbachev
Clive Granger
Paul Greengard
David J. Gross
Robert H. Grubbs
Peter Grünberg
Roger Guillemin
John B. Gurdon
F. Duncan M. Haldane
Jeffrey Hall
John L. Hall
Theodor W. Hänsch
Lars Peter Hansen
Serge Haroche
Oliver Hart
Lee Hartwell
Herbert A. Hauptman
Harald zur Hausen
Richard F. Heck
Alan C. Heeger
Stefan W. Hell
Richard Henderson
Dudley R. Herschbach
Avram Hershko
Antony Hewish
Peter Higgs
Jules A. Hoffmann
Roald Hoffmann
Bengt Holmström
Tasuku Honjo
Gerardus 't Hooft
H. Robert Horvitz
David H. Hubel
Robert Huber
Russel Hulse
John Hume
Timothy Hunt

Leonid Hurwicz
Andrew F. Huxley
Louis Ignarro
Brian D. Josephson
Daniel Kahneman
Takaaki Kajita
Eric R. Kandel
Charles K. Kao
Jerome Karle
Tawakkol Karman
Martin Karplus
Imre Kertész
Wolfgang Ketterle
Har Gobind Khorana
Lawrence R. Klein
Frederik Willem de Klerk
Klaus von Klitzing
Aaron Klug
Makato Kobayashi
Brian K. Kobilka
Walter Kohn
Arthur Kornberg
Roger D. Kornberg
Masatoshi Koshiba
J. Michael Kosterlitz
Edwin Krebs
Herbert Kroemer
Harold W. Kroto
Finn Kydland
Willis E. Lamb
Robert Laughlin
Paul C. Lauterbur
Leon M. Lederman
David M. Lee
Tsung-Dao Lee
Yuan Tseh Lee
Robert J. Lefkowitz
Jean-Marie Lehn
Rita Levi-Montalcini
Michael Levitt
Edward B. Lewis
Tomas Lindahl
William N. Lipscomb
Robert E. Lucas Jr.
Alan G. MacDiarmid
Roderick MacKinnon
Peter Mansfield
Rudolph A. Marcus
Harry M. Markowitz
Barry Marshall

Toshihide Maskawa
Eric S. Maskin
John C. Mather
Arthur B. McDonald
Daniel L. McFadden
Simon van der Meer
Craig C. Mello
Bruce Merrifield
Robert C. Merton
Hartmut Michel
James A. Mirrlees
Paul Modrich
William E. Moerner
Mario Molina
Luc Montagnier
Dale T. Mortensen
Rudolf Mößbauer
Edvard Moser
May-Britt Moser
Gérard A. Mourou
Karl Alexander Müller
Kary B. Mullis
Robert A. Mundell
Ferid Murad
Joseph E. Murray
Roger B. Myerson
Shuji Nakamura
Yoichiro Nambu
John F. Nash jr.
Ei-ichi Negishi
Erwin Neher
Marshall Nirenberg
Douglass C. North
Konstantin S. Novoselov
Ryoji Noyori
Christiane Nüsslein-Volhard
Paul M. Nurse
Yoshinori Ohsumi
John O'Keefe
George A. Olah
Satoshi Ōmura
Douglas Osheroff
Arno Allen Penzias
Saul Perlmutter
Edmund S. Phelps
William D. Phillips
Christopher A. Pissarides
John Polanyi
John Pople
Lord George Porter

Edward C. Prescott
Ilja Prigogine
Venkatraman Ramakrishnan
José Ramos-Horta
Norman F. Ramsey
Robert Richardson
Burton Richter
Adam G. Riess
Richard J. Roberts
Heinrich Rohrer
Paul M. Romer
Michael Rosbash
Joseph Rotblat
Alvin E. Roth
James E. Rothman
F. Sherwood Rowland
Carlo Rubbia
Bert Sakmann
Paul A. Samuelson
Bengt Samuelsson
Aziz Sançar
Frederick Sanger
Juan Manuel Santos
Thomas J. Sargent
Kailash Satyarthi
Jean-Pierre Sauvage
Andrew V. Schally
Randy W. Schekman
Thomas C. Schelling
Brian P. Schmidt
Myron S. Scholes
John Robert Schrieffer
Richard R. Schrock
Melvin Schwartz
Reinhard Selten
Amartya Sen
Phillip A. Sharp
William F. Sharpe
K. Barry Sharpless
Lloyd S. Shapley
Dan Shechtman
Robert J. Shiller
Osamu Shimomura
Kai M. Siegbahn
Christopher A. Sims
Ellen Johnson Sirleaf
Jens C. Skou
Richard Smalley
George E. Smith
George P. Smith

Hamilton O. Smith
Michael Smith
Vernon L. Smith
Oliver Smithies
George F. Smoot
Wole Soyinka
Robert M. Solow
Jack Steinberger
Ralph M. Steinmann
Thomas A. Steitz
Joseph E. Stiglitz
J. Fraser Stoddart
Donna Strickland
Thomas C. Südhof
John Sulston
Aung San Suu Kyi
Akira Suzuki
Jack W. Szostak
Henry Taube
Joseph H. Taylor
David J. Thouless
Samuel C. C. Ting
Jean Tirole
Susumu Tonegawa
Charles H. Townes
Tomas Tranströmer
David Trimble
Roger Y. Tsien
Daniel C. Tsui
Desmond Mpilo Tutu

Mario Vargas Llosa
Harold E. Varmus
Martinus J. G. Veltman
John E. Walker
Robin Warren
Ariel Warshel
James D. Watson
Rainer Weiss
Thomas H. Weller
Carl E. Wieman
Eric F. Wieschaus
Elie Wiesel
Torsten N. Wiesel
Frank Wilczek
Maurice H.F. Wilkens
Jody Williams
Robert Wilson
David J. Wineland
Gregory P. Winter
Kurt Wüthrich
Rosalyn Yalow
Shinya Yamanaka
Mo Yan
Chen Ning Yang
Ada E. Yonath
Michael W. Young
Muhammad Yunus
Ahmed Zewail
Rolf Zinkernagel



Recent addition to the Founders Assembly: Tasuku Honjo, Nobel Laureate in Physiology or Medicine 2018



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The members of the most prestigious committee of the Foundation Lindau Nobel Laureate Meetings, the Honorary Senate, function as advisors to the board and distinguished ambassadors for the cause of the Lindau Meetings. With their considerable experience and expertise, they are dedicated to advance the values and aims of Lindau's 'Mission Education'.

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Klaus Kleinfeld, member of the Honorary Senate of the Foundation, at the 69<sup>th</sup> Lindau Nobel Laureate Meeting

# In Memoriam



Zhores Alferov  
1930–2019

**Nobel Laureate  
in Physics 2000**

**Lindau Meeting:  
2001**



Manfred Eigen  
1927–2019

**Nobel Laureate  
in Chemistry 1967**

**Lindau Meetings:  
1969, 1971, 1972, 1974, 1975,  
1977, 1978, 1980, 1983, 1990,  
1995, 2000, 2002, 2005, 2007,  
2008, 2010**



Murray Gell-Mann  
1929–2019

**Nobel Laureate  
in Physics 1969**

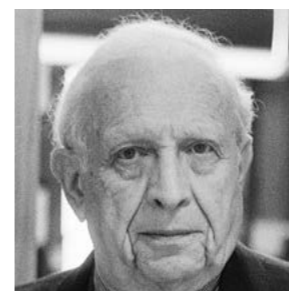
**Lindau Meeting:  
1994**



Riccardo Giacconi  
1931–2018

**Nobel Laureate  
in Physics 2002**

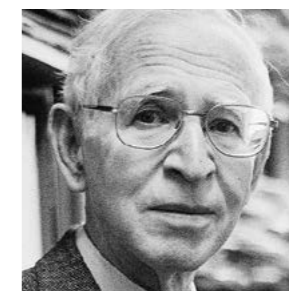
**Lindau Meetings:  
2004, 2005, 2008**



Roy Glauber  
1925–2018

**Nobel Laureate  
in Physics 2005**

**Lindau Meetings: 2006, 2008,  
2010, 2012, 2013, 2015, 2016**



Sir Aaron Klug  
1926–2018

**Nobel Laureate  
in Chemistry 1982**

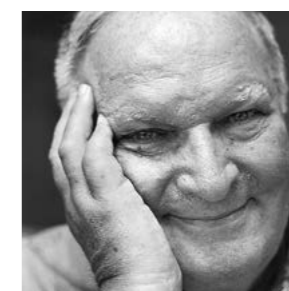
**Lindau Meetings:  
2002, 2005**



Kary B. Mullis  
1944–2019

**Nobel Laureate  
in Chemistry 1993**

**Lindau Meetings:  
2000, 2005**



John R. Schrieffer  
1931–2019

**Nobel Laureate  
in Physics 1972**

**Lindau Meetings:  
1973, 1982, 1985**



# Impressions

HRH Princess Maha Chakri Sirindhorn of Thailand and Countess Bettina Bernadotte



Nikolaus Turner and Jón Atli Benediktsson, Rector of the University of Iceland, signing a new memorandum of understanding



Memorandum of understanding with the National Research Foundation (NRF), Singapore: Wei Yang Cheong, Deputy CEO NRF, Teck Seng Low, CEO NRF and Jürgen Kluge



Christiane Haupt and Ilka Schießler-Gäbler from the Max Planck Society talking to young scientists



Participants of the academic dinner hosted by Bayer AG

Participants of a Zeppelin flight supported by the Helmholtz Association





# Organisation

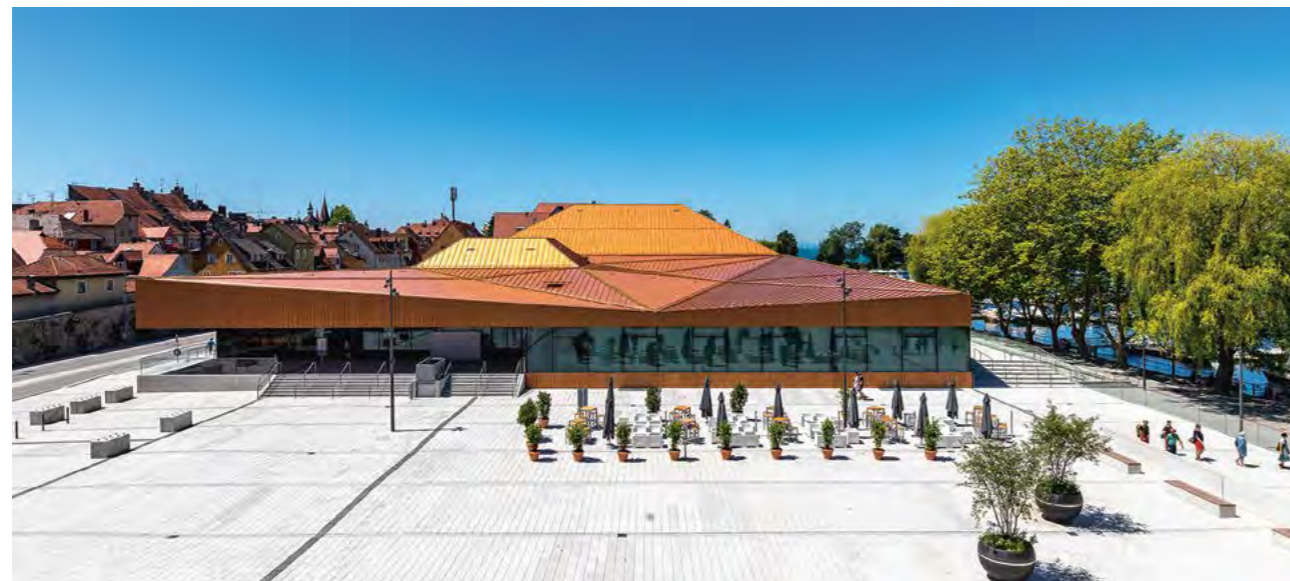
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<b>Secretariat</b> Margit Stütze	

Inselhalle Lindau – the venue of the Lindau Meetings



## » Preliminary Account 2019: Expenditures

	(in Euro)
<b>Travel</b>	
Nobel Laureates	177,969.23
Young Scientists	3,251.72
Media	6,388.82
Others	28,490.50
<b>Lodging</b>	
Nobel Laureates	73,046.00
Young Scientists	296,096.40
Media	9,779.00
Others	62,892.30
<b>Boarding</b>	
Nobel Laureates	19,235.94
Young Scientists	225,542.63
Media	7,533.20
Others	37,121.61
<b>Meeting Organisation</b>	
Scientific Programme & Selection of Young Scientists	12,068.27
Rental Fees Locations	104,372.64
Technical Equipment	215,312.12
Utilities & Services	48,601.37
On-Site Staff	116,632.18
Transfers	24,332.75
Supporting Programme	37,393.62
Printed Matters	48,059.00
Expendable Items	11,434.96
Audio, Video & Web Productions	81,211.58
Science & Media Services	67,669.92
Website	6,251.77
Telecommunications, Postage	27,067.21
IT Services, Hardware, Software	79,583.16
Accounting, Legal Advice, Insurances	41,420.70
Other Costs	16,438.18
<b>Executive Secretariat</b>	
Staff	836,451.62
Office Operating Costs	117,729.54
Office Supplies & Equipment	8,042.62
<b>Expected Total Expenditures</b>	<b>2,847,420.56</b>

Please note:  
The total expected costs include € 340,907.17 of expected costs for October–December 2019.  
The budget does not include costs of the meeting covered directly by the Foundation.



## » Preliminary Account 2019: Revenues

**Grants, donations, funds and donations in kind from the Significant Meeting Benefactors** (Academy of Science of South Africa, Bayerisches Staatsministerium für Wissenschaft und Kunst, Bundesministerium für Bildung und Forschung (BMBF), Germany, Dieter Schwarz Stiftung gGmbH, Foundation Lindau Nobel Laureate Meetings and their endowment contributors, Klaus Tschira Stiftung gGmbH, Mars, Incorporated, Rolex SA, Wilhelm und Else Heraeus-Stiftung), **Principal Benefactors** (AKB Stiftung – Stiftung der Familie Carl-Ernst Büchting, BASF SE, Bayer Science & Education Foundation, BMW AG, Beisheim Stiftung, Bundesministerium für Bildung, Wissenschaft und Forschung (BMBWF), Austria, Carl Zeiss AG, Carl Zeiss Stiftung, Deutsche Forschungsgemeinschaft (DFG), International Lake Constance Conference (IBK), Jacobs Foundation, Land Baden-Württemberg, Max-Planck-Gesellschaft zur Förderung der Wissenschaften e.V. (MPG), Merck KGaA, National Research Foundation, Singapore), **Benefactors** (Alexander S. Onassis Public Benefit Foundation, Christa und Hermann Laur-Stiftung, Continental Division Chassis & Safety Lindau, Deutscher Akademischer Austauschdienst (DAAD), Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e.V., Hans und Wolfgang Schleussner-Stiftung, Helmholtz-Gemeinschaft Deutscher Forschungszentren e.V., Jörnvall Foundation, Jones Day, Lennart-Bernadotte-Stiftung, Ludwig-Maximilians-Universität München, Mainau GmbH, Mineralbrunnen Teinach GmbH mit Tochterunternehmen, Ministerium für Wissenschaft, Forschung und Kunst Baden-Württemberg, Peter-Dornier-Stiftung, PwC PricewaterhouseCoopers AG, rose plastic AG, Sixt SE, Sparkasse Memmingen-Lindau-Mindelheim, Spielbank Lindau, Staatliche Lotterieverwaltung (Bayern), Stadt Lindau (B), Stadtwerke Lindau (B) GmbH & Co. KG, Stiftung van Meeteren, The Nobel Foundation, Ubuntu-Stiftung Lüneburg, Warth & Klein Grant Thornton GmbH & Co. KG, Wissenschaftsgemeinschaft Gottfried Wilhelm Leibniz e.V., Würth-Gruppe), **Contributors** (Anton Heine GmbH Fidelisbäck, Förderverein Römerbad e.V., Gabriele David, Lighthouse GmbH, Meckatzer Löwenbräu Benedikt Weiß KG, Steinhauser GmbH, Tchibo GmbH, Wein- und Obstgut Haug), **from anonymous benefactors, and from the Foundation Lindau Nobel Laureate Meetings with its Principal Maecenates** (Klaus Tschira Stiftung gGmbH, Mars, Incorporated), **Maecenates** (AstraZeneca, Bayer AG, Ecoscientia Stiftung, Freistaat Bayern – Bayerisches Staatsministerium für Wissenschaft und Kunst, Microsoft Corporation, Robert Bosch GmbH, Rolex SA, SAP SE, Thomas Schmidheiny, Verband der Bayerischen Metall- und Elektroindustrie), **Principal Patrons** (Bertarelli Foundation, Carl Zeiss Stiftung, Monika and Wolfgang Schürer, National Research Foundation, Singapore, Novartis International AG, Siemens AG, Südwestmetall Verband der Metall- und Elektroindustrie Baden-Württemberg e.V., Swiss Reinsurance Company Ltd, Verein der Bayerischen Chemischen Industrie e.V.), **Patrons** (Deutsche Telekom Stiftung, LafargeHolcim Ltd),

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<b>Total Revenues*</b>	<b>€ 2,847,420.56</b>
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**\*Note:**

The calculated revenues refer to the meetings and selected outreach projects. Deficits have been covered by the Foundation Lindau Nobel Laureate Meetings as guaranteed to the Council for the Lindau Nobel Laureate Meetings.



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70<sup>th</sup> Lindau Nobel Laureate Meeting  
Interdisciplinary  
28 June–3 July 2020  
#LINO20

7<sup>th</sup> Lindau Meeting on Economic Sciences  
25–29 August 2020  
#LINOecon

71<sup>st</sup> Lindau Nobel Laureate Meeting  
Chemistry  
27 June–2 July 2021  
#LINO21



# Imprint

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69<sup>th</sup> Lindau Nobel Laureate Meeting  
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