

News Review



The Nobel Prize Winners in the Natural Sciences for the Year 2022

Introduction

The awarding of Nobel Prizes began from the year 1901. Award founder Alfred Bernhard Nobel, a Swedish, was known as chemist, engineer, inventor, businessman, and philanthropist. He with 355 different patents, dynamite being the most famous one, left his fortune to the Nobel Prize institution. According to his will in 1895, five separate prizes in the fields of Physics, Chemistry, Physiology or Medicine, Literature, and Peace are awarded. In 1968, the sixth prize was established in the field of Economic Sciences. However, it is not a “Nobel Prize” but considered as a “Nobel Memorial Prize” sponsored by the Sveriges Riksbank in Memory of Alfred Nobel. Nobel prizes are widely regarded as the most prestigious awards available in the respective fields and are awarded to those who have conferred the greatest benefit to humankind during the preceding years.

Between 1901 and 2022, the Nobel Prizes and the Nobel Memorial Prize were awarded 615 times to 989 people and organizations. Fourteen laureates and organizations were awarded Nobel

Prize and Nobel Memorial Prize in 2022 as follows:

- Nobel Peace Prize to human rights advocate Ales Bialiatski (Born: 1962), Russia and two organizations -the Russian human rights organization Memorial and the Ukrainian human rights organization Center for Civil Liberties “for work to promote human rights, democracy and peaceful coexistence in the neighbouring countries of Belarus, Russia and Ukraine”
- Nobel Prize in Literature to the French author Annie Ernaux (Born: 1940), “for the courage and clinical acuity with which she uncovers the roots, estrangements and collective restraints of personal memory”
- Three Nobel Memorial Prize in Economic Sciences to three Americans Ben S. Bernanke (Born: 1953), Douglas W. Diamond (Born: 1953) and Philip H. Dybvig (Born: 1955), “for research on banks and financial crises”
- Seven Nobel laureates from Natural Sciences - three from Physics, three from Chemistry and one from Physiology or Medicine.

The Nobel Prize in Physics 2022

The Nobel Prize in Physics 2022 was awarded to Frenchman Alain Aspect, American John F. Clauser and Austrian Anton Zeilinger. Prize motivation was “experiments with entangled photons, establishing the violation of Bell inequalities and pioneering quantum information

science”. They discovered the way that unseen particles, photons, can be linked or entangled with each other, even when they are separated by large distances.

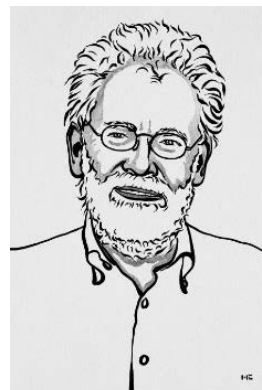
Bell inequalities make it possible to differentiate between quantum mechanics’



Alain Aspect



John F. Clauser



Anton Zeilinger

indeterminacy and an alternative description using secret instructions, or hidden variables. The Northern Irish physicist John Stewart Bell (1928–1990), who worked at CERN, the European particle physics laboratory, took a closer look at the problem. He discovered that there is a type of experiment that can determine whether the world is purely quantum mechanical, or whether there could be another description with hidden variables. According to Bell's inequality, if the experiment is repeated many times, all theories with hidden variables show a correlation between the results that must be lower than, or equal to, a specific value. However, quantum mechanics can violate this inequality. Experiments have shown that nature behaves as predicted by quantum mechanics. When two or more particles exist in a shared state, regardless of how far apart they are - it is called entanglement. When two particles are in entangled quantum states, someone who measures a property of one particle can immediately determine the result of an equivalent measurement on the other particle without checking. What happens to one particle in an entangled pair, determines what happens to the other, even if they are really too far apart to affect each other. Using groundbreaking experiments, Alain Aspect, John Clauser and Anton Zeilinger have demonstrated the potential to investigate and control particles that are in entangled states. This entangled quantum states hold the potential for new ways of storing, transferring and processing information.

Alain Aspect was born on 15 June, 1947 in Agen, France. He did his PhD in 1983 from Paris-

Sud University, Orsay, France. He is a Professor at Institut d'Optique Graduate School Université Paris-Saclay and École Polytechnique, Palaiseau, France. Alain Aspect developed experiment using a new way of exciting the atoms so they emitted entangled photons at a higher rate. He could also switch between different settings, so the system would not contain any advance information that could affect the results.

John F. Clauser was born on 1 December, 1942 in Pasadena, CA, USA. He did his PhD in 1969 from Columbia University, New York, USA. At the time of the award J.F. Clauser & his Associates were affiliated with Walnut Creek, CA, USA. John Clauser became interested in the fundamentals of quantum mechanics in 1960s when he was a student. He could not shake off John Bell's idea once he had read about it and eventually, he and three other researchers were able to present a proposal for a realistic type of experiment that can be used to test Bell inequality. In 1972, along with doctoral student Stuart Freedman (1944–2012), he was able to show a result that was a clear violation of Bell inequality. John Clauser used calcium atoms that could emit entangled photons after he had illuminated them with a special light.

Anton Zeilinger was born on 20 May, 1945 in Ried im Innkreis, Austria. He did his PhD in 1971 from University of Vienna, Austria. He is a Professor at University of Vienna, Austria. For conducting more tests of Bell inequalities, he created entangled pairs of photons by shining a laser on a special crystal. Even in one experiment he used signals from distant galaxies. Interesting

things happen if the particles in an entangled pair travel in opposite directions and one of them then meets a third particle in such a manner that they become entangled. They then enter a new shared state. The third particle loses its identity, but its original properties have now been transferred to the solo particle from the original pair. This way of transferring an unknown quantum state from one particle to another is called quantum teleportation. This type of experiment was first conducted in 1997 by Anton Zeilinger and his colleagues and the entanglement swapping was first demonstrated in 1998 by Anton Zeilinger's research group.

In a short time, researchers around the world have found many new ways to utilize the most powerful property of quantum mechanics. Entangled quantum states have now been demonstrated between photons that have been sent through tens of kilometres of optical fibre, and between a satellite and a station on the ground. Intense research and development on the fundamentals of quantum mechanics are underway to utilize the special properties of individual particle systems to construct quantum computers, build quantum networks and establish secure quantum encrypted communication.

The Nobel Prize in Chemistry 2022



Carolyn R. Bertozzi



Morten Meldal



K. Barry Sharpless

The Nobel Prize in Chemistry 2022 was awarded jointly to American Carolyn R. Bertozzi, Danish Scientist Morten Meldal and American K. Barry Sharpless “for the development of click chemistry and bioorthogonal chemistry”.

The 2022 Nobel Prize in Chemistry is about making difficult processes easier. Morten Meldal and Barry Sharpless – independently of each other – presented what is now the crown jewel of click chemistry: the copper catalysed azide-alkyne cycloaddition. This is an elegant and efficient chemical reaction that is now in widespread use. Among many other uses, it is utilised in the development of pharmaceuticals, for mapping DNA and creating materials that are fit for the purpose. Sharpless and Meldal have brought chemistry into the era of functionalism

and laid the foundations of click chemistry in which molecular building blocks snap together quickly and efficiently without producing lot of unwanted side-products. Carolyn Bertozzi has taken click chemistry to a new dimension and started utilising it in living organisms. Their field of research can be used to design better medicines. These reactions are now used globally to explore cells and track biological processes. Using bioorthogonal reactions, researchers have improved the targeting of cancer pharmaceuticals, which are now being tested in clinical trials.

Carolyn R. Bertozzi was born on 10 October 1966, USA, did her PhD in 1993 from UC Berkeley, CA, USA. Her affiliation at the time of the award is with Anne T. and Robert M. Bass Professor at Stanford University, CA, USA and

Investigator, Howard Hughes Medical Institute, USA. She is only the eighth woman to win the chemistry prize in Nobel history.

Morten Meldal was born in 1954, Denmark. He did his PhD in 1986 from Technical University of Denmark, Lyngby, Denmark and his affiliation at the time of the award is with the University of Copenhagen, Copenhagen, Denmark.

K. Barry Sharpless was born on 28 April, 1941, Philadelphia, PA, USA and did his PhD in 1968 from Stanford University, CA, USA.

His affiliation at the time of the award is as W. M. Keck Professor Scripps Research, La Jolla, CA, USA. Around the year 2000, he coined the concept of click chemistry. It is his second Nobel Prize in chemistry, his first Nobel Prize being in 2001 for work on “chirally catalysed oxidation reactions”.

Prof Gill Reid, the president of the Royal Society of Chemistry said of the winners. “Their work has incredible potential for applications in human health and medicines and the possibilities are incredibly exciting.”

The Nobel Prize in Physiology or Medicine 2022

The 2022 Nobel Prize in Physiology or Medicine is awarded to Swedish geneticist Svante Pääbo for his discoveries concerning the genomes of extinct hominins and human evolution. His pioneering work is on ancient DNA, in particular, sequencing the genetic code of the Neanderthal, an extinct relative of modern humans.

We are interested to know - where do we humans come from, and how are we related to extinct hominins? The question of our origin remains the focus of intense interest and discussion. Through the ground breaking discoveries, Pääbo opened a new window to our evolutionary past. It reveal an unexpected complexity in the evolution and admixture of ancient hominins. In 2010, Svante Pääbo succeeded in sequencing the genome of the Neanderthal. Svante Pääbo in 1990 was recruited to the University of Munich and he was determined to reach his goal. Pääbo set out on his ambitious quest to study the Neanderthal genome. He first turned for access to the precious remains that he needed as a source of material. Fortunately, he obtained a piece of a Neanderthal humeral bone from the collection of this type specimen from Rheinisches Museum in Bonn, Germany. Pääbo founded the institute in Leipzig, Germany in 1999. He helped study of paleogenetics, prehistoric humans and Neanderthals using ancient genetic materials. He and his team discovered a new human species called the Denisovans, which helped map the evolution of humans and trace their migration.



Svante Pääbo

He also found that gene transfer had occurred from these now extinct hominins to Homo sapiens following the migration out of Africa around 70,000 years ago. It also provides the basis for an improved understanding of genetic features that make us uniquely human. This ancient flow of genes to present-day humans has physiological relevance today, as an example it affects how our immune system reacts to infections.

Svante Pääbo, born on 20 April 1955 in Stockholm, Sweden, is a Swedish geneticist who specialises in the field of evolutionary genetics. As one of the founders of paleogenetics, he has worked extensively on the Neanderthal genome. His father, biochemist Sune Bergstrom, shared the Nobel Prize in Physiology or Medicine with Bengt I. Samuelsson and John R. Vane in 1982, “for

discoveries concerning prostaglandins and related substances”. However, Svante Pääbo credits his mother, the late chemist Karin Pääbo, for encouraging his interests in archaeology and science.

At the time of the award, Svante Pääbo was affiliated with Max Planck Institute for Evolutionary Anthropology, Leipzig, Germany, Okinawa Institute of Science and Technology, Okinawa, Japan. Apart from 2022 Nobel prize in physiology or medicine, various awards achieved by him are - Gottfried Wilhelm Leibniz Prize (1992), Max Delbrück Medal (1998), Louis-Jeantet Prize for Medicine (2005), Pour le Mérite (2008), Kistler Prize (2009), Great Cross of Merit with star (2009), Gruber Prize in Genetics (2013), Lomonosov Gold Medal (2014), Foreign Member of the Royal Society (2016), Breakthrough Prize in Life Sciences (2016), Keio Medical Science Prize (2016), Princess of Asturias Award (2018), Darwin–Wallace Medal (2019), Japan Prize (2020), Massry Prize (2021). Pääbo wrote about his sexuality, family, and work in his 2014 memoir, “Neanderthal Man – In Search of Lost Genomes.”

Conclusion

The prestigious Nobel Prizes are awarded annually and Nobel Prize season begins every October as committees in Sweden and Norway name laureates in the variety of fields. Generally the Nobel Prize winners are invited to receive their awards at prize ceremonies held on December 10, the anniversary of Alfred Nobel’s death in 1896. The prize includes a diploma, a gold medal and a monetary award of 10 million Swedish kronor (about \$900,000). All awards are presented in Stockholm, the capital of Sweden except the Nobel Peace Prize which is handed out in the Norwegian capital, Oslo.

Alain Aspect (France), John F. Clauser (USA), and Anton Zeilinger (Austria) have been

awarded the 2022 Nobel Prize in Physics for their groundbreaking experiments on demonstrating the violation of Bell inequalities. Their experiments, so called entangled quantum states have implications in the fields of quantum computers, quantum networks and secure quantum encrypted communication. Albert Einstein talked about spooky action at a distance and Erwin Schrödinger said it was quantum mechanics’ most important trait. The first quantum revolution gave us transistors and lasers, but we are now entering a new era of tools to construct quantum computers, build quantum networks and establish secure quantum encrypted communication.

The 2022 Nobel Prize in Chemistry is about making difficult processes easier. K. Barry Sharpless (American) and Morten Meldal (Danish) have laid the foundation for a functional form of chemistry ‘click chemistry’, in which molecular building blocks snap together quickly and efficiently. It is like methods to connect molecules in essentially the same way we build legos. Click chemistry and bioorthogonal reactions have taken chemistry into the era of functionalism. This is bringing the greatest benefit to humankind. The reactions developed by the winners have led scientists to make new types of biomolecules and create materials that can deliver cancer drugs precisely where they are needed in human patients.

The 2022 Nobel Prize in Physiology or Medicine went to Swedish scientist Svante Pääbo for discoveries about human evolution achieved through analyses of the DNA of Neanderthals and other ancient relatives of modern humans. His extraordinary discovery has proved modern humans share DNA with extinct relatives Neanderthals and Denisovans. The Swedish scientist provided key insights into our immune system and what makes us unique compared with our extinct cousins.

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N.B.: Information collected from various Internet sites and different news papers.

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