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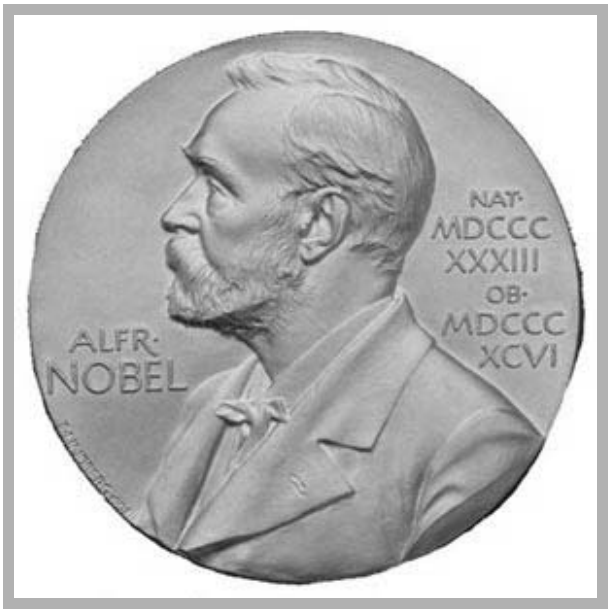
The Basics: 2011 Nobel Prizes in Chemistry, Physics, and Medicine

The first three 2011 Nobel Prizes went to scientists who helped to show how the body's immune system works, that the structure of crystals is weirder than scientists had believed, and that the universe is flying apart at an ever-faster pace.

BY STEPHANIE WARREN



Physics

We may think of Nobel Prize–worthy discoveries as those that find the answers to big scientific questions. But this year's Nobel in physics was a little different—it honors the discovery of a mystery.

Three U.S.-born astrophysicists will split the $1.5 million award: Saul Perlmutter, at Lawrence Berkeley National Laboratory; Adam Riess, at Johns Hopkins University; and Brian Schmidt, at the Australian National University. During the 90s, they worked on two separate teams—Perlmutter on one, Riess and Schmit on the other—racing to track how the universe was expanding.

What they expected to find was that the universe's expansion—going on since the big bang 13.7 billion years ago—was slowing down, because the universe's 100 billion galaxies all pull on one other. But when they tracked the speed of supernovae, they saw, to their surprise, that the universe's rate of expansion is actually speeding up with each passing minute.

At the time, their discovery garnered skepticism. But subsequent studies confirmed the find. Scientists still don't know why the universe seems to be resisting gravity's pull and expanding outward faster and faster, and that's led to the idea of dark energy—the mysterious proposed force that pushes the universe apart.

Chemistry

In 1982, Israeli scientist Daniel Shechtman at the Israel Institute of Technology discovered quasicrystals, a chemical structure previously believed impossible. Shechtman was examining a mixture of aluminum and manganese under a microscope when he saw a pattern of crystals that seemed to contradict the laws of chemistry. Scientists didn't believe the discovery at first—Shechtman was even kicked out of his research group. But 29 years later he's a Nobel Prize winner.

Before Shechtman's discovery, crystals were thought of as orderly arrangements of atoms that form a repeating pattern. But the crystals Shechtman saw under his microscope had a different kind of symmetry—pentagonal symmetry. The pattern these crystals make when packed together is mathematically regular, but it cannot be repeated. Thus, the discovery of quasicrystals overturned a fundamental belief about chemistry.

Before long, other scientists began to corroborate Shechtman's discovery. Some remembered seeing similar patterns in the past but dismissing them as mistakes. It turned out that crystallographers had been seeing quasicrystals for years without realizing what they were looking at. Now, quasicrystals have been synthesized in labs for many years, and in 2009, the first naturally occurring quasicrystals were discovered in a new mineral in a river in eastern Russia. Quasicrystals are extremely hard and poor conductors of heat, so scientists are experimenting with them for use in razor blades, needles, LEDs and surface coatings for frying pans.

Medicine

The winners of the Nobel Prize in medicine revolutionized our understanding of how our own immune systems protect us from disease. In the 1990s, Bruce Beutler at the Scripps Research Institute in La Jolla, California, and Jules Hoffman, who headed a research laboratory in Strasbourg, France, discovered the receptor proteins that recognize a foreign invader such as bacteria and activate the body's immune response. Twenty years earlier, Ralph Steinman of Rockefeller University discovered dendritic cells, responsible for the next stage of our body's defense—our adaptive immune response. Dendritic cells are present in tissues that make contact with the outside environment, like the skin and lungs. They produce antibodies that destroy infections. Once the infection has been destroyed, the body remembers it, and the next time that same microorganism attacks, the body can produce the antibodies more quickly and powerfully.

Together, these discoveries made it possible to develop new vaccines to fight infections and to encourage the immune system to attack tumors. Indeed, Steinman prolonged his own life as he battled pancreatic cancer by using a treatment derived from his own research into dendritic cell. Sadly, Steinman passed away last week before he could find out that he'd been honored with the Nobel prize. Nobel prizes are not awarded posthumously, but because the committee had made its decision before they knew about Steinman's death, it was ruled on Monday that the award will stand.

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