

Discoveries and explanations

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In May 1498 Christopher Columbus set out from the Spanish port of Sanlúcar de Barrameda on his third and final voyage across the Atlantic. When he reached the broad delta of the Orinoco River, he deduced that the river drained a vast continent, which he presumed to be Asia. When Amerigo Vespucci encountered the same delta in 1503, he realized he had found a new continent, the New World.

Writing in 1922, British historian Richard Lodge pithily compared the two explorers: “Columbus remains the discoverer of America and Vespucci its explainer.”

Lodge’s distinction between discoverers and explainers also arises in physics. In 1928 Paul Dirac incorporated special relativity into the quantum mechanics of the electron. His equations predicted negative energy states that could not be dismissed, even though the states implied, weirdly, that electrons spontaneously switch charge from negative to positive or that positively charged electrons exist.

Dirac did not ignore the nettlesome negative states. Three years later he published a paper in which he boldly predicted the existence of antimatter. In 1932 Carl Anderson published his discovery of particles that behaved like positive electrons. He named them positrons. Unaware of Dirac’s paper, he did not cite it.

Arnold Penzias and Robert Wilson were initially unaware of predictions that the universe is pervaded by a uniform background of microwave radiation left over from the Big Bang. The source of a weak signal that they had found in their horn antenna in 1964 mystified them. But when Penzias and Wilson learned that a Princeton team had begun looking for the predicted cosmic background, whose emission resembled what they had found, they realized the significance of their detection. Penzias and Wilson’s discovery and the Princeton team’s explanation were published side by side in the August 1965 issue of the *Astrophysical Journal*.

Some momentous discoveries await explanation. In 1983 I took an astronomy course at Imperial College London as part of my physics BSc. During one class the lecturer sheepishly admitted that he and his fellow astronomers did not know what most of the universe is made of. But he did give the mysterious component a name: dark matter.

The lecturer also cited the strongest evidence at the time for dark matter: measurements by Vera Rubin of stars in the outskirts of spiral galaxies. Working at Kitt Peak and Cerro Tololo, Rubin used a sensitive spectrometer designed and built by her colleague, Kent Ford. In a paper published in 1980, the two

astronomers wrote: “The conclusion is inescapable that non-luminous matter exists beyond the optical galaxy.”

Anderson, Penzias, and Wilson were awarded Nobel Prizes for their discoveries. Rubin, who died this past December, was not (her obituary appears on page 73). In an op-ed that appeared in the *New York Times* in January, particle theorist and cosmologist Lisa Randall contended that Rubin deserved the prize. In making her case, Randall noted legitimate objections to Rubin’s cause. Evidence for the existence of dark matter comes not only from galaxy rotation curves. Other astronomers did more than Rubin and Ford to interpret the curves. Still, the significance of Rubin and Ford’s observations outweighs the objections in the view of Randall and others, me among them.

When I read Randall’s op-ed, I was reminded of one of the first feature articles I edited for *PHYSICS TODAY*, “A Nobel tale of postwar injustice” by Elisabeth Crawford, Ruth Lewin Sime, and Mark Walker, which appeared in September 1997 (page 26). The three historians had consulted the Royal Swedish Academy of Sciences archives to find out why Lise Meitner did not share the 1944 Nobel Prize in Chemistry with Otto Hahn for their discovery, with Fritz Strassmann, of nuclear fission, or why she and her nephew, Otto Frisch, were not awarded the 1946 Nobel Prize in Physics for their physical explanation of fission, despite being nominated by Niels Bohr. From the records of the deliberations in the 1940s, Crawford, Sime, and Walker concluded that Meitner had been excluded for a variety of reasons, including the inability of the academy’s chemistry prize committee to evaluate an interdisciplinary discovery that involved physics.

Only two women, Marie Curie and Maria Goeppert Mayer, have been awarded the Physics Nobel. Some commentators, including Randall, have argued that Meitner, Rubin, and other eminent women physicists missed out on Nobel Prizes because of bias against their sex. Sexism was not among the reasons that Crawford, Sime, and Walker found in Meitner’s case. But they were working from formal written reports. Sexism and other prejudices need not be voiced to take their pernicious effect. **PT**



LOOK FOR Elisabeth Crawford, Ruth Lewin Sime, and Mark Walker’s article about Lise Meitner on **PHYSICS TODAY’S WEBSITE.**