

## BOOK REVIEWS

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## HISTORICAL NOTES

### Remembering John Bardeen in his centenary year: The physicist who shared two Nobel Prizes

*Bhupati Chakrabarti*

Marie Curie was the first person to receive the Nobel Prize twice when she won the 1911 Nobel Prize in Chemistry. Her first Nobel Prize was in Physics in 1903 that she had shared with her husband, Pierre Curie and French scientist, Henri Becquerel. It took more than fifty years for another person to emulate the feat, when Linus Pauling received his second Nobel Prize in Peace in 1962, his first one being in Chemistry in 1954. Then it was the turn of John Bardeen. When Bardeen shared the 1972 Nobel Prize with Leon Cooper and Joseph Schrieffer for their theory of superconductivity, he became the first scientist to receive two Nobel Prizes in one discipline. Marie Curie and Linus Pauling won their second Nobel Prizes in disciplines that were different from the first ones. Later on, Frederick Sanger achieved a similar distinction as that of Bardeen, when he shared the Nobel Prize in Chemistry in 1980. He was the sole winner of the Nobel Prize in Chemistry in 1958.

During the first quarter of the 20th century, breakthroughs that were achieved by physicists also brought about changes in the study of some branches of chemistry. The atomic structure was revealed, the nucleus was discovered, the behaviour of electrons began to become clearer and quite naturally the borderline of physics and chemistry became somewhat fuzzy.

That led to Marie Curie's selection for the second Nobel Prize in Chemistry.

Bardeen's father was a Professor in a Medical College. Bardeen completed his BS in electrical engineering from Wisconsin University and MS in the same discipline. Then he started research in geo-



physics. In the late 1920s, Bardeen along with his supervisor Peters, joined Gulf Research Laboratory and did commendable work in geophysics. In fact, the physical principles were being applied to the geological work of oil-prospecting. However, Bardeen always had the inclination to work in a university atmosphere. So he resigned from Gulf Oil and joined

Princeton University to do his Ph D. Here he came in touch with E. P. Wigner, who also went on to win a Nobel Prize in 1963, after Bardeen's first Nobel Prize. Bardeen became interested in solid-state physics. J. van Vleck who taught Bardeen different aspects of theoretical physics, was also a Nobel laureate in later life and received the Nobel Prize in Physics in 1977 after Bardeen's second Nobel Prize. Bardeen was also attracted towards physics after listening to lectures from the visiting faculty in the university, including Paul Dirac, Werner Heisenberg and Arnold Sommerfield. This is in fact one of the many examples where top-level scientists in a field have inspired researchers and students to take a plunge in a subject with more vigour.

Bardeen completed his Ph D from Princeton and then joined the University of Minnesota in 1938, where he worked till 1941 before joining the *Naval Ordnance Laboratory* as a civilian physicist to render service in research related to war, as was done by a large number of scientists during that period both in Europe and USA. However, it appears that this sort of work on applied research was not his cup of tea. That possibly explains why he refused to join the Manhattan Project, arguably the most significant and heavily budgeted programme during the war years, with a very large number

of frontline scientists in its ambit. Instead, he wanted to go back to the university domain and to continue teaching and do basic research. In his later life he recollected, 'My introduction to semiconductors came just after the war, in late 1945, when I joined the Bell Laboratories research group on solid-state physics, which was being formed under the leadership of Stanley Morgan and William Shockley'. He also observed, 'Following a PhD under Eugene Wigner at Princeton and post-doctoral years with John H. van Vleck at Harvard, I had been interested in the theory of metals before the war and was anxious to go back to solid-state physics after five years at the *Naval Ordnance Laboratory* in Washington'.

After the war, Bardeen joined the Solid State Research Group in Bell Laboratories. He felt that he would get enough financial support for his research work in Bell Lab, as the universities were yet to realize the potential of solid-state physics as a research discipline. The group including Bardeen and William Brattain at Bell Lab was headed by William Shockley, who was actually two years junior to Bardeen by age. They knew each other from their schooldays at Massachusetts. At that time, Shockley was already an established scientist in the field of solid-state physics. While working on the problem of a semiconductor device, Bar-

deen and Brattain came up with a device known as the 'transistor', between late 1947 and early 1948. Shockley, though the leader of the group, was not closely involved with the work. In fact, the patent filed by the attorney did not include the name of Shockley. However, Shockley believed that this invention was based on his earlier work on the point-contact transistor. This transistor had certain drawbacks and could not click as an amplifier and had unreliable characteristics.

Shockley was upset and finally the group broke up, with Bardeen leaving Bell Laboratories in 1951 to join the university system. Bardeen became a part of the engineering faculty and the physics faculty at the University of Illinois at Urbana-Champaign. Shockley also left Bell Laboratories in 1955 to establish his own semiconductor company, while Brattain, who was a hardcore experimentalist continued with Bell Laboratories. The first instrument to use a transistor was a hearing aid in 1951, while a fully transistorized computer came out in 1953. Then there was no looking back for the transistor. All this was possible as Bell Laboratories transferred the technology to the industry.

The Nobel Committee awarded the 1956 Nobel Prize in Physics to all the three above-mentioned scientists for the invention of the transistor. The work was done in Bell Laboratories, the epitome of ex-

perimental research. On the other hand, Bardeen's second Nobel Prize winning work in 1972 was in theoretical physics carried out in a university department. He shared the Prize with Cooper and Shreifer for successfully developing the theory of superconductivity, now known as the BCS theory.

Bardeen kept a low profile in his private life that even his neighbours did not know about his stature. He was neither a stereotype scientist nor a public figure and was possibly overlooked by the media. But his work did change the face of science and technology. Bardeen remained a professor for nearly 40 years at the University of Illinois at Urbana Champaign, till he passed away on 30 January 1991.

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Materials from the following publications and website have been used in the note.

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