

First, we underscore the broader need for research funding by pointing out that the topic of weather damage encompasses more than hurricanes developing from severe storms over water. Dawson's November article stated, "Politicians from the Dakotas and Montana 'don't think [research on hurricanes] is their problem.'" However, tornadoes spawned by severe storms over land are very much an increasing threat to people, infrastructure, and property in the US interior. Tolls associated with these devastating killers are staggering. On average, 800 tornadoes occur nationwide each year. The Environmental Protection Agency states that tornadoes annually cause approximately \$1.1 billion in damages and around 80 fatalities. On 3 May 2003, for example, a series of tornadoes ripped through Oklahoma City and its environs, leaving 48 people dead and causing more than \$1 billion in damage. The hurricane insurance losses for 2005 were \$57 billion, the highest ever before Hurricane Katrina, whose costs are still being counted. And on 5 May 2007, a single tornado with winds up to 205 miles per hour struck and essentially destroyed the town of Greensburg, Kansas. Thus, whether over land or sea, there are more than enough concerns about personnel, infrastructure, and finances to warrant investing in research on severe storms.

Second, now appears to be an optimum time for bringing together the previously estranged communities of weather modification practitioners, who are mostly supported by insurance industries, and research academics, who have very limited funds. A considerable amount of data on practical weather modifications has accumulated, and significant advances have occurred in fundamental model descriptions of severe-weather-based instabilities; for example, two of us (Armstrong and Glenn) have reexamined the role of electrification forces in contributing to tornado formation.¹ With coordinated efforts, a new, stronger community can be formed to advance the art and science of weather modification.

In another case, Jürgen Michele, Vladimir Pudov, and one of us (Alammaro) have been discussing a concept inspired by a 1970s Soviet weather-modification program in the Baltics.² In that program, an array of jet engines was employed to form a vertical air flow that, it was hoped, would be sufficient to cause cloud formation. Even in

a stable atmosphere, 9 out of 15 tests led to cloud formation. Alammaro and coworkers presented the hypothesis that the method may be used for such weather modification applications as frost prevention, fog dispersion, and, most ambitiously, hurricane modification. In the case of hurricane modification, a designed array of multiple jets would be used to create atmospheric perturbations that might turn a hurricane back to sea.

References

1. R. W. Armstrong, J. G. Glenn, *J. Weather Modif.* **38**, 77 (2006); available at http://alammaro.home.comcast.net/JWM_armstrong_glenn.pdf.
2. M. Alammaro, J. Michele, V. Pudov, *J. Weather Modif.* **38**, 82 (2006); available at http://alammaro.home.comcast.net/WMA_April_2006.pdf.

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Stories and statistics of Bose

Kameshwar Wali's article on Satyendra Nath Bose (*PHYSICS TODAY*, October 2006, page 46) prompts me to narrate a few incidents about the great physicist. My father, cardiologist Sunil Bose, was his contemporary at Presidency College in Kolkata, India (1909–11), and later his doctor and friend. My siblings and I were thus brought up on tales of his genius. Bose was omnivorous in his quest for knowledge, and even as a student of physics at Presidency College, he would often borrow and devour books on anatomy and physiology. Chemists would come to him to solve their problems and would leave wiser. Here is an example of his creativity: An "indelible" ink was used in the first Indian general election in 1952 to mark the fingers of voters. He playfully found a solution that could erase the ink mark.

It is fairly well known that Bose never bothered to submit a doctoral thesis. Of value to the physics community is the role he played as mentor to generations of students and researchers. I offer one example: In the early 1940s, his student Shyamadas Chatterjee had set up an experiment at

the Bose Institute in Kolkata to study the newly reported fission of uranium when bombarded with neutrons. While setting up the experiment, Chatterjee found that distinct counts were recorded even without the neutron source. Puzzled, he reported the phenomenon to Bose, who at once came to the conclusion that it must be due to spontaneous fission. The half-life they calculated, which later proved to be correct, was way above that attributed to Edward Teller. As a result, by order of the institute's director, whose permission he had failed to obtain, Chatterjee had to withdraw the paper describing his findings. The phenomenon was discovered almost at the same time by Georgii Flerov and Konstantin Petrzhak in the Soviet Union. Chatterjee published his work later and was recognized by the Russian authors.

Chatterjee shared with me the story of a visit Paul Dirac made to Kolkata in the early 1950s to give a lecture at the Institute of Nuclear Physics. As Dirac spoke, Bose, sitting in the front row, appeared to doze off. Writing an equation on the blackboard, Dirac seemed to hesitate and looked toward the white-haired Bose for confirmation. Bose lumbered to his feet, scribbled the rest of the equation, and then resumed his earlier somnolent posture.

After the lecture, Dirac and his wife were ushered into the rear seats of a car, while Bose, Chatterjee, and one other person were about to occupy the front seats. Dirac demurred and requested that Bose join him in the back. Quick as a flash came the reply—"We follow Bose–Einstein statistics in front, you should follow Fermi–Dirac at the back!"

Wali mentions Bose's connection with the swadeshi movement and the names of Manabendranath Roy and Abani Mukherjee. Bose was also a close family friend of the nationalist leaders Sarat and Subhas Chandra Bose, who were students at Presidency College at almost the same time as S. N.

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In his excellent article "The Man Behind Bose Statistics," Kameshwar Wali mentions that Albert Einstein proposed to Bose that he work on two problems: "first, whether the new statistics implied a novel type of interaction between light quanta; and second, how the statistics of light quanta and transition probabilities would look in the new quantum mechanics."