

mental work in fluid dynamics was very productive and influential. Chandrasekhar was an early supporter, with John von Neumann and others, of forming APS's division of fluid dynamics, and he served as division chairman in 1955. Today the division is one of the most rapidly growing in APS.

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The interesting articles on Subrahmanyan Chandrasekhar dealt primarily with his accomplishments in astrophysics. Less known, perhaps, is his pivotal role in bringing the significance of the Stokes polarization parameters¹ to the attention of the optics community in 1946. Those parameters are now considered a cornerstone of modern optics.

In the late 1960s at the Catholic University of America, my doctoral thesis adviser, Peter Livingston, suggested that I express my final results in terms of the Stokes polarization parameters, which I had never heard of. After a little searching I found a paper by Ugo Fano² that discussed the Stokes parameters. The first two references in Fano's paper were to two French scientists,³ and the next was to Chandrasekhar's 1946 paper.⁴ By 1940 the Stokes parameters were nearly forgotten in the English-language scientific literature, although they continued to be taught in France.

In 1942 one of those two French papers (reference 3, Perrin) suddenly and quietly brought the Stokes parameters back to light in the English-speaking world. However, few optical physicists regularly read the *Journal of Chemical Physics*. Furthermore, allied efforts during World War II meant that few US and UK scientists had time to read the literature.

I was especially interested in knowing how Chandrasekhar, working in astrophysics, had found out about the Stokes parameters. He was to receive an astrophysics award at the 1969 annual meeting of the American Physical Society, and I decided to attend. Arriving early at the ceremony, I found him sitting by himself. I introduced myself, told him briefly about my research, and asked how he had learned about the

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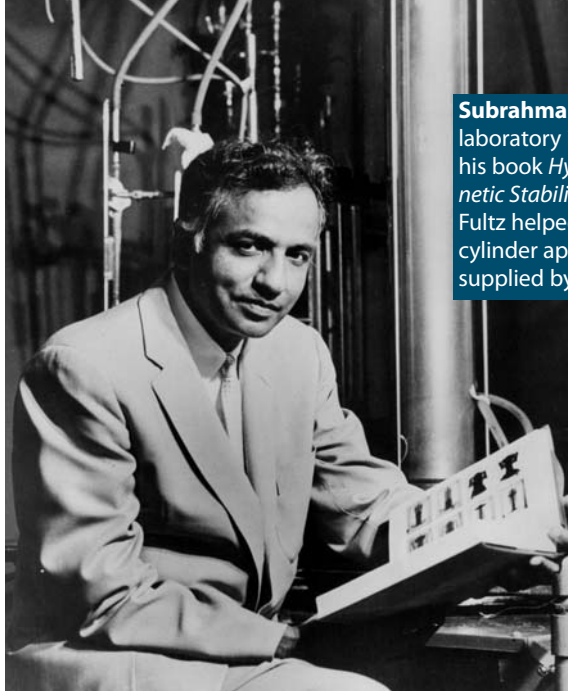
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Subrahmanyan Chandrasekhar in the laboratory in 1961, with the first copy of his book *Hydrodynamic and Hydromagnetic Stability* (Clarendon, 1961). Dave Fultz helped build the Taylor rotating-cylinder apparatus behind him. (Photo supplied by Russell J. Donnelly.)

Stokes parameters. His face lit up, he invited me to sit down, and he answered, "Because of a bet!"

In the early 1940s at the University of Chicago, Chandrasekhar explained, he had begun to write a series of papers on radiative transfer, and every Monday he would meet George Uhlenbeck and Gregory Breit for tea and coffee in the university lounge. At one of those meetings in 1945 he said that he had gone as far as he could with radiative transfer and that all that was left was to include the effects of optical polarization. Uhlenbeck said, "That might be more difficult than you think." But Chandrasekhar was so confident he would have the complete solution by the following Monday that he made a \$1 bet with Uhlenbeck.

The next day he set to work. By Friday evening, however, he was unable to find a means of introducing polarization into his radiative equations. He'd become frustrated, desperate, and, he said, "exhausted." The next morning he went to the university library and searched every optics book he could find to see how polarized light was treated. No success! A bit frantic, he finally came across a 1904 English optics textbook⁵ that described Stokes's formulation of polarized light in terms of intensity—the first parameter—and three remaining polarization parameters. He immediately recognized the connection between the intensity formulation of the Stokes parameters and the radiative intensity equations. Despair turned to elation. He then found Stokes's 1852 paper, quickly absorbed it, and proceeded to reformulate the radiative equations to include polarization.

He tidied up his paper on Monday

morning and met his two colleagues at tea time. He proudly laid his radiative equation paper, with Stokes parameters, on the table. He told Uhlenbeck he had found the solution using polarization parameters he "discovered" that had been introduced by George Gabriel Stokes in 1852.¹ With those parameters he had been able to reformulate the radiative equations to include polarization and so had won the bet. Uhlenbeck casually replied, "Oh, *that* set of Stokes parameters. I know all about them, and here is your dollar." Chandrasekhar was taken aback and thought to himself, "You could have told me that last week and made my life much simpler!" Probably, Uhlenbeck had not seen the connection between the radiative transfer equations and Stokes parameters. But, Chandrasekhar said, at least his reputation was intact!

I had one last question: Where had Uhlenbeck learned about the Stokes parameters? Chandrasekhar said, "I don't know," but pointed out Uhlenbeck on the stage. "Tell him I sent you, and ask him how he knew about the Stokes parameters." I walked up to Uhlenbeck, and when I told him Chandrasekhar had sent me and asked him my question, he immediately said that he had learned the Stokes parameters from Paul Ehrenfest. I asked "Where did Ehrenfest learn about them?" Uhlenbeck replied, "I don't know, but Ehrenfest knew everything about physics!"

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Anotating the history of rotation ideas

In his letter "Blackett Adopted Earlier Rotation Idea" (*PHYSICS TODAY*, January 2011, page 10), Thomas Ruedas complains about an error by implication in Greg Good's article "Rutherford's Geophysicists" (*PHYSICS TODAY*, July 2010, page 42). He says Good gave the impression that Patrick Blackett originated the idea that the magnetic field of a rotating body such as Earth or the Sun is produced by its rotation. True, Good could have used better phrasing, but Blackett himself made no such claim; his papers fully acknowledged the long previous history of the subject. Blackett's 1947 paper includes a reference to Arthur Schuster's paper of 1891, and his final, 1952, paper on this topic goes back to an obscure German work by Henry Rowland in 1885, presumably reporting the experiment Rowland did in 1875, an experiment that started the ball rolling.

Some years ago I prepared an annotated bibliography "Rotation Theories of the Production of the Magnetic Field of the Earth and Other Bodies"; it is available online at <http://www.agu.org/history/mf/contrib/rotation.doc>.

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A last word on scientists' last word

In his letter, Brian Sutcliffe rightly calls attention to the long history of scientists speaking out on scientific matters of societal importance (*PHYSICS TODAY*, March 2011, page 8). Here is an especially flamboyant example. Arthur Shipley, an eminent zoologist and master of Christ's College in Cambridge, UK, wrote about the Scopes "monkey" trial then under way in Tennessee, "The average American of the Middle and Southern States is a very naïve mammal. . . . The United States is a nation of adult children and some of the things they do seem to older and more mature countries decidedly childish."¹

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