author Arthur I. Miller's flawed socio-historical analysis of the Eddington–Chandrasekhar controversy and of its impact on the development of stellar astrophysics.

Subrahmanyan Chandrasekhar's own perceptions of his life and times in Cambridge, UK, are quite different from what Miller would have us believe. I quote from two of Chandra's letters to the Indian physicist Kariamanikkam Krishnan, who was the co-discoverer of the Raman effect and a close friend of Chandra's. The first letter, dated 11 August 1934, was written a few days after Chandra received news of the unpleasant episode in which Chandrasekhara Raman and Krishnan were removed from their positions on the management committee of the Indian Association for the Cultivation of Science and a new management structure sans Raman was put in place. Raman had to resign from the membership of the institution with which he had been associated for more than a quarter century and where he had done his best work. In this letter Chandra says,

> Oh! How I wish that you had come to Cambridge. The atmosphere here is so pure, so encouraging and so wholesome—and so free of personal animosities and jealousies. The sincere collaboration of the best minds, sacrificing personalities for the progress of science—it seems so impossible now that in India we would build a similar school—where the same spirit would prevail, even if a Rutherford, Eddington, Fowler or Dirac do not exist. You can never know how much I owe to the inspiration of your friendship, and even in Cambridge I miss you so much, and to me it is ever so intense a sorrow that one whom I respect and admire so much should now be in the whirl of such bitter winds.

A second letter was written on 20 March 1935, barely two months after what Miller has called Chandra's "fatal collision" with Eddington. Chandra was spending some time in Niels Bohr's institute in Copenhagen. He genuinely wanted Krishnan to come to Cambridge and savor the Cambridge atmosphere. Chandra writes:

> Is there any possibility of your coming to Europe sometime before the summer of 1936. I hope myself to return to India by about that time and imagine our travelling back together! Somehow I think that you will enjoy a small tour in Europe if you cannot afford the time to spend a longer time. As for me I am continuing in the same way more or less. I sent you last week my recent work on Stellar Structure. I should be glad to know what you think about it.
>
> In Cambridge I get the utmost sympathy and encouragement for my work. Fowler, Eddington and Dirac are all extremely kind and encouraging and even spend quite considerable time to clear up some difficulties that I may come across. When I first came to Cambridge, I used to look forward to returning home, but now after nearly five years in Cambridge I feel so very unhappy that I should soon return.
>
> Last term in Cambridge, I gave a course of about 20 lectures on "Special Problems in Astrophysics" and these and some of my later work all kept me so busy that I am glad to have come now to Copenhagen again. I came here on Sunday and expect to stay on till the middle of April when I will return to Cambridge.

A proper scientific understanding of the full implication of Chandra's discovering the mass limit, and the consequent acceptance of the possibility that black holes existed, had to wait for many related things, among them the implications of supernova explosions, the theoretical studies of J. Robert Oppenheimer and his students, the discovery and observation of mass loss in stars, the advent of x-ray astronomy, and the discovery of pulsars and their identification as rotating neutron stars. All these developments took time. Eddington did not delay anything by asserting that "there should be a law of Nature to prevent a star from behaving in this absurd way."

I acknowledge with gratitude the permission granted by Vijay R. Thiruvady, grandson of K. S. Krishnan, to quote from his grandfather's correspondence with Chandrasekhar.

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Wali replies: Arthur Miller's assertion that I had "very limited access" to Chandra's letters, manuscripts, and other primary and secondary sources when I wrote my biography of him,[1] and that I elected to believe Chandra's word is totally false. I have had full access to the Chandrasekhar archive since its inception in the late 1970s. Besides extensive conversations with Chandra, I interviewed more than 50 people, including his friends and relatives in India; his former students and associates at Yerkes Observatory and the University of Chicago; his Cambridge University contemporaries David Shoenberg, William Macrea, and Paul Dirac; and US physicists and astrophysicists Margaret Burbidge, Freeman Dyson, Martin Schwarzschild, Kip Thorne, and Victor Weisskopf. Audiotape copies and transcripts of these interviews are in the Chandrasekhar archive.

Miller asserts that Chandra publicly "pretended" the Eddington episode was behind him, but that he could not shake it off. As Miller writes in his book:

> His [Chandra's] life was tinged with tragedy. . . . Chandra never really regained his confidence. . . . I wondered what other great discoveries he might have made, had his early life not been blighted by disappointment.

Those statements are a travesty of Chandra's vast, almost unparalleled legacy of theoretical and mathematical physics. As Thorne has noted, for instance, "Nobody has done more than S. Chandrasekhar to bring general relativity to its 'natural home,' astronomy."[2]

Miller's "complex" interpretation of Eddington's sexual preferences leading to a "fragile psychological well-being" as an explanation for his behavior in scientific controversies is too simplistic, purely suppositional, and without evidentiary basis.

About the theory of white dwarf stars and the theory of black holes, Miller says a great deal more in his book than he presents in his letter.

> Chandra's mathematical verification of black holes and his four decade wait until the scientific community accepted it . . . Chandra's great discovery concerned nothing less than the ultimate fate of the universe. Like Einstein, he had lifted a corner of a great veil, revealing a majestic yet terrifying picture of the fate of stars and of humanity.

I find it, as I said in my review, an overblown and inaccurate account of Chandra's discovery.

Chandra did not have to fight for recognition of the fact that his physics was right and Eddington's was wrong.

Chandra's work was vindicated fairly promptly—first, through acceptance by all serious theorists working in the field, and second, through observations that empirically established the range of masses of white dwarf stars.

The footnote in Fowler's book that Miller refers to was in the general context of authority and prestige held by Eddington, which prevented people from coming out and openly saying he was wrong.

As for the Chandra–Eddington relationship subsequent to the incident, anyone who reads the letters in the archive will disagree with Miller that they lack warmth and affection. I recount one of Chandra's own recollections as an example of their continued friendship in spite of the controversy:

> When Chandra returned from India after getting married [in 1936], Eddington invited the couple for tea. When he learned that they were leaving for America soon, he asked Chandra to his rooms one morning. "Let us not talk science," Chandra recalls him saying. "That is what we have done all along." Eddington then talked about his early years, the poor circumstances he grew up under, his living alone, and the loneliness of an intellectual life. He then brought out a map of England on which he had pinned all the places to which he had bicycled and marked the routes he had taken. "You are the first person to see this map," he said to Chandra. Chandra was obviously moved. "I sort of felt," says Chandra, "that Eddington was trying to add to our professional relationship a personal dimension. The enormous respect I had for him made me feel grateful, grateful that I had such an opportunity to know him."[3]

Chandra did not seek a position in Cambridge, and to the best of my knowledge none were available. Through consultations with Eddington, Chandra decided to join Yerkes rather than Harvard University.

Miller's last comment is most insulting to Chandra and to me. Miller implies that Chandra's sole purpose in allowing me to write his biography was to put on record that he had finally set the Eddington episode behind him, and that I did just that.

Chandra had not forgotten what he had written in his diary two years earlier. He repeated it to me verbatim; that led to our intense discussion. His not finding the peace that could be expected after such enormous success had little or nothing to do with Eddington, but with the larger, more complex reality of how an individual creates the measure of his or her life.

References

1. K. C. Wali, *Chandra: A Biography of S. Chandrasekhar*, U. Chicago Press, Chicago (1991).
2. K. Thorne, in S. Chandrasekhar, *Selected Papers, Vol. 5: Relativistic Astrophysics*, U. Chicago Press, Chicago (1990), p. x. For more information about Chandra's extensive contributions, see R. M. Wald, ed., *Black Holes and Relativistic Stars*, U. Chicago Press, Chicago (1998), and K. C. Wali, ed., *S. Chandrasekhar: The Man Behind the Legend*, Imperial College Press, London (1997).
3. Ref. 1, p. 139.

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