letters

Creating the measure of Chandrasekhar's life

In his review of my book *Empire of the Stars: Obsession, Friendship, and Betrayal in the Quest for Black Holes* (PHYSICS TODAY, February 2006, page 53), Kameshwar Wali refers to his own biography of Subrahmanyan Chandrasekhar,[1] "based on more than a decade of extensive conversations with him," and asserts that "Miller's account is totally different from Chandra's."

Quite so! As historians of science worth their salt are well aware, there is a vast difference between what a subject tells you in an interview and what is to be found in the archives. It is the historian's job to probe beyond the subject's own assertions. Wali had very limited access to Chandra's letters, manuscripts, and other papers, and he elected to believe to the word Chandra's account of events that had occurred 40 years before. His book is now outdated.

My book was based on the huge Chandrasekhar archive in the Joseph Regenstein Library at the University of Chicago, together with other extensive primary and secondary materials. Such resources are absent from Wali's book, and nowhere in his review does he support his allegations with historical evidence. Instead, yet again, he tells us to believe what Chandra told him.

What I discovered through my research was a complex man, as we would expect of someone of Chandra's brilliance, who never recovered from his 1935 encounter with Arthur Stanley Eddington at the Royal Astronomical Society. In public Chandra pretended that the Eddington episode was behind him—as it should have been. But, as I learned from diary entries, letters, and interviews with his friends, he could not shake it off.

Wali dismisses my suggestion that Eddington was homosexual. My argument is complex and based on historical evidence. Many people have made the same suggestion, and indeed homosexuality was not unusual among Oxbridge dons in the 1930s. Living "a life of concealment" at a time when draconian laws prohibited homosexuality meant that Eddington's psychological well-being was fragile. His life's work was his fundamental theory—which would be threatened if Chandra's theory of white dwarf stars was right. Wali is the only person who has publicly questioned my interpretation of Eddington's personal life.

Wali claims that Chandra's theory of white dwarf stars "was not the theory of black holes." But that was not what I said. What Chandra's theory did was to show, for the first time, that after burning up their fuel, stars could begin an eternal collapse to an infinitely tiny point of infinite density. The dramatic collapse contained the seeds of the concept of black holes. General relativity was not necessary to come up with the insight. But no one believed it, not even Eddington, who had speculated on just that in his 1926 book, *The Internal Constitution of the Stars* (Cambridge U. Press), using general relativity—albeit tongue in cheek.

Wali says that Chandra "did not have to fight for recognition" of his theory of white dwarf stars and asserts that Ralph Howard Fowler, for one, supported him. To the contrary, I have documented this at great length and Wali seems to have forgotten that he, too, made this same point in his biography of Chandra. After quoting from a footnote in Fowler's 1936 book on statistical mechanics[2] in which Fowler points out Eddington's disagreement with Chandra's theory of white dwarf stars, Wali states that Fowler did "not come out to say that he" disagreed with Eddington.[3]

Certainly, Eddington took Chandra to a tennis match and on bicycle rides. But that does not contradict the evidence of the heated exchanges they had over the years. Wali writes in his review that Eddington's later letters to Chandra were "full of warmth, humor, and affection." In fact, there was very little warmth between the two, and they certainly avoided discussing the death of stars.

Wali questions my comments on racism in 1930s Britain. Chandra was the first Indian to lecture on astrophysics, but no one offered him a position, even though positions were available. Chandra wrote to his father in 1936 that there was "some prejudice giving Indians a definite appointment" at Cambridge University.

Indeed, Chandra must have been delighted when Wali appeared at his door in 1977. He could finally put on record through a biographer that he had set the Eddington episode behind him. Perhaps Chandra forgot that two years earlier he had made the following diary entry:

> I recall that during my first year in Cambridge (in 1930–31), I saw Eddington, going by on the other side of the street, smoking his pipe as usual, looking so confident and serene. And I thought to myself: how wonderful it must be to be secure in one's accomplishments with the recognitions of one's fellow scientist. And I thought of being [a fellow of the Royal Society], a Gold medallist of the Royal Astronomical Society, and being famous. I suppose that I have all the tangible recognitions that Eddington had at that time received. But in my heart I have none of the serenity that I thought I saw in Eddington's face, 45 years ago.

References

1. K. C. Wali, *Chandra: A Biography of S. Chandrasekhar*, U. Chicago Press, Chicago (1991).
2. R. H. Fowler, *Statistical Mechanics*, 2nd ed., Cambridge U. Press, Cambridge, UK (1936), p. 652.
3. Ref. 1, p. 145.

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Kameshwar Wali's review of *Empire of the Stars: Obsession, Friendship, and Betrayal in the Quest for Black Holes* exposes

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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.
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> 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.
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> 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.