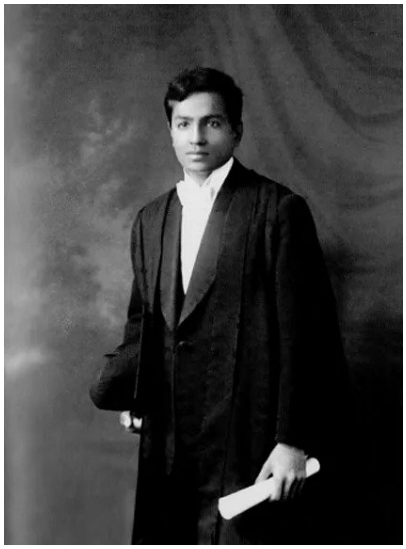
Lecture 17 : Quantum Stars



S Chandrasekhar with his PhD degree from Trinity College, Cambridge, 19 December 1933.
[Credit: Kameshwar C Wali, 1991, ***Chandra A Biography***, University of Chicago Press]

By 1923, the stability of stars was well understood. Stars are stable because the inward pull due to gravity is balanced by the combined pressure of gas and radiation. What will happen to a star when it is no longer able to generate heat? This was the question confronting astronomers when a highly dense star, with a density of a million grams per cubic centimetre, was discovered in 1925. Around the same time, great discoveries were being made in the new Quantum Theory of matter. This lecture tells the story of how Fowler (in Cambridge) and young Subrahmanyan Chandrasekhar (a young college student) answered this question by invoking the new quantum theory. This lecture will also discuss the truly revolutionary discovery by Chandrasekhar in 1930.

Not only did Chandra (as Chandrasekhar has been universally known) found the answer to the stability of stars, his discoveries clearly hinted at the ultimate collapsed state of stars. Even though this was not readily accepted by the Astrophysics community, ultimately Chandra's discoveries would bring in the the new era of high energy astrophysics in the form of supernovae, neutron stars and black holes which would be discussed in the following four lectures.

Lecture 18. **Neutron Stars and Supernovae**

Lecture 19. **Pulsars**

Lecture 20. **Journey to the centre of a neutron star**

Lecture 21. **Maximum mass of a neutron star**

19 August 2022

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Astronomy & Astrophysics : An Introductory Survey

A lecture series by Prof. G. Srinivasan

A 'Golden Jubilee Celebration' Event of the Astronomical Society of India

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[Supplementary Material : Dr. Sushan Konar]

Suggested References

For a long time, the only bit of Astrophysics to be found in an under-graduate or post-graduate physics course used to be the theory of White Dwarfs, discussed in the context of degenerate electron gas. Even though the current generation of students have access to more extensive material, the classical textbooks on *Statistical Mechanics* still provide some of the best student problems on White Dwarfs.

1. Introductory & Advanced Texts on White Dwarfs :
   (a) P. B. Pal, 2008, ***An Introduction to Statistical Mechanics (Chapter 10)***, Alpha Science
   (b) R. K. Pathria, 2004, ***Statistical Mechanics (Chapter 8)***, Elsevier
   (c) G. Srinivasan, 2011, ***Life and Death of the Stars***, Universities Press / Springer
   (d) S. D. Kawaler, I. Novikov, G. Srinivasan, 1997, ***Stellar Remnants (Chapter 1)***, Springer
   (e) S. L. Shapiro & S. A. Teukolsky, 1983, ***Black Holes, White Dwarfs and Neutron Stars (Chapters 1-3)***, Wiley-Interscience
2. Following is a compilation of essays written by some of the world's leading astrophysicists and edited by none other than Prof. G. Srinivasan himself. Accroding to J. P Ostriker, a renowned astrophysicist, "These essays not only given excellent accounts of Chandrasekhar's work but also, in putting that work in context, provide a very high-level assessment of an extraordinarily productive half century of astrophysics."
   • G. Srinivasan (Ed.), 1999, ***From White Dwarfs to Black Holes : The Legacy of S Chandrasekhar***, Universities Press

The following are some of the early papers by Chandrasekhar, written at a very young age, that fundamentally changed Astrophysics. They are based on elegant yet simple physical and mathematical principles. Some of the not-so-easily-accessible papers can be found reprinted in Journal of Astrophysics and Astronomy (Volume 15, Issue 2) published by the Indian Academy of Sciences.

1. S. Chandrasekhar, 1931, Phil. Mag., 11, 592
2. S. Chandrasekhar, 1931, MNRAS, 91, 456
3. S. Chandrasekhar, 1931, ApJ, 74, 81
4. S. Chandrasekhar, 1932, Zeitschrift fur Astrophysik, 5, 321
5. S. Chandrasekhar, 1934, The Observatory, 57, 373

26 August 2022