NOBEL LAUREATE SUBRAHMANYAN CHANDRASEKHAR

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The 1983 Nobel Prize for physics has been shared by two astrophysicists, both of them past the age of seventy. Subrahmanyan Chandrasekhar (b. 1910) from the University of Chicago and William Fowler (b. 1911) from the California Institute of Technology.

Chandrasekhar is the fourth Nobel Laureate in science from this subcontinent, the previous three being C. V. Raman, Hargobind Khorana and Abdus Salam. Statisticians point to several examples of close relationships (father-son, mother-daughter, teacher-pupil) amongst Nobel prize winners. Chandrasekhar adds to the list; he is the nephew of C. V. Raman.

It is not often that astrophysicists have got the Nobel prize. Probably the physics community still feels that these subjects are speculative in spite of their many advances in the recent past. The award to Chandrasekhar therefore reflects the respect and confidence his work enjoys internationally. Indeed many scientists feel that he should have got the award long ago.

Chandrasekhar was born in Lahore and educated in the Madras Presidency College before going to Cambridge University in 1930 for research in astrophysics. Like many great scientists he did his outstanding work while in his twenties, at Cambridge.

This work, which is today part of astrophysics text books and which is now considered respectable enough for a Nobel award, was received with ridicule and hostility when it was first presented. What was it all about?

In the 1920s two important development took place which were to affect Chandrasekhar's work significantly. The first was in astrophysics itself and it arose out of the work done by the Cambridge astronomer Arthur Stanley Eddington. Eddington set up equations describing the internal structure of a star like the Sun. These equations described how the star maintains equilibrium under two opposing forces, the force of contraction due to its own gravity and the outward forces of pressure produced by the hot furnance in its core. It was Eddington's conjecture that the furnance was kept fuelled by thermonuclear fusion.

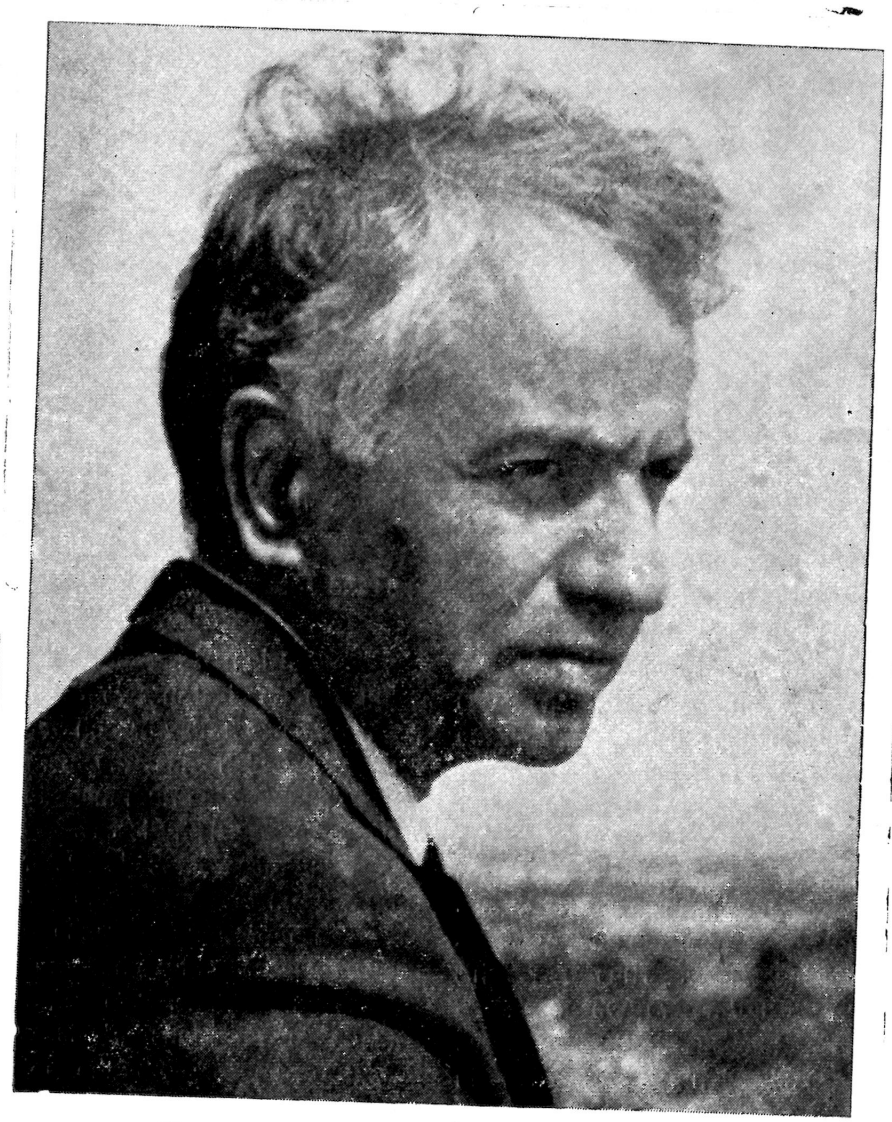
The second development was of quantum mechanics which prescribed laws governing the behaviour of subatomic particles. These laws altered many preconceptions of physicists who were brought up on Newton's laws of motion. One of the 'strange consequences of quantum laws was the so called exclusion principle' which forbade two identical particles like the electrons to be present together in the same state.

To see the connection between these two developments and their relevance to Chandrasekhar's work imagine what would happen to a star which has exhausted all its nuclear fuel. Will such a star be able to keep itself in equilibrium against the contracting force of gravity? The visually faint but highly dense and compact stars called the white dwarfs indicated that the answer should be 'yes'. But how?

The answer is in the exclusion principle. The tendency of a star to contract means more and more particles in the same small volume. The exclusion principle puts limit on how closely we can pack the matter together. Out of such restrictions a new pressure emerges which opposes further contraction.

Chandrasekhar used this idea together with the modifications needed by special relativity theory and showed that provided the star was not very massive it could be maintained in equilibrium by the above pressure. The limit on the star's mass which emerged from Chandrasekhar's calculations is called the **Chandrasekhar limit** and it equals 1.44 times the mass of the Sun. Thus all white dwarfs must respect this mass limit in order to survive.

Contrary to Chandrasekhar's expectations this elegant result was ridiculed and criticized by a person



Nobel Laureate Prof. S. Chandrasekhar

no less than Eddington himself. This is indeed ironical since in the 1920s Eddington's ideas of thermal fusion were also criticized by the established atomic physicists of the day.

However, the result gradually gained its due recognition while Chandrasekhar moved on to new things. His later works on stellar dynamics, stability of liquid masses and on Einsteins' general relativity are all internationally recognized. In each case his in-depth studies formed subject matters for his books, all of which are regarded as land-marks in their fields.

He brought the same thoroughness and attention to the famous Astrophysical Journal whose managing editorship he carried for nearly two decades.

Last year when I met him during his tour of India, I asked him "What new field will you now take up after finishing the book on black holes? He replied" At the age of 72 it is hardly the time totake up new fields of research".

Judging by his past performance, I would tend to disagree. In his seventies, despite a serious but successful open heart surgery Professor Chandrasekhar is as active in scientific research as he ever was before.