research in the first place.

Taube recalled that he was "bored silly" by the task of preparing an undergraduate course in coordination chemistry. But he realised in the process how little was known about the differing rates of chemical reactions. "It shows how important the connection between teaching and research can be" he commented.

Taube's name would be remembered in chemistry even without the Nobel prize because he has a compound named after him. The Creutz-Taube complex, discovered in 1972, consists of two pentammine ruthenium complexes one in the (II) and the other in (III) oxidation state, joined by a special bridging ligand that should allow electrons to pass from one metal centre to the other. In other words, electrons should be delocalised over the two metal centres making the molecule symmetrical. If this were to occur, then it would mean that the metal centres would be both of fractional oxidation state (2·5). If on the other hand the ruthenium valencies are trapped one on each end, then it would mean that the ends of the molecule are not equivalent. This should be observable. It turns out that the answer you get depends on the spectroscopic technique used. This is because each technique operates within its own timescale. For relatively slow techniques like X-ray crystallography, the complex seems to have untrapped valence states delocalised over the molecule. Fór fast techniques like Mossbaüer spectroscopy, the valence states appear trapped. The analogy is like trying to see the spokes of a rotating wheel.

Creutz-Taube complexes are important because they model the electron transfer events that go on between metal centres in coordination complexes. But being mixed valency compounds they also model the redox action of metals in the enzymes responsible for cellular energy transfer processes.

Taube's published work (over 200 precision papers and a book) is not terribly easy to read but is experimentally solid and dependable.

Taube is no stranger to prestigious awards, only last August he received $150 000 as part of the Robert A. Welch award in chemistry founded in 1972 as part of the estate of a Houston multimillionaire. With the $190 000 attached to the Nobel prize, he now has $340 000 tax free. "I got a screen door with the Welch Award". He said ruefully when asked what he would do with the money: "I will have a redwood frame and the Texans will inscribe it with a plaque reading 'Robert A. Welch Memorial Door'."

The wit and humour that his colleagues praised so highly last week was well in evidence at the press conference. When asked by the TV journalist what his wife's reaction was, Taube replied: "I guess she said 'really'."

Taube becomes the 10th living Nobel Laureate at Stanford (but he is probably the only one with a collection of 8000 78 rpm records, many of them from German opera) remarkably, he is the fourth Nobel recipient from the same department. The other chemistry winners were Paul Ber (1980) Paul Flory (1974) and Linus Pauling (1954). □

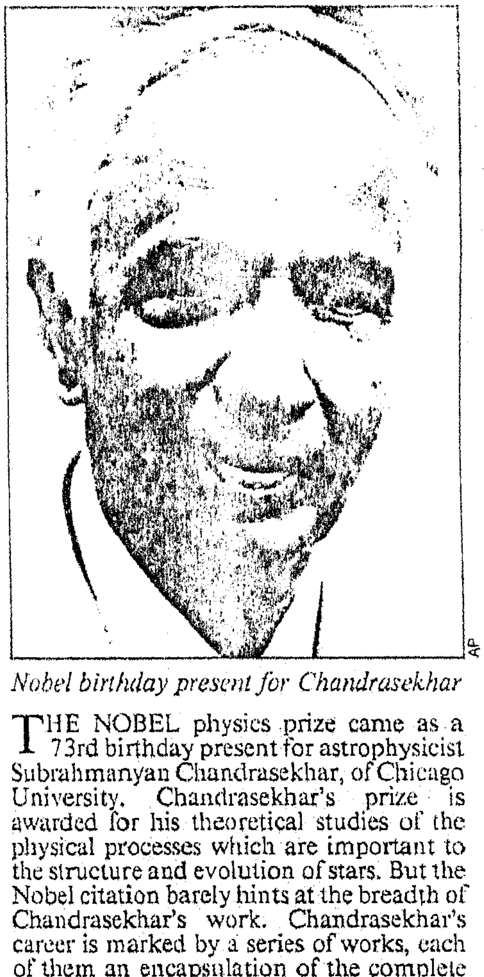
Inside the stars

The award of this year's Nobel prize in physics jointly to Willy Fowler and Subrahmanyan Chandrasekhar recognises the importance of their independent work on the birth and death of stars and the origin of the chemical elements

John Gribbin

WHERE do we come from? In the words of the song *Woodstock*, "we are stardust . . . billion year old carbon". The composer of the song clearly knew something of the work for which Willy Fowler has just been awarded a half-share in this year's Nobel prize for physics, since it was the work of Fowler and his colleagues in the mid-1950s that established the origin of chemical elements (give or take a factor of five in the age). It is now generally accepted by astronomers and physicists that all of the chemical elements except for primordial hydrogen and a little helium produced in the big bang have been built up from hydrogen and helium by nuclear fusion processes inside stars. Distributed across interstellar space in great stellar explosions, the chemical elements produced by the first generations of stars provided the raw material for the formation of a planet like the Earth and the structure of living things. Every atom in your body, except those of hydrogen, has been produced by nuclear fusion reactions occurring in the heart of a star.

The irony of the establishment of this concept within the framework of Big Bang cosmology is that the driving force behind the work on stellar nucleosynthesis in the 1950s was Fred Hoyle's passionate conviction that we live in a steady state universe, and that there never was a Big Bang. In the early 1950s, those astronomers who bothered with the problem of the origin of the elements were able to argue, in a general sort of way, that the conditions of intense heat and pressure during the Big Bang could have been extreme enough to make anything. Indeed, this argument was used against the steady



AP

Nobel birthday present for Chandrasekhar

THE NOBEL physics prize came as a 73rd birthday present for astrophysicist Subrahmanyan Chandrasekhar, of Chicago University. Chandrasekhar's prize is awarded for his theoretical studies of the physical processes which are important to the structure and evolution of stars. But the Nobel citation barely hints at the breadth of Chandrasekhar's work. Chandrasekhar's career is marked by a series of works, each of them an encapsulation of the complete basic theory of one branch of astrophysics. For example, his *Introduction to the Study of Stellar Structure*, published in 1939, is still both a cornerstone of undergraduate courses, and a fundamental reference quoted in the most abstruse research papers.

Chandrasekhar entered astronomy at a time when astrophysicists like Sir Arthur Eddington were beginning to calculate the internal structure of the stars. Born in 1910, in Lahore (now in Pakistan), Chandrasekhar studied at Madras University. Fired by Eddington's book on the internal structure of stars, which he won in an essay competition, Chandrasekhar came to Cambridge in 1930.

At 20 years of age, Chandrasekhar calculated the detailed physics of white dwarfs. Eddington did not accept Chandrasekhar's results, however, and a famous controversy ensued between the young student and the grand old man of stellar structure.

In 1937, Chandrasekhar moved to Chicago University, where he has remained. He turned to the gravitational interactions between stars in a star cluster, a study resulting in another classic, *Principles of Stellar Dynamics*.

His next field was the passage of radiation through the gases of a star's interior and its atmosphere, and these problems were neatly tied up in *Radiative Transfer*, published in 1950. In recent years, he has turned to general relativity, and published work on gravitational radiation, and—just last year—produced a definitive book on black holes.

Chandrasekhar was for many years the editor of the *Astrophysical Journal*, a publication which undoubtedly owes some of its present pre-eminence to Chandrasekhar's thoroughness: he read and checked every paper published.

Nigel Henbest