The Great Rebel

Fred Hoyle's Contribution to Astronomy

By J V NARLIKAR

RENOWNED astrophysicist Fred Hoyle, who passed away on August 20 this year, was a great scientific rebel, an iconoclast who questioned many of the accepted beliefs and practices of astronomy.

Born in Bingley in Yorkshire, young Fred displayed an irreverent attitude right from the beginning.His class teacher once asked the kids to collect a certain type of flower which, she claimed had five petals. The children brought several to show that she was right. Fred produced one of the same variety that had six petals. Indeed, he asked the teacher, whether the rule of five petals was not sacrosanct after all. The teacher did not like being contradicted and hit the boy on the left ear. Whereupon he left the classroom in protest and came home announcing that he was not returning to the school unless and until the teacher properly answered the question. Fred Hoyle's autobiography describes how the situation was handled by his mother, who fully supported his stand, and the school authorities.

Some five decades later, history was to repeat itself, when Fred Hoyle, then Plumian Professor of Astronomy and Experimental Philosophy, resigned from the chair on an issue of principle and opted for the life of an academic recluse. A lover of hiking in the mountains, he bought a house in a less-frequented part of the Lake District in northwestern England and spent the next fifteen years there. But neither did it stop his creativity, nor prevent his influence from being felt on whatever subject he chose to work on.

The clue to Fred's creativity may be found in his originality. His argument was that the beaten track did not interest him; for, with so many clever minds exploring it, if anything new had to be found, it would have been long found. So he preferred to stray off the beaten track and use his remarkable intuition and unconventional reasoning to unearth 'gems'.

In the mid-1950s, astrophysicists knew that a star like the Sun shines on the strength of the energy its core produces by nuclear fusion of hydrogen to helium, the same reaction that sets off the hydrogen bomb. But they were bogged down at the next step: what happens after the star has exhausted all its hydrogen fuel? Does it get 'extinguished' or does it find a new source of energy? Proceeding further along the nuclear fusion ladder suggested that some of the helium produced by the star could be used as a fuel to make bigger nuclei. But how? Conventional thinking using the then available knowledge of nuclear physics, suggested that ahead lay a series of unstable nuclei which could not sustain the fusion process.

If you are climbing a ladder and the next rung you wish to stand on is known to be weak, what would you do? Look for a higher rung which is strong and try to bypass the weak one. Hoyle calculated that the familiar nucleus of carbon had to have a state of higher energy. Moreover, to describe this state, called the excited state, Hoyle used the idea of a resonant reaction well known to nuclear physicists. Just as a sitar player adjusts the tension of the sitar wires so that they resonate and augment the tone produced by the instrument, Hoyle argued that resonance helped nuclear reactions to proceed faster and thereby produce enough carbon from helium. Without resonance, very little carbon would be produced.

IN BRIEF

- Renowned astrophysicist Fred Hoyle was a born rebel
- His rebelliousness made him question accepted scientific truisms
- His significant scientific breakthroughs were a result of these leaps of imagination

Apart from this reasoning Hoyle was convinced that chemical elements like carbon, oxygen and silicon, and metals like iron, cobalt and nickel, are all produced inside stars through reactions like this. But, if the helium to carbon reaction were not possible, then there would neither be any carbon in the universe, nor any of the elements we see around us. What is more, life as we know it would not exist. So the bottom line of his argument was: we exist, ergo, so must the excited state of carbon.

For testing this hypothesis, Hoyle asked the nuclear physicists at Caltech to look for such an excited state of carbon. Willy Fowler at Caltech who was awarded a Nobel Prize for his work in nuclear astrophysics, recalled how his first reaction was to dismiss this claim because of its unconventional reasoning. However, Hoyle persuaded Fowler and his colleagues to perform the necessary experiment and, lo and behold, they found the predicted state. That proved to be a turning point in Fowler's career and he began a long-time collaboration with Hoyle. Indeed in 1957, Hoyle, Fowler, and the husband-wife team of astrophysicists Geoffrey and Margaret Burbidge published a mammoth paper detailing how most of the familiar chemical elements are produced inside stars and ejected in stellar explosions. Most astronomers today express surprise that Hoyle was not awarded the Nobel Prize for his work on stellar nucleosynthesis.

In today's age of super specialisation, it is impossible to find an astronomer like Hoyle whose work influenced such a wide range of subjects, from the solar system, through stars and galaxies, to cosmology. He was forever opposed to the widely accepted view that the universe exploded into existence some ten to fifteen billion years ago. There was a brief period during 1965-66 — when the microwave background was discovered — when he wavered in his opposition to the theory. However, when he saw it become increasingly speculative with no matching direct proof, he reverted to his skepticism. His last major work published last year, together with Geoffrey Burbidge and myself was to present a case opposing this paradigm and to suggest an alternative. This book, called *A Different Approach to Cosmology* reflects Hoyle's iconoclastic view.

It is ironic that it was Hoyle who coined the phrase 'Big Bang' to describe — derisively — this exploding model, in his famous lectures on BBC radio. Delivered half a century ago, the lectures were immensely popular and the name stuck and is proudly used by the 'Big Bang' supporters.

The BBC lectures launched Hoyle as a successful science populariser. His science fiction play for school children called *Rockets in Ursa Major* played to packed houses in London in 1964. His sci-fi novel *The Black Cloud* turned out to be a precursor to the discovery of giant molecular clouds in the Galaxy. Hoyle once mentioned that because astronomers would not accept the idea of huge interstellar clouds containing chemical molecules, he described the idea through the novel!

In many respects, Hoyle was ahead of his times. Such visionaries have to face considerable hostility in their lifetime. And when they are proved right, it is often too late.