

January 17, 2001. The queues of people at Siri Fort reminded one of the lines of people waiting during the International Film Festival for tickets to a steamy, European film. Except, in this case, the profile of the crowds is different. Students, bureaucrats, academics, and of course socialites. The 4000 odd people stand patiently, waiting for their turn to get inside. A few students ask around for spare passes. The cops at the gate are not sure why there are so many people waiting to attend a lecture by someone who can't speak and has to move around in a wheelchair. But for the waiting people, it is a chance of a lifetime to actually see and "hear" the living legend, Stephen Hawking.

The Lucasian Professor at Cambridge who is fascinated with Marilyn Monroe; a theoretical physicist in search of the Theory of Everything; a patient of a rare and incurable motor neuron disease; the best-selling author of 'A Brief History of Time', a book which stayed for months on the bestseller lists and has been translated into most languages. All this and much more is Stephen Hawking.

Hawking delivered a public lecture on "Predicting the Future: From Astrology to Black Holes". Maybe it was the "astrology" in the title, or the fact that here was a latter day Einstein, who has lost almost total control over his muscles or the hype generated in the press before his talk. The net result was that almost everyone from the English speaking set of the capital was talking about the lecture. And of course, the auditorium overflowed; mostly with people who would normally come to a Hrithik Roshan show or a Jagjit Singh concert at Siri Fort. Like everything else in this city, the bureaucratic and political set got the passes while school and college students who really wanted to be there, had to be content with watching him over television. Never mind that most people confused his name with that of the popular pressure cooker, Hawkins! It was nevertheless important to be seen at the event!

Hawking's "public lecture" was only public in form. The lecture was at the level of a research seminar; the only concession given by Hawking was the absence of any equations. Probably he was adhering to his publishers advise that with every equation in a book, you lose a few readers! Hawking started with astrology and demonstrated why physicists do not believe in it. He claimed that the so-called predictions of astrology were in fact so general that anything can be read into them. He then went on to talk about the growth of determinism by Laplace that along with the work of Newton, allowed physicists to claim that given the positions and velocities of the particles at any given time, it is possible to know their positions and velocities at any time in the future. Determinism was the central principle of classical physics that was only questioned by the birth of quantum mechanics in the early part of the twentieth century.

In quantum mechanics, the objects of relevance are not the positions and velocities of particles but instead a mathematical object called the wave function. The wave function evolves in time according to the celebrated Schrodinger equation. A central principle of quantum mechanics is the Uncertainty principle that forbids arbitrary accuracy in measuring certain pairs of variables like position and velocity. Thus with quantum mechanics, in the words of Hawking, only "half" of determinism survived. But physicists could live with it.

The big blow came with the work of Hawking and others in the late seventies. In their investigations of the properties of black holes (stars which have collapsed under their own gravity into such dense objects that not even light can escape from them), Hawking and others found that contrary to the received dogma, black holes are not totally black.

Instead, they give out radiation that is now called Hawking radiation. The temperature of this radiation is dependent upon the mass of the black hole.

The process of black holes emitting radiation leads to a curious conundrum. Since the black holes are losing energy, their mass would decrease and eventually they would have evaporated. This is fine except that it leads to a loss of determinism even in quantum mechanics. For a particle close to the black hole, part of the wave function is outside and part inside the black hole. Schrodinger equation is still valid and can be used to evolve the wave function in time. However, when the black hole disappears, the part of the wave function inside vanishes, and with it the information that it carried! This would lead to the curious result that even the past becomes indeterminate.

It is not just the past but also the future that becomes indeterminate in such a scenario. The reason for this is the curious nature of quantum mechanics whereby the wavefunction only exists as a probability or a potentiality till such time as it is measured. Since one part of the wave function is lost in the black hole, it becomes impossible to measure the other part as well since they are connected!

Finally Hawking commented briefly on some new results in String Theory, a mathematical theory that is formulated as an attempt to unify all the interactions of nature. Several people have recently shown that in certain cases, it might be possible to measure the information that is inside the black hole! This connection between the mathematical structures called p-branes and black holes has evoked a tremendous interest among physicists in the last few years. Hawking believes that the string theory result of information becoming retrievable is wrong or at best only applicable in special cases. However, he still believes that the unification of all the forces of nature within the framework of a unified theory (which will be based on strings) is only a matter of time. Once we have the complete unified theory, Hawking believes that physics will end.

The audience listened to all of this in rapt attention. Even by generous estimates, no more than 100 out of 5000 people present would have understood what he was saying beyond the first five minutes. Barring a few brave people, no one left the hall till after the standing ovation.

Interestingly, Hawking's lecture had a curious fall out. Several people claimed that Hawking had endorsed the correctness of astrological predictions! The reason for this confusion (deliberate or otherwise!) were two of his statements on astrology. Firstly, he claimed that 'astrology was an effective theory'. This statement was meant as play on words but unfortunately this joke was lost on everyone except the physicists in the audience. The operative word is "effective" whose meaning in physics is somewhat different from that in everyday language. In physics, an effective theory is one that though not fully consistent gives us some explanation of the phenomenon. This is useful especially when the underlying correct theory is either too complicated or unknown. Thus an effective theory in physics is an approximate theory, which is used for convenience.

Hawking also said that "astrology has more predictive power than String Theory", a statement that once again, some people construed to mean that astrology was "better" than string theory in explaining the universe! Actually, what Hawking meant, as he clarified in the next sentence was that though in its present form string theory does not predict anything experimentally verifiable, we still believe in it because it is built on struc-

tures which have been proved. Further, it has an internal consistency and is part of a larger effort of scientists to unify all the forces of nature. This is a far cry from astrology.

Hawking came, he saw, he delivered and went back just as overawed by the public adulation he received in this city as the city was by his presence. The spectacle that his visit has left many questions unanswered. It is being argued that the euphoria and enthusiasm generated by his visit has had a positive fallout. There will now be a greater appreciation of science among the people in general and the government in particular. After all, how many people does the President invite for a special tête-à-tête? And going by the bureaucratic big wigs present in the audience, it can be seen that there is an upswing in the interest in science.

I think that this optimism is misplaced. There is no doubt that Hawking's visit was a good thing that happened to the scientific community. His presence will certainly be a source of inspiration to many youngsters who otherwise may not have been attracted towards science as a vocation. The row kicked up about his not being able to access the Red Fort because there was no entrance that was disabled friendly would also hopefully make the government agencies a bit more sensitive to the needs of differently abled people.

Having said this, one needs to place his visit and its fallout in context. The government (and of course the public in general) has to realize that minds of Hawking's caliber need a congenial environment to flower. Agreed that there is an innate capability in some people towards excellence in certain fields. But for these and for a broader range of people, there have to be institutional structures that would allow them to realize their potentials. Making appropriate noises and a big hoopla on one occasion will not necessarily translate into actions. If the powers that be are really serious about science in this country, it is important to ensure that we build and nurture institutions where minds such as Hawking can be nurtured. One look at the sad state of our universities and the science departments in particular will convince anyone that the state is not serious about nurturing scientific talent. Sponsoring one-time events like this is mere lip service. The state (and the industry) needs to put its money where its mouth is. After all, one must realize that apart from the enormous determination that he possesses to battle his disease and continue to work, it is also true that the infrastructure present in the West ensures that he can actually lead a productive life.

Yes, people saw in Hawking, an example of the unconquerable courage of the spirit against an incurable, debilitating disease. They also saw the best-selling author of a book on science that most people have bought, but few have read! Here was truly a living example of the victory of "mind over matter" as the President put it. But, in the end, Hawking's visit to the city in my opinion amounted to little more than just another event that will be talked about for some time and then forgotten.

