

Interstellar Explorations: Stephen Hawking Shows the Way

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THE void left by the demise of Stephen Hawking is hard to fill. For, the brilliant scientist and cosmologist not only revolutionised the way we deciphered our universe, but also his futuristic ideas paved the way for pathbreaking changes in the field of space sciences. Despite being confined to his wheelchair, the physicist and thinker not only cracked the origins of our universe but was also a passionate advocate of space explorations.

His indomitable spirit and enthusiasm saw him tour the Earth physically in his wheelchair and the cosmos mentally, giving us insight into unfathomable concepts – introducing terms like Big Bang, Black Holes and colonising other planets.

As the chairperson and advisory board member of several prestigious institutions and space organisations, Hawking, with his advanced concepts change the way we look at space travel in the coming decades.

We are in Peril

"Humanity has about 1000 years left on earth before we destroy ourselves," predicted Stephen Hawking in 2016, at a conference in Trondheim, Norway. "Shouldn't we be content to be cosmic sloths, enjoying the universe from the comfort of the Earth? The answer is, no," he said in his address, adding, "The Earth is under threat from so many areas that it is difficult for me to be positive."

However, a year later, the professor slashed his estimation by 900



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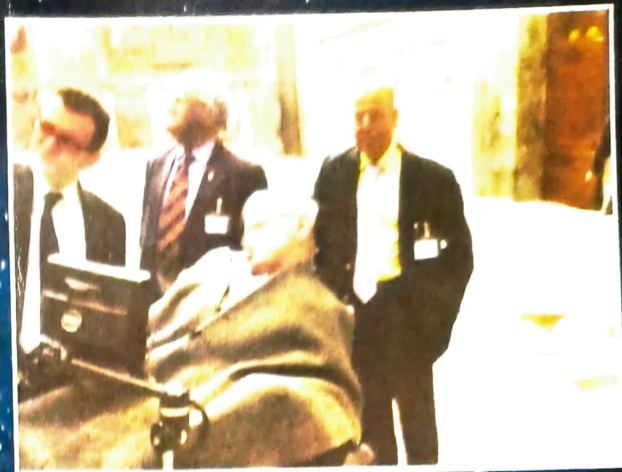
years, giving us only 100 more years on the planet, attributing the reasons to the exponential degradation of the Earth: over-crowding, depletion of natural resources, the threat of climate change and loss of animal species.

"When we have reached similar crises in our history, there has usually been somewhere else to colonise. Columbus did it in 1492 when he discovered the New World. But now

there is no new world. No Utopia around the corner," Hawking said.

In Search of Other Worlds

Are we doomed then, without a survival mechanism? In reply, the thinker had this to say: "If humanity is to continue for another million years, our future lies in boldly going where no one else has gone before." In other words, exploring space to colonise other planets.



Stephen Hawking in India, with his guide (left) and with Prof. CNR Rao and Dr. K. Kasturirangan (right)

"Human colonisation on other planets is no longer science fiction. It can be science fact. The human race has existed as a separate species for about 2 million years. Civilisation began about 10,000 years ago, and the rate of development has been steadily increasing," Hawking said.

While the Moon and Mars are the nearest to explore in our immediate vicinity, the lack of liquid water on their surface for human survival is an impediment. Moreover, Moon lacks a strong magnetic field to shield us from radiation and Mars no longer holds liquid water and a suitable atmosphere. The only option the physicist state is to look further into our neighbourhood.

Recent observations have witnessed the existence of many Earth-like planets in our galaxy and the neighbouring clusters. The discovery of a star system as close as 4.5 light years away from us — the Alpha Centauri — and the availability of exo-planets around the star Proxima Centauri raised many interesting questions.

Observations reveal that Proxima Centauri hosts possible exo-planets

among which Proxima b is a strong contender in the habitable zone. However, how hospitable Proxima b is can be ascertained only through observations from Earth or by space telescopes. To take actual stock of its surface would necessitate a probe to travel to the planet system.

So why are we not sending a probe to Proxima?

Though 4.5 light years is astronomically close, in the actual distance it translates to roughly 45 trillion kilometres. To travel such enormous distances using present technology and speeds available from chemical propulsion will take thousands of years to reach there, forcing it to be a non-viable project even in thought.

Hawking rekindled the hope among the scientific fraternity by presenting a futuristic concept which is now making interstellar travel promising. Not just content with theorising of such an idea, Hawking was keen on seeing it come alive. Bringing to fruition his concept, Hawking joined hands with a group of scientists and Yuri Milner, the billionaire venture capitalist, to invest

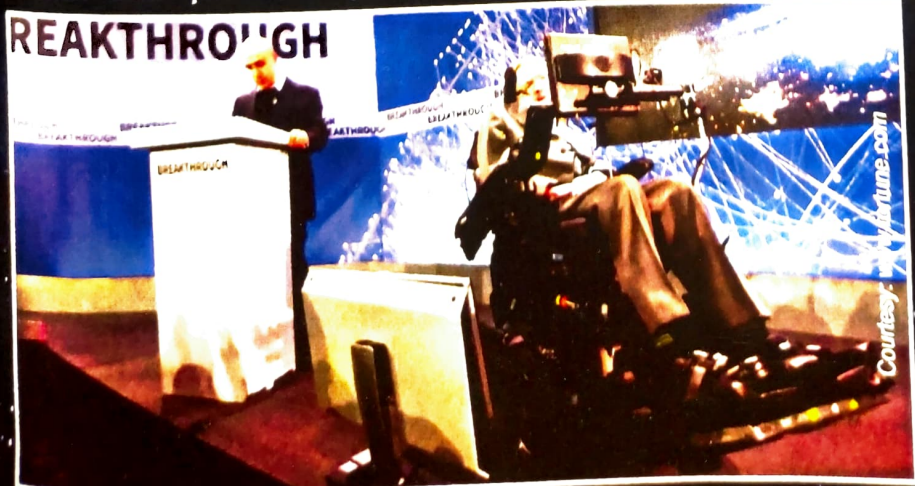
130 million in the project *Breakthrough Initiatives* in 2015. Their aim: *Observe, Detect, Listen and Visit* distant planetary systems.

The next couple of decades will witness innovative space probes vying to make it a reality. *Breakthrough Initiatives* commits to full transparency of their projects for consideration of both experts and public alike.

Riding on Light

To traverse enormous interstellar distances, the speeds of future probes should be comparable to the speed of light, conjectured the physicist. Light, being a source of energy can push objects, albeit small in size. "A powerful beam of light from the rear could drive the spaceship forward. Nuclear fusion could provide 1 percent of the spaceship's mass-energy, which would accelerate it to a tenth of the speed of light."

As a part of this, the *Breakthrough Starshot* was launched which devised miniature robotic spacecrafts which will be propelled by light. The wafer-sized spacecraft is fitted to ultra-thin LightSails. A cloud of such nanocrafts will launch aboard a mothership into low Earth orbit. From there, a laser-light beamer of giga-watt power from several ground facilities will propel the nanocrafts to speeds of 100 million miles an hour into the required interstellar region. These enormous velocities are many times greater than that of our present-day probes.





Did you know?

- Hawking (January 8, 1942-March 14, 2018) was born exactly 300 years after Galileo's death and died on Einstein's birthday.
- A young Hawking and family visited India on holiday. They lived in Lucknow and on a houseboat in Kashmir.
- After graduating from Oxford in 1962, Hawking travelled to Iran on a college travel grant. Here he was caught in the Bou'In-Zahra earthquake. This natural disaster killed nearly 12000 people, and we are fortunate that Hawking survived it!
- The young scientist did a summer course with Jayant Narlikar at Cambridge and was much inspired by the Indian scientist's work.
- Three decades ago he lost his natural speech. Since then he communicates through a computer-controlled voice synthesiser.

scientists are working on developing advanced instruments which will meet the required stringency.

Should these ventures hit success by detecting habitations from other worlds, then, what will we, the earthlings, convey to them?

Precise communication is the agenda of the *Breakthrough Message*. Making it an open-for-all competition (the dates are yet to be announced), the initiative will invite people to come up with a suitable message to communicate with the other civilisations. The challenge, however, is that this digitised message should speak for us and also be understood by alien life forms. Evidently, such a communication calls for insight into mathematics, physics, psychology, language and art.

These tiny crafts hold communication systems, computers, and cameras required for the exploration. The light sail attached to it will absorb the laser beam power and steer the spacecraft into deep space.

Such a craft would reach Proxima Centauri in a mere 20 years while travelling to Mars is just a matter of weeks (against the current eight months to one-year time).

Currently, *Starshot* has sent prototype miniature crafts called 'Sprites' piggybacking on launchers and have even reached the space station. They are now undergoing rigorous testing and are found to be communicating well with ground-based systems.

Still in experimental stages, *Starshot's* crafts are being modified further to attain optimum functioning. With an estimated time-frame of 20 years to realise the functioning spacecraft, the scientists are enthusiastically working on them to commit to an actual launch within the next generation.

Brimming with enthusiasm and confidence, Hawking presented the *Breakthrough Starshot* to the world in 2016, and in his address said: "The limit that confronts us now is the great void between us and the stars, but now we can transcend it. Today, we commit

to this next great leap into the cosmos. Because we are human, and our nature is to fly."

An Ear to the Skies

Breakthrough Listen is another pathbreaking initiative supported by Hawking. The scope of the project is to scan and listen to 100 closest galaxies outside Milky Way. For this they are using the world's most sensitive telescopes and radar equipment; the far-off skies are scanned ten times more intensely for any form of signal that may be coming our way.

"These spectroscopic searches are 1000 times more effective at finding laser signals than ordinary visible light surveys. They could detect a 100-watt laser (the energy of a normal household bulb) from 25 trillion miles away. *Listen* combines these instruments with innovative software and data analysis techniques," claims the Initiative.

Keeping an Eye

Acting as a bridge between *Starshot* and *Listen*, the *Breakthrough Watch* programme will scrutinise Alpha Centauri and other star systems within 20 light years. The objective is to look for oxygen and other biosignatures in this zone. Here too, a group of global

Setting an Example

Hawking's enthusiasm for space did not stop at just theorising or passionately following space explorations. At the age of 65, he took off in a specially designed plane to experience four minutes of microgravity. As he expressed later, he was hoping the experience would prepare him for space-flights in future! He is the only citizen who had a free ticket offer on Virgin Galactic's soon-to-be maiden commercial space flight.

Hawking made his last appearance in a documentary produced by the Smithsonian Channel titled, *Leaving Earth: Or How to Colonize a Planet*. In this film, he urges humans to embark on futuristic space explorations and sets tasks to colonise other worlds before we are overcome by an unanticipated or uncontrollable disaster or event. He ignites hope and curiosity in the space race and urges us to display our ingenuity.

To quote his iconic enthusiasm: "In the next 100 years, we will embark on our greatest ever adventure. Our destiny is in the stars."

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