# Giant telescope project

India's association as an observer for the present will enable more concrete participation at a later stage, says **S Ananthanaryanan**

INDIA is to join the international Thirty Metre Telescope project as an observer, the first step in becoming a full partner and participating in the development of what will be the world's most advanced and capable ground-based astronomical observatory.

The core TMT technology will be a *segmented primary mirror* with a 30-metre diameter. The largest telescopes so far are the *Gran Telescopio* in Spain, with an aperture of 10.4 metres and the pair of two 10-metre telescopes on the summit of *Mauna Kea* in Hawaii. With three times the diameter, TMT will have nine times the collecting area and images three times as sharp.

Only a minute fraction of the light from distant objects like stars and galaxies many light years away is able to reach the earth. As the distance increases, the information carried by the light crossing a given area reduces by the square of the distance. This is to say that if an object is 10 times further away than another, then the information reaching us from the further object is 10x10 = 100 times less than what we receive from the nearer object.

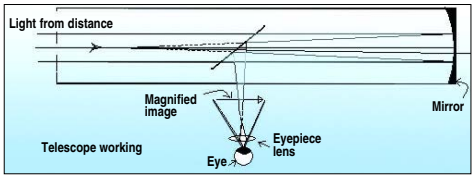
It can be compared to the clarity of a picture, which depends on the number of pixels on the screen. Nearby objects are clearer, like a picture with more pixels. The object can then be magnified and seen in greater detail. But magnification of the image of the further object, expressed in a smaller number of pixels, does not increase clarity. The only recourse then is to collect more light from distant objects, which is the same thing as increasing the diameter of the telescope.

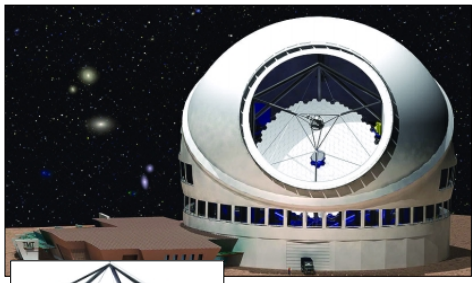
Telescopes with larger and larger objective lenses, or mirrors (the objective lens or the mirror is the foremost lens, or the mirror which collects light from the distant object), have thus been constructed. Lenses are usually of glass and it is difficult to create large diameter lenses. This apart, glass, or any material, behaves differently with different colours of light and this effect has to be corrected by using lenses that combine different materials. The larger telescopes are, therefore, always constructed with the main part made of curved mirrors and not of lenses.

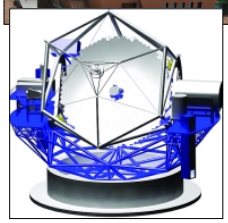
**How it works**

The eye sees objects by focusing an image of the object on the retina, which is the light-sensitive screen within the eye. The effect of the telescope is to bend the rays of light from a distant object so that they strike the eye as if they are from a nearer object. A larger image is thus formed on the retina and greater detail is seen. But, as explained, the detail available cannot be more than what the telescope has received — and hence the need to have a larger main lens or mirror, so that more information becomes available.

The information received also depends on the wavelength of the light. At short wavelengths, such as with UV light, or X-Rays, greater information is packed and images can reveal more detail. But light at these wavelengths is stopped by the earth's atmosphere and the telescope needs to be launched into space or kept in orbit around the earth, like the Chandra X-Ray satellite-based observatory. Chandra has rendered yeoman service since its launch in 1999 and has sent immense information about supernovae and black holes in the UV and gamma ray regions.





Such short wavelengths, however, are more easily scattered and are weak when received from distant objects. In contrast, long wavelength signals in the microwave or the radio region are hardy and are the only ones that can make it from the furthest parts of the universe. The problem is that such long wavelengths need telescopes with exceedingly large apertures. Fortunately, microwave or radio waves are detected not by optical means but by radio antennae. Data from an array of such antennae, spread over many kilometres, can be combined with the help of computers to simulate collection from a large aperture. Such arrays have been working for years to collect images of the earliest events of the universe.

**Visible region telescopy**

While X-Ray and microwave telescopy have their value, imaging in the visible region and also the near UV or Infrared still remains an important area of enquiry. Hence the project needs to have a really large aperture optical telescope. The first steps towards this end were taken in the 1990s, as the *California Extremely Large Telescope* project, which metamorphised, with changing support and funding, into the TMT in 2003-04.

The main part of the TMT is the large 30-metre diameter curved mirror. It is difficult even for a much smaller mirror, to a limit of some five metres, to rigidly maintain its shape and focus as it is moved about to point in different directions. The larger curved mirrors are thus not built as one piece but are composed of segments, usually hexagonal pieces.

The TMT mirror is similarly built of 492 hexagonal 14-metre pieces that fit together. In order to move the segments in unison and maintain their combined effect, the position of each segment is controlled by computer. The method is called "active control", with the position being adjusted dynamically to get the sharpest image for every orientation of the telescope.

But for all the benefit of the large aperture and the high resolution, starlight gets *distorted by atmospheric disturbances*. Movement of air, or layers with different density tends to distort images. The TMT will counter this by incorporating a system of "adaptive optics". In this system, the image in the telescope is continuously compared with the image of a reference star or known object, from which the light has traversed approximately the same path. The comparison enables computers to work out the distortions that have arisen and compensate by adjustment of portions of the telescope mirror.

As a suitable reference star may not always be available, the back scatter of laser light can serve as a reference.

**The project**

The TMT project is an international partnership among the California Institute of Technology, the University of California and the Association of Canadian Universities for Research in Astronomy. The National Astronomical Observatory of Japan joined TMT as a collaborating institution in 2008. The National Astronomical Observatories of the Chinese Academy of Sciences joined TMT as an observer in 2009.

India's association as an observer for the present will enable more concrete participation at a later stage. "The TMT and its partners are extremely pleased that India has selected TMT as their next-generation astronomical research project. As an observer, we can now begin exploring the specific areas where India can contribute to the project and look forward to its becoming a full partner with a formal agreement and commitment for funding," said Edward Stone, vice-chairman of the TMT board and Caltech's Morrisroe Professor of Physics.

The last cost estimate of the TMT, which is designed to weigh 2,000 tonnes, is almost a billion dollars. The project is located at Mauna Kea in Hawaii, a choice which was based on a combination of scientific, financial and political criteria.

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# Journey into the unknown

For 520 days, six astronauts simulating a trip to Mars will endure stress, surveillance – and no windows. How they cope will shape future space travel, says **David Whitehouse**

IN a large hall at the Institute of Biomedical Problems in Moscow six astronauts have begun the first full-duration Mars simulation mission. After a brief ceremony, the hatch of their mock-up spaceship was closed on 3 June. It will not open again for 520 days — the time it takes to get to Mars and back using conventional rocket technology. It's not certain they will make it. They'll be subjected to the psychological stress of isolation and forced to live and work with others. Their health, moods, performance and interactions will all be monitored, Big Brother-style. Few will be surprised if before the year is out some are hammering at the walls trying to get out.

More than 300 people applied to be crew members, only six entered the simulator — three Russians, two Europeans and a Chinese astronaut — all of them men. Initially, the selection criteria said that all candidates had to speak both Russian and English, but that was later relaxed. As it is, not all speak Russian and they have varying levels of English.

Living in five modules divided between areas for work and rest, the crew will first simulate a 250-day outbound flight to Mars, followed by a landing. Then, during a 30-day Mars surface stage, three of them will move to the Mars lander simulator, don space suits and walk around in a specially designed sandpit that is standing in for the Red Planet. Finally, there is the 240-day return trip to earth.

Of course, it can only be a partial simulation, as there is no weightlessness and the crew know they have not really ventured into the vastness of interplanetary space. They are able to abandon the mission at any time — but that won't make it any less tough. Although they are supposed to be simulating a space mission in a mock-up spaceship, one has to say it doesn't look very spaceship-like in any of the five modules. All have pine walls, pine furniture and pine bookcases, making it look more like a Swedish sauna than an interplanetary craft. As for the bedrooms, think student accommodation. Taken as a whole, it looks like a holiday cottage with no windows.

But holiday it is not — as the crew will find out once the novelty has worn off. The prepackaged food will, after a while, become tedious. The astronauts can take a shower every 10 days but in between have to rely on sterilised wet-wipes to keep clean. Communications with the outside world will be mostly via email, with a 20-minute delay simulating the radiowave travel time to Mars. One of the crew, Diego Urbina, will be twittering (twittername @diegou).


*The Moscow-based simulator.*

*Under pressure: if they complete their year-and-a-half mission in the Moscow-based simulator, the Mars 500 crew will each get paid £64,000.*

They've been in training for more than a year, with a strict fitness regime and intensive medical and psychological monitoring to determine their precise states as they start the mission. They have had innumerable lectures and demonstrations about the scientific experiments they will be carrying out, and even a two-day survival course involving camping out in a makeshift shelter in snowy woods outside Moscow.

All that will seem far away, now that the hatch has closed behind them. Inside, they have the freedom to organise their various tasks, and "non-standard events" and emergencies will also be thrown at them at random times to see how they cope, especially in the later phases of the mission. For this first month they have had voice communication with Mission Control. After that it will be email only.

It's bound to be stressful. Although they know each other well and have been psychologically profiled not to have obvious clashes, this is no 10-day space-shuttle flight — during which a crew can put up with personal problems. If they are not careful, simmering resentment, jealousy, inappropriate competition and even mutiny could wreck the mission.

Some of the previous isolation missions have not gone well. An eight-month mission in 2000 contained something not seen in this expedition: alcohol and women crew members. There were two women — a Russian and a Canadian — among a crew of six. The Russian said afterwards that she felt it had gone OK, as any Russian woman knows how to keep their men at bay. The Canadian was not so lucky, and was once grabbed by the arm as a prelude to an unwanted kiss. She locked herself in her room and said later, "I had lost my dreams about astronauts and cosmonauts, who had always been heroes for me." Alcohol has been banned ever since.

This time, the crew selection panel said they did not intentionally set out to make the crew all male. They said that when they had reduced the competition to 11 candidates, they noticed that none was a woman.

In the Mars module, there are no windows, so the sense of claustrophobia is intense. The mission can only address the psychological stresses of a mission to Mars. For most astronauts used to the physical rigours of training, that will be the real unknown frontier. They have laptops, books, music and DVDs. They have a gym and a sauna and spaces where they can get away from others, at least for a while.

According to the mission timeline, the six astronauts in Moscow have already left earth's orbit and are headed for the uncharted blackness of interplanetary space. Soon, the only people they will talk to will be each other — and hell, it has been said, is other people. If they stay the entire 520 days, they will be paid three million rubles, or about £64,000. The expedition's commander, 38-year old Alex Sitev, may be looking forward the most to getting out. He got married just a month before his voluntary incarceration.

If they complete the mission and emerge relatively unscathed and sane at the end, they will deserve a crack at a real space mission — if that can, in fact, be organised, in an uncertain post-space shuttle era.

**The Independent, London**

# What not to eat

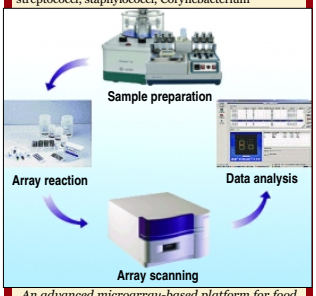
The detection of pathogenic organisms plays an important role in the routine monitoring of contaminants in food, says **Tapan Kumar Maitra**

PROTEINS, carbohydrates, vitamins and other nutrient substances in food products have a favourable effect not only on the preservation of different micro-organisms but also on their multiplication.

Products of sour milk and foodstuff produced by fermentation contain a great number of microbes which lend them flavour and consistency. These are called specific microflora. Besides, micro-organisms or their spores may get into foodstuff from the environment, which are called non-specific microflora.

The reproduction of some micro-organisms may cause spoiling of food products that become inedible. In some cases, a food product may be seeded with Salmonella and Shigella organisms, staphylococci, Clostridium botulinum, Escherichia coli, Bacillus cereus, Clostridium perfringens and other microbes that cause toxico-infections and other diseases among humans.

Milk may be contaminated with Mycobacterium tuberculosis bovis, Bryceallae, Coxiella burnetti, pathogenic streptococci and encephalitis viruses from sick animals. During transportation, or when it is bottled or treated, milk may be infected with Salmonella and Shigella organisms, pathogenic streptococci, staphylococci, Corynebacterium




*An advanced microarray-based platform for food safety applications.*

diphtheriae, Vibrio, cholerae and other microbes by sick personnel or microbe-carriers.

Meat may be contaminated when the animals or poultry are still alive but sick, or when they are slaughtered, cut or the carcasses improperly stored and transported. Cl. perfringens, B. cereus, enteric bacteria, Streptococcus faecalis, Proteus and other bacteria are usually found in meat. Meat products — minced meat in particular — are most frequently contaminated during treatment when pathogenic microbes are found on the surface of the meat chopper and on the utensils used, especially the cutting board.

The flesh of fish is infected with a wide variety of microbial species found in water, the scales and guts of fish, on the hands of persons involved in processing the products and on various objects — knives, tables, boards used in preparing fish as well as the deck of a fishing boat. The most lethal micro-organisms are Cl. botulinum which produce an exotoxin in canned fish products and Vibrio parahaemolytica. When sanitary regimens are given the short shrift, S. typhi, Sh. flexneri and, in some cases, the El Tor vibrio are found in the flesh of fish and oysters.

Vegetables and fruit may be seeded with Shigella and Sabnonella organisms, Vibrio cholerae and microflora found in the soil and on the hands of persons who take part in harvesting, packing and transportation as well as those who sell them. Improperly canned vegetables — tomatoes, mushrooms — may sometimes cause botulism.

Various microflora and pathogenic species like

*The US Food and Drug Administration recently issued a warning not to eat raw oysters from the southern tip of the Hood Canal in Washington that have been linked to an outbreak of vibriosis – a rare illness caused by the Vibrio parahaemolyticus bacteria.*

Salmonella organisms, fungi and actinomycetes penetrate eggs quite often; egg powder may get contaminated with staphylococci.

Bakery products are a relatively rare source of infection with pathogenic micro-organisms. Only those baked from grain left in the field the whole winter cause fusariotoxicosis due to pathogenic Fusarium genus moulds.

Among all the different types of food poisoning in humans, 70 per cent are due to pathogenic bacteria. Salmonella organisms, staphylococci and streptococci are the most dangerous — they multiply and accumulate in foodstuffs without causing changes in their organoleptic properties.

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