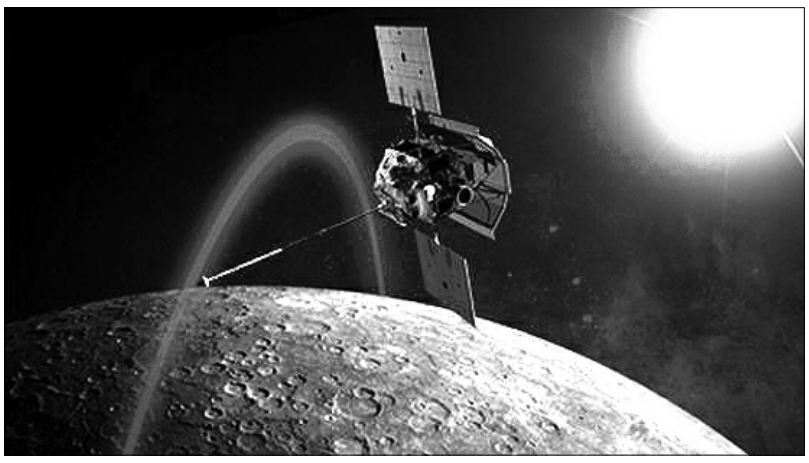
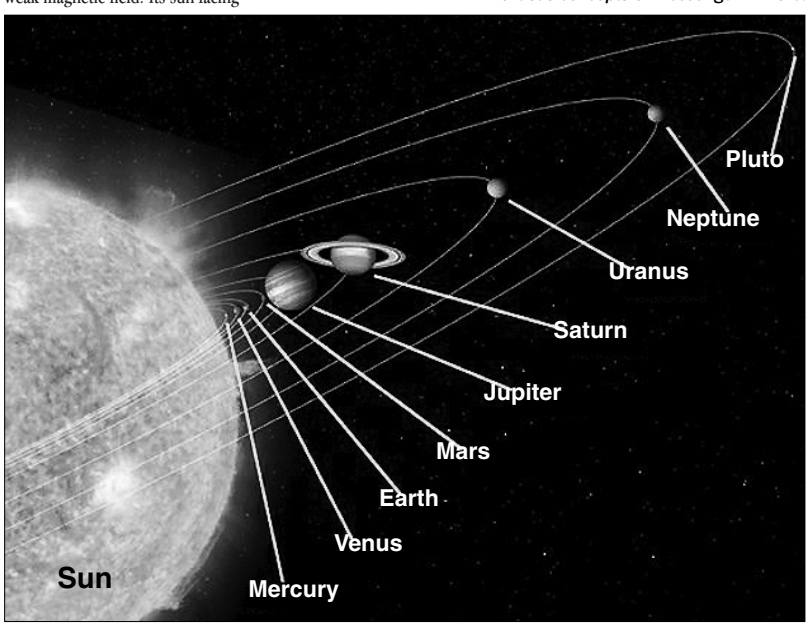
In orbit at the first circle

With the National Aeronautics and Space Administration's *Messenger* spacecraft having entered orbit around Mercury, the stage is set for a close look at the sun's nearest planet, says s ananthanarayanan



An artist's concepts of Messenger *in Mercury's orbit.*



AFTER more than six years of travel since its launch in August 2004, and having been guided by the gravitational forces of earth, Venus and Mercury, *Messenger* is in place to beam back the first quality data to answer key questions about the sun's innermost planet. The spacecaft's name, *Messenger*, is an achronym for *ME*rcury *S*urface, *S*pace, *EN*vironment, *GE*ochemisty and *R*anging, which describes its objectives. Although Mercury is a relatively nearby planet, and of interest, being the nearest to the sun, *Messenger* will be the first major close range study, after the flypast 37 years ago by *Mariner 10*. Interestingly, the method of propulsion or speed control of the current mission, viz — planetary gravity, is the same as was used by *Mariner 10*.

Once out of earth's orbit after its launch from Cape Canaveral in the USA, *Messenger* was propelled by the attraction of the sun and other planets and sent on its way, but the important thing lay in guiding the spacecraft to its destination, Mercury, and slowing it down so that it was captured into orbit around Mercury. This was managed by first a return to near earth, a year after launch, and then twice flying by Venus, in 2006 and 2007, to be nudged into a path closer to Mercury. Three Mercury flybys, in 2008 and 2009, made it possible to carry out a course-correcting manoeuvre, which draws on the valuable fuel of the spacecraft's rockets, to enter Mercury's orbit, which has just happened.

Messenger's total journey has been about eight billion km, while the entry into Mercury's orbit has taken place at just 150 million km, about the distance of earth from the sun. This is natural as Mercury is right next to the sun, though in a very eccentric (egg shaped) orbit, 50 million km, on the average.

Mercury

Mercury's year, or time to go round the sun, is only as long as 88 earth days. But the planet goes round on its axis (which earth does once every day) very slowly and it has only some three days in two of its years! Mercury is not often seen from earth because of the glare of the sun, but when it is seen, like during a solar eclipse or in the early morning or evening twilight, it is fairly bright. It is the smallest planet of the solar system, just 4,880 km across, and has a cratered surface, somewhat like the moon. It is very heavy for its size, the second densest planet, after earth, which suggests a heavy iron core. And sure enough, it has a weak magnetic field. Its sun-facing side reaches the scorching temperature of 700º Celsius. And because it has very little atmosphere, the dark side of the planet cools to a freezing -183? Celsius.

With our last close look at Mercury being in 1975, when *Mariner* went past, we have had very little information about Mercury. But with *Messenger*, all this is set to change. The main questions are: Why is Mercury so dense and what is the nature of its geology? Its magnetic field is another question, for it has one, like the earth, which is not so of Venus or Mars. What may be the structure of Mercury's core? Measuring gravity at different points, which can be done by an orbiting station, can provide clues. What are the materials at the poles? Could there be – perhaps like on the moon — ice trapped in shadows, despite Mercury being so close to the sun? What are the gases in the light atmosphere? Is there unseen volcanic activity?

Messenger

As most of the load in the package that is launched from earth is the fuel required to get *Messenger* into orbit around Mercury, the weight of the actual spacecraft needs to be kept as low as possible. The design also needs to be robust to withstand the searing heat and intense cold. All this places limitations on what can be carried. The craft itself is made of a graphite epoxy material that combines strength and light weight. The craft has its power supply, two solar panels and a battery, its computer, navigation and radio communication with earth. The instruments include cameras to image topography, devices to detect radioactivity and hence map the abundance of different elements that are reacting to cosmic ray bombardment, instruments to measure magnetism and gauge distances of surface promontories, instruments to assess gasses in the atmosphere and magnetosphere and an arrangement to record the spacecraft's speed and hence deduce Mercury's mass distribution.

While the spacecraft has now entered orbit, starting 23 March, all systems will be checked out and from 4 April will begin actual recording of close range data. In fact, even during the course-correcting flashbys in 2008 and 2009, when *Messenger* came pretty near Mercury's surface, sizeable data has already been collected to help plan what to look for once well placed in orbit.

The mission was organised with three specialised teams — the launch, operations and science teams. The first team has finished its work and the second has only routine tasks. It is the third team that will now get active, maximising the output of this resource placed right in orbit around Mercury, for the time that the resource is there. A close look at the sun's nearest planet will place in context all other knowledge about the Solar System and our ideas of planet formation.

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Reaction of incomplete antibodies

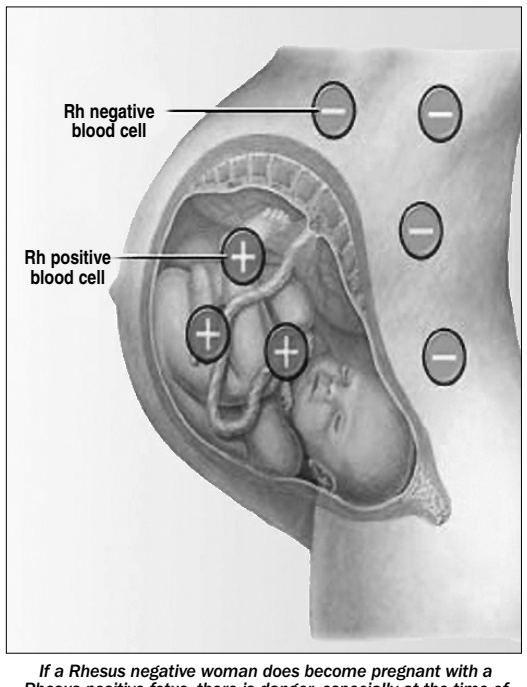
After penetrating the blood of the mother, the rhesus-factor provokes the production of rhesus-agglutinins, which later enter the blood of the foetus through the placenta and cause agglutination of erythrocytes, writes tapan kumar maitra

INTERRELATIONS between protective (defensive) antigens and the corresponding antibodies are of a completely different nature. During this interaction no typical immunological reactions are observed — neutralisation, precipitation and complement-fixation. It has been suggested that protective antigens provoke the formation of incomplete, or blocking antibodies, capable of rendering harmless the aggressins of anthrax bacilli, capsular proteins of the causative agents of plague, tularaemia and other bacteria.

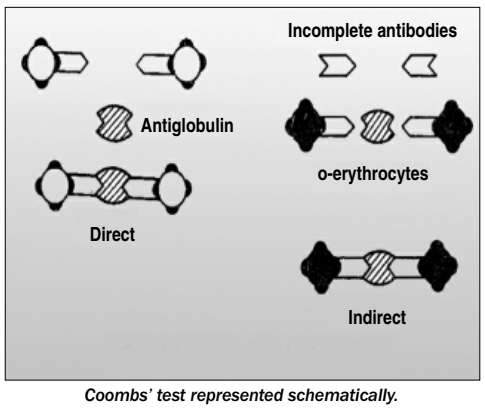
Incomplete (monovalent) or blocking antibodies are fixed by the antigens, but do not cause their agglomeration. In contrast to ordinary — complete — antibodies they have proved to be more stable to heat, pressure and chemicals, and quite easily penetrate through the placenta.

They include rhesus-agglutinins, non-precipitating thermolabile antibodies and reagins of allergic patients as well as of patients with systemic lupus, infectious polyarthritis and collagenosis. Incomplete hetero-, iso-, and auto-antibodies may cause drug leuco- and thrombocytopenia.

Incomplete agglutinins and haemagglutinins have been demonstrated in the immunisation of animals with the capsular antigen of the causative agent of plague. They were found in the sera of patients suffering from dysentery, typhus and brucellosis in titres 4-32 times those of complete antibodies — in the sera of animals immunised with the cholera vaccine their titre was four to eight times that of complete antibodies.



If a Rhesus negative woman does become pregnant with a Rhesus positive fetus, there is danger, especially at the time of delivery, that some of the fetal red blood cells will escape into the mother's circulation and stimulate her to produce anti-Rhesus positive antibodies.



Coombs' test represented schematically.

Of great interest are agglutinins against the rhesus-antigens of erythrocytes of children suffering from haemolytic disease which is the result of the presence of a rhesus-factor in the erythrocytes inherited from the father.

After penetrating the blood of the mother, the rhesus-factor provokes the production of rhesus-agglutinins, which later enter the blood of the foetus through the placenta and cause agglutination of erythrocytes. Haemolytic disease is due to the incompatibility of the rhesus-factor in the blood of the mother and the foetus.

The rhesus-factor is capable of causing the production of two types of agglutinins — a) complete — bivalent — agglutinins, which in a saline and colloidal medium may cause the agglutination reaction of erythrocytes containing a particular antigen, and b) incomplete — monovalent — agglutinins inhibiting agglutination, which do not cause the agglutination reaction in a saline solution.

For detecting incomplete antibodies special methods are employed. Coombs' test is used, in particular to detect incomplete agglutinins in rhesus-negative mothers. To determine the fixation of agglutinins by the patients erythrocytes, antiglobulin serum is added, which, in a saline solution, is capable of causing marked agglutination of erythrocytes sensitised by incomplete agglutinins. A molecule of antiglobulin binds two molecules of incomplete agglutinins fixed to two different erythrocytes, due to which the agglutination reaction takes place.

The direct reaction (left) demonstrates the presence in the patient's blood of antibodies bound with the erythrocytes by means of antiglobulin: in the indirect reaction (right) free incomplete antibodies are revealed by adding to the serum normal erythrocytes, bacteria or rickettsia and then antigamma globulin.

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Nuclear secrecy is a matter of concern

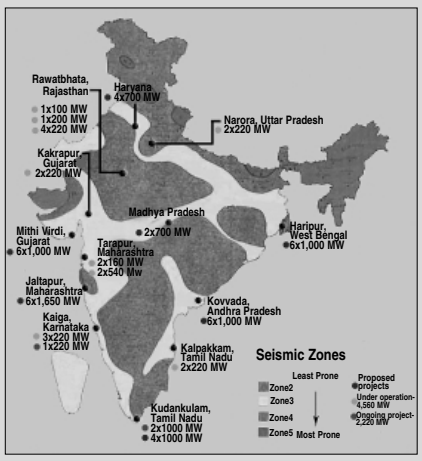
There has to be a clear demarcation of civilian and military establishments, writes richard mahapatra

THE nuclear crisis in Japan has highlighted the perils of restricting the flow of information. Starting from the International Atomic Energy Association to senior officials in charge of managing the crisis in Japan, there is a growing frustration over the way the country's nuclear power company has shared information on the state of affairs in the tsunami-stricken reactors. This has apparently contributed negatively to crisis management.

For us in India nuclear secrecy is a home truth. Nuclear power is still an exclusively government affair. The Atomic Energy Act of 1962 allows our nuclear establishments to not share information as well as keeps the establishment completely out of bounds for people, except for the few chosen ones. It is impossible to get information on a nuclear power plant — say, on design, evaluation or internal review reports — except on its potential generation capacity. Besides, nuclear establishments also use radioactive material. The Act prevents people from knowing their credibility as well.

To dig history a bit, the blanket ban on information on the nuclear establishments through the Act was necessitated by the fact that India had never demarcated between civilian and military nuclear facilities till recently.

When then Prime Minister Jawaharlal Nehru introduced the Bill for Parliament to enact, there was opposition to giving so much information protection to the nuclear establishment. Parliament records of sessions show that member of Parliament Krishnamurthy Rao vehemently opposed the secrecy granted to the nuclear establishment. He compared it to a similar legislation in the UK that debarred



information sharing on defence-related nuclear establishments only. He posed a question to Nehru, "Does the proposed bill cover the peaceful (nuclear) purposes?" And Nehru replied, "I do not know how to distinguish the two (peaceful and defence purposes)."

That dilemma continues to this day. Despite the nuclear sector undergoing a major makeover, particularly in the past 12 years, in a short span India has turned from a nuclear pariah to a global darling. In 1998, we tested five nuclear weapons. Officially, we became a country possessing nuclear weapons.

Soon a series of developments followed that culminated in the Indo-US nuclear deal in 2005. This has opened up the nuclear sector to global investments. Now there is a virtual scramble for setting up nuclear power plants in India.

As part of this push for civilian nuclear use, there has to be a clear demarcation of civilian and military establishments. In 2000, the Atomic Energy Regulatory Board was given charge of the civilian establishments, keeping strategic centres out of its purview. The AERB looks after safety aspects of nuclear plants. Even here, getting information on nuclear power plants and their safety is difficult.

Many doubt its credibility. This comes from the fact that the AERB is not independent. Its administrative control lies with the Atomic Energy Commission, which is chaired by the head of the department of atomic energy. The Nuclear Power Corporation also has administrative control over the AERB. It means the latter is prone to manipulation as it is controlled by the same organisations that it is supposed to regulate for safety. Experts see this as a violation of the International Convention on Nuclear Safety, of which India is a signatory. With new nuclear plants coming up, sharing of information will be of critical importance. The government cannot give the excuse of "strategic affairs" with the new plants as they are meant for power generation only. India will also be using new nuclear technology brought in by various companies. A safety plan will be ineffective if we do not have complete information on the power plants.

The Japan nuclear crisis has further emphasised that foolproof scrutiny of nuclear plants in totality is vital. For example, the reactor in crisis in Fukushima Daiichi plant did not simulate a scenario of failure of the back-up power supply to the reactor, even though it is situated in tsunami-prone areas. The plant had been in operation since 1971.

In October 2010, former minister of state in the Prime Minister's Office Prithviraj Chavan said that the Central government was about to amend the Atomic Energy Act. This was because India was already a major player in the global nuclear energy field and regulation of new plants was essential. But not much progress has been made on this front.

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