

Chandrayaan & the water quest

On the moon, temperature has trapped water which gravity could not hold down, writes **S Ananthanarayanan**

THE discovery of the Indian Space Research Organisation's Chandrayaan-1 of substantial water reserves, in the form of ice, on the moon is a shot in the arm for prospects of colonization. Chandrayaan-1 carried the National Aeronautics and Space Administration's 6.5 kg Miniature Synthetic Aperture Radar, which bounced specially designed radio waves off the lunar North Pole and detected not just water molecules but water in the form of ice, which promises large quantities.

Moon gravity

Being a smaller heavenly body, the force of gravity is low on the moon. It is only 17 per cent as strong as on the earth, in fact. This has an effect on how long the moon can hold on to its atmosphere. As we know, the earth's atmosphere weighs down, at sea level, with the weight of a 30-ft water column. The pressure reduces as we go higher, but there is a substantial downward pull for many kilometres, till the atmosphere is scarce, indeed.

The result is that the earth has a strong hold on its atmosphere. Yes, there is some loss all the time, as a molecule of some gas which is moving fast away from earth does not get deflected by another molecule and is able to escape. But the leakage is slow and negligible.

This is not so on the moon. Because of the low gravity, it is difficult for the atmosphere to stay rooted and the moon has long lost all of it. With no atmosphere, there is nothing to stop projectiles, like meteors that shoot in from outer space, and hence the battered, pock-marked look of the moon's surface. Again, with no atmosphere, not only has all the water vapour gone, but even the surface temperature gets frightfully hot. Any trace of water trapped in the soil or rocks is also roasted out and sent on its way into the void.

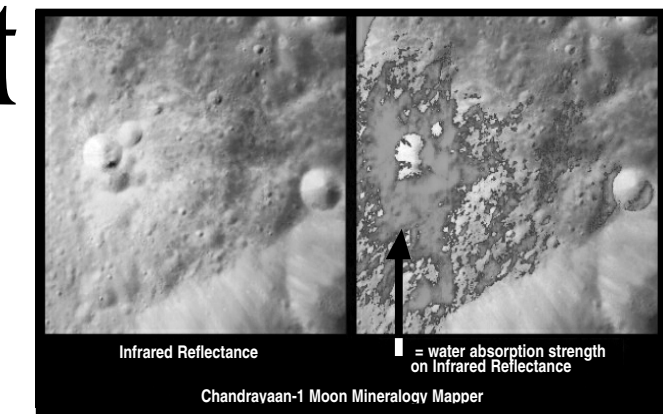
Moon temperature

Along with permitting rapid heating, the lack of an atmosphere also speeds up

cooling. Thus, while the sunny side temperature on the moon rises to 123°C Celsius, on the dark side it goes down to 233°C Celsius below freezing. As the lunar day is as long as the lunar month, every part of the moon gets fried for a good 14 days before it cools for another equal period. Thus the temperature rises above boiling during the day and then, with no atmosphere, rapidly cools in the night, till it reaches the intense cold of more than 200°C Celsius below freezing.

As the axis of rotation of the moon is also slightly slanted, like the earth's, there are arctic circles that have six months of daylight, with slanting sunshine, followed by six months of night. It is in these poles, if there are pits or valleys, that there could be regions that never see sunshine and where the low, sub-zero temperatures could endure through the year!

It is in such cold regions that it has been expected that water may freeze and be trapped. Any scraps of water vapour that come in with cosmic debris that crashes into



Chandrayaan-1 Moon Mineralogy Mapper

the moon, if they stray into these cold water traps, get locked in. And over the eons, this could amount to millions of tonnes, which is important when we consider locating any facility or settlement on the moon.

The MiniSar

The presence of water had been confirmed in September 2009 by Isro's Moon Impact Probe and Nasa's Moon Mineralogy Mapper (M₃), both of which were carried by Chandrayaan-1. But these discoveries were of water molecules embedded in minerals and rocks, and in minute quantities — "We could extract half a litre from a tonne of soil," Isro chief G Madhavan Nair had said.

The method employed was analysis of

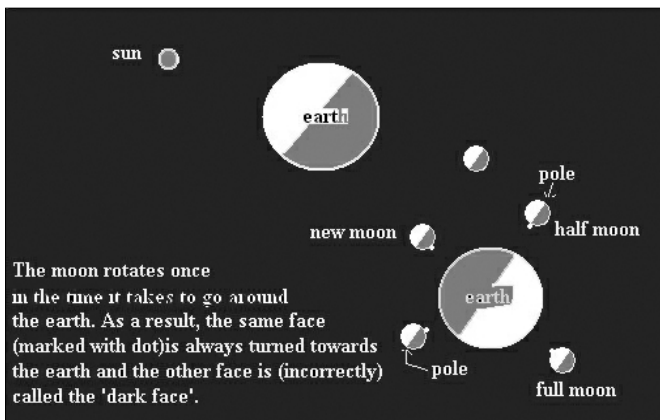
infrared light received from the moon's surface, which revealed absorption at the wavelengths characteristic of water molecules. Isro's Mip picked up signals on its way down to the moon's surface, while Nasa's M₃ worked from a distance, while in orbit around the moon.

But the objective of MiniSar was to detect bulk water, not just molecules. MiniSar made use of high frequency radio waves, (2.38 GHz) and a wavelength of some 13 cm) and looked for changes in the orientation of the plane of oscillation of the radio waves which were returned.

Electromagnetic waves consist of an electric and a magnetic vibration, in planes perpendicular to each other. In an ordinary beam, there are waves of all orientations, with the electric and magnetic vibrations being in perpendicular planes in each wave. But it is possible to generate waves that are "lined up", or polarised, along a single plane, or even with the plane itself turning a circle as the wave progresses.

The planes characteristic of specially prepared waves like this get altered on reflection from different surfaces. This modification is not absorption by molecules but is due to large reflecting surfaces and indicates the presence of specific materials in bulk. Reflection by ice crystals leaves a clear footprint. MiniSar analysed the proportion of unaltered and also the differently altered components of reflected radio waves, which confirmed the presence of water as ice in as many as 40 craters, from two to 15 km across, the total water estimated at about 600 million tonnes!

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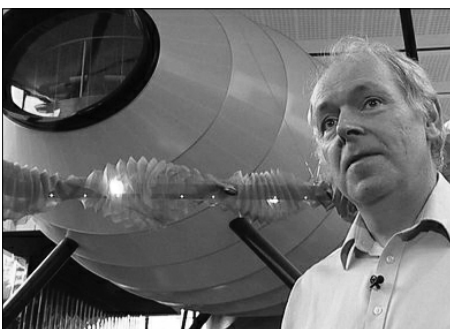
The moon rotates once in the time it takes to go around the earth. As a result, the same face (marked with dot) is always turned towards the earth and the other face is (incorrectly) called the 'dark face'.

a study published in the journal *Science*. "The rings were still a nearly unstructured object in even the best telescopes when I was a student, but Cassini has brought us an intimate familiarity with them." He is one of the scientists in the joint American-European mission named after the great Italian-born astronomer, Giovanni Cassini.

From earth it is only possible to see a

couple of the biggest rings but there are many more, each composed of small objects, some the size of a grain of sand, that orbit the planet around its equator. The particles are "shepherded" by some of the 62 known moons of Saturn, covering a distance of 150,000 miles across, but less than a mile thick.

Professor Carl Murray, an astronomer at Queen Mary, University of London, who



Professor Carl Murray

works on the Cassini mission, said that the most bizarre ring of all, the outer F-ring, was routinely bombarded with cannonball-like objects that appeared to come from nowhere and disappear just as suddenly. "Rapid change is the order of the day at the F-ring with bizarre structures created by the combined effect of gravity and impacts from nearby objects. Each Cassini image gives us another piece of the F-ring jigsaw puzzle and gradually a complete picture of this strange ring is

starting to emerge," he said. The Cassini spacecraft, launched in 1997, arrived at Saturn in 2004 and has since captured some of the most remarkable images of the planet's ring system. It has shown that the brightness of the rings is caused by the purity of the water ice they contain, which reflects sunlight. However, the rings have a reddish tinge caused by an as yet unidentified contaminant.

Cassini has also monitored the immense weather systems that take place on Saturn, a "gas giant" planet mostly composed of hydrogen and helium. It has monitored the sound of the lightning strikes caused by the electrical storms that take place every few years on the planet. Even bigger equatorial storms erupt and encircle the planet once every 15 or 20 years.

As Cassini approached Saturn in 2004 it released Huygens, a small probe, into the dense atmosphere of the planet's largest moon, Titan, which is believed to be the most earth-like world in the Solar System. Cassini revealed that Titan's surface, shrouded in an orange haze, is shaped by rivers of liquid methane and ethane that form clouds that rain down on the moon's surface.

One of the most startling discoveries to emerge from the mission was the discovery of plumes of ice particles and water vapour spouting from "volcanoes" on Saturn's icy moon Enceladus.

The Independent, London

A ringside seat

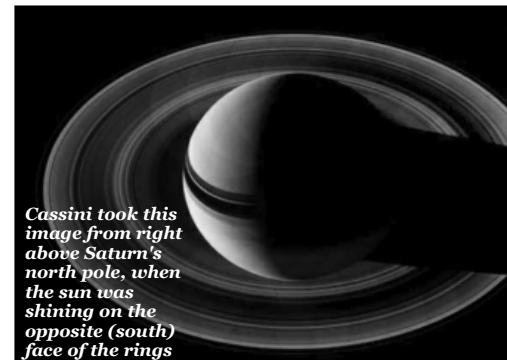
The Cassini mission has shed new light on one of the great mysteries of the solar system, says **Steve Connor**

THEY are one of the most spectacular sights in the solar system, yet the visual serenity of Saturn's rings belies the violent destruction that continually takes place to maintain these remarkable planetary structures. From earth, the distinctive set of rings belonging to the sixth planet from the sun appears to be tranquil garlands adorning their mother planet, but on closer inspection the rings of Saturn — composed of orbiting, ice-strewn debris — are far from peaceful.

Immense tidal forces tear into the materials

researchers involved in the \$ 1.6 billion Cassini mission believe they can show that the planetary rings are far from a static collection of space debris orbiting their host but rather a highly dynamic interaction of continually colliding objects.

"It has been amazing to see the rings come to life before our very eyes, changing even as we watch," said Dr Jeff Cuzzi of the National Aeronautics and Space Administration's Ames Research Centre in Moffett Field, California, and lead author of



Cassini took this image from right above Saturn's north pole, when the sun was shining on the opposite (south) face of the rings



The Cassini spacecraft in orbit

that make up the rings to prevent them clumping together to form bigger objects and, eventually, a new moon. Giant rocks and meteorites pummel the rings with violent collisions that break apart the orbiting debris still further.

Ever since Galileo Galilei first observed the rings of Saturn — which he thought were a pair of twin moons on either side of the planet — they have been an object of fascination. Now scientists working on data sent back from the Cassini space probe believe they are close to answering some of the most intriguing questions of Saturn's defining feature.

After six years of studying the rings, the

In numbers

62 ~ The number of known moons of Saturn, 53 of which have been officially named. Titan is the largest and most interesting in that it is similar to a rocky, earth-like planet.

93 per cent ~ The composition of water ice in the rings of Saturn. The high water content explains why the rings are so prominent — they reflect sunlight easily.

7 ~ The number of years it took for the Cassini space probe to arrive at Saturn. Nasa has recently announced a further seven years of life, which will end with the probe being crashed into the planet.

TENDER
The Shipping Corporation Of India Ltd.
 (A GOVERNMENT OF INDIA ENTERPRISE)
 SHIPPING HOUSE, 13, STRAND ROAD, KOLKATA-700001

Sealed tenders are invited from reputed contractors for Repair, Maintenance & Renovation of Toilet Blocks at our office at 'Shipping House'. Estimated contract value is Rs. 50 lakhs, EMD: Rs. 50,000/-. Due Date: 14/04/2010. Tender document will be available from the office of our architect M/s. De Sarker & Associates, DB-34, Sect-I, Salt Lake, Kolkata-64 by paying Rs. 2500/- by DD or pay order in favour of The Shipping Corporation of India Ltd., payable at Kolkata or may be downloaded from websites: <http://www.shipindia.com> or <http://tender.gov.in> SCITM/1197

TRANSPORTING GOODS. TRANSFORMING LIVES

Steel Authority of India Limited
SAIL Refractory Unit Bhandaridah
 Bhandaridah-829 132, Dist., Bokaro, Jharkhand (India)
 Ph. 06549-239222/239462, Fax : 06549-239220

SRU BHP/Prod./Trans.-BSP/10-921 Dated : 22.03.2010

ABRIDGED TENDER NOTICE

- Name of work : Transportation of Refractory materials from SRU/Bhandaridah to M/S. Bhilai Steel Plant, Bhilai (C.G.) by road.
- Cost of Tender Document : Rs. 1500/- per set on payment in our cash counter & Rs. 1600/- by way of DD drawn in favour of Bharat Refractories Limited payable at SBI, Bhandaridah (Code : 6076) in case of purchase of the same by post.
- Tender Documents are available for sale from the office of Dy. Manager (Prod.) from 25.03.2010 to 20.04.2010
- Last date of submission of offer : 23.04.2010 upto 3.00 P.M.
- Opening of Technical Bid : 23.04.2010 at 3.30 P.M.

For further details visit our WEBSITE www.sailtenders.co.in Dy. Manager (Prod.)

Mahanadi Coalfields Limited
 (A Subsidiary of Coal India Limited)

e-Tender Notice (NIT No. 572 (Re-Tender) & NIT-573 Dt. 18.03.2010)

Tenders are invited on-line on the website : <http://mcltenders.gov.in> from the experienced contractors having Digital Signature Certificate (DSC) issued from any agency authorized by Controller of Certifying Authority (CCA), Govt. of India for the work : (1) NIT-572 : Mechanical transfer of coal into Tippers by pay Loader at Lakurua ROM Stock Yard and transportation of same to Lakurua OCP, CHP Lakurua OCP IB-valley area at lead of 0-1 KM for a total quantity of 9.70 Lakh Tons. (2) NIT-573 : Mechanical transfer of crushed coal into Tippers at Samaleswari OCP Crushed Coal Stock No. 2 and 7 and Transportation of same to Lakurua siding No. III for a total quantity of 10.00 Lakh Tons. Samaleswari OCP, IB Valley Area, Estimated Cost : (1) Rs. 1,46,47,000/- & (2) Rs. 2,83,64,000/-. EMD : (1) Rs. 37,700/- & (2) Rs. 5,67,300/-. Tender Fees : (1) 1,500/- & (2) Rs. 3,000/-. Completion Period : (1) 1095 days & (2) Rs. 125 days. Bid Submission Start date : 25.03.2010 at 10.00 AM, Pre-Bid Meeting : 24.03.2010 at 11.00 AM (NIT-572) and 12.30 PM (NIT-573). Bid Submission end date: 09.04.2010 upto 5.00 PM. All bids are to be submitted on-line only. No bid shall be accepted off-line. Further details and submission of tender please visit our website : <http://mcltenders.gov.in> The link to this website is also available from our website: <http://mahanadi.coal.nic.in> NOTE : MCL will not be responsible for any consequences due to misprinting or any wrong translation by newspaper concerned. (R-4305)

ANDREW YULE & CO. LTD.
 (A Govt. of India Enterprise)
 14, Mayurbhanj Road, Kolkata - 700 023

Notice No. : ED / SWG / Security / 09-10/06 / RNB

Description of Work : Providing security Personnel of different category at our three factories of Electrical Division (Kolkata Operation).

Tender Fees : Rs. 200.00. E.M.D. : Rs. 20000.00 (Without interest). Two separate D. Ds in favour of Andrew Yule & Co. Ltd. to be paid in the sealed envelop of **Techno-commercial Bid**. Envelop of **Price Bid** should contain only Price part.

For details, please visit our website : www.andrewyule.com or Tender Documents can be collected from our above address by paying Tender fees of Rs. 200.00 by DD. Interested parties may send their sealed offer addressed to the Manager - Materials, Inspection of our Factories may be done on any working day between 10.00 AM to 3.00 PM with prior intimation.

Last date of submitting sealed offer : 03/05/2010. Tender will be opened on 05/05/2010. Manager - Materials.

BHARAT SANCHAR NIGAM LIMITED
 (A Govt. of India Enterprise)
 Office of The Executive Engineer (Electrical), BSNL
 Electrical Division, 87/1, Ramkrishna Pally, Malda-732101

PRESS NOTICE

The Executive Engineer (E), BSNL Electrical Division Malda, invites on behalf of Bharat Sanchar Nigam Limited (A Government of India Enterprise) sealed item rate tenders for the works: 1) "SITC of (3+1) x 7 TR package A.C. unit 1st floor of TE Bldg., Raiganj" (S/H-Associated work for Part-B). 2) "SITC of (4+1) x 7 TR package A.C. unit 2nd floor of TE Bldg., Raiganj" (S/H-Associated work for Part-B).

For further details kindly visit our website at www.wb.bsnl.co.in

NHPC Limited
 (A Government of India Enterprise)

Teesta Low Dam Project, Stage-III, Rambi, P.O. - Reang, Distt. Darjeeling (W.B.), Pin - 734321
 Telephone No. : 03552-261010, Fax : 03552-261007
CORRIGENDUM 1st

Ref: 1. NIT-NH/TLDP-III/Rambi/P&C/PR-247/2010/2579 dated 02.03.2010
 2. Corrigendum 1st-NH/TLDP-III/Rambi/P&C/PR-247/2010/2603 dated 22.03.2010

Supply of 10,000 MT of Portland Pozzolana Cement (PPC) conforming to IS-1489 (Part-1) for Teesta Low Dam HE Project, Stage-III, Rambi.

Following amendments are hereby notified: **Special conditions of contract:** Detailed as per Corrigendum 1st. **Date of sale of Tender Document:** Till 10.04.2010 (During office hours). **Date & Time of submission of Tender Document:** 12.04.2010/15:00hrs. **Date and Time of opening of Technical Bids:** 12.04.2010/15:30hrs. All other contents of the original NIT (Open) shall remain unchanged. Details may be downloaded from www.nhpcindia.com.
 Dy. Manager (P&C)

NORTHERN RAILWAY

Invitation of Tenders through E-Procurement system
 Fax No: 011-23384008 E-mail Address: cos@nr.railnet.gov.in

Controller of Stores, Northern Railway, New Delhi for and on behalf of the President of India, invites tenders through e-procurement system for the supply of the following items: **SN: 01 Tender No.: 41-03-10-0109 Description:** Push trolley for digital axle counter with phase reversal type track device as per RDSO DRG-S-2004, each complete set of four nos. wheel and one set i.e. 02 nos. axle complete with insulated coupling and bearing housing each set. Qty: 100 Nos. Cost of tender document in Rs.: 1000/- Earnest Money Rs.: 37,000/- Due date: 22.04.2010 **SN: 02 Tender No.: 41-19-10-6139 Description:** Metallised carbon strips for electric loco as per RDSO Tech. spec.no. ELRS/TC/0071-2001 (rev. '0') & drawing No. SKEL 4303 (rev.4') or latest. NB: This item is reserved for RDSO approved sources only. Qty.: 1918 Nos. Cost of tender document in Rs.: 2000/- Earnest Money Rs.: 1,23,100/- Due date: 27.04.2010 **SN: 03 Tender No.: 41-20-10-2259 Description:** T.B.U. complete without parking brake (RH) DRG NO./TPL-5003, item 44, sheet 2 of 2, ALT. F. NR ALT.(I) Qty.: 63 Nos. Cost of tender document in Rs.: 1000/- Earnest Money Rs.: 49,600/- Due date: 27.04.2010 **SN: 04 Tender No.: 41-07-10-2635 Description:** Lavatory door arrangement for NAC coaches, drawing No. ICF/SK-3-5-6-007, all (a) items as per col. II. **Special terms & conditions:** supplier should purchase items to RDSO SPEC. C-K 513 (amndt.1) from RDSO approved sources. Qty.: 1651 Nos. Cost of tender document in Rs.: 2000/- Earnest Money Rs.: 1,07,400/- Due date: 29.04.2010. **SN: 05 Tender No.: 41-07-10-2634 Description:** Lavatory door arrangement for NAC coaches, drawing No. ICF/SK-3-5-6-007, all (a) items as per col. III. **Special terms & conditions:** supplier should purchase items to RDSO SPEC. C-K 513 (amndt.1) from RDSO approved sources. Qty.: 1651 Nos. Cost of tender document in Rs.: 2000/- Earnest Money Rs.: 1,07,400/- Due date: 29.04.2010. **SN: 06 Tender No.: 41-07-10-2587 Description:** Back stop (B.G.) DRG NO. W/BD-699 alt.(2) Qty.: 1115 Nos. Cost of tender document in Rs.: 1000/- Earnest Money Rs.: 29,100/- Due date: 03.05.2010. **SN: 07 Tender No.: 41-107-10-2638 Description:** UIC type roller bearing for dia 130mm axle for LHB coaches. Item no. DRG No. E-48999 (Assy) NO.H127746-H-900101 or SKF DRG NO. 1639438C. NB: To be procured either from timken or M/S. SKF. Qty.: 138 Nos. Cost of tender document in Rs.: 1000/- Earnest Money Rs.: 56,500/- Due date: 10.05.2010. 1. Above tenders are uploaded on IREPS site i.e. www.ireps.gov.in. The firm who desires to participate against e-tenders, are advised to electronically register themselves on the above website for which they would require to obtain class III digital certificate (if already not obtained) from certifying agencies, authorized under govt. of India IT Act 2000. Manual offers against e-tenders will not be accepted. **Tender Notice No 78/2009-2010 Dated: 19.03.2010** 10332010

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