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## India to send Jaguars, Su 30 fighters for IAF's toughest exercise with US

By Manu Pubby

India is sending its frontline Su 30 MKI air superiority fighters as well as the Jaguar deep penetration attack aircraft for the most complex air exercise with US forces in Alaska next year. The prestigious 'Red Flag' exercise will also see NATO forces taking part in war games that will have a focus on special operations. Sources have told ET that the Indian air force will be sending a 12 aircraft team to the US in April that would include four each of the Su 30 and Jaguar fighters, besides two C 17 tactical lift aircraft and IL 78 midair refuelers each. "The final plan is in place and 176 personnel from the Indian side will take part. A special focus will be on carrying out air operations in an environment where troops are also functioning closely on the ground," an official involved in the exercise told ET. The Red Flag would be the most complex aerial war game between the two nations and would include Aerial Early Warning aircraft from NATO forces as well as a small delegation from Denmark. India has once again refrained from taking its Aerial early warning aircraft for the overseas exercise. The US side is expected to take part with its cutting edge fighters, including the F 22 Raptor. Red Flag is a showcase aerial exercise that features the best pilots and aircraft from around the world. India was to take part in a 2013 edition of the war game which was abruptly called off after a series of budget cuts by Washington to the US military training program. The last time the Indian Air Force took part in an exercise of this scale was at the Nellis Red Flag in 2008 where the Su 30 MKI fighters featured, crossing swords with advanced western fighters for the first time. Sending aircraft for such an exercise has to be carefully planned, particularly due to the high expenses involved. By some estimates, the budget for the exercise could well exceed Rs 100 crore.



The Pioneer

07 December 2015

## Cross-border terrorism by Pak may figure in Parrikar-Carter talks

Defence Minister Manohar Parrikar and his US counterpart Ashton Carter will explore all possibilities to further strengthen strategic ties between the two countries during his visit to Washington later next week. The two leaders will focus on avenues to manufacture of advanced weapon systems here as part of 'Make in India' policy besides terrorism with Parrikar likely to raise the issue of cross-border terrorism by Pakistan. Incidentally, Parrikar's maiden visit as Defence Minister comes in the backdrop of the US emerging as the biggest arms supplier to India having supplied hardware worth over ten billion dollars in the last three to four years. The weapon systems imported by India from the US include C-17 and C-130J transport planes, P-8 I long range maritime reconnaissance aircraft and other equipment. The two leaders will hold extensive talks on December 9 and 10 wherein they will take stock of progress made regarding Defence Technology and Trade Initiative (DTTI) inked by the two countries. The pact aims at manufacturing Defence equipment in India in collaboration with private and public sectors, officials said here on Sunday. Parrikar and Carter will also review the functioning of the joint working group on aircraft carrier and identify technologies India could acquire in future. The US has evinced interest in collaborating in design and manufacturing of India's second indigenous aircraft carrier. The first aircraft carrier INS Vikrant is under construction in Cochin Shipyard and expected to join service by 2018. Lockheed Martin has already offered to manufacture its planes here in line with the Government's 'Make in India' push. Indicating its growing interest in the Indian market, Lockheed recently entered into a joint venture with the Tatas to manufacture parts of C-130J aircraft at a newly built facility in Hyderabad. A forward movement is also expected in India's decision to acquire 145 pieces of M777 Ultra-Light Howitzers from the US under a government-to-government deal that would see its manufacturer BAE Systems invest over \$200 million in India as offset. Parrikar is also likely highlight the issue of cross border terrorism by Pakistan and articulate India's stand on the situation in Afghanistan and the Middle East during his talks with Carter, sources said. Parrikar is also likely to flag India's concerns over Islamabad's "threat" to use tactical nuclear weapons against India. India's concern about the US policy in Middle-East relates to the rise of the Islamic State (IS) which recently carried out terror strikes in Paris killing more than 120 people.

## Nuclear, defence deals likely during Japan PM's India visit

**Simran Sodhi**

As Japan's Prime Minister Shinzo Abe prepares for his mid-December India visit, the government is hopeful that ties between the two nations, which have got better of late, will get further boost. The progress can be attributed to the China factor and its recent aggressive behaviour in the South China Sea, which has seen Japan and India move closer. Another reason could be the "personal chemistry" shared by Prime Minister Narendra Modi with his Japanese counterpart. While the dates for the visit are yet to be announced, sources said it could be December 11-12. On the second day of his visit, Abe is likely to travel to Modi's constituency Varanasi and may also pay his respects at Sarnath. It has been learnt that Foreign Ministry officials have been working with other central agencies to take care of this visit. Of late, India-Japan relations have grown in many dimensions. The civil nuclear co-operation agreement, currently under discussion, however, has seen a slow progress. The main reason is Japan's domestic concerns where signing such a deal with India, which has yet to sign the NPT (Non-Proliferation Treaty), is seen as a risk by many. India, despite its clean track record in proliferation, is negotiating hard with Japan, the only country to have faced an atomic bomb on Hiroshima and Nagasaki during World War-II and the Fukushima tragedy of 2011. Both the incidents have made the country extremely sensitive towards nuclear threats. While the signing of this deal would be the highlight of Abe's visit, negotiations continue on both sides and are likely to go on till the last minute. India and Japan are also likely to give a major boost to their defence co-operation and a number of agreements are likely to be signed during the visit. The most significant one would be the agreement to jointly produce the amphibious aircraft US-2. During Modi's visit to Tokyo last year, Japan had announced doubling of its private and public investments in India to the tune of USD 34 billion over the course of five years. Two months ago, India, Japan and the United States held the first ministerial trilateral in New York. The coming together of these three countries, who then called for freedom of navigation and promised co-operation in maritime security, set Chinese alarm bells ringing.

### May come in mid-Dec

\* India and Japan are likely to discuss the civil nuclear co-operation agreement, which is currently under discussion

\* On defence front, the most significant deal could be of the amphibious aircraft US-2



File pic of PM Narendra Modi with Japanese counterpart Shinzo Abe

## Innovative measures earn Navy personnel PM's salute

From in-house modification to increase the speed of a sub-sonic missile to a supersonic level to ingenious repair of a submarine's exhaust system to ensure it could stay underwater for a longer period, several personnel have been awarded "innovation trophies" in the Navy. Prime Minister Narendra Modi awarded the best innovation trophy to the crew of INS Sindhudhwaj, a Russian-origin Kilo-class submarine, for ensuring "an uninterrupted dived operation" during a patrol after they ingeniously repaired the vessel's exhaust system under challenging conditions. The award, presented on the occasion of Navy Day on Friday night, was received by the submarine commanding officer Nandkumar Das. The best trophy for a shore establishment, in turn, went to the Navy's missile preparation facility INS Tunir for modifying an old surface-to-surface missile, which was originally designed for sub-sonic flight, to fly at a supersonic flight. The award was received by the facility's commanding officer, Commodore P K Singh. "Around 135 entries for significant innovations in operations and maintenance domains were received for the newly-instituted awards, which are in line with the government's directive to promote and facilitate innovations by the youth of the nation," said an officer.

# Largest Private Sector Defence Delegation to Flank Parrikar on Maiden Visit to US

**Top execs from Tata, L&T, M&M, Bharat Forge & Reliance heading to Washington**  
Manu Pubby

Defence Minister Manohar Parrikar will be accompanied by a large group of officials from private sector defence manufacturers on his first visit to the US, signalling New Delhi's determination to give a push to the 'Make in India' initiative in the sector. New Delhi is also keen to access high-end technology. Officials from Tata Group, L&T, M&M, Bharat Forge and Reliance Group will be part of two industry teams to the US. The officials from private sector defence companies will meet top policymakers as well as US arms manufacturers. Officials involved in the process have told ET that two delegations from the defence manufacturing sector -one each from the Confederation of Indian Industry (CII) and the Federation of Indian Chambers of Commerce & Industry (Ficci) -will hold detailed discussions with US policymakers on December 9 in the presence of the Indian official delegation that will include the defence secretary and three-star generals from all forces. Officials from 15 Indian companies will be travelling to the US. It isn't unusual for Indian businessmen to be associated with visits undertaken by ministers. But this is the first time officials from India's relatively nascent defence manufacturing sector will be associated with a trip undertaken by the defence minister, an indication of the government's keenness to involve the Indian private sector in defence-related manufacturing. While the industry representatives are not part of the official Indian delegation to the US, close collaboration is expected between the public and private sectors on ways and means to transfer highend technology, a focus area of the Bharatiya Janata Party government.

**Two working groups functional** - Two Indo-US working groups on high-end technology are already functional, one focussing on aircraft carrier technology and the other on jet engines, with significant milestones reached in the latter. However, with collaboration between the Indian private sector and US companies not moving at the pace at which government-to-government talks have progressed, more industry interactions are planned. The Ficci delegation, led by SN Subrahmanyam, deputy managing director of Larsen & Toubro, will be visiting the US Army Research Laboratory as well as MassChallenge facilities - a startup accelerator that has partnerships with Boeing and NASA to fund innovation in the aerospace and defence sectors. Among the US officials the private sector delegates will meet are Frank Kendall, undersecretary of defence for acquisition, technology & logistics, who is leading a defence technology transfer initiative between New Delhi and Washington. "We hope this visit pushes the envelope regarding tech transfer and 'Make in India' between the US and India," Sukaran Singh, MD, Tata Advanced Systems, who is leading the CII delegation, told ET. Sources also told ET that some progress is expected on the policy front during Parrikar's visit. Discussions on firming up a Logistics Support Agreement (LSA) between the two nations are likely to enter an advanced stage. The agreement, which was stalled during the United Progressive Alliance regime, would benefit both sides by easing the process of sharing fuel, training costs and logistics during overseas deployments. Indian companies whose officials will be travelling to the US include L&T, Alpha Design Technologies, CHW Forge, Dynamatic Technologies, Elcom Group, Maharashtra Minerals, Premiere Explosives, Reliance Defence, Servocontrols Aerospace, Tata Advanced Systems, Bharat Forge, Tata Motors, Mahindra Telephonics, Punj Lloyd, Boeing India, Solar Industries, Ashok Leyland.



**Talking Tech in Defence**

Top 15 private companies to attend conference in Washington on December 9

Representatives from Indian and US government and US industry

Focus on obtaining high-end tech for 'Make in India' in defence sector

Will also be hosted by US Defence Secretary Ashton Carter

List includes Tata, L&T, M&M, Bharat Forge, Reliance Group

We hope this visit pushes the envelope regarding tech transfer and 'Make in India' between the US and India

**SUKARAN SINGH**  
MD, TATA ADVANCED SYSTEMS

## Navy's cadet training plans go for a toss

S. Anandan

Bankruptcy, it is learnt, has forced the ABG Shipyard to stall the construction of two purpose-built cadet training vessels for the Navy, dealing a severe blow to the force's training arrangements. "The cash-strapped yard has halted the construction of the vessels for three months now. Slated for delivery in the last quarter of 2016 as per a revised schedule, they are now unlikely to be ready for induction around that time," said a senior Navy officer. The Navy was hoping to take delivery of the two ships as replacements for the already-decommissioned INS Krishna and the antiquated INS Tir - both forming part of the Navy's Kochi-based First Training Squadron. Left with no other option, Tir has now been given a fresh lease of life. Along with that, landing ship Shardul and patrol vessel Sujata have also been customised to meet the 'afloat' training requirements in the interim. Besides these, the squadron also comprises sail training ships INS Tarangini and Sudarshini and Coast Guard ship Varuna. The ABG Shipyard was contracted for the Rs. 970-crore project as far back as June, 2011, but delays in freezing detailed design held up the project for some time when insolvency forced the yard to go for corporate debt restructuring (CDR).

**Ambitious project** - "It was an ambitious defence project. Each ship, with a length of 110 metres, was to displace 4,000 tonnes and cruise at 20 knots. The delivery of the first vessel was to take place in 42 months and the second, six months later. However, even after a private bank pumped in some money as part of CDR, construction could not be put back on track and the project has now fallen in limbo much to the Navy's dismay," said an official. When contacted by The Hindu, Syed Abdi, managing director of ABG Shipyard, declined to officially comment on the development. Sources, in the meantime, said design issues had been resolved and efforts were under way to resume construction. But the Navy is keeping its fingers crossed. The purpose-built vessels were meant to train naval midshipmen in basic seamanship and disaster-relief operations.

Deccan Herald

05 December 2015

## Women to fly fighter jets for 5 yrs

The defence ministry on Friday said women would be inducted into the combat stream of the Indian Air Force (IAF) to fly fighter aircraft on an 'experimental basis' for five years beginning June 2016. "Government has accorded the approval to entry of women into the fighter stream of IAF on an experimental basis for five years," the Minister of State for Defence Rao Inderjit Singh said. The women trainees undergoing stage-I training at the Air Force Academy would be first assessed for their suitability. Based on the suitability and willingness, they would be selected for stage-II training in the fighter stream. "Upon successful completion of the stage-II training, these women trainees are likely to be commissioned into the fighter stream in June, 2016", Singh told the Lok Sabha. The induction of women as fighter pilots in the IAF was cleared by the government in October, overruling decades of refusal by the armed forces to consider women in any kind of combat role. The idea is still not acceptable to the Army and Navy. "I would approach the authorities for a switch once the stream is open for women pilots. There are lots of women interested in flying the fighter jets," Flight Lieutenant Nilofar Tariq, who fly helicopters in the IAF, told Deccan Herald last month at Hindon airbase in Ghaziabad. The minister said all women pilots in IAF are cleared for all operational roles, including low-level tactical flying, para drop, air maintenance (northern and eastern sector) and special heli-borne operations. They also undergo jungle and snow survival courses. Currently the IAF inducts women in transport and helicopter flights, besides navigation, aeronautical engineering, administration, logistics, accounts, education and meteorology branches. The defence ministry has taken up a comprehensive review pertaining to induction of women in armed forces, both in short service commission and permanent commission, and once finalised, more branches would be opened up for induction of women. The Army now has 1,466 women officers in its ranks followed by 418 in the Navy and 1,428 in the IAF.

## **Army shows strength through a major War Exercise**

The Indian Army's biggest exercise 'Dradh Sankalp' in Thar Desert is a massive show of force, undertaken to hone combat skills and validate strike capabilities. More than 45,000 troops are participating in it. Army chief general DS Suhag is likely to arrive to witness the war game on December 5. The exercise involved practicing offensive manoeuvres in the desert terrain. Troops were inserted by air in coordination with the ground mechanized forces thereby testing the effectiveness and developing synergy between the three services and the adoption of the latest weaponry available. The exercise, by the Southern Command, aims to make sure the capabilities of the Army are being tested and validated on a capability-based approach in a tri-service environment, while relying on the adoption of new age technologies, transformed war fighting and integrated theatre battle concepts, the Army said in a statement. The exercise is also focusing on the aspect of jointmanship between the three services and developing the required synergy to achieve operational effectiveness. Indian Army undertakes exercises at regular intervals at different levels to ensure that the forces are given a real war like situations and the equipment is kept in battle readiness state. The formations and units have been undergoing this exercise for over two months now and the final phase of the exercise along with the validation is underway.

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**The Pioneer****07 December 2015**

## **US Pacific Air Forces Commander visits Delhi**

US Pacific Air Forces Commander Gen Lori J Robinson is on an official visit to the capital for strengthening Indo-US military cooperation, especially in the wake of America's "rebalance" to Asia Pacific. "I'm truly grateful to be invited to see the Indian Air Force (IAF) up close and learn more about their mission," Robinson said, adding that both forces have much to learn from one another. The visit is designed to further enhance military ties between the US and India at a crucial time in the Obama government's strategic rebalance in the Pacific, a statement by the US Embassy here said. Strengthening ties between US and Indian forces is a key focus area for US Pacific Command, it said. As PACOM's air component, PACAF seeks to improve compatibility between the US and Indian air forces for better response to regional crises. "We place a high value on the PACAF-IAF relationship and desire to continue to grow the relationship with routine flying exercises and other engagements," Robinson said. "Building and maintaining an active and reliable USAF-IAF relationship is a PACAF priority," she added. In 2016, IAF is scheduled to participate in RED FLAG-Alaska, providing yet another avenue for engagement and partnership between the two nations.

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**The Tribune****07 December 2015**

## **Canada sends uranium for N-power reactors**

Canada has sent the first uranium consignment of 250 tonnes to India for its nuclear power reactors, over two years after the civil nuclear deal signed between the two countries came into force. "The first lot of Canadian uranium has been received in India," a senior government official said. In April, Cameco signed a uranium supply contract with India after the nuclear cooperation agreement between Canada and India came into force in September 2013. According to the Canadian government, the contract to supply 7.1 million pounds of uranium concentrate (about 2,730 tonnes of uranium) to India's Department of Atomic Energy was worth around 350 million Canadian dollars (USD 262 million). The government of the Canadian province of Saskatchewan yesterday said the shipment consists of uranium mined and milled at Cameco's McArthur River and Key Lake operations in northern Saskatchewan. Saskatchewan premier Brad Wall said, "India has just received its first shipment of Saskatchewan uranium under the Canada-India nuclear cooperation agreement, and today we mark the economic milestone for our uranium mining industry and our province." India currently has 21 power reactors in operation, with another six under construction and scheduled to start up over the next four years. The country plans to increase its nuclear generating capacity from the current 5,800 MWe to 27,500 MWe by 2032.

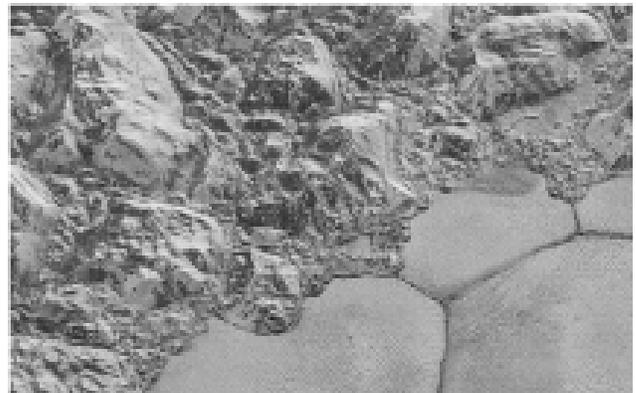
## U.S. military to open all roles, including combat, to women

The U.S. military will open up all positions, including frontline combat roles, to women, Defense Secretary Ashton Carter announced on Thursday in a sweeping move officially ending centuries of men-only tradition. The historic step served as a rebuke to a Marine Corps call this year for a partial exemption, after it argued mixed-gender combat units were not as effective as male groups. "There will be no exceptions," Mr. Carter said, adding he was confident the change would enhance "combat effectiveness". He noted that while, on average, physical differences exist between sexes, plenty of women can meet the military's rigorous physical standards for combat roles - just as there are some men who cannot. "As long as they qualify and meet the standards, women will ... be allowed to drive tanks, fire mortars, and lead infantry soldiers into combat," Mr. Carter said. "They'll be able to serve as Army Rangers and Green Berets, Navy SEALs, Marine Corps infantry, Air Force parajumpers and everything else that was previously open only to men." Given the tough physical standards, Mr. Carter stressed that equal opportunity would probably not translate to equal participation of men and women in all roles. Currently, the U.S. military comprises some 1.34 million people, about 15.5 per cent of them women. The nature of the U.S.-led wars in Iraq and Afghanistan meant many women found themselves in combat anyway - for instance if their travelling convoy came under fire or if they were hit by a roadside bomb. Three women made history this year when they graduated from the U.S. Army's elite Ranger school, previously only open to men. The Ranger course physical fitness test includes 49 push-ups, six chin-ups, 59 sit-ups, a five-mile run in 40 minutes and a slew of other challenges.

**Paradigm shift** - President Barack Obama's administration in 2013 asked for all combat positions to be open to women by 2016, including the infantry, artillery, armour and special forces. But Mr. Obama gave the Pentagon the opportunity to request exceptions, provided these were justified by operational constraints. The Marine Corps asked for such an exemption. So, though it was widely expected, Mr. Carter's announcement brings to a head something of a paradigm shift in how the U.S. views its fighting forces. Mr. Carter, who is Mr. Obama's fourth defense secretary and started his job in February after battling his way up the Pentagon's bureaucratic ranks, has spoken frequently about the need for the vast U.S. military to be inclusive.

## Nasa releases highest resolution images ever taken of Pluto

The US space agency has released a series of sharp Pluto snapshots, billing them as the best close-ups of the dwarf planet we may see for decades. On July 14, Nasa's New Horizons became the first spacecraft to pass by Pluto, offering scientists unprecedented insight. Previously released high-resolution images from that historic flyby have revealed unparalleled geographical variety on the planet, from soaring mountains, to sand dunes and frozen ice floes. The latest pictures, made available on Friday, are part of a sequence taken near New Horizons' closest approach to Pluto and show a mix of terrains that are cratered, mountainous and glacial in nature, Nasa said in a statement. "These new images give us a breathtaking, super-high resolution window into Pluto's geology," said New Horizons Principal Investigator Alan Stern in the statement. "Nothing of this quality was available for Venus or Mars until decades after their first flybys; yet at Pluto we're there already -- down among the craters, mountains and ice fields - less than five months after flyby!" he added. "The science we can do with these images is simply unbelievable." The images have resolutions of some 250 to 280 feet per pixel and form a strip 80 kilometers wide, according to Nasa.

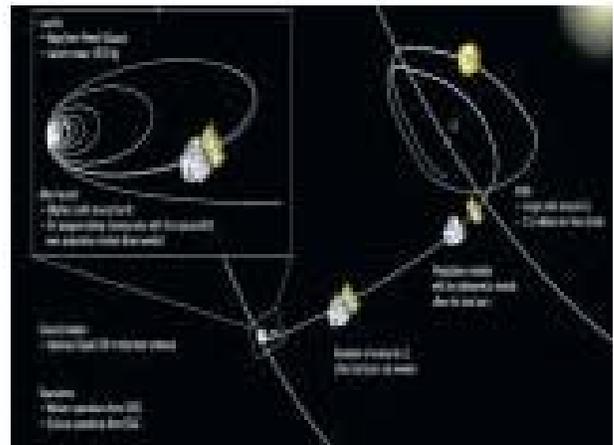


This handout picture obtained from NASA on December 5, 2015 shows an image taken from NASA's New Horizons spacecraft showing great blocks of water-ice crust jammed together in the informally named al-Idrisi mountains on the planet Pluto.

# Of free fall space cubes & waves

Elizabeth Gibney

There is a lot riding on the LISA Pathfinder mission, an ambitious effort to test whether intricate technology designed to detect ripples in space-time can be deployed in space. Scheduled to launch on December 2, the spacecraft is a long-awaited test-drive for a future one billion-euro (\$1.1 billion) space observatory planned by the European Space Agency (ESA). The follow-up mission would track the largest objects in the Universe, including mergers between supermassive black holes and collisions between galaxies, by the space-time ripples that they create. First predicted by Albert Einstein almost exactly 100 years ago as part of his general theory of relativity, such gravitational waves have never been observed directly - let alone used to study the cosmos. There are already Earth-based observatories hunting these waves, but a space-based one would search for waves at the opposite end of the spectrum. "It's like having a radio telescope as well as an optical one," says Karsten Danzmann, director of the Max Planck Institute for Gravitational Physics in Hanover, Germany, and co-principal investigator for the Pathfinder mission. "The part of the Universe you see is completely different." The final space-based observatory will try to spot the stretching and compressing of space by bouncing laser beams between three masses floating in free fall, each separated from the others by some five million kilometres (3.1 million miles). Because the masses would be protected from all other external forces, only a gravitational wave should disrupt the synchrony of their falling motion - a disturbance that would affect laser frequency. The LISA Pathfinder (named after the Laser Interferometer Space Antenna, the concept behind the gravitational-wave observatory) is a smaller-scale test of this ultimate plan. With a price tag of 400 million euros (\$426.2 million), it uses just two masses - each a two-kilogram (4.4-pound) cube of gold and platinum - separated by a mere 38 centimetres (15 inches), which allows them to fit inside the same spacecraft. Unlike that of the observatory that it is designed to test-drive, this setup is not sensitive enough to detect gravitational waves - instead, its purpose is to show that the masses can be completely isolated, and that any deviations in their relative motion can be measured with picometre accuracy. "We're missing out the five million kilometres, but so what?" says Paul McNamara, the mission's project scientist. "Pretty much everything that could affect our ability to measure gravitational waves is here." From the time of Pathfinder's launch from ESA's spaceport in Kourou, French Guiana, to the end of its subsequent eight-week journey, the masses will stay pinned to their housing deep inside the craft. But on arrival in orbit around a stable point between the Sun and Earth called Lagrange point 1, or L-1, about 1.5 million kilometres (.9 million miles) away, the cubes will be gently released to float within the spacecraft. Once in free fall, "the challenge is to isolate this little cube from everything around it, so the only thing it sees is space-time," says Paul. Expected disturbances are pressure from solar radiation and stray magnetic fields; the equipment is so precise that it should detect even a force equal to the weight of a small bacterium on Earth. As a high-precision laboratory in space, the LISA Pathfinder is unlike anything that ESA has done before, says Tim Sumner, an astrophysicist at Imperial College, London who led the team that constructed one of the craft's protection mechanisms. Another unusual element is that the major cargo - the cubes - will define the craft's trajectory, rather than vice versa. As they orbit around L-1 and fall in microgravity, Pathfinder will deploy microthrusters that are so gentle, it would take around 1,000 to lift a piece of paper on Earth. The thrusters will monitor the cubes' positions, ensuring that the craft hovers around the cubes without letting them touch its sides. Such a setup required the teams who built the instruments and the engineers who made the craft to work together to an unprecedented degree, says Tim. These complexities go a long way toward explaining why the launch has taken so long to orchestrate, says Stefano Vitale, a physicist at the University of Trento in Italy, and a principal investigator for the Pathfinder mission; Pathfinder was approved by ESA in 2000 and originally intended for launch in 2006. "Coarsely speaking, I think people underestimated the difficulty," says Stefano. "But that's why you have a Pathfinder." The final step in the planned mission will test



Contd...

part-2

## Of free fall space cubes & waves

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Pathfinder's limits by instructing onboard instruments to tweak the internal temperature and magnetic and electrostatic fields to see how such changes affect the cubes. "We want to learn everything we can about the physics of a free-floating body, and everything we learn will feed back into design of the future mission," says Paul. However, some opportunistic ESA scientists are already thinking about how Pathfinder's instruments could be used to inform other problems once its main mission, which could take up to a year, is complete. Measurement of the gravitational constant, known as Big G, for example, should fall naturally out of Pathfinder's data, Tim says. Because the true value of Big G is disputed, a fresh measurement from space would provide useful perspective. To get a higher precision measurement, ESA may also consider extending the mission - although Tim says that scientists would only request this after Pathfinder has proved itself, a few months in. He and his colleagues have also discussed using the craft's thrusters to send it to a spot known as a saddle point, where the gravitational pulls of Earth and the Sun cancel each other out. This could reveal how gravity behaves at its lowest level possible in the solar system, with little extra cost. Few scientists doubt that Einstein's theories hold, says Tim, but it would be interesting to do the test nonetheless. Stefano, however, points out that it is important for researchers to stay focused on the mission's immediate goal. "Our main objective is to demonstrate free fall," he says, "and we don't want to be distracted from that."

The Hindu

06 December 2015

## PSLV bags two more US launch orders

To lift weather company PlanetiQ's first two satellites next year.

Madhumathi D. S.

Two more U.S. satellite launch contracts have come the way of ISRO's PSLV rocket, this time from commercial weather satellite company PlanetiQ. A couple of space industry observers noted this as an inevitable trickle of business, if not a flow yet, from a top space market such as the U.S. to the now proven Indian player. PlanetiQ, the Maryland-based commercial weather satellites operator, recently signed a deal with Antrix Corporation, ISRO's marketing arm, for launching its first two weather satellites. Its final fleet totally will have 12 to 18 satellites.

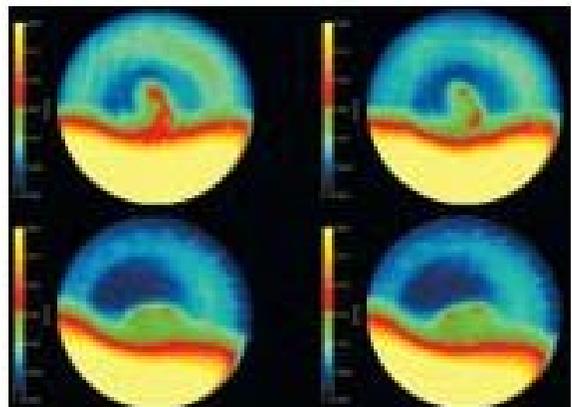
**Secondary passengers** - The two spacecraft, just 10 kg each and carrying a special sensor to glean weather data globally, are planned to be put in space in the last quarter of 2016 as secondary passengers of a PSLV, according to the company. PlanetiQ quoted its Chairman and CEO Chris McCormick mentioning "the stellar track record of the PSLV" in its Thursday night's announcement of the contract. The global launch market scene for small satellites and PlanetiQ's keenness for the Indian launcher may well bring its remaining weather fleet also to the PSLV, said ISRO Chairman A.S. Kiran Kumar on Friday. Antrix has bagged nine such U.S. launch orders for 2015-16. The PlanetiQ satellites are small bites for the PSLV, which can launch up to 1,200 kg to medium distances (36,000 km) and 1800-kg satellites to low-Earth (below 2,000 km) orbits. Until about a year ago, U.S. satellite operators could not conceive of launching from India because of a longstanding U.S. policy bar. In recent years, established U.S. launch companies have moved on to lifting far heavier satellites [ten tonnes and beyond], leaving a demand for launchers that can put smaller satellites in space. In September, US operator Spire Global became the PSLV's first US customer by getting four 4-kg-each Lemur satellites from Sriharikota. Antrix, which has won around 55 foreign launch orders to date, a bulk of them small ones, prefers to get bigger foreign satellites to launch from here.

**Lobbying works** - Susmita Mohanty, co-founder and CEO of Earth2Orbit, the country's first space start-up, who is familiar with the Indian and U.S. space industry scenes, said: "[US] companies can benefit tremendously now that PSLV has been added to their portfolio of international launch options. This has been made possible by the companies themselves lobbying for access to the PSLV, the export control reforms introduced by the Obama administration and the efforts of "NewSpace companies" such as hers. Russia's converted missile launcher, Dnepr, Soyuz and the newer European vehicle Vega are in the same category as the PSLV. Space industry tracking agency Euroconsult estimated in February this year that by 2020, governments and private operators would launch a total of 510 small satellites. The biggest number of small satellites is foreseen to come from the U.S. in the next five years. That country has also launched almost half of 600-plus smallsats in the last decade, the report says.

# Unravelling the rotational puzzle of Venus

B S Shylaja

We know that every celestial body spins like a top with varying speeds and planets are no exception. A careful look at their pictures will tell you which are fast rotators and which are slow. Often, we look upon rotation and changes in it as clues on the dynamics of the planet and the influence of other planets, which in turn will help us understand our own planet. In fact, the shape of Earth with its polar axis shorter than the equatorial radius is defined by its rotation. Venus, with its almost perfect spherical shape, is a classic example of a slow rotator. A day on Venus is longer than a year. This interpretation arises from the fact that Venus takes 243 (Earth) days to turn once on its axis, while it takes 225 (Earth) days to revolve around the Sun. Moreover, as you watch the Sun from the surface of Venus, another peculiar phenomenon attracts your attention - on Venus, the Sun rises in the west and slowly drifts to east to set after 117 days, (but whether we can make out the Sun rise or set cannot be resolved so easily here). This is referred to as retrograde rotation, which means Venus orbits the Sun in the direction opposite to the one the Sun is rotating in. Of the many theories explaining retrograde rotation, one particular theory believes that billions of years ago, Venus was impacted by another large body, which resulted in a complete change of rotational speed and direction. Another argument favours a continuous chaotic effect caused by planetary perturbations and tidal effects. The latter makes a lot of sense as Venus has a dense atmosphere. **What lies beneath?** - The surface of Venus is barely visible through the dense envelope of the atmosphere. Thus, determining its rotation was only possible after the invention of the radio telescope, which measured the small Doppler shift in the beam reflected from the surface. A very interesting phenomenon was noticed while studying the winds on Venus. On the surface, the winds were gentle enough to just scatter dust. However, at the upper layers, the speed increased by over a factor of 60. The atmospheric circulation, though similar to Earth in patterns, differs from our planet in this respect. This fetched Venus the title 'super rotator'. The circulation scheme in the atmosphere can be broadly explained by the wave patterns generated. Again, the large variety is not fully understood, but studies point to the slow rotation as one of the major causes. In the absence of the angular momentum available through rotation, winds take charge of the maintenance of equilibrium here. You will be fascinated to know that on Venus, cyclonic storms have two eyes, unlike the one-eyed storms in our planet. The two vortices appear to be a permanent feature on its South Pole as it has remained the same since the first observation in 2006. These storms are at heights of 40 km and unlike their counterparts on Earth, cannot produce rains since all water will evaporate at a height of 20 km. One of the recent studies based on the results from Venus Express Mission, which identifies six different types of waves with different characteristics, necessitated to explain the energy balance via transportation through the globe. Oscillations of 255 days have been identified in its atmosphere. Quite interestingly, Cassini mission has detected similar oscillations on Titan, a natural satellite of Saturn. While studying the surface features and comparing with the ones taken two decades ago by Magellan spacecraft, another interesting fact emerged: there was a displacement of nearly 20 km. The pictures could be matched only after forcing a decrease in the rotation period by 6.5 minutes. Recent measurements with radar have also confirmed the change in the rotational speed. So, why is the planet Venus slowing down so fast? The extreme weather conditions, tides associated with the winds - all have been considered as possible sources of decrease as of yet. It is possible that close approaches to Earth may also be contributing to the long-term changes in the rotation speed. For example, at inferior conjunctions, (when Venus passes between Earth and the Sun), the average distance from Earth is about 41 million km, which recurs in about 584 days. Although the orbit of Venus is almost spherical, the eccentricity of the orbit of Earth causes a variation in this distance. For example, in these 5,000 years, there have been 526 approaches with separations less than 40 million km, (some as close as 38 million km). Thereafter, there are none with such small separations for about 60,200 years. Venus has always been offering vital clues on important concepts - right from the heliocentric concept to the green house effect. Now it can do the same for rotation.



## Climate diplomacy Goal difference

**Limiting global warming to 2°C above pre-industrial levels is more a political target than a scientific one**

"Rescuing our planet and our fellow man from impending catastrophe." That was item one on Prince Charles's to-do list for delegates attending the UN's latest climate talks, which began in Paris this week. In his speech, he urged those present to think of their grandchildren, and to remember that they will pave "the road to a saner future". Such sentiments have been heard many times since the inception of the United Nations Framework Convention on Climate Change (UNFCCC), an environmental treaty, in 1992. More than 190 countries have signed up to it. All agree therein to stabilise greenhouse-gas concentrations in the atmosphere so as to limit "dangerous anthropogenic interference within the climate system". Since 2010 they have also had an agreed target: to prevent planetary doom, global mean surface temperature must not rise more than 2°C above that of pre-industrial times. The prince reminded listeners of the fact in his speech. That figure, 2°C, has become a touchstone. Stay beneath it, the feeling is, and all will be well-or, at least, wellish. Breach it, though, and the horsemen of the apocalypse will be unleashed in all their fury. But breached it almost certainly will be. Even if emissions do not increase from their present level (implausible in itself), enough pollution to bust through the 2°C barrier will enter the atmosphere within a mere three decades. As the horsemen's mounts snort, then, it is worth inquiring how so much significance has come to be invested in this particular number.

**Into the sausage factory** - Otto von Bismarck, the first chancellor of a united Germany, is supposed to have said that laws are like sausages: it is better not to see them being made. That aphorism might apply equally to the 2°C maximum, which is a hybrid of political need and scientific haze. It was born in the 1970s, in papers written by William Nordhaus, now an economics professor at Yale. Back then, few had heard of the idea of global warming, and fewer cared. Mr Nordhaus, who had the foresight to realise something important might be happening, suggested that a reasonable precaution would be to stop temperatures exceeding their upper bound during the past 100,000 years-the period for which ice-core data are available and for which the correlation between temperatures and other environmental effects can thus be seen reasonably clearly. The cores suggested this upper bound was 2°C above pre-industrial levels. Mr Nordhaus himself agreed this estimate was "deeply unsatisfactory". It was based merely on the observation that it did not push the climate into unknown territory, whose safety could not be assessed. So little was known about the impacts of warming at that stage, he wrote later, that his target was "a substitute" for balancing costs and damages. Since then things have moved on. Some findings suggest even 2°C is too much. Other people argue that the limit is meaningless because it will surely be breached, and that more effort should go into adapting to a hotter world. Either way, once promulgated, the idea of a 2°C limit has taken on a life of its own. It received attention from European scientists at various workshops during the late 1980s. It was accepted in a report published by the Stockholm Environment Institute in 1990, even though this also found, based on its authors' understanding of "the vulnerability of ecosystems to historical temperature changes", that warming above just 1°C could trigger "rapid" and "unpredictable" consequences. Despite that, the report's authors admitted it was too late to keep within such a limit, settling on 2°C instead. Pragmatic, certainly. But not strictly scientific. Six years later, a meeting of the European Union's Council of Ministers, which included Angela Merkel (now Bismarck's latest successor, but then Germany's environment minister), endorsed the limit, giving it political credibility. Thence it spread. By 2009 the G8 countries had signed on, and it was mentioned in the Copenhagen Accord-an agreement salvaged from the wreckage of the UNFCCC's meeting that year. At the following get-together, in Cancun, Mexico, in 2010, a maximum rise of 2°C was established as the goal of international climate policy. Despite its questionable past, the 2°C limit does have merits. By boiling the vast complexities of the climate system down into a single, comprehensible number it gives politicians something simple to aim at, and against which they can measure the success of their endeavours. But some worry that it is not simple enough, for taking the world's temperature is not as easy as it sounds. Different parts of the planet warm at different rates, as do different layers of the atmosphere, so all sorts of corrections have to be applied to arrive at a single number. A truly simple, and arguably better, approach would be to use concentrations of greenhouse gases-the cause of the warming-as putative maxima. These gases mix rapidly into the atmosphere, so are easily sampled in ways that brook little dissent. Others think the idea of a single-number limit is itself flawed. They would try to create some sort of index out of greenhouse-gas concentrations, measures of soot (which absorbs heat), sulphate pollution (which reflects it) and the heat content of the oceans. Such arguments, however, rather miss the point. To quote Bismarck again, "politics is not an exact science". The 2°C limit is certainly not perfect, and will almost certainly be breached. But its existence focuses minds. And, when the disparate interests of 190-odd countries have to be reconciled, a little mind-focusing is, perhaps, not such a bad thing.

# A new device for more efficient phones, computers

Mayank Shrivastava

At the heart of all modern gadgets, like mobile phones and computer chips, are tiny transistors that carry electrical signals at close to the speed of light. Their design and the way they are placed decide how efficiently a gadget can perform its operations. My group at the Indian Institute of Science, Bangalore, has invented and demonstrated a transistor design which can lead to a breakthrough in future chip technology. The proposed transistor has significantly better performance and scalability as compared to the technology used in current computer and cellphone chips. The invention has been recently patented by the IISc and the results were subsequently published by our group. Over the years, transistors have become smaller and smaller, which has resulted in denser, cheaper, sleeker and high-performing chips, as predicted by Moore's law in 1970. Intel co-founder Gordon Moore had then predicted that the number of transistors and other such components in an integrated circuit would roughly double every year. The law has held till now and the chip industry has planned its development according to this prediction. We see consistent improvement in speed and power consumption of wireless and handheld devices.

The current generation of transistors, widely adopted by semiconductor giants since 2011, is called FinFETs, mainly because they resemble the fin of a fish. They measured about 22 nanometres when they came about. A hydrogen or helium atom is roughly one tenth of a nanometre. The FinFETs are expected to shrink further to the size of about 10 nanometres (nm) by 2018. However, a below-10nm size can adversely affect FinFET's performance. At this scale, the movement of electrons, which carry the signals and perform the electronic tasks, does not obey the switch that is meant to regulate their movement. The transistor starts behaving like a wire without a switch. An out-of-the-box transistor design is the need of the day for consistent improvement in computer chips and mobile phones. Because the chip designing industry was staring at stagnation beyond 10nm, a new transistor design needed to be worked out. What was important was that this new design needed to be supported by the existing manufacturing processes in order to facilitate a smooth transition. A 'disruptive technology' that calls for an entirely new way to put things together takes years to be adopted and requires fresh investment. Since it takes time for a new technology to go from prototype to mass production, the semiconductor industry feels that the newer design must be in line with current-day manufacturing technology. In the multi-billion-dollar semiconductor industry, any abrupt change in structure and manufacturing process of devices is prohibitively expensive. The solution we need for the future is to have a fundamentally different mechanism of operation but with a manufacturing process that is similar to current FinFET technology. This will ensure a smooth and economically viable transition to the new solution. The proposed transistor design keeps all this in mind. This has been achieved through a process called quantum tunnelling. The device can make use of existing-FinFET based chip manufacturing facilities and process; however, unlike FinFETs, it modulates vertical tunnelling across hetero junction to control electron flow. Published results depict that this breakthrough transistor technology, beside higher speed, consumes less power and will heat up less as compared to the existing transistors. This will help in extending the battery power of next-generation electronics.

## **NASA's Curiosity rover is among the most advanced robots today**

### **What is a robot?**

Although there is no comprehensive definition, perhaps the simplest way to describe a robot is by calling it a machine made to replace human efforts by performing work in a human-like manner. Two essential requirements for a machine to be called a robot is a programmable 'brain' and a body that can move. By this definition, all other programmable machines like desktop computers, which cannot move, are excluded from being robots. Recently, NASA's video of the R5 humanoid robot, also known as Valkyrie, has created a buzz online for being able to dance. Unlike R5, a robot may or may not resemble human beings in appearance.

### **When was the term coined?**

The modern term robot was first used by Czech playwright Karel Capek to describe artificial humans in his 1920 play RUR. It is derived from the Czech word *robota* meaning forced labour or serf. Capek's robots were heartlessly exploited by factory owners and ultimately revolted and went on to destroy humanity. The word robotics first appeared in Isaac Asimov's 1942 science-fiction story *Runaround* in which he wrote the famous Asimov's Three Laws of Robotics.

### **When were the first robots developed?**

Among the first commercially viable robots were the industrial robots developed in the 1950s. These non-humanoid robots were programmable machines with electronically controlled heavy lifting arms that could repeat a sequence of motions. By the 1960s, production line robots were introduced and sold to the automobile industry. These machines were used for doing dangerous tasks like removing and stacking hot metal parts and so on. The next advancement in robotics was with the development of sensors in the late 1960s and 1970s that enabled the introduction of robotic eyes to these machines. The advent and widespread use of microprocessor technology in the 1980s helped in the development of much smarter robots that could be programmed to respond to sound or light as well as to recognise voices and words. Among the most advanced robots of the present time is NASA's Curiosity rover, which is being used to explore the surface of Mars.

### **What are the other contemporary uses of robots?**

The most widespread use of robots is done by the automobile industry, where industrial robots are used in automated production lines. Industrial robots are also used extensively by the packaging industry as well as in mass production of printed circuit boards. Apart from this, robots find use in space exploration as well as by the military where they are used to perform tasks which are extremely dangerous for humans. It is believed that industrial robots will play a far more important role in the future as the population in most advanced countries is gradually aging and the labour cost is going up. Because of the aging population, the Japanese industry was the first to introduce widespread industrial use of robots, which is now being replicated by the European Union. It is believed that since 2001, EU economies have overtaken Japan in terms of installation of industrial robots.