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## **DRDO Chairman G Satheesh Reddy awarded honorary fellowship by UK's Royal Aeronautical Society**

*He led the development of advanced avionics and achieved a streak of successful missions of long-range Agni 5 strategic missile*

Defence Research and Development Organisation (DRDO) chairman G Satheesh Reddy was awarded the honorary fellowship by the Royal Aeronautical Society of United Kingdom.

The aeronautical society recognised contributions of Reddy towards indigenous design, development and deployment of diversified missile systems, aerospace vehicles, guided weapons and avionics technologies in India. "Dr Reddy spearheaded Mission Shakti, the country's first Anti-Satellite Missile Test (ASAT) mission which demonstrated an extremely high degree of precision and technological prowess, enabling India to join a select group of four nations with such capability. He bolstered the Ballistic Missile Defence (BMD) programme and successfully demonstrated missile interception capabilities at high altitudes," said a release by the Royal Aeronautical Society.



"He led the development of advanced avionics and achieved a streak of successful missions of long-range Agni 5 strategic missile. His R&D contributions have made India self-reliant in Missiles and Avionics technologies," it added.

According to the statement, Reddy is the first Indian recipient of the prestigious award in over 100 years.

"Dr Reddy is known for his vision and capability to develop indigenous technologies and is famous in students as "Junior Kalam" and "Next Generation Missile Man" due to his knack on advanced technologies," the society said.

"Dr Satheesh Reddy has received numerous awards that include AIAA Missile Systems Award, National Aeronautical Prize, National Systems Gold Medal, National Design Award, IEI-IEEE (USA) award for engineering excellence, Homi J Bhabha Gold Medal and Technology Leadership Award," it said. (ANI)

<http://www.businessworld.in/article/DRDO-Chairman-G-Satheesh-Reddy-Awarded-Honorary-Fellowship-By-UK-s-Royal-Aeronautical-Society/26-11-2019-179415/>

## **Royal Aeronautical Society honour for DRDO Chief G Satheesh Reddy**

*First Indian recipient in over 100 years*

*By V Rishi Kumar*

Hyderabad: Royal Aeronautical Society (RAeS) London has conferred the Honorary Fellowship of the Society for the year 2019 to G Satheesh Reddy, Secretary Department of Defence R&D and Chairman DRDO.

Reddy is the first Indian recipient of this prestigious award in over 100 years.

The Society's highest award is bestowed in recognition of Reddy's pioneering technological contributions over the past three decades which has enabled the country to realise frontline military systems and world class missile technologies.

Reddy received the Honorary Fellowship during the Medals and Awards presentation ceremony in London.

Honorary Fellowship from RAeS is one of the world's highest distinctions for aerospace achievement awarded for only the most exceptional contributions to the aerospace profession. It is considered as equivalent to the Nobel Prize in the aerospace domain.

The first Honorary Fellowship was awarded in the year 1917 and eminent persons have been conferred with this award which includes doyens of Aerospace such as Orville Wright, aviation pioneer known for inventing the airplane with his brother, Wilbur.

Reddy has made outstanding contributions to Defence Research and Development and is renowned for his pioneering contributions to the Indian defence and aerospace sector.

A visionary and an institution builder, he led the indigenous design, development and deployment of state-of-the-art mission critical aerospace technologies and advanced missile systems. These cutting edge technologies have been the backbone for key strategic programmes and other defence applications in India.

Reddy spearheaded Mission Shakti, the country's first Anti-Satellite Missile Test mission, bolstered the Ballistic Missile Defence (BMD) programme and successfully demonstrated missile interception capabilities at high altitudes.

He led the development of advanced avionics and achieved successful missions of long range Agni 5 strategic missile.

<https://www.thehindubusinessline.com/news/royal-aeronautical-society-honour-for-drdo-chief-g-satheesh-reddy/article30089089.ece>



DRDO chairman G Satheesh Reddy presents a student with her degree during the annual convocation of Mumbai University on Tuesday. PTI

## INDIAN DEFENCE NEWS

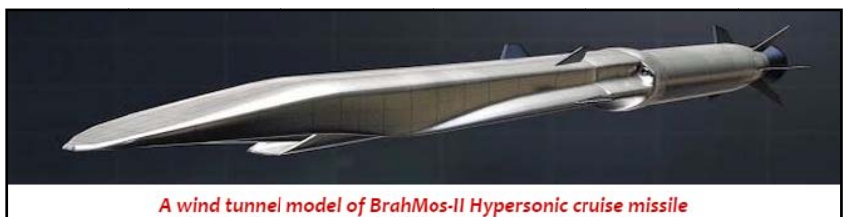
Wed, 27 Nov 2019

# DRDO working on next generation hypersonic weapon

*By Lt. General Prakash C Katoch (Retd)*

News reports of October 2019 indicate that DRDO has commenced work on a next generation hypersonic weapon – a missile that can travel at five times the speed of sound, or a little over 1.6 km every second, and for testing and fine tuning the technology a wind tunnel will be operational soon. Defence Minister Rajnath Singh is expected to inaugurate the wind tunnel facility soon. The race to acquire hypersonic weapons technology is heating up globally. China, Russia, and the United States are testing hypersonic weapons of various types to enhance strategic nuclear deterrence and strengthen front-line combat units. Existing intercontinental ballistic missile (ICBM) re-entry vehicles also travel at those super fast speeds, but the hypersonic glide vehicles now in development are far more manoeuvrable, making their tracking and interception nearly impossible.

Hypersonic weapons are specifically designed for increased survivability against modern ballistic missile defence systems. Hypersonic vehicles typically consist of a Supersonic Combustion Ramjet, or Scramjet



A wind tunnel model of BrahMos-II Hypersonic cruise missile

propulsion system to enable such high speeds. A Scramjet engine is an engine that uses 'air breathing' technology; the engine collects oxygen from the atmosphere as it is travelling and mixes the oxygen with its hydrogen fuel, creating the combustion needed for hypersonic travel. This is different than a traditional ramjet, which is used on space shuttles and satellite launches. In contrast to conventional

Reentry Vehicles (RV) that travel at supersonic speeds (between Mach 1 and Mach 5), hypersonic weapons travel along the edge of space and accelerate to between Mach 5 (around 3,800 mph) and Mach 10 (over 7,500 mph). While conventional ballistic missiles are launched at steep trajectories that inhibit speed during the high friction of launch and reentry, hypersonic missiles glide atop the atmosphere while engaging specialised jet engines to perpetually accelerate up to hypersonic speeds.

Ability to travel at ultra-high velocity is the primary appeal of hypersonic missiles because it extends their range and allows them to bypass modern layered missile defences. Hypersonic missiles are capable of delivering conventional or nuclear payloads at ultra-high velocities over long ranges. Hypersonic missiles can be fired from the last stages of an ICBM or Submarine-Launched Ballistic Missiles (SLBM) and skip along the top of the atmosphere using specialised jet engines to accelerate to hypersonic speeds. Alternatively, hypersonic missiles can be launched independently or released from a bomber, similar to cruise missiles, before accelerating to ultra-high speeds.

The US has invested in research and development of a hypersonic missile called the Advanced Hypersonic Weapon (AHW), which uses boost glide technology to propel warheads. During a test in 2011, the glide vehicle successfully struck a target located 3,700 km away with precision. Concurrently, Lockheed Martin has developed a hypersonic vehicle called the Falcon Hypersonic Technology Vehicle 2 (HTV-2), which is a manoeuvrable rocket-launched aircraft that glides through the Earth's atmosphere at speeds up to Mach 20 (13,000 mph). US is using the HTV-2 and AHW in its 'Prompt Global Strike', which would allow the US to launch a hypersonic strike against targets anywhere on the planet in less than one hour.

Russia has been designing and testing various hypersonic glide vehicles (HGV) and hypersonic cruise missiles. Avangard, a hypersonic glider has been tested multiple times since February 2015. It can reach speeds of Mach 20 (15,000 mph). In March 2018, President Putin announced completion of testing and commencement of its series production. It was then set to become operational in late 2018 or early 2019, nearly five years ahead of schedule. India and Russia are also jointly developing the BrahMos-II hypersonic cruise missile, testing of which is ongoing. BrahMos-II is likely to enter service in Indian and Russian military in 2025. BrahMos-II will be one of the fastest hypersonic cruise missile in the world reaching speeds of Mach 7 (5,000 mph/8,050 kph).

Russia's 3M22 Zircon anti-ship hypersonic cruise missile was successfully launched in June 2017, reaching Mach 8 (6,000 mph). KH-47M2 Kinzhal is another Russian hypersonic cruise missile. It can reportedly travel as fast as Mach 10 over a distance of 1,200 miles. Kinzhal is designed to counter US missile defence systems like THAAD and heavily defended US aircraft carriers. As of May 5, 2018 ten MiG-31 fighter jets have reportedly been fitted with Kinzhal missiles. China has been developing its hypersonic weapon capabilities with advancements in both hypersonic glide vehicles (HGV) and hypersonic cruise missiles since 2014.

China's hypersonic glide vehicle 'DF-ZF' had undergone six plus development tests between 2014 and 2016. Launched during the last stage of a missile, the DF-ZF can reach nearly 7,500 mph (Mach 10), as well as manoeuvre to avoid missile defences and zero in on targets. Scheduled to be operational in early 2020, China claims it can attack ships at sea with precision. PLA has also been testing its DF-17 ballistic missile combined with an HGV. The DF-17 underwent two tests in November 2017. It has an estimated range of 1,100 to 1,500 miles and can reach mach 10, without losing any of its manoeuvrability. The DF-17 combined with HGV is also expected to be operational by 2020. India's missile program is impressive thank to the initial push given by former President A.P.J. Abdul Kalam and BrahMos-II will be good addition to India's combat capability. But considering the level of R&D and focus by China in next generation weapon systems, the DRDO will need to work with top speed in conjunction the private industry. China appears to be racing ahead not only in swarm drones warfare but there is also speculation that China may have raced ahead of the US in stealth technology.

<http://www.indiandefensenews.in/2019/11/drdo-working-on-next-generation.html>



## Defence Min: 274 Indigenous production projects worth Rs 62,852 cr ongoing at DRDO

New Delhi: There are 56 ongoing Mission Mode (MM) Projects with a cost of Rs 49,424.54 cr. and 218 ongoing Technology Demonstration (TD) mode projects with a cost of Rs 13,427.45 crore by the Defence Research & Development Organisation (DRDO).

The above projects are directed for 100% indigenous productions, however a few projects have collaboration with foreign countries during development phase.

This information was given by Minister of State for Defence Shripad Naik in a written reply to Tiruchi Siva in Rajya Sabha today. The total number of ongoing projects is 274, and the total expenditure is Rs 62,852 crore.

Last week, Naik revealed that Rs 1,812 crore FDI has been channeled into the Defence sector since 2014.

Defence Minister Rajnath Singh also said earlier in November that under the Defence Production Policy and Make in India initiative, the Ministry of Defence (MoD) has set a target of \$26 billion for aerospace, Defence services and goods by 2025. He urged the Defence Research & Development Organisation (DRDO) to cooperate with the industry to achieve this target.

<https://indusdictum.com/2019/11/25/defence-min-274-indigenous-production-projects-worth-rs-62852-cr-ongoing-at-drdo/>



DRDO Exhibition at India International Science Festival (IISF) 2019.

Wed, 27 Nov 2019

# India's Army to deploy third generation anti-tank guided missiles in Jammu and Kashmir

*The Indian Army has reportedly been inducting the Israeli-made Spike anti-tank guided missile system along the Line of Control in Jammu and Kashmir*

*By Franz-Stefan Gady*

The Indian Army is deploying Israeli-made Rafael Advanced Defense Systems Spike medium-range (MR) anti-tank guided missiles (ATGM) along the Line of Control in Jammu and Kashmir to bolster the service's defense capabilities on the Pakistan border, according to local media reports.

The Indian Army has not officially confirmed whether the missile systems have already been deployed.

The service approved the import of 240 Spike ATGMs and 12 launchers as part of an "emergency purchase" to meet immediate operational requirements in April. (According to some Indian media reports, the Indian Army approved the purchase of an initial batch of 210 rather than 240 Spike ATGMs.)

The decision to buy the third-generation fire-and-forget weapon system fitted with a tandem-charge high-explosive anti-tank (HEAT) warhead and featuring an operational range of up to 4 kilometers was taken at the biannual Army Commanders' Conference in New Delhi in April.

"Following the February 2019 military standoff between India and Pakistan following the Balakot airstrikes, the Indian Army's vice chief of staff has been given authority to procure goods and materiel worth up to \$72 million without prior approval from the Indian Ministry of Defense (MoD) under an emergency purchase provision," I explained at the time.

The "first lot" of 210 Spike ATGMs and a dozen launchers "arrived in India about ten days ago," the *Times of India* reported on October 4, citing an Indian defense official. The Army is reportedly also interested in procuring additional Spike ATGM systems.

In December 2017, the Indian government scrapped a \$500 million deal with Rafael for 321 Spike ATGM systems and 8,356 missiles in favour of an indigenous ATGM system currently under development by India's Defense Research and Development Organization (DRDO). As I reported last year:

"The cancellation of the deal has led to severe disagreements between the Indian Army's senior leadership and the DRDO, as the service remains deeply skeptical of the DRDO-developed man portable anti-tank guided missile (MPATGM). The Indian Army leadership has reportedly stated that it does not think that the MPATGM will meet the service's operational requirements. It is also concerned about likely delays in the induction of the new weapon system."

"The order will be repeated if the man-portable ATGM being developed by DRDO is not ready by next year. We don't want to be slowed down any longer in plugging our critical operational deficiencies by DRDO," an Indian Army source was quoted as saying in October of this year.

DRDO conducted the third successful test firing of the MPATGM system in September 2019. Serial production of the MPATGM is expected to begin in 2021.

<https://thediplomat.com/2019/11/indias-army-to-deploy-third-generation-anti-tank-guided-missiles-in-jammu-and-kashmir/>

## सेना ने एलओसी पर तैनात की इजरायल में बनी 'दागो और भूल जाओ' मिसाइलें

**'दागो और भूल जाओ' एटीजीएमएस की मारक क्षमता चार किलोमीटर तक है और  
इनका इस्तेमाल नियंत्रण रेखा के करीब बंकरों, शेल्टरों, घुसपैठ के अड्डों और  
आतंकवादी प्रशिक्षण शिविरों को नष्ट करने के लिए किया जा सकता है।**

नई दिल्ली: भारतीय सेना ने इजरायल में बनी टैंक रोधी मिसाइल (एटीजीएमएस) 'स्पाइक' को जम्मू-कश्मीर में उत्तरी कमान के युद्ध क्षेत्र में [नियंत्रण रेखा](#) पर तैनात किया है। इससे पाकिस्तान के साथ लगी देश की सीमा पर सुरक्षा व्यवस्था मजबूत होगी। स्पाइक एटीजीएमएस मिसाइलों को 'दागो और भूल जाओ' मिसाइल के नाम से भी जाना जाता है। ये पूरी तरह पोर्टेबल हैं और शक्तिशाली इतनी हैं कि टैंक को नष्ट कर सकती हैं और चार किलोमीटर के दायरे में बंकर को तबाह कर सकती हैं।

सेना के सूत्रों ने बताया कि इन टैंक रोधी गाइडेड मिसाइलों और इसके लॉन्चर को उत्तरी युद्ध क्षेत्र में नियंत्रण रेखा के साथ 16-17 अक्टूबर से शामिल किया गया और इस समय इनका इस्तेमाल किया जा रहा है। इजरायल ने सेना को 'आपातकालीन खरीद' तंत्र के तहत 280 करोड़ रुपये के सौदे में कुल 210 मिसाइलों और 12 लॉन्चरों की आपूर्ति की थी।

यह बहुप्रतीक्षित सौदा भारतीय वायुसेना के बालाकोट में आतंकी शिविरों पर हवाई हमलों के बाद पाकिस्तानी सेना द्वारा सीमा पर सैनिकों की तैनाती बढ़ाने के बाद हुआ था। 'दागो और भूल जाओ' एटीजीएमएस की मारक क्षमता चार किलोमीटर तक है और इनका इस्तेमाल नियंत्रण रेखा के करीब बंकरों, शेल्टरों, घुसपैठ के अड्डों और आतंकवादी प्रशिक्षण शिविरों को नष्ट करने के लिए किया जा सकता है।

<https://navbharattimes.indiatimes.com/india/army-inducts-israel-made-anti-tank-guided-missiles-along-loc-to-bolster-defence/articleshow/72251800.cms>



## **Def Min: 'India exporting helicopters, radars & more; Importing from Russia, Israel, UK, USA'**

Capital procurement of Defence equipment is undertaken from various domestic as well as foreign vendors, based on operational requirements of the Armed Forces, the availability or capacity to produce the equipment in India and abroad, to keep the Armed Forces in a state of readiness to meet the entire spectrum of security challenges.

During last three financial years (2016-17 to 2018-19), 149 capital acquisition contracts have been concluded, out of which 58 contracts worth about Rs. 1,38,727.16 crores and 91 contracts worth about Rs.76,955.73 crores have been placed on foreign vendors and Indian vendors respectively for procurement of Defence equipment for the Indian Defence Forces.

The countries from which Defence equipment imports are being undertaken include Russia, USA, Israel, France and United Kingdom.

There are 41 Ordnance Factories and 9 Defence Public Undertakings (DPSUs) in the Public sector in India manufacturing Defence equipment. In addition, 452 number of Industrial Licenses (ILs) have been issued to Defence industry in private sector for manufacturing of Defence equipment.

The major Defence equipment exported during the last three years by India to foreign countries are Patrol Vessels, Helicopters, Sonars and Radars, Avionics, Radar Warning Receivers (RWR), Small Arms, Small Calibre Ammunition, Grenades, Telecommunication equipment, Coastal Surveillance, Simulators, Bullet Proof Jackets and Body Armour.

The details of Defence export authorisations for the last 3 years are as follows:

2016-17 : Rs 1,521 crores

2017-18 : Rs 4,682 crores

2018-19 : Rs 10,745 crores

This information was given by Minister of State for Defence Shripad Naik in a written reply to Md. Nadimul Haque in Rajya Sabha yesterday.

Naik also said yesterday that there are 56 ongoing Mission Mode (MM) Projects with a cost of Rs 49,424.54 crore, and 218 ongoing Technology Demonstration (TD) mode projects with a cost of Rs 13,427.45 crore by the Defence Research & Development Organisation (DRDO).

Last week, Naik revealed that Rs 1,812 crore FDI has been channeled into the Defence sector since 2014.

Defence Minister Rajnath Singh also said earlier in November that under the Defence Production Policy and Make in India initiative, the Ministry of Defence (MoD) has set a target of \$26 billion for aerospace, Defence services and goods by 2025. He urged the Defence Research & Development Organisation (DRDO) to cooperate with the industry to achieve this target.

<https://www.defencenews.in/article/Def-Min-%e2%80%98India-exporting-helicopters,-radars-and-more;-Importing-from-Russia,-Israel,-UK,-USA%e2%80%99-768170>

## **Porbandar: Navy to commission its 6th Dornier aircraft squadron on Nov 29**

*The squadron, based in Porbandar, will operate the upgraded Dornier 228 aircraft, which was indigenously manufactured by the Hindustan Aeronautics Limited (HAL) under licence from RUAG Aerospace*

*By Avinash Nair*

Ahmedabad: The Indian Navy will commission its sixth squadron of Dornier aircraft at Porbandar in Gujarat on November 29. The state-of-the-art multi-role Short Range Maritime Reconnaissance aircraft will keep an eye in the north Arabian Sea where India shares its maritime border with Pakistan.

“The squadron, nicknamed “Raptors” with four newly inducted CS Dorniers, will be commissioned at an event in Porbandar where Deputy Chief of Naval Staff, Vice-Admiral MS Pawar, will be present,” said Wing Commander Puneet Chadha, spokesperson, Ministry of Defence, Gujarat.

The new INAS 314 squadron will be commanded by Captain Sandeep Rai who was commissioned into the Indian Navy on January 1, 1999. Captain Rai has over 3,000 hours of flying experience and has been part of a crew, which set up the Seychelles Dornier Flight for combating piracy off Seychelles in the Indian Ocean, stated the information shared by the spokesperson with The Indian Express.

The squadron, based in Porbandar, will operate the upgraded Dornier 228 aircraft, which was indigenously manufactured by the Hindustan Aeronautics Limited (HAL) under licence from RUAG Aerospace. These upgraded aircraft are equipped with glass cockpit, advanced surveillance radar, ELINT (Electronic Intelligence) sensors and networking features used for electronic warfare mission, maritime surveillance, search and rescue and providing targeting data to weapon platforms, it stated.

The squadron will also provide round-the-clock sensor-based surveillance that will help ward off terror and other sea-borne threats in a region where China has a significant stake in Pakistan’s Gwadar port, located about 500 nautical miles away from Porbandar.

The Indian Navy has about 23 Air Squadrons made up of Dorniers, UAVs, IL-38, Mig-29K, P-81, Chetak, Advanced Light Helicopters, Seaking 42B, Kamov 28 and Hawk Mk 132. However, there are only five Dornier aircraft squadrons currently being operated by the Indian Navy. The latest Dornier aircraft squadron to be commissioned into the Indian Navy on July 22, 2019 was INAS 313 named “Sea Eagle” at Meenambakam in Tamil Nadu. The others Dornier squadrons are based in Goa, Vishakhapatnam, Kochi and Port Blair.

Porbandar has become an important hub for the Navy after it commissioned a forward operating base INS Sardar Patel in 2018. Apart from Dorniers, the Navy’s Air Squadron at Porbandar also houses an Unmanned Aerial Vehicle (UAV) squadron — The Frontier Formidables. According to defence sources, the new Dornier squadron in Gujarat will help add to the surveillance provided by the Israeli-origin UAVs that have shorter flying range compared to the Dornier aircraft, which can remain airborne for about 10 hours and has a range of over 1,000 nautical miles.

<https://indianexpress.com/article/india/porbandar-navy-to-commission-its-6th-dornier-aircraft-squadron-on-nov-29-6137377/>

## Why is the F-21 being offered to India?

United States aerospace giant Lockheed Martin has unveiled a ‘new’ fighter, dubbed the F-21, which it intends to offer India, instead of the F-16, in the global contest to sell the Indian Air Force 114 fighters.

Launched on Wednesday, February 20, the first day of Aero India 2019 in Bengaluru, the F-21 has the tagline ‘The F-21: Different — Inside and Out’.

But in almost every respect — engine, basic airframe and most avionics — it is a slightly improved F-16 Block 60, an aircraft already in service.

In rebranding the F-16 into the F-21, Lockheed Martin appears to have accepted what many have warned it for years: That the IAF would never buy a fighter whose very name is associated across India with the Pakistan air force which has operated the F-16 since the 1980s.

The F-16 also carries the reputation of a dated fighter, having already been in service for four decades.

A new F-21 which Lockheed Martin says is ‘specially configured for the IAF’, would perhaps overcome the reputation of an old-timer.

To be sure, this is not the first time this ploy has been used.

Russia Aircraft Corporation rebranded its MiG-29 as the MiG-35 and fielded it as a new aircraft in India’s medium multi-role combat aircraft contest from 2007 to 2015.

Lockheed Martin has briefed this correspondent on the improvements in the aircraft, not all of which it says can be revealed due to operational secrecy.

However, the airframe remains largely the same, as does the fighter’s engine.

Randy Howard of Lockheed Martin says the changes include a ‘dorsal fairing’ — a rib along the fighter’s spine in which additional equipment can be carried in the future, in order to improve the fighter’s avionic capability.

The IAF has not asked for a dorsal fairing, but Howard says it is a “unilateral offer from Lockheed Martin”.

Aerospace experts say there is little to differentiate the F-21 from the F-16 Block 70 which will first enter service in Bahrain.

The dorsal fairing, they say, is an attempt to overcome the IAF’s key reason for rejecting the F-16 in the MMRCA contest — that it lacked potential for growth.

“This is a straight marketing play, following the same playbook as the Russians did when they rebranded the MiG-29 as the MiG-35,” says Pushpinder Singh, who publishes the aerospace trade journal, Vayu.

Incongruously, the US military already has an F-21 fighter, suggesting the rebranding was done in haste.

In the late 1980s, the US navy bought the Israeli Kfir fighter to play the role of ‘aggressor’ (enemy) aircraft in two-sided air exercises. That aircraft was named the F-21.

In unveiling the F-21 fighter, Lockheed Martin stated: ‘The F-21 addresses the IAF’s unique requirements and integrates India into the world’s largest fighter aircraft eco-system with the world’s pre-eminent defence company. Lockheed Martin and Tata Advanced Systems would produce the F-21 in India, for India.’

Meanwhile, a US air force F-16 Fighting Falcon carried out aerobatic displays at Aero India as did three Boeing F/A-18EF Super Hornets.

The Rafale had a high voltage presence, with two flying displays daily.

Swedish company Saab, which intends to offer the Gripen E in the IAF tender for 114 fighters, did not participate in the flying display, but displayed a fighter and a cockpit simulator.

The other aircraft in the contest — the Eurofighter and Russia's MiG-35 and Sukhoi-35 — were not displayed. Aero India 2019 also witnessed the of the Tejas Light Combat Aircraft.

This clears the way for manufacture of another 20 Tejas fighters — the IAF's second Tejas squadron.

<https://www.defencenews.in/article/Why-is-the-F-21-being-offered-to-India-768182>



*Wed, 27 Nov 2019*

## **India pays Russia a hefty \$1.2 bn in technology transfer fees for T-90S main battle tank**

India is in the process of manufacturing 464 T-90s Main Battle Tanks after paying a hefty Technology Transfer Fee to Russia. The total contract for 464 Tanks and for Full Technology Transfer signed earlier this month is valued at \$3.12 Billion.

The deal stipulates that India will pay \$1.2 billion to the Russian original equipment manufacturer UralVagonZavod and arms export agency Rosoboronexport for full technology transfer, while India's state-owned Ordnance Factory Board will be paid \$1.92 billion for local production of 464 T-90S tanks.

As per the contract, Russian defense companies will have to undertake full production and localization guarantees. Both Indian and Russian firms will be penalized by the MoD if the project hit production delays or cost overruns.

To avoid US sanctions, India will pay the Russian defense companies in Roubles.

One of the official from the Ministry of Defence described the price tag of the technology transfer as too high, but at the same time it will increase domestic production of the tanks from the current level of 40 percent to 80 percent. Complete localization of T-90S tanks in India is impossible, as a large number of parts must continue to be imported.

The 80 percent parts that will be locally manufactured are panoramic night sights, thermal imaging fire-control systems and explosive reactive armor, he added. The T-90 engines along with the transmission system that makes up 45 percent of the cost of a T-90S Tank will have to be imported from Russia.

India will manufacture a total of 120 T-90S tanks per year at OFB's Heavy Factory in Avadi, southern India and complete the project within four years.

A senior Indian Army official said that 80 percent localization of the tank does not necessarily mean 'advantage' because life cycle support of the T-90S Tanks is not included. Absence of Life Cycle Support will force the Indian Army to pay three times more than the original cost of the tank.

The Indian Army currently operates 1,100 T-90S tanks. 300 out of the 1,100 tanks were directly imported from Russia.

[https://www.defencenews.in/article/India-pays-Russia-a-hefty-\\$12-bn-in-Technology-Transfer-Fees-for-T-90S-Main-Battle-Tank-768180](https://www.defencenews.in/article/India-pays-Russia-a-hefty-$12-bn-in-Technology-Transfer-Fees-for-T-90S-Main-Battle-Tank-768180)

## **India, Japan likely to sign logistics support deal during Shinzo Abe's India visit**

India and Japan are likely to sign a logistics support agreement during Prime Minister Shinzo Abe's visit next month.

The agreement will ensure that Indian warships and air force planes, among other things, will be able to enter, refuel and pick up provisions in Japanese defence bases and vice-versa. This is another example of the growing closeness between the defence establishments of both countries. India has a similar agreement-- the LEMOA-- with the United States. A similar one with Russia is almost ready for signing.

While the agreement will be signed during Abe's visit, it will be readied during the first 2+2 meeting between the two countries this weekend. Japan's foreign minister Moshimitsu Motegi and defence minister Taro Kono will be meeting with Defence Minister Rajnath Singh and External Affairs Minister S Jaishankar. So far, India has had 2+2 meetings only with the Americans, and that too, just once. The next 2+2 meeting with the USA is in Washington on December 18.

During the 2+2 meeting with Japan and the Abe visit, the Indo-Pacific will be on the agenda, especially the desire to have "free and open" movement. This is clearly a reference to China. For the Japanese and the Americans feel very strongly about the islets "created" by the Chinese in the South China Sea to define where its territorial waters are.

The two countries, apart from the logistics support agreement, will be considering closer defence ties. Both India and Japan and of course, the United States are part of Exercise Malabar, a big annual naval exercise, recently held off the coast of Japan. There are also smaller exercises between the armies and the air forces, but there is a wish to take things further, possibly in areas like training. Japan wants India to buy its seaplanes but there is a wariness, primarily because of the cost.

The Modi-Abe summit is unlikely to happen in New Delhi, as of now. It is probably easier to say where it won't happen. The Japanese aren't keen on Varanasi or Gujarat-- Abe has been there already-- or Mahabalipuram, where Chinese leader Xi Jinping met Modi. The venue is expected to have a historical or cultural background. The dates are under discussion, but the meeting will be after December 9, as the Diet, Japanese Parliament, is in session till that date. Mid-December is being seen as a likely option.

<https://www.defencenews.in/article/India,-Japan-likely-to-sign-logistics-support-deal-during-Shinzo-Abes-India-visit-768177>

## इमेज सैटेलाइट 'कार्टोसैट-3' का प्रक्षेपण हुआ, अंतरिक्ष में बनेगा भारत का अमोघ हथियार

चेन्नई: धरती की निगरानी एवं मानचित्र उपग्रह कार्टोसैट-3 के साथ अमेरिका के 13 नैनो उपग्रहों के प्रक्षेपण हो चुका है। भारतीय अंतरिक्ष अनुसंधान संगठन (इसरो) ने मंगलवार (26 नवंबर) को इसकी जानकारी दी थी। अंतरिक्ष एजेंसी ने 27 नवंबर को सुबह नौ बजकर 28 मिनट पर कार्टोसैट-3 के प्रक्षेपण की योजना बनाई थी।

यह कार्टोसैट श्रृंखला का नौवां उपग्रह है जिसे यहां से 120 किलोमीटर दूर श्रीहरिकोटा स्थित सतीश धवन अंतरिक्ष केंद्र के द्वितीय लॉन्च पैड से प्रक्षेपित किया जाएगा। इसरो ने मंगलवार (26 नवंबर) को कहा, "पीएसएलवी-सी47 अभियान के प्रक्षेपण के लिए श्रीहरिकोटा में मंगलवार सुबह सात बजकर 28 मिनट पर 26 घंटे की उल्टी गिनती शुरू हो गई। इसे 27 नवंबर बुधवार (27 नवंबर) को सुबह नौ बजकर 28 मिनट पर प्रक्षेपित किया जाना है।"

पीएसएलवी-सी47 की यह 49वीं उड़ान है जो कार्टोसैट-3 के साथ अमेरिका के वाणिज्यिक उद्देश्य वाले 13 छोटे उपग्रहों को लेकर अंतरिक्ष में जाएगा। कार्टोसैट-3 तीसरी पीढ़ी का बेहद चुस्त और उन्नत उपग्रह है जिसमें हाई रिजोल्यूशन तस्वीर लेने की क्षमता है। इसका भार 1,625 किलोग्राम है और यह बड़े पैमाने पर शहरी नियोजन, ग्रामीण संसाधन और बुनियादी ढांचे के विकास, तटीय भूमि के उपयोग तथा भूमि कवर के लिए उपभोक्ताओं की बढ़ती मांग को पूरा करेगा।

इसरो ने कहा है कि पीएसएलवी-सी47 'एक्सएल कनफिगरेशन' में पीएसएलवी की 21वीं उड़ान है। न्यू स्पेस इंडिया लिमिटेड, अंतरिक्ष विभाग के वाणिज्यिक प्रबंधों के तहत इस उपग्रह के साथ अमेरिका के 13 नैनो वाणिज्यिक उपग्रहों को भी प्रक्षेपित किया जा रहा है। इसरो ने बताया कि श्रीहरिकोटा स्थित सतीश धवन अंतरिक्ष केंद्र से यह 74वां प्रक्षेपण यान मिशन होगा। कार्टोसैट-3 का जीवनकाल पांच साल का होगा। कार्टोसैट-3 तथा 13 अन्य नैनो उपग्रहों का प्रक्षेपण गत 22 जुलाई को चंद्रयान -2 के प्रक्षेपण के बाद हो रहा है।

<https://www.livehindustan.com/national/story-imaging-satellite-cartosat-3-launch-countdown-began-by-isro-2870234.html>



## Pieces of the cosmic puzzle

**ELEONORA DI VALENTINO**

**N**o matter how elegant your theory is, experimental data will have the last word. Observations of the retrograde motion of the planets were fundamental to the Copernican revolution, in which the Sun replaced Earth at the centre of the solar system. And the unusual orbit of Mercury provided a spectacular confirmation of the theory of general relativity. In fact, our entire understanding of the universe is built on observed, unexpected anomalies.

Now our new paper, published in *Nature Astronomy*, has come to a conclusion that may unleash a crisis in cosmology — if confirmed. We show that the shape of the universe may actually be curved rather than flat, as previously thought — with a probability larger than 99 per cent. In a curved universe, no matter which direction you travel in, you will end up at the starting point — just like on a sphere, though the universe has four dimensions, including time.

The result was based on recent measurements of the Cosmic Microwave Background, the light left over from the Big Bang, collected by the Planck Satellite. According to

### Could the shape of the universe be curved instead of flat?

Albert Einstein's theory of general relativity, mass warps space and time, around it. As a result, light rays take an apparent turn around a massive object rather than travelling in a straight line — an effect known as gravitational lensing.

There is much more such lensing in the Planck data than there should be, which means the universe could contain more dark matter — an invisible and unknown substance — than we think. In our study, we showed that a closed universe can provide a physical explanation to this effect, because it is able to host a lot more dark matter than a flat universe. Such a universe is perfectly compatible with general relativity.

#### Major headache

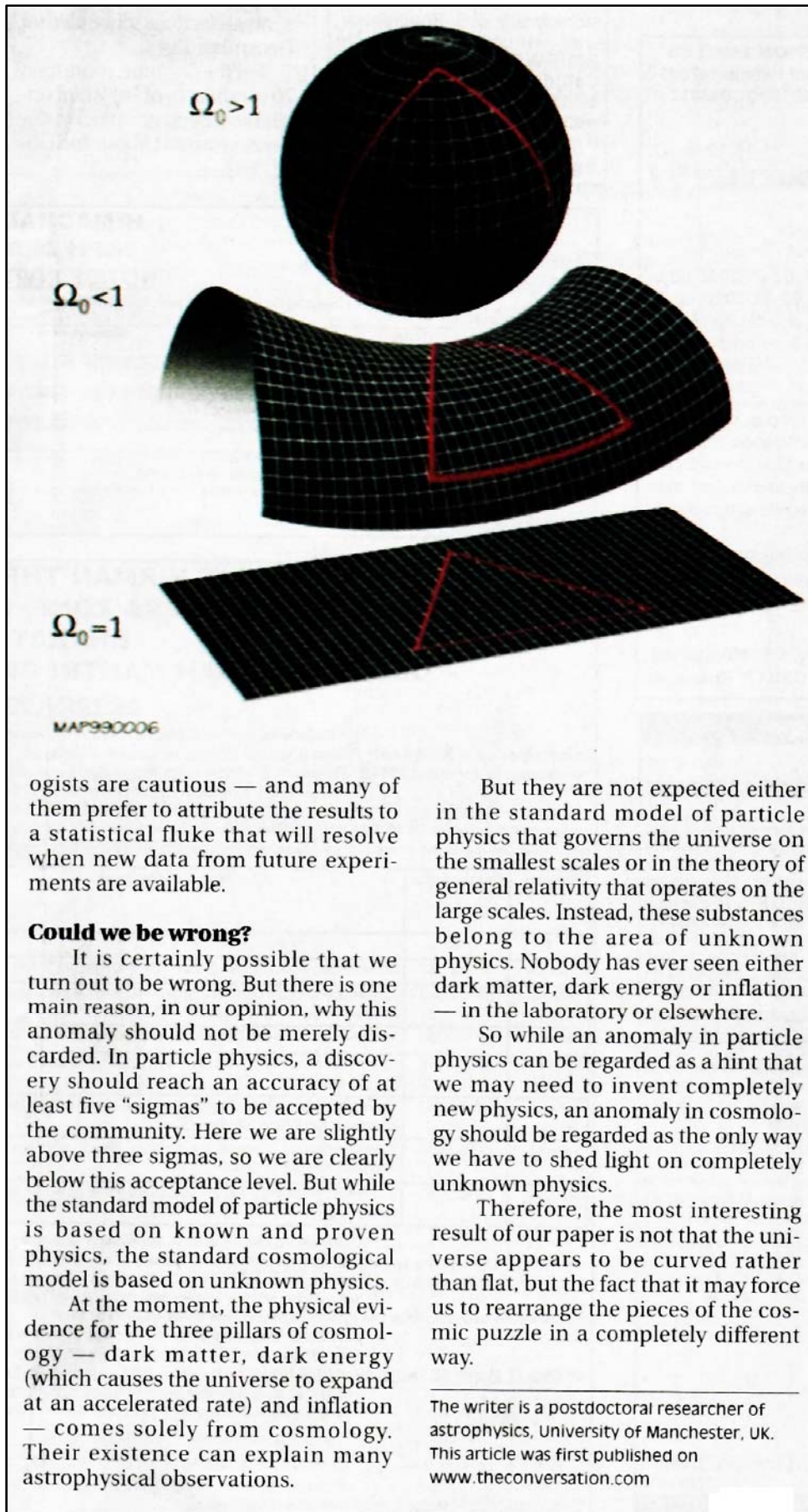
Not all cosmologists are convinced by a closed universe though — previous studies have suggested the cosmos is indeed flat. And if a spherical universe is a solution to the lensing anomaly, then we have to deal with several significant consequences. First of all, we have to revise a fundamental cornerstone of cos-

mology — the theory of cosmological inflation. Inflation describes the first instants after the Big Bang, predicting a period of exponential expansion for the primordial universe.

The theory was developed over the last 40 years to explain why distant parts of the universe look the same and have the same temperature, when they are too far apart to ever have been in contact. Inflation solves the problem because it means that far-flung regions of the universe would once have been connected. But the period of rapid expansion that hurled these regions apart is also thought to have also brought the universe to flatness with exquisite precision.

If the universe is closed, standard inflation is in trouble. And that means we lose our standard explanation for why the universe has the structure it has.

Once we assume that the universe is curved, the Planck data is essentially in disagreement with all other datasets. This all boils down to a real crisis for cosmology, as we say in our paper. For these reasons, cosmol-



ogists are cautious — and many of them prefer to attribute the results to a statistical fluke that will resolve when new data from future experiments are available.

**Could we be wrong?**

It is certainly possible that we turn out to be wrong. But there is one main reason, in our opinion, why this anomaly should not be merely discarded. In particle physics, a discovery should reach an accuracy of at least five “sigmas” to be accepted by the community. Here we are slightly above three sigmas, so we are clearly below this acceptance level. But while the standard model of particle physics is based on known and proven physics, the standard cosmological model is based on unknown physics.

At the moment, the physical evidence for the three pillars of cosmology — dark matter, dark energy (which causes the universe to expand at an accelerated rate) and inflation — comes solely from cosmology. Their existence can explain many astrophysical observations.

But they are not expected either in the standard model of particle physics that governs the universe on the smallest scales or in the theory of general relativity that operates on the large scales. Instead, these substances belong to the area of unknown physics. Nobody has ever seen either dark matter, dark energy or inflation — in the laboratory or elsewhere.

So while an anomaly in particle physics can be regarded as a hint that we may need to invent completely new physics, an anomaly in cosmology should be regarded as the only way we have to shed light on completely unknown physics.

Therefore, the most interesting result of our paper is not that the universe appears to be curved rather than flat, but the fact that it may force us to rearrange the pieces of the cosmic puzzle in a completely different way.

The writer is a postdoctoral researcher of astrophysics, University of Manchester, UK. This article was first published on [www.theconversation.com](http://www.theconversation.com)