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THE HINDU

Thu, 20 Jan 2022

Year of hectic activity for Hyderabad-based DRDO labs

Missile launches and testing of other weapon systems were meticulously planned despite the cascading effect of COVID-induced lockdown in 2020

By V. Geetanath

Hyderabad: It has been a year of an unusual spree of missile launches, testing of new weapon and defence systems by the Defence Research and Development Organisation (DRDO) labs, most of which are established here. Testing centres at Balasore, offshore site at the Kalam island, Jaisalmer and Pokhran in Rajasthan and others became a beehive of activity when at least a dozen new age advanced weapon systems for the armed forces underwent trials before the induction.

Senior officials, requesting anonymity, explained that the missile launches and testing of other weapon systems were meticulously planned despite the cascading effect of COVID-induced lockdown in 2020. Though defence lab works were in full swing with protocols in place, field trials which involved coordination among different agencies, movement of equipment and the likes, made it an assembly line of trial launches.

Defence Research and Development Organisation (DRDO) successfully flight test a New Generation Nuclear Capable Ballistic Missile 'Agni P' from Dr APJ Abdul Kalam island. File | Photo Credit: PTI

A.P.J. Abdul Kalam Missile Complex, housing Research Centre Imarat (RCI), Defence Research and Development Laboratory (DRDL) and the Advanced Systems Laboratory (ASL) has had a key role in almost all trials as scientists tested for advanced radars, avionics, algorithms, integrated software, rocket motors, propulsion systems and so on.

Top of the pops is new generation nuclear-capable ballistic surface to surface 'Agni P' missile which was successfully flight tested twice. Another significant one is the quasi-ballistic surface to surface tactical new generation 'Pralay' - which too achieved twin success, they said.

Defence Minister Rajnath Singh handed over MRSAM - Medium Range Surface to Air Missile System to Indian Air Force (IAF). It is an advanced network centric combat air defence system developed jointly with Israel Aerospace Industries (IAI); Long Range Surface to Air Missiles (LRSAM) - final production batch was flagged off for Indian Navy, also developed with IAI to tackle targets like fighter aircraft and cruise missiles.

HELINA - Helicopter launched Nag missile (for army) and Dhruvastra (forIAF) missile are third generation, Lock On Before Launch (LOBL) fire and forget Anti-Tank Guided Missiles to engage targets both in direct hit mode and top attack mode underwent trials. Indigenously developed low weight, fire and forget Man Portable Antitank Guided Missile (MPATGM) with miniaturized infrared imaging seeker and advanced avionics was test fired so was vertical launch

of Short-Range Surface to Air Missile (VL-SRSAM) for Indian Navy to neutralize threats at close ranges like sea-skimming targets.

Indigenously developed low weight, fire and forget Man Portable Antitank Guided Missile (MPATGM) with miniaturized infrared imaging seeker and advanced avionics was test fired so was the vertical launch of Short-Range Surface to Air Missile (VL-SRSAM) for the Indian Navy to neutralize threats at close ranges including sea-skimming targets.

Air version of BrahMos supersonic missile was successfully test fired from fighter aircraft Sukhoi 30 MK-I as also the supersonic cruise missile assisted torpedo system. Flight trial of new generation surface to air Akash missile was conducted from a land-based platform for the air defence capability of IAF against fast targets.

Another one 'Akash Prime' was successfully flight tested with an indigenous active Radio Frequency (RF) seeker for improved accuracy. Two flight tests of indigenously-developed smart anti-airfield weapon was carried with IAF where satellite navigation and electro optical sensors were successfully tested for the first time. Another important development was flight test of Solid Fuel Ducted Ramjet (SFDR) for development of long-range air-to-air missiles, they said.

Finished products like 'Shakti', an advanced electronic warfare system was handed over to Indian Navy by Prime Minister Narendra Modi. Incidentally, DRDO Young Scientist Lab - Assymetric Technologies (DYSL-AT), the brainchild of the PM and also located here, had successfully demonstrated the drone swarm tech last year, senior officials added.

https://www.thehindu.com/news/national/telangana/year-of-hectic-activity-for-hyderabad-based-drdo-labs/article38292304.ece

The Nelson Post

Thu, 20 Jan 2022

India creating native enemy of robot innovation, powers will get it soon.

By Shivi G

India creating native enemy of robot innovation, powers will get it soon: Amit Shah

India is creating native innovation to upset the developing danger of robots on the nation's lines and it will before long be made accessible to the security powers, Union Home Minister Amit Shah said Sunday.

"The best innovation accessible on the planet will be given to you for line security. It is the public authority's responsibility. To meet the danger of robots, the BSF, the NSG, and the DRDO are together dealing with an enemy of robot protection framework. I have full trust in our researchers. Very soon we will have a native enemy of robot framework in the country," Shah said while tending to BSF staff on the event of the power's 57th Raising Day in Jaisalmer, Rajasthan.

This is whenever BSF's Raising Day first is being praised close to the India-Pakistan line. The Home Minister liked this move by the power and said that such festivals ought to be sure be made at where the power's jawans are setting instances of fortitude consistently and not in Delhi.

"Any nation can possibly advance and cause its way of life to flourish when it is secure. Furthermore you are the ones who secure the country. The country is glad for you. For the Modi government, the significance of boundary security is public safety. So recall, you are getting the boundaries as well as offering the country a chance to get its situation on the planet," Shah said.

Shah said the public authority was not just dedicated to the government assistance of the power faculty but at the same time was putting vigorously in further developing boundary framework. "For better foundation on the lines, the spending plan for street development has been expanded

from Rs 23,000 crore somewhere in the range of 2008 and 2014 to Rs 44,600 crore somewhere in the range of 2014 and 2020. This shows we are focused on further developing line foundation," Shah said.

The home priest likewise laid weight on further developing relations between BSF staff and regular folks residing in line regions. He said BSF should deal with individuals and check whether all administration plans are being carried out on the ground.

"The public authority has dispatched various government assistance plans for those living close to the lines. I ask BSF jawans that alongside getting the lines, at whatever point you carve out opportunity, give some consideration to the execution of these plans. Assuming that we can keep our line individuals glad, improve their offices, it will help you in getting the boundaries. I'm certain you will both keep up with relations and interchanges with the line individuals," he said.

https://thenelsonpost.ca/news/1366/india-creating-native-enemy-of-robot-innovation-powers-will-get-it-soon/

INDIA TODAY

Thu, 20 Jan 2022

Why India needs a dedicated defence export department

An export-focused department could help build on export successes like the recent sale of BrahMos missiles to the Philippines

By Sandeep Unnithan

New Delhi: On January 14, the Philippines government announced it was purchasing BrahMos cruise missiles from India. The choice of both the missile and the platform the selection was announced on, turned some heads. In a Facebook post, Philippines' Defence Secretary Delfin Lorenzana said that his country was acquiring three batteries of the ground-launched cruise missiles for $374.96 million (Rs 27,968 crore). BrahMos Aerospace Ltd, an Indo-Russian joint venture which makes the missiles, won the contract after a five-year evaluation process. The BrahMos was pitted against rival Israeli and Ukrainian missiles.

BrahMos supersonic cruise missile, with major indigenous systems, successfully test-fired from ITR, at Chandipur, in Odisha on Sept. 30, 2019: (ANI Photo)

The BrahMos (a portmanteau of the Brahmaputra and Moskva rivers) is a variant of Russia's Yakhont supersonic anti-ship missile. It has ground-launched, air-launched, sea- and underwater-launched versions and has been in service with the Indian armed forces for over 20 years. BrahMos Aerospace has pitched the missile to potential buyers in Brazil, UAE, South Africa, Malaysia, Chile and Indonesia for over a decade without success. The Philippines deal, defence officials say, not just brightens the BrahMos' export potential with other clients, but also for an identical order for the Philippines army worth over $300 million.

Each coastal defence missile battery has six vehicles—three missile launch trucks each with two missiles, one missile loading truck, an Over the Horizon Radar and a command-and-control centre.

It is a deal with significant geopolitical consequences. Philippines is currently locked in a territorial dispute over the South China Sea with China. It needs the mobile supersonic missiles each with a range of 290 km to deter intruding Chinese ships. (Interestingly, the deal has been okayed at the highest levels in Moscow, a close ally of Beijing). The BrahMos missile systems are air-portable and can be flown in the Philippine air force C-130 transport aircraft and rapidly deployed for launch.

Defence exports are a pillar of the government's drive to attain self-sufficiency in defence production. The Ministry of defence (MoD) informed parliament last December that India had exported defence equipment worth Rs 8,434 crore in 2020-21, compared to Rs 1,940 crore in 2014-15. Over 30 Indian defence companies have exported arms and equipment to countries like Italy, Maldives, Sri Lanka, Russia, France, Nepal, Mauritius, Sri Lanka, Israel, Egypt, UAE, Bhutan, Ethiopia, Saudi Arabia, Philippines, Poland, Spain and Chile. The exports include personal protective items, defence electronics systems, engineering mechanical equipment, offshore patrol vessels, advanced light helicopters, avionics suits, radio systems and radar systems.

In 2020, the MoD targeted defence exports of Rs 35,000 crore ($5 billion) till 2024. In order to achieve this target, a 2020 KPMG report says, defence exports have to grow at over 40 per cent until 2024. There is however a huge gap between intent and action. The Stockholm International Peace Research Institute (SIPRI) ranked India at number 23 in the list of major arms exporters for 2015-2019. India still accounts for only 0.17 per cent of global arms exports. This is why India's MoD needs to study best practises of the biggest arms exporting countries. Most of these countries have successfully sold arms worth billions of dollars to New Delhi and enriched their own R&D base, generated jobs in the high-technology defence sector and created diplomatic leverage for their governments.

The US, the world's largest arms exporter, has a Bureau of Political-Military affairs that oversees defence exports. Israel, the world's eighth-largest defence exporter has a dedicated defence exporting agency called SIBAT under its defence ministry. India's MoD so far has no such dedicated agency to drive exports. Exports are left to individual corporations, like BrahMos or the defence public shipyards and undertakings. India's private sector defence firms are pretty much on their own. In March 2020, Bharat Electronics Ltd (BEL) bagged a $30 million dollar order to sell four Swathi Weapon Locating Radars to Armenia. For every success story like the BrahMos there are numerous others where Indians firms were missing in action.

Not surprisingly for a system unused to using defence exports as political leverage, the battles for exporting the BrahMos all lay within the Indian system. The sale was initially questioned by the MEA, which evidently was worried it could upset the Chinese government. "The biggest thing was to get our government to grant us export clearance," says a defence official familiar with the negotiations.

The success in the Philippines, says an official familiar with the deal, was largely the work of two key officials—former BrahMos Aerospace CEO Sudhir Misra and India's current ambassador to the Philippines, Shambhu Kumaran. Misra, a senior DRDO scientist was BrahMos CEO until last December. It also helped that Kumaran was earlier joint secretary, Planning and International Corporation (PIC), a key MEA post in the MoD to leverage defence cooperation with friendly countries.

A dedicated agency focused only on defence exports would not only onboard scientists like Misra, bureacrats like Kumaran, but also defence industry experts to identify global export opportunities and link them with Indian domestic manufacturers to create global partnerships. It could hand-hold component level manufacturers and help original equipment manufacturers of indigenous weapon systems like warships, missile and artillery systems to identify foreign buyers.

A June 2020 KPMG report titled 'Defence Exports: Untapped Potential' makes the case for such a dedicated department. The department would "need to identify existing opportunities, create new horizons, facilitate G2G deals, establish lineages with domestic industry, handhold potential suppliers and establish partnerships", the report says.

The report recommends a first step of setting up of an exclusive "defence export help desk". On the basis of inputs from the help-desk, the report says, Indian companies could work with government machinery to realise exports. Indian arms could greatly benefit from a government hand.

https://www.indiatoday.in/india-today-insight/story/why-india-needs-a-dedicated-defence-export-department-1901972-2022-01-19

The EurAsian Times

Thu, 20 Jan 2022

BrahMos gives India a 'big breakthrough' but here are other 'made-in-India' missiles New Delhi is pitching to key allies

By Sakshi Tiwari

The Philipines recently became the first customer of Indo-Russian BrahMos missiles. Experts say BrahMos could just be the beginning as India looks to export other powerful missiles to ally nations.

File Image: BrahMos Missile System

India's Ministry of Defense (MOD) had informed the country's Parliament last year that it had clocked a massive hike in the export of military equipment in the past five years.

MOD also announced that the government has set an ambitious goal of exporting aerospace and defense equipment and services worth around 35,000 crores (approx $5 billion) by 2025.

While this may sound too optimistic for a country that has traditionally been a large defense importer, there are a few policy decisions that may be indicative of a changing trend.

In what could be the first major defense export deal for India, the Philippines accepted BrahMos Aerospace's proposal to supply supersonic cruise missiles to its navy on January 14. This has essentially put all speculations to rest about the BrahMos missile contract that has been a topic of discussion on both sides for quite some time.

The $374.9 million agreement was announced via a 'Notice of Award' signed by Secretary Delfin Lorenzana of the Philippines Department of National Defense. The order instructed BrahMos Aerospace to deliver the Shore-based Anti-ship Missile System within 10 calendar days of receiving it. BrahMos Aerospace is a joint venture between India and Russia.

On January 11, the Indian Navy's newly commissioned INS Visakhapatnam successfully test-fired a long-range sea-to-sea variant of the BrahMos missile. The test was carried out by the Defence Research and Development Organisation (DRDO), as previously reported by EurAsian Times.

BrahMos, which was first deployed on Navy warships in 2005, has the capability to hit targets at sea that are beyond the radar horizon. This naval version of the missile can be fired vertically or horizontally from moving or stationary assets, and it can hit both land and water targets.

New Delhi and Manila have been in talks to buy a variety of Indian defense platforms, including the BrahMos missile, then-Indian ambassador to the Philippines, Jaideep Majumdar had said in 2020.

The current agreement with the Philippines is part of India's 'Made-in-India' defense weapons effort. The claimed order would be the country's largest in the field, even as India last year had won a $40 million deal for the DRDO-developed weapon locating radar systems from the Armenian government.

Apart from the Philippines, many Southeast Asian countries, including Thailand, Indonesia, and Vietnam, have expressed interest in the land and sea-based variants of BrahMos, according to reports. Argentina, Brazil, South Africa, the United Arab Emirates, and Saudi Arabia are also among the potential customers.

Other Missiles For Potential Export

Apart from BrahMos for the Philippines Navy, there are other made-in-India missiles that have also found popularity outside the country and remain on the export list of the Indian government.

Akash Surface-To-Air Missile

The Narendra Modi government had approved the export of the Akash surface-to-air missile system, which was developed in India. If media reports are anything to go by, at least a dozen nations including the United Arab Emirates, Vietnam, and the Philippines, have expressed interest in purchasing the Akash system.

The Government's approval will enable Indian manufacturers to participate in contracts issued by various countries, as previously stated by The Hindu.

Akash has a range of 25 kilometers and can engage several targets at the same time in all weather conditions. With over 96 percent indigenization, Akash is the country's one of most important missiles. The Akash surface-to-air missile was inducted into the Indian Air Force (IAF) in 2014 and the Army in 2015.

Earlier, the Akash missile was given clearance for exports by the Indian government but now other missiles have also been added to the list.

Astra Air-To-Air Missile

The Astra air-to-air missile is India's first beyond-visual-range (BVR) missile, conceived and developed by the Defence Research and Development Organisation (DRDO).

With exceptional maneuverability and supersonic speeds, it is designed to engage and destroy aerial targets. The sophisticated air combat capabilities of the missile enable it to engage multiple high-performance targets.

The Indian Air Force (IAF) and the Indian Navy are the primary users of the Astra missile. It has been incorporated with the Su-30MKI fighter jet of the Indian Air Force. The Mk-II model, which would have a range of 160 kilometers, is also being developed by DRDO. India and Russia are working together to create the Astra Mk-III, a future model.

Nag & Pinaka

Nag is a third-generation anti-tank guided missile developed by DRDO to support the Indian Army's mechanized infantry and airborne forces.

Nag can be launched from both the ground and the air. It has been designed to take out current main battle tanks and other heavily defended targets. The Nag missile system, which is launched from a Nag Missile Carrier (NAMICA), has a range of 4 to 7 kilometers and is equipped with an advanced seeker to help it find its target.

The final test of the Nag anti-tank guided missile was successfully completed in 2020, and the weapon system is now ready for induction into the Indian Army.

The Nag missile was developed in India as part of the Indian Ministry of Defense's Integrated Guided Missile Development Program (IGMDP), which also included the Agni, Akash, Trishul, and Prithvi missiles.

Pinaka is a multiple rocket launcher designed for the Indian Army by the Defence Research and Development Organisation (DRDO). For mobility, the system is installed on a Tatra truck.

Previously, the army had relied on the Pinaka Mark I, which had a range of 37.5 kilometers. Last year, the army successfully tested the Pinaka Extended Range (Pinaka-ER) Multiple Launch Rocket System (MLRS), one of the army's most potent fire support systems, with rockets built by private companies.

Enhanced Pinaka has a range of 75 kilometers; it has the "ability to strike within 10 meters of where it is aimed, allowing the army to destroy a terrorist camp, or an enemy post, logistics dump or headquarters, without needing to send soldiers across the border," wrote Ajai Shukla, a defense analyst.

Barak 8 Missile

Barak 8 missile developed jointly by Israel and India could also be exported on the same lines as the BrahMos.

The Barak-8 is said to be capable of countering airborne threats from distances of up to 70 kilometers. It was the result of a joint effort between India's Defence Research and Development Organization (DRDO) and Israel's Aerospace Industry (IAI).

Israeli company Rafael, India's state-run Bharat Electronics Limited (BEL), Bharat Dynamics Limited, and private enterprise Larsen and Toubro were also important stakeholders (L&T).

Radars, command and control systems, and mobile launchers are all part of the Barak-8. For excellent maneuverability in the terminal phase, the air defense system's missiles are powered by an indigenous rocket motor and control system.

Further, India's sale of LCA Tejas to friendly countries which remain in the works could also ignite interest in missiles that could be integrated with this Light Combat Aircraft for various countries.

In 2020, the Modi government had set a goal for the Indian defense industry to export $5 billion by 2025. A renewed push towards indigenous manufacturing and diplomatic outreach could mean India will be in the position to export more missiles and other weapon systems to friendly countries.

https://eurasiantimes.com/brahmos-other-made-in-india-missiles-modi-govt-is-pitching-to-allies/

THE EPOCH TIMES

Thu, 20 Jan 2022

Philippines Purchase of India's Supersonic Missile Breaks 'Psychological Barriers,' Expert Says

By Venus Upadhayaya

New Delhi: In its first-ever major military export, India is set to supply supersonic cruise missiles valued at over $350 million to the Philippines.

The move is likely to help the two countries overcome Cold War-era psychological barriers due to their respective affinities to the United States and the Soviet Union, according to Richard Heydarian, associate professor at the Polytechnic University of the Philippines.

"In a lot of ways, this is about breaking psychological barriers. I think for a long time, the Philippines and India, two of the oldest democracies in the world, very similar countries on so many levels, for some reason were mutually estranged … with India closer to Russia and the Philippines closer to the United States," Heydarian told The Epoch Times.

A Brahmos supersonic cruise missile is on display at the International Maritime Defense Show in Saint Petersburg on June 28, 2017. (Olga Maltseva/AFP/Getty Images)

Philippines' decision to import the Indian Brahmos missile, a shore-based anti-ship missile, was announced on January 14. Delfin Lorenzana, Secretary of National Defence of the Philippines, said that the Philippine Marines will be the primary user of the new weapons system. India will train the operators and maintainers and provide logistics support, Lorenzana said.

Heydarian said that in the past decade the two countries have moved closer to each other—both have "strong and populist" national leaders who shared a "lot of rapport" during their meeting in New Delhi in 2018. He was referring to the meeting between Philippines President Rodrigo Duterte and Indian Prime Minister Narendra Modi during the ASEAN-India Commemorative Summit.

A year earlier, Modi had visited Manila and a year later, Indian President Ram Nath Kovind visited the Philippines to commemorate 70 years of bilateral relations between the two countries.

"That may have also facilitated this bourgeoning defense cooperation between the U.S. treaty ally, one of the key claimants in the South China Sea on one hand and, of course, India, the other major rising power of Asia, on the other," said Heydarian.

Pathikrit Payne, a New Delhi-based research consultant on geopolitical affairs, with a specialization in the management of defense technology, told The Epoch Times that the "strategic imperatives" may further help in strengthening relations between India and the Philippines.

"Defence sales itself help in building a different level of trust. It may, later on, grow in other spheres of business," said Payne.

New Equations in South East Asia

Dr. Satoru Nagao, a non-resident fellow at the Washington D.C.-based Hudson Institute, told The Epoch Times that, until today, India's military imports to southeast Asian countries have been in the form of training, maintenance, and logistics support for the Russian imports, or training for the militaries at large.

"For example, in Malaysia, India has trained pilots and ground crews of Russian-made MIG-29 and SU-30 fighter jets. In Indonesia, maintenance of SU-30 fighter jets is implemented by India. In the case of Vietnam, India trained pilots and ground crew of SU-30 and MIG-21 fighter jets and crews of Russian-made Kilo-class submarines," said Nagao, adding that India has leased its training fields to Singaporeans that use American weaponry.

"When Thailand bought an aircraft carrier, India trained their crew in the 1990s. These 'software' supports are the main contribution of India in South East Asia," said Nagao.

The Philippines and Singapore traditionally depend upon the United States for weapons, while Vietnam depends upon Russia. Indonesia and Malaysia are importing weapons from both the United States and Russia, while Thailand, Myanmar, and Cambodia rely on China. Laos is dependent on Vietnam, but the Chinese influence is developing, he said.

"That is why Southeast Asia could be an arena for U.S.-China competition. ASEAN is a group of 10 independent countries. China is exerting pressure from the land side of the ASEAN while the U.S. is keeping the sea side of the ASEAN. Vietnam is located between the land side and the sea side. India is not in Southeast Asia but India is on the U.S. side. India is also quite independent. India is a great power," said Nagao. By "great power" Nagao meant an influencer in the region.

As the Cold War equations change, India's strategic role is evolving in the region because, though the U.S. weapons are high quality, they are expensive for the Southeast Asia nations.

"(The) Russian weapon is not expensive but it demands a high cost of maintenance. That's why Southeast Asian countries ask India for maintenance and training of Russian weapons with cheap cost," said Nagao.

For a long time, the Philippines' military power was limited and its defense imports were limited to the United States. But because of increasing threats from China, the current Philippine government has started to diversify its weapons acquisition and is now importing weapons from India, Japan, South Korea, and Russia.

"It's just not only that the Philippines has territorial disputes with China, similar to India. There's also the element of the Philippines actually being a very NATO American weaponry-equipped country. And we know that Brahmos was a joint venture with Russia. So I think this definitely paves the way for the Philippines to have a much more diversified pool of suppliers, including Russian great weaponry and Indian weaponry, which use a lot of Russian inputs and technology," said Heydarian.

Indian Defense Exports

Heydarian described it as a "big win" for India, one of the world's largest arms importers. With a share of 9.5 percent of the total global arms imports, India emerged as the second-largest importer

of arms between 2016-2020 and the country has been increasingly trying to change this by promoting indigenous defense manufacturing and exports.

Payne said India is trying to create a niche for itself in the global defense industry. The Indian Ministry of Defense came out with a notification on December 27 declaring a ban on the import of 2,851 items because they have been indigenized and said that the country will save over $402 million annually.

Payne said that India would target those countries for defense exports that traditionally don't buy strategic weapon systems from China.

"Of course, the larger objective is to wean many of these countries away from China, and thus a certain level of competition can't be ruled out," he said.

Heydarian said that India can now credibly claim to become an emerging exporter, especially to other frontline states in Asia and the Indo-Pacific, which is also growing fast economically.

"We are looking also at Vietnam, Indonesia, and Malaysia. Singapore and other countries are also acquiring advanced weaponry from India in the future. So I think this is definitely a kind of turning point for India's defense industry," said Heydarian.

Anti-Access and Area Denial

Nagao said the importance of the Brahmos acquisition by the Philippines lies in the "anti-access, anti denial (A2AD) capabilities" with which the missile system equips the Philippines.

"China is trying to use the South China Sea as a route; Philippines' effort to stop China's access to the South China Sea is anti-access. China is also trying to deny the Philippines access to the South China Sea and the Philippines' effort to maintain their access is anti-denial," he said. To fight the strong Chinese naval power, the weaker Philippines need A2AD capabilities by possessing missiles, he added.

"This is asymmetric defense. Symmetrical defense is naval ship versus naval ship. Asymmetrical defense is naval ship versus missile. Now to deal with China, the Philippines are seeking A2AD by using asymmetric defense by Brahmos missile," said Nagao.

Heydarian said that the Brahmos will help the Philippines to develop minimum deterrence capability. No country in the region is in a position to match the Chinese head-to-head and they need to use A2AD against China, the way China is using A2AD to overcome its quantitative and qualitative disadvantage with the United States.

"Smaller countries, from South Korea to Vietnam, and the Philippines are also trying to mix and match different sorts of cutting-edge technology in order to develop their own asymmetric A2AD defense deterrence capability against China. So, definitely that's where the Brahmos comes into the picture," said Heydarian.

Nagao said affordable Indian missiles could build the long-range strike capabilities of countries surrounding China and help to strengthen the quadrilateral alliance between India, the United States, Japan, and Australia in the region.

https://www.theepochtimes.com/philippines-purchase-of-indias-supersonic-missile-breaks-psychological-barriers-expert-says_4217965.html

COVID 19: DRDO's Contribution

Hindustan Times

Thu, 20 Jan 2022

DRDO Covid facility in Lucknow set to start again

The DRDO Covid facility, which was established to help the Uttar Pradesh government combat corona cases, was later put on standby mode after the Covid cases began to decline.

Lucknow The Atal Bihari Vajpayee Covid Hospital, a 450-bed makeshift facility set up by Defence Research and Development Organisation (DRDO) here in May last year, is all set to start functioning again. The Covid facility, which was established to help the state government combat corona cases, was later put on standby mode after the Covid cases began to decline. Besides, another 250-bed Covid facility established by Hindustan Aeronautics Limited (HAL) is also likely to become functional soon.

The DRDO Covid facility was inaugurated by chief minister Yogi Adityanath on May 5, 2021. (HT)

The decision is part of the state government's anti-Covid 19 exercise that it is carrying out, anticipating rise in Covid cases. "With all mock drills done, we are ready and waiting for the state government's nod. The hospital is currently on standby mode," said nodal officer for DRDO hospital AP Singh. The DRDO's 450 bedded-Covid facility was the initiative of defence minister Rajnath Singh.

The facility was the most sought after Covid hospital that was inaugurated by chief minister Yogi Adityanath on May 5, 2021.

The hospital is equipped with 150 ICU beds with 24-hours oxygen supply. "Back then, The Indian Armed Forces had deployed 30 medical specialists, 28 medical officers, six officers for administrative support, 51 nursing officers, 110 nursing assistants/technicians and 79 support staff to run the hospital," said a senior official posted with the hospital. Similarly, the makeshift 250-bed hospital set up by the HAL is likely to re-start soon. Of the total beds, 150 would be ICU beds of L3 category.

https://www.hindustantimes.com/cities/lucknow-news/drdo-covid-facility-in-lucknow-set-to-start-again-101642616243755.html

DRDO on Twitter

19 January 2022

Defence News

Defence Strategic: National/International

THE NEW INDIAN EXPRESS

Thu, 20 Jan 2022

Second defence export deal this month: India to supply ALH (MkIII) to Mauritius

The Indian defence manufacturing setup has earlier got a major export order worth USD 374 million from the Philippines to supply shore-based anti-ship missiles for the country's navy.

New Delhi: Close on the heels of the BrahMos supply contract India has got another contract to supply Indigenously manufactured Advanced Light Helicopter (ALH).

Hindustan Aeronautics Limited (HAL) in its official statement on Wednesday said, "HAL has signed a contract with the Government of Mauritius (GoM) for export of one Advanced Light Helicopter (ALH)-MkIII for Mauritius Police Force."

"With this contract, HAL and the Government of Mauritius have further strengthened the long-standing business relations spanning over three decades," Added HAL.

Image of Advanced Light Helicopter for representational purpose only (File Photo)

Mauritius already operates an ALH and Dornier Do-228 aircraft built by HAL.

The contract was signed by Mr. BK Tripathy, General Manager, Helicopter Division-HAL and Mr. OK Dabidin, Secretary of Home Affairs, Prime Minister's Office, Government of Mauritius recently at HAL's Transport Aircraft Division, Kanpur.

In a first, the Indian Defence manufacturing setup got a major export order from the Philippines with an offer to supply the BrahMos supersonic cruise missile.

The notice was signed on 31 December in which the Philippines approved a $374.96 million (Rs 2700 cr) contract for the purchase of a shore-based anti-ship missile system from India.

The ALH Mk III is a multi-role, multi-mission helicopter in the 5.5-tonne category in extensive use by the Indian armed forces and has also been exported.

More than 335 ALHs have been produced to date logging around 3,40,000 cumulative flying hours. HAL also ensures technical assistance and product support to the customer to ensure the healthy serviceability of the helicopter, the statement added.

India has been pushing for Made in India in order to develop self-reliance in defence manufacturing.

https://www.newindianexpress.com/nation/2022/jan/19/second-defence-export-deal-this-month-india-to-supply-alh-mkiii-to-mauritius-2408794.html

FINANCIAL EXPRESS
Read to Lead

Thu, 20 Jan 2022

HAL exports ALH Mk III to Mauritius for its Police Force

This export of the ALH Mk III is for the Police Force of that country and is going to further boost India's efforts in defence exports to Friendly nations

By Huma Siddiqui

State owned Hindustan Aeronautics Limited (HAL) on Wednesday (January 19, 2022) has inked a contract with the Government of Mauritius (GoM) for one Advanced Light Helicopter (ALH Mk III). This export of the ALH Mk III is for the Police Force of that country and is going to further boost India's efforts in defence exports to Friendly nations. And with the export of ALH, India has further cemented its relationship with the country in the Indian Ocean Region. The government of that country is already operating ALH and Do-228 aircraft – both have been built by HAL.

More about the Helicopter

This helicopter made in India, is indigenous and multi-role, multi-mission versatile helicopter in 5.5 tonne category.

According to the HAL statement issued after the signing of the contract, it has proven itself in various utility roles. And these include lifesaving missions especially during natural calamities locally as well as overseas.

Till date more than 335 ALHs have been produced and have logged in 3, 40, 000 flying hours.

Importance of Mauritius

For India, Mauritius is a very important island nation located in the Indian Ocean Region (IOR) and is headquarter of an Indian led initiative the Indian Ocean Rim Association (IORA). IORA has eight African member countries including the strategic island states like Madagascar and Comoros.

Another initiative, the Indian Ocean Naval Symposium, a multinational naval mechanism, was set up by the Indian Navy in 2008. This body is meant to foster closer cooperation amongst the navies in the region and the focus is on greater interoperability and shared awareness in the maritime domain.

Mauritius is one of the six African member states. Others include Tanzania, Kenya, South Africa, Seychelles, and Mozambique.

OPV for Mauritius

In 2021, the country located in the IOR received an offshore Patrol Vessel for its police force, after a major refit. This was designed and built by Kolkata based Garden Reach Shipbuilders and Engineers Ltd. (GRSE), Kolkata has recently undergone extensive refit. The refit took almost seven months and was done on a gratis basis.

The OPV was for around USD 58.5 million, and the Indian government had extended one time grant of USD 10 million for this and the rest was paid through the Line of Credit through EXIM Bank to the government of that country.

https://www.financialexpress.com/defence/hal-exports-alh-mk-iii-to-mauritius-for-its-police-force/2410679/

जागरण

Thu, 20 Jan 2022

'मेक इन इंडिया' को फिर बड़ी कामयाबी, मारीशस को उन्नत हल्के हेलीकॉप्टरों ALH Mk III का निर्यात करेगा हिंदुस्तान एयरोनॉटिक्स लिमिटेड

हिंदुस्तान एयरोनॉटिक्स लिमिटेड (Hindustan Aeronautics Limited HAL) ने मॉरीशस सरकार के साथ उन्नत हल्के हेलीकॉप्टर (ALH Mk III) के निर्यात के लिए एक अनुबंध पर हस्ताक्षर किए हैं। इसका इस्तेमाल मॉरीशस पुलिस बल करेंगे। पढ़ें यह रिपोर्ट ..

By Krishna Bihari Singh

बेंगलुरू: हिंदुस्तान एयरोनॉटिक्स लिमिटेड (Hindustan Aeronautics Limited, HAL) **ने मॉरीशस सरकार के साथ उन्नत हल्के हेलीकॉप्टर** (ALH Mk III) **के निर्यात के लिए एक अनुबंध पर हस्ताक्षर किए हैं। इसका इस्तेमाल मॉरीशस पुलिस बल करेंगे। मॉरीशस सरकार पहले से ही हिंदुस्तान एयरोनॉटिक्स लिमिटेड निर्मित एएलएच और डीओ**-228 **विमान संचालित कर रही है। एचएएल ने अपने बयान में कहा कि इस अनुबंध के साथ एचएएल और मॉरीशस सरकार ने तीन दशकों में लंबे समय से चले आ रहे अपने व्यापारिक संबंधों को और मजबूत किया है।**

जारी बयान में कहा गया है कि यह समझौता मित्र देशों को रक्षा निर्यात को बढ़ावा देने के भारत सरकार के दृष्टिकोण के अनुरूप है। अनुबंध पर एचएएल के हेलीकॉप्टर डिवीजन के महाप्रबंधक बीके त्रिपाठी और मॉरीशस सरकार के प्रधानमंत्री कार्यालय के गृह मामलों के सचिव ओके दाबिदीन द्वारा हाल ही में एचएएल के परिवहन विमान प्रभाग कानपुर हस्ताक्षर किए गए थे। एएलएच एमके थ्री 5.5 **टन वजह की श्रेणी में एक मल्टी रोल, बहु-मिशन बहुमुखी हेलीकॉप्टर है।**

हिंदुस्तान एयरोनॉटिक्स लिमिटेड (Hindustan Aeronautics Limited, HAL) **के बनाए इस हेलिकाप्टर ने भारत और विदेशों में प्राकृतिक आपदाओं के दौरान कई जीवन रक्षक मिशनों सहित विभिन्न उपयोगिता भूमिका में अपनी योग्यता साबित की है। अब तक इस तरह के** 335 **से अधिक एएलएच हेलिकाप्टरों का उत्पादन किया जा चुका है। बयान में कहा गया है कि एचएएल हेलिकॉप्टर की सेवाक्षमता को सुनिश्चित करने के लिए ग्राहकों को तकनीकी सहायता भी सुनिश्चित करता है।**

उल्लेखनीय है कि सरकार की रक्षा निर्यात बढ़ाने की योजनाओं को लगातार सफलताएं मिल रही हैं। हाल ही में फिलीपींस ने भारतीय ब्रह्मोस एयरोस्पेस प्राइवेट लिमिटेड के 37.49 **करोड़ अमेरिकी डालर** (2779 **करोड़ रुपये**) **के प्रस्ताव को मंजूरी दी थी। यह प्रस्ताव फिलीपींस नौसेना के लिए तट-आधारित पोत रोधी मिसाइल प्रणाली की आपूर्ति से संबंधित था। फिलीपींस के राष्ट्रीय रक्षा विभाग ने प्रस्ताव को स्वीकार करने के बाद ब्रह्मोस के अधिकारियों को इसकी सूचना दी।**

फिलीपींस सरकार के रक्षा विभाग ने अपनी वेबसाइट पर उक्त अनुबंध के नोटिस को अपलोड किया था। दरअसल रक्षा अनुसंधान विकास संगठन (डीआरडीओ) और ब्रह्मोस एयरोस्पेस पिछले कुछ महीनों से मित्र देशों को इस मिसाइल का निर्यात करने में जुटे थे। जानकारों की मानें तो ब्रह्मोस के निर्यात से देश के

रक्षा क्षेत्र में स्वदेशी अभियान को बड़ी मजबूती मिलेगी। इससे हथियार निर्यातक देशों की कतार में भारत भी तेजी से आगे बढ़ेगगा। इससे अन्य मित्र राष्ट्रों से भी मिसाइल के लिए आर्डर मिलने की उम्मीद है।

https://www.jagran.com/news/national-hindustan-aeronautics-limited-hal-to-export-advanced-light-helicopter-to-mauritius-22395285.html

The Tribune

Thu, 20 Jan 2022

India's N-project going strong

Capable of meeting challenges faced by national security

By G Parthasarathy

An important feature of India's nuclear deterrent has been the calibrated secrecy surrounding its growth. This is essential, as India's nuclear weapons and missile programmes have a large involvement of dedicated scientists and engineers from the DRDO, the Department of Atomic Energy, academic institutions, and commercial organisations from the public and private sectors. India's nuclear weapons programme is under continuing worldwide scrutiny, including by specialist organisations like the Federation of American Scientists and similar organisations in the UK, France, Russia, and doubtless, China and Pakistan.

India has produced three nuclear-powered submarines, and could induct the fourth next year.

While Indian scientists have made discreet statements about our ballistic missile tests, one finds more details of our nuclear weapons and ballistic missiles in studies by American scientific publications like the Bulletin of Atomic Scientists and other organisations like the MacArthur Foundation. Such studies are carefully researched and counterchecked. These are not significantly different from what one periodically finds in writings in India.

Catching up: China has 350 nuclear warheads, Pakistan 165, and India 156. PTI

According to the Bulletin of Atomic Scientists, India has enough weapons grade plutonium to produce 150 to 200 nuclear weapons, with a current estimated stockpile of 150 nuclear weapons. There is potential to step up production of fissile material significantly through the growing numbers of fast breeder and other plutonium reactors. According to the infamous Dr AQ Khan, Pakistan provided China with the centrifuge technology for enriched uranium, whose details he had purloined in Europe in the 1970s and 1980s. China, in turn, provided Pakistan the knowhow to utilise enriched uranium produced in Pakistan for nuclear weapons. The then US President Jimmy Carter looked the other way at these developments after he was swept off his feet by his 'friendship' with Chinese leader Deng Xiaoping.

China now possesses 350 nuclear warheads, while Pakistan has 165, and India 156, according to the latest assessment of the Stockholm International Peace Institute (SIPRI). Apart from its land-based nuclear missiles, India launched its third nuclear submarine barely a month ago. It is said to have a capability to launch eight ballistic missiles. The two earlier submarines can reportedly launch four missiles each. India now has the capability of 'canisterising', or storing the missiles in a sealed, climate controlled tube to protect them during transportation. This would apply to the entire range of missiles, including the recently tested Agni-P and the Agni-V, which has a range of 5,500 km. Many studies allude to an important role of the French-built Mirage 2000 and Rafale, as carriers of India's nuclear weapons.

China has provided Pakistan with the designs for its nuclear weapons and a wide range of missiles. The missiles provided by China to Pakistan extend from the short range (320 km) Ghaznavi missiles to Shaheen 2 (2,500 km) and Shaheen 3 (2,750 km). The Chinese nuclear weapons designs given to Pakistan were transferred by AQ Khan to Islamic countries with nuclear ambitions, like Libya and Iraq. While India now has produced three nuclear-powered submarines, there are reports that a fourth submarine could be inducted next year. There are also reports that India is developing the technology for multiple warheads on its missiles. A recent report by the Federation of American Scientists noted that India carried out the second test of its Agni-P missile. The first test of the missile was reportedly carried out in January 2020. This could lead to the missile being berthed in the growing fleet of India's nuclear submarines. This would be complemented by submarine-launched Agni-V missiles with multiple warheads.

China will inevitably continue to pretend it has no interest in having any nuclear dialogue with India. India is, in the meantime, also developing a K-4 submarine-launched missile, with a 3,500-km range. It is a naval version of Agni-3, an intermediate-range ballistic missile (IRBM). The K-4 has undergone a number of tests but it has yet to be deployed. The missile was tested in January 2020. Though the DRDO did not confirm the test, media reports, quoting officials, claimed that the launch was successful. While Pakistan has not formally enunciated a nuclear doctrine, the long-time head of the Strategic Planning Division of its Nuclear Command Authority, Lt Gen Khalid Kidwai, told a team of physicists from Italy's Landau Network in 2002 that Pakistan's nuclear weapons were 'aimed solely at India'. Kidwai added that Pakistan would use nuclear weapons if India conquers a large part of Pakistan's territory, or destroys a large part of Pakistan's land and air forces, or if India tries to 'economically strangle' Pakistan, or pushes it to political destabilisation.

This elucidation, by the man who has been the de facto custodian of Pakistan's nuclear arsenal for over a decade and a POW in India in 1971-73, was a precise formulation of Pakistan's nuclear thresholds. It is now clear that a bankrupt Pakistan facing pressure from international finance organisations will have to think carefully before resorting to support for terrorists seeking to destabilise India. With the Taliban supporting Pashtun aspirations on issues like the Durand Line, India's readiness to provide essential economic assistance to Kabul should be taken forward. Defence Minister Rajnath Singh recently noted that while India presently stood by its commitment of 'no first use' of nuclear weapons, 'what happens in future depends on the circumstances'.

The nation needs to always remember the contribution of Dr APJ Abdul Kalam, his team of engineers and scientists, and the distinguished scientists in the Department of Atomic Energy for developing the country's nuclear and missile potential to meet the challenges to national security, posed jointly by China and Pakistan. There is also need to remember those in the private sector, who discreetly played a key role in this effort.

(G Parthasarathy, *Chancellor, Jammu Central University & former High Commissioner to Pakistan*)

https://www.tribuneindia.com/news/comment/indias-n-project-going-strong-362708

ThePrint

Thu, 20 Jan 2022

Over 45 countries expected to participate in multilateral exercise Milan in 2022: Indian Navy

The Navy has been hosting the biennial exercise since 1995. This year, Milan is scheduled to be held at Visakhapatnam from 25 February to 4 March.

New Delhi: Biennial multilateral exercise Milan's 2022 edition is expected to be the largest one with likely participation of navies of 45-plus countries, the Indian Navy said on Wednesday.

Final planning conference for Milan 2022 was held on Wednesday at New Delhi in hybrid format — participants attending virtually as well as physically — said the Indian Navy on Twitter.

Representational image of Indian Navy ships | Photo: Commons

Milan's 2022 edition is scheduled to be held at Visakhapatnam from February 25 to March 4, the Navy mentioned.

Theme of Milan's 2022 edition would be 'Camaraderie-Cohesion-Collaboration', it noted.

Milan is a biennial multilateral event hosted by the Indian Navy since 1995.

"This 2022 edition of Milan is expected to be the largest with likely participation of more than 45 countries," it mentioned.

https://theprint.in/defence/over-45-countries-expected-to-participate-in-multilateral-exercise-milan-in-2022-indian-navy/807647/

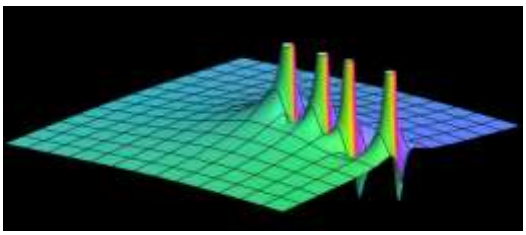
Science & Technology News

PHYS.ORG

Thu, 20 Jan 2022

Quantum zeta epiphany: Physicist finds a new approach to a $1 million mathematical enigma

Numbers like π, e and φ often turn up in unexpected places in science and mathematics. Pascal's triangle and the Fibonacci sequence also seem inexplicably widespread in nature. Then there's the Riemann zeta function, a deceptively straightforward function that has perplexed mathematicians since the 19th century. The most famous quandary, the Riemann hypothesis, is perhaps the greatest unsolved question in mathematics, with the Clay Mathematics Institute offering a $1 million prize for a correct proof.



Remmen's scattering amplitude (pictured) translates the Riemann zeta function into the language of quantum field theory. Credit: Grant Remmen

UC Santa Barbara physicist Grant Remmen believes he has a new approach for exploring the quirks of the zeta function. He has found an analog that translates many of the function's important properties into quantum field theory. This means that researchers can now leverage the tools from this field of physics to investigate the enigmatic and oddly ubiquitous zeta

function. His work could even lead to a proof of the Riemann hypothesis. Remmen lays out his approach in the journal*Physical Review Letters*.

"The Riemann zeta function is this famous and mysterious mathematical function that comes up in number theory all over the place," said Remmen, a postdoctoral scholar at UCSB's Kavli Institute for Theoretical Physics. "It's been studied for over 150 years."

An outside perspective

Remmen generally doesn't work on cracking the biggest questions in mathematics. He's usually preoccupied chipping away at the biggest questions in physics. As the fundamental physics fellow at UC Santa Barbara, he normally devotes his attention to topics like particle physics, quantum gravity, string theory and black holes. "In modern high-energy theory, the physics of the largest scales and smallest scales both hold the deepest mysteries," he remarked.

One of his specialties is quantum field theory, which he describes as a "triumph of 20^{th} century physics." Most people have heard of quantum mechanics (subatomic particles, uncertainty, etc.) and special relativity (time dilation, $E=mc^2$, and so forth). "But with quantum field theory, physicists figured out how to combine special relativity and quantum mechanics into a description of how particles moving at or near the speed of light behave," he explained.

Quantum field theory is not exactly a single theory. It's more like a collection of tools that scientists can use to describe any set of particle interactions.

Remmen realized one of the concepts therein shares many characteristics with the Riemann zeta function. It's called a scattering amplitude, and it encodes the quantum mechanical probability that particles will interact with each other. He was intrigued.

Scattering amplitudes often work well with momenta that are complex numbers. These numbers consist of a real part and an imaginary part—a multiple of $\sqrt{-1}$, which mathematicians call i. Scattering amplitudes have nice properties in the complex plane. For one, they're analytic (can be expressed as a series) around every point except a select set of poles, which all lie along a line.

"That seemed similar to what's going on with the Riemann zeta function's zeros, which all seem to lie on a line," said Remmen. "And so I thought about how to determine whether this apparent similarity was something real."

The scattering amplitude poles correspond to particle production, where a physical event happens that generates a particle with a momentum. The value of each pole corresponds with the mass of the particle that's created. So it was a matter of finding a function that behaves like a scattering amplitude and whose poles correspond to the non-trivial zeros of the zeta function.

With pen, paper and a computer to check his results, Remmen set to work devising a function that had all the relevant properties. "I had had the idea of connecting the Riemann zeta function to amplitudes in the back of my mind for a couple years," he said. "Once I set out to find such a function, it took me about a week to construct it, and fully exploring its properties and writing the paper took a couple months."

Deceptively simple

At its core, the zeta function generalizes the harmonic series:

This series blows up to infinity when $x \leq 1$, but it converges to an actual number for every $x > 1$.

In 1859 Bernhard Riemann decided to consider what would happen when x is a complex number. The function, now bearing the name Riemann zeta, takes in one complex number and spits out another.

Riemann also decided to extend the zeta function to numbers where the real component was not greater than 1 by defining it in two parts: the familiar definition holds in places where the function behaves, and another, implicit definition covers the places where it would normally blow up to infinity. Thanks to a theorem in complex analysis, mathematicians know there is only one formulation for this new area that smoothly preserves the properties of the original function. Unfortunately, no one has been able to represent it in a form with finitely many terms, which is part of the mystery surrounding this function.

Given the function's simplicity, it should have some nice features. "And yet, those properties end up being fiendishly complicated to understand," Remmen said. For example, take the inputs where the function equals zero. All the negative even numbers are mapped to zero, though this is apparent—or "trivial" as mathematicians say—when the zeta function is written in certain forms. What has perplexed mathematicians is that all of the other, non-trivial zeros appear to lie along a line: Each of them has a real component of ½.

Riemann hypothesized that this pattern holds for all of these non-trivial zeros, and the trend has been confirmed for the first few trillion of them. That said, there are conjectures that work for trillions of examples and then fail at extremely large numbers. So mathematicians can't be certain the hypothesis is true until it's proven.

But if it is true, the Riemann hypothesis has far-reaching implications. "For various reasons it crops up all over the place in fundamental questions in mathematics," Remmen said. Postulates in fields as distinct as computation theory, abstract algebra and number theory hinge on the hypothesis holding true. For instance, proving it would provide an accurate account of the distribution of prime numbers.

A physical analog

The scattering amplitude that Remmen found describes two massless particles interacting by exchanging an infinite set of massive particles, one at a time. The function has a pole—a point where it cannot be expressed as a series—corresponding to the mass of each intermediate particle. Together, the infinite poles line up with the non-trivial zeros of the Riemann zeta function.

What Remmen constructed is the leading component of the interaction. There are infinitely more that each account for smaller and smaller aspects of the interaction, describing processes involving the exchange of multiple massive particles at once. These "loop-level amplitudes" would be the subject of future work.

The Riemann hypothesis posits that the zeta function's non-trivial zeros all have a real component of ½. Translating this into Remmen's model: All of the amplitude's poles are real numbers. This means that if someone can prove that his function describes a consistent quantum field theory—namely, one where masses are real numbers, not imaginary—then the Riemann hypothesis will be proven.

This formulation brings the Riemann hypothesis into yet another field of science and mathematics, one with powerful tools to offer mathematicians. "Not only is there this relation to the Riemann hypothesis, but there's a whole list of other attributes of the Riemann zeta function that correspond to something physical in the scattering amplitude," Remmen said. For instance, he has already discovered unintuitive mathematical identities related to the zeta function using methods from physics.

Remmen's work follows a tradition of researchers looking to physics to shed light on mathematical quandaries. For instance, physicist Gabriele Veneziano asked a similar question in 1968: whether the Euler beta function could be interpreted as a scattering amplitude. "Indeed it can," Remmen remarked, "and the amplitude that Veneziano constructed was one of the first string theory amplitudes."

Remmen hopes to leverage this amplitude to learn more about the zeta function. "The fact that there are all these analogs means that there's something going on here," he said.

And the approach sets up a path to possibly proving the centuries-old hypothesis. "The innovations necessary to prove that this amplitude does come from a legitimate quantum field theory would, automatically, give you the tools that you need to fully understand the zeta function," Remmen said. "And it would probably give you more as well."

More information: Grant N. Remmen, Amplitudes and the Riemann Zeta Function, *Physical Review Letters* (2021). DOI: 10.1103/PhysRevLett.127.241602

Journal information: *Physical Review Letters*

https://phys.org/news/2022-01-quantum-zeta-epiphany-physicist-approach.html