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समाचार पत्रों से चयित अंश Newspapers Clippings

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COVID-19: DRDO's Contribution**hindustantimes**

Sun, 06 Sept 2020

UV light disinfection, foot pedals for lifts: Delhi Metro to bank on tech push for safe ride*DMRC managing director Mangu Singh said the Delhi Metro was trying out "tech friendly" ways to ease the commute and ensure safety of passengers**By Soumya Pillai*

New Delhi: A lot has been happening behind the closed doors of the Delhi Metro for the past five-and-a-half months -- the Delhi Metro Rail Corporation (DMRC) was utilising the time to experiment with new technology that would make travel safer and operations more efficient once services resume on September 7 (Monday).

DMRC managing director Mangu Singh said the Delhi Metro was trying out "tech friendly" ways to ease the commute and ensure safety of passengers. The Metro has remained since March 22, three days before the nationwide lockdown, in view of the Covid-19 pandemic, was imposed on March 25.



In the first few days, the Metro will operate in two shifts of four hours each -- from 7am to 11am and 4pm to 8pm. It will start full-fledged operations, through the day and on all routes, from September 12.

From ultraviolet (UV) lights for disinfecting surfaces to using CCTV cameras to monitor work in construction sites and installing touch-free foot pedals in elevators, the Delhi Metro has chalked out a detailed plan for its reopening. The DMRC also was holding regular video meetings with transportation experts from across the globe to discuss best practices of running a mass transit system during a pandemic.

Singh said the Delhi Metro is in talks with the Defence Research and Development Organisation (DRDO) to develop the use of UV disinfection technology to sanitise surfaces that frequently come in contact with commuters, especially on the station premises and on trains, he said.

"Some of the measures that we have taken in view of the pandemic is that instead of using chemical disinfectants, we are in talks with the DRDO to develop a UV disinfection technology, which can be used to thoroughly sanitise common area touchpoints. Till the time the Covid-19 pandemic lasts, maintaining a hygienic system for passengers will be our ultimate aim," Singh averred.

Unlike chemical or water disinfection, UV disinfectants provide rapid and effective elimination of harmful bacteria and viruses that are present on any surface, making this method of cleaning the safest, especially for a mass transit system.

Christian Zollner, University of California, United States, who has co-authored a study that was released in April on the large-scale efficacy of the use of UV disinfection said the light can be used on protective equipment (PPE) gear, surfaces, floors, and within the HVAC (heating, ventilation and air-conditioning) systems.

“Many technological advances are needed for the UV LED to reach its potential for efficiency, reliability and cost-effectiveness,” said Zollner, whose work centres on advancing deep ultraviolet light LED technology for sanitisation and purification purposes.

Apart from that, the Metro is also strengthening its internal functioning through the use of technology. Singh said at all its Phase-4 construction sites, they will install CCTV cameras to monitor work progress. The corporation had already installed these cameras at some of the sites, before construction activities were allowed to be resumed on May 3.

“The idea is to reduce physical contact between persons as much as possible. The cameras will also improve monitoring and increase efficiency at construction sites,” the DMRC Chief said.

To sail through the Covid-19 pandemic, many government agencies are also resorting to technology to reduce physical contact between persons, while ensuring that the work does not suffer.

When the DMRC resumes its operations on Monday, commuters will be greeted by foot-operated systems inside elevators at several Metro stations. Senior officials said at present, such systems will be available on 50 elevators across 16 Metro stations and they will be installed across the network in the coming months.

In the initial phase, this system will be available in stations such as Kashmere Gate, New Delhi, Rajiv Chowk, Central Secretariat, Hauz Khas, Dwarka Sector-21, Janakpuri West, Rajouri Garden, IGI Airport and Nehru Enclave. “These foot-operated switches will reduce surface contact and, hence, a safer way to use lifts. When we restart our operations, we will only allow three people to board the lift at a time to ensure social distancing,” a DMRC spokesperson said.

<https://www.hindustantimes.com/delhi-news/uv-light-disinfection-foot-pedals-for-lifts-dmrc-will-use-tech-to-sanitise-metro-premises-make-travel-safer/story-4UwTBxFXQMgoke2knbyysK.html>



Sun, 06 Sept 2020

इसमें 120 बेड की है आईसीयू:डीआरडीओ अस्पताल में आज से कोरोना का इलाज

- **दवाखाना और जांच समेत सभी जरूरी सुविधाएं हैं भीतर ही उपलब्ध**

मुजफ्फरपुर: पताही हवाई अड्डा परिसर में 500 बेड के कोविड केयर अस्पताल में रविवार से कोरोना पॉजिटिव मरीजों का इलाज शुरू हो जाएगा। डीएम डॉ. चंद्रशेखर सिंह व एसएसपी जयंतकांत ने शनिवार को अस्पताल का निरीक्षण कर निर्माण की स्थिति पर संतोष जताया। डीएम ने कहा की कल से पॉजिटिव मरीज आने पर उन्हें यहां भेजा जाएगा। उन्होंने बताया कि अस्पताल के अंदर 500 बेड लगाए गए हैं। इसमें 120 बेड की आईसीयू है। सभी 500 बेड पर ऑक्सीजन की सुविधा उपलब्ध है। अस्पताल के भीतर ही दवाखाना व सभी प्रकार की कहा कि एक ही परिवार के अधिक



मरीज आने जांच समेत अन्य जरूरी सुविधाएं हैं। पर उन्हें अलग रहने की सुविधा उपलब्ध कराई जाएगी। इसके लिए 4 बेड के अलग-अलग केबिन बनाए गए हैं। कोविड अस्पताल की सुरक्षा के लिए भी विशेष तैयारी की गई है। अस्पताल के मुख्य गेट पर चौकी का निर्माण कराया गया है। वहां 24 घंटे पुलिस तथा सुरक्षा अधिकारियों की तैनाती रहेगी।

पताही हवाई अड्डा परिसर स्थित कोविड केयर अस्पताल का निरीक्षण करते डीएम।

पॉजिटिव मरीज ही इस अस्पताल में किए जाएंगे भर्ती

डीएम डॉ. चंद्रशेखर सिंह ने बताया कि इस अस्पताल में भर्ती होने के लिए कुछ मापदंड निर्धारित किए गए हैं। मरीज के पास कोरोना वायरस पॉजिटिव होने का प्रमाण पत्र तथा एक आधार कार्ड या पहचान पत्र होना आवश्यक है। इसके अलावा मेडिकल कॉलेज और अस्पतालों से भी पॉजिटिव मरीजों को वहां भेजा जाएगा।

<https://www.bhaskar.com/local/bihar/muzaffarpur/news/corona-treatment-in-drdo-hospital-from-today-127690125.html>

DRDO Technology News



Sat, 05 Sept 2020

From being a weapons importer, India must turn into an exporter: DRDO Chairman

New Delhi: To implement Prime Minister Narendra Modi's idea of an Atmanirbhar Bharat in the defence sector, India must turn from being one of the largest importers of weapons in the world to the largest exporter, said G Satheesh Reddy, chairman of the Defence Research and Development Organisation (DRDO) on Friday.

Speaking at the online India Foundation Dialogue 75, the DRDO chairman said that several steps had been taken in different sectors to inculcate 'Atmanirbhar Bharat' in defence.

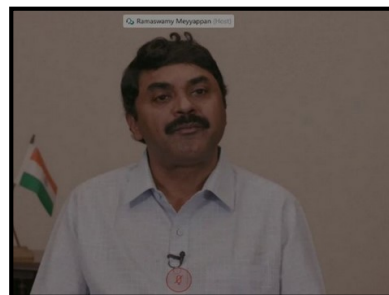
"When one talks about self-reliance in India's defence technology, it means that we should have the design, development and manufacturing capabilities for particular equipment or weapon systems that are required by our armed forces. Although in the last two decades, we have made significant strides in our technology, we are still one of the largest importers of defence equipment, arms and ammunition in the whole world," Reddy said in his address to the attendees of the video conference.

"What we are doing is not sufficient. Many things need to be developed and we must produce state-of-the-art systems, rather than importing from outside. Generally, we are followers of new technology. This has to change. We need to develop first of its kind, home-grown systems that others should want to buy from us," he added.

He further said that The Prime Minister had given very specific instructions to make all the required changes in order to indigenise weapons, adding that the DRDO had started several initiatives and schemes to draw more people into defence, including inculcation of relevant courses at the undergraduate and postgraduate level.

"From being one of the largest importers, we have to become the largest exporter. In order to achieve this, our country's academia must work on core research areas. We have so far established about eight centres of excellence for this kind of academic research work and with various scheme, we are trying to develop many core technologies which will greatly benefit our future generations. Thousands of crores have been invested in 200-300 projects and we hope to yield good results in the coming years," he said.

He also added, "With the Ministry of Education, we have also picked about 500 PhD students who will do their research at DRDO labs and take our defence problems as their research subject.



From being a weapons importer, India must turn into an exporter: DRDO Chairman

They will have guides from academia as well as scientists from the DRDO. In the next 4-5 years, we will have extensive research material on 500 defence-related problems and their potential solutions."

He further said that defence was going to be introduced as part of college curriculum by this year, and B.Tech and M.Tech students were already given similar elective subjects.

"We have brought in certified courses through our academic institute in Pune called DIAT (Defence Institute of Advanced Technology) wherein a lot of people study artificial intelligence and cyber tech. These courses have just started now and per year at least 1,000 people in each course will be trained and certified in these areas," Reddy said.

He also added that between 5,000-10,000 students were doing projects with the DRDO and many schemes were being brought to provide paid apprenticeships for the students.

With regard to the defence industry, Reddy said that the DRDO had risen to the occasion and declared that we would be working more on the critical and advanced state-of-the-arts systems only. Design and development would be incorporated from the industry.

"The Ministry of Defence has announced a list of 101 items that will not be imported from outside at all and will be made, designed, developed and produced in the country. A new update to the list is soon to come. The DRDO has also opened test facilities and over 1,700 patents to the industry so that more manufacturers and developers can have the support of the DRDO wherever it is required, Reddy added.

He further said that a new scheme called the technology development fund had been established for the indigenisation of imported systems. Firms and companies who think they have the capability to produce such items here will be fully funded by the DRDO.

"If our country is going to be prosperous, industries must not only supply to our own armed forces but export to other countries in large number," Reddy said. (ANI)

<https://www.aninews.in/news/national/general-news/from-being-a-weapons-importer-india-must-turn-into-an-exporter-drdo-chairman20200904172743/>

अमर उजाला

Sat, 05 Sept 2020

हथियार आयातक के बजाय भारत को निर्यातक में बदलना होगा: डीआरडीओ चेयरमैन

नई दिल्ली: डीआरडीओ के चेयरमैन जी. सतीश रेड्डी ने शुक्रवार को प्रधानमंत्री नरेंद्र मोदी के आत्मनिर्भर भारत के विचार को रक्षा क्षेत्र में लागू करने की अपील की। उन्होंने कहा, ऐसा करके भारत खुद को विश्व के सबसे बड़े हथियार आयातकों में से एक होने की बजाय सबसे बड़े निर्यातक में बदल सकता है।

रक्षा अनुसंधान व विकास संगठन (डीआरडीओ) के चेयरमैन ने ऑनलाइन इंडिया फाउंडेशन डायलॉग-75 में कहा कि रक्षा के क्षेत्र में आत्मनिर्भर भारत का विचार विकसित करने के लिए विभिन्न कदम उठाए गए हैं।

वीडियो कांफ्रेंसिंग के जरिये अधिवेशन को संबोधित कर रहे रेड्डी ने कहा, जब कोई भारत के रक्षा तकनीक में आत्मनिर्भरता की बात करता है तो उसका मतलब होता है कि हमारे पास उस खास हथियार या वैपन सिस्टम का डिजाइन, विकास और उत्पादन क्षमता होनी चाहिए, जिसकी सेना को जरूरत है।



डीआरडीओ के अध्यक्ष जी सतीश रेड्डी - फोटो: ANI

उन्होंने कहा, हालांकि पिछले दो दशक में हमने तकनीक के मामले में अहम छलांग लगाई है, लेकिन अब भी हम रक्षा उपकरणों, हथियारों और गोला-बारूद के पूरे विश्व में सबसे बड़े आयातकों में शामिल हैं।

रेड्डी ने कहा, हम क्या कर रहे हैं, ये काफी नहीं है। बहुत सारी चीजों के विकास की जरूरत है और हमें स्टेट ऑफ द आर्ट सिस्टम बाहर से मंगाने के बजाय अपने यहां ही विकसित करने होंगे। अमूमन हम नई तकनीक के फॉलोअर हैं। यह स्थिति बदलनी चाहिए। हमें पहले इस तरह की चीजें, घरेलू निर्मित सिस्टम विकसित करने होंगे ताकि दूसरे हमसे इन सबको खरीदना चाहे।

डीआरडीओ चालू करेगा कई पाठ्यक्रम, जोड़ेगा 500 पीएचडी छात्र अपने साथ

रेड्डी ने कहा कि प्रधानमंत्री ने स्वदेशी हथियारों के विकास को लेकर सभी तरह के आवश्यक बदलाव करने का निर्देश दिया है। डीआरडीओ रक्षा क्षेत्र में ज्यादा लोगों को रोजगार देने के लिए विभिन्न प्रकार की पहल व योजनाएं लाएगा। इसके तहत स्नातक व परास्नातक स्तर पर संबंधित पाठ्यक्रम चालू करने की भी योजना है।

उन्होंने कहा, सबसे बड़े आयातक से सबसे बड़ा निर्यातक बनने के लिए हमारे देश के शिक्षाविदों को कोर रिसर्च के क्षेत्र में काम करना होगा। उन्होंने कहा, हमारे पास रक्षा क्षेत्र के तकनीकी शोध व विभिन्न योजनाओं का लाभ उठाने के लिए 8 सेंटर ऑफ एक्सीलेंस मौजूद हैं।

उन्होंने कहा, अभी तक 200 से 300 प्रोजेक्टों में हजारों करोड़ रुपये का निवेश किया जा चुका है और हमें इसका लाभ आने वाले सालों में देखने को मिलेगा। उन्होंने यह भी बताया कि मानव संसाधन मंत्रालय के साथ मिलकर हम 500 पीएचडी छात्रों का चयन करेंगे, जो डीआरडीओ की लैब में काम करेंगे और हमारी रक्षा समस्याओं को दूर करने के लिए शोध करेंगे।

<https://www.amarujala.com/india-news/drdo-chairman-says-that-india-needs-to-be-converted-into-exporter-instead-of-arms-importer>

ManufacturingToday

Sat, 05 Sept 2020

L&T Defence awarded a significant contract by Ministry of Defence

It has executed similar orders before

The defence arm of Larsen & Toubro has been awarded a significant contract by the Indian Ministry of Defence (MoD) for the supply of four regiments of Pinaka weapon systems.

The contract involves supply of Pinaka launchers, battery command posts and associated engineering support package (ESP) for four regiments. The Pinaka launch system has been indigenously developed by L&T as part of Pinaka development program of Defence Research & Development Organization (DRDO, ARDE) and functions as a high tech, all weather, long range, area fire artillery weapon system.



JD Patil, Member of the Board and sr. executive VP (defence & smart technologies), Larsen & Toubro, said, “As a proponent of Aatmanirbhar Bharat philosophy from inception and a practicing Make-in-India company, we have been associated with the Pinaka program since its development in the nineties, and induction in Armed Forces and serial production since one and a half decade. We continue to live up to our ethos to build strong India and commitment to the nation by producing

high-class weapon systems within scheduled time frames and will keep up to that for these orders as well. We are glad that the MoD and the Armed Forces have trusted us to produce front line weapon systems and keeping to their tag line 'Wining Indian Wars with Indian Solutions' and furthering the Aatmanirbhar Bharat initiative."

With these orders, L&T takes pride in attaining cumulative six out of ten regiments of Pinaka systems with the Indian Army. L&T Defence is also engaged with DRDO for future developments on this artillery system.

L&T has already executed similar orders from Ministry of Defence and supplied two regiments of Pinaka systems earlier. With these orders, L&T takes pride in attaining cumulative six out of ten regiments of Pinaka systems with the Indian Army. L&T Defence is also engaged with DRDO for future developments on this artillery system.

L&T has built in-house capabilities and capacities over three and a half decades to provide indigenous defence solutions (land, sea and under-water application) by building competencies in conceptualisation, design, analysis, engineering, embedded software, manufacturing, assembly, integration, testing and through life support to the Armed Forces over the life cycle of the equipment, systems and platforms towards attaining self-reliance in this critical sector and contribute to nation building.

<https://www.manufacturingtodayindia.com/products-suppliers/8278-lt-defence-awarded-a-significant-contract-by-ministry-of-defence>



Fri, 04 Sept 2020

लद्दाख: चीन के सामने डटे जवानों को सर्दी में न हो दिक्कत, DRDO मिशन पर जुटा

भारत और चीन के बीच पिछले काफी वक्त से सीमा पर तनाव बना हुआ है। हाल ही में चीन ने पैंगोंग झील के दक्षिणी किनारे के कुछ भारतीय क्षेत्रों पर कब्जा करने का असफल प्रयास किया है।

स्टोरी हाइलाइट्स

- सीमा पर भारत और चीन के बीच तनाव जारी
- ठंड से निपटने के लिए प्रौद्योगिकियां विकसित
- चीन ने किया था भारतीय क्षेत्रों पर कब्जा करने का प्रयास

नई दिल्ली: देश के उत्तरी पहाड़ों में अत्यधिक ठंड के मौसम से निपटने के लिए कई प्रौद्योगिकियां विकसित की गई हैं। डीआरडीओ चेयरमैन जी सतीश रेड्डी ने कहा कि सशस्त्र बल इन सभी प्रौद्योगिकियां का इस्तेमाल भी कर रहे हैं।

न्यूज एजेंसी पीटीआई के मुताबिक डीआरडीओ चेयरमैन जी सतीश रेड्डी ने इंडिया फाउंडेशन के जरिए आयोजित एक वेबिनार के दौरान कहा कि सशस्त्र बलों के लिए हिमस्खलन की भविष्यवाणी करने तक तकनीकें विकसित की गई हैं। दरअसल, लद्दाख क्षेत्र में अत्यधिक ठंड का मौसम देखा जाता है और सर्दियों के दौरान तापमान हिमांक बिंदु से काफी नीचे चला जाता है।



भारतीय सेना का जवान (फाइल फोटो-पीटीआई)

क्या सशस्त्र बल सर्दियों से निपटने के लिए तैयार हैं क्योंकि सीमा पर तनाव के बीच लद्दाख में अधिक सैनिकों को ले जाया जा रहा है। इस सवाल पर रेड्डी ने कहा, 'उत्तरी पर्वतीय क्षेत्र में कई प्रौद्योगिकियां विकसित की गई हैं, चाहे वह कपड़े की आवश्यकता हो, जूते की आवश्यकता हो या हीटिंग तत्वों की आवश्यकता हो, भोजन को गर्म करने से संबंधित चीजें हों।'

रक्षा अनुसंधान और विकास संगठन (डीआरडीओ) के चेयरमैन ने कहा, 'हिमस्खलन और हिमपात की भविष्यवाणी सहित कई चीजें विकसित की गई हैं। देश में इन चीजों के लिए कई चीजें विकसित की गई हैं और इनका इस्तेमाल आज सशस्त्र बलों द्वारा किया जा रहा है।'

भारत-चीन के बीच तनाव

वहीं भारत और चीन के बीच पिछले काफी वक्त से सीमा पर तनाव बना हुआ है। हाल ही में चीन ने पैंगोंग झील के दक्षिणी किनारे के कुछ भारतीय क्षेत्रों पर कब्जा करने का असफल प्रयास किया है। वहीं भारत ने अतिरिक्त बल और हथियारों को संवेदनशील क्षेत्र में पहुंचा दिया है।

इससे पहले इसी साल जून के महीने में भारत और चीन की सेनाओं के बीच गालवान घाटी में झड़प देखने को मिली थी। इस हिंसक झड़प में कर्नल सहित भारतीय सेना के 20 जवान शहीद हो गए थे। हालांकि चीन ने अभी तक कोई हताहत का आंकड़ा जारी नहीं किया है। झड़प के बाद से चीन के साथ उत्तरी सीमा पर तनाव बढ़ रहा है।

<https://www.aajtak.in/india/news/story/ladakh-technologies-developed-cold-weather-northern-mountains-drdo-chief-g-satheesh-reddy-china-1123974-2020-09-04>

THE ECONOMIC TIMES

Fri, 04 Sept 2020

Tata Power's Strategic Engineering Division bags Rs 490 cr order for 2 Pinaka regiments

Synopsis

Pinaka Multi Barrel Launcher Rocket System is an all-weather indirect fire artillery rocket system. According to the statement, the contract is awarded for two regiments of Pinaka Multiple Rocket Launcher System.

New Delhi: Tata Power on Thursday said it has bagged an order worth Rs 490 crore from the Ministry of Defence to supply two Pinaka regiments. Pinaka regiment is a system of rocket launchers.

"We are pleased to inform you that the Strategic Engineering Division (SED) of the company has signed the Pinaka 3 contract with the Ministry of Defence, Government of India," a BSE statement said.

Pinaka Multi Barrel Launcher Rocket System is an all-weather indirect fire artillery rocket system.

<https://economictimes.indiatimes.com/news/defence/tata-powers-strategic-engineering-division-bags-rs-490-cr-order-for-2-pinaka-regiments/articleshow/77909244.cms?from=mdr>



Multi rocket launcher system 'Pinaka' on display during 64th Republic Day celebrations in New Delhi



Sun, 06 Sept 2020

Why does the IAF deploy HAL Tejas near the borders, even when it is not yet ready?

While there is a massive military buildup on the India-China de facto border, the Indian Air Force (IAF) has strengthened its western border and deployed its indigenous Light Combat Aircraft (LCA) Tejas jets.

“The LCA Tejas was deployed by the Indian Air Force on the western front close to the Pakistan border to take care of any possible action by the adversary there,” said a government source and quoted by ANI.

According to the report, the first squadron of the home-developed fighter – 45 Squadron (Flying Daggers), which was based out of Sullur under the Southern Air Command was deployed for an operational role in the area.



Why IAF Deploy HAL Tejas IOC near the borders?

01. Advanced Combat Training

In many Air Forces, a newly formed squadron sharp its skills and adapt with fighter aircraft in peace time, away from conflict or possible conflict zones. Once the squadron completes the training, it is deployed on a Forward Operating Base (FOB) to gain some real combat experience. In case of Tejas, the No.45 “Flying Daggers” squadron is operational since 2016. But it was based in Sullur, Tamil Nadu, in South India. Therefore, miles away from North and Western Indian regions, where combat aircrafts armed with missiles fly everyday. A new squadron can’t practice in such regions, because it may be an easy target for hostiles.

Once the pilots and personnel of the squadron master the aircraft, there are low chances of unexpected events. For example, a mid-air failure occurs and if the pilot has high flying hours in the record, he is surely trained to handle such situations. With 4 years of experience, it looks like IAF is impressed from No.45 squadron and ready to deploy the indigenous aircraft for important roles.

Note that we are talking about an interceptor aircraft, not an attack aircraft like Jaguar. It is essential for interceptors to be placed at FOBs, so that in case of scramble, aircraft can reach the site of action in less time possible.

We can also take an example of Su-57 5th generation fighter aircrafts of Russia. After completing major flight and weapon trials, it was deployed in Syria for an advanced combat training. To test its performance in combat zone. Well, it is unclear whether the aircraft performed any strikes or not.

02. India is preparing for war

In a situation where war is inevitable, a military doesn’t have any other option than pushing every available unit in combat. Since 70s, India is facing two major powers, one is western neighbour and arch rival Pakistan, and other is China. So, military planning needs to be done by keeping in mind that India is facing two fronts. In current scenario, the two best friends in the region, China and Pakistan, treat India as a mutual enemy. The major disturbance in relations indicates that both Pakistan and China are quite ready to take action against India whenever possible. And military action is also a possibility.

It is a well known fact that IAF is facing aircraft shortage and it needs more aircrafts to handle air superiority in a two front war. With PLA stretching its muscle, Pakistan is also preparing to

assist its ally whenever it demands. So IAF needs to be prepared for both fronts. Therefore, a squadron of Interceptor Tejas can provide a little help to IAF against Pakistan. It is better than MiG-21 atleast.

Is Tejas ready?

For me, it is the main point of interest in the question. It is 100% true that the “Flying Daggers” doesn’t operate a complete Tejas. That means, it is still in Initial Operational Clearance (IOC) variant, and hence, has a lot of shortcomings. Three critical one are as follows:-

01. Lack of Guns

The majority of IOC aircrafts are flying without guns. Guns are only valuable in close combat situations. But these days, fighter jet guns have negligible value because of increasing dependence on AAMs. However, guns can be used as a last option. For example, if aircraft runs out of missile, and there is a bandit still flying in front of it, pilot can switch to guns and try it until he goes Winchester (a term used to define that the aircraft is out of weapons). Due to lack of guns in Tejas, it may not be able to do something if it runs out of missiles. I would like to mention an important incident occurred in 1965. An Indian Air Force MiG-21 failed to shoot a Pakistan Air Force Sabre only because it ran out of missiles, and unfortunately, there was no gun in that particular MiG-21 variant, that was F-13. The Indian pilot was really frustrated after the incident. For a detailed account, you can click ‘For just a bloody cannon’: How a MiG-21 nearly took down a PAF Sabre on debut for IAF in 1965

(I said “majority of aircrafts are flying without guns” because few units, 1 or 2, are integrated with guns, and used during trials)

02. Lack of OBOGS

This is really critical because it reduces flying hours of Tejas once it takes off. As the name suggests, OBOGS provides regular oxygen supply to the pilot. Without OBOGS, pilot has to rely on oxygen cylinders that provides limited amount of oxygen. If I remember correctly, IOC Tejas can fly 1.5-2.0 hours (corrections are welcome in this regard) max once it takes off. However, Tejas is an interceptor, and unlike Strike/Attack aircrafts, hours per flight doesn’t affect its combat capability because it is going to remain in Indian airspace and protect it from intruders.

03. Lack of EW equipment

Unfortunately, it is completely incapable of carrying a Self Protection Jammer (SPJ). Integrated EW suite is also not a possibility because of small size of airframe and hence small space to accommodate equipments. A jammer is only planned for variant Mk-1A and beyond. Without any SPJ, active radar missile like AIM-120 or PL-12 are tough challenges for aircraft. So it needs to rely on chaff, and maneuverability to evade any incoming missile.

Now please note that except jammer, everything is integrated in FOC Tejas. Unfortunately, only 1 FOC Tejas is inducted while 1 is in final stage of testing. Therefore, only 2 and new aircrafts may serve more as a liability than the asset in such conditions.

But IOC Tejas is not completely an incapable aircraft.

It features Israeli Elta-2032 pulse doppler radar that comfortably supports Derby BVRAAMs. The Derby BVRAAM with 50-60km. Please note that it is Derby variant. Alongside Derby, it has R-73E IR CCM, and when used in conjunction of DASH-IV, it is highly lethal during dogfights. Small size and hence small Radar Cross Section (RCS) also favours the Tejas in long range or beyond visual range combat.

So overall, there are shortcomings in Tejas IOC but it fulfills the requirements of an interceptor. A jet equipped with Israeli BVRAAM and experienced pilot is no joke. There must be a wise reason why IAF placed it for combat role in a disturbed region.

But I am pretty sure that if someday JF-17 comes close to the border, a Tejas pilot will be first to tell him on the comms: “Return back to your airspace or you will be shot down!”

<https://www.defenceaviationpost.com/2020/09/why-does-the-iaf-deploy-hal-tejas-near-the-borders-even-when-it-is-not-yet-ready/>

Business Standard

Sun, 06 Sept 2020

Indian, Chinese defence ministers meet, no breakthrough on border face-off

*Rajnath Singh says India determined to protect its sovereignty;
his Chinese counterpart accuses New Delhi of 'provocations'*

By Ajai Shukla

Defence Minister Rajnath Singh met his Chinese counterpart, Defence Minister and State Councillor General Wei Fenghe, on Friday and discussed the on-going border confrontation in Ladakh, but without any breakthrough in resolving the four-month-long confrontation.

The Ministry of Defence (MoD) says the meeting was requested by the Chinese delegation on the side-lines of a meeting of Shanghai Cooperation Organisation defence ministers in Moscow.

In what the MoD characterizes as “frank and in-depth discussions”, both sides stuck to repeating their stated claims and positions on the border face-off.

“The Defence Minister categorically conveyed India’s position on the developments along the Line of Actual Control (LAC) including in the Galwan valley... He emphasised that the actions of the Chinese troops, including amassing of large number of troops, their aggressive behaviour and attempts to unilaterally alter the status quo were in violation of the bilateral agreements and not in keeping with the understandings reached between the Special Representatives of two sides,” stated the MoD on Saturday.

Rajnath Singh “stated clearly that while the Indian troops had always taken a very responsible approach towards border management, but at the same time there should also be no doubt about our determination to protect India’s sovereignty and territorial integrity,” said the MoD.

According to a statement on the Chinese Defence Ministry website Wei told Rajnath: “India should strengthen management and control of its frontline troops and not make provocations or deliberately hype and spread negative information.”

The statement said: “Wei also reaffirmed to [Rajnath] Singh China's commitment and ability to safeguard national sovereignty and territorial integrity in the meeting.”

According to a Xinhua report, Wei told Rajnath: “The cause and fact of the current tension on the border between China and India are very clear, and the responsibility lies entirely with India.”

According to India’s MoD Wei said: “Both sides should scrupulously implement the consensus reached between Prime Minister [Narendra] Modi and President Xi Jinping and continue to solve the issues through dialogue and consultation, strictly follow the various bilateral agreements,



Rajnath Singh meets Wei Fenghe in Moscow

strengthen the regulation of frontline troops and not undertake any provocative actions that might escalate the situation.”

Rajnath agreed that “Both sides should take guidance from the consensus of the leaders that maintenance of peace and tranquillity in the India-China border areas was essential for the further development of our bilateral relations and that two sides should not allow differences to become disputes,” said the MoD.

Rajnath said the two sides should work together “for complete disengagement at the earliest from all friction areas, including Pangong Lake, as well as de-escalation in border areas in accordance with the bilateral agreements and protocols on maintenance of peace and tranquillity in border areas.”

The Indian defence minister was referring to a web of Sino-Indian agreements designed to keep peace on the border. These include the 1993 Agreement on the Maintenance of Peace and Tranquillity along the LAC; the 1996 Agreement on Confidence Building Measures in the Military Field; the 2005 Modalities for the Implementation of Confidence Building Measures in the Military Field; the 2012 Working Mechanism for Consultation and Coordination on India–China Border Affairs, and the 2013 Border Defence Cooperation Agreement.

According to Xinhua, Wei conveyed to Rajnath that he “hoped that the Indian side will strictly abide by the series of agreements reached between the two sides, effectively strengthen the control of the front-line forces, refrain from provoking the current line of actual control, refrain from any actions that may cause the situation to heat up, and refrain from deliberately hyping and disseminating negative information.”

According to the MoD, Rajnath responded to Wei that both sides should “strictly respect and observe the LAC and should not make attempts to unilaterally change status quo. He further said that the current situation should be handled responsibly and that neither side should take any further action that could either complicate the situation or escalate matters in the border areas.”

More than 35,000 soldiers from the Indian and Chinese militaries are ranged against each other in Eastern Ladakh, across the Depsang, Galwan, Hot Spring and Pangong Lake sectors. India has acknowledged the deaths of 20 soldiers, while China is also believed to have suffered casualties, but has not acknowledged any deaths.

Dialogue has taken place at the levels of Special Representatives, foreign ministers, diplomats and senior military commanders, but without a breakthrough so far.

https://www.business-standard.com/article/current-affairs/indian-chinese-defence-ministers-meet-no-breakthrough-on-border-face-off-120090501004_1.html

India's security would be maintained in 'extended neighbourhood' as well: Gen Bipin Rawat

The Chief of Defence Staff said that India values its emerging relationship with the US and cherishes its traditional relationship with Russia, adding the country shares a mature and robust defence and security framework with both these powers

New Delhi: In the emerging defence paradigm, India's security would be maintained not only along the northern and western borders but in the strategic space of the "extended neighbourhood" as well, Chief of Defence Staff Gen Bipin Rawat said on Saturday.

He also said that India values its emerging relationship with the US and cherishes its traditional relationship with Russia, adding the country shares a mature and robust defence and security framework with both these powers.

Addressing a symposium on defence exports, Gen Rawat said the armed forces will have to work through the budgetary constraints by finding the best solutions through new acquisitions and optimisation considering the macro-economic parameters.

Referring to proposed reforms in the military structure, Gen Rawat said the Chief of Defence Staff and the theatre commanders would "conjointly" provide "unity of command" while the service headquarters and the "component commanders" could provide "unity of effort".

Under a big-ticket reform initiative, India is working on setting up of a number of theatre commands, integrating some of the commands of the three services, to deal with future security challenges facing the country.

Each of the theatre commands will have units of the Army, the Navy and the Air Force and all of them will work as a single entity looking after security challenges in a specified geographical territory under an operational commander.

The government had appointed Gen Rawat as India's first Chief of Defence Staff on December 31 last year to bring synergy in the functioning of the three services.

Talking about the regional security paradigm, he touched upon key aspects of India's security doctrine. In this context, he mentioned International Border (IB) and Line of Control (LoC) with Pakistan as about Line of Actual Control (LAC) with China.

"In the emerging security paradigm, India's security would be maintained not, as hitherto, on the IB, LC or the LAC alone, but in the strategic space of the 'extended neighbourhood' and the 'strategic frontier'," he said without elaborating further.

India has been ramping up defence and security ties with a number of countries in its extended neighbourhood like Indonesia, Singapore and several countries in the Gulf region in the last few years.

Delving into the evolving security matrix in the region, the Chief of Defence Staff pitched for seamless integration of surveillance and communication resources of the three services, saying such a convergence is essential for evolving a framework for having a composite real-time air situation "picture".

Gen Rawat said robust interaction between the CDS, COSC (Chairman of the Chiefs of Staff Committee) and political executive (Cabinet Committee on Security) must ensure single-point military advice, strategic direction and resource optimisation.



Gen Rawat said that the armed forces will have to work through the budgetary constraints by finding the best solutions through new acquisitions and optimisation considering the macro-economic parameters.(PTI photo)

On the modernisation of the Indian armed forces, he said it has been in line with the changing global security environment and with a focus on the utmost optimisation of resources.

“We are witnessing seismic changes in geopolitics shaped by a ‘nation first’ approach and geoeconomics,” he said, adding the armed forces should be structured in a manner that they provide the operational flexibility to pursue “wider strategic objectives”.

The country’s first CDS also said the pursuit of disruptive technologies like artificial intelligence, robotics, big data analytics, drone technology, militarisation of space, quantum communications, along with manipulation of social media is leading to new threats, and further complicating the security environment.

He said the asymmetric advantages created by unmanned aerial vehicles (UAVs) are being seen as opportunities by non-state actors, adding future defence systems must be qualitatively and quantitatively capable of dealing with the new threats.

“In this era of multidimensional technology, we must focus on constant innovations and modern technological solutions, to keep ourselves ahead of the adversaries,” he said.

Gen Rawat said the creation of the Department of Military Affairs headed by the CDS, having a central staffing scheme along with amendments to the business rules, in effect, admits the military into the central edifice of the government of India.

“This restructuring of the Ministry of Defence gives us the opportunity to embrace forward-looking strategies to seize and exploit the moment and set in motion a dynamic transformation process,” he said.

<https://www.hindustantimes.com/india-news/india-s-security-would-be-maintained-in-extended-neighbourhood-as-well-gen-bipin-rawat/story-EqBHzKsoOKoCiuT8x2mCII.html>

THE TIMES OF INDIA

Sat, 05 Sept 2020

Medak armour set to add more muscle to Indian Army

By Ch. Sushil Rao

Hyderabad: Amid the charged atmosphere along the border, the Indian Army is looking forward to the infantry combat vehicles (ICVs) manufactured at the Ordnance Factory Medak (OFM) in Telangana.

The OFM will start supplying 156 upgraded ICVs to the Army from next financial year with work at the factory going on at a frenetic pace. The ICVs are different from main battle tanks (MBTs), in role and onboard weapons. These vehicles can be deployed as light tanks, command or recon vehicles, weapons carrier or an ambulance.

An indent for Rs1,094 crore worth Boyevaya Mashina Pekhoty (BMP) 2/2K ICVs was placed in June.

While the Army is in possession of Sarath ICV, which is a BMP-II vehicle, the OFM has come up with other variants. “There will be an advanced navigation system, radio sets and digital cable harness,” said Alok Prasad, OFM general manager.

The OFM has also taken up another project for night-enablement for BMPs. Trials are going on. “If missiles have to be fired in the night, the ICV has to be made night-active. This is being done with the help of Bharat Electronics Limited,” sources said.





ICVs TO ROLL OUT FROM MEDAK

With its advanced navigation and communication features, ICVs from OFM will be a much-needed addition to the Indian Army, reports **Sushil Rao**

Pics: Ramoorthy P

FEATURES OF BMP 2/2K ICV

- 285 horsepower engine
- Speech can reach up to 70 km/hr
- The amphibious ICV can travel in water at 7 km/hr
- Designed to overcome slope of 35 degrees
- Can cross obstacles of 0.7 metre
- Will have lethal fire power capability

Weight of the vehicle
14 tonnes



“We are absolutely charged up and geared up to meet any additional requirement for the Indian Army due to enhanced threat at our borders – **Alok Prasad** | OFM GENERAL MANAGER **”**

WHAT OFM HAS PRODUCED SO FAR

- Infantry Combat Vehicles known under the Indian name Sarath with ToT from erstwhile USSR
- Variants of the BMP II have been conceptualised and produced
- Mine proof vehicle was indigenously produced
- Bullet proofing of vehicles in India was done for the first time at OFM



The 156 ICVs being produced at Ordnance Factory Medak

The integrated fire control system will give Sarath power to fire guns and missiles accurately even at night. “This upgradation is being made available for earlier produced ICVs also,” Prasad said.

The ICVs from OFM are 98% indigenous, he said.

<https://timesofindia.indiatimes.com/city/hyderabad/medak-armour-set-to-add-more-muscle-to-indian-army/articleshow/77943321.cms>

Sun, 06 Sept 2020

HAL focusing on R&D to increase indigenisation: CMD Madhavan

Hindustan Aeronautics Limited (HAL) is aiming to boost its research and development efforts to increase indigenisation. Chairman-Managing Director R Madhavan, in the company's annual report 2019-20, said HAL has incurred a total expenditure of Rs 1,232 crore towards the progress of R&D for the year 2019-20, which is six per cent of the turnover, and that a further amount of Rs 254 crore has been transferred to R&D reserve.

The disruption in the supply chain, due to the pandemic, is likely to impact production at HAL, but the public sector undertaking is confident of overcoming the challenge. "Since the pandemic broke out, suppliers are stressed due to cash flow and liquidity problems.

Possible production hold-ups in suppliers' facilities and restrictions on the movement of goods can lead to disruption of established supply chains, and hence, there could likely be a disruption of production in the short term," Madhavan said, adding that the company is confident of tiding over such aberrations.

He said defence projects, policies and funding from the Centre play a crucial role in the growth of aerospace and defence industries. "Downsizing of the defence budget and risk of economic recession could lead to difficulty in the availability of working capital," he added.

Centre's policies, including Atmanirbhar Bharat Abhiyan that gives significant impetus to self-reliance and local production, is expected to favourably impact the operations of the company, Madhavan said.

<https://www.defencenews.in/article/HAL-focusing-on-RandD-to-increase-indigenisation-CMD-Madhavan-942235>



Sat, 05 Sept 2020

China rapidly expanding its space warfare capabilities: Pentagon report

Despite China's overt stance against the militarization of space, a new report from the U.S. Department of Defense highlights that the People's Republic of China (PRC) continues the development and acquisition of offensive space technologies designed to restrict/destroy the enemy's space-based assets, i.e. satellites

According to reports, the PLA continues to acquire and develop technologies including kinetic-kill missiles, ground-based lasers, and orbiting space robots, as well as expanding surveillance capabilities that can monitor objects in space within their field of view and enable actions.

"The CCP desires the PLA to become a practical instrument of its statecraft with an active role in advancing the PRC's foreign policy, particularly with respect to the PRC's increasingly global interests and its aims to revise aspects of the international order," the report mentions.

The PLA's Strategic Support Force (SSF), is a theater command-level organization established to centralize the PLA's strategic space, cyber, electronic, and psychological warfare missions and capabilities.

The SSF Network Systems Department is responsible for cyberwarfare, technical reconnaissance, electronic warfare, and psychological warfare. Its current major target is the United States.

Under this organization, the PLA employs tactics of strategic support to its armed forces with the ways mentioned, and the recent focus of the SSF has been space, describing it as a "critical domain in the international strategic competition".

"The PRC's space enterprise continues to mature rapidly. Beijing has devoted significant resources to growing all aspects of its space program, from military space applications to civil applications such as profit-generating launches, scientific endeavors, and space exploration", it says.

After an analysis of the report, one can find that China's investment in technological innovations especially in Aerospace, including UAVs and stealth aircraft and satellites makes it the single most effective power in this domain in Asia. India lags far behind both economically and militarily, even when ISRO and DRDO are trying to develop these strategic assets.

China currently operates the world's largest drone fleet, including the most variety of UAVs from smaller swarm drones for SEAD operations to high-tech stealth surveillance UAVs. Not to forget about the largest fleet of combat drones too.

India displayed its Anti-Satellite capabilities last year, while PRC had achieved this feat back in 2007. By the end of 2018, China had a reconnaissance and remote-sensing fleet consisting of more than 120 satellites designed to collect data for civil, commercial, or military applications, and half of these satellites are owned by PLA. Comparatively, India has about 10% of this remote sensing constellation, reports TOI.

"Building military space capabilities doesn't directly come under the Department of Defense. That said, all strategic needs will be met, our focus has largely been on the civilian side and even there we have certain gap areas. Whatever required for the strategic needs will also be done by ISRO, and we will also see private contributions in this area as we've seen with DRDO missiles and so on," said ISRO chairman K Sivan to the Times of India.

The Pentagon report also finds that China now operates the world's largest Navy, with an overall battle force of approximately 350 ships and submarines including over 130 major surface combatants. In comparison, the U.S. Navy's battle force is approximately 293 ships as of early 2020.

<https://eurasianimes.com/china-rapidly-expanding-its-space-warfare-capabilities-pentagon-report/>

Indian troops are using ‘new rules of engagement’ along LAC to counter Chinese aggression

Specialised elements of Indian Army carried out 'tactical signalling' to dissuade China's People's Liberation Army from coming closer

By Snehesh Alex Philip

New Delhi: New rules of engagement are in play along the Line of Actual Control (LAC) and could have helped prevent tensions from spiralling over the weekend when Indian troops won the “race for the passes” on the southern bank of Pangong Tso, ThePrint has learnt.

Sources in the defence and security establishment said when the movement of Chinese soldiers was witnessed at around Saturday midnight along with their armoured personnel carriers, specialised elements of the Indian Army carried out “tactical signalling” to dissuade the People’s Liberation Army (PLA) from coming closer.

The signalling worked and the Chinese Army did not move forward even though they had brought in additional troops after warnings were first issued, the sources said.

“The Chinese realised that India meant serious business and would defend its territory strongly,” a source said. India has changed the rules of engagement at the LAC after the deadly clash on 15 June in Galwan, which led to the death of 20 Indian soldiers and undeclared casualties on the Chinese side too.

This came after China used crude weapons like clubs and sticks with nails on them to attack the Indian soldiers who had gone to talk and check on China’s promise to dismantle an observation post set up inside the Indian side near Patrol Point 14.

The new rules

According to the new rules, commanders on the ground will have the full freedom to put in use any instrument under their command for tactical operations as deemed fit.

Previously, not all soldiers on the ground carried loaded firearms while on patrol, sources had said earlier. The practice of not opening fire draws its inspiration from the 1996 agreement between India and China, which says “neither side shall open fire or conduct blast operations within 2 km of the Line of Actual Control”.

Asked about specific developments that took place over the weekend, an Army source said, “We dissuaded them from coming closer to our precautionary deployment positions. The details of tactical operations cannot be shared with the media”.

As reported by ThePrint, specialised elements of the Army have dominated the southern bank of the Pangong Tso in eastern Ladakh and are now in control of Requin Pass and Spanggur Gap in the hills under the Chushul sector.

In a change of tactics, the Army has redeployed troops over the last few days along the entire LAC, especially in Eastern Ladakh.

Sources have underlined that these redeployment is defensive in nature and to pre-empt more aggressive behaviour by the Chinese and to prevent land grabbing attempts.

<https://theprint.in/defence/indian-troops-are-using-new-rules-of-engagement-along-lac-to-counter-chinese-aggression/495543/>

INDRA NAVY 2020: Indian, Russian navies begin naval exercise; guided missile destroyers, frigates in action

The Indian Navy has deployed guided missile destroyer Ranvijay, indigenous frigate Sahyadri and fleet tanker Shakti, along with their integral helicopters for the exercise

New Delhi: The 11th edition of exercise 'INDRA NAVY', a biennial bilateral maritime exercise between the Indian Navy and Russian Navy started in the Bay of Bengal on Friday. Due to restrictions imposed by the COVID-19 pandemic, the two-day naval exercise would be undertaken in a 'non-contact, at sea only' format.

The Indian Navy has deployed guided missile destroyer Ranvijay, indigenous frigate Sahyadri and fleet tanker Shakti, along with their integral helicopters for the exercise. However, Sahyadri is presently redeployed to provide assistance to MT New Diamond, which has caught fire off the coast of Sri Lanka.

The Russian Federation Navy is being represented by destroyer Admiral Vinogradov, destroyer Admiral Tributs and fleet tanker Boris Butoma of the Pacific Fleet, based at Vladivostok.



INDRA NAVY 2020 exercise | Photo Credit: ANI

Exercise INDRA NAVY was started in 2003 with a aim to 'further consolidate inter-operability built up by the two navies over the years and also to enhance understanding and procedures for multi-faceted maritime operations'.

The exercise is aimed at enhancing interoperability, improving understanding and imbibing best practices between the two navies, and would involve surface and anti-aircraft drills, firing exercises, helicopter operations, seamanship evolutions etc. The last edition of the exercise was conducted off Visakhapatnam in December 2018.

"Exercise INDRA NAVY 2020 will help to further boost mutual confidence and cooperation between the two Navies and would reinforce the long-standing bond of friendship between the two countries," the Indian Navy said.

Meanwhile, Defence Minister Rajnath Singh is in Russia to attend the Shanghai Cooperation Organisation (SCO) meeting in Moscow. Singh on Thursday met his Russian counterpart General Sergey Shoigu.

"Excellent meeting with the Russian Defence Minister General Sergey Shoigu in Moscow today. We talked about a wide range of issues, particularly how to deepen defence and strategic cooperation between both the countries," he said in a tweet.

Reports said that India and Russia have finalised a major deal for manufacturing AK-47 203 rifles in India. The AK-47 will replace the Indian Small Arms System (INSAS) 5.56x45 mm assault rifle.

<https://www.timesnownews.com/india/article/indra-navy-2020-indian-russian-navies-begin-naval-exercise-guided-missile-destroyers-frigates-in-action/647623>

सीमा पर चीन से तनाव के बीच भारत और रूस की नौसेनाओं ने बंगाल की खाड़ी में शुरू किया युद्धाभ्यास

पूर्वी लद्दाख में चीन से जारी सैन्य तनाव के बीच शुक्रवार को भारत और रूस की नौसेनाओं ने बंगाल की खाड़ी में दो दिवसीय संयुक्त युद्धाभ्यास शुरू किया।

नई दिल्ली: पूर्वी लद्दाख में चीन से जारी सैन्य तनाव के बीच शुक्रवार को भारत और रूस की नौसेनाओं ने बंगाल की खाड़ी में दो दिवसीय संयुक्त युद्धाभ्यास शुरू किया। इसका मकसद विभिन्न सुरक्षा चुनौतियों के मद्देनजर समन्वय को बढ़ाना है। भारतीय नौसेना के प्रवक्ता कमांडर विवेक मधवाल ने बताया कि इस युद्धाभ्यास का मकसद दोनों देशों के नौसेना के बीच समझबूझ बढ़ाना और एक-दूसरे के सर्वश्रेष्ठ तरीकों को अपनाना है। यह युद्धाभ्यास दोनों देशों की नौसेना के बीच दीर्घकालिक सामरिक रिश्तों को दर्शाता है।

बता दें कि चीन की आक्रामक और उकसावे वाली कार्रवाइयों से निपटने के लिए भारत ने हिंद महासागर क्षेत्र में अपनी नौसेना की तैनाती बढ़ा दी है। इसमें बड़ी संख्या में युद्धपोत और पनडुब्बियां शामिल हैं। इस नौसैनिक अभ्यास का नाम इंद्र रखा गया है। इसमें सतह और हवा में मौजूद लक्ष्यों को मार गिराने जैसे अभ्यास किए जा रहे हैं। इसमें रूसी युद्धपोत एडमिरल विनोग्रादोव, एडमिरल त्रिबुत्स और बोरिस बुतोमा के अलावा हेलीकॉप्टरों का बेड़ा भी भाग ले रहा है। इस युद्धाभ्यास को पहले रूस के व्लादिवोस्तक में आयोजित होना था लेकिन कोरोना महामारी के चलते इसे टाल दिया गया था।



पूर्वी लद्दाख में चीन से जारी सैन्य तनाव के बीच शुक्रवार को भारत और रूस की नौसेनाओं ने बंगाल की खाड़ी में दो दिवसीय संयुक्त युद्धाभ्यास शुरू किया।

भारतीय नौसेना अपने युद्धपोत रणविजय, सहयाद्रि, किल्टान, शक्ति और हेलीकॉप्टरों के साथ इस युद्धाभ्यास में भाग ले रही है। यह युद्धाभ्यास ऐसे समय हो रहा है जब भारत के रक्षा मंत्री राजनाथ सिंह शंघाई सहयोग संगठन की बैठक में भाग लेने के लिए रूस के दौरे पर हैं। राजनाथ सिंह ने गुरुवार को अपने रूसी समकक्ष जनरल सेर्गेई से मुलाकात की थी। इस बैठक में दोनों के बीच कई अहम मुद्दों पर सहयोग को लेकर बातचीत हुई थी। माना जा रहा है कि इस युद्धाभ्यास से दोनों देशों के बीच संबंधों में और मजबूती आएगी।

साल 2003 से ही भारत और रूस की सेनाओं के बीच यह युद्धाभ्यास होता आ रहा है। साल 2017 के बाद से दो वर्षों में एक बार संयुक्त रूप से तीनों सेना का अभ्यास इंद्र आयोजित किया जा रहा है। इंद्रा युद्धाभ्यास का पिछला संस्करण साल 2018 में विशाखापट्टनम में आयोजित किया गया था। अभी जुलाई महीने में ही भारतीय नौसेना ने अमेरिकी नेवी के साथ युद्धाभ्यास किया था। उल्लेखनीय है कि मलक्का जलडमरूमध्य के आसपास का समुद्री क्षेत्र समुद्री मार्ग के जरिये चीन की आपूर्ति श्रृंखला के लिए बेहद अहम माना जाता है।

<https://www.jagran.com/news/national-indian-navy-holds-naval-drill-with-russia-in-bay-of-bengal-20709984.html>

India sends a clear signal to China

Beijing has to decide if it wants to rescue or ruin the relationship

Over the past week, there have been both a series of developments in eastern Ladakh and a series of statements from India's top decision-makers. In terms of events, India has pre-empted a possible Chinese intrusion and positioned forces at strategically important points. In terms of statements, the Chief of Defence staff, Bipin Rawat said that the military option was on the table — and more recently, has highlighted the threat of “coordinated action” from both China and Pakistan. And external affairs minister S Jaishankar has emphasised the importance of finding a resolution in the domain of diplomacy.

Unpacking these events and statements provides a glimpse into how India has decided to approach the Chinese aggression. For one, there is absolute clarity that the Chinese have flouted border agreements, intruded into Indian territory, and the onus rests on them to both disengage and de-escalate and India will resist the incursion. Two, there is a recognition that China's behaviour is not just India-specific but in line with its pattern of aggression elsewhere — and this is because Beijing sees an opportunity to change the rules of the game even as the world struggles with the pandemic (that began in China) and the United States (US) remains distracted with domestic elections. The corollary of this is that when the geopolitical situation changes, and international opinion continues to build against it, China may be forced to review its approach. Three, while there is a sense that China will be India's most critical longer-term challenge, in the immediate context, countering it will require a host of strategies — ensuring effective military mobilisation to send a message of strength; inflicting economic costs to send a signal that the entire relationship is in jeopardy; cementing international partnerships to build pressure; and pursuing bilateral dialogue to find an acceptable solution.

The latest developments are in line with this broad approach. India has made tactical military advances — which sends a message of military determination. It has continued banning Chinese apps — and Huawei can well write off its 5G prospects in the Indian market. It has reiterated its commitment to Quad. The defence ministers of the two countries met in Moscow on Friday. And Mr Jaishankar has confirmed that he will meet the Chinese foreign minister Wang Yi in Moscow next week. The ball is now entirely in China's court — it needs to decide if it wants to rescue the relationship or ruin it.

<https://www.hindustantimes.com/editorials/india-sends-a-clear-signal-to-china/story-WHly68afQEUSySiZWn3BQI.html>



There is absolute clarity in New Delhi that the Chinese have flouted border agreements, intruded into Indian territory, and the onus rests on them to both disengage and de-escalate and India will resist the incursion. (AP)

China creating a flashpoint in South China Sea

In a brazenly hegemonic stand China refused to respect The Hague tribunal's ruling that China's sovereignty claims in South China Sea had no legal basis

By Arvind Kumar & Seshadri Chari

China's foray into the controversial and disputed South China Sea is not a new phenomenon. It is part of Beijing's long term strategy to bring a large area of land and sea into its sphere of influence. This is being done by China mainly to harness resources exclusively. More recently, China's firing of medium range missiles into the South China Sea is a growing assertion, largely to reflect its sovereignty over disputed waters. Such action by China has attempted to demonstrate its strategic dominance and sovereignty over the whole of South China Sea.

China has also been engaging itself in military exercises over its territorial claims in the South China Sea. The growing frequency of exercises and the new types of capabilities displayed has demonstrated the progress China has achieved in its continuing military modernisation programme.

Initially, under the guise of "peaceful rise of China" Beijing could project its forays as cooperative engagement with countries in the periphery. Even the US, especially under the Obama administration gave the benefit of doubt to Xi Jinping. The US also advocated a UN intervention and a peaceful resolution to maritime disputes in the area claimed as "South China Sea", although other countries contested the new name.



The Donald Trump administration took a strong view of the situation and began to deviate from the earlier stand, rejecting China's maritime claims in South China Sea. As expected, this resulted in the escalation of hostilities between two competing world powers. In response to China's recent action, the US military has stepped up operations in the area including the deployment of two aircraft carriers in the waters China claims.

US Secretary of State Mike Pompeo highlighted the "unprecedented threat that the allies of US in the region face" from People's Republic of China (PRC) and described China's claims in SCS as "completely unlawful". Elaborating US' policy further, Pompeo went on to say that China could not lawfully claim waters around the Scarborough Reef and the Spratly Islands, which an international tribunal in 2016 found to be part of the Philippines' exclusive economic zone. The US also rejected the Chinese claim to waters surrounding Vanguard Bank off the coast of Vietnam, Luconia Shoals off Malaysia, waters in Brunei's exclusive economic zone, and Natuna Besar off Indonesia. Washington has also not recognised Beijing's claims to James Shoal, an entirely submerged area just 50 nautical miles from Malaysia but nearly 1,000 nautical miles from China's coast.

In a brazenly hegemonic stand China refused to respect The Hague tribunal's ruling that China's sovereignty claims in the SCS had no legal basis. China does not have any regard for international legal principles. There was a tribunal formed in 2016 to hear a case brought by the Philippines ruled that any claims to historic rights in the SCS implied by the nine-dash line on Chinese maps was invalid.

Close on the heels of the trade war, the US began supporting the idea of "free and open" SCS, respecting the rights of all the rim countries regardless of their geographic size and economic clout. In addition to their views, the White House also emphasised its resolve to initiate all possible and necessary actions to counter Chinese bullying. This required the US to openly align itself with Malaysia, the Philippines, Brunei and Vietnam, which it did.

The US State Department went one step further and imposed restrictions on individuals, companies and officials who were found to be responsible in taking decisions and implementing them with regard to large-scale reclamation and construction, including militarisation of specific zones in SCS in blatant violation of international laws. China was clearly violating all norms of maritime regulations and usurping common resources. The State Department also imposed severe visa restrictions on as many as 24 PRC state-owned companies and subsidiaries of China Communications Construction Company (CCCC).

Even as the US increased its naval presence in the disputed SCS, India added its naval strength to the US force to ensure freedom of navigation. In a swift move, the Indian Navy stationed its warships in SCS and maintained constant contact with US warships through secure systems, which the Chinese side objected to during the talks to resolve the Galwan standoff. In addition to this, India also deployed its Navy along the Malacca Straits near the Andaman and Nicobar Islands and other entry points through which the Chinese commercial vessels and oil tankers enter the Indian Ocean Region (IOR).

New Delhi's strategic move in assisting the US Navy in SCS, increasing surveillance in IOR and keeping a check on Chinese movement in India's periphery has earned dividends. New Delhi has maintained its strategic autonomy and at the same time effectively created a firewall to restrict Chinese access into areas of India's strategic influence.

Needless to say, New Delhi will have to do much more than merely increase its naval presence. There is an urgent need to reach out to countries in SCS, South Asia and IOR so as to ensure the freedom of navigation, regional security and above all increase trade and commerce in a cooperative spirit. China will need to decrease its growing physical presence and power projection in the SCS. Otherwise, China's action will accentuate instability in the region. It must be emphasised here that while the rest of the world is busy in dealing with the pandemic, China has been engaging in creating its influence across the region. China's action will have negative ramifications in the disputed waters which might make the SCS an imminent flashpoint.

(Arvind Kumar is Professor of Geopolitics and International Relations at Manipal Academy of Higher Education (MAHE), Manipal. Seshadri Chari is a well known political commentator and strategic Analyst.)

<https://www.sundayguardianlive.com/news/china-creating-flashpoint-south-china-sea>

ISRO's Chandrayaan 1 spots rusting on the Moon - NASA scientists believe Earth's atmosphere could be the reason why

By Prabhjote Gill

- *Data from Indian Space Research Organisation's (ISRO) Chandrayaan 1 orbiter shows that the Moon may be rusting along the poles.*
- *The occurrence of rust is a conundrum because even though the Moon is known to have iron-rich rocks littered across the surface, it's not known for the presence of water and oxygen — two elements that need to interact with iron to create rust.*
- *Researchers at the National Aeronautics and Space Administration (NASA) believe that this could be because Earth's own atmosphere is lending a helping hand.*

Another sign that the Moon's poles are home to water has emerged from the Chandrayaan 1's data.

The Indian Space Research Organisation's (ISRO) maiden mission to Earth's natural satellite has revealed that there may be rusting on the Moon — something that can only occur if iron interacts with water and oxygen.

And, even though the Moon has a lot of iron, it's not known to be rich in oxygen and water. "The Moon is a terrible environment for hematite to form in," said Shuai Li, the lead author of the paper published in Science Advances.

Researchers with the National Aeronautics and Space Administration (NASA) believe that Earth may have had a role to play.

The Earth's atmosphere could be protecting the Moon as well

The Moon is constantly bombarded by solar particles coming off the Sun. Without an atmosphere to protect itself, the hydrogen should make it difficult for rust to form.

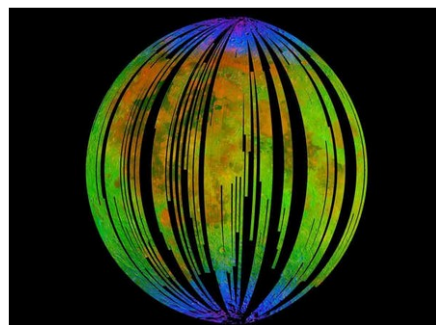
Hydrogen is a reducer. It adds electrons to the material it touches. For iron to rust, it needs the opposite — an oxidiser which removes electrons instead.

Instead, Earth's atmosphere may have had a helping hand to give. The planet's magnetotail — the part of its magnetic atmosphere that extends away from the Sun — is capable of blocking out 99% of the solar wind aimed at the Moon when it's in its Full Moon phase.

That part of the lunar cycle gives iron on the Moon occasional windows of opportunity for rust to form.

Building the perfect storm for the Moon to rust

Earth's magnetotail does more than just provide the Moon with a shield. During that interaction, some of the oxygen from the planet also gets transferred over. This was confirmed by Japan's Kaguya orbiter in 2007.



The blue areas in this composite image from the Moon Mineralogy Mapper (M3) aboard the Indian Space Research Organization's Chandrayaan-1 orbiter show water concentrated at the Moon's poles. Homing in on the spectra of rocks there, researcher found signs of hematite, a form of rust. ISRO/NASA/JPL-Caltech/Brown University/USGS

So, even though the Moon isn't rich in oxygen, it does have access to oxygen during the same window of opportunity when it's not being bombarded with hydrogen.

The last piece of the puzzle is water. Even though the rest of the Moon is bone dry, it's poles have long been suspected of hosting water. Albeit only in shadowed craters located on the far side of the Moon — far from where the rust has been detected.

Researchers propose that fast-moving dust particles, which regularly pelt the Moon, could release surface-borne water molecules and mix them with iron in the lunar soil. Compounding the

interaction, the resulting heat from these impacts could increase the oxidation rate.

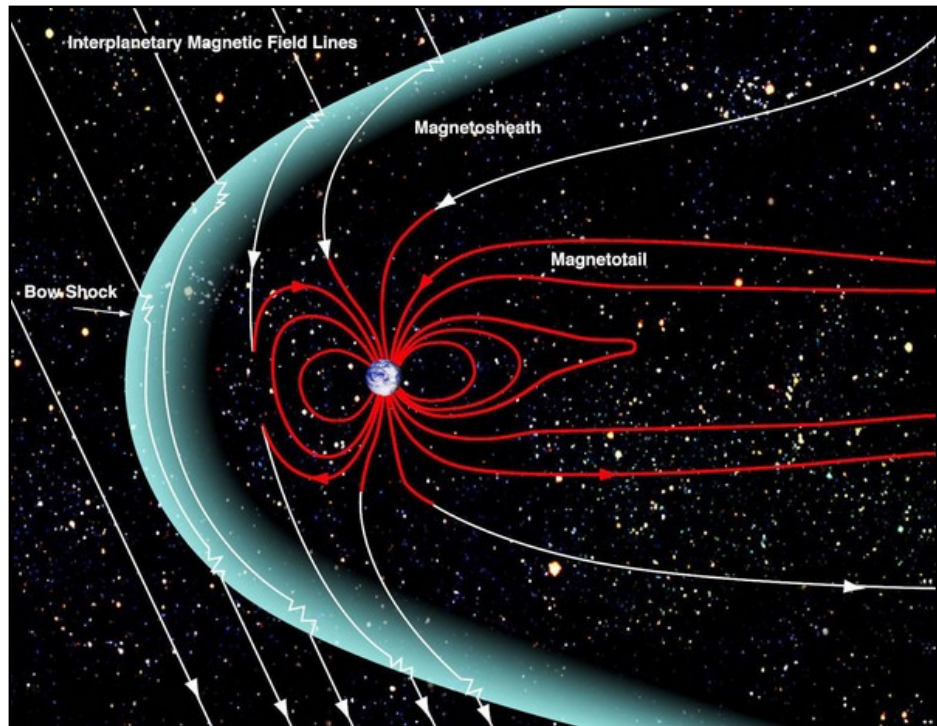
So if all three ingredients are in place — a Full Moon phase, water molecules and oxygen travelling from Earth — the perfect storm to create rust can in fact occur.

Questions still left unanswered

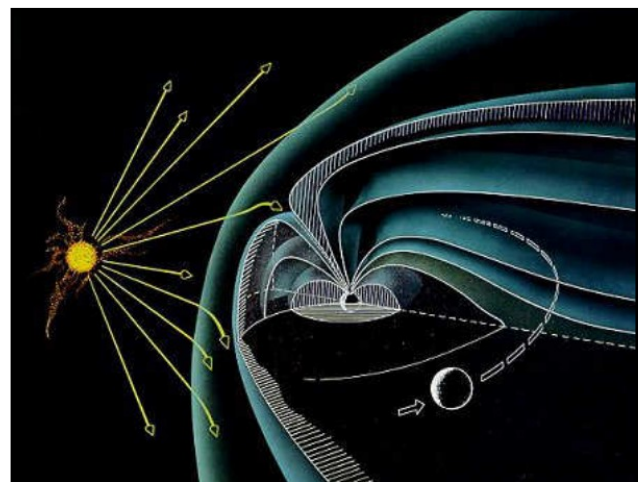
While the theory is sound on paper, there is still more information that's needed to understand exactly how water is interacting with lunar rocks. The insights could also help explain why rusting is occurring on the far side of the moon, where it's blocked off from Earth's oxygen.

This study was published using Chandrayaan-1's Moon Mineralogy Mapper instrument (M3) built by the National Aeronautics Space Administration's (NASA) Jet Propulsion Laboratory (JPL). It detects how light is reflected off the surface of the Moon.

<https://www.businessinsider.in/science/space/news/isro-chandrayaan-1-and-nasa-spot-rust-on-moon-earth-atmosphere-could-be-the-reason-why/articleshow/77926459.cms>



Earth's magnetic atmosphere and magnetotail, which extends away from the Sun NASA



How the Earth's Magnetotail protects the Moon from solar particles from the Sun NASA

चांद पर मिले पानी के संकेत, ISRO

चंद्रयान 1 के डेटा से मिली बड़ी कामयाबी

ISRO के चंद्रयान-1 (Chandrayaan 1) का डेटा दिखाता है चांद के ध्रुवों (Poles of Moon) पर जंग लग रही है। बिना पानी और ऑक्सीजन के संपर्क में आए जंग नहीं लग सकती। इसलिए चांद पर पानी (Water on Moon) की मौजूदगी की उम्मीदें प्रबल हो गई हैं।

By Deepak Verma

हाइलाइट्स:

- भारतीय अंतरिक्ष अनुसंधान संगठन (ISRO) के चंद्रयान-1 के डेटा से खोज
- साइंस एडवांसेज में छपा रिसर्च पेपर, चांद पर मिले जंग लगने के निशान
- चांद के ध्रुवों पर पानी की मौजूदगी का दावा काफी पुराना, अबतक कोई नहीं पहुंचा
- चांद की सतह पर प्रकाश के रिफ्लेक्शन को मैप पर खोजी गई जंग

नई दिल्ली: इसरो को चंद्रयान-1 मिशन भले ही अपने मकसद में पूरी तरह कामयाब न हो पाया हो। मगर उसके डेटा से रिसर्चर्स आज भी नए तथ्य पता लगा पा रहे हैं। चंद्रयान-1 के मिनरोलॉजी मैप इंसट्रुमेंट के डेटा का यूज करके साइंटिस्ट्स ने पाया कि चांद में जंग लग रही है। चॉकिए मत! 'साइंस एडवांसेज' में छपी रिसर्च के अनुसार, चांद के पहाड़ों में जंग की मौजूदगी हो सकती है। ऐसा तभी होता है जब लोहे का पानी और ऑक्सिजन से इंटरएक्शन हो। इस रिसर्च से चांद के ध्रुवों पर पानी की मौजूदगी का एक और संकेत मिला है। चांद पर भारी मात्रा में लोहा मौजूद है, लेकिन ऑक्सिजन और पानी होने की पुष्टि नहीं है।

बिना वायुमंडल लोहे में जंग मुश्किल

रिसर्च के लीड ऑथर शुआई ली के अनुसार, चांद की सतह पर जंग का एक रूप, हेमाटाइट मिला है। उन्होंने कहा, "चांद का वातावरण हेमाटाइट बनने के लिए काफी खराब है।" चांद पर लगातार सूरज के कण पड़ते रहते हैं। अपनी रक्षा के लिए वायुमंडल की मौजूदगी के बिना, हाइड्रोजन के चलते जंग लगना मुश्किल हो जाता है। हाइड्रोजन जिस भी मैटीरियल को छूती है, उसके इलेक्ट्रॉन बढ़ा देती है जबकि लोहे पर जंग लगने के लिए ऑक्सिडाइजर चाहिए जो इलेक्ट्रॉन्स को कम कर सके।

चांद पर कहां से आती है ऑक्सिजन?

अमेरिकी अंतरिक्ष एजेंसी NASA के रिसर्चर्स का मानना है कि यह जंग लगने के पीछे धरती का वायुमंडल हो सकता है। धरती के चुंबकीय वायुमंडल की मैग्नीटोटेल् पूर्णिमा के दौरान चांद तक आने वाली 99% सौर हवाओं को ब्लॉक करने में सक्षम है। यानी उस दौरान चांद पर मौजूद लोहे में जंग लगनी शुरू होती है। मैग्नीटोटेल् चांद के लिए सिर्फ शील्ड का काम नहीं करती, कुछ ऑक्सिजन भी ट्रांसफर होती है। यह 2007 में जापान के कगुया ऑर्बिटर से कन्फर्म हो चुका है। इसका मतलब ये कि चांद पर ऑक्सिजन भले ही न हो, मगर कुछ वक्त के लिए उसे ऑक्सिजन मिलती है। उसी वक्त हाइड्रोजन की बमबारी भी उसपर नहीं हो रही होती क्योंकि धरती बीच में होती है।

पानी का इंतजाम चांद पर ही मौजूद!

लोहे को जंग लगने लिए ऑक्सिजन के अलावा पानी भी चाहिए। ऐसे तो चांद बिल्कुल सूखा है मगर उसके ध्रुवों पर पानी है, ऐसा वैज्ञानिक लंबे समय से अनुमान लगाते आए हैं। लेकिन जहां जंग मिली है, उससे खासी दूर पर केवल क्रेटर ही मिले हैं, उनमें पानी नहीं। रिसर्चर्स का कहना है कि धूल के कणों से सतह पर पानी के अणु रिलीज होते होंगे

और फिर चांद की मिट्टी में मिल जाते होंगे। इंटरएक्शन ज्यादा होने पर पैदा होने वाली हीट से ऑक्सिडेशन रेट बढ़ सकता है।

<https://navbharattimes.indiatimes.com/india/isro-chandrayaan-1-data-reveals-rusting-on-the-moon/articleshow/77927496.cms>



Sat, 05 Sept 2020

New evidence that the quantum world is even stranger than we thought

By Steve Tally

New experimental evidence of a collective behavior of electrons to form "quasiparticles" called "anyons" has been reported by a team of scientists at Purdue University.

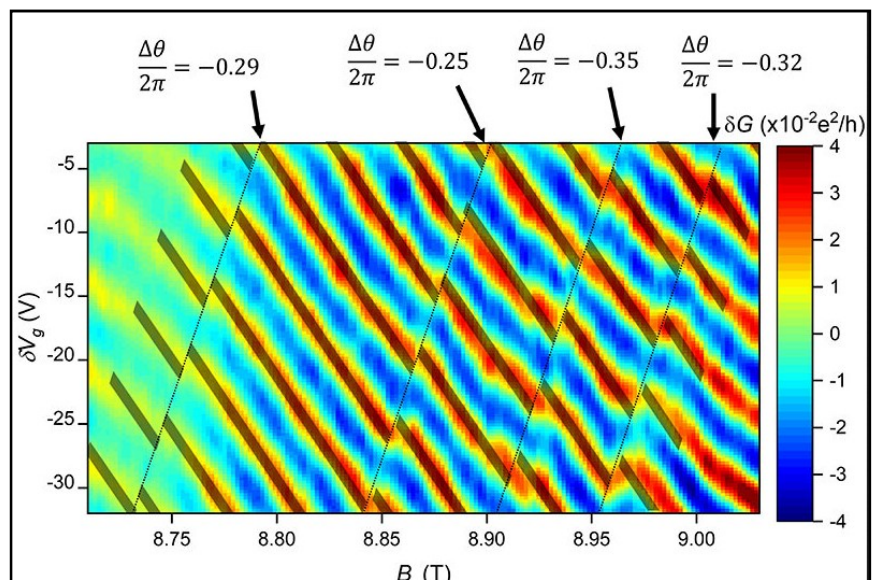
Anyons have characteristics not seen in other subatomic particles, including exhibiting fractional charge and fractional statistics that maintain a "memory" of their interactions with other quasiparticles by inducing quantum mechanical phase changes.

Postdoctoral research associate James Nakamura, with assistance from research group members Shuang Liang and Geoffrey Gardner, made the discovery while working in the laboratory of professor Michael Manfra. Manfra is a Distinguished Professor of Physics and Astronomy, Purdue's Bill and Dee O'Brien Chair Professor of Physics and Astronomy, professor of electrical and computer engineering, and professor of materials engineering. Although this work might eventually turn out to be relevant to the development of a quantum computer, for now, Manfra said, it is to be considered an important step in understanding the physics of quasiparticles.

A research paper on the discovery was published in this week's *Nature Physics*.

Nobel Prize-winning theoretical physicist Frank Wilczek, professor of physics at MIT, gave these quasiparticles the tongue-in-cheek name "anyon" due to their strange behavior because unlike other types of particles, they can adopt "any" quantum phase when their positions are exchanged.

Before the growing evidence of anyons in 2020, physicists had categorized particles in the known world into two groups: fermions and bosons. Electrons are an example of fermions, and photons, which make up light and radio waves, are bosons. One characteristic difference between fermions and bosons is how the particles act when they are looped, or braided, around each other. Fermions respond in one straightforward way, and bosons in another expected and straightforward way.



Experimental evidence of quasiparticles called anyons has been found by a team of scientists at Purdue University. Electrical interference in the experiment created a pattern which the researchers called a "pyjama plot"; jumps in the interference pattern were the signature of the presence of anyons. Credit: Purdue University image/James Nakamura

Physics and Astronomy, Purdue's Bill and Dee O'Brien Chair Professor of Physics and Astronomy, professor of electrical and computer engineering, and professor of materials engineering. Although this work might eventually turn out to be relevant to the development of a quantum computer, for now, Manfra said, it is to be considered an important step in understanding the physics of quasiparticles.

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Anyons respond as if they have a fractional charge, and even more interestingly, create a nontrivial phase change as they braid around one another. This can give the anyons a type of "memory" of their interaction.

"Anyons only exist as collective excitations of electrons under special circumstances," Manfra said. "But they do have these demonstrably cool properties including fractional charge and fractional statistics. It is funny, because you think, 'How can they have less charge than the elementary charge of an electron?' But they do."

Manfra said that when bosons or fermions are exchanged, they generate a phase factor of either plus one or minus one, respectively.

"In the case of our anyons the phase generated by braiding was $2\pi/3$," he said. "That's different than what's been seen in nature before."

Anyons display this behavior only as collective crowds of electrons, where many electrons behave as one under very extreme and specific conditions, so they are not thought to be found isolated in nature, Nakamura said.

"Normally in the world of physics, we think about fundamental particles, such as protons and electrons, and all of the things that make up the periodic table," he said. "But we study the existence of quasiparticles, which emerge from a sea of electrons that are placed in certain extreme conditions."

Because this behavior depends on the number of times the particles are braided, or looped, around each other, they are more robust in their properties than other quantum particles. This characteristic is said to be topological because it depends on the geometry of the system and may eventually lead to much more sophisticated anyon structures that could be used to build stable, topological quantum computers.

The team was able to demonstrate this behavior by routing the electrons through a specific maze-like etched nanostructure made of gallium arsenide and aluminum gallium arsenide. This device, called an interferometer, confined the electrons to move in a two-dimensional path. The device was cooled to within one-hundredth of a degree from absolute zero (10 millikelvin), and subjected to a powerful 9-Tesla magnetic field. The electrical resistance of the interferometer generated an interference pattern which the researchers called a "pyjama plot." Jumps in the interference pattern were the signature of the presence of anyons.

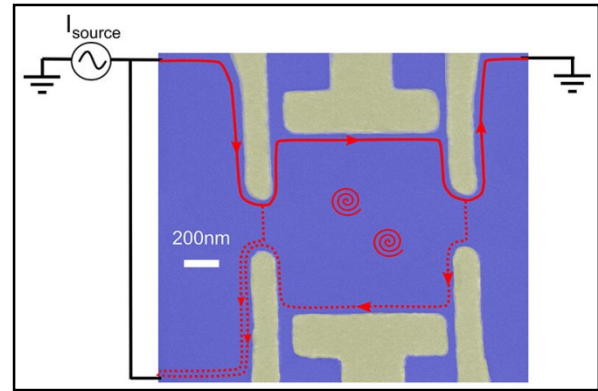
"It is definitely one of the more complex and complicated things to be done in experimental physics," Chetan Nayak, theoretical physicist at the University of California, Santa Barbara told Science News.

Nakamura said the facilities at Purdue created the environment for this discovery to happen.

"We have the technology to grow the gallium arsenide semiconductor that's needed to realize our electron system. We have the nanofabrication facilities in the Birck Nanotechnology Center to make the interferometer, the device we used in our experiments. In the physics department, we have the ability to measure ultra-low temperatures and to create strong magnetic fields," he said. "So, we have all of the necessary components that allowed us to make this discovery all here at Purdue. That's a great thing about doing research here and why we've been able to make this progress."

Manfra said the next step in the quasiparticle frontier will involve building more complicated interferometers.

"In the new interferometers we will have the ability to control the location and number of quasiparticles in the chamber," he said. "Then we will be able to change the number of



Scientists at Purdue have announced new experimental evidence of a collective behavior of electrons to form "quasiparticles" called "anyons." The team was able to demonstrate this behavior by routing the electrons through a specific maze-like etched nanostructure in a nanoscale device called an interferometer. Credit: Purdue University image/James Nakamura

quasiparticles inside the interferometer on demand and change the interference pattern as we choose."

More information: J. Nakamura et al. Direct observation of anyonic braiding statistics, *Nature Physics* (2020). DOI: [10.1038/s41567-020-1019-1](https://doi.org/10.1038/s41567-020-1019-1)

Journal information: [Nature Physics](https://phys.org/news/2020-09-evidence-quantum-world-stranger-thought.html)
<https://phys.org/news/2020-09-evidence-quantum-world-stranger-thought.html>



Sat, 05 Sept 2020

'Floppy' atomic dynamics help turn heat into electricity

by Ken Kingery

Materials scientists at Duke University have uncovered an atomic mechanism that makes certain thermoelectric materials incredibly efficient near high-temperature phase transitions. The information will help fill critical knowledge gaps in the computational modeling of such materials, potentially allowing researchers to discover new and better options for technologies that rely on transforming heat into electricity.

The results appear online on September 4 in the journal *Nature Communications*.

Thermoelectric materials convert heat into electricity when electrons migrate from the hot side of the material to the cold side. Because providing a temperature difference between its two sides is required, researchers are interested in trying to use these materials to generate electricity from the heat of a car's tailpipe or recovering energy lost as heat in power plants.

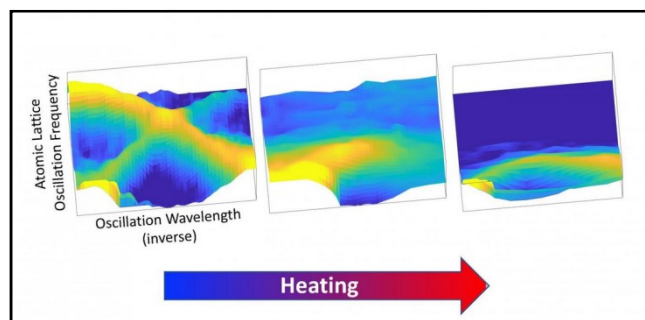
Over the past couple of years, new records were set for thermoelectric efficiency with an emerging material called tin selenide and its sister compound, tin sulfide. The sulfide version is not quite as good a thermoelectric yet, but it is being optimized further because it is cheaper to produce and more environmentally friendly.

While scientists know that both of these compounds are excellent thermoelectric materials, they don't exactly know why. In the new study, Olivier Delaire, associate professor of mechanical engineering and materials science at Duke, and two of his graduate students, Tyson Lanigan-Atkins and Shan Yang, tried to fill in a bit of that knowledge gap.

"We wanted to try to understand why these materials have such low thermal conductivity, which helps enable the strong thermoelectric properties they're known for," said Delaire. "Using a powerful combination of neutron scattering measurements and computer simulations, we discovered that it's related to the material's atomic vibrations at high temperature, which nobody had seen before."

Low thermal conductivity is a necessary ingredient of any good thermoelectric material. Because electricity generation requires a heat differential between its two sides, it makes sense that materials that stop heat from spreading across them would perform well.

To get a view of tin sulfide's atomic vibrations in action, Delaire and Lanigan-Atkins took samples to the High Flux Isotope Reactor at Oak Ridge National Laboratory. By ricocheting



Evolution of atomic lattice oscillation waves upon heating the tin sulfide crystal, as measured with neutron scattering. Credit: Tyson Lanigan-Atkins, Delaire group, Duke University

neutrons off of the tin sulfide's atoms and detecting where they end up after, the researchers could determine where the atoms were and how they were collectively vibrating in the crystal's lattice.

The facilities at ORNL were particularly well-suited for the task. Because the atomic vibrations of tin sulfide are relatively slow, the researchers need low-energy "cold" neutrons that are delicate enough to see them. And ORNL has some of the best cold-neutron instruments in the world.

"We found that the tin sulfide effectively has certain modes of vibration that are very 'floppy,'" said Delaire. "And that its properties are connected with inherent instability in its crystal lattice."

At lower temperatures, tin sulfide is a layered material with distorted grids of tin and sulfide lying on top of another, corrugated like an accordion. But at temperatures near its phase transition point of 980 degrees Fahrenheit—which is where thermoelectric generators often operate—that distorted environment begins to break down. The two layers, as if by magic, become undistorted again and more symmetric, which is where the "floppiness" comes into play.

Because the material is sloshing between the two structural arrangements at high temperature, its atoms no longer vibrate together like a well-tuned guitar string and instead become anharmonically damped. To understand this better, think of a car with terrible shocks as having a harmonic vibration—it will keep bouncing long after going over the slightest bump. But proper shocks will dampen that vibration, making it anharmonic and stopping it from oscillating for a long time.

"Heat waves travel through atomic vibrations in a material," said Delaire. "So when the atomic vibrations in tin sulfide become floppy, they don't transmit vibrations very quickly and they also don't vibrate for very long. That's the root cause of its ability to stop heat from traveling within it."

With these results in hand, Delaire and Yang then sought to confirm and understand them computationally. Using supercomputers at Lawrence Berkeley National Laboratory, Yang was able to reproduce the same anharmonic effects at high temperatures. Besides confirming what they saw in the experiments, Delaire says these updated models will allow researchers to better search for new thermoelectric materials to use in tomorrow's technologies.

"Researchers in the field have not been accounting for strong temperature dependences on heat propagation velocities, and this modeling shows just how important that variable can be," said Delaire. "Adopting these results and other theoretical advances will make it easier for materials scientists to predict other good thermoelectric materials."

More information: T. Lanigan-Atkins et al, Extended anharmonic collapse of phonon dispersions in SnS and SnSe, *Nature Communications* (2020). DOI: [10.1038/s41467-020-18121-4](https://doi.org/10.1038/s41467-020-18121-4)

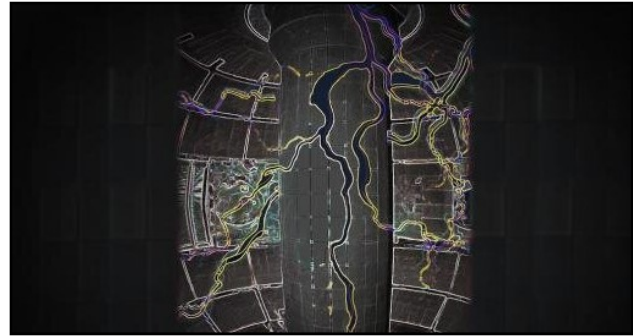
Journal information: [Nature Communications](https://www.nature.com/articles/s41467-020-18121-4)
<https://phys.org/news/2020-09-floppy-atomic-dynamics-electricity.html>

Researchers find unexpected electrical current that could stabilize fusion reactions

By Raphael Rosen

New Delhi: India's armed forces are capable of handling aggressive Chinese actions in "best suitable ways", Chief of Defence Staff Gen Bipin Rawat said on Thursday, remarks that came against the backdrop of China's attempts to change the status quo in certain areas in eastern Ladakh.

Electric current is everywhere, from powering homes to controlling the plasma that fuels fusion reactions to possibly giving rise to vast cosmic magnetic fields. Now, scientists at the U.S. Department of Energy's (DOE) Princeton Plasma Physics Laboratory (PPPL) have found that electrical currents can form in ways not known before. The novel findings could give researchers greater ability to bring the fusion energy that drives the sun and stars to Earth.



An artist's rendering of electrical current flowing through a tokamak fusion facility. Credit: Elle Starkman

"It's very important to understand which processes produce electrical currents in plasma and which phenomena could interfere with them," said Ian Ochs, graduate student in Princeton University's Program in Plasma Physics and lead author of a paper selected as a featured article in *Physics of Plasmas*. "They are the primary tool we use to control plasma in magnetic fusion research."

Fusion is the process that smashes together light elements in the form of plasma—the hot, charged state of matter composed of free electrons and atomic nuclei—generating massive amounts of energy. Scientists are seeking to replicate fusion for a virtually inexhaustible supply of power to generate electricity.

The unexpected currents arise in the plasma within doughnut-shaped fusion facilities known as tokamaks. The currents develop when a particular type of electromagnetic wave, such as those that radios and microwave ovens emit, forms spontaneously. These waves push some of the already-moving electrons, "which ride the wave like surfers on a surfboard," said Ochs.

But the frequencies of these waves matter. When the frequency is high, the wave causes some electrons to move forward and others backward. The two motions cancel each other out and no current occurs.

However, when the frequency is low, the waves pushes forward on the electrons and backward on the atomic nuclei, or ions, creating a net electrical current after all. Ochs found that researchers could surprisingly create these currents when the low-frequency wave was a particular type called an "ion acoustic wave" that resembles sound waves in air.

The significance of this finding extends from the relatively small scale of the laboratory to the vast scale of the cosmos. "There are magnetic fields throughout the universe on different scales, including the size of galaxies, and we don't really know how they got there," Ochs said. "The mechanism we discovered could have helped seed cosmic magnetic fields, and any new mechanisms that can produce magnetic fields are interesting to the astrophysics community."

The results from the pencil-and-paper calculations consist of mathematical expressions that give scientists the ability to calculate how these currents, which occur without electrons directly interacting, develop and grow. "The formulation of these expressions was not straightforward,"

Ochs said. "We had to condense the findings so they would be sufficiently clear and use simple expressions to capture the key physics."

The results deepen understanding of a basic physical phenomenon and were also unexpected. They appear to contradict the conventional notion that current drives require electron collisions, Ochs said.

"The question of whether waves can drive any current in plasma is actually very deep and goes to the fundamental interactions of waves in plasma," said Nathaniel Fisch, a coauthor of the paper, professor and associate chair of the Department of Astrophysical Sciences, and director of the Program in Plasma Physics. "What Ochs derived in masterful, didactic fashion, with mathematical rigor, was not only how these effects are sometimes balanced, but also how these effects sometimes conspire to allow the formation of net electrical currents."

These findings lay the groundwork for future research. "What especially excites me," Fisch said, "is that the mathematical formalism that Ochs has built, together with the physical intuitions and insights that he has acquired, now put him in a position either to challenge or to put on a firm foundation even more curious behavior in the interactions of waves with resonant particles in plasma."

More information: Ian E. Ochs et al, Momentum-exchange current drive by electrostatic waves in an unmagnetized collisionless plasma, *Physics of Plasmas* (2020). DOI: [10.1063/5.0011516](https://doi.org/10.1063/5.0011516)

Journal information: *Physics of Plasmas*

<https://phys.org/news/2020-09-unexpected-electrical-current-stabilize-fusion.html>



Sat, 05 Sept 2020

Electric current is manipulated by light in an organic superconductor

A polarized petahertz current is driven by an ultrashort laser in an organic superconductor. This is in contrast to the common sense belief which is justified by Ohm's law, i.e., a net current cannot be induced by an oscillating electric field of light. The current enhances near the superconducting transition temperature. The light-driven petahertz current opens a way to high-speed operation of computers which is one million times faster than conventional ones.

In modern information technology (IT), data are processed and carried by the motions of electrons in a CPU. In the electric circuits, the electrons move in a desired direction by an applied electric field. A frequency of the on-off switching of the electron

motion, which is referred to as a "CPU clock" for example, is an order of gigahertz (10^9 Hz).

On the other hand, an oscillating field of light with a frequency of petahertz (10^{15} Hz) has the potential for realizing petahertz operation of the on-off switching. If one can move electrons with the light frequency, the speed of data processing could be one million times faster than those in conventional computers. An electromagnetic oscillation of light has, however, never driven polarized current (i.e., the time average of the current during the light pulse is zero), because the oscillating light field is temporally/spatially symmetric. Researchers at Tohoku University, Nagoya University, Institute

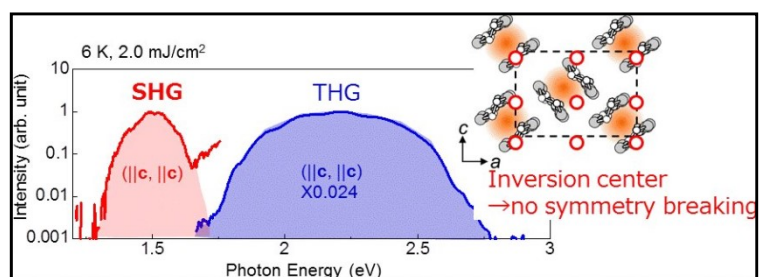


Fig. 1. Spectra of SHG and THG which are emitted by irradiation of 6 fs laser pulses in an organic superconductor, κ -(BEDT-TTF) $_2$ Cu[N(CN) $_2$]Br. Observation of the SHG in the centrosymmetric materials indicates a non-linear current which cannot be described

for Molecular Science, Okayama Science University and Chuo University have succeeded in moving electrons in an organic superconductor in a specific direction by irradiation of ultrashort laser pulses.

According to Ohm's law, an induced current (and velocity of electrons) is proportional to the applied electric field. Note that Ohm's law holds, if the electrons are scattered many times in solids. In fact, the resistivity of the materials is determined by the electron-electron and/or electron-phonon scattering processes. If the electric field can be applied on the time scale shorter than the scattering time, however, the electrons in solids do not have enough time to be averaged. Instead, the electrons should be accelerated and generate a polarized net current. Therefore, the researchers have attempted to realize such a 'scattering-free current' using ultrashort laser pulses which are sufficiently shorter than the electron scattering time (about 40 femtoseconds in organic superconductors).

One obstacle to realize such an experiment is that electric detection of such a short-time current is impossible. Therefore, the researchers employ the optical detection. Second harmonic generation (SHG) has been well known as the method for detecting electronic symmetry breaking such as a macroscopic dipole moment in ferroelectrics. The SHG can be also induced by the polarized current which is another type of the electronic symmetry breaking.

The researchers shine their ultrashort laser with a pulse width of about 6 fs (6×10^{-15} s) on an organic centrosymmetric superconductor, κ -(BEDT-TTF)₂Cu[N(CN)₂]Br, and detect a second harmonic generation (SHG). This is in contrast to the common sense because the SHG is generated only in the materials in which spatial symmetry is broken. Their detection of the SHG in the centrosymmetric material indicates that a polarized net current is generated during the light irradiation.

To confirm such a non-linear polarized current, the researchers investigate carrier-envelope phase (CEP; relative phase between the oscillation of light and its envelope) dependence of the SHG, because CEP sensitive nature is a characteristic behavior of the current induced SHG. A periodic change of the SHG intensity as a function of the CEP is an evidence that the observed SHG is actually attributable to the scattering-free current.

The researchers further demonstrate that the relation between the scattering-free current and the superconductivity. The present result (Fig. 2b) shows that the SHG is detected at the temperature range below 50 K ($>$ superconducting transition temperature ($T_{SC}=11.5$ K)). The result also shows the intensity of the SHG rapidly grows toward the transition temperature below 25 K ($\sim 2 \times T_{SC}$), indicating that the scattering-free current is sensitive to a "superconducting fluctuation". In many superconductors, the superconducting fluctuation, or microscopic seeds of superconductivity, has been found at temperatures higher than the superconducting transition, and the increase in the intensity of the second harmonic seems to be related to the superconducting fluctuations.

The researchers say, "With further understanding of the scattering-free non-linear petahertz current, we may be able to make computers with an operation speed of petahertz which is million times faster than the present ones of gigahertz. This phenomenon can be used also as a tool to elucidate the microscopic mechanism of superconducting states, because it is sensitive to the superconducting fluctuation."

More information: Y. Kawakami et al, Petahertz non-linear current in a centrosymmetric organic superconductor, *Nature Communications* (2020). DOI: [10.1038/s41467-020-17776-3](https://doi.org/10.1038/s41467-020-17776-3)

Journal information: [Nature Communications](https://www.nature.com)
<https://phys.org/news/2020-09-electric-current-superconductor.html>

Opto-thermoelectric microswimmers

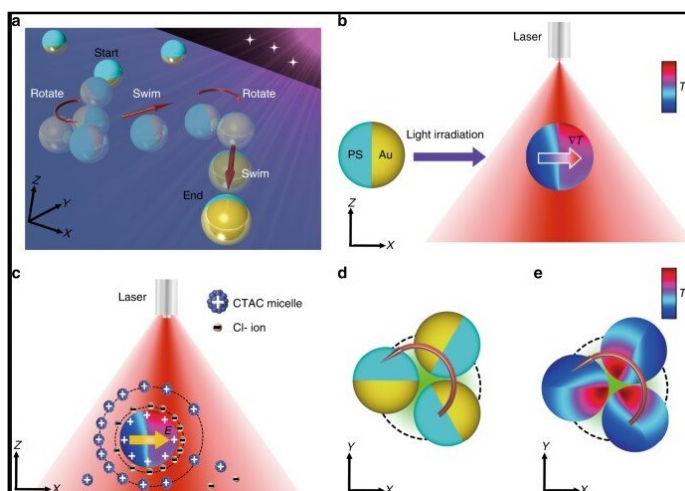
By Thamarasee Jeewandara

In a recent report, Xiaolei Peng and a team of scientists in materials science and engineering at the University of Texas, U.S., and the Tsinghua University, China, developed opto-thermoelectric microswimmers bioinspired by the motion behaviors of [Escherichia coli](#) (*E. coli*). They engineered the microswimmers using dielectric gold Janus particles driven by a self-sustained electric field arising from the optothermal response of the particles. When they illuminated the constructs with a laser beam, the Janus particles showed an optically generated temperature gradient along the particle surfaces, forming an opto-thermoelectrical field to propel themselves along.

The team discovered the swimming direction of microswimmers based on the orientation of the particle. They proposed a new optomechanical approach to understand the navigation direction of microswimmers that relied on a temperature-gradient-induced electric field, using a focused laser beam. By timing the second rotation laser beam in the setup, they positioned the particles at any desired orientation to efficiently control the swimming direction. Using dark-field optical imaging and a feedback control algorithm the scientists facilitated automated microswimmer propulsion. The opto-thermoelectric microswimmers will have applications in colloidal systems, targeted drug delivery and biomedical sensing. The research is now published in *Nature Light: Science & Applications*.

Microswimmers

Microswimmers are a class of micromachines that can convert external chemical, acoustic or electromagnetic energy into swimming motion. Such machines can be used for diverse biomedical applications ranging from targeted drug delivery to precision nanosurgery and diagnostic sensing. In this work, Peng et al. used all-optical microswimmers based on Janus particles in an optothermally generated electric field to build opto-thermoelectric microswimmers that mimicked the 'run-and-tumble' motion of *E. coli* cells. In its mechanism of action, the asymmetric light absorption of a Janus particle under laser beam irradiation caused a self-generated temperature gradient for a resulting opto-thermoelectric field that propelled the particle along. The scientists drove the process using two laser beams, where the second focused laser beam triggered the in-plane rotation of individual Janus particles under optical heating. The team achieved stable particle rotation due to the thermoelectric force, optical force and Stokes drag force in the setup. Peng et al. further investigated the working mechanisms by coupling experiments with theory and simulations.



Conceptual design for optical driving and steering of opto-thermoelectric microswimmers. (a) Under light fields, PS/Au Janus particles are set to swim and rotate alternatively to follow a predefined path. (b) Upon light irradiation on a Janus particle, a temperature gradient ∇T pointing from the PS side to the Au side is generated on the particle surface due to the asymmetric absorption of PS and Au. (c) Once the Janus particle is dispersed in a 0.2 mM CTAC solution, a thermoelectric field is induced to drive the Janus particle along the temperature gradient. The white “+” symbols indicate the positively charged surface. In b, c, the asymmetric heating and thermoelectric field under a defocused laser beam are shown in the X-Z plane. (d) Schematic illustration and e asymmetric heating of the Janus particle when set to rotate (as shown by the maroon arrow) in the X-Y plane by another focused laser beam (indicated by the green region surrounded by a dashed circle). In d, e, the defocused laser beam is switched off. Credit: *Light: Science & Applications*, doi: 10.1038/s41377-020-00378-5

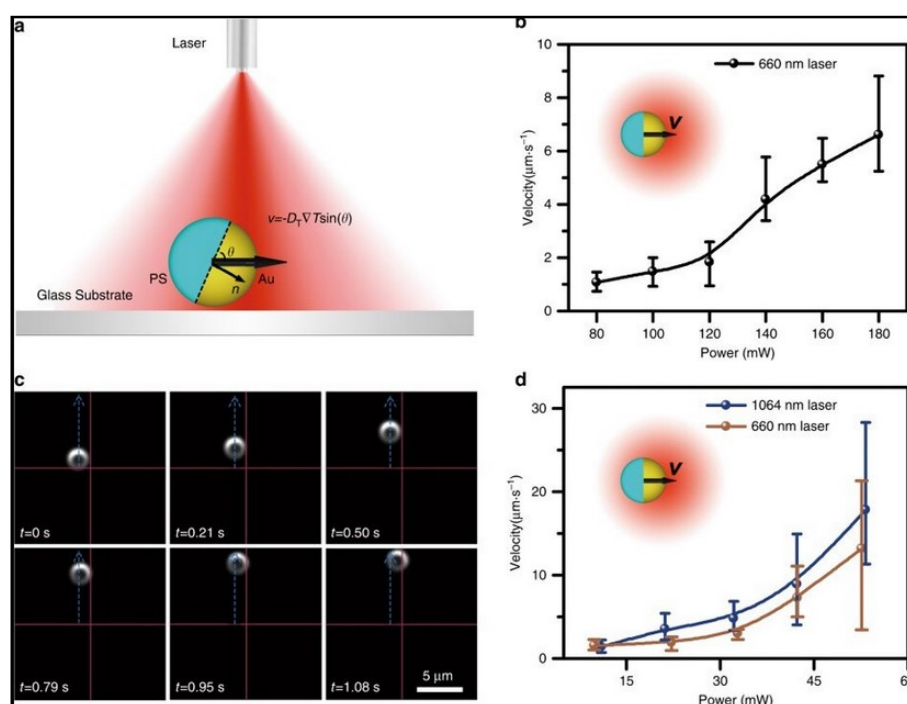
Concept and Design

To facilitate photon-to-phonon (light to sound) energy conversion, the team developed opto-thermoelectric swimmers by half-coating a thin gold (Au) layer on the surface of polystyrene (PS) beads. Upon light irradiation, the absorption difference between PS and Au created a temperature gradient on the PS/Au Janus particle surface. Peng et al. dispersed the Janus particles into a water solution to convert the thermal energy to mechanical energy. When driven by the thermoelectric field and irradiated by a laser beam, the Janus particles migrated along the PS-to-Au direction to demonstrate the swimming state. However, thermal fluctuations could change the orientations of Janus particles causing them to drift away from their courses during migration. To maintain the target course, the scientists switched off the defocused laser beam and used a focused laser beam to rotate and trap Janus particles for reorientation. Upon reaching their destined orientation, they turned off the focused laser beam and reverted the Janus particles to the defocused laser beam to bring them back to the swimming state. This two-state switching process provided the best possible design to actively navigate microswimmers for a variety of functionalities.

Opto-thermoelectric swimming and orientation control

When Peng et al. used a defocused laser beam for directed motion of opto-thermoelectric microswimmers, they achieved an "energy pool" for the Janus particles. They named the motion along the self-generated temperature gradient as self-thermophoresis. In the surrounding solution of cetyltrimethylammonium chloride (CTAC), self-thermophoresis arose from thermoelectric effects to enable the characteristic motion of the particles. The team could reduce the chamber thickness of the experimental setup to stabilize the fluidic flow and facilitate the directional transport of Janus particles. Since the orientation of Janus particles could be randomly changed through thermal fluctuations, the team used a second focused laser beam to achieve particle rotation to efficiently navigate the swimming direction. They accomplished this by switching laser beams to quantitatively analyze the rotating Janus particle and extract their real-time position, as well as orientation data.

When the laser power increased, the particle rotation also increased, although continued increase of laser power caused strong heating effects and thermal damage to the Janus particle. The rotational speed was dependent on the particle size. To understand the thermoelectric force, Peng et al. simulated the temperature distribution on the surfaces of PS/Au Janus particles. Then they



Opto-thermoelectric swimming of PS/Au Janus particles under a defocused laser beam. (a) Schematic illustration of the swimming mechanism. The velocity is directed from the PS hemisphere to the Au-coated hemisphere. (b) Swimming velocity as a function of the optical power for 5 μm PS/Au Janus particles. A 660 nm laser beam with a beam size of 31 μm was applied to drive the swimming. (c) Time-resolved images of a swimming 2.1 μm PS/Au particle. A 1064 nm laser beam with a beam size of 31 μm and a power of 32 mW was applied to drive the swimming. (d) Swimming velocity as a function of the optical power for 2.1 μm PS/Au Janus particles. Two different laser beams, i.e., a 1064 nm laser beam with a beam size of 45 μm and a 660 nm laser beam with a beam size of 45 μm , were applied to drive the swimming. The insets of b, d show a PS/Au Janus particle driven to swim under a defocused laser beam. All the aforementioned beam sizes were obtained by experimental measurement. Credit: Light: Science & Applications, doi: 10.1038/s41377-020-00378-5

calculated the thermoelectric force and optical force to understand the rotation dynamics. The team conducted further investigations to understand the self-alignment behavior of the Janus particle.

Feedback control method

The team then established a feedback algorithm to facilitate active navigation and steer the swimming direction of Janus particles. To accomplish closed-loop control, they developed a computer program to track the real-time position and orientation of a given Janus particle and automatically coordinated the control system. In the experimental setup, two computer-controlled shutters dictated the on/off states of two individual laser beams. The scientists successfully drove the directional swimming of Janus particles, where an increase in rotation speed reduced the control accuracy of the swimming direction. To account for this, Peng et al. used a higher-frame-rate charged-coupled device (CCD) camera to significantly improve the accuracy of feedback control. They then demonstrated active navigation of the PS/Au Janus particles using the feedback control algorithm for targeted transportation of opto-thermoelectric swimmers. The work indicated the potential of opto-thermoelectric microswimmers to carry drug molecules and non-metallic parts for precise delivery with potential applications in targeted nano/micro-drug delivery.

In this way, Xiaolei Peng and colleagues developed opto-thermoelectric microswimmers with all-optical actuation and navigation. They accomplished this by harnessing opto-thermoelectrical coupling of the Janus particles. The heat generated by the light-irradiated Janus particles created a thermoelectric field to propel the particles in a specific direction without chemical fuel. They used a focused laser beam to steer the orientation of the microswimmers and controlled the rotation of Janus particles with a second beam. The mechanism can be further explored to develop intelligent microrobots for multiple tasks in biomedicine.

More information: 1. Peng X. et al. Opto-thermoelectric microswimmers, *Nature Light: Science & Applications*, doi.org/10.1038/s41377-020-00378-5

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3. Kim K. et al. Ultrahigh-speed rotating nanoelectromechanical system devices assembled from nanoscale building blocks. *Nature Communications*, 10.1038/ncomms4632

Journal information: *Nature*, *Light: Science & Applications*, *ACS Nano*, *Nature Communications*
<https://phys.org/news/2020-09-opto-thermoelectric-microswimmers.html>

Indian Scientists discover ‘dance’ of Covid spike proteins, could help design vaccines

IISER Kolkata has managed to minutely study the interactions of the amino acid chains that make up the spike protein — the protrusions on the Covid virus that help it infect human cells

By Mohana Vasu

New Delhi: Scientists at the Indian Institute of Science Education and Research (IISER) Kolkata have decoded the various dynamic structures of the SARS-CoV-2 spike protein — the molecular machine that allows the entry of coronavirus into our cells. The research, the scientists say, can serve as a ‘recipe’ for Covid-19 vaccine developers.

The majority of the vaccines being developed worldwide work on a simple basic principle: Exposing the body to the spike protein — which make up the protrusions seen on the outer surface of the novel coronavirus — to trick the body into believing that it has been attacked by a pathogen and hence trigger an immune response.

For this reason, the 3D structure of the spike protein was one of the first to be fully studied and characterised, and even now, researchers are trying to learn as much as possible about the spike proteins of SARS-CoV-2.

IISER’s breakthrough

The stability of every biomolecular structure is governed by a parameter called ‘free energy’ which is fundamental in understanding how the molecule will react with its surroundings.

What the scientists at IISER Kolkata have done is to describe this free energy profile for different structures of the SARS-CoV-2 spike protein.

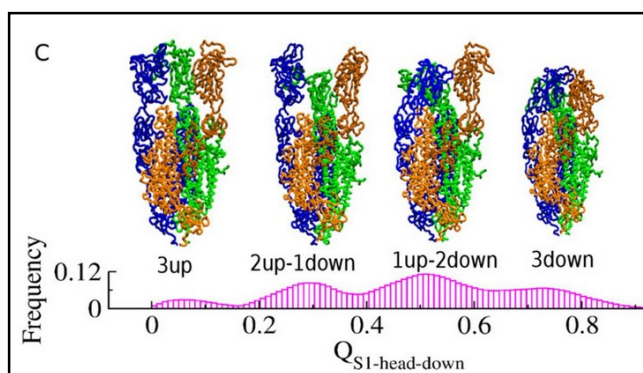
Susmita Roy, assistant professor of IISER Kolkata, told ThePrint that the spike proteins are made of three intertwined chains of amino acids, the building blocks of proteins.

The interactions between these chains cause a very unique set of dynamics within the spike proteins, which Roy describes as the “dance of the spike protein”. These interactions can cause the top ends of each chain of amino acid to unfurl into an ‘up’ position or fold into a ‘down’ position. The continuous shift from up to down positions make up the ‘dance’.

In a study published in *The Journal of Physical Chemistry Letters*, the team identified the states in which spike proteins are most likely to help the SARS-CoV-2 hook on to host human cells.

“When the chains are upwards, they are more exposed, which helps them to find and bind to the host cell receptors,” Roy said.

According to the researchers, these states trigger the human body’s immune response, and so understanding it can help design vaccines that induce a better immune response.



The ‘dance’ of the spike protein, as illustrated in the study ‘Dynamic Asymmetry Exposes 2019-nCoV Prefusion Spike’.

The team used existing data on the structure of the spike protein to find the ‘free energy’ associated with the different structures and determined which structures lead to a higher affinity towards the ACE2 receptors, the enzyme with which the spike protein binds to gain entry into human cells.

“In our study, we have found all the possible structural ensembles in spike proteins. We found that when either one or two chains are up, then the ACE2 receptors can bind very well,” Roy said.

How the study can help

The interaction-level information of the spike protein could provide deep insight into developing effective therapeutic targets as well as design vaccines, the researchers said in the study.

Most of the vaccine designs mimic the coronavirus spike protein, tricking the body into believing that it is under attack by a virus. As a result the body launches an immune response, and also learns to recognise the spike protein. This allows the body to be prepared with a more robust immune response the next time it encounters the real, live virus.

“We can say that our study is like a recipe for manipulating the spike proteins. Now that we know the atomic level mechanism of the spike protein, vaccine manufacturers can tweak the amino acid chains to get the best configuration of the spike protein,” Roy said.

This is not the first time a team has attempted to decode the molecular level structure of the spike protein. But, these earlier studies used Cryogenic electron microscopy (Cryo-EM) which failed to capture the changing dynamics of the structures.

The IISER Kolkata team’s computational study, though, was able to create a detailed map of the structures’ change in response to interactions within the spike protein.

The study also highlights some of the differences between the SARS-CoV-2 spike structures and the spike protein of the SARS virus that caused a pandemic in 2003.

“Although the structures are very similar, the dynamics of the spike proteins are different,” Roy said.

The up-down movement in the SARS-CoV-2 virus is more frequent compared to the dynamics of the spike protein in SARS and MERS viruses, which may be one of the reasons why the novel coronavirus spread as fast as it did, she added.

<https://theprint.in/health/indian-scientists-discover-dance-of-covid-spike-proteins-could-help-design-vaccines/494315/>

Neutrons probe biological materials for insights into COVID-19 virus infection

By Olivia Trani

SARS-CoV-2, the coronavirus responsible for the disease COVID-19, is infecting the world at a rapid rate. Understanding how this infection works at the molecular level could help experts discover ways to moderate or stop the spread.

A team of scientists at the Department of Energy's (DOE's) Oak Ridge National Laboratory (ORNL) is using neutron reflectometry to do just that.

Neutrons are capable of probing biological materials under physiological conditions without damaging them. By harnessing these properties, the researchers can measure the infection dynamics of the virus as it happens.

Their mission is to get a detailed look at some of the first stages of infection occurring at the cell membrane. These findings will help the team test antiviral drug candidates that could disrupt this process. The data obtained from these experiments could also inform other studies focused on developing therapeutics and vaccines.

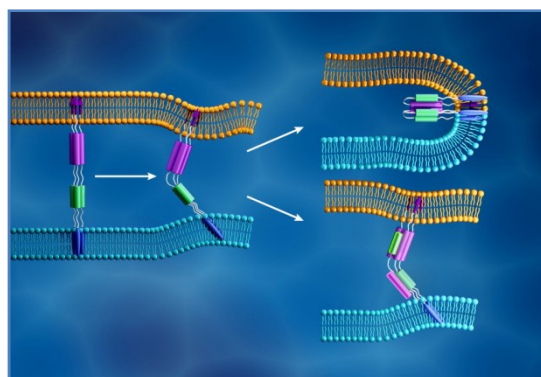
The researchers are focusing their analysis on SARS-CoV-2 spike proteins, barb-like structural proteins that cover the surface of the virus and trigger the infection process. The spike protein binds to a receptor on the host cell's outer layer and facilitates fusion between the viral and cellular membranes, allowing the virus to enter the cell and release its genetic material. The cell's protein-making machinery then uses this genetic information to make new copies of the virus.

When SARS-CoV-2 hijacks a host cell, its spike protein splits into two subunits, called S1 and S2. The two parts are both essential for infection. The S1 subunit contains a receptor binding domain that recognizes and latches on to a cell receptor. Cell receptors are proteins embedded within the cell membrane that can bind to specific molecules outside the cell. This connection can cause the components to change shape, which in turn could induce cascading changes within the cell. For the SARS-CoV-2 spike protein, this connection activates the S2 subunit, which helps the virus merge its membrane with that of the cell. Therefore, the spike protein's function is similar to opening a locked door, with S1 as the key that unlocks the door and S2 as the force that pushes the door open.

Learning from past epidemics

The overall structure of the SARS-CoV-2 spike protein is very similar to that of SARS-CoV, an earlier coronavirus that caused severe acute respiratory syndrome (SARS), and this resemblance helped the team develop their research strategy.

The S1 subunit is the focus of many drug development studies, since this part of the spike protein has been shown to provoke an immune response in the human body. However, previous SARS-CoV studies found the S1 subunit experiences high rates of mutation, allowing the virus to evade antibody-based treatments while maintaining its ability to infect cells. "This is the lesson we learned from the original SARS epidemic," said Minh Phan, a postdoctoral research associate at ORNL and principal investigator of this project.



The novel coronavirus membrane (light blue) and the human cell membrane (orange) merge together when the viral S2 subunit's fusion peptide (purple arrows) inserts into the cell membrane and a different component of the S2 subunit (purple and green) folds to form a tight structure, as shown in the top right. In contrast, as illustrated in the bottom right, fusion inhibitors are designed to prevent viral infection by disrupting this process. Credit: ORNL/Jill Hemman

Phan and his colleagues are studying the S2 subunit because this component of the spike protein does not mutate as quickly. Treatments that prove successful in inhibiting the S2 function may stay effective for a longer time.

A nanoscale view of coronavirus

To better understand the dynamics of viral S2 subunits and host cell membranes, the researchers are employing the liquids reflectometer (LIQREF) at ORNL's Spallation Neutron Source (SNS). By measuring how neutrons reflect at different angles when passing through different types of matter, the instrument can help shed light on the structure of biological materials at the molecular scale.

The team first synthesized a lipid membrane that mimics the outer membrane of cells that line the surfaces inside human lungs, where this viral infection can take place. They identified how the lipids were organized within the membrane and how this arrangement changes when the membranes are exposed to different conditions, such as temperature, pressure, and acidity.

At the LIQREF instrument, the researchers spread the lipid membrane atop a thin layer of water in an apparatus called a Langmuir trough. They then introduce the S2 subunit to these membranes to observe in detail how the S2 and lipid membranes change shape when they interact.

Neutrons are also ideal for this study because they are sensitive to the element hydrogen, common to all biological molecules, and its isotopes. By replacing some hydrogen atoms with deuterium atoms, scientists can create contrast in their samples and selectively zero in on different structural features. This technique is useful for studying samples that involve multiple components with similar densities, like lipid membranes.

"Generally, these membranes are not single-lipid membranes," said John Ankner, an instrument scientist involved with this study. "They consist of lipids of a certain structure, lipids of another structure, cholesterol, proteins, and things that come in contact with them."

To capture this complexity, the research team is investigating multiple versions of the membrane, changing the contrast of the sample with deuterium each time.

"By taking multiple measurements and assembling all of this information together, you can create a single picture of how these different components go together," said Ankner.

The information derived from these experiments will then help steer the team's efforts in selecting and testing drug candidates that could block this interaction, such as fusion inhibitors that successfully blocked original SARS-CoV infections. If these inhibitors can stop the new coronavirus from invading healthy cells, existing drugs could potentially be repurposed to treat COVID-19 patients. The results may also help guide the design of new fusion inhibitors.

Capturing infection

While other studies have used protein crystallography to better understand the atomic structure of the coronavirus S2 subunit alone, this project is analyzing how S2 changes shape when interacting with a lipid membrane. A shape change could be important for inducing actions within a cell after the spike S1 subunit binds to the cell receptor. Phan also notes that the LIQREF instrument allows the team to measure these dynamics under physiological conditions, whereas protein crystallography only allows researchers to capture what the S2 subunit looks like in a crystallized form.

"At ORNL, we have the right tools to study the dynamics of the interaction under physiological conditions. This allows us to better understand how the S2 subunit moves and changes shape naturally in a wet environment," said Phan. "Such information could complement what experts already know about the protein from crystallography. If we can help verify what this mechanism



Researchers at ORNL are using neutron scattering at the Spallation Neutron Source to better understand how spike proteins help the COVID-19 virus infect human cells and what drugs could be effective in stopping them. This research team includes John Ankner (left) and Minh Phan (right). Credit: ORNL/Genevieve Martin

looks like, then we may have a clearer understanding to guide the development of drugs that block the fusion process.

Collaboration is key

Of course, learning more about the S2 subunit and its certain behaviors depends on the ability to grow quality samples, which involves synthesizing S2 subunit proteins, purifying them, and preparing them for experimentation.

Phan and Ankner note that this part of their research has been made possible only through collaboration with labs across ORNL and at outside institutions.

The S2 subunit protein was synthesized in mammalian cell cultures by Steve Foster, a biomedical researcher at the University of Tennessee Medical Center in Knoxville, Tennessee. Through this method, he can develop S2 proteins for research that retain several aspects of its natural structure and function.

"In our lab we routinely use mammalian cell cultures for protein production, so we hope we've produced an S2 protein best suited for this research analysis. Our proximity to ORNL also works well in that the sample doesn't have to travel far, meaning less risk of damaging the protein or distorting its original structure, which is critical for this work," said Foster.

Following its synthesis, the sample was purified by Jessy Labbé and Michael Melesse Vergara from ORNL's Biosciences Division. Scientists from the ORNL Neutron Sciences Directorate then performed a series of tests to confirm the structure of the sample protein and check its purity. This effort was implemented by Yichong Fan and Wellington Leite from the Bio-Labs team, and Jacob Kinnun and Mary Odom from the SNS team.

"We put an enormous effort into making sure the protein has the right properties going into the experiment. If it does not, we could get spurious results and misinterpret what we're doing," said Hugh O'Neill, director of ORNL's Center for Structural and Molecular Biology and lead researcher for the Bio-Labs team.

"This virus is extremely delicate in its components, and it's a big challenge to get these materials to the neutron instrument," said Ankner. "That's why involving various ORNL labs and the University of Tennessee is so crucial. Each step that eventually gets the sample onto our instrument requires the expertise of lots of people."

This project also relied on efforts from the LIQREF instrument staff, who were instrumental in developing the systems, protocols, and modeling frameworks necessary to run the experiments and interpret the data.

"Experts across the division, across ORNL, and from partner institutes have come together for this project," said Phan. "We couldn't have done this without their support, and it's greater motivation to fulfill our mission."

<https://phys.org/news/2020-09-neutrons-probe-biological-materials-insights.html>

