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Illustration: Niklas Elmehed

THE NOBEL PRIZE IN PHYSICS 2026



Francis Halzen

"for decisive contributions to the IceCube
Neutrino Observatory and the discovery
of high-energy neutrinos of astrophysical origin"

THE ROYAL SWEDISH ACADEMY OF SCIENCES

1. Nobel Prize in Physics 2026: IceCube Neutrino Observatory

Source: The Hindu

GS: GS-3 — Science & Technology | Astronomy | Particle Physics

Context: Francis Halzen received the 2026 Nobel Prize in Physics for his contributions to the IceCube Neutrino Observatory and the discovery of high-energy neutrinos of astrophysical origin.

1. Neutrinos: Basic Understanding

1. **Nature:** Electrically neutral and extremely light subatomic particles that interact very weakly with matter.
2. **Abundance:** They are the **second most abundant known particles in the universe after photons**.
3. **Sources:** Produced by the Sun, nuclear reactions and energetic cosmic events such as supernovae and active galaxies.

2. IceCube Neutrino Observatory

1. **Location:** Built beneath the **South Pole, Antarctica**, using nearly one cubic kilometre of Antarctic ice as a detector.
2. **Detection system:** Contains around **5,160 optical sensors** embedded deep in the ice to detect faint flashes of light.
3. **Purpose:** Detects high-energy cosmic neutrinos and helps identify the distant astrophysical sources from which they originate.

3. How Does It Detect Neutrinos?

1. **Interaction:** A neutrino occasionally collides with an atomic nucleus in the ice, producing a charged particle.
2. **Cherenkov radiation:** The charged particle produces a faint blue flash called Cherenkov radiation while moving through the ice.
3. **Detection:** Optical sensors record the light, allowing scientists to estimate the neutrino's direction and energy.

4. Major Scientific Breakthroughs

1. **2013:** IceCube detected the first high-energy cosmic neutrinos, providing direct evidence of neutrinos arriving from outside our Solar System.
2. **2018:** A high-energy neutrino was associated with a distant **blazar**, an active galaxy powered by a supermassive black hole.
3. **Neutrino astronomy:** These discoveries established neutrinos as a new way of studying extreme cosmic phenomena beyond conventional light-based astronomy.

5. Significance

1. **New window to the universe:** Neutrinos can reveal information that electromagnetic radiation may not provide.

2. **Study of extreme objects:** Helps scientists investigate black holes, active galaxies and other high-energy cosmic events.
3. **Future discoveries:** Continued neutrino observations could reveal new astrophysical sources and improve our understanding of cosmic particle acceleration.

Supreme Court gets three new judges, strength goes up to 37

The Hindu Bureau

NEW DELHI

Three new Supreme Court judges took oath on Tuesday, raising the working strength to 37 even as case pendency hovers near one lakh. Chief Justice of India (CJI) Surya Kant administered the oath of office to Justices Sunita Agarwal, Devendra Kumar Upadhyay and Aparesh Kumar Singh at the Supreme Court.

The three judges were sworn in a day after the Centre notified their appointments. The Supreme Court Collegium had recommended their names to the government on September 28.

The appointment of the new judges has increased the number of working



CJI Surya Kant administers oath of office to newly appointed SC judge Sunita Agarwal during a swearing-in ceremony. PTI

judges in the apex court to one short of its sanctioned judicial strength of 38, including the CJI.

Justice Agarwal was serving as the Gujarat High Court Chief Justice before her appointment to the Supreme Court. The parent High Court of the judge is Allahabad. Justice Upadhyay's parent High Court is

also Allahabad though he was serving as the Delhi High Court Chief Justice at the time of his recommendation.

Justice Aparesh Kumar Singh, whose parent High Court is Jharkhand, was serving as Chief Justice of the Telangana High Court before being appointed to the Supreme Court.

2. Supreme Court Strength Rises to 37 Judges

Source: The Hindu | GS: GS-2 — Indian Polity | Constitution | Judiciary

Context: Three new judges took oath, raising the Supreme Court's working strength to 37 against its sanctioned strength of 38, amid pendency of nearly one lakh cases.

1. Supreme Court Strength

Sanctioned strength: 38 judges — One Chief Justice of India (CJI) and 37 other judges.

Working strength: 37 judges — Three new appointments leave one vacancy.

Legal basis: Supreme Court (Number of Judges) Amendment Act, 2019 — increased the sanctioned strength from 31 to 34; it was subsequently increased to 38.

2. Appointment of Supreme Court Judges

Article 124: The President formally appoints Supreme Court judges.

Collegium system: The CJI and four senior-most Supreme Court judges recommend appointments.

Government's role: The Union Government processes recommendations. If the Collegium reiterates a recommendation after reconsideration, the established convention is to accept it.

3. Case Pendency

Backlog: Nearly one lakh cases are pending before the Supreme Court, according to the report.

Major causes: Vacancies, repeated adjournments, procedural delays and increasing litigation.

Impact: Delays justice, raises litigation costs and weakens timely access to remedies.

4. Significance of the Appointments

Faster disposal: More judges can hear cases through additional benches.

Constitutional cases: Adequate strength helps constitute larger benches for important constitutional questions.

Judicial reforms: Timely appointments must be accompanied by better case management and fewer unnecessary adjournments.

More than half of overnight travel is by bus: NSO survey

India's first national travel survey finds 55.8% of overnight household journeys are by bus and 17.7% by rail; two-wheelers are main mode of transport for daily work, accounting for 42.6% of journeys

Jagriti Chandra
NEW DELHI

Buses are used significantly more than trains for overnight travel in India, with more than half of all household overnight journeys undertaken by bus, according to the country's first-ever National Household Travel Survey released by the National Statistics Office (NSO) on Monday.

The survey found that 55.8% of overnight household journeys are undertaken by bus, compared with 17.7% by inter-city railways. Together, buses and railways account for nearly three-fourths, or 73.5% of all overnight travel. Cars account for 15.1% of such journeys, while two-wheelers make up another 8.8%.

Railway use is significantly higher among urban households. About 22.7% of urban households use rail for overnight journeys, compared with around 14% of rural households.

Overnight journeys, however, are largely not undertaken for tourism. The survey found that 70.2% of



The survey found that 70.2% of overnight household trips are for social, communication, and religious purposes. FILE PHOTO

overnight household trips are for social, communication, and religious purposes. Culture, leisure, sports and tourism account for just 7.4% of such trips.

The daily commute

The pattern changes sharply when it comes to daily travel to work. Two-wheelers are the dominant mode of transport for workers, accounting for 42.6% of journeys. Their share rises to 52.3% among urban workers, compared with 37.1% in rural areas.

Public transport has a much smaller share of daily workforce mobility nationally. Buses account for

6.7% of work trips, while trains, the monorail, and trams together account for 2.1%. However, urban mass transit is considerably more important in some States and cities.

In Maharashtra, metro, suburban rail, monorail, and trams account for 20.7% of urban worker commutes, followed by West Bengal at 16.5% and Delhi at 14.4%, against the national urban average of 5%.

The survey also shows that most Indians have relatively short daily commutes.

The average journey to a fixed workplace takes 25

minutes, with the average rising to 27 minutes in urban areas.

The average monthly expenditure on commuting to a fixed workplace is ₹785 per worker.

Urban workers spend substantially more, at ₹1,044 a month, compared with ₹612 for rural workers. Male workers spend an average of ₹835 on their commute each month, against ₹533 for female workers.

The survey also highlights a gender disparity in workforce mobility. While 61.9% of male workers undertake work-related trips of more than one kilometre, the corresponding share for women is only 41.9%.

There is also a gender gap in commuting expenditure: male workers spend an average of ₹835 a month, compared with ₹533 for female workers.

The National Household Travel Survey, conducted between July 2025 and June 2026, covered 4,92,023 households and 20,34,371 people across 14,274 villages and 10,377 urban blocks.

3. National Household Travel Survey: Key Findings on Mobility

Source: The Hindu

Context: India's first National Household Travel Survey, conducted by the National Statistics Office (NSO) between July 2025 and June 2026, provides nationwide evidence on travel patterns, commuting costs and mobility inequalities.

1. Key Findings

Overnight travel: Buses account for 55.8% of overnight household journeys, followed by railways at 17.7%.

Daily commuting: Two-wheelers account for 42.6% of work-related journeys nationally.

Survey coverage: 4,92,023 households and 20,34,371 people across 14,274 villages and 10,377 urban blocks.

2. Rural–Urban Differences

Rail connectivity: Around 22.7% of urban households use rail for overnight journeys, compared with about 14% of rural households.

Two-wheeler dependence: Two-wheelers account for 52.3% of urban workers' journeys and 37.1% in rural areas.

Public transport: Urban mass-transit use varies considerably across States, reflecting differences in transport infrastructure.

3. Commuting Costs and Gender

Monthly expenditure: Average commuting expenditure is ₹785 per worker, rising to ₹1,044 in urban areas compared with ₹612 in rural areas.

Gender gap in mobility: 61.9% of male workers undertake work-related journeys exceeding one kilometre, compared with 41.9% of female workers.

Gender gap in spending: Male workers spend an average of ₹835 monthly on commuting, compared with ₹533 for female workers.

4. Significance

Evidence-based planning: Helps governments align transport investment with actual travel patterns and regional needs.

Sustainable mobility: Supports better bus and rail networks, reducing excessive dependence on private vehicles and urban congestion.

Inclusive connectivity: Highlights rural–urban and gender disparities, helping improve safe, affordable access to employment, education and healthcare.

Economic productivity: Reliable and affordable transport can reduce commuting burdens, expand access to jobs and markets, and support regional development.

– ‘Beyond self-reliance’: Rajnath flags off *Surya*, India’ first indigenous fleet support ship

V. Kamalakara Rao
VISAKHAPATNAM

Defence Minister Rajnath Singh launched the Navy’s first indigenous fleet support ship (FSS-1), named *Surya*, and laid the keel for the fifth vessel of the series, FSS-5, at Hindustan Shipyard Limited (HSL) in Visakhapatnam on Tuesday.

The ceremony was attended by Chief of the Naval Staff Admiral Krishna Swaminathan, Defence Secretary Rajesh Kumar Singh, Secretary (Defence Production) Sanjeev Kumar, Flag Officer Commanding-in-Chief of the Eastern Naval Command Vice Admiral Sanjay Bhal-la, HSL CMD Rear Admiral C. Raghuram, and other dignitaries.

The Minister urged Indian shipyards to look



Rajnath Singh addressing the gathering at the launch of the fleet support ship, *Surya*, in Visakhapatnam on Tuesday. V. RAJU

beyond self-reliance towards global competitiveness, aiming to serve international markets, build a presence in marine technology, and provide advanced ship repair services.

The massive Fleet Support Ship (FSS) initiative is backed by a landmark ₹19,000-crore contract between the Ministry of Defence and HSL to con-

struct five indigenous auxiliary vessels.

The FSS platform, with 82% indigenous content, serves as a floating supply powerhouse, engineered to sustain protracted, high-intensity naval engagements and battle groups far from home ports.

Its internal storage holds up to 20,000 tonnes of high-speed diesel, 2,500 tonnes of aviation turbine

fuel, fresh water, alongside dry cargo containers for ammunition and spares. It can simultaneously transfer fuel, stores, and personnel to multiple warships to maintain continuous high-seas deployment.

Massive overhaul

To execute this mega-project, HSL underwent a massive infrastructural overhaul, highlighted by the inauguration of its newly modernised Slipway No. 4 and a 300-tonne Goliath crane. These upgrades expanded covered building dock capacity to 80,000 DWT, enabling construction up to 45,000 DWT. Incorporating 82% indigenous content, the FSS programme secures strategic autonomy and reinforces Aatmanirbhar Bharat Abhiyan, the mission to make India self-reliant.

4. **Surya: India's First Indigenous Fleet Support Ship**

Source: The Hindu

GS: GS-3 — Defence Technology | Indigenous Manufacturing | Maritime Security

Context: Defence Minister Rajnath Singh launched *Surya*, the Indian Navy’s first indigenous Fleet Support Ship (FSS), at Hindustan Shipyard Limited (HSL), Visakhapatnam, strengthening naval logistics and defence self-reliance.

1. **Fleet Support Ship: Role and Features**

At-sea replenishment: Supplies fuel, fresh water, ammunition, spare parts and other essential stores to warships at sea.

Extended deployment: Allows naval vessels to operate for longer periods without returning to port.

Logistical support: Can transfer fuel, supplies and personnel to multiple warships, sustaining prolonged naval operations.

Indigenous content: Incorporates 82% indigenous content, supporting domestic defence manufacturing.

2. Key Project Details

Project cost: ₹19,000-crore contract between the Ministry of Defence and HSL for five indigenous Fleet Support Ships.

Fuel capacity: Designed to carry up to 20,000 tonnes of high-speed diesel and 2,500 tonnes of aviation turbine fuel.

Shipyard modernisation: HSL upgraded its infrastructure, including Slipway No. 4 and a 300-tonne Goliath crane.

Construction capability: The upgraded facilities support construction of larger vessels and strengthen India's shipbuilding ecosystem.

3. Significance

Maritime endurance: Enables Indian Navy ships to remain deployed longer, including far from home ports.

Defence self-reliance: Reduces dependence on foreign suppliers for naval logistics platforms.

Industrial development: Strengthens domestic shipyards, skilled employment and maritime supply chains.

Strategic reach: Enhances India's ability to sustain naval operations across the Indian Ocean Region.

Aatmanirbhar Bharat: Advances indigenous defence production and the development of domestic shipbuilding capabilities.

4. Way Forward

Indigenous technology: Expand domestic production of propulsion systems and critical naval components.

Timely delivery: Ensure quality construction and timely completion of all five ships.

Global competitiveness: Develop Indian shipyards as competitive suppliers of advanced vessels and marine technologies.

Why NASA wants to build a nuclear reactor on the moon

NEWS ANALYSIS

Vasudevan Mukunth

NASA wants to install a nuclear reactor near the moon's south pole by 2030. Its planned output, 20 kilowatt (kW), could power a few households on earth. Russia's planned reactor for the International Lunar Research Station (ILRS), led by China, will produce around 10 kW. But the fact that they are nuclear makes them significant. The U.S. and China are pursuing parallel efforts today – in partnership with other countries – to be the first to set up a semi-permanent, and in future permanent, moon base. Such a facility will need electricity for everything from heating and life-support to recharging rover batteries. European scientists are also exploring lunar microreactors.

At most locations on the moon, a fortnight of daylight follows a fortnight of darkness. Near the south pole, where both factions are focusing their activities, promontories and craters create a pastiche of lit and shadowed patches, with temperatures inside some of the latter dipping under a frigid -200 C. But unlike solar panels, a nuclear reactor can produce



View of Moon limb. ISTOCKPHOTO

lysed to produce hydrogen and oxygen, to power rockets launched from the moon itself. In one 2020 assessment, NASA scientists Julie Kleinhenz and Aaron Paz figured producing 10 tonnes of oxygen this way would require around 68 kW of power. So a 20-kW reactor could be a stepping stone in countries' plans to set up an array of reactors on the moon.

While the moon as a whole is barren, the more ideal locations, with longer periods of sunlight, terrain more suitable to land on, access to craters with water ice, and so on, are highly limited. Research commissioned by NASA has recommended situating nuclear reactors at least 1 km away from humans.

Now, the Outer Space Treaty 1967 says no country may appropriate any part of the moon through occupation or other means. But the Artemis Accords, to which the U.S. and its allies vis-à-vis the

on the moon to limit access to others: it can simply plonk a nuclear reactor there and appeal to the need for legitimate safety requirements.

The Accords say these zones must be temporary and respect free access – but a country or a bloc operating a cluster of reactors, landing pads, mines, and habitats could nevertheless gain a controlling advantage. For the appeal of this idea, however, both Artemis and ILRS face breathtaking technical hurdles. Shielding a nuclear reactor on the moon demands either launching the components to ensure its safe operation or producing them on the moon with lunar resources. Distancing a reactor from a base demands deployment machines and power cables. The reactor core will also have to be launched unirradiated and, once online, space agencies will have to find ways to absorb and store all the heat – or radiate waste heat away from large surfaces kept free of moondust. If a reactor fails on the moon, it could contaminate the same few places astronauts would like to be at.

While nuclear power could prove indispensable to a mature economy centred on the moon, no country possesses that

5. NASA's Plan for a Nuclear Reactor on the Moon

Source: The Hindu

GS: GS-3 — Science & Technology | Space Technology | Nuclear Energy | International Relations

Context: NASA aims to deploy a nuclear reactor near the Moon's south pole by 2030 to provide reliable power for long-duration lunar missions. The initiative reflects growing competition to establish sustained human and scientific activity on the Moon.

1. Why Does the Moon Need Nuclear Power?

Long lunar nights: Night lasts approximately 14 Earth days, limiting the reliability of solar power.

Continuous electricity: Habitats require power for heating, life-support systems, communications and equipment.

Rover operations: Nuclear energy can support exploration vehicles and scientific instruments during darkness.

Lunar resource utilisation: Electricity could help extract water ice and process it into hydrogen and oxygen.

Future settlements: A reliable energy supply is essential for a sustained human presence on the Moon.

2. Proposed Lunar Nuclear Reactors

NASA's plan: A proposed reactor producing approximately 20 kilowatts (kW), targeted for deployment by 2030.

China–Russia initiative: The International Lunar Research Station (ILRS) plans a nuclear power system with an estimated output of around 10 kW.

Location: The lunar south pole is a priority because of its water-ice deposits and favourable illumination in certain areas.

Site selection: NASA research recommends placing reactors at least one kilometre away from human habitats.

Strategic competition: Reliable power could give early lunar operators an advantage in sustaining scientific facilities and exploration activities.

3. Major Technical Challenges

Radiation protection: The reactor must shield astronauts and sensitive equipment from harmful radiation.

Heat dissipation: Engineers must manage waste heat in the Moon's near-vacuum environment.

Transportation: Heavy reactor components must be safely launched, landed and assembled.

Lunar manufacturing: Producing reactor components using local resources remains technically challenging.

Accident prevention: Reactor failure or radioactive contamination could threaten astronauts and valuable lunar research sites.

4. Legal and Geopolitical Concerns

Outer Space Treaty, 1967: Prohibits national appropriation of the Moon through sovereignty claims or occupation.

Artemis Accords: Support peaceful exploration and temporary safety zones to prevent harmful interference, while respecting free access.

Risk of de facto control: A country operating reactors, landing pads and habitats could gain practical advantages over other lunar explorers.

Resource access: Competition may intensify around water-ice deposits and permanently shadowed craters.

Need for cooperation: Transparent operations, shared safety standards and international coordination can reduce disputes.

5. Significance

Sustained lunar exploration: Enables longer missions that are not dependent solely on sunlight.

Space economy: Could support lunar mining, scientific facilities and future production of rocket propellant.

Scientific advancement: Provides power for experiments and exploration in areas that are difficult to access.

Energy technology: Advances compact nuclear systems designed for extreme environments.

Global governance: Tests whether international space law can manage strategic competition while preserving peaceful access to the Moon.

Centre plans 5-pronged reform as GST panel meets tomorrow

T.C.A. Sharad Raghavan
NEW DELHI

The Centre will propose a five-pronged plan for the next set of reforms to the Goods and Services Tax (GST) system at the upcoming GST Council meeting on Thursday, according to sources in the Union Finance Ministry.

These reforms are aimed at automating and easing a lot of the current administrative bottlenecks in the GST system, and reducing the compliance burden, especially for small businesses. Rates, including the GST on the Merchant Discount Rate (MDR) on UPI transactions, will not be on the agenda.

The five-pronged proposal covers process reforms, structural reforms, ease of living and doing business, exports of services, and e-commerce.

Some of the key changes proposed involve automatic invoice matching between buyers and sellers, reducing paperwork

Reform proposal

The five-pronged plan aims at automating and easing administrative bottlenecks in the GST system

FOCUS ON:

- Process reforms
- Structural reforms
- Ease of living and doing business
- Export of services
- E-commerce

- Key beneficiaries will be small businesses, inter-State businesses, and service exporters



- The proposals will be discussed at the GST Council meeting and, if approved, will be implemented in a staggered manner

around claiming input tax credits (ITC), reducing the number of times small taxpayers have to file returns, and removing multi-state registrations for small businesses looking to sell across the country.

Relief measures

The Centre will be sharing a concept note with the States on allowing small taxpayers who supply only to consumers to file their returns once a year instead of once a month as is currently the case.

Another major demand of service providers is to

widen the net of what constitutes an export.

At the moment, providing a service to a foreign client through a branch abroad is not counted as an export of service. The Centre is proposing to amend this to categorise such business as an export. The proposals are to be discussed at the GST Council meeting and, if approved, will be implemented in a staggered manner to give businesses time to adapt to the new systems.

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6. Five-Pronged GST Reform Plan

Source: The Hindu

Context: The Centre has proposed five areas of Goods and Services Tax (GST) reform to simplify compliance, reduce administrative burdens and support small businesses and service exporters.

1. GST: Concept and Constitutional Basics

1. **Meaning:** GST is a destination-based indirect tax levied on the supply of goods and services. It replaced several central and state indirect taxes and aims to create a unified national market.
2. **Constitutional basis:** The 101st Constitutional Amendment Act, 2016 introduced GST. Article 279A provides for the GST Council, which recommends tax rates, exemptions and other key GST policies.
3. **GST Council composition:** Chaired by the Union Finance Minister, it includes the Union Minister of State for Finance/Revenue and a nominated minister from each State.
4. **Quorum and voting:** Quorum requires one-half of the total members. Decisions require at least three-fourths of weighted votes of members present and voting; the Centre has one-third weight and the States collectively have two-thirds.
5. **Types of GST:** CGST (Central GST) and SGST (State GST) apply to intra-State supplies; IGST (Integrated GST) applies to inter-State supplies and imports. UTGST applies to supplies within Union Territories without legislatures, as applicable.

2. Five Areas of GST Reform

1. **Process reforms:** Automate invoice matching between buyers and sellers, simplify Input Tax Credit (ITC) claims and reduce paperwork.
2. **Structural reforms:** Simplify registration requirements for small businesses operating across multiple States, reducing administrative burdens.
3. **Ease of living and doing business:** Allow eligible small taxpayers supplying only to consumers to file annual rather than monthly returns, reducing compliance costs.
4. **Service exports:** Clarify rules so that services provided to foreign clients through overseas branches may qualify as exports, subject to applicable conditions.
5. **E-commerce:** Simplify GST procedures for online sellers, particularly small businesses facing registration, reporting and compliance difficulties.

3. Significance of the Reforms

Lower compliance burden: Simplified procedures save time and reduce the cost of tax compliance, especially for small businesses.

Ease of doing business: Easier registration and filing can support business expansion across States and encourage formalisation.

Export competitiveness: Clearer service-export rules can improve the ability of Indian service providers to compete internationally.

Digital tax administration: Automated invoice matching can improve transparency, reduce errors and strengthen tax-credit verification.