QUANTUM ROSE

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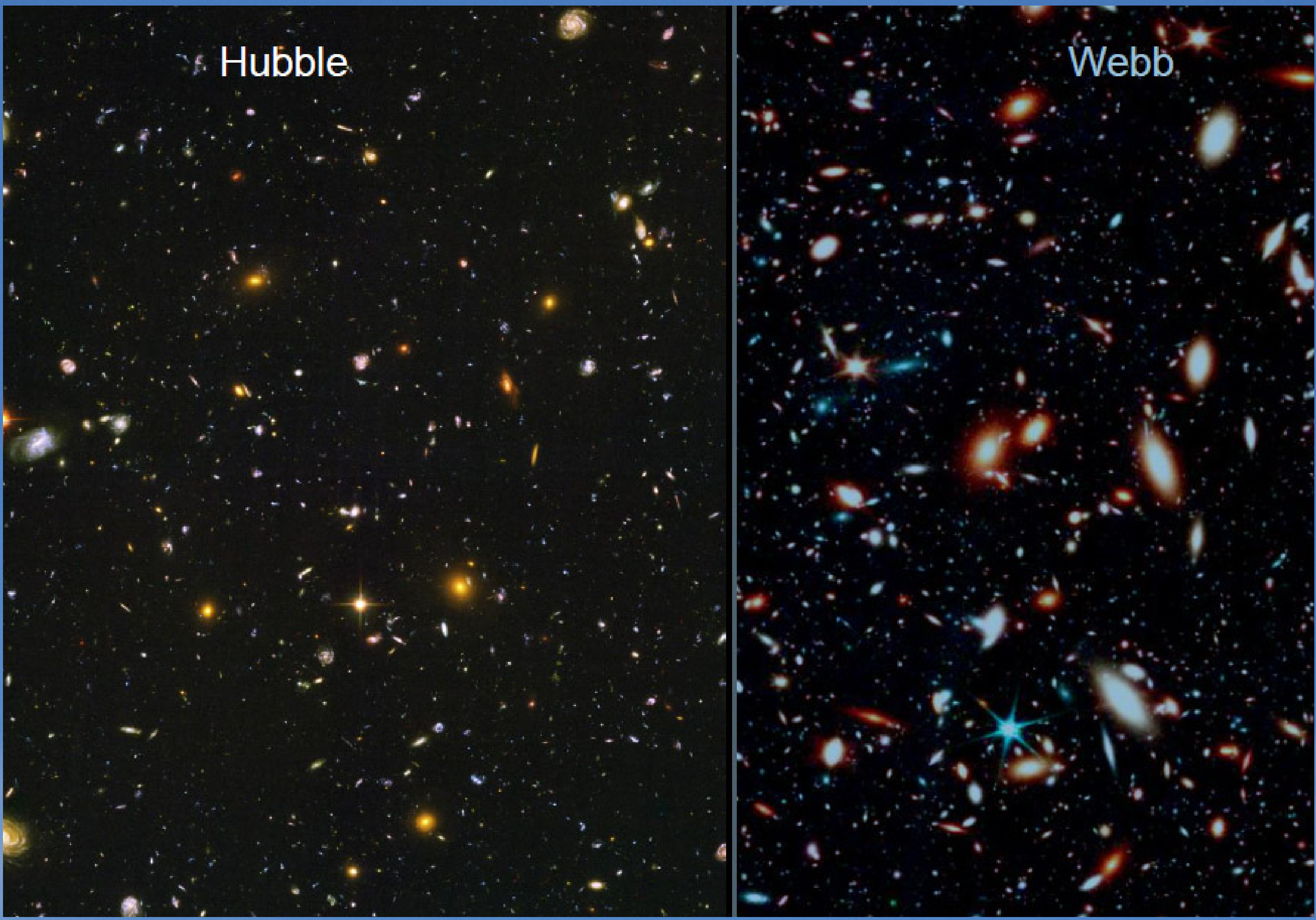
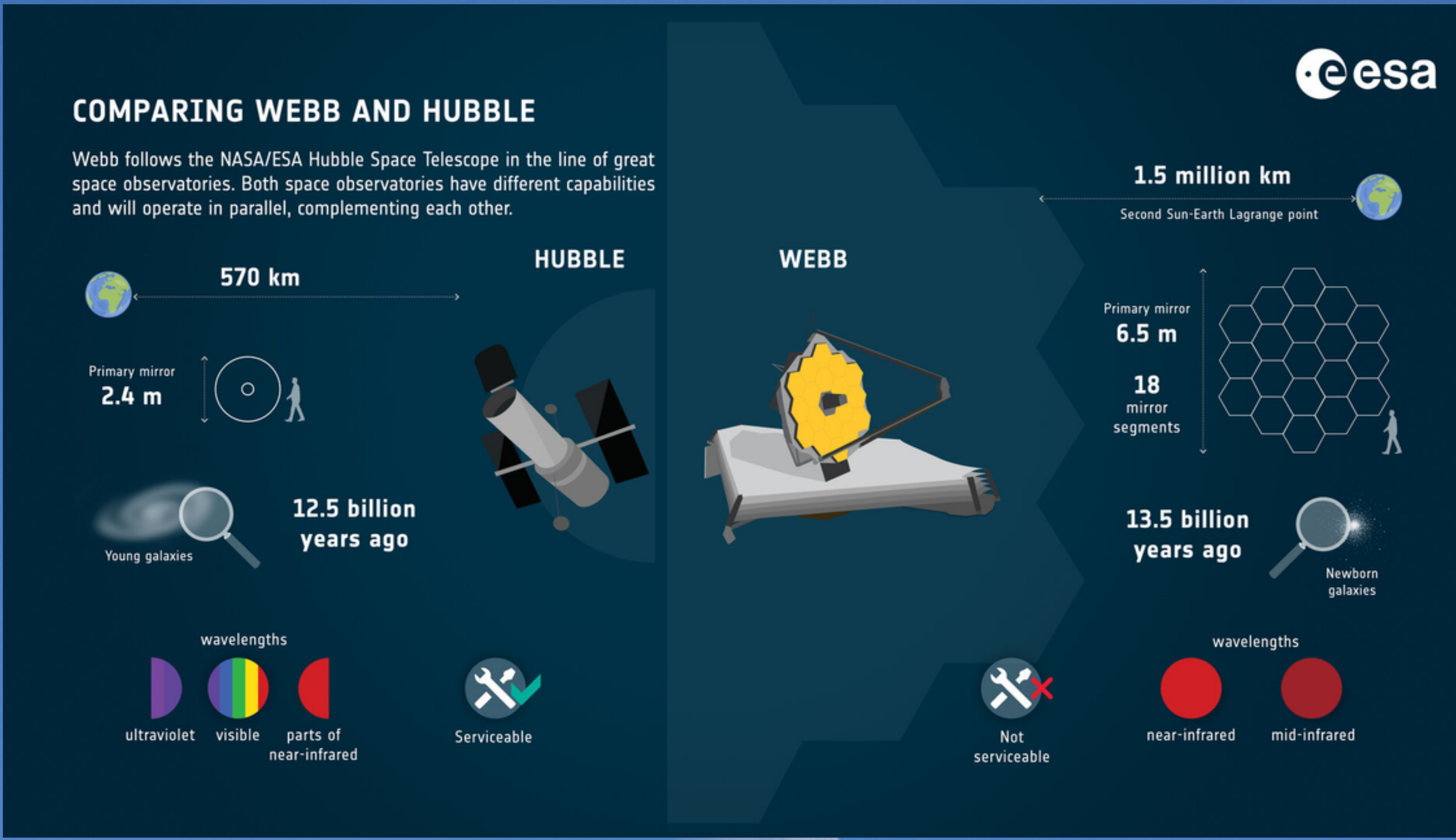
James Web Telescope

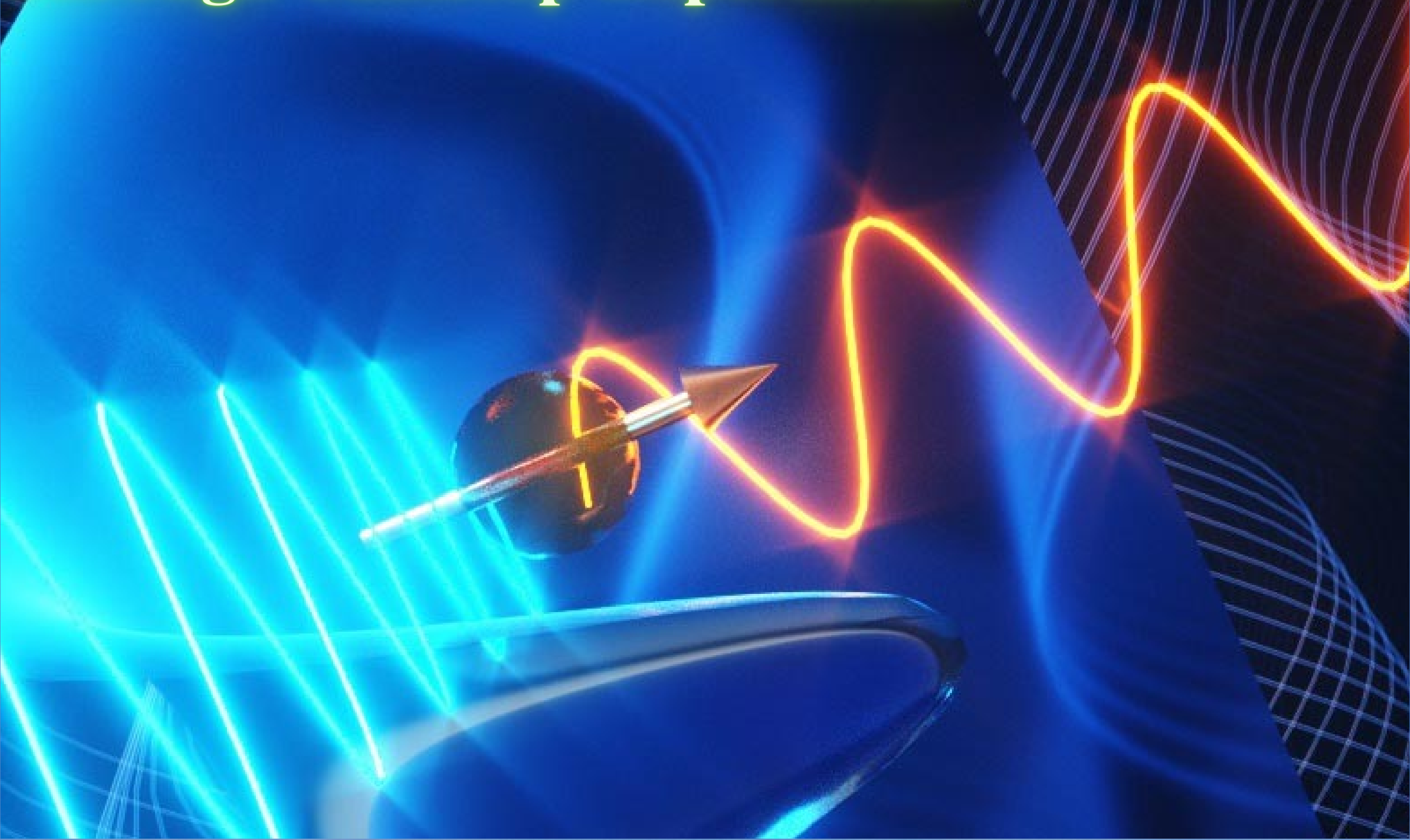


The JWST was designed to use a broad range of infrared light. And this is a key reason the JWST can see further back in time than Hubble. Galaxies emit a range of wavelengths on the electromagnetic spectrum, from gamma rays to radio waves, and everything in between.



Webb's First Images

Physicists Discover Elusive New Particle Through Tabletop Experiment



An interdisciplinary team of scientists led by Boston College physicists announced that they have discovered a new particle – or previously undetectable quantum excitation – known as the axial Higgs mode, a magnetic relative of the mass-defining Higgs Boson particle. The team published their report today (June 8, 2022) in the online edition of the journal Nature.

The Higgs boson is the fundamental particle associated with the Higgs field, a field that gives mass to other fundamental particles such as electrons and quarks. A particle's mass determines how much it resists changing its speed or position when it encounters a force.

The detection a decade ago of the long-sought Higgs Boson became central to the understanding of mass. Unlike its parent, axial Higgs mode has a magnetic moment, and that requires a more complex form of the theory to explain its properties.
Theories that predicted the existence of such a mode have been invoked to explain "dark matter," the nearly invisible material that makes up much of the universe, but only reveals itself via gravity,

Whereas Higgs Boson was revealed by experiments in a massive particle collider, the team focused on RTe3, or rare-earth tritelluride, a well-studied quantum material that can be examined at room temperature in a "tabletop" experimental format.

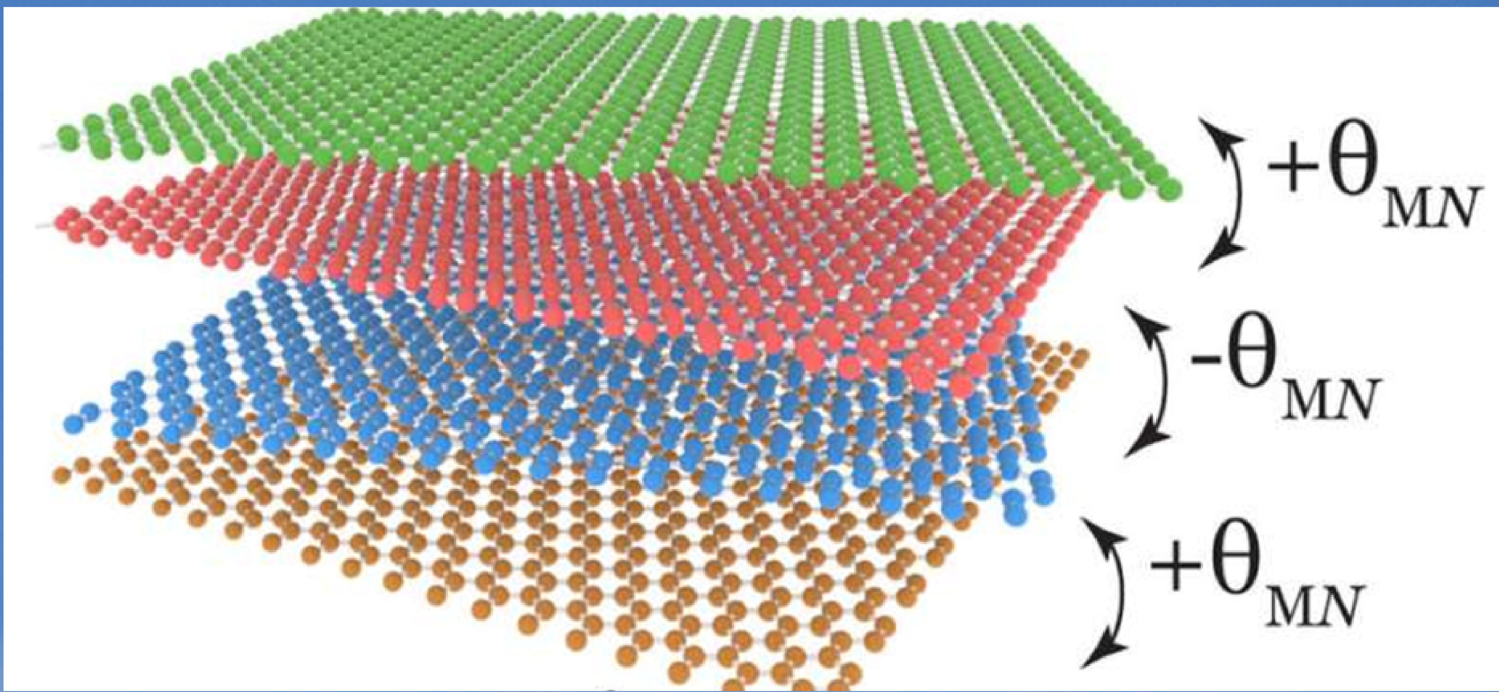
RTe3 has properties that mimic the theory that produces the axial Higgs mode. But the central challenge in finding Higgs particles in general is their weak coupling to experimental probes, such as beams of light, he said. Similarly, revealing the subtle quantum properties of particles usually requires rather complex experimental setups including enormous magnets and high-powered lasers, while cooling samples to extremely cold temperatures.

The team reports that it overcame these challenges through the unique use of the scattering of light and proper choice of quantum simulator, essentially a material mimicking the desired properties for study.
Specifically, the researchers focused on a compound long known to possess a “charge density wave,” namely a state where electrons self-organize with a density that is periodic in space.
The fundamental theory of this wave mimics components of the standard model of particle physics. However, in this case, the charge density wave is quite special, it emerges far above room temperature and involves modulation of both the charge density and the atomic orbits. This allows for the Higgs Boson associated with this charge density wave to have additional components, namely it could be axial, meaning it contains angular momentum.
In order to reveal the subtle nature of this mode, the team used light scattering, where a laser is shined on the material and can change color as well as polarization. The change in color results from the light creating the Higgs Boson in the material, while the polarization is sensitive to the symmetry components of the particle.

In addition, through proper choice of the incident and outgoing polarization, the particle coulc be created with different components – such as one absent magnetism, or a componen pointing up. Exploiting a fundamental aspect of quantum mechanics, they used the fact tha for one configuration, these components cancel. However, for a different configuration they add.
The detection of the axial Higgs was predicted in high-energy particle physics to explain dark matter, However, it has never been observed. Its appearance in a condensed matter system was completely surprising and heralds the discovery of a new broken symmetry state that had no been predicted. Unlike the extreme conditions typically required to observe new particles, this was done at room temperature in a tabletop experiment.

PHYSICISTS DISCOVER A 'FAMILY' OF ROBUST, SUPERCONDUCTING GRAPHENE STRUCTURES

Graphene is a single-atom-thin material that can be exfoliated from the same graphite that is found in pencil lead. The ultrathin material is made entirely from carbon atoms that are arranged in a simple hexagonal pattern, similar to that of chicken wire. Since its isolation in 2004, graphene has been found to embody numerous remarkable properties in its single-layer form.



In 2018, MIT researchers found that if two graphene layers are stacked at a very specific "magic" angle, the twisted bilayer structure could exhibit robust superconductivity, a widely sought material state in which an electrical current can flow through with zero energy loss. Recently, the same group found a similar superconductive state exists in twisted trilayer graphene—a structure made from three graphene layers stacked at a precise, new magic angle.

Now the team reports that—you guessed it—four and five graphene layers can be twisted and stacked at new magic angles to elicit robust superconductivity at low temperatures. This latest discovery, published this week in Nature Materials, establishes the various twisted and stacked configurations of graphene as the first known "family" of multilayer magic-angle superconductors. The team also identified similarities and differences between graphene family members.

The findings could serve as a blueprint for designing practical, room-temperature superconductors. If the properties among family members could be replicated in other, naturally conductive materials, they could be harnessed, for instance, to deliver electricity without dissipation or build magnetically levitating trains that run without friction

The magic-angle graphene system is now a legitimate 'family,' beyond a couple of systems," says lead author Jeong Min (Jane) Park, a graduate student in MIT's Department of Physics. "Having this family is particularly meaningful because it provides a way to design robust superconductors."

For more details click https://bit.ly/3AD2EEM
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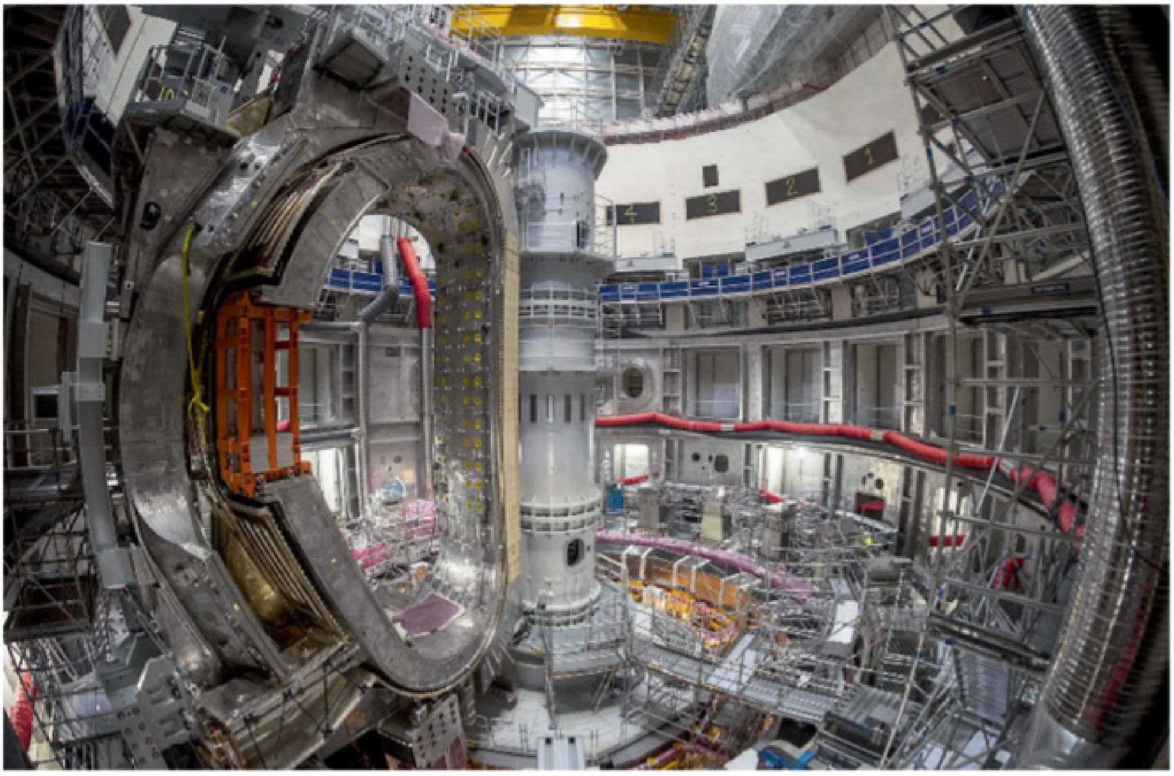
ITER-International Thermonuclear Experimental Reactor



ITER, being built in France, will inform commercial fusion

Fusion plans announced

A European consortium is beginning to design a commercial nuclear fusion power plant to be built by 2054, reports **Adam Vaughan**

NUCLEAR fusion engineers are starting to design a power station they hope will mimic how the sun works to provide a clean, almost unlimited source of energy.

This week marks the beginning of a five-year "conceptual design" phase to flesh out key technology decisions for the DEMOnstration power plant (DEMO), a project backed by a European consortium, EuroFusion, to take fusion power from the concept stage to a commercial reality. The group plans for the 300 to 500 megawatt reactor to be generating low-carbon energy by 2054.

There has been plenty of experimental work on nuclear fusion, largely with machines known as tokamaks. These use powerful magnets to confine and control hot matter – or plasma – usually in the shape of a doughnut. The plasma is typically produced from two hydrogen isotopes: deuterium and tritium.

Much of the research has focused on tweaking the materials and magnets in the walls of tokamaks, and better modelling how experiments with plasmas will play out, with the ultimate aim of getting more energy out of a fusion reaction than goes in.

That major milestone of "net gain" has yet to be achieved, but there is progress: a global energy record was set last year. More may occur when an €18 billion research tokamak in France, known as ITER, is switched on. It is scheduled for completion in 2025 and due to achieve full power in 2035.

The DEMO power station will need to control and maintain the plasma for much longer than experiments to date. DEMO will also need to collect the heat from the reaction and turn it into electricity, all while working 24 hours a day. "It's hard. But that's why we need to start – that's exactly the point," says Ambrogio Fasoli, chair of the EuroFusion General Assembly, the decision-making body for the consortium, which is funded by EU member states and Switzerland.

> **"DEMO will need to collect heat from the reaction and turn it into electricity, for 24 hours a day"**

There are problems to overcome, such as generating tritium. Supplies of the isotope are limited and expensive because it decays quickly. Research projects have so far used only grams, but a power station will need kilograms. This will require design choices about how to create more tritium by allowing neutrons to escape the plasma and interact with lithium in the tokamak's walls.

Other design choices include the materials to use in the tokamak walls, which will be exposed to a huge influx of neutrons from the fusion reaction. "The dose [of neutrons] that the structure absorbs is much, much bigger than we ever had to do. It's really orders of magnitude larger," says Fasoli.

He says work on DEMO can't wait for the completion of ITER, but must happen in parallel. "[Otherwise] there will be a big gap of decades and then nobody will have an interest in fusion," says Fasoli. Nonetheless, he says DEMO must learn from ITER.

Where the power plant will be built remains to be seen. Juan Matthews at the University of Manchester, UK, is betting on Germany, given it has no fusion device and France and the UK have won competitions to host previous ones.

Whatever DEMO's conceptual design looks like when it is finished in 2027, the plant is unlikely to be the world's first fusion power station. Several private fusion start-ups have claimed they will have one operating by the early 2030s, while the UK government has said its "STEP" fusion power plant will be running by 2040. China has said it will have one complete in 2035. ▮

By - Gaurav Kumar Singh

India's first Liquid Mirror Telescope

India has set up the nation's first-ever 'liquid mirror telescope' at Uttarakhand's Devasthal Observatory, which also happens to be Asia's largest International Liquid Mirror Telescope.

The telescope is owned and operated by Aryabhatta Research Institute of Observational Science (ARIES). It also happens to be the first-ever liquid mirror telescope to be commissioned for astronomy.

A liquid mirror telescope makes use of reflective liquids. The one installed at Devasthal makes use of Mercury and is capable of showcasing numerous celestial objects including stars, galaxies, supernovae explosions, asteroids, space debris etc.

These are made of liquid stored in a cylindrical container made of a composite material, such as Kevlar, which is a heat-resistant and strong synthetic fiber,. The cylinder is spun until it reaches a few revolutions per minute. The liquid gradually forms a paraboloid, the shape of a conventional telescopic mirror.
(conventional telescopes make use of polished glass mirrors)

WHAT IS A QUASAR!!!

A quasar also known as a quasi-stellar object, abbreviated (QSO) is an extremely luminous active galactic nucleus powered by a supermassive black hole, with mass ranging from millions to tens of billions of solar masses, surrounded by a gaseous accretion disc. Gas in the disc falling towards the black hole heats up because of friction and releases energy in the form of electromagnetic radiation. The radiant energy of quasars is enormous; the most powerful quasars have luminosities thousands of times greater than that of a galaxy such as the Milky Way. Usually, quasars are categorized as a subclass of the more general category of AGN. The redshifts of quasars are of cosmological origin.

The term quasar originated as a contraction of "quasi-stellar (star like) radio source"—because quasars were first identified during the 1950s as sources of radio-wave emission of unknown physical origin—and when identified in photographic images at visible wavelengths, they resembled faint, star-like points of light. High-resolution images of quasars, particularly from the Hubble Space Telescope, have demonstrated that quasars occur in the centers of galaxies, and that some host galaxies are strongly interacting or merging galaxies. As with other categories of AGN, the observed properties of a quasar depend on many factors, including the mass of the black hole, the rate of gas accretion, the orientation of the accretion disc relative to the observer, the presence or absence of a jet, and the degree of obscuration by gas and dust within the host galaxy.