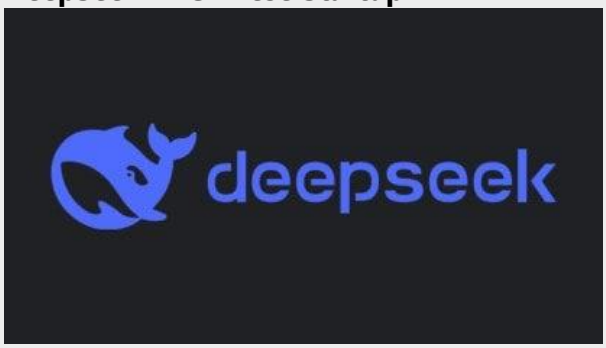
1. Deepseek: How open-source AI is disrupting big tech's monopoly

DeepSeek AI Chinese Startup



Recently, the stock market opened with a massive dip, especially the tech-heavy Nasdaq, which dropped by about 3 per cent. This is its worst performance in the last two years. This drop has been attributed to the meteoric rise of Chinese AI startup DeepSeek, which has in the last few weeks grabbed global attention after it unveiled its AI models — DeepSeek-V3 and DeepSeek-R1, a reasoning model.

The AI models from the Chinese startup went on to gain widespread acceptance, eventually surpassing ChatGPT as the most downloaded app on the App Store. DeepSeek-V3 and DeepSeek-R1 rival OpenAI's cutting-edge models o1 and o3, as the Chinese lab achieved this feat only with a fraction of their investments.

What is DeepSeek?

DeepSeek is a Chinese AI company based out of Hangzhou founded by entrepreneur Liang Wenfeng. What sets DeepSeek models apart is their performance and open-sourced nature with open weights, which essentially allows anyone to build on top of them. The DeepSeek-V3 has been trained on a meager $5 million, which is a fraction of the hundreds of millions pumped in by OpenAI, Meta, Google, etc., into their frontier models.

What is different about DeepSeek AI models?

Owing to its optimal use of scarce resources, DeepSeek has been pitted against US AI powerhouse OpenAI, as it is widely known for building large language models. DeepSeek-V3, one of the first models unveiled by the company, earlier this month surpassed GPT-4o and Claude 3.5 Sonnet in numerous benchmarks.

DeepSeek-V3 stands out because of its architecture, known as Mixture-of-Experts (MOE). The MOE models are like a team of specialist models working together to answer a question, instead of a single big model managing everything.

Relevance: GS Prelims; Science & Technology
Source: The Hindu

2. Why China's recent nuclear fusion breakthrough is significant

Introduction

An experimental nuclear fusion reactor in China last week triggered a lot of excitement by keeping its operational state maintained for more than 1,000 seconds, or over 17 minutes, which is a new record. Nuclear fusion is what produces the energy in the Sun, or any other star.

Scientists across the world have been trying to recreate this process to produce electricity. The technology can eliminate the world's energy crisis, and the problem of climate change, but it has not been mastered yet.

The Chinese reactor did not produce electricity. It did not even carry out a fusion reaction. The technology has not yet reached that stage.

However, the reactor managed to maintain plasma in a steady state of confinement for a long time, longer than it had previously been possible. This itself was a major step forward towards the dream of realising a fusion-based nuclear reactor in the near future.

Extreme conditions

Fusion reactions require very high temperatures, hundreds of millions of degrees Celsius — higher than the temperatures in the Sun's core.

At such high temperatures, matter exists only in the plasma state, in which atoms get split into positively and negatively charged particles. But such hot plasma cannot be handled by or contained in any material.

Within the reactor, this plasma needs to be kept suspended in a confined space, surrounded by very strong magnetic fields acting as walls.

Charged particles respond to magnetic fields, and this property is used to guide the flow of plasma within an enclosed space, separated from any matter. This condition, necessary for facilitating fusion reactions, is extremely delicate and unstable, with the tiniest of changes in the magnetic field disturbing the whole set-up. Scientists have not been able to maintain these conditions for longer than a few seconds.

That is why the achievement of the Experimental Advanced Superconducting Tokamak (EAST) reactor, located at the Institute of Plasma Physics in Anhui province in eastern China, is being seen as so important. It is a significant improvement on this reactor's previous record of a little over 400 seconds achieved in 2023.

Real-life electricity-generating reactors would require this state to be maintained for hours, even days, at a stretch. Only then would continuous operations be possible, like current nuclear reactors which are based on fission technology.

Energy source of future

Fusion technology has been under development for more than 70 years but progress has been slow. Even the optimistic forecasts, at least till a few years ago, suggested a functional fusion reactor, producing electricity at a commercial scale, would not be realised before 2050.

For this reason, none of the global energy transition pathways for a net-zero world in 2050, or 2070, factor in the potential of fusion electricity.

However, the promise of fusion energy is alluring. If, and when, it comes through, other sources of alternative clean energy being explored, like solar or wind, to tackle the climate crisis are likely to become peripheral or even redundant.

The fusion process produces far greater amounts of energy than any other source — one gram of fuel can yield as much energy as burning about eight tonnes of coal. It uses cheap input materials, available in almost limitless supply (deuterium and tritium, two heavier isotopes of hydrogen that are used as fuel, are easily available in nature), has a zero emission footprint, and can be set up and operated almost anywhere. Unlike the fission process, it does not leave dangerous nuclear waste.

Recent breakthroughs

In the last few years, fusion research has produced a string of breakthroughs. In December 2021, the United Kingdom-based JET laboratory set a new record in the amount of energy produced through fusion. It produced about 12 MW of electricity for five seconds, enough to cater to the demands of about 10,000 homes for that period of time.

A year later, a reactor in the United States achieved a net gain in energy for the first time. The extreme conditions needed in a fusion reactor require a very large amount of input energy. Fusion would be viable only if the output energy is significantly larger. The performance of this US reactor has improved since then. Last year, researchers at MIT said they had developed a new material that could better withstand the extreme conditions within the reactor.

The feats of the Chinese EAST reactor, in 2023 and now, are the latest additions to these successes. This week, fresh evidence emerged to show that China was building a large laser-ignited fusion research centre that could also be used to develop thermonuclear weapons, commonly known as hydrogen bombs.

The US facility at the Lawrence Livermore National Laboratory in California, which was the first to produce a net gain in energy in 2022, is based on a similar technology.

Greater optimism

The recent breakthroughs have triggered a big surge in interest, and ambition, for fusion energy, particularly among private companies which have entered the field in a major way. A total of 163 fusion reactors, in about 30 countries, are currently in operation, under

construction, or being planned, according to the Fusion Device Information System (FusDIS) database maintained by International Atomic Energy Agency (IAEA).

ITER

The largest fusion reactor, an international collaborative project called ITER, is coming up in southern France. More than 30 countries are participating with India being one of the seven member countries contributing to the reactor's construction and research. This project, which has been under development since 2005, is slated to become one of the biggest international science facilities in the world. According to its current timeline, it would begin deuterium-tritium fusion reactions by 2039, producing 500 MW of fusion power.

Relevance: GS Prelims & Mains Paper III; Science & Technology
Source: Indian Express

3. Mahakumbh stampede: Why there was a bigger crowd than usual at Prayagraj

Prayagraj MahaKumbh Mela Stampede News

A stampede at the Mahakumbh Mela underway in Prayagraj has led to deaths and injuries, although the number of casualties is so far unclear.

The stampede took place in the early hours of January 29, a day unusually large crowds were flocking to the riverbank for the ritual dip. This was because January 29 is Mauni Amavasya, one of the days considered very auspicious for taking a bath at the Kumbh Mela. PTI had reported that 10 crore pilgrims were expected to make their way to the Maha Kumbh in just a day on January 29.

What is Mauni Amavasya?

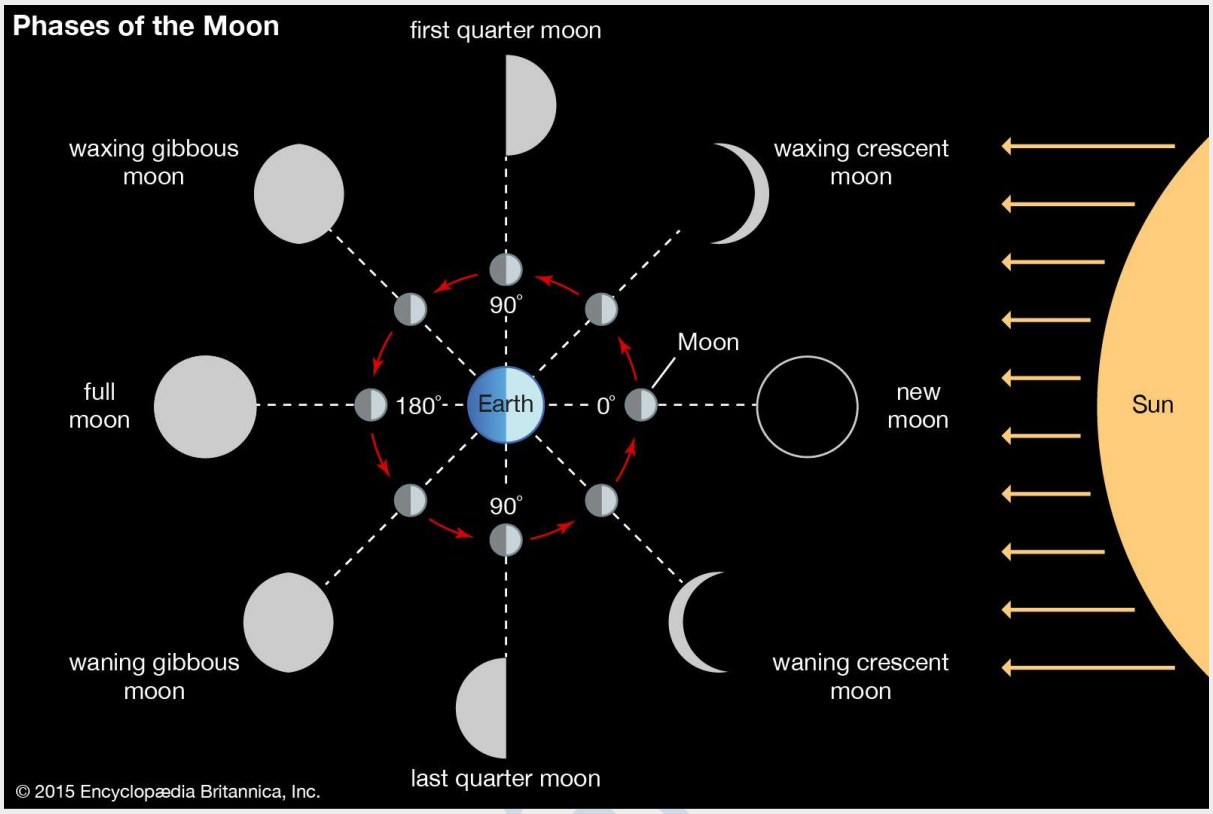
Mauni Amavasya is the new moon night of the krishna paksha (the waning moon fortnight) of the Hindu month of Magh. On this day, both the Sun and Moon are in the same raashi of Makar (Capricorn), which makes it astrologically significant. Maun means silence, and on Mauni Amavasya, it is believed that observing silence, at least till before one takes a bath, is beneficial. According to Hindu religious beliefs, taking a ritual bath in a river on Mauni Amavasya washes away one's sins. Triveni in Prayagraj (the confluence of Ganga, Yamuna, and the mythical Saraswati) is considered a sacred spot. Taking a dip in the Triveni on a Mauni Amavasya during Kumbh Mela is, thus, of added spiritual significance.

About why silence is observed on this day-The new moon is a day of big happenings in the world of nature. The high tide and low tide are more pronounced, the moon is between the earth and the sun. On such a day, when nature is so dynamic, Hindu sages have advised stillness and silence for humans.

What are the special 'snan' days at the Kumbh?

In the ongoing Kumbh, Makar Sankranti was the first amrit snan (earlier called shahi snan) day, and Mauni Amavasya the second. The third is Vasant Panchami on February 3. Shiv Ratri, which falls on February 26, the last day of the Kumbh Mela, is also significant.

On these days, the saadhus who gather at the Kumbh take the first ritual dip as part of the amrit snan, followed by other devotees. It is the specific planetary alignments of a day that make it specially auspicious.



Relevance: GS Prelims
Source: Indian Express