

Phonons as qubits

Comparison of Phonons & Photons

PHONONS

- Quantized normal modes of lattice vibrations. The energies & momenta of phonons are quantized

$$E_{\text{phonon}} = \frac{h\nu_s}{\lambda}$$

$$P_{\text{phonon}} = \frac{h}{\lambda}$$

Phonon wavelength:
 $\lambda_{\text{phonon}} \approx a_0 \approx 10^{-10} \text{ m}$

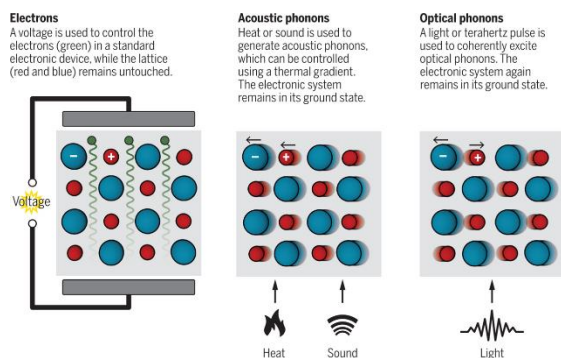
PHOTONS

- Quantized normal modes of electromagnetic waves. The energies & momenta of photons are quantized

$$E_{\text{photon}} = \frac{hc}{\lambda}$$

$$P_{\text{photon}} = \frac{h}{\lambda}$$

Photon wavelength (visible):
 $\lambda_{\text{photon}} \approx 10^{-6} \text{ m}$



What are qubits?

- Quantum computers use qubits as their basic units of information.
- A qubit can be a particle like an electron; a collection of particles; or a quantum system engineered to behave like a particle.
- Particles can do funky things that large objects, like the semiconductors of classical computers, can't because they are guided by the rules of quantum physics.
- For example, these rules allow each qubit to have the values 'on' and 'off' at the same time
- As a result, quantum computers are

expected to perform complicated calculations that are out of reach of the best supercomputers of today.

- Other forms of quantum computing use other units of information.
- For example, linear optical quantum computing (LOQC) uses photons, the particles of light, as qubits
- LOQC offers to use optical equipment like mirrors, lenses, splitters, and waveplates with photons to process information.

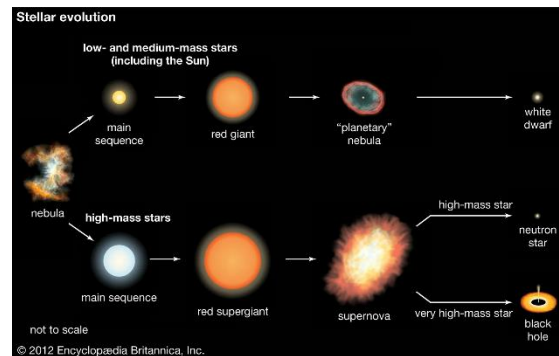
Understanding phonons

- Physicists thus wondered whether they can use phonons as qubits.
- Photons are packets of light energy; similarly, phonons are packets of vibrational energy
- While researchers can manipulate electrons using electric currents, magnetic fields, etc., and photons with mirrors, lenses, etc, they needed new tools to manipulate phonons.
- To this end, in the new study, researchers from the University of Chicago have reported developing an acoustic beam-splitter.
- Beam-splitters are used widely in optics research. Imagine a torchlight shining light along a straight line.
- This is basically a stream of photons.

- When a beam-splitter is placed in the light's path, it will split the beam into two, that is, it will reflect 50% of the photons to one side and let the other 50% pass straight through.
- While it seems simple, the working of a beam-splitter actually draws on quantum physics.
- If you shine a million photons at it, it will create two beams, each of 5,00,000 photons.
- We can then reflect these two beams to intersect each other, creating an interference pattern
- In the new study, the researchers developed an acoustic beamsplitter a tiny device resembling a comb, with 16 metal bars jutting out of it.
- It was placed in the middle of a two-mm -long channel of lithium neonate.
- Each end of the channel had a superconducting qubit a qubit whose circuit components were superconducting that could both emit and detect individual phonons.
- The whole setup was maintained at an ultra-low temperature.
- If these phonons were converted to sound, their frequency would be too high for humans to hear.

THE HINDU

Betelgeuse as a variable star



- The bright, red star Betelgeuse in the constellation Orion has shown some unexpected behavior. In late 2019 and 2020, it became fainter than we had ever seen it at least in records going back more than a century.
- Briefly it became fainter (just about) than Bellatrix, the third brightest star of Orion.
- This event became known as the "great dimming". But Betelgeuse has since become bright again. For a few days this year, it was the brightest star in Orion
- Stars are, by and large, remarkably stable.
- They shine with the same brightness year after year.
- But there are exceptions and some stars dubbed variable stars change in brightness.
- Most famous is Mira, the "star of wonder", which was discovered as a variable star by the German pastor David Fabricius in 1596 -it is a pulsating star that regularly expands

and contracts.

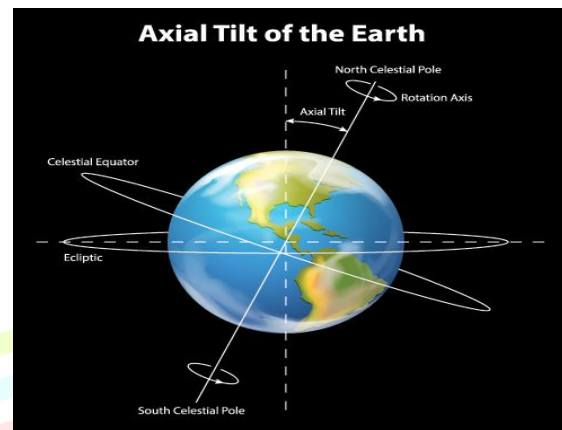
- Algol is another well-known example
- Betelgeuse, the seventh brightest star in the sky (discounting the Sun), is the brightest of the variable stars.
- Sometimes Betelgeuse becomes nearly as bright as Rigel (the blue fourth brightest star in the constellation), while at other times it is notably fainter.
- The variation is caused by pulsations, similar to those of Mira although not as large or as a regulator
- We still don't know what caused the sudden brightening it is now 50% brighter than usual.
- But an impending supernova doesn't seem that likely. In these kinds of stars, a supernova explosion is triggered in the core
- The extreme brightening may, in fact, be due to the same dust cloud that caused the dimming, now reflecting light from the star towards us and making it appear brighter. But we can't be sure, and astronomers are excited.
- Betelgeuse is about 15- to 20-times more massive than the Sun, and stars of this mass are expected to end their lives in a powerful explosion known as a supernova.
- Betelgeuse's red color shows it is a red supergiant, meaning it's already

approaching the end of its life. But that end may still be a million years away.

- Stars like Betelgeuse can live in excess of 10 million years

THE HINDU

Groundwater and Earth axis



- Groundwater pumped up from the earth and moved elsewhere to quench the thirst of humans and their activities have caused the earth's axis to tilt nearly 80 cm to the east, a new study has found.
- Unlike a globe, which has a fixed axis and rotates stably the earth's axis wobbles.
- Scientists have also known for a long time that the movement of water can affect the earth's rotation.
- The study found that nearly 2,150 billion tonnes of groundwater have been pumped and drained into the oceans between 1993 and 2010, raising sea levels by 6.24 mm.
- The scientists also said that the

location of groundwater depletion is important because that affects how much the axis wanders.

- With their model, they found that pumping groundwater from mid-latitude areas affected the drift the most

THE HINDU

India's growth potential

- India took 63 years to reach \$1 trillion in GDP, seven years to hit \$2 trillion, three years to hit \$3 trillion, and is estimated to reach \$25 trillion by 2047 (according to PricewaterhouseCoopers), 100 years after Independence.
- In 1700, India accounted for over 35% of global GDP, making it the world's biggest, and by the time of the economic crises in 1991, it was down to almost 1%.
- Today, it is at around 4%--5% and rising.
- The United States needs this market desperately, and India needs America's capital and its technology military and non-military, both.
- By 2030, India will have a working population of one billion, which is more than the entire G-8 population; today, it has Internet coverage almost equal to it.
- As recently as eight years ago, India's per capita mobile data consumption was one of the lowest in the world (122nd), and today it is ranked at one, more than that of the U.S. and China combined, which is helping take
- A coal cess and an infrastructure development cess, found enough savings to fund at least a part of the rail, roads, and ports expansion
- Even a mere listing of a project on PRAGATI, or Pro-Active Governance and Timely Implementation (the monthly review of every Union, State government stakeholder by the Prime Minister) makes officials issue long pending government orders or clearances, and generally positively smoothens the system to 'debottleneck' infrastructure.
- Or the first time, the private sector was allowed into commercial coal mining, leading to Odisha, West Bengal, and Chhattisgarh.
- Another unspoken reform of the Public Financial Management System.
- It is a centralized transaction system to improve transparency, accountability, and efficiency in government financial spending and to plug waste and leakages.
- It has driven what was often considered impossible to do a centralized core database integration of different platforms with banks, thereby enabling direct

payments to beneficiaries, reducing time and cost while enhancing efficiency

- Paryatan system, which is a one stop system for transport across 1,400 transport offices, enabling leakage-proof revenue collection of ₹4,000 billion through the registration of about 350 million vehicles and 150 million licenses.
- India gets \$100 billion in remittances and at around 20 million, is a tad less than the overall global migrant population of about 280 million, who are influential and now extremely proud and confident on the global stage
- India needs greater digitalization of internal processes and better services delivery using India Stack, revive stalled agriculture reforms, build up supply chain capability and move manufacturing to India as companies look for other homes outside China, and carry out deeper judicial reforms, to name a few.
- India has a \$290 billion balance of trade deficit (9% of GDP and two times its pre-COVID-19 highs); almost 50% of India is still stuck in agriculture and manufacturing remains stuck at 14%-15% of GDP. U.S. capital and technology can help in many of these areas

THE HINDU

Summit for a New Global Financing Pact

- A Summit for a New Global Financing Pact will take place in Paris on June 22 and 23,
- The global financial system, which manages around 300 trillion dollars in financial assets, is simply not fit for purpose.” He recently stated, “Today’s poly-crises are compounding shocks on developing countries in large part because of an unfair global financial system that is short-term, crisis-prone, and that further exacerbates inequalities”
- The aim of this Summit is to concurrently tackle the challenges of climate change, biodiversity protection, and the fight against inequality in order to achieve the Sustainable Development Goals (SDGs).
- The Summit is co-organized by France and India, with the latter holding the presidency of the G20 this year.
- The purpose of the Summit is to align various agendas (climate, development, debt) and propose innovative solutions to these challenges.
- The summit is taking place in a unique international context: in 2022, the United Nations noted a reversal of human development in nine out of ten countries across the

globe, primarily driven by a decrease in life expectancy and a rise in poverty.

- The COVID-19 pandemic and the conflict in Ukraine, along with their consequences, have indeed reduced the income of many countries, affecting their ability to finance their populations' access to basic social services.
- Countries in the Global South, which pollute less than the rest of the world, are the most threatened by the climate crisis.
- In 2022, natural disasters cost over \$300 million, heavily weighing on their economies.
- As a result, the 'great financial divide' continues to widen, leaving the countries in the Global South more sensitive to shocks.
- Developing countries lack the urgently needed resources to invest in recovery, climate action, and Sustainable Development Goals, which puts them even further behind in the event of the next crisis
- Its main objectives include creating fiscal space, promoting private sector development, fostering green infrastructure investment, and generating innovative financing for countries vulnerable to climate change.