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QUANTUM COMPUTING- A NEW WORLD OF COMPUTERS

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***ABSTRACT*:** Can our computers be faster than existing classical computers? Can computers offer faster speeds for aiding different organizations? Can we expect much faster calculation and processing speed ? The answer goes here is yes. It is possible to use the concepts of quantum mechanics, a branch of physics, with computer science to build a faster system. Thus, we get a quicker manner of computing referred to as Quantum Computing that's primarily based totally on precept of physics and computing technology. Quantum computing is a new and interesting discipline on the intersection of mathematics, computer technology and physics. It uses quantum mechanics to enhance the performance of computation. Here we present a number of the thoughts in quantum computing. The paper starts with the aid of using motivating the valuable concepts of quantum mechanics and quantum computation. This discipline continues to be improving and has massive potential.

I. INTRODUCTION:

The theory for the combination of computer science with Quantum mechanics goes up for around 30 years or more. This introduces us to the new branch of physics and computer called Quantum Computing. This area researches a way to harness a number of the odd elements of quantum physics to be used in computer science. Many of the texts in this area require information of a wide corpus of higher math or physics. We try to help this situation with the aid of imparting the simple concepts of quantum computing in a way comprehensible to everybody who has some simple understanding of physics, arithmetic and computer science. The reason why we're not employing the higher arithmetic and physics is that we do now no longer intention to educate the reader all of quantum mechanics and all of quantum computing. Rather, we put our intention to honestly gift that component important to gift a reader of what quantum computing is all about.

Quantum computing commenced with the idea of turing machine in early 1980s. Physicist Paul Benioff proposed a quantum mechanical version of turing machine. Quantum computing is the study of a relativistic model of computation. Whereas a classical computer saves the data into the basic units called 'bits'. The bits in classical computer refers to '0' and '1', a quantum computer encodes data into 'Qubits' which can represent 0, 1 or some combination (between 0 and 1). This combination is known as 'Quantum Superposition'. The bits obtained by Quantum Superposition are known as 'qubits'. Qubits represent zero, one and intermediate values too. It develops the capability in Quantum computers for faster calculation. Fig. An image of existing quantum computer.

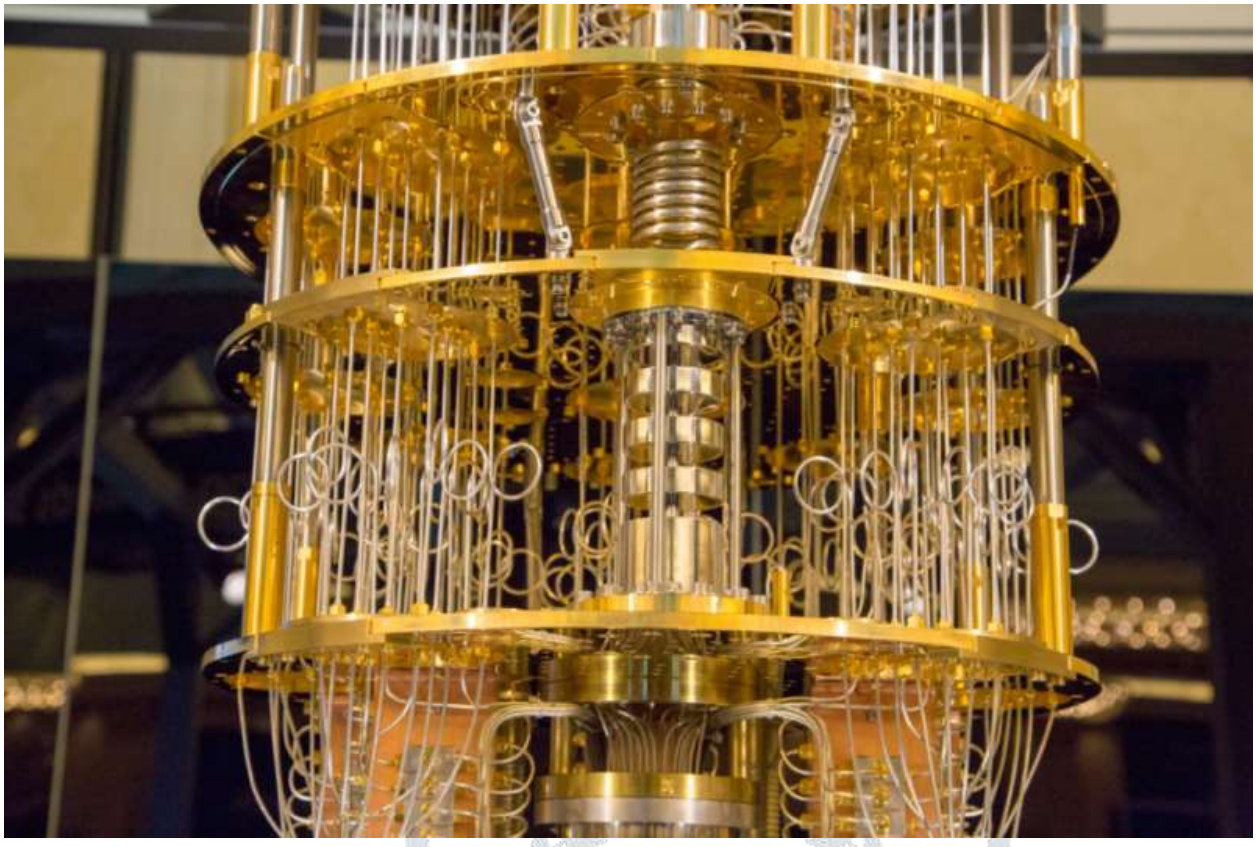

Fig. An image of existing quantum computer

II. QUANTUM SUPREMACY:

Introduced by John preskill, quantum supremacy refers to the speedup advantage that a quantum computer would have over a classical computer in a certain field. The research is still in progress. Physicists believe that developing a quantum computer which is fault free is still a distant dream, but not too far away as of now. Due to the superposition of quantum states, allowing parallel (rather than one-by-one) computations, increasing exponentially powers and speed with the increase in number of qubits, even for extremely complex calculations, reducing processing times from years to minutes. Google AI, in partnership with NASA demonstrated a result which was accurately performed in 200 seconds was by a quantum computer, which if performed by an even the fastest super computers of today will take approximately 10000 years for completion. Google used a 54-qubit quantum computer named “Sycamore” to do an exceptionally complex simulation in around four minutes—running a quantum random value generator 1 million times, in contrast to the various results of a classical supercomputer.

III. QUANTUM SUPERPOSITION:

The quantum computation describe the computation with use of connections of quantum logic gates. A memory along with n bits of data has (2^n) possible states. A vector representing all memory states has (2^n) entries (one for every state). This vector is considered as a probability vector and represents the truth that the memory is to be located in a specific state. In the classical view, one state will have a value of 1 (i.e. a 100% possibility of being in this state) and all different entries will be zero. A quantum memory will be found in quantum superposition ‘Φ’ of the two classical states ‘0’ and ‘1’ as-

$\Phi = \alpha(0) + \beta(1) = (\alpha\ \beta)$

$|\alpha|^2 + |\beta|^2 = 1$

Where α and β represent complex numbers.

In this, one qubit of memory is encoded to quantum memory. The quantum state is not a probability vector,, but it can be associated with a probability vector. The state of this one qubit quantum memory may be manipulated by making use of logic gates, in an identical manner as classical memory may be manipulated in the use of classical logic gates. Qubits are made by the

use of physical systems, together with the orientation of a photon or the spin of an electron. These systems may be in lots of different arrangements all at one time, a condition referred to as quantum superposition. Qubits can be inextricably linked collectively in the use of a phenomenon known as quantum entanglement. The end result is a many qubits that can contain several things at the same time.

In summary, a quantum superposition refers to infinite values that is available between classical '0' and '1' bits, as 0.1, 0.2, 0.25, 0.26, and so on. These value represent qubit in quantum computers and can be taken infinite as per requirements and ability to handle number of qubits. These qubit works like classical computer's bits.

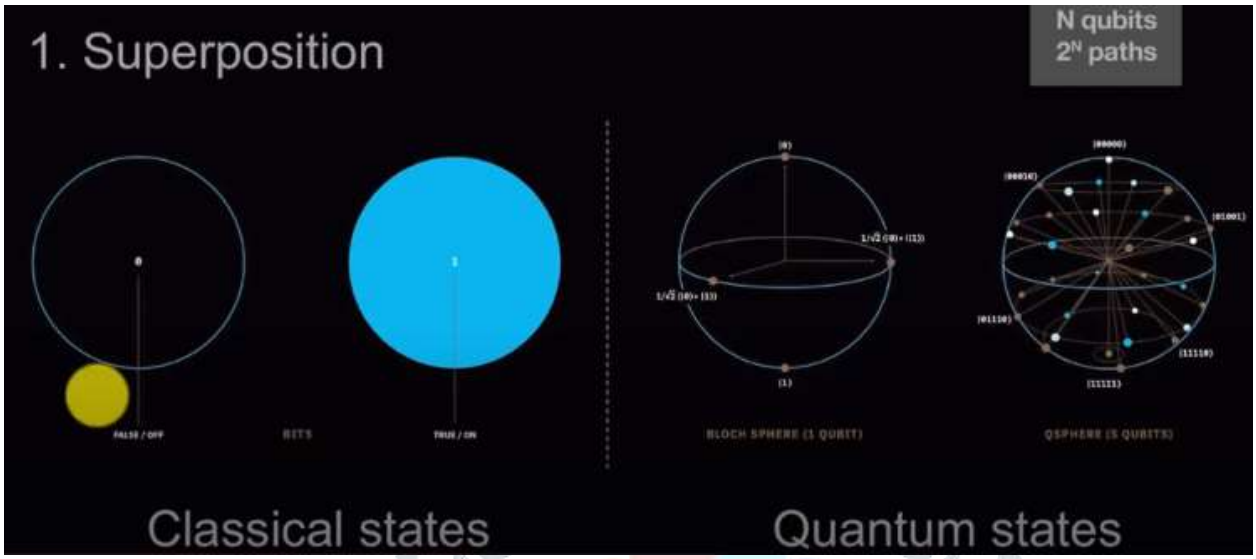

Fig. Representation of classical states and quantum states

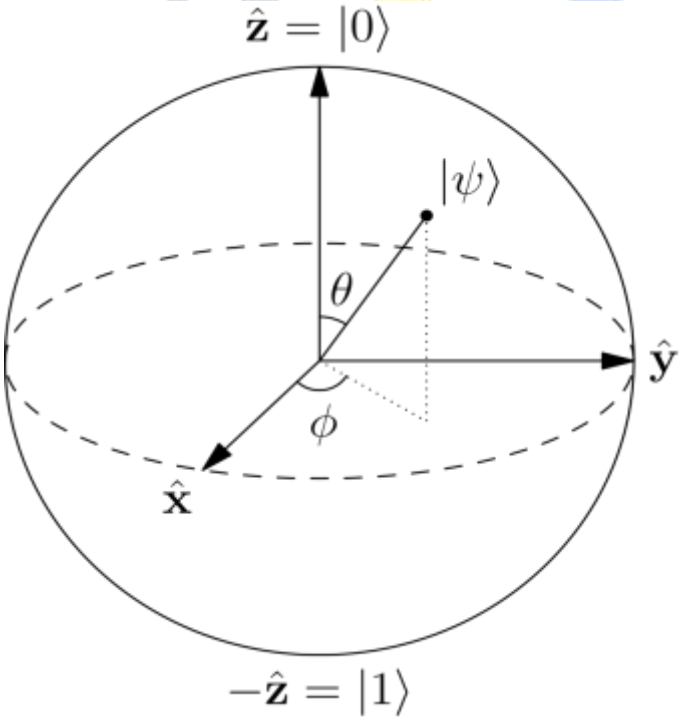

Fig. showing superposition state with the help of a vector for a qubit

IV. FUTURE SCOPE AND CHALLENGES:

The above stated google's demonstration of a quantum system supremacy recently and the pace at which different organization are showing enthusiasm in the research of this field show that in upcoming years are going to be totally special, faster, different computing which is the solution for many existing complications due to which computations cannot be performed with existing supercomputers will be solved by quantum computers in this decade.

There are many possibilities and a lot of possibilities for the development of superior quantum system which is better isolated from its environment and its operation is not affected. So we will get a new world computer. Quantum computers can do computing tasks that are outside the reach of even the best computers today. They will be more in use in the field of medicine, cybersecurity, Internet of things, research studies of scientific basis, structure of many complex compounds in chemistry, machine learning, cryptography and many more.

Quantum computers can also make communication more secure by biasing information teleported. There's some other term related to sci-fi films. However, the phenomenon of "entanglement" lies at the back of quantum mechanics: qubits are connected collectively in this type of manner that a change to the first one creates alterations to its corresponding second qubit. This happens without any time lags, over any distance, and without any connection with cables or radio waves.

V. CONCLUSION:

This area has a whole lot of potential. At least for now, critical quantum computer systems are far off. Even now, specialists are seeking to get quantum computer systems to work sufficiently good to top classical supercomputers. That stays extraordinarily challenging, basically due to the fact quantum states are fragile. It's difficult to absolutely prevent qubits from interacting with their outer environment, in spite of specific lasers in super cooled or vacuum chambers. Any noise inside the device outcomes in a situation called "decoherence," wherein superposition breaks down, and the quantum device lose track of information. Little blunders are obvious in quantum computing, due to the reason that we are interacting with chances instead of fixed condition and states as that of binary machine. But decoherence frequently introduces a lot of noise that it block and lose track of the result.

But with billions of rupees of funding from governments and the world's largest companies, the race for quantum computing abilities is underway. The authorities of India in its finances in year 2020 additionally proposed new funding of rupees 8000 crores in area of quantum technology and applications for the upcoming five years.

The actual question that arises is: how will quantum computing change what a "computer" actually means to us. How will it change how our electronically connected world works? And when? All that will be soon achieved as a lot of investment and research efforts are underway. It can not be denied that Quantum computers can make happen computing tasks that are outside the reach of even the best computers we have today.

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