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Quantum Computing and Storing – A Stimulated Emission Approach

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Abstract: Strange as it sounds, the computer of tomorrow could be built around a cup of coffee. The caffeine molecule is just one of the possible building blocks of a 'quantum computer', a new type of computer that promises to provide mind boggling performance that can break secret codes in a matter of seconds. Quantum computing studies theoretical computation system (quantum computers) that make direct use of quantum-mechanical phenomena, such as superposition and entanglements.

This technique uses the idea of ‘qubits’ or quantum bits which are different from normal digits. Qubits which is basically a single electron trapped inside a cage of atoms. When the dot is exposed to a pulse of laser light of precisely the right wavelength and duration, the electron is raised to an excited state: a second burst of laser light causes the electron to fall back to its ground state. The ground and excited states of the electron can be thought of as the 0 and 1 states of the qubit and the application of the laser light can be regarded as a controlled NOT function as it knocks the qubit from 0 to 1 or from ' to 0.

But the problem is the excited electrons just stays at either 1 or 0. But if the electron is subjected to ‘stimulated’ emission, then at each sub-energy levels can be interpreted to different solutions. Which is described in later part. This approach gives the idea that the excited electron instead of being in 0 or 1 state, it can have values other than these or along with these values. Quantum computers will be able to solve certain problems that are currently far beyond the reach of even the most powerful classical supercomputers. In cryptography, for example, the time required for a conventional computer to break the RSA algorithm, which is based on the prime factorization of large numbers, would be comparable to the age of the universe. A quantum computer, on the other hand, could solve the problem in a matter of minutes. Hence this study can be a big revolutionary in technological progress.

Key words: qubits, stimulated emission, sub-energy levels.

Introduction:

Stimulated emission is the process by which an incoming photon of a specific frequency can interact with an excited atomic electron (or other excited molecular state), causing it to drop to a lower energy level. The liberated energy transfers to the electromagnetic field, creating a new photon with a phase, frequency, polarization, and direction of travel that are all identical to the photons of the incident wave. This is in contrast to spontaneous emission, which occurs at random intervals without regard to the ambient electromagnetic field. Consider a three bit register which generally can store three bits of data. If we can think about the probability of storing the data, the three bit register may able to store 2^3=8 bits of data but the stimulated emission can be able to increase the storage to 2^9=512 bits of data in a three bit register.

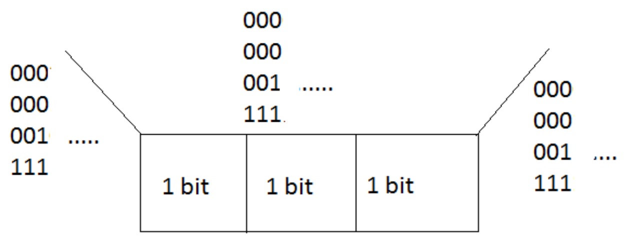

Fig: 3 bit register with probabilistic storage

This can be explained using the single-particle quantum interference experiment. Which shows the presence of photon in many states simultaneously.

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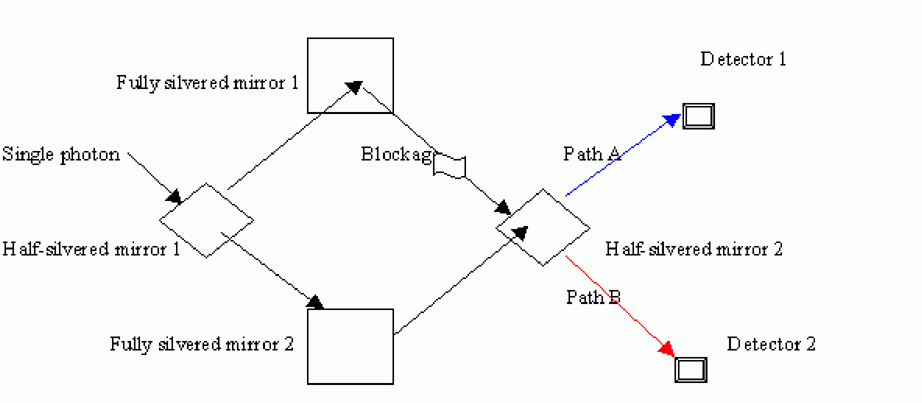

Fig : single-particle quantum interference

In this experiment we can observe that every time a photon leaves the source, the two sets of waves that represent the photon existing simultaneously along the two paths, would always cancel each other before reaching D2. But those who proceed to reach D2 will reinforce, and those will be detected at D1. This means that the photon has in reality travelled not one but both paths simultaneously and underwent self interference to be detected only at D1. Hence this idea can be implemented to increase the storage area of the quantum computer where the data are stored in a probabilistic way and retrieved back in a probabilistic way and resulting in a realistic way to store the information without any data loss. Another way of this is explained using the stimulated emission and metastable state of an element.

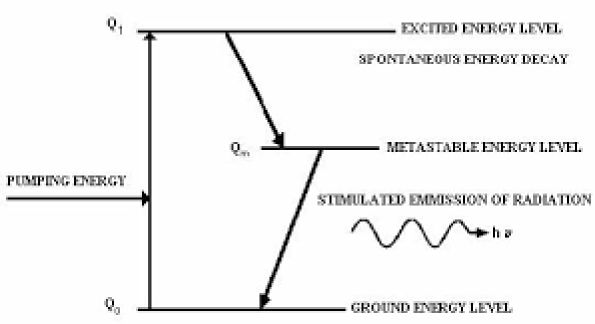

Fig : metastable state and stimulated emission

Generally the electron which is at ground energy level is taken as logic 0 and which is in excited state is taken as logic 1. But in stimulated emission we can think of one more energy state which is called as 'metastable' state. Which is state exists between the excited energy state to the ground energy state and the electron when coming back to the ground energy state it stays in its metastable state for a particular period of time. In this method

- Act of exciting atoms from lower energy state to higher energy state by supplying energy from external source is called 'pumping'.
- The process which leads to emission of stimulated photons after establishing the population inversion is 'lasing'.
- Quantum system between whose energy levels, the pumping and lasing action occurs is called an 'active system'.

Objectives:

Creation of a quantum computer and the register which can store the information in an elegant way which leads in increase in the current storage capacity of any storage to a very high extent.
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Materials and Methods:

As explained above we can think of solving the storage problem of any device in two elegant ways , one is using the single-particle quantum interference theory and other using the stimulated emission and metastable state theory . In metastable state theory, The technique or approach used to store the data is : Consider an electron which upon pumping excites to higher energy state and while coming back it stays in its metastable state for particular period of time and then reaches to its ground state. Now let us consider these three states and resolve the problem of normal register.

Algorithm for the storage technique is as follows:

- Given numbers, symbols or characters are converted to its ASCII code.
- Converted ASCII is then converted to its equivalent binary format.
- This binary code is now grouped according to number of three's. i.e three binary numbers in a group.
- Then each group of three is represented by an single electron by just moving in between the excited states.
- Hence 'Kn' number of information needs just 'K' number of electrons to store it.

Example:

Consider a binary number 100010111 which is to be stored. Now according to the algorithm we first group these digits into group of three. That is 100 010 111. When an electron jumps from lower energy state to higher energy state then there is a sensing device which senses the movement of electron and a detector detects it as 1. The detector is designed in such a way that it detects the output then stores in its fixed memory and resets after a particular time period 'T'. This time period may vary according to genuine applications. The excited electron is made to stay in its excited state for next 'T' intervals and hence there is no movement or jump of electron and hence the detector gets the value 0. For the next 'T' intervals again there is no detection and output is 0 again. Hence in the first cycle an electron is used to store the data 100. Next again electron stays in its ground state and hence there is no movement of electron and the detector output is 0. Now the excitation takes place and hence electron goes to its excited state and hence the detector stores 1. After T seconds it stays in its excited state only and hence detector stores 0. Detector is programmed in such a way that after the three records are taken, it starts to take the recordings only after the electron comes back to its ground state . Hence wherever is the state of the electron once after it loses all its energy and comes back to its ground state then its ready for its next excitations.

Special Conditions:

In this method we encounter one condition where we are going to take use of the metastable state. For example if we want to store the digit 011, electron has got only one excited state which can make it to 1. But if the metastable state is taken into considerations then after it has excited to higher energy state and for the next time T, it fall back to its metastable state where it again stays for time T. Movement of electron from higher energy state to metastable state is sensed by the sensor and detector stores 1 for next time period T. Hence its able to store 011. Similarly 101 and 110.

Second Condition:

In this condition we encounter 111. Its easy once if we understand the concept and algorithm of storing the data. Even this is similar to what I have explained as above, where electron first jumps to its first excited state which results in 1 at the output. Then after T seconds it jumps to its metastable state and again movement of electron is encountered and again detector stores 1. After when it stays there for time T then it jumps back to its original state and again detector store the value 1. Hence we could be able store 111.

After when all the digits are stored the final result is the entangled result of all these electron position and corresponding values which is noted by the detector. The compiler is designed in such a way that after when the grouping is done then the corresponding values which is to be represented using the electrons is monitored by itself by providing the proper pumping action and syncing between every electron jumping states to the input values.

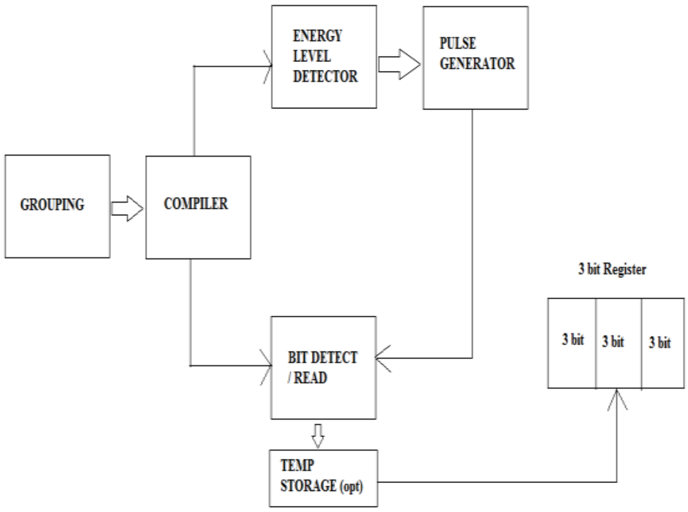

fig: Deterministic data storage

Thus from the stimulated emission approach we can observe that the deterministic way of storage has 3+3+3= 9 bits of data in a 3 bit register. Whereas the probabilistic way of storage will have 2^9 = 512 bits of data.

Materials:

- Compiler designed for this particular application
- Digit grouping device
- Energy level detector
- Pulse generator
- Bit detector and temporary storage
- RAM/ROM

Conclusion:

The field of quantum computing is growing rapidly as many of today's leading computing groups, universities, colleges, and all the leading IT vendors are researching the topic. This pace is expected to increase as more research is turned into practical applications. Although practical machines lie years in the future, this formerly fanciful idea is gaining plausibility.

The current challenge is not to build a full quantum computer right away; instead to move away from the experiments in which we merely observe quantum phenomena to experiments in which we can control these phenomena. Thus from the experiments and observations we can note that, the probabilistic way of getting an output finds its limitations in various aspects and may not be able implement for the current scenario. But on the other hand we find that there is a possible method for which storage enhancement of a register is possible and can be implemented. Hence mind boggling level of computing power has enormous commercial, industrial and scientific applications.

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