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Matchmaking in cybertech

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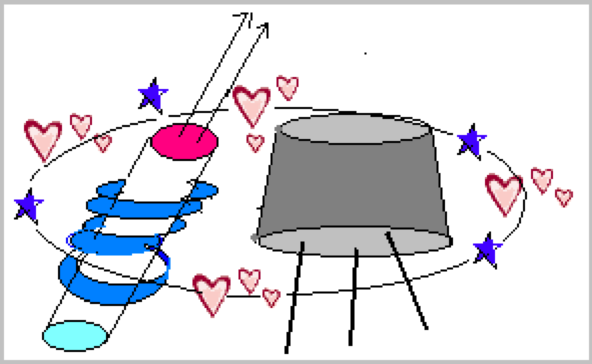
Semiconductors and lasers have revolutionised electronics and communications these last few decades. But the two are distinct entities and need a ponderous interface for them to work together. The next revolution may be to find semiconductors that act like lasers.



Semiconductors

Elements form crystals with the 'outer shell' electrons of atoms of the element 'holding hands' in regular patterns. Atoms share outer electrons like this to try and have as near a stable, ***octet***, or eight electrons in the outer shell. In the case of Silicon, there are just 4 electrons in the outer shell and each atom can have the number of eight by sharing electrons with four neighbours. Now, in such a crystal of Silicon, if traces of another atom, with one more electron, were added, the crystal ends up with 'unpaired' electrons, which the atoms then toss about, like players passing a football. Conversely, if the atom added had not one more electron but one less, the crystal ends up with an unpaired 'lack of electron'. This, again, can be passed from atom to atom, like the extra electron.

Now, if a team that had an extra, or 'hot' football were placed next to another team, which passes around a 'lack of a football', then the 'extra' football of the first team could easily pass to the other team. But the 'lack of footballs' in the second team could not pass on to the first, because a 'hole' is not really a 'thing'! This interface between the two teams would then be a 'one-way' gate – footballs can go one way, but not the other.

The structure of the Silicon crystal allows these two kinds impurity, and if a crystal with the extra electron were placed in contact with one that had 'one less' outer shell electron, this second crystal would behave like the 'other' football team. A junction of these two kinds of crystals then becomes a 'one way gate' for electric currents and this is the basis of 'diodes', transistors, 'integrated circuits' 'chips', 'microprocessors', supercomputers.

Lasers

Lasers are a different thing altogether. There are elements whose atoms can collect 'photons', or particles of light, all of exactly the same kind, and hold them for some time (millionths of a second). The atom then either 'spontaneously' emits the photon, or is 'stimulated' to do it, on being struck by a photon emitted by another atom. In the second case, the atom would emit the two photons together, identical and 'in step'. In lasers, things are arranged so that the photons get the best chance to strike other ‘excited’ atoms, so that there is a steady, ‘amplified’ stream of unidirectional and ‘in step’ photons, the laser beam.

This kind of ‘coherent’ light is ideal for use in ‘optical fibres’, or ‘light pipes’ made of hair-like slivers of glass, spun many kilometers long. Information can be coded on the laser pulses sent through these fibres and their use has revolutionised data, voice and image communication.

The interface

Thus, we have two kinds of devices – computers, telephones or other devices, where information is processed and made ready to convey, with the help of semiconductors, and then the optical fibre network, which transmits the information using laser light.. And again, at the other end, the messages received as light are converted back to electricity, to be processed by computers, telephones or TV sets.

To eliminate the interface between the semiconductor devices and the optical fibre channel. researchers are getting closer to finding semiconductor materials that also emit light. This could also eliminate the ‘wiring’ inside semiconductor devices apart from the need for interface for communications!