FASCINATING QUASICRYSTALS

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Introduction: Quasicrystal is a new emerging domain lying amidst chemistry, physics, and material science. A quasicrystal, is a structure that is ordered but not periodic. A quasicrystalline pattern can continuously fill all available space, but it lacks translational symmetry. While crystals, according to the classical crystallographic restriction theorem, can possess only two, three, four, and six-fold rotational symmetries.The Bragg diffraction pattern of quasicrystals shows sharp peaks with other symmetry orders, for instance five-fold.

Quasicrystals had been investigated and observed earlier, but, until the 1980s, they were disregarded in favor of the prevailing views about the atomic structure of matter. In 2009, after a dedicated search, a mineralogical finding, icosahedrite, offered evidence for the existence of natural quasicrystals.

Difference between Crystals and Quasicrystals: Most crystals are composed of a three-dimensional arrangement of atoms that repeat in an orderly pattern. But quasicrystals behave differently than other crystals. They have an orderly pattern that includes pentagons, fivefold shape, but unlike other crystals, the pattern never repeats itself exactly.In crystals, single unit cell are used to generate the structure but in the quasicrystal, two prototiles are required to generate the structure.

Discovery of Quasicrystals: The discovery of quasicrystal was nothing more than a coincidence by a chemist known as Dan Shechtman, who has recently been awarded Nobel Prize in Chemistry in 2011. The story begins in his laboratory; in the year 1982. The substance he was working on was a mix of aluminum and manganese, a strange looking material. He used electron microscope in order to observe it at the atomic level. The picture he obtained at the microscope was very different and exclusive it countered all the recent discoveries and theories. He was able to see concentric circles, each made of ten bright dots at the same distance from each other. The thing was Shechtman had rapidly chilled the glowing molten metal, and the sudden change in temperature should have created complete disorder among the atoms. But the pattern he observed told a completely different story, the atoms were arranged in a manner that was opposing the laws of nature. Shechtman counted and recounted the dots. It is possible to appear four or six dots in the circles would, but Shechtman was shocked to see that he was observing concentric circles each made of ten bright dots at the same distance from each other which were impossible. He jotted down only single thing in his notebook "10 Fold???"

Dan Shechtman tried to prove his works and discovery yet he faced disappointment and distress, he tried to explain all the facts to his researchers but none believed and tried.to note his works nothing more than creation of "Double Crystals". However, in November 1984, together with his research colleagues Cahn, Blech and Gratias.Shechtman finally got to publish his data in Physical Review Letters. The article created interest among crystallographers, It questioned the most fundamental truth of their science: that all crystals consist of repeating and periodic patterns.

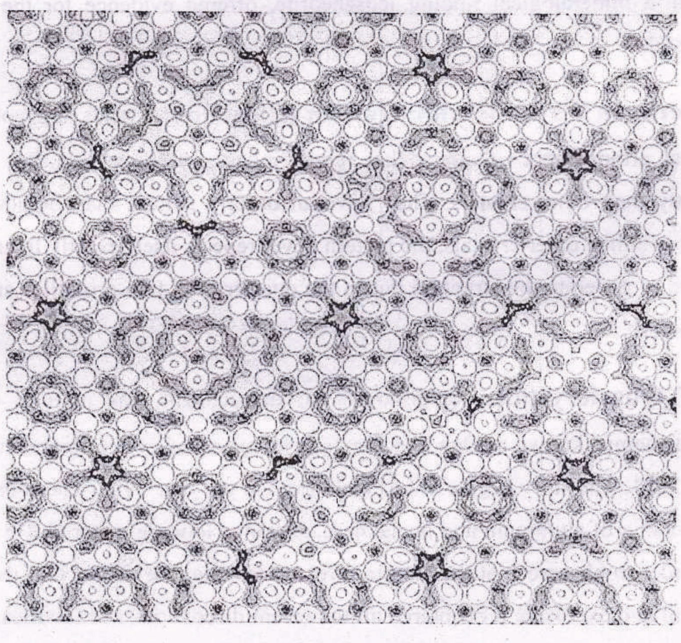

Fig: Shechtman's Nobel Prize winning work was in the area of quasicrystals, ordered crystalline materials lacking repeating structures, such as this Al-Pd-Mn alloy.

After the publication of his article, scientist all around the globe started to work on this discovery many said they had also observed the same phenomenon yet overlooked. Many scientists and mathematicians started resolving this observation and a mosaic model resembling to produce similar diffraction pattern was prepared by a British professor of mathematics, Roger Penrose. He created aperiodic mosaics with just two different tiles, for example, a fat and a thin rhombus.

Application of Quasicrystal: Modern research is motivated by the prospect that quasicrystals could lead to new technologies.Quasicrystalline materials could be used in a large number of applications, including the formation of durable steel used for fine instrumentation, and non-stick insulation for electrical wires and cooking equipment. Quasicrystals have been used in surgical instrumentsand LED lights. They have poor heat conductivity, which makes them good insulators. Sandvik, a company in Sweden, produces a precipitation-hardened stainless steel that has interesting properties. The steel is strengthened by small quasicrystalline particles and it does not corrode. It is extremely strong steel. It is used for anything that touches the skin, for instance, razor blades or surgery tools.

References: Wikipedia and various journals related to Quasicrystal.