QUASI CRYSTALS

Quasicrystals are structural forms that are both ordered and nonperiodic. They form patterns that fill all the space but lack translational symmetry. Classical theory of crystals allows only 2, 3, 4, and 6-fold rotational symmetries, but quasicrystals display symmetry of other orders (folds). They can be said to be in a state intermediate between crystal and glass. Just like crystals, quasicrystals produce modifiedBragg diffraction.

Aperiodic tilings were found to apply to the study of quasicrystals

Roughly, an ordering is non-periodic if it lacks translational symmetry, which means that a shifted copy will never match exactly with its original.

The more precise mathematical definition is that there is never translational symmetry in more than $n - 1$ linearly independentdirections, where n is the dimension of the space filled; i.e. the three-dimensional tiling displayed in a quasicrystal may have translational symmetry in two dimensions.

The ability to diffract comes from the existence of an indefinitely large number of elements with a regular spacing, a property loosely described as long-range order. Experimentally the aperiodicity is revealed in the unusual symmetry of the diffraction pattern, that is, symmetry of orders other than 2, 3, 4, or 6. The first officially reported case of what came to be known as quasicrystals was made by Dan Shechtman and coworkers in 1984.[2] The distinction between quasicrystals and their corresponding mathematical models (e.g. the three-dimensional version of the Penrose tiling) need not be emphasized.

PATTERNS & CLASSIFICATION

- There are several ways to mathematically define quasicrystalline patterns. One definition, the "cut and project" construction, is that a quasicrystal consists of a slice (an intersection with one or more hyperplanes) of a higher-dimensional periodic pattern. In order that the quasicrystal itself be aperiodic, this slice must not be a lattice plane of the higher-dimensional lattice. (For example, Penrose tilings can be viewed as two-dimensional slices of five-dimensional hypercubic structures.) Equivalently, the Fourier transform of such a quasicrystal is nonzero only at a dense set of points spanned by integer multiples of a finite set of basis vectors (the projections of the primitive reciprocal lattice vectors of the higher-dimensional lattice).
- Classical theory of crystals reduces crystals to point lattices where each point is the center of mass of one of the identical units of the crystal. The structure of crystals can by analyzed by defining an associated group. Quasicrystals, on the other hand, are composed of more than one type of unit, so instead of lattices, quasilattices must be used. Instead of groups, groupoids, the mathematical generalization of groups in category theory, is the appropriate tool for studying quasicrystals.
- Using mathematics for construction and analysis of quasicrystal structures is a difficult task for most experimentalists. Computer modeling, based on the existing theories of quasicrystals, however greatly facilitated this task. Advanced programs have been developed allowing one to construct, visualize and analyze quasicrystal structures and their diffraction patterns.

SOME QUASI_CRYSTAL MATERIALS & INTERESTING FACTS

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- Ho-Mg-Zn dodecahedral quasicrystal

- Since the original discovery of Shechtman hundreds of quasicrystals have been reported and confirmed. Undoubtedly, the quasicrystals are no longer a unique form of solid; they exist universally in many metallic alloys and some polymers.

- Found most often in aluminium alloys (Al-Li-Cu, Al-Mn-Si, Al-Ni-Co, Al-Pd-Mn, Al-Cu-Fe, Al-Cu-V, etc.), but numerous other compositions are also known (Cd-Yb, Ti-Zr-Ni, Zn-Mg-Ho, Zn-Mg-Sc, In-Ag-Yb, Pd-U-Si, etc.).

- Regarding thermal stability, three types of quasicrystals are distinguished:
  i.stable quasicrystals grown by slow cooling or casting with subsequent annealing,
  ii.metastable quasicrystals prepared by melt-spinning, and
  iii.metastable quasicrystals formed by the crystallization of the amorphous phase.

- Except for the Al–Li–Cu system, all the stable quasicrystals are almost free of defects and disorder, as evidenced by x-ray and electron diffraction revealing peak widths as sharp as those of perfect crystals such as Si. Diffraction patterns exhibit fivefold, threefold, and twofold symmetries, and reflections are arranged quasiperiodically in three dimensions.