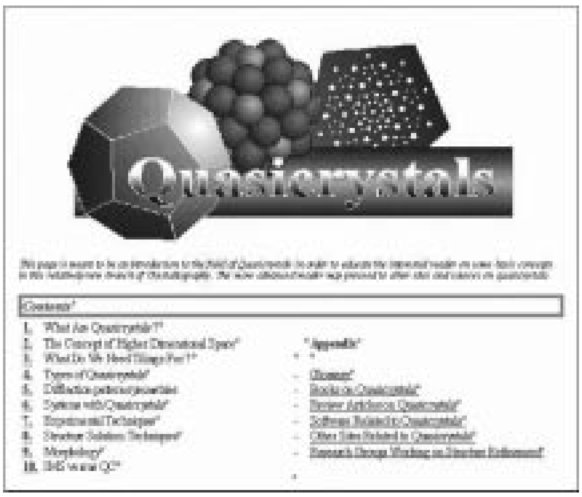
Quasicrystallography

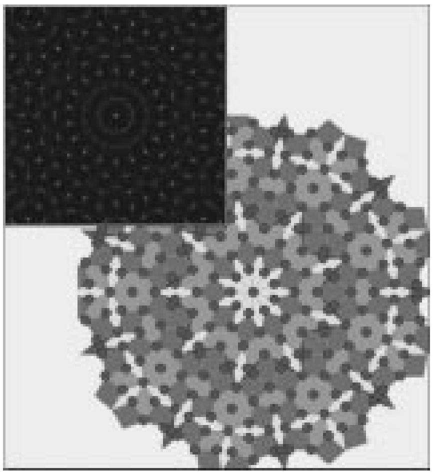
Maybe you have already heard about those strange quasicrystals or the famous Penrose tiling. And possibly you always wanted to know what quasiperiodicity means or what these fascinating tilings are good for. Now you have the opportunity to be introduced to this fascinating science by surfing Steffen Weber's quasicrystal web site. Ten chapters and several Java applets will guide you through the world of quasicrystals on an introductory level.

You will discover that quasicrystals are intermetallic phases with noncrystallographic diffraction symmetry. This means that the sharp Bragg spots on diffraction patterns order in patterns with eightfold, tenfold, twelvefold or icosahedral point group symmetry. Since this kind of order is incompatible with three-dimensional lattice periodicity, the usual unit cell description of the crystal structure does not apply. This problem is elegantly overcome, however, by embedding quasiperiodic structures in an appropriate higher-dimensional space. For instance, fivefold rotation axes are proper symmetry operations in four dimensions leaving the hyperlattice invariant. What higher-dimensional embedding means is nicely illustrated by a Java applet based on the strip-projection method for the example of the one-dimensional quasiperiodic Fibonacci sequence. You can manipulate the sequence in an acceptance window and, by rotating it around the origin of the two-dimensional embedding space, generate all kinds of quasiperiodic sequences or their periodic approximants.

Another applet, based on the dual grid method, allows you to explore the world of tilings. A set of equidistant parallel lines is generated first. Then, by the action of *n*-fold rotational symmetry, a multigrid is obtained therefrom. Finally, rhombic tiles are generated around the crosspoints of the multigrid to yield beautiful colored tilings from 5- to 22-fold symmetry. Clicking on the "random" button allows you to surf easily through a wealth of great tilings without having to worry about any plot parameters. Quasiperiodic tilings can be seen as a kind of quasilattice. Decorating them by atoms at the vertices, for instance, gives you simple models of real quasicrystal structures. With the help of another Java applet, Fourier transforms of such model structures can be calculated to simulate the electron or X-ray diffraction patterns of quasicrystals. The best results are obtained with the 300 × 300 pixel fast Fourier transform. You have to be patient, however, this may take up to a minute, depending on the speed of your computer. Have a look at the gallery of diffraction patterns first, maybe what you are interested in is already there.



It is also a pleasure to run the applet that generates the shapes of crystals and quasicrystals of arbitrary symmetry from their stereographic projections. You just have to move the poles in the stereographic projection with your mouse, the crystal morpholgy will change synchronously. It works really well; however, it will also take its time for more complex face forms.



To summarize, in ten short, well-organized chapters almost all parts of structural quasicrystallography are covered on an introductory level. A quite useful glossary of quasicrystal nomenclature is found in the appendix, and a number of links to quasicrystal and other interesting web sites are given. At Steffen Weber's home page you will also find a lot of other programs dealing with problems of conventional crystallography. It might be helpful to know that all Java applets run very well with MS Internet Explorer 5. I had difficulties, however, with Netscape Communicator 4.7. I wish you a lot of fun at Steffen Weber's web site.

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