Why symmetry?

A very few historical remarks
Crystals of the Russian Urals, late 19th century, Mineralogical Museum, Mining Institute, St. Petersburg, Russia

This model of a mine shaft shows the rich variety of crystals in that region.
In his 1664 masterpiece, *Micrographia*, the English scientist Robert Hooke speculated that crystals have regular geometric shapes because they consist of regular sphere packings.
160 years later, Haüy explained crystals as stacks of blocks.
Crystal symmetry is restricted by the building block model: pentagonal faces cannot be regular.
With the invention of the goniometer, mineralogists could measure the angles between crystal faces with great precision.

The goniometer that belonged to E. S. Federov, now in the St. Petersburg Mining Institute.
Atlas der Krystallformen by Victor Goldschmidt (pub. 1913 to 1923) contains 23606 crystal drawings and a short description of each drawing.

Symmetry-equivalent faces have the same labels. Interfacial angles are rendered precisely.
With the discovery of x-ray diffraction in 1912, attention turned to internal symmetry. Morphology was ignored.
CRYSTAL SYMMETRY has developed into a huge subject, involving many branches of mathematics, especially geometry and group theory.

- symmetry group of the motif
- site symmetry group
- symmetry group of the lattice
- symmetry group of the pattern
- all of the above, taking colors into account.
But crystals aren’t groups, and crystallography continues to surprise us.

Compare this pyrite crystal with the “quasicrystal” on the left.

Al-Pd-Re single “quasicrystal” shown over a mm scale. Fisher Research Group, Geballe Laboratory for Advanced Materials, Stanford University.
Towards fivefold symmetry?

Crystallography is in for a minor upheaval, with the recognition of forbidden icosahedral symmetry by both construction and experiment.

Cold water on icosahedral symmetry

Linus Pauling has produced an alternative explanation of the observation that solid manganese-aluminum alloy may have 5-fold symmetry on the atomic scale. How can the two views be reconciled?

Puzzling Crystals Plunge Scientists Into Uncertainty

By MALCOLM W. BROWNE

Most solid things are made of crystals, and for nearly two centuries scientists assumed that every crystal must have an orderly structure, its constituent atoms fixed at predictable, periodic positions within a lattice framework. But the discovery of a new type of crystal that violates some of the accepted rules has touched off an explosion of conjecture and research that may lead to the founding of a new branch of science.

The finding has galvanized microstructure analysis, mathematicians, chemists, metallurgists and physicists in at least eight countries. According to one estimate, scientists around the world are now producing a paper a day relating to the discovery, and an end to this torrent of research is nowhere in sight.

Whether the discovery will have practical consequences remains to be seen. But as one investigator put it: "If this kind of crystal proves to have properties as peculiar as its structure, the stuff seems certain to find important uses. That's what one would expect in the field of condensed-matter physics."

Skepticism Overwhelmed by Experimental Evidence

Among the many past achievements of condensed-matter physicists the discovery of semiconducting crystals, which provided the