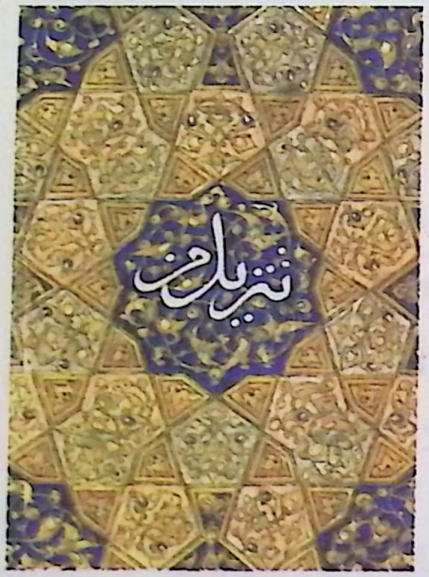
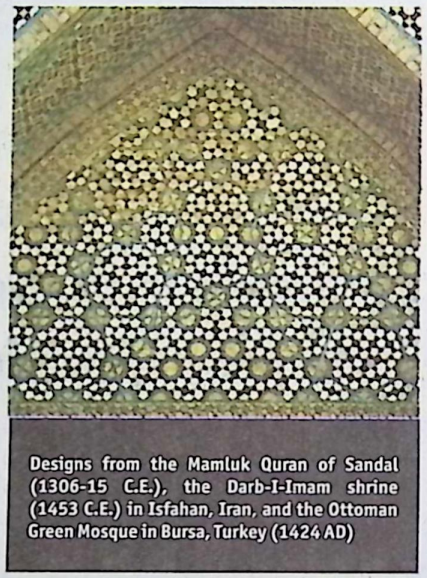
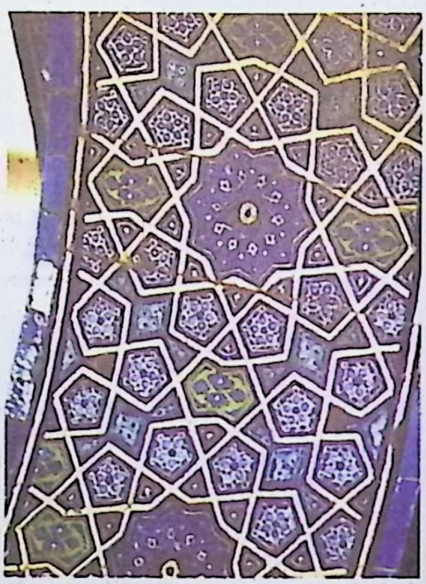
Discovering the forbidden in Islamic architecture

Rashida Ahmad reports on mathematical mysteries in medieval Islam







Designs from the Mamluk Quran of Sandal (1306-15 C.E.), the Darb-I-Imam shrine (1453 C.E.) in Isfahan, Iran, and the Ottoman Green Mosque in Bursa, Turkey (1424 AD)

ISLAMIC architects of the fifteenth century were constructing geometric tessellations with such complex symmetries that it took another five centuries for mathematicians in the West to discover and be able to reproduce the same patterns. But the exact identity of these anonymous designers and how they were able to create such patterns remains a mystery.

Designs from medieval Islamic tile work give us examples of what mathematicians and physicists would today recognize as "quasi-crystalline tilings" with "forbidden rotational symmetries," according to a recent paper by Peter J. Lu and Paul J. Steinhardt in *Science* magazine.

Such patterns are said to have "forbidden" symmetry as they are created using five-sided (pentagonal) figures. In geometry, periodic or repeating patterns using triangles, rectangles, or hexagons can be created that are ever-repeating and are perfectly symmetrical when rotated around an axis. Crystalline structures in nature possess such perfect symmetry.

But simple pentagons alone cannot be set in a repeating pattern without creating gaps. Thus, western mathematicians proved in the 19th century that three-, four- and six-fold symmetries are "allowed." But five-fold rotational symmetry was expressly forbidden.