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Traditional symmetries of Japan: Manji and kamon

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Manji, the Japanese Buddhist swastika symbol, forms a part of a typical Japanese *p*4gm pattern. Besides this 'parent' pattern, an interesting, affinely modified pgg variety and other derivatives are used. These form a subset of a family of swastika-meander patterns of classical Greek, Roman, Seldjuk, Ummayad and Buddhist art. In this vast body, families of 'rotation homologues' (*p*4 and *p*4gm, respectively), based either on 'normal' or 'recurving' swastikas or on their combination, as well as 'inclusion derivatives' which accommodate other elements besides swastikas, and other pattern types can be defined. A variety of swastika patterns was created by substituting the swastikas for squares, lozenges and triangles (as triskalions) of the Archimedean patterns. Plane groups with swastikas are altered into layer groups by assigning a 'spin' to each swastika. For example, p4gm alters into a layer group *p*4212. Kamon are heraldic symbols, originally used by aristocratic families, later also by commoners, guilds and temples. There can be one, three or five mon on a formal kimono. The medieval use of mon for friend-and-foe recognition in battles between clans is well known. The pictorial contents of kamon are rich: animals, plants, objects of everyday life and work, and pure geometric forms. Collections of kamon, such as that by Hondaso Ichiro (1992) show 2D point groups (from 16.m.m to 1) and layer groups, both of which show interesting variations derived skilfully from the symmetry of the object depicted, combinations of 2-3 different symmetries in one mon, as well as (projected) 3D groups and further motif varieties situated outside a point-group definition. As always in such cases, the statistics of the resulting symmetry groups is of great interest.

Keywords: traditional symmetry, manji (swastika), kamon (coat-of-arms)

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Self-similar ornaments obtained from girih tiles

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It has been discussed by various authors (Necipoglu, Makovicky, Bonner, Lu/Steinhardt) that islamic ornaments dating back as far as the 12th century possess geometric structures of the same type on different scale levels and thus give rise to self-similar patterns. A particularly intriguing example that gives insight into the construction of such ornaments is the pattern no. 28 of the Topkapi scroll. This sketch shows line ornaments on two different scale levels supplemented by additional lines indicating how the pattern can be constructed from a set of five girih tiles (i.e. tiles decorated with a line pattern constituting the overall line ornament). A close analysis of this pattern in the Topkapi scroll and of a portal at the Darb-i Imam Mosque in Esfahan showed that some of these tiles can be subdivided into smaller scaled versions of the same girih tiles. This raises the question whether these tiles give rise to genuine quasicrystal tilings via an iterated subdivision/inflation process. We demonstrate that a subset of three of these girih tiles (decagon, bowtie, elongated hexagon) indeed allow various inflation rules, even with different scaling factors and different possibilities for the symmetry properties of the subdivision. In contrast to the fairly large scaling factors (of approximately 5.2 and 8.5) found in the examples, we obtain subdivisions with scaling factor 2.6 which allow at least three iteration levels to be visible in an actual design. The non-periodicity of the resulting tilings is in all cases evident from the irrationality of the frequency ratios for the different tiles. Finally, we show that the by removing certain parts in the subdivision it is possible to produce fractals analogous to e.g. the Sierpinski triangle.

Keywords: girih tiles, self-similarity, quasicrystals

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Microstructure and formation process of reddish color pattern hidasuki on bizen stoneware

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Bizen stoneware, one of the famous artistic Japanese unglazed ceramics, has been loved for about 1,000 years because people perceive wabi and sabi from this stoneware. Here, wabi is a concept of the richness and beauty in simplicity and poverty, and sabi is an aesthetic sense of existing loneliness. The art is considered to be "an art of clay and flame " because the different colors appear in various forms without the aid of artificial glazing or dyeing figures. Fine control of these patterns is extremely difficult because multiple parameters such as the chemical composition of the clay, firing temperature, cooling rate, and effective oxygen partial pressure are involved. However, we believe that studies of the essential coloring mechanism from the viewpoint of solid state chemistry can provide artists with new inspiration and chemists with new concepts with respect to the creation of novel functional materials. In this study, we focus on a characteristic reddish pattern called Hidasuki appearing specifically where the clay contacts rice straw, which is used as a separator to prevent the adhesion of stoneware in the kiln. The reddish color on Hidasuki has been considered to be derived from hematite. We note here that the clay mined from the Bizen area in Okayama prefecture, Japan contains approximately 2-3 wt% of Fe_2O_3 and also that rice straw generates SiO_2 (84 wt%) and K_2O (13 wt%) when heated at 1273 K in air. A glassy phase forms through reactions of the clay with potassium provided by rice straw, in which small and red hematite crystals precipitate on cooling. Here, we report the evolution of a specific microstructure through model experiments.

Keywords: arts, stoneware, microstructure

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Symmetrical aspect of the Nabeshima ware

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