# **Errata for WEYL's *Symmetry***

MARIUS KEMPE

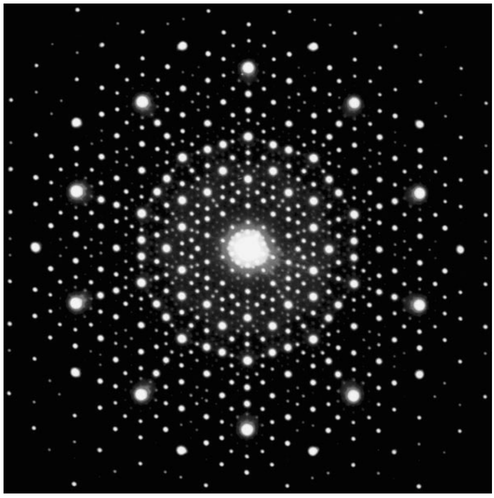
p. 20: *"The net result is that in all physics nothing has shown up indicating an intrinsic difference of left and right."*

Four years after the book was published, physicists discovered a fundamental left-right asymmetry, of which there is a wonderful discussion in Feynman's *Lectures on Physics*, vol. I, ch. 52. More recent experiments seem to indicate that charge, reflection and time symmetry all go together.

p. 25: *"It seems difficult to devise physical laws in which they are not intrinsically alike; but the negative counterpart of the positively charged proton still remains to be discovered."*

This was discovered three years after the book's publication and is now called the 'antiproton'. For a description of its physical properties, see the chapter of Feynman's *Lectures* cited above.

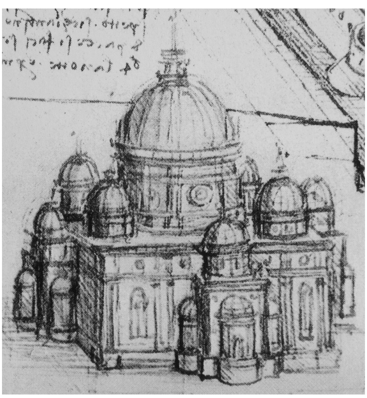
p. 63: *"While pentagonal symmetry is frequent in the organic world, one does not find it among the most perfectly symmetrical creations of inorganic nature, among the crystals."*

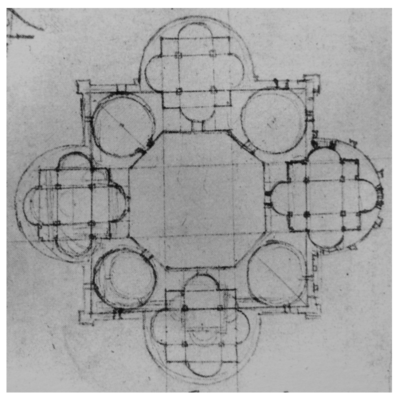


Crystallographers have since discovered crystals with, amongst other properties, five-fold symmetry of sorts, called 'quasicrystals'. The figure on the first page shows a Laue diagram of an aluminium-nickel-cobalt quasicrystal (compare the diagrams on p. 124 of the book).

p. 66: *"Leonardo da Vinci engaged in systematically determining the possible symmetries of a central building and how to attach chapels and niches without destroying the symmetry of the nucleus."*

I have examined several books on Leonardo's architectural work and found no trace of a systematic examination of central symmetry, nor even of a building design which has a cyclic symmetry group. The figures below show a view and plan of a church design from one of Leonardo's notebooks.





p. 75: *"Here is a page from Haeckel's Challenger monograph showing the skeletons of several Radiolarians."*

D'Arcy Thompson wrote[1]: "As to Haeckel, I wouldn't trust him round the corner, and I have the gravest doubt whether his pentagonal dodecahedron and various others ever existed outside his fertile fancy. I believe I may safely say that no type-specimens of these exist in the British

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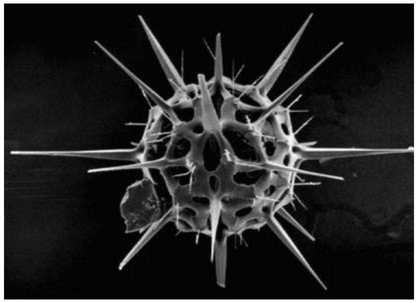
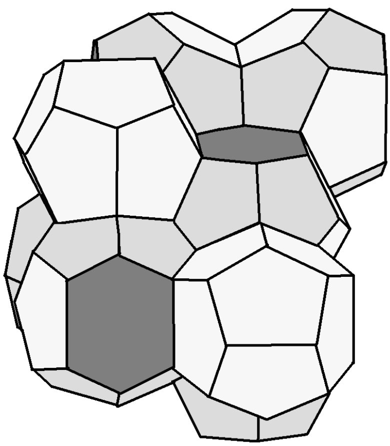
[1] In a letter quoted in H. S. M. Coxeter's review of *Symmetry* in the *American Mathematical Monthly* (1953), 60 (2): p. 136-139.

Museum, or anywhere else." Here is a photograph of a radiolarian.



p. 93: *"I am inclined to believe that Lord Kelvin's configuration gives the absolute minimum; but so far as I know, this has never been proved."*

In fact, a better configuration was discovered by Weaire & Phelan in 1994. It uses two types of cells, with 12 and 14 sides. It is not known whether it is optimal.



p. 103: *"Examples for all 17 groups of symmetry are found among the decorative patterns of antiquity, in particular among the Egyptian ornaments."*

Only 12 of the 17 symmetry groups can be found in extant ancient Egyptian decorations[1], with the five groups that preserve hexagonal lattices missing. Two example patterns are shown below (and see fig. 65 of the book).

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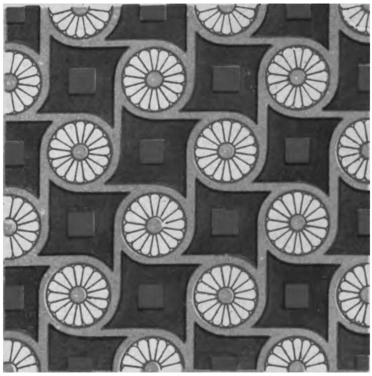
[1] See Owen Jones, *The Grammar of Ornament*, plates 9-11.

p. 104: *"Strangely enough the proof was carried out only as late as 1924 by George Pólya, now teaching at Stanford."*

Actually the proof was first given by E. S. Fedorov in 1891[1], though Pólya discovered the result independently. Moreover, Pólya did not actually give a proof in his 1924 article, but merely stated the result.

p. 104: *"Galois' ideas, which for several decades remained a book with seven seals but later exerted a more and more profound influence upon the whole development of mathematics, are contained in a farewell letter written to a friend on the eve of his death, which he met in a silly duel at the age of twenty-one."*

This letter was only a sketch of various results Galois had obtained. His most important work was a memoir[2] on the solvability of algebraic equations which he had been submitting versions of to the *Académie des Sciences* every year for three years previous to his death, and which was finally published by Liouville in his journal in 1846. Also, Galois died at twenty.

*Image sources:* Quasicrystal – Abe et al., *Nature Materials* (2004), 3: p. 759-767; Leonardo's sketches – Paris manuscript B, ff. 18 v & 19 r; Radiolarian – *Encyclopedia of Life* (eol.org); Weaire-Phelan structure – Tom Ruen, *Wikipedia;* Egyptian patterns – Owen Jones, *The Grammar of Ornament*.

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[1] 'Symmetry in the plane', *Proceedings of the Imperial St. Petersburg Mineralogical Society*, 28 (2), p. 345-390.
[2] Translated into English in Appendix 1 of H. M. Edwards, *Galois Theory* (1984).