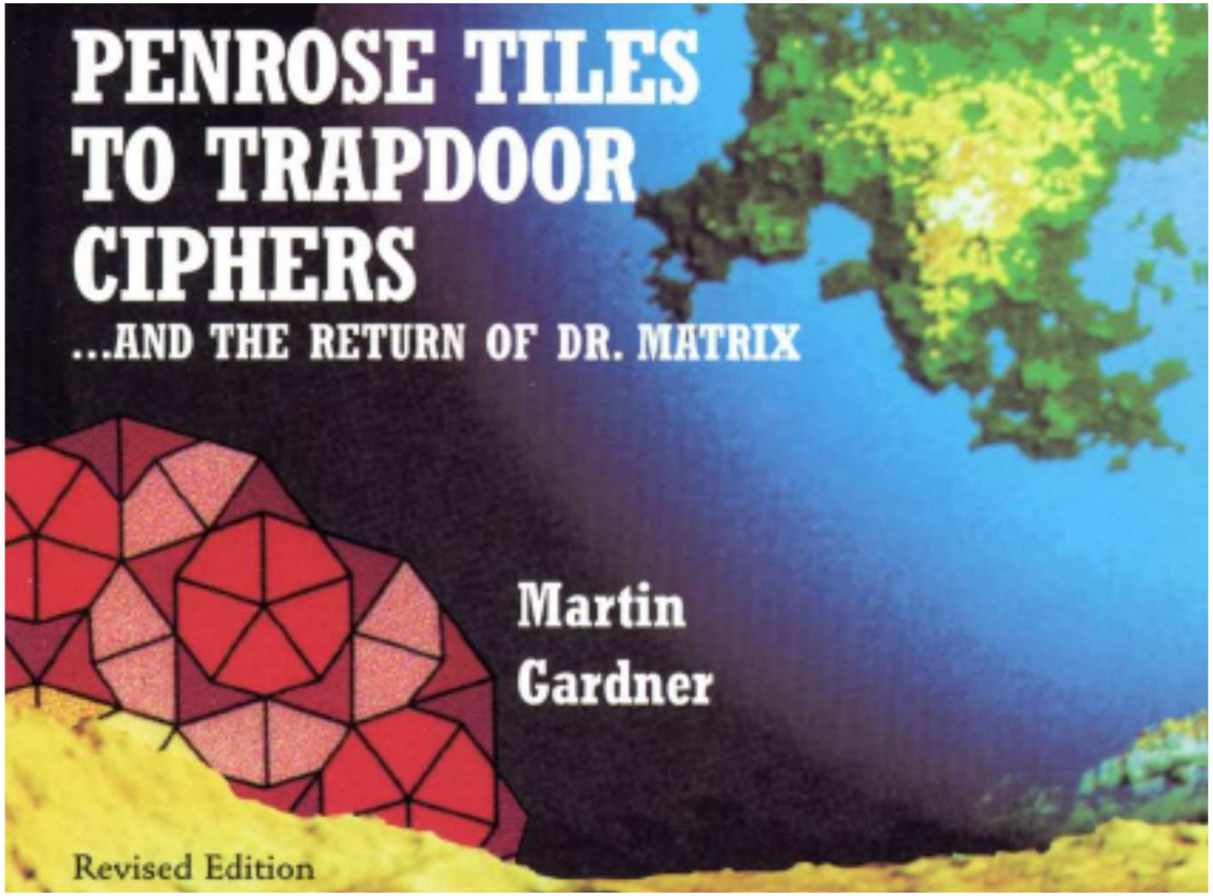
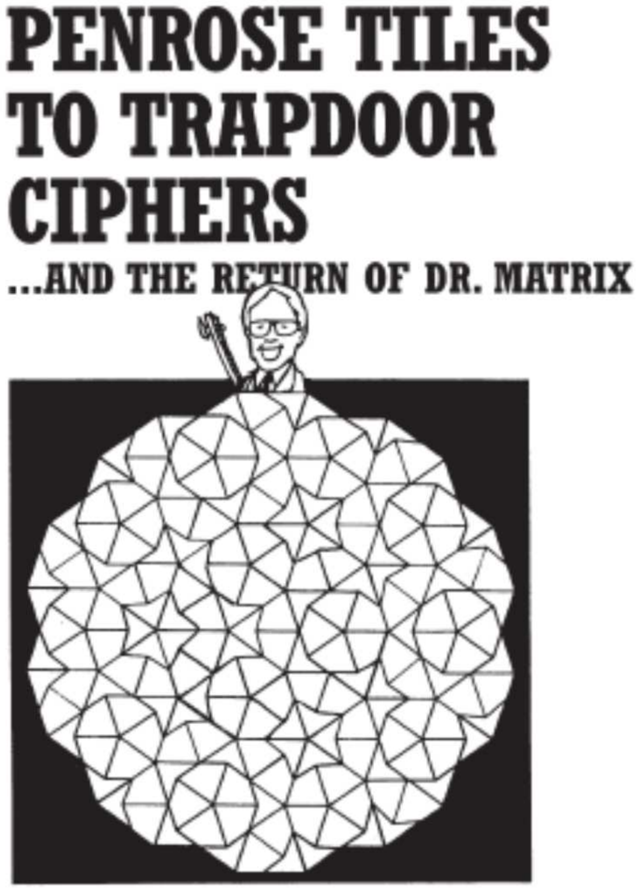
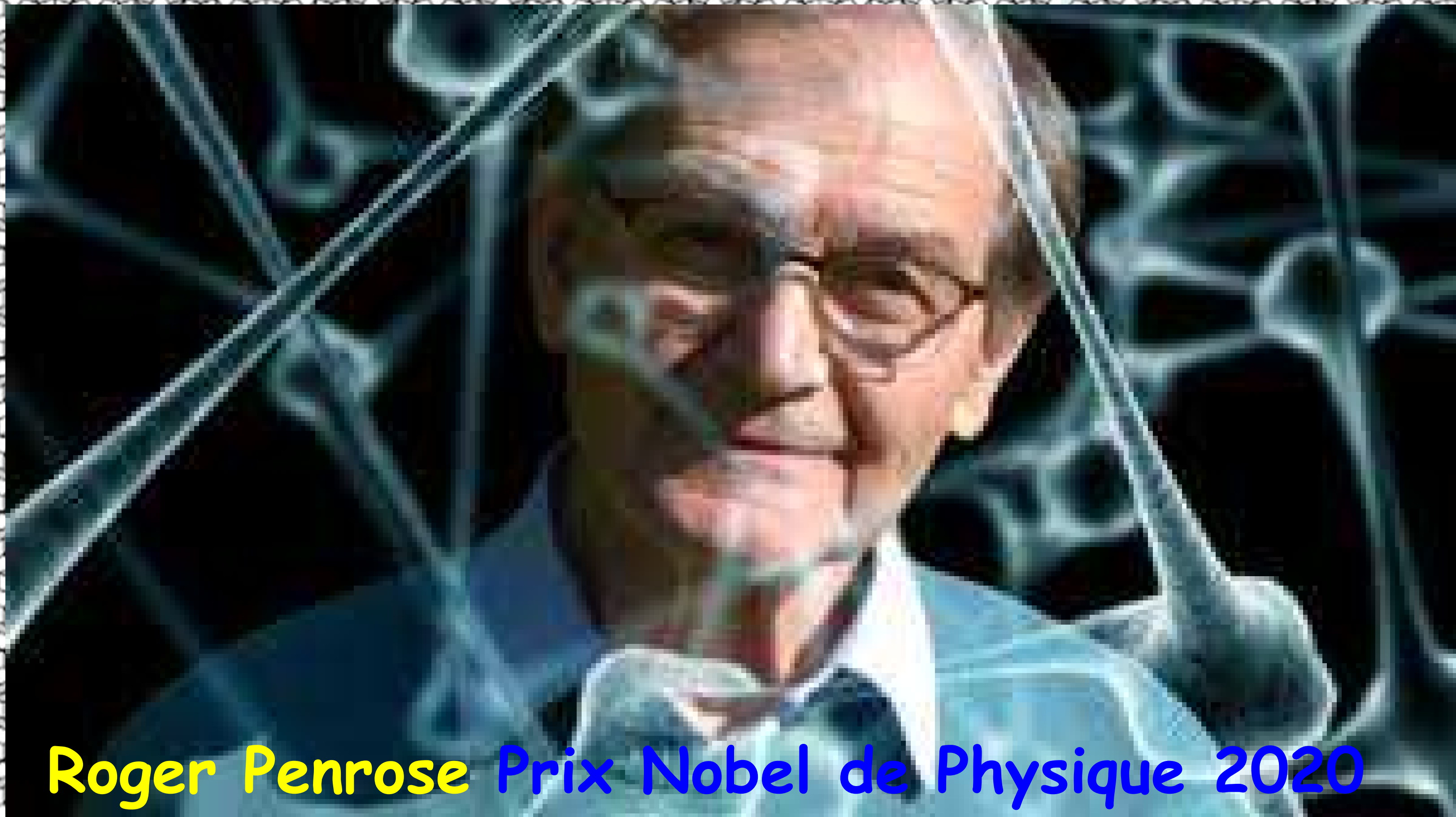
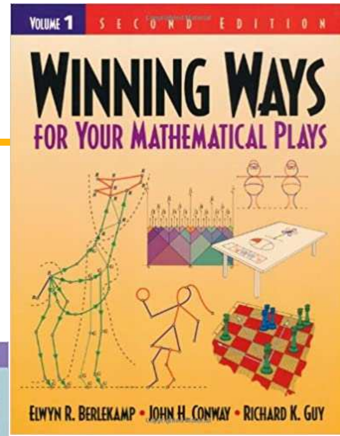

PENROSE TILES
TO TRAPDOOR
CIPHERS
...AND THE RETURN OF DR. MATRIX
Martin
Gardner
Revised Edition

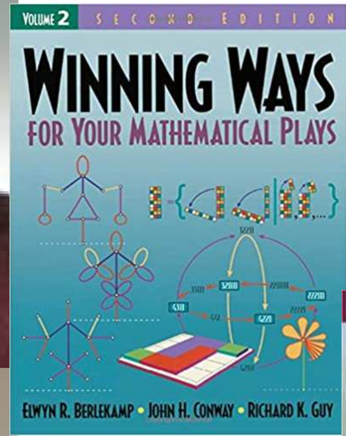

PENROSE TILES
TO TRAPDOOR
CIPHERS
...AND THE RETURN OF DR. MATRIX

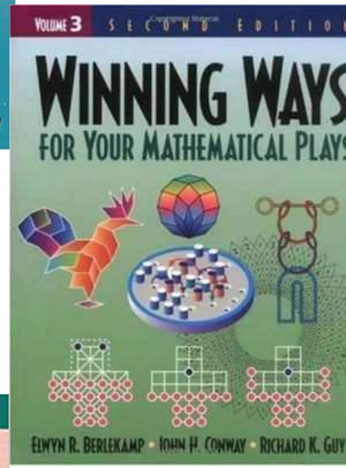
Pavages de Penrose

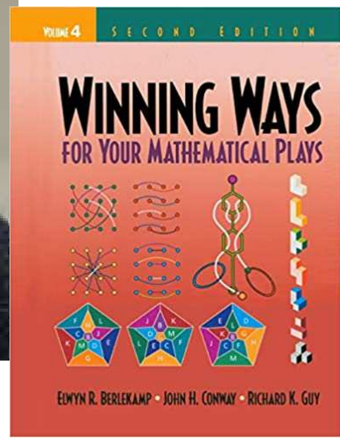


B.C.G.: l'art de ne pas penser Covid









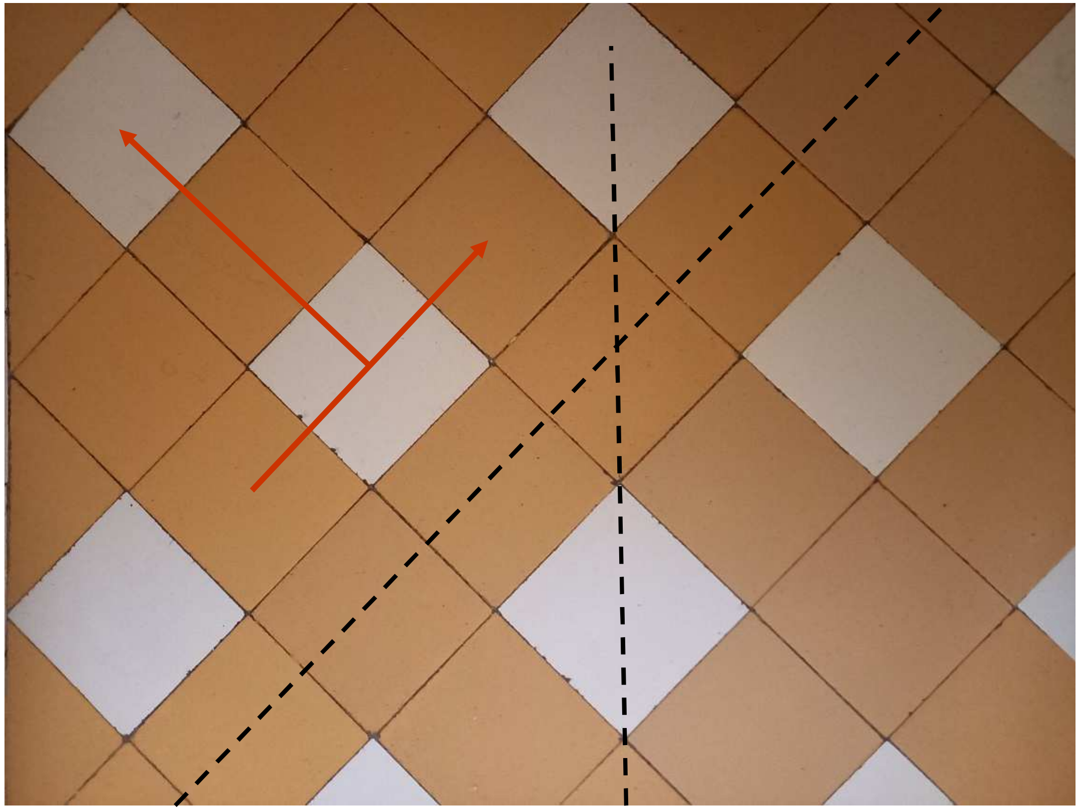
Définitions (plan)

Pavage: Ensemble de tuiles disjointes recouvrant le plan

Groupe de symétrie d'un pavage P
=
Ensemble des isométries S du plan telles que S(P) = P.

Isométries:

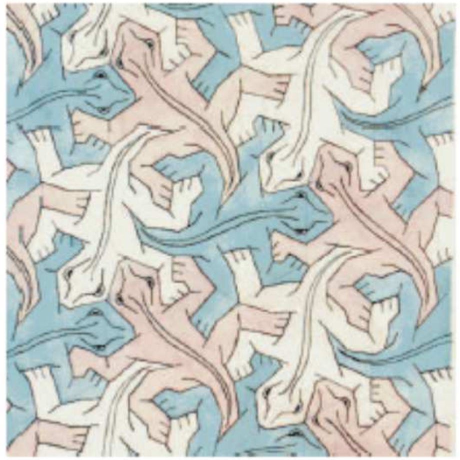
- Translations
- Rotations
- Symétries axiales



Périodique: S(P) contient 2 translation indépendantes

Antiquité: motifs décoratifs

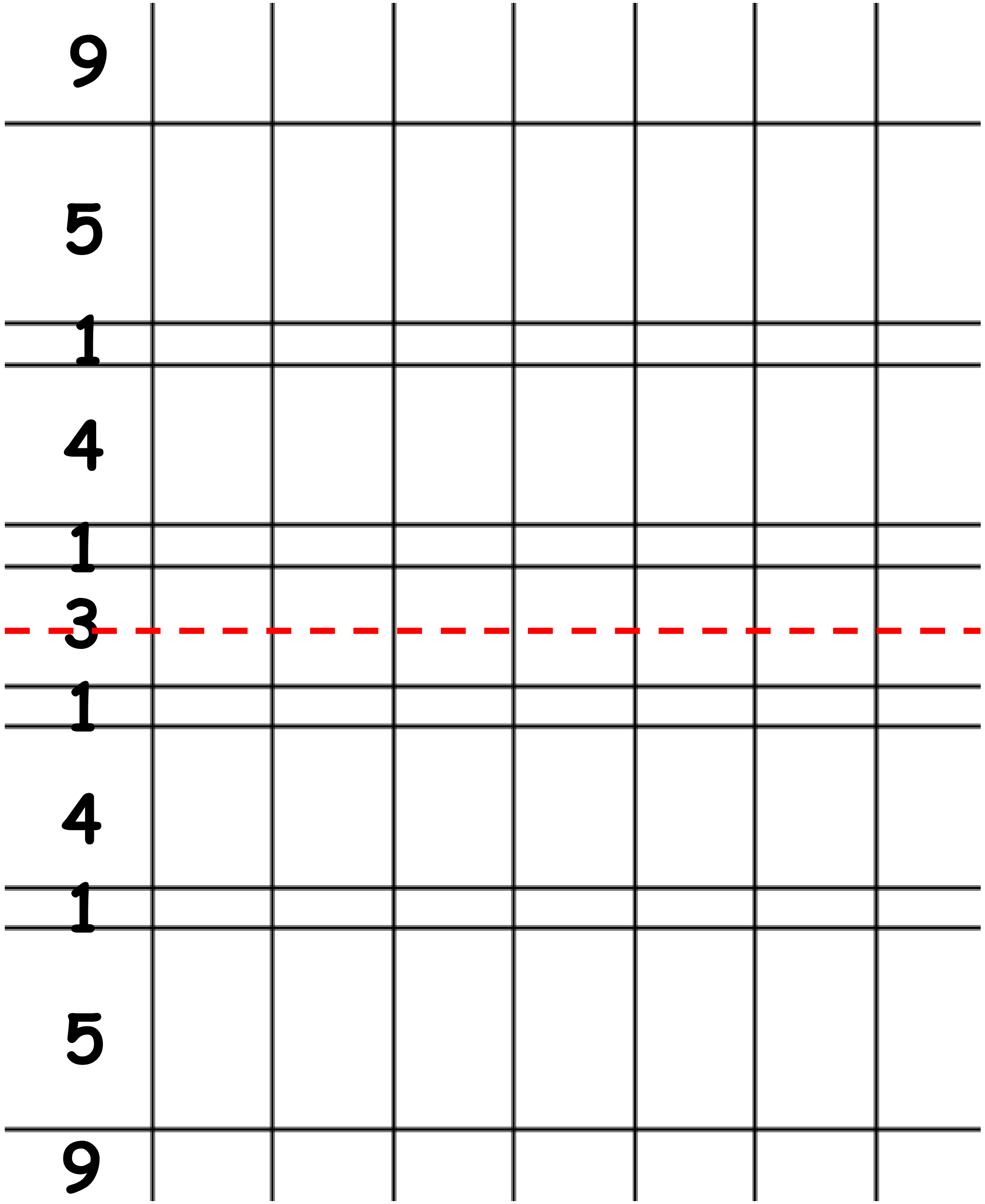
Evgraf Fedorof : 17 groupes cristallographiques du plan
19 types de pavés



Pavage sous-périodique:

S(P) contient

une seule translation.



Pavages quasi-périodique

Pavages de Penrose

Quasi-périodique : pour tout motif *m*, il existe un entier M tel que toute fenêtre de diamètre M contienne *m*.

Non périodique: S(P) ne contient aucune translation.

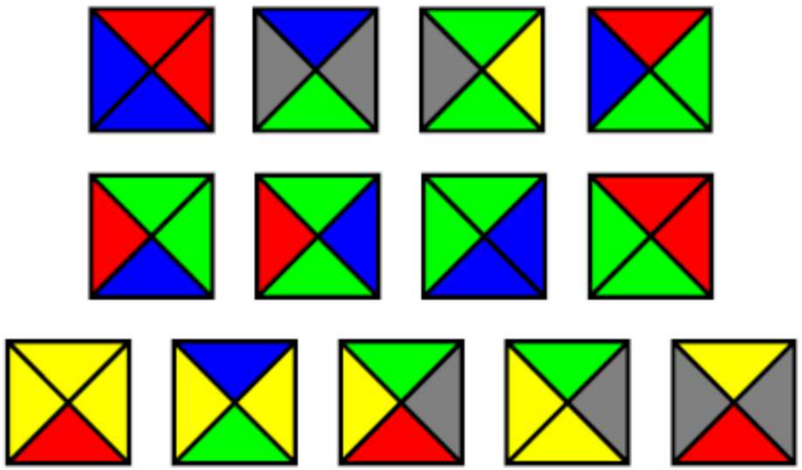
Infinité de tuiles pour Pavage

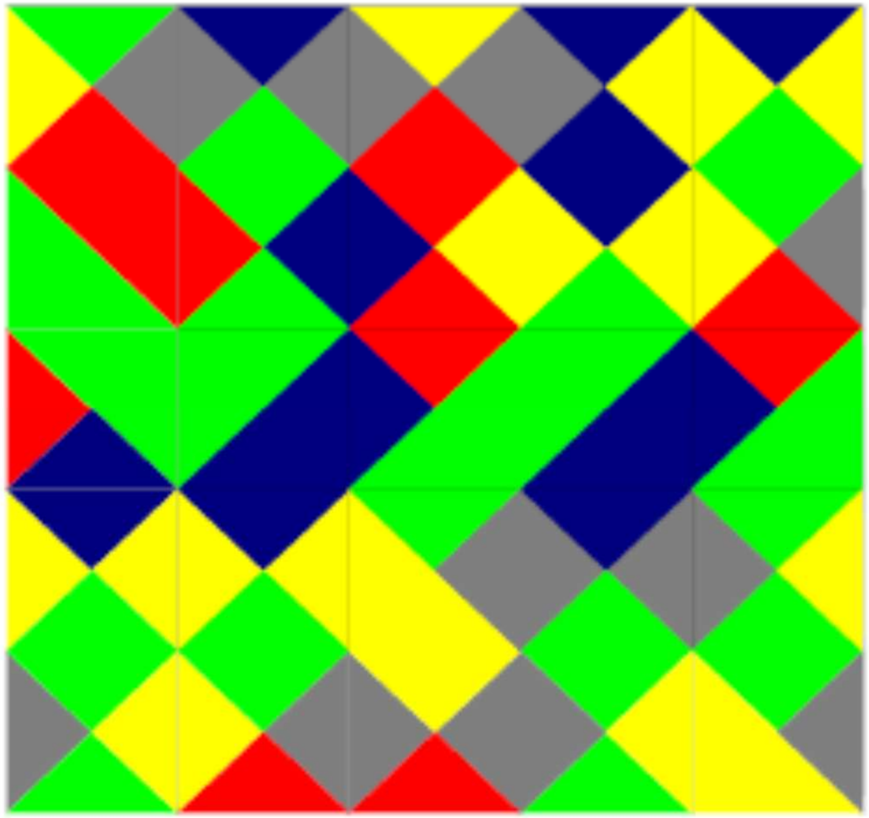
périodique

ET

non périodique

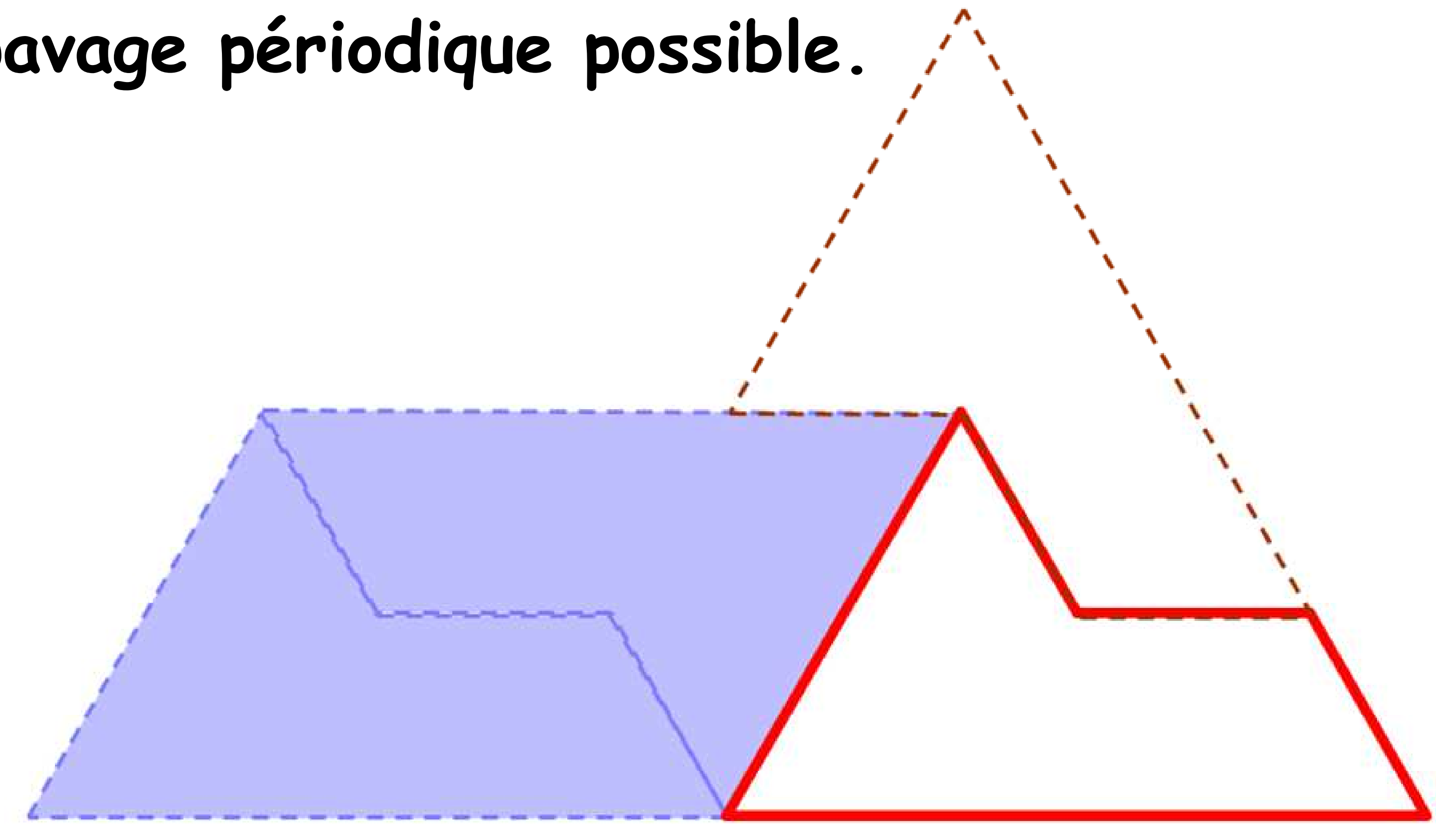
(Wang)





Pavage non périodique si REP-TILE

Alors: pavage périodique possible.



Existe-t-il un ensemble de tuiles
qui ne pavent que non périodiquement?

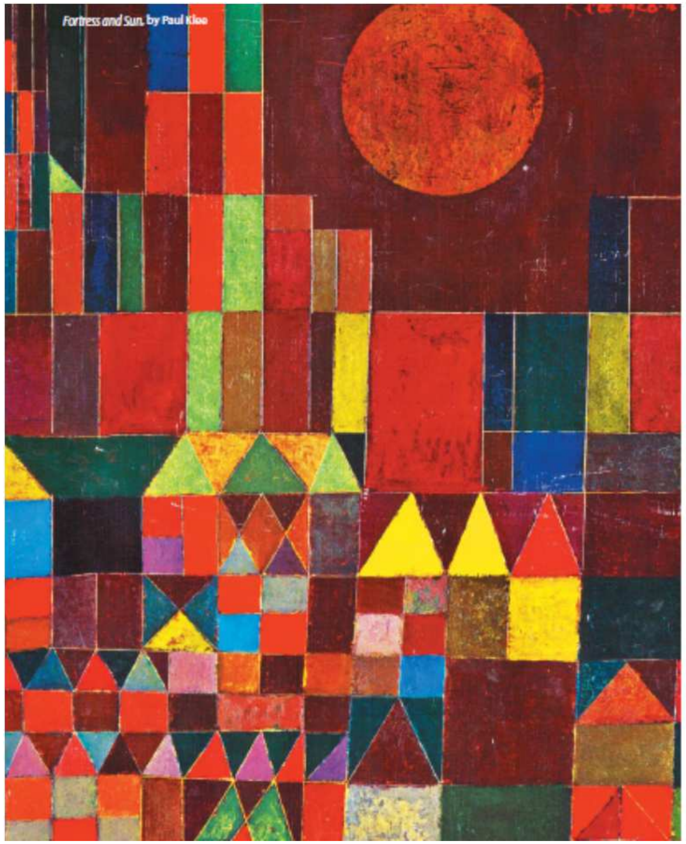
Existe-t-il des pavés, tuiles, tesselles qui ne permettent que des pavages non périodiques (PNP)?

1964: Berger plus de 20.000 pièces

1973: Penrose 6

1974: Penrose

4, 2 pièces



1978

Pentaplexity

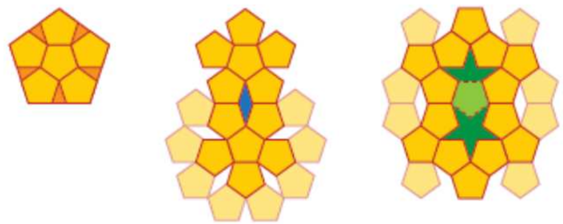
Sir Roger Penrose

First published in issue 39, 1978

Certain shapes, when matched correctly, can form a tiling of the entire plane but only in a non-periodic way. These tilings have a number of remarkable properties, and I shall give here a brief account explaining how these tiles came about and indicating some of their properties.

The starting point was the observation that a regular pentagon can be subdivided into six smaller ones, leaving only five slim triangular gaps. This is familiar as part of the usual "net" which folds into a regular dodecahedron, as shown in Figure 1. Imagine now, that this process is repeated a large number of times, where at each stage the pentagons of the figure are subdivided according to the scheme of Figure 1. There will be gaps appearing of varying shapes and we wish to see how best to fill these. At the second stage of subdivision, diamond-shaped gaps appear between the pentagons (Figure 2). At the third, these diamonds grow "spikes", but it is possible to find room, within each such "spiky diamond", for another pentagon, so that the gap separates into a star (pentagram) and a "paper boat" (or Jester's cap?) as shown in Figure 3. At the next stage, the star and the boat also grow spikes, and, likewise, we can find room for new pentagons within them, the remaining gaps being new stars and boats (as before). These subdivisions are shown in Figure 4.

Since no new shapes are now introduced at subsequent stages, we can envisage this subdivision process proceeding indefinitely. At each stage, the scale of the shapes can be expanded outwards so that the new pentagons that arise become the



United States Patent [19]   [11] **4,133,152**

Penrose   [45] **Jan. 9, 1979**

[54] **SET OF TILES FOR COVERING A SURFACE**

[76] Inventor: **Roger Penrose,** Flat 2, 6 Winchester Rd., Oxford, England

[21]

[22]

[30]

Jun. 26904/75

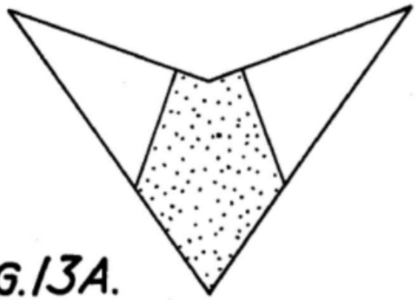


FIG. 13A.

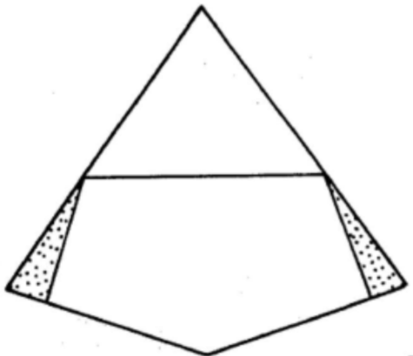


FIG. 13B.

[57] **ABSTRACT**

A set of tiles for covering a surface is composed of two types of tile. Each type is basically quadrilateral in shape and the respective shapes are such that if a multiplicity of tiles are juxtaposed in a matching configuration, which may be prescribed by matching markings or shapings, the pattern which they form is necessarily non-repetitive, giving a considerable esthetic appeal to the eye. The tiles of the invention may be used to form an instructive game or as a visually attractive floor or wall covering or the like.

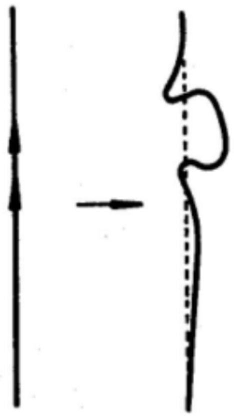


FIG. 5A.

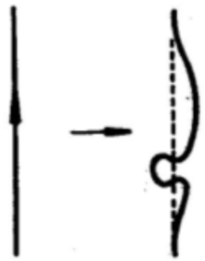


FIG. 5B.

Contraintes: couleur, forme, …

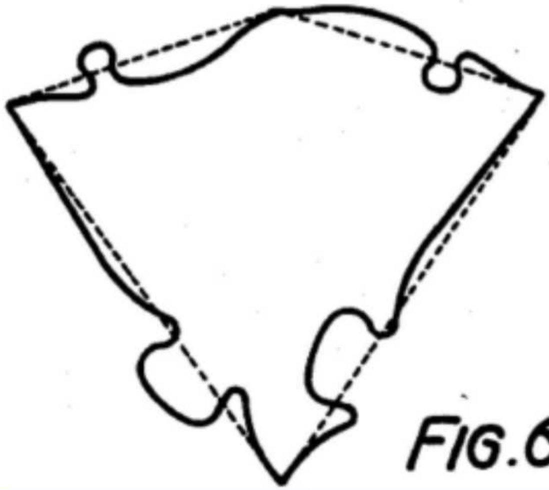


FIG.6B.

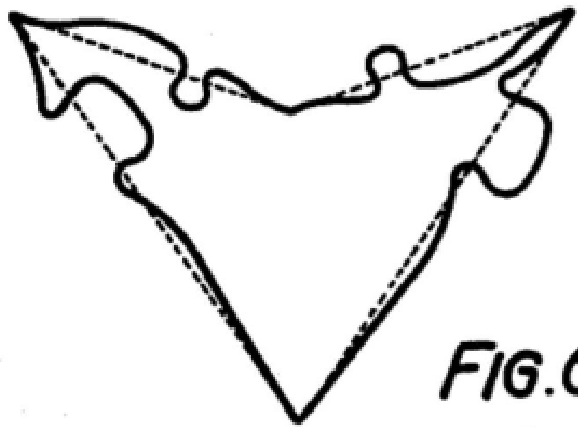
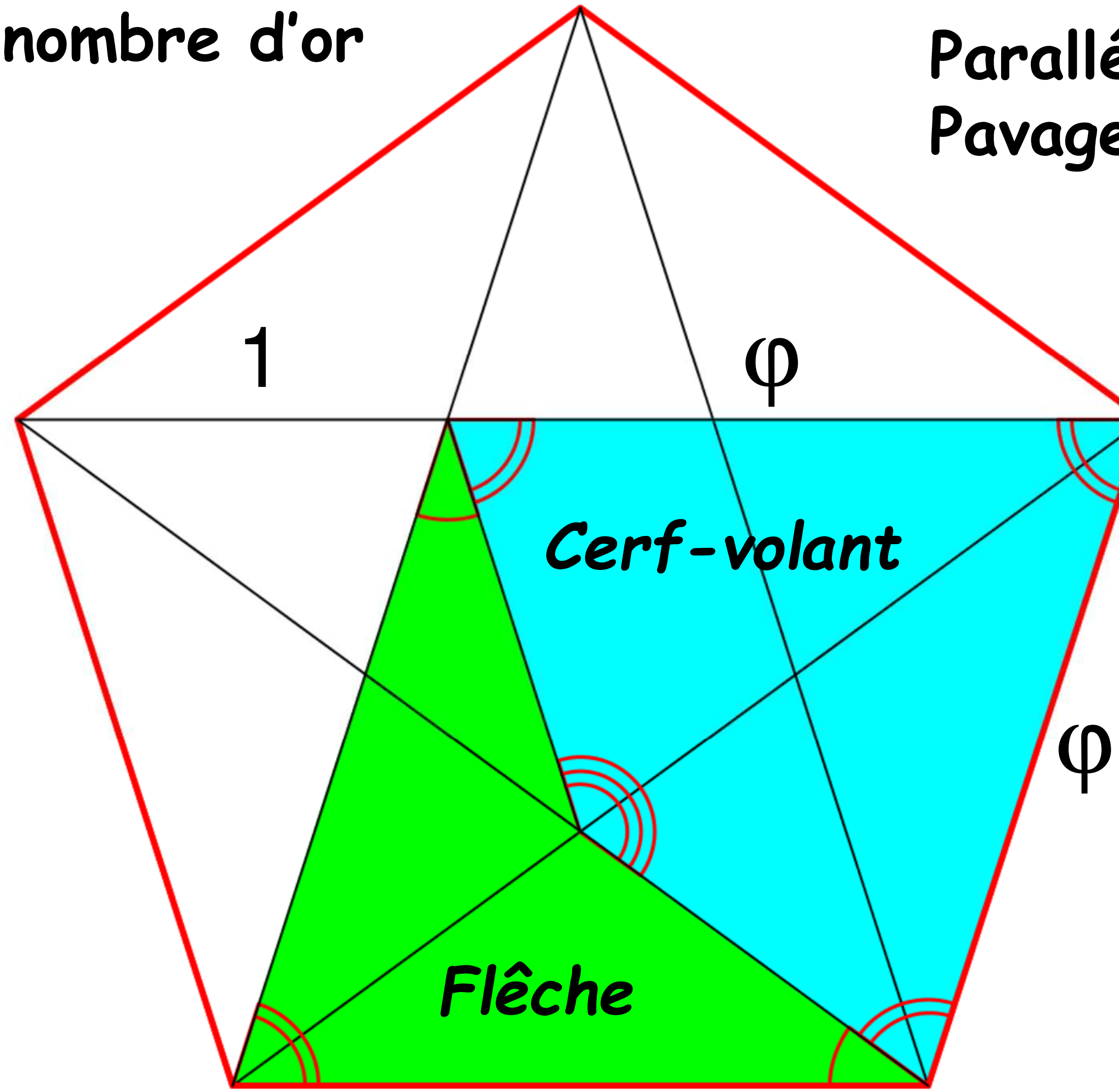


FIG.6A.

φ = nombre d'or

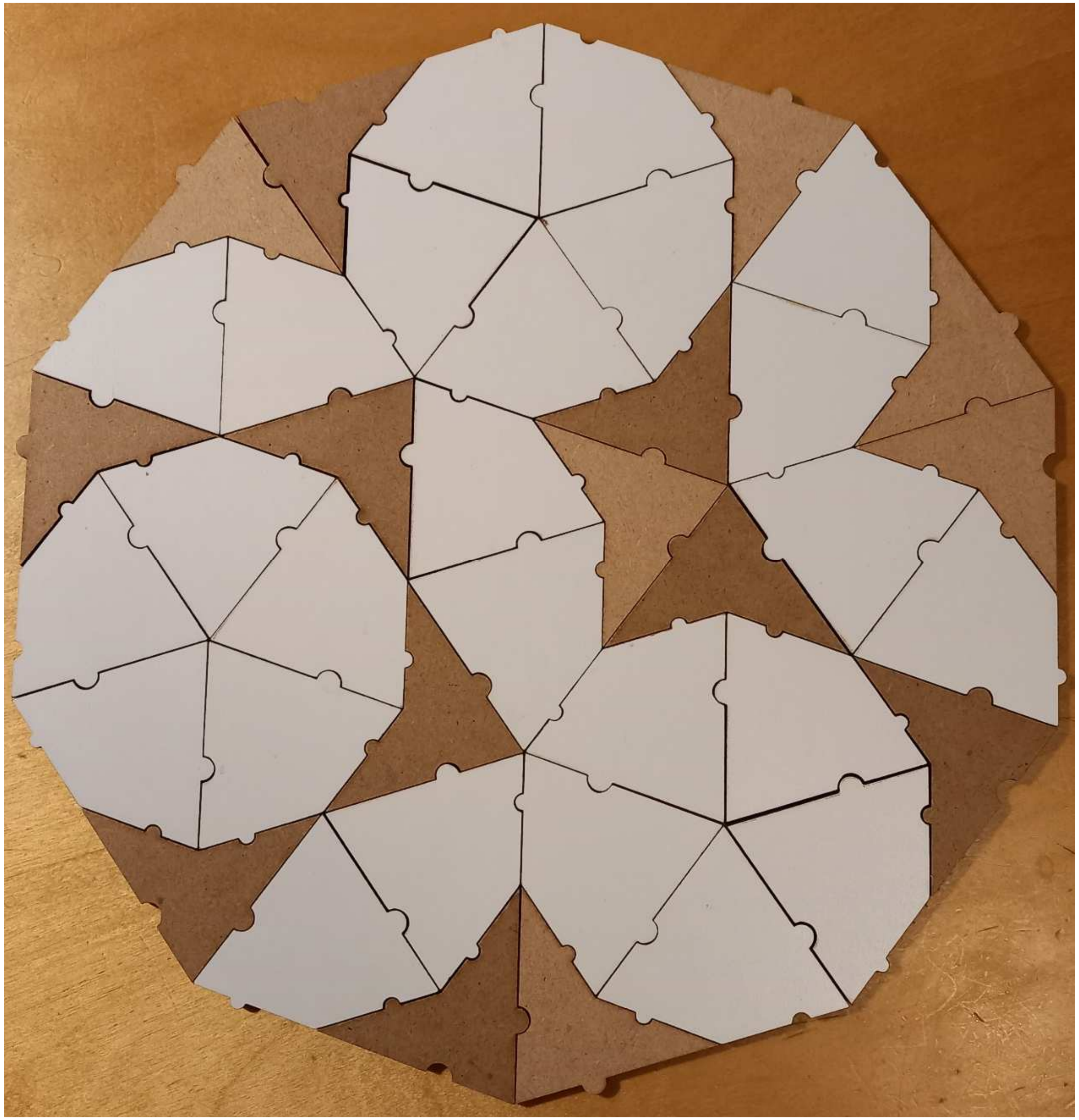
Parallélogramme :
Pavage périodique



Décagone

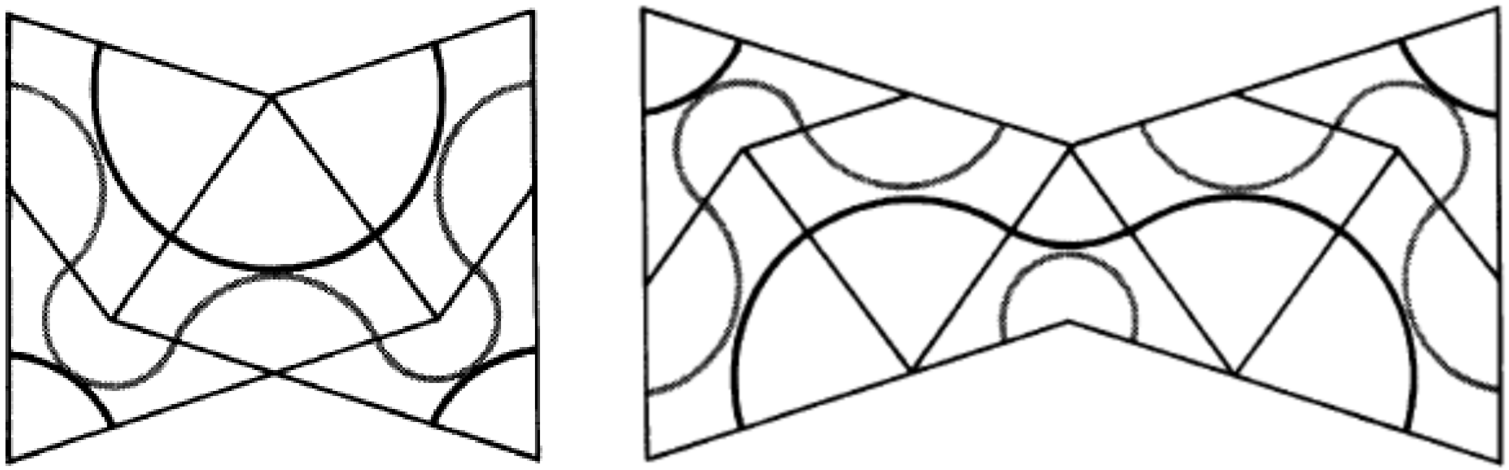
25 cerfs-volants
15 flêches

25/15 = 5/3

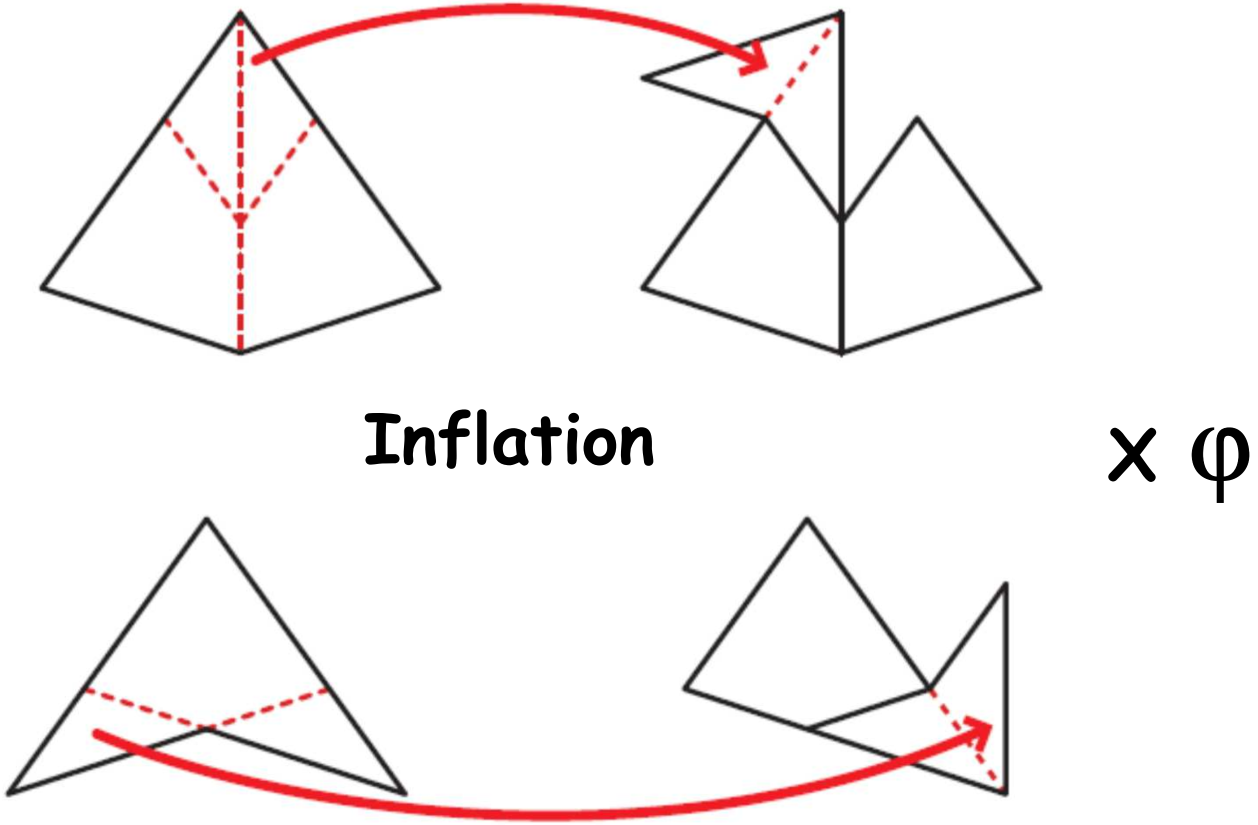


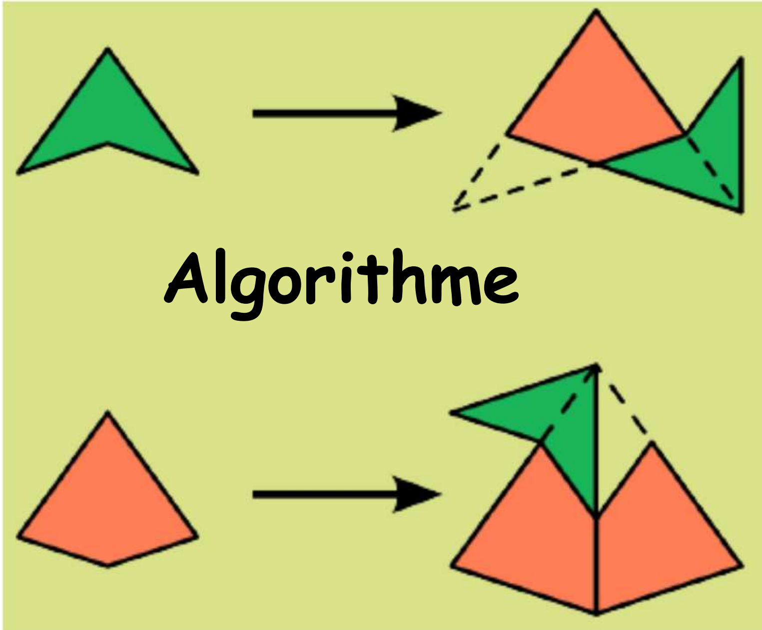
Conway:
Arcs de cercle
pour les contraintes

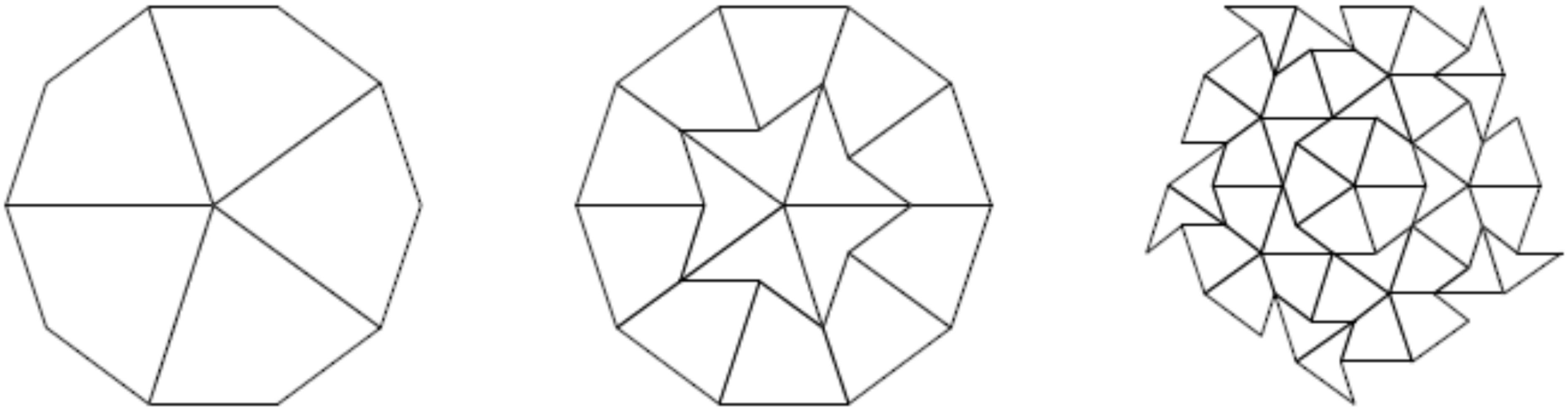
Deux motifs récurrents:
Grand et petit nœud PAP
(Pavage APériodique)



Dualité: Inflation-déflation



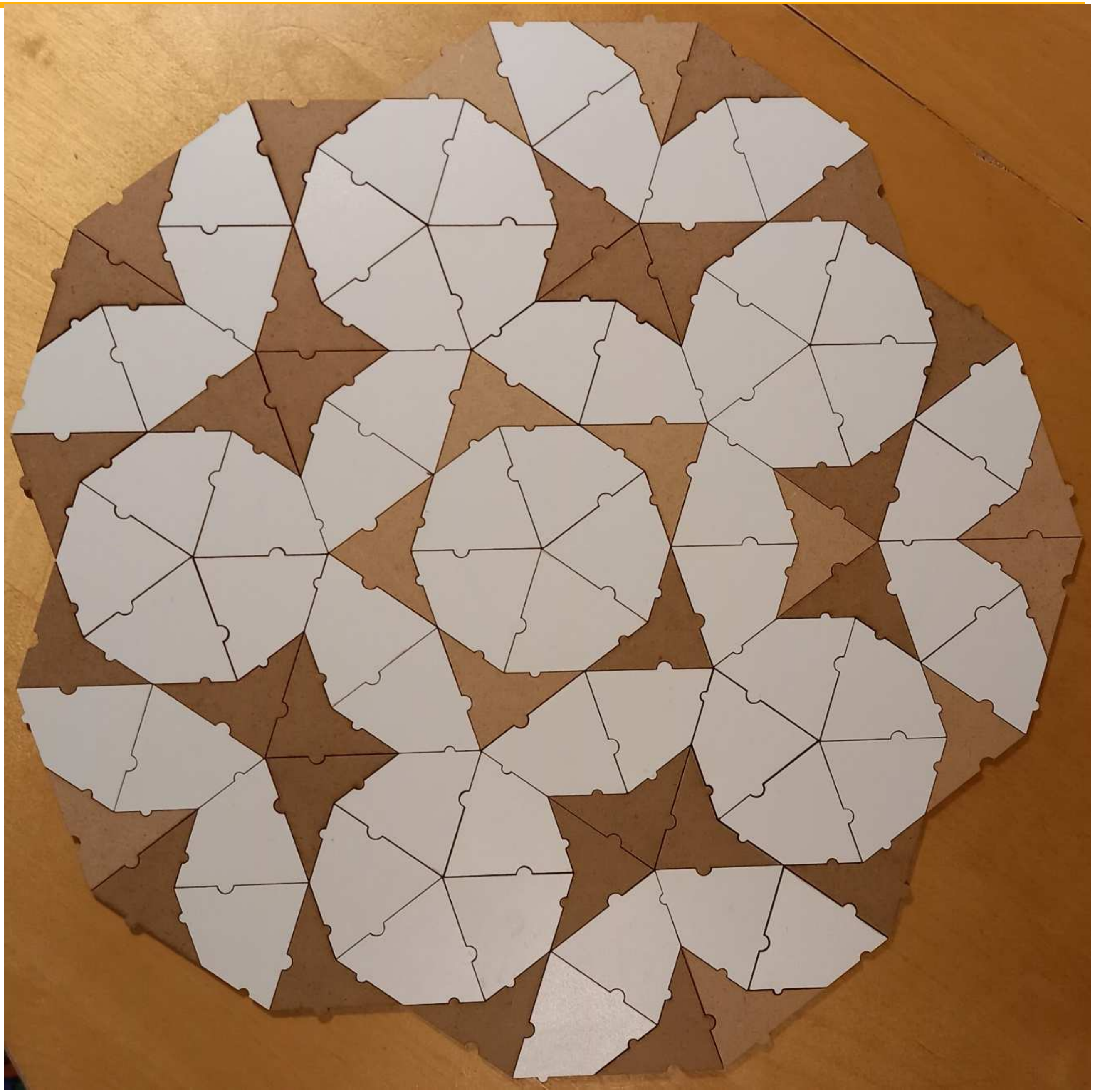




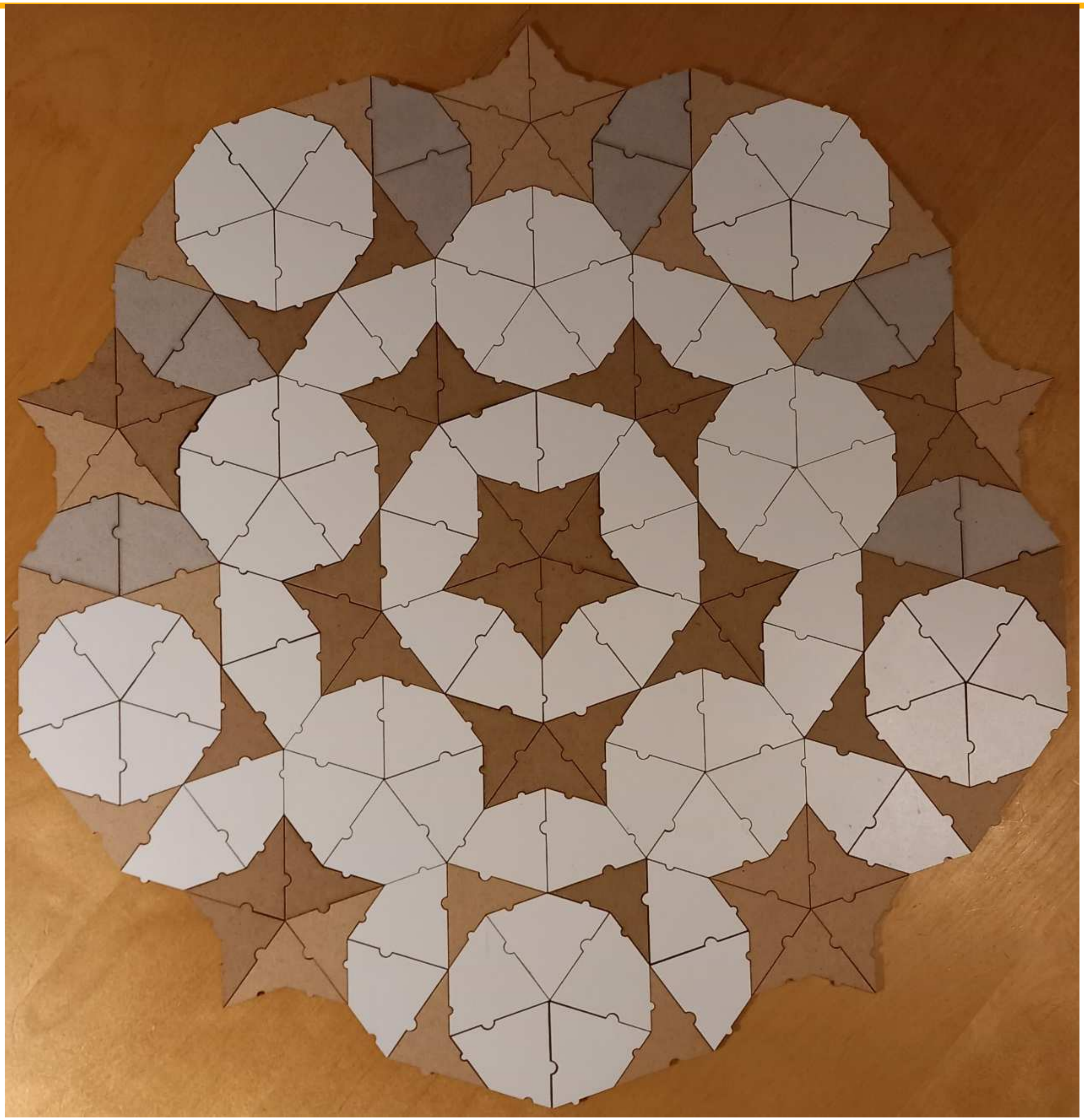
Etape 1

Etape 2

SOLEIL



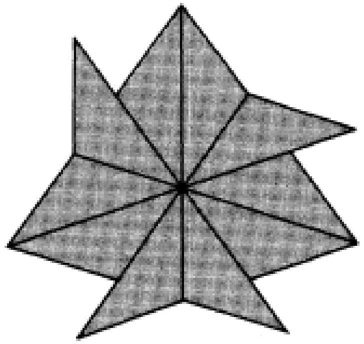
ETOILE



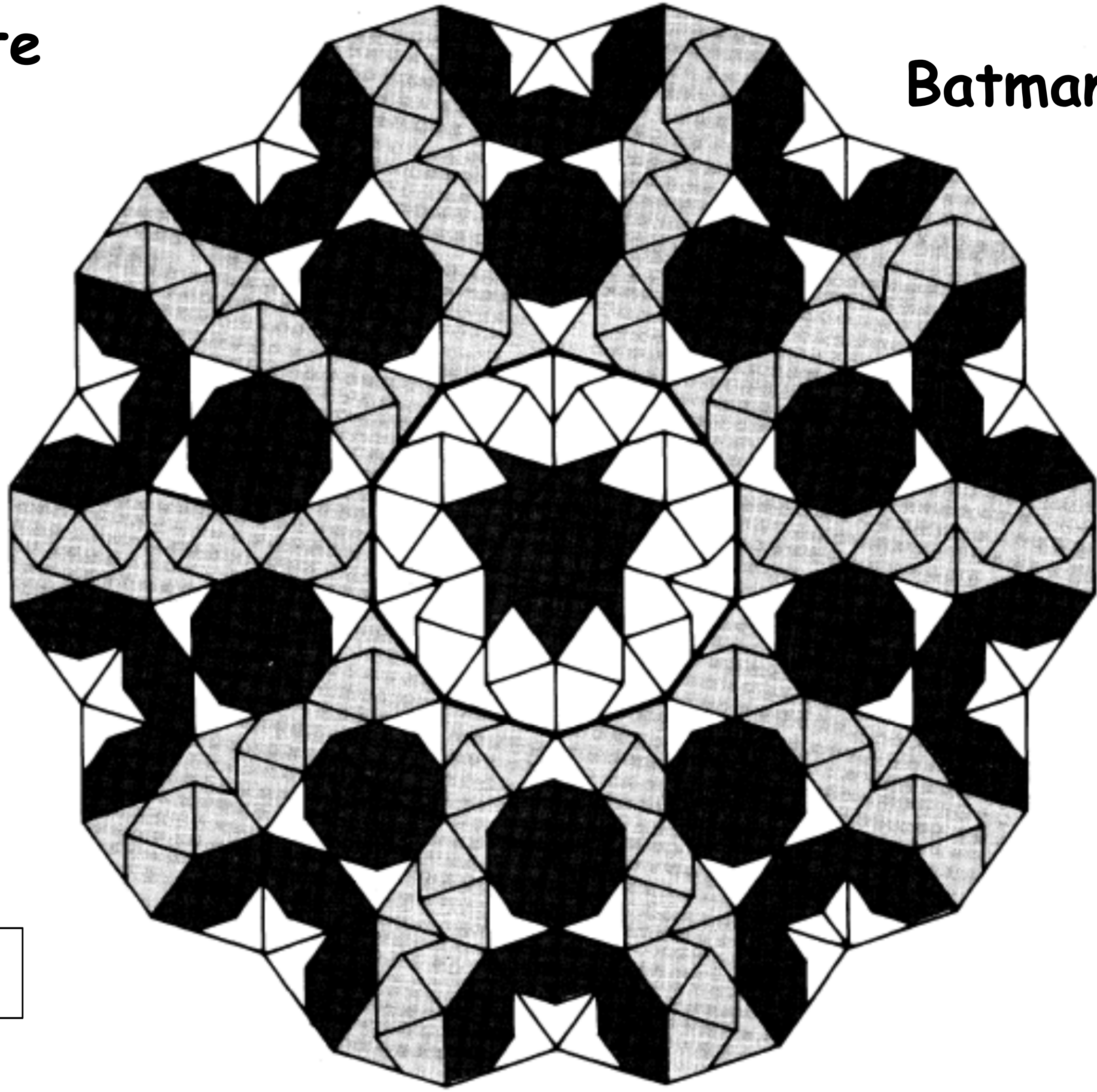
Pavages quasi-périodiques — Pavages de Penrose

Roue de charette

62 Décapodes



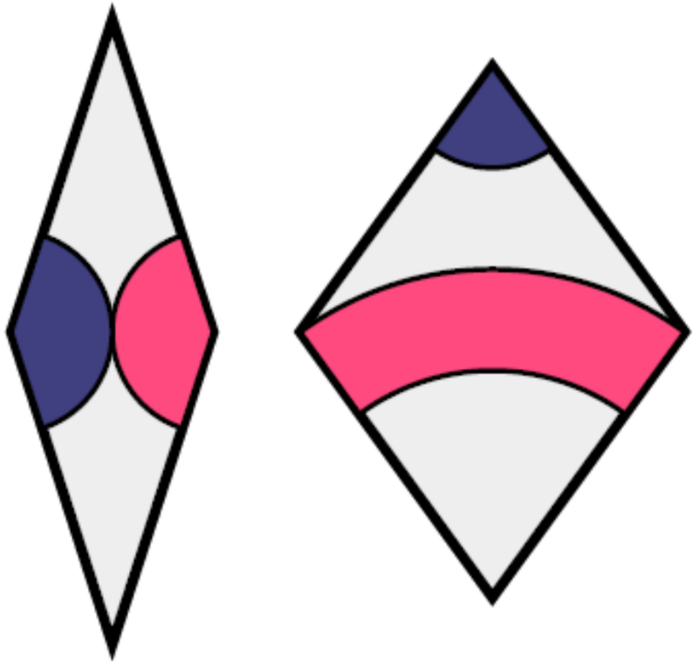
Asterix

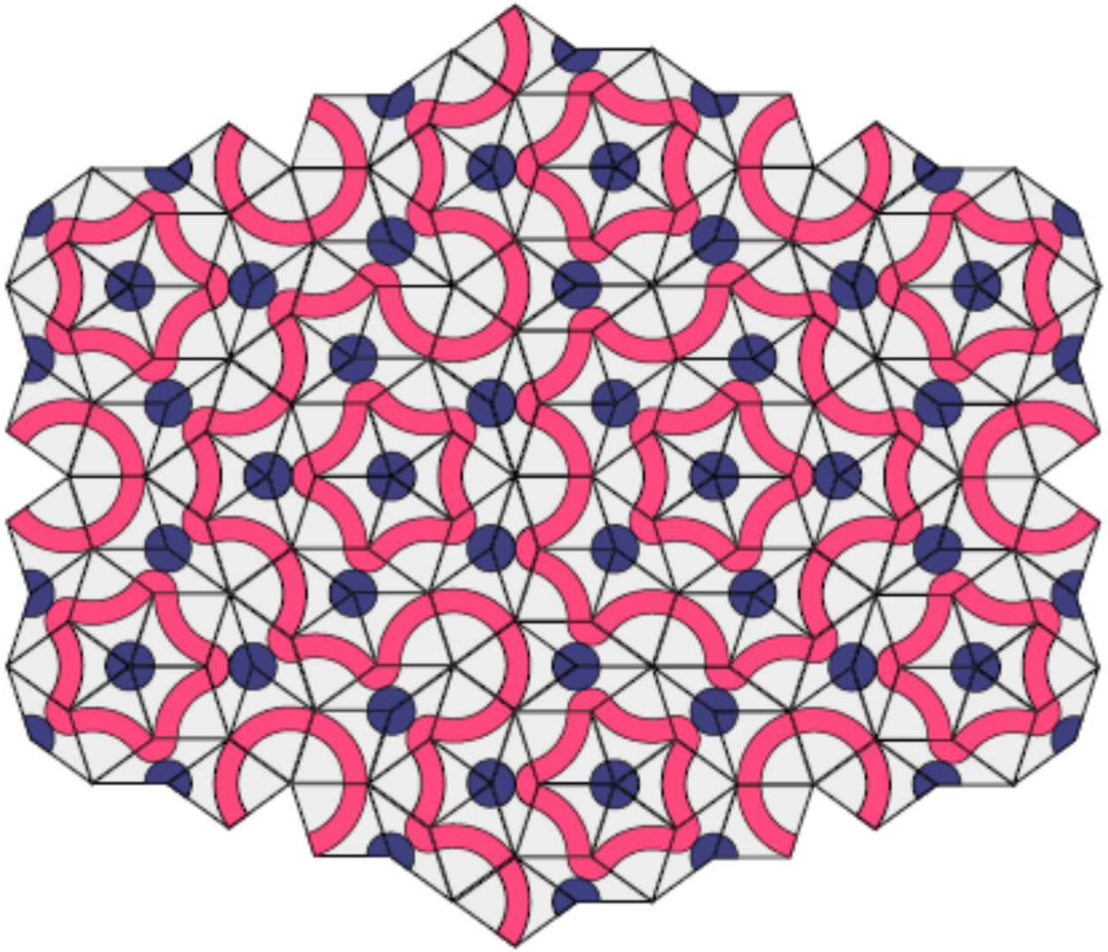


Batman

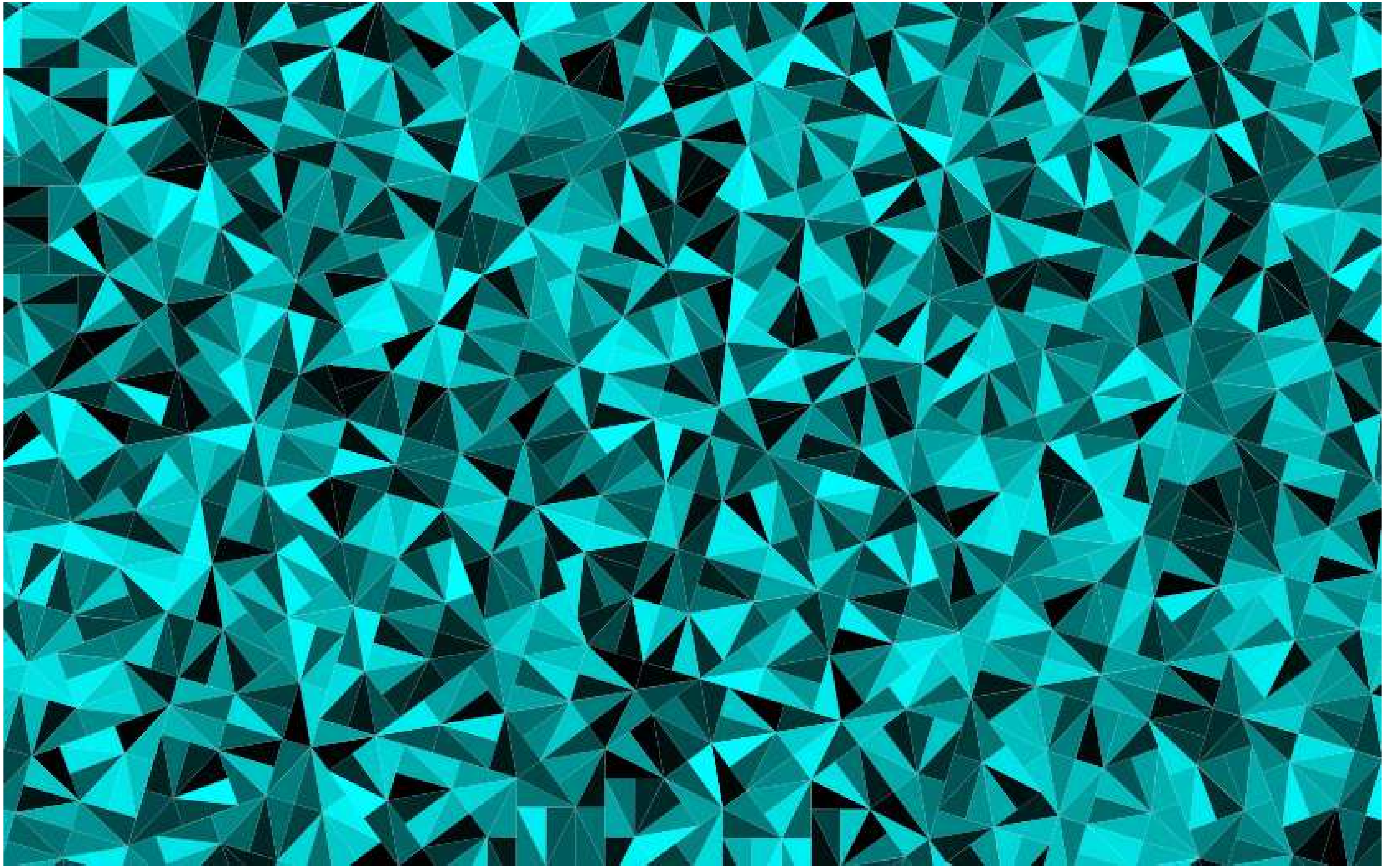
Borne de Conway

Losanges





Moulins à vent (après…)



(Radin, Conway)