

IMAGINARY



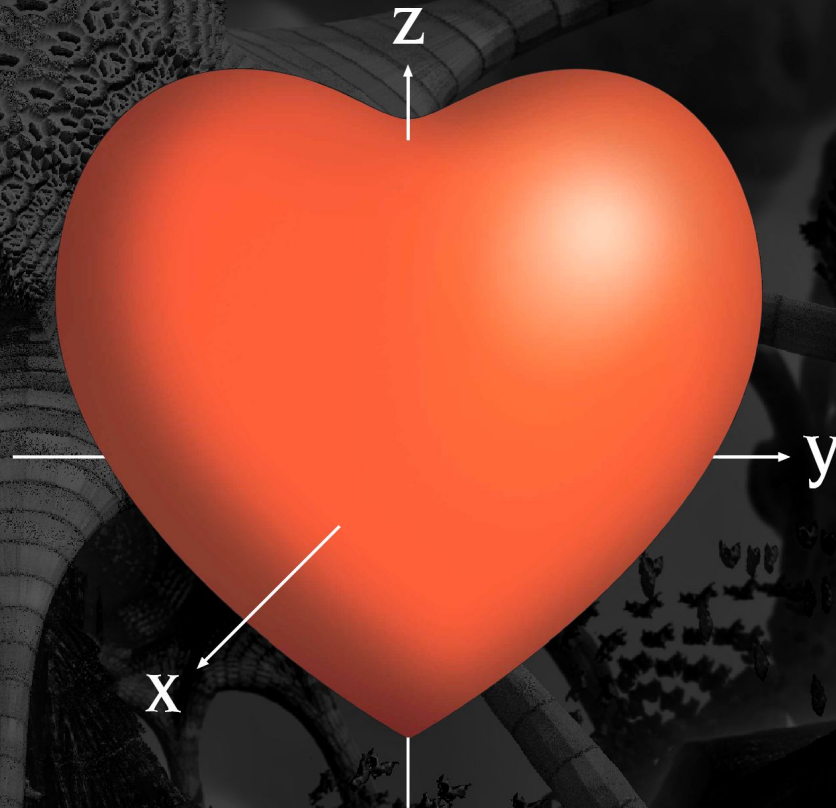
FORM UND FORMEL MATHEMATISCHER FANTASIE

AUSSTELLUNG

>>> KOMM-BILDUNGSBEREICH

Teil 1

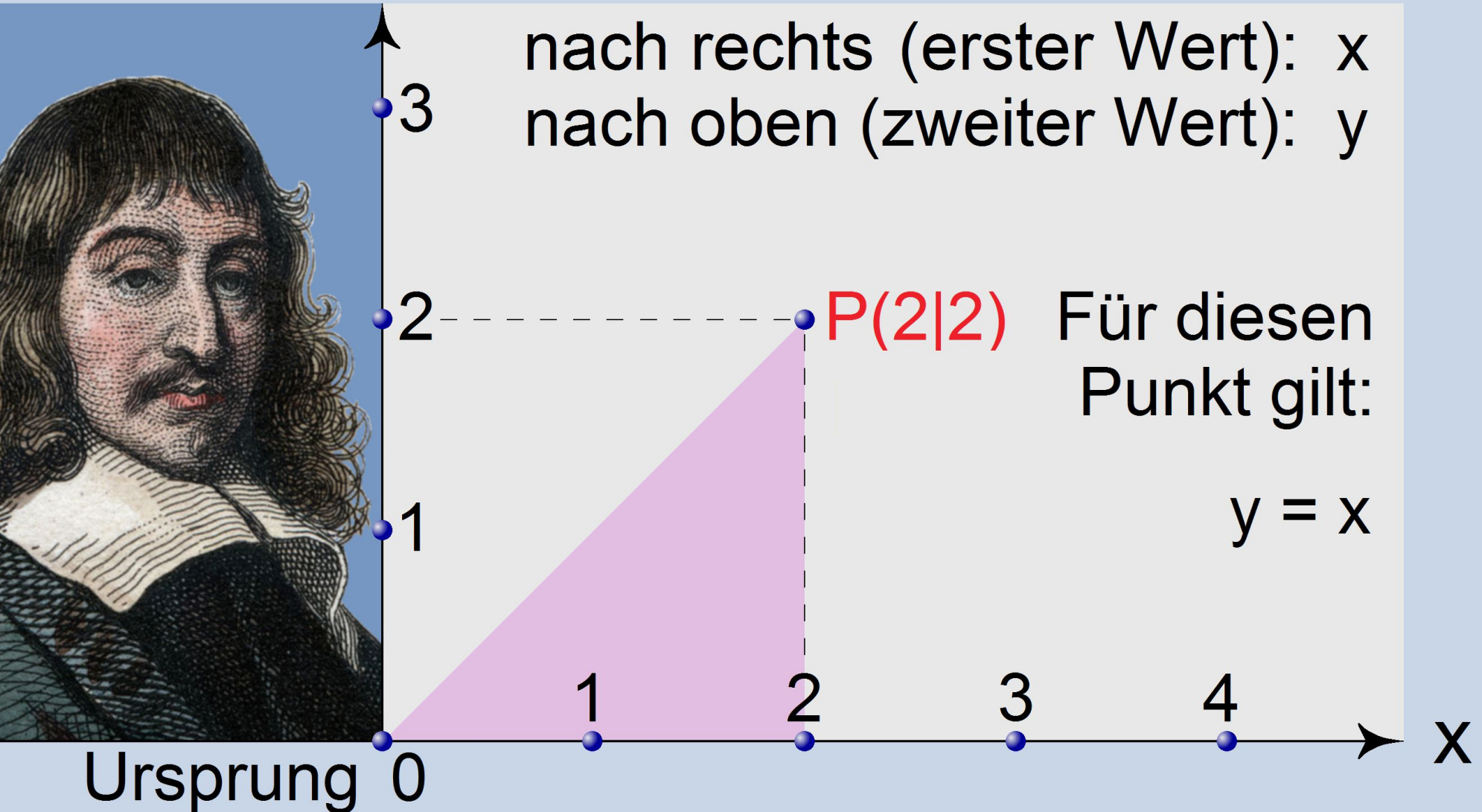
Algebraische Flächen



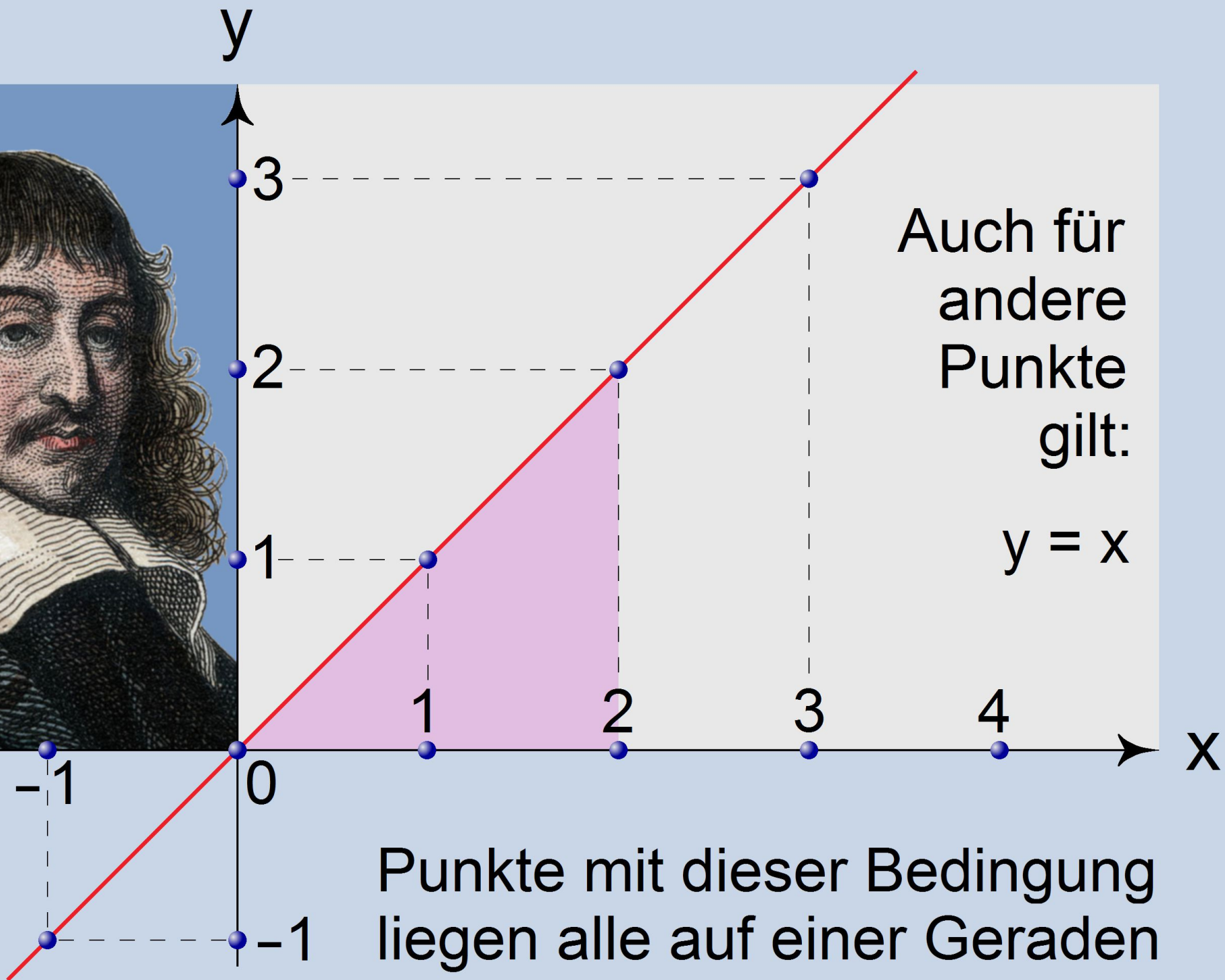
Auch intensivste Gefühle sind letztlich Formel:

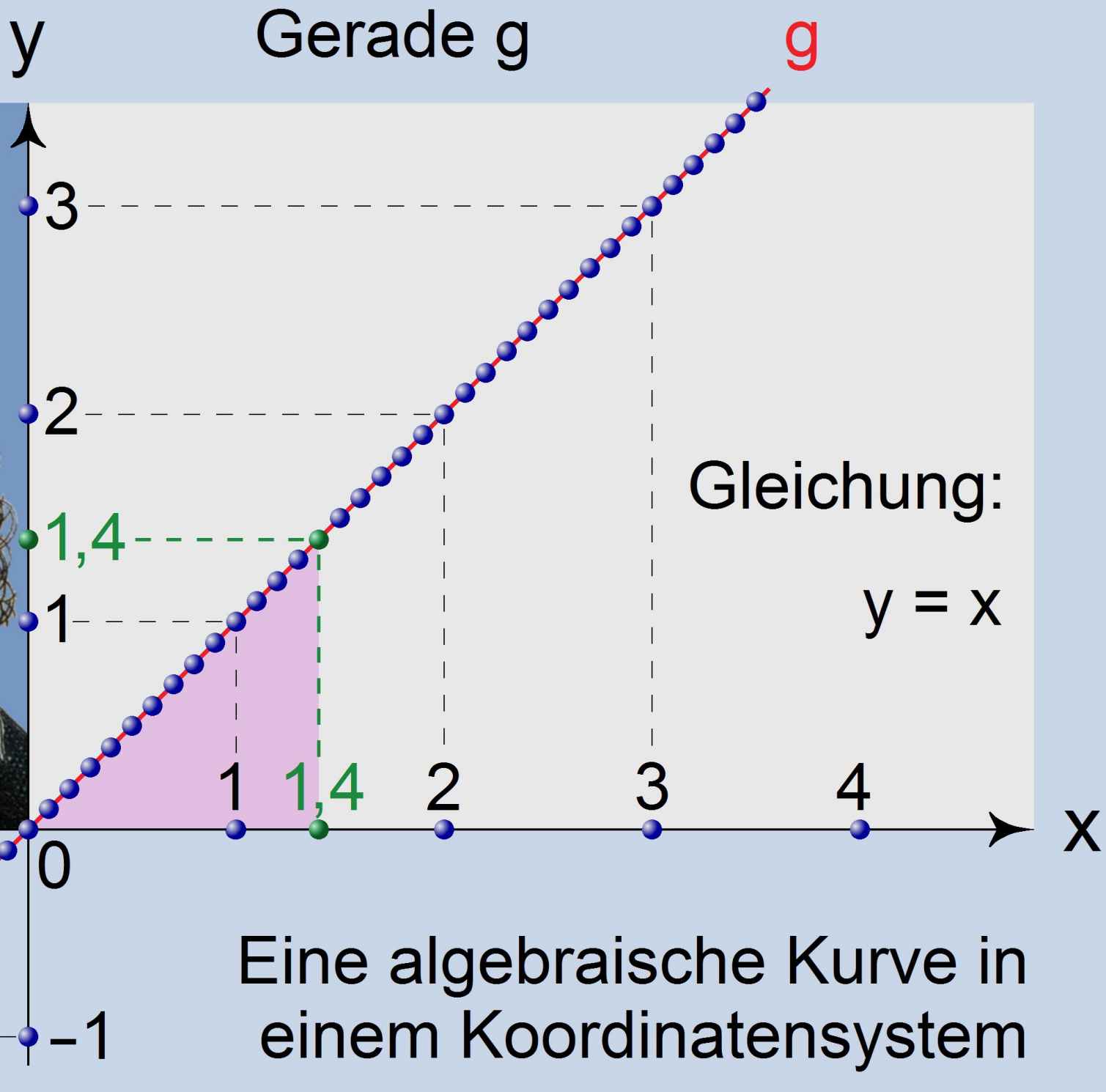
$$(2x^2 + y^2 + z^2 - 1)^3 - 0.1x^2z^3 - y^2z^3 = 0$$

René Descartes (1596-1650)

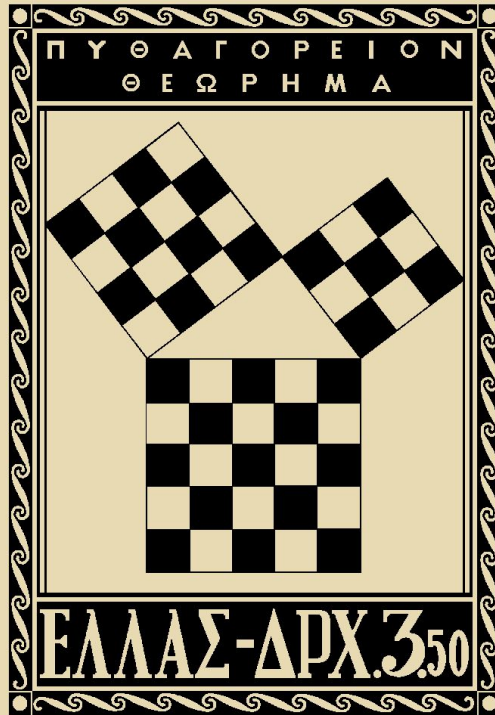


Festlegung eines Punktes P
in einem kartesischen Koordinatensystem

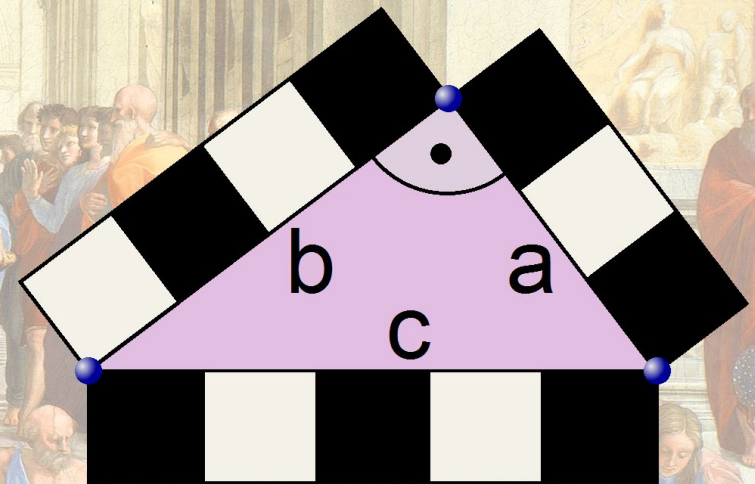




In rechtwinkligen Dreiecken gilt: $a^2 + b^2 = c^2$
(Satz des Pythagoras)



Ganzzahliges Beispiel:
 $a = 3$ $b = 4$ $c = 5$



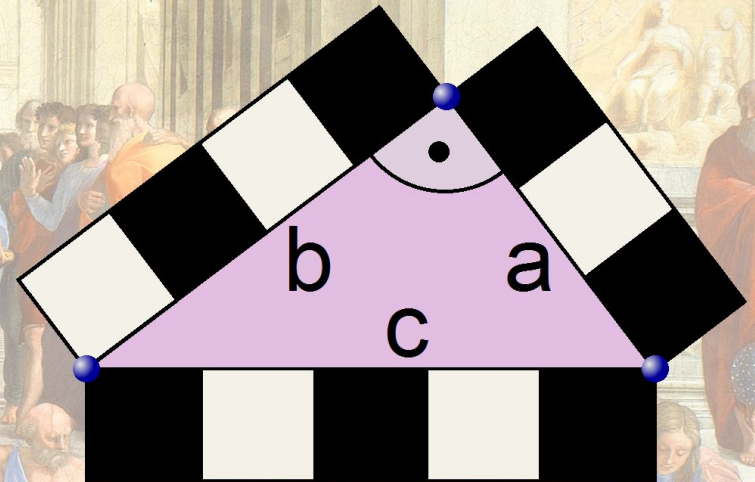
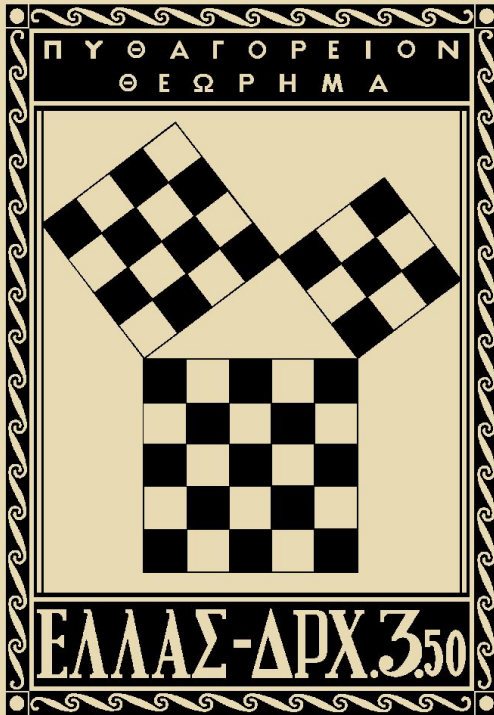
$$3^2 + 4^2 = 5^2$$

$$3 \cdot 3 + 4 \cdot 4 = 5 \cdot 5$$

$$9 + 16 = 25$$

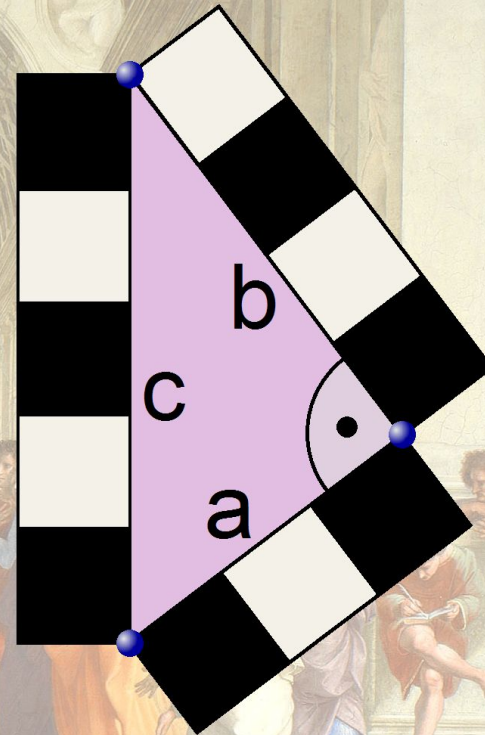
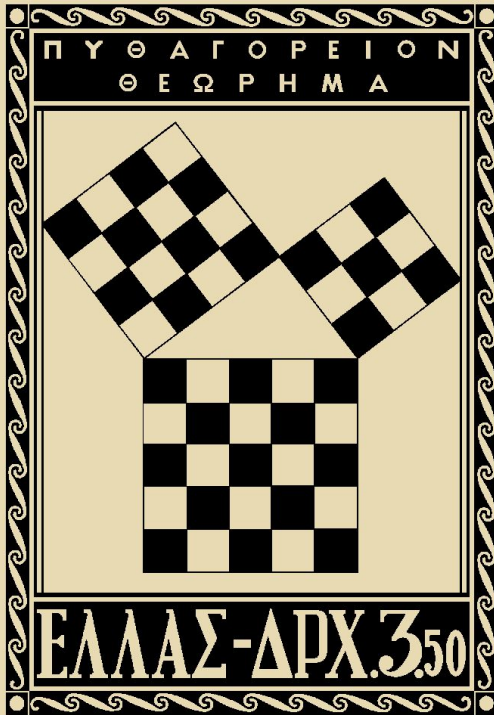
Pythagoras lebte im 6. Jahrhundert v. Chr.

Portrait des Pythagoras
in Raffaels Fresko
Die Schule von Athen



$$3 \cdot 3 + 4 \cdot 4 = 5 \cdot 5$$

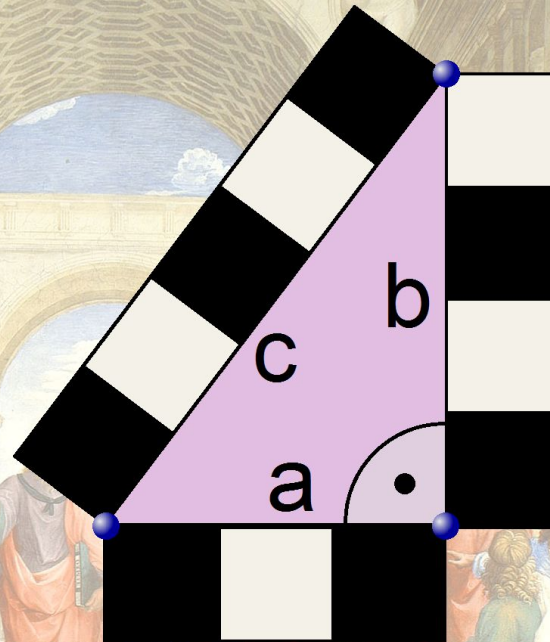
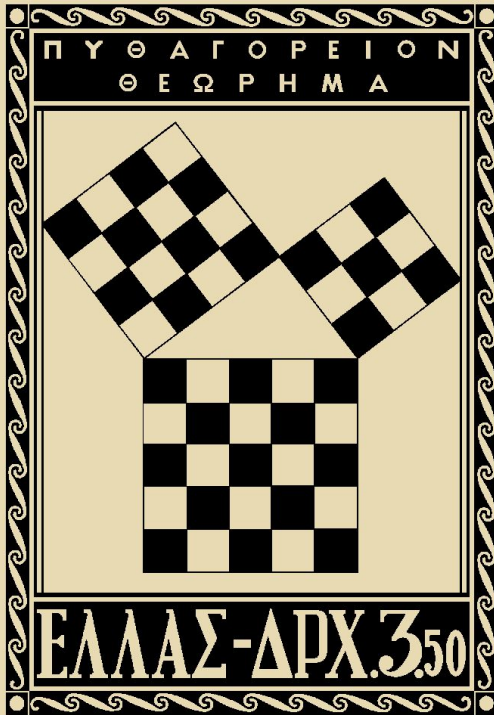
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$$3^2 + 4^2 = 5^2$$

$$3 \cdot 3 + 4 \cdot 4 = 5 \cdot 5$$

$$9 + 16 = 25$$



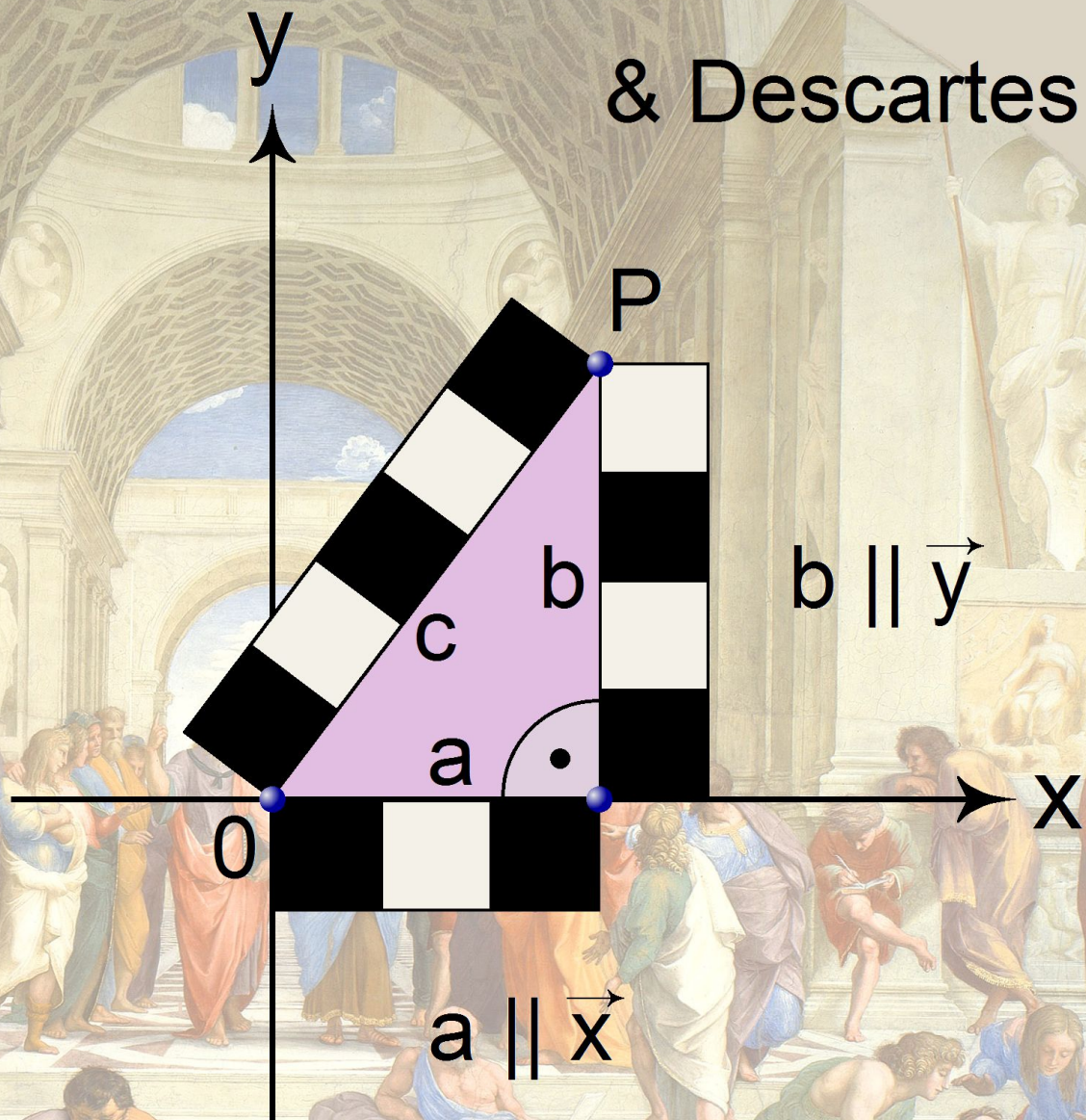
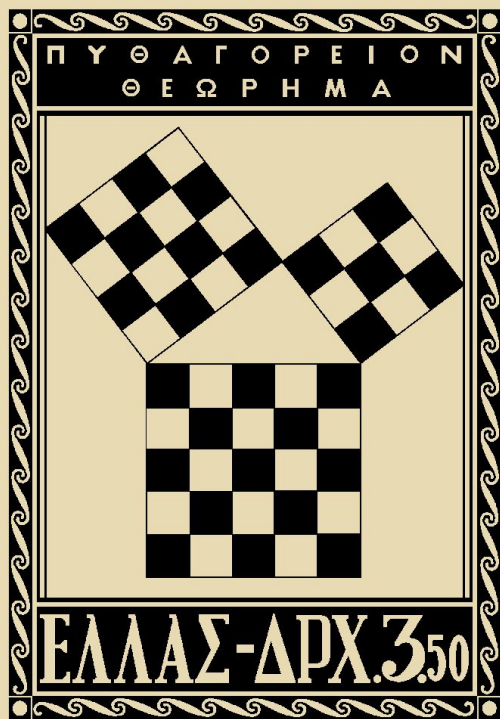
$$3^2 + 4^2 = 5^2$$

$$3 \cdot 3 + 4 \cdot 4 = 5 \cdot 5$$

$$9 + 16 = 25$$

Pythagoras

& Descartes

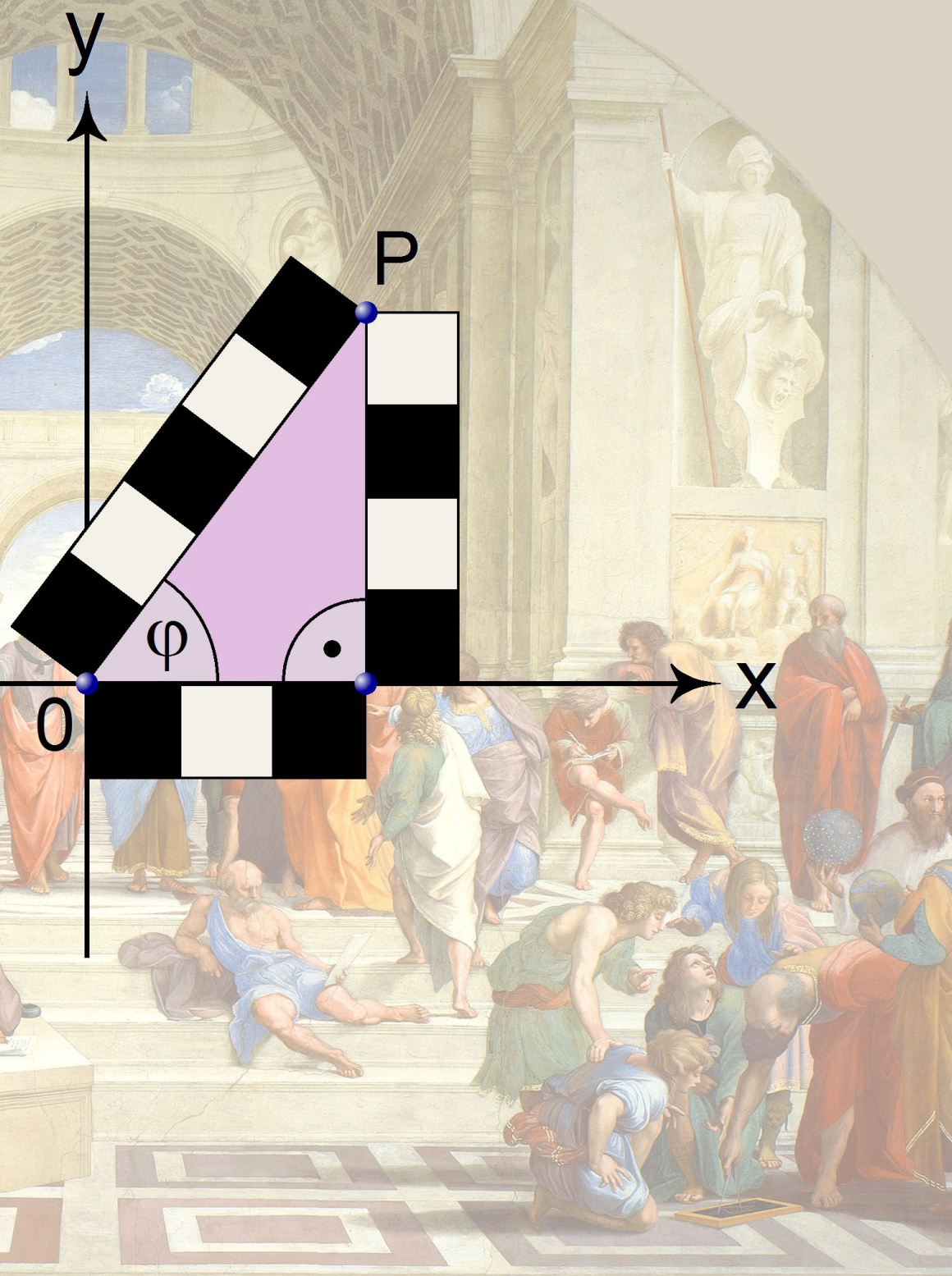


$$3^2 + 4^2 = 5^2$$

$$3 \cdot 3 + 4 \cdot 4 = 5 \cdot 5$$

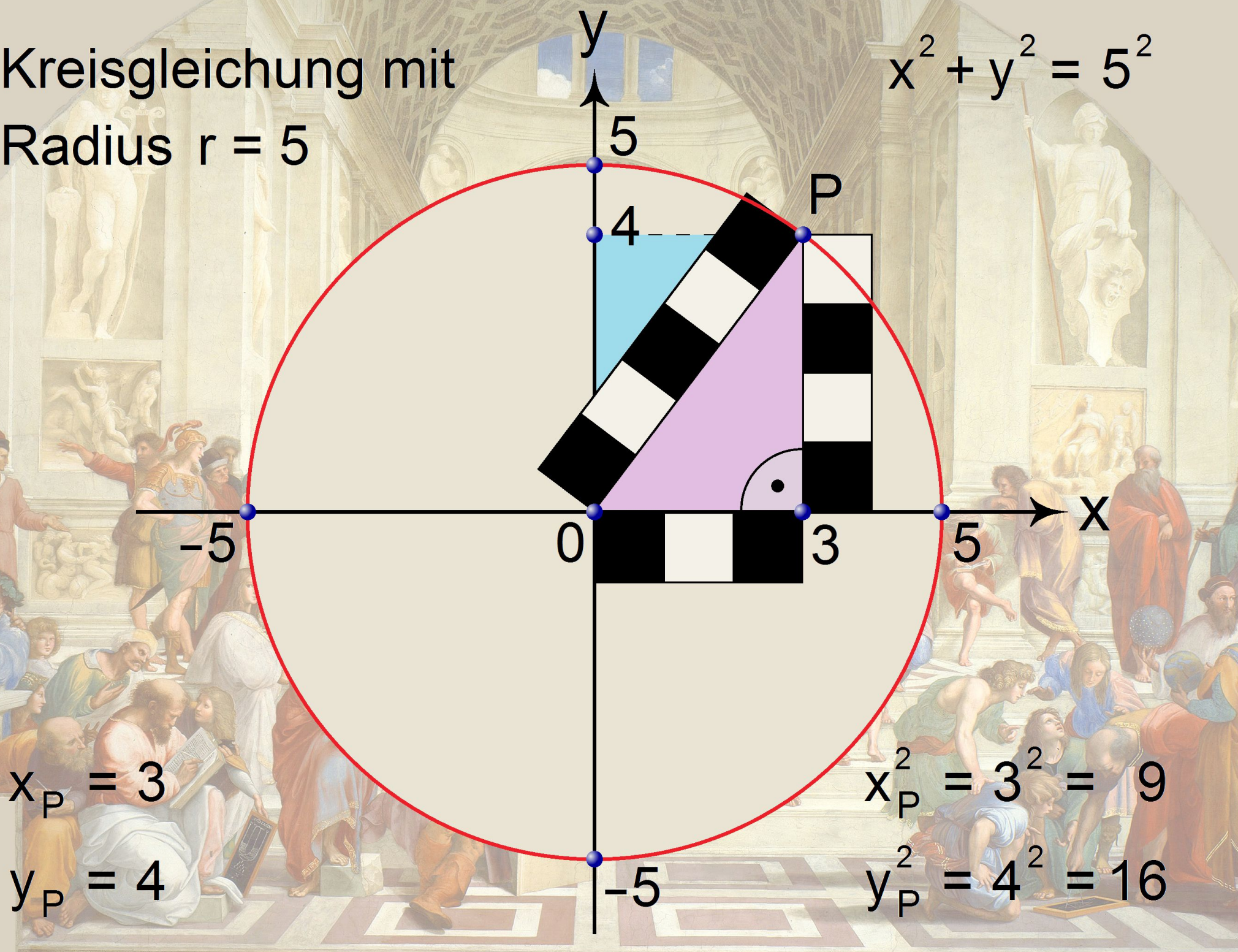
$$9 + 16 = 25$$

Der Lehrsatz des
Pythagoras gilt für
jeden Winkel φ



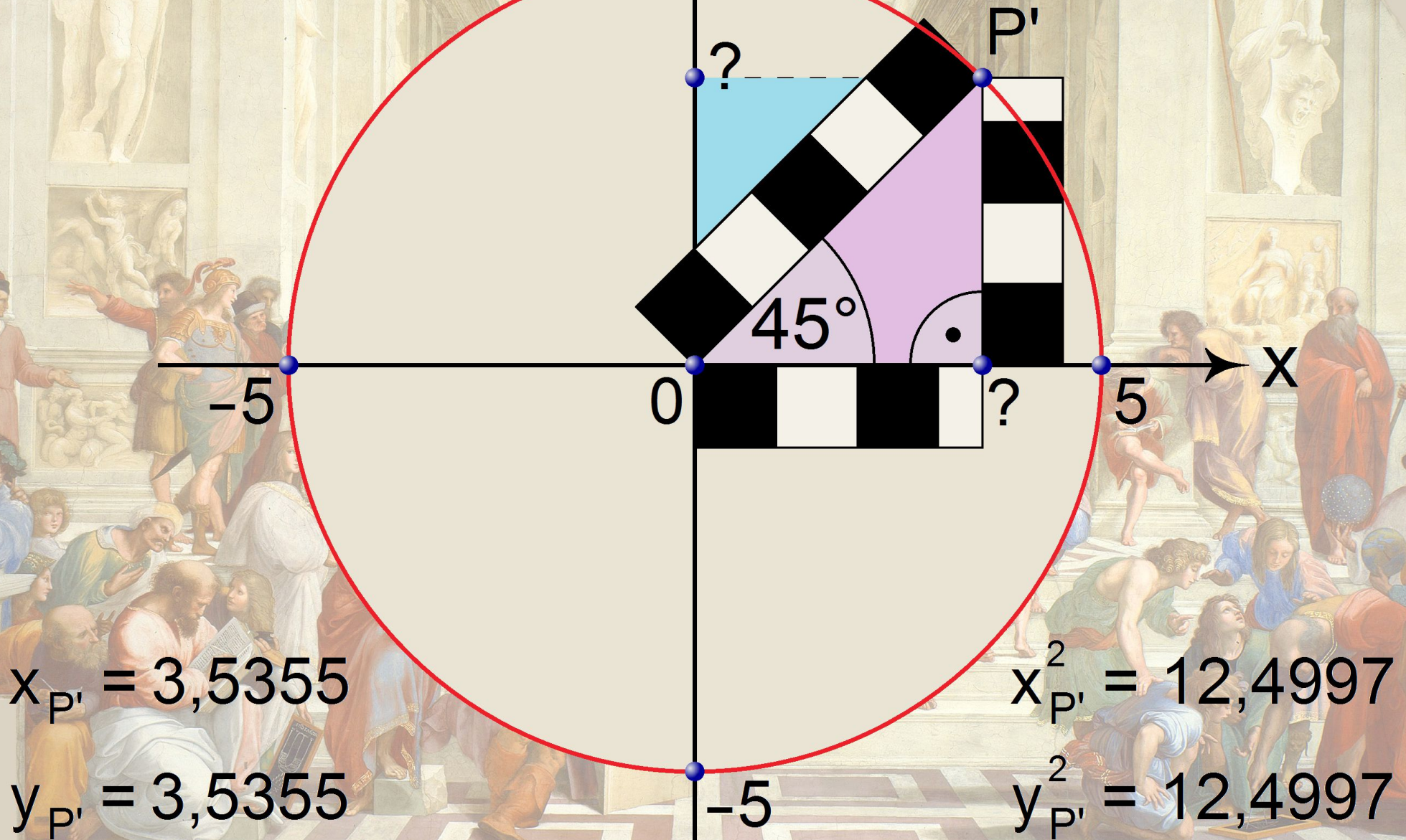
Kreisgleichung mit
Radius $r = 5$

$$x^2 + y^2 = 5^2$$



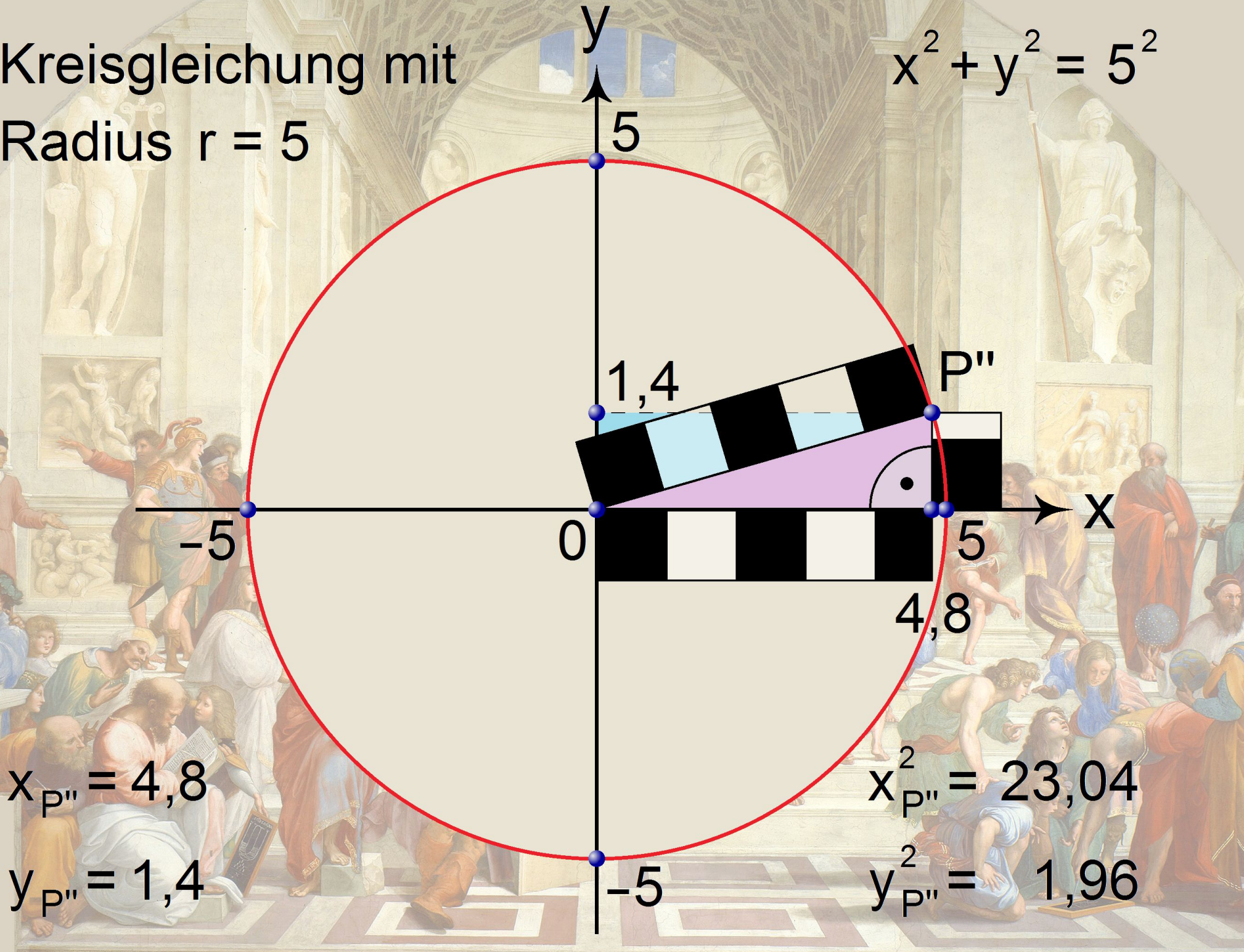
Kreisgleichung mit
Radius $r = 5$

$$x^2 + y^2 = 5^2$$



Kreisgleichung mit
Radius $r = 5$

$$x^2 + y^2 = 5^2$$

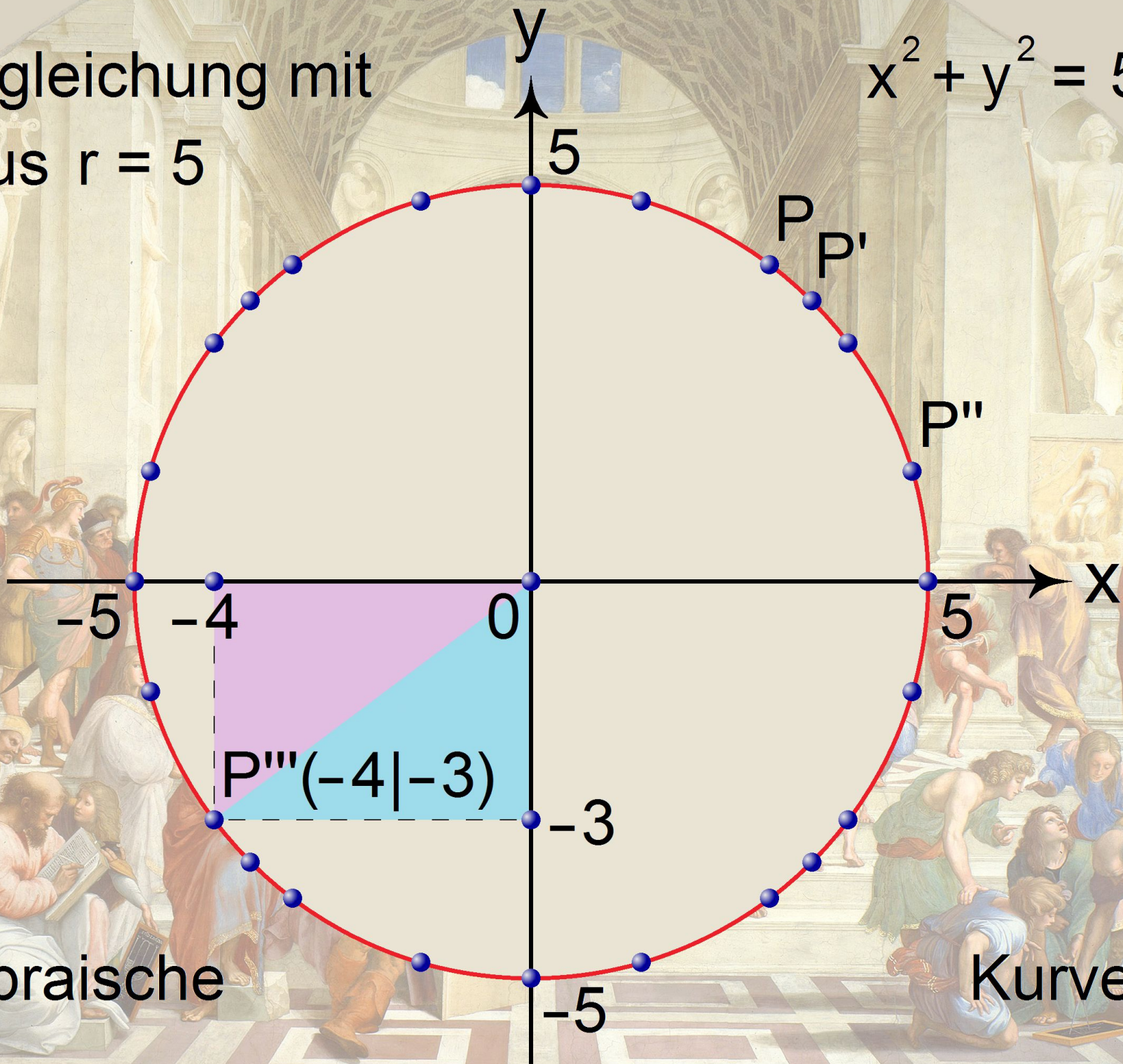


Kreisgleichung mit
Radius $r = 5$

$$x^2 + y^2 = 5^2$$

Algebraische

Kurve



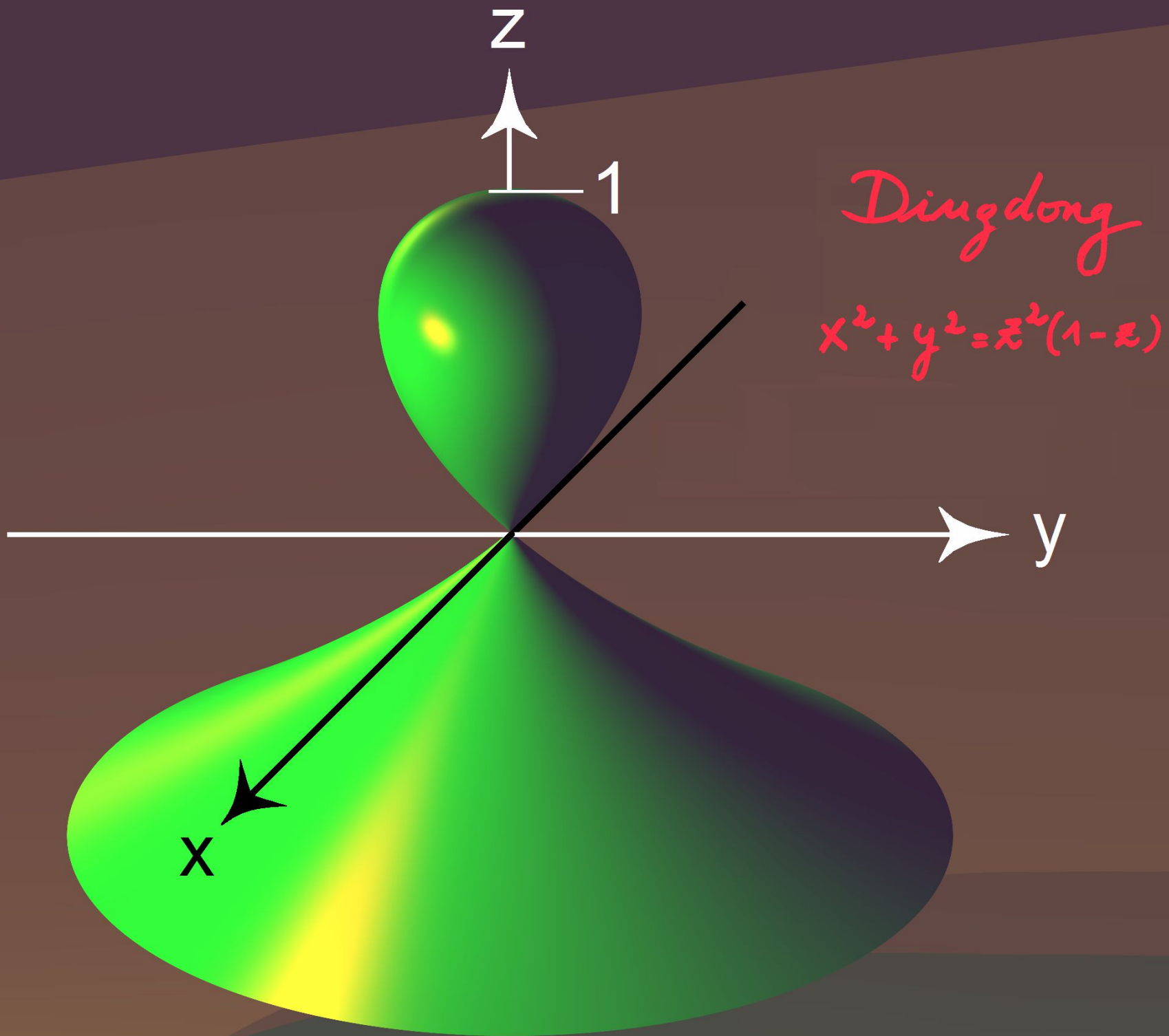
Kugelgleichung mit
Radius $r = 5$

$$x^2 + y^2 + z^2 = 5^2$$



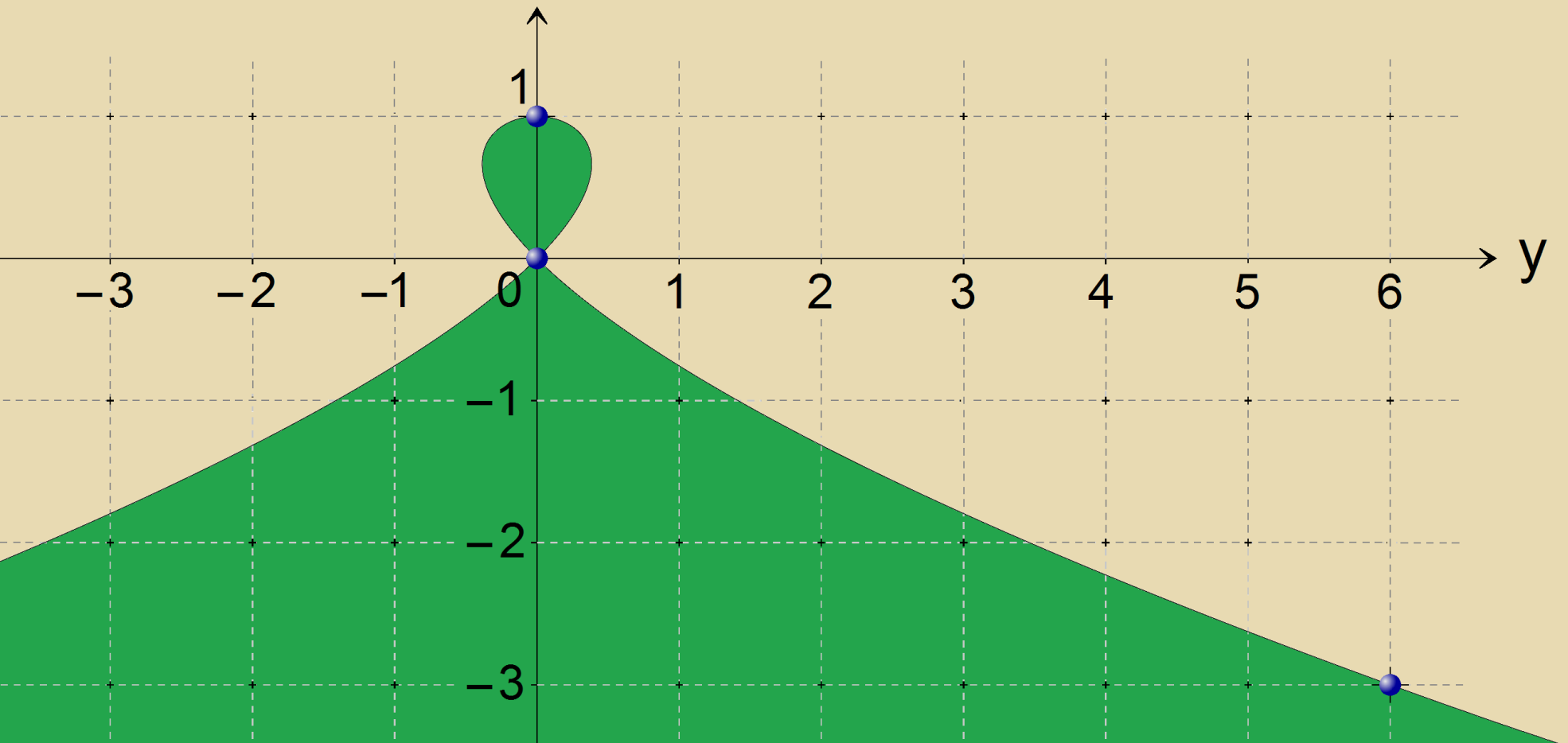
Algebraische

Fläche



$$y^2 = z^2 \cdot (1 - z)$$

Schnitt durch Dingdong bei $x = 0$



Punkt ganz oben

$$y = 0$$

$$z = 1$$

$$0^2 = 1^2 \cdot (1 - 1)$$

Punkt im Ursprung

$$y = 0$$

$$z = 0$$

$$0^2 = 0^2 \cdot (1 - 0)$$

Punkt rechts unten

$$y = 6$$

$$z = -3$$

$$6^2 = (-3)^2 \cdot (1 + 3)$$



Fraktale

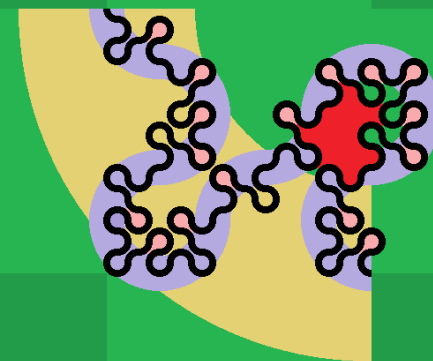


L 

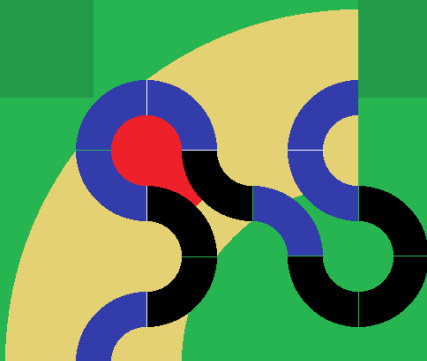
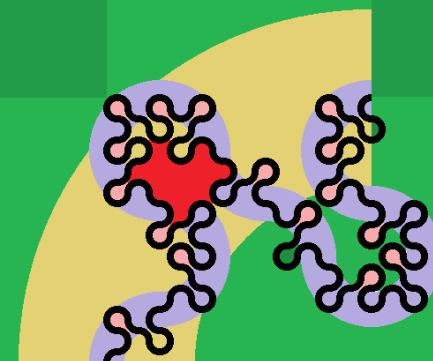
Initiator

 L' 

Generator

 L'' 

Erste Iteration

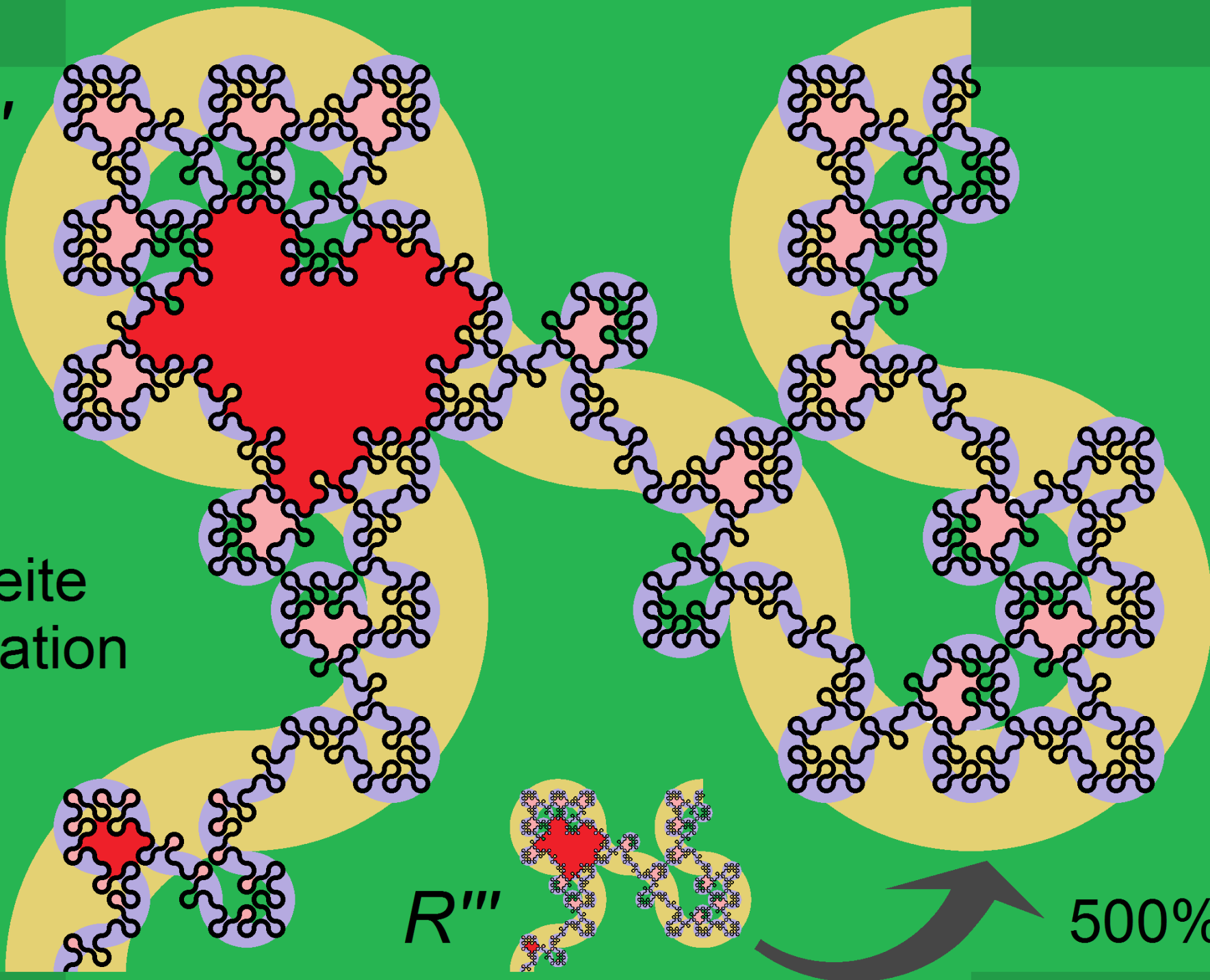
 R  R'  R'' 

R'''

Zweite
Iteration

R'''

500%



Skaleninvarianz

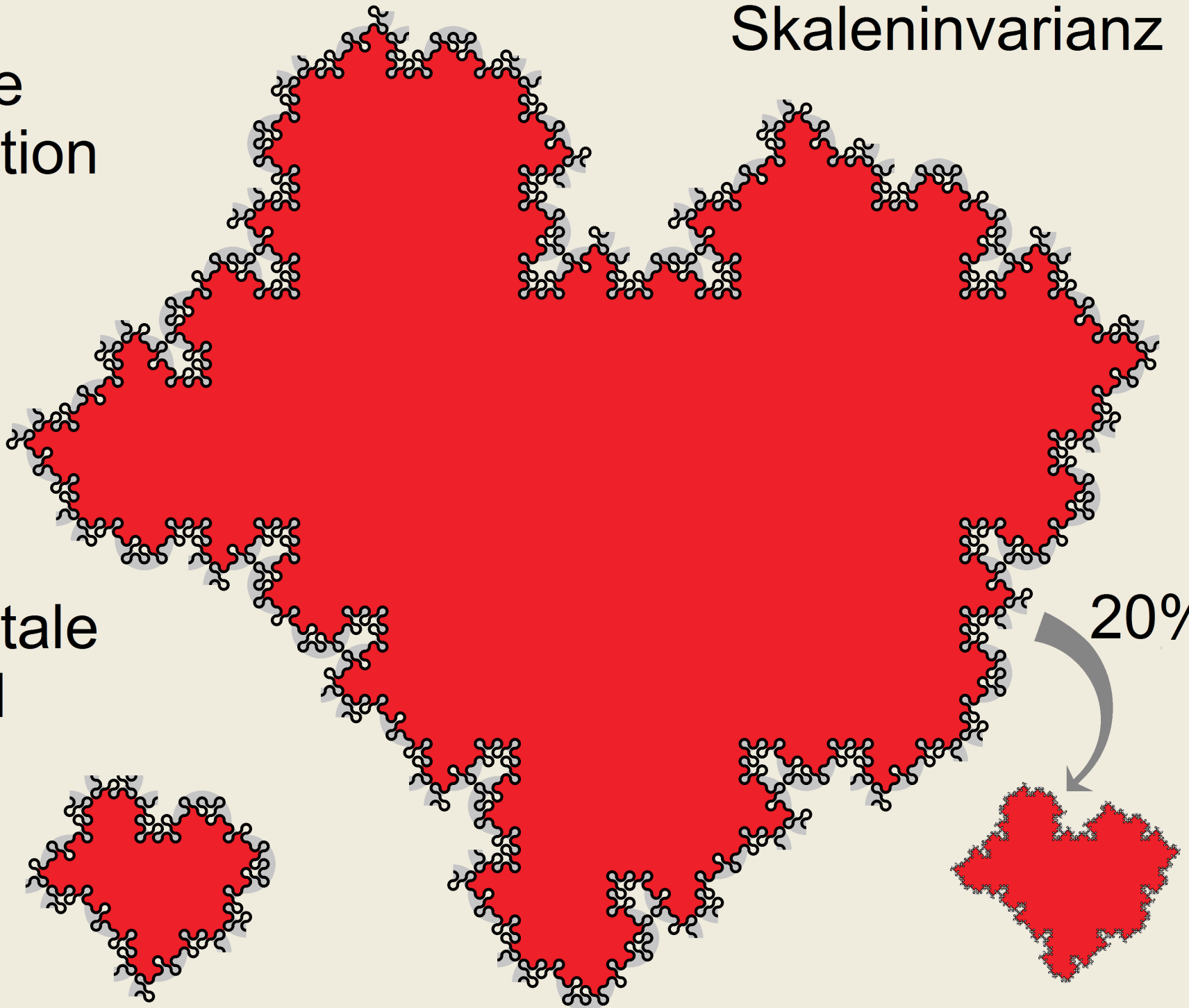
Dritte
Iteration

R''''

Fraktale
Insel

R'''

20%

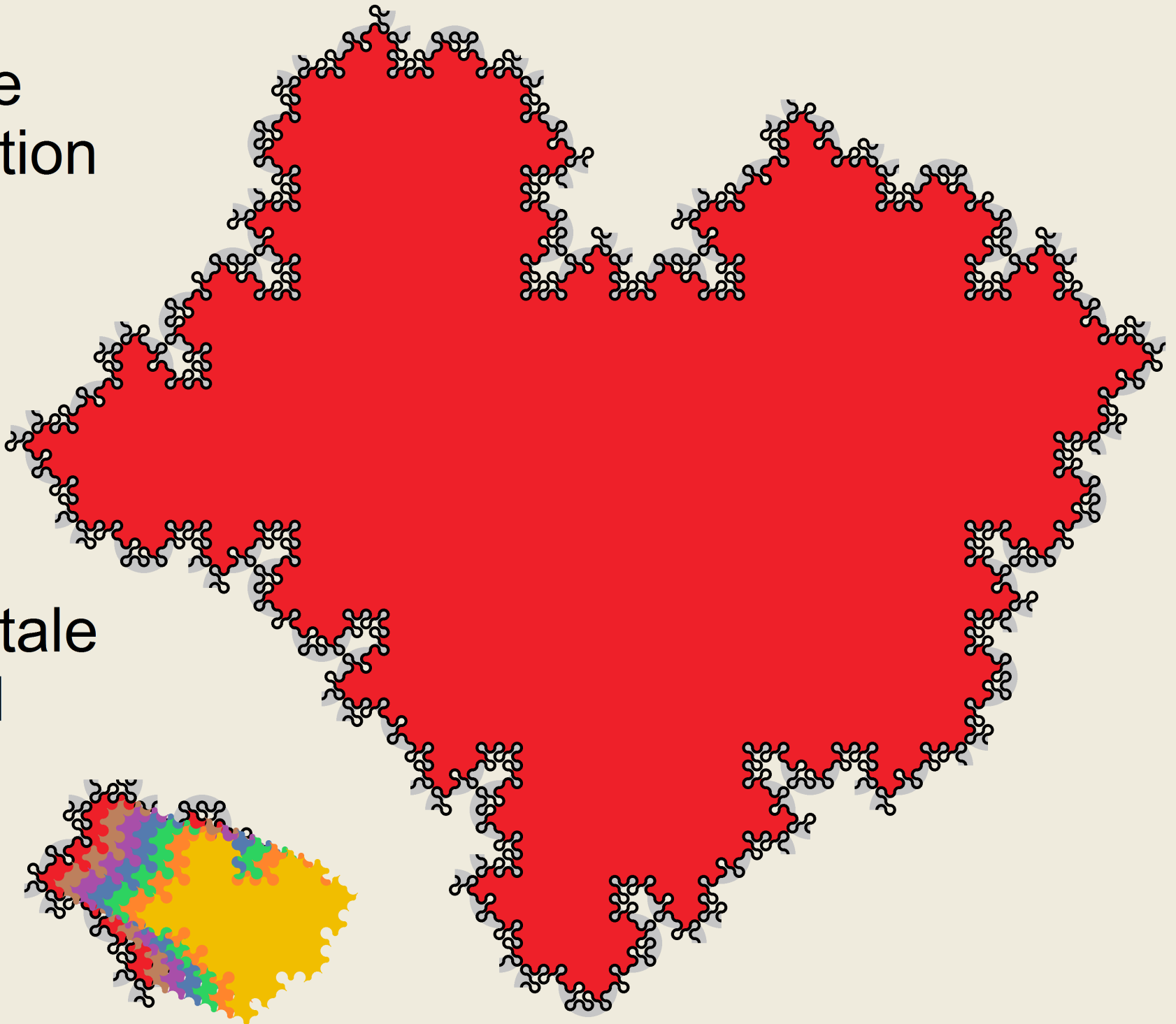


Dritte
Iteration

R''''

Fraktale
Insel

R'''

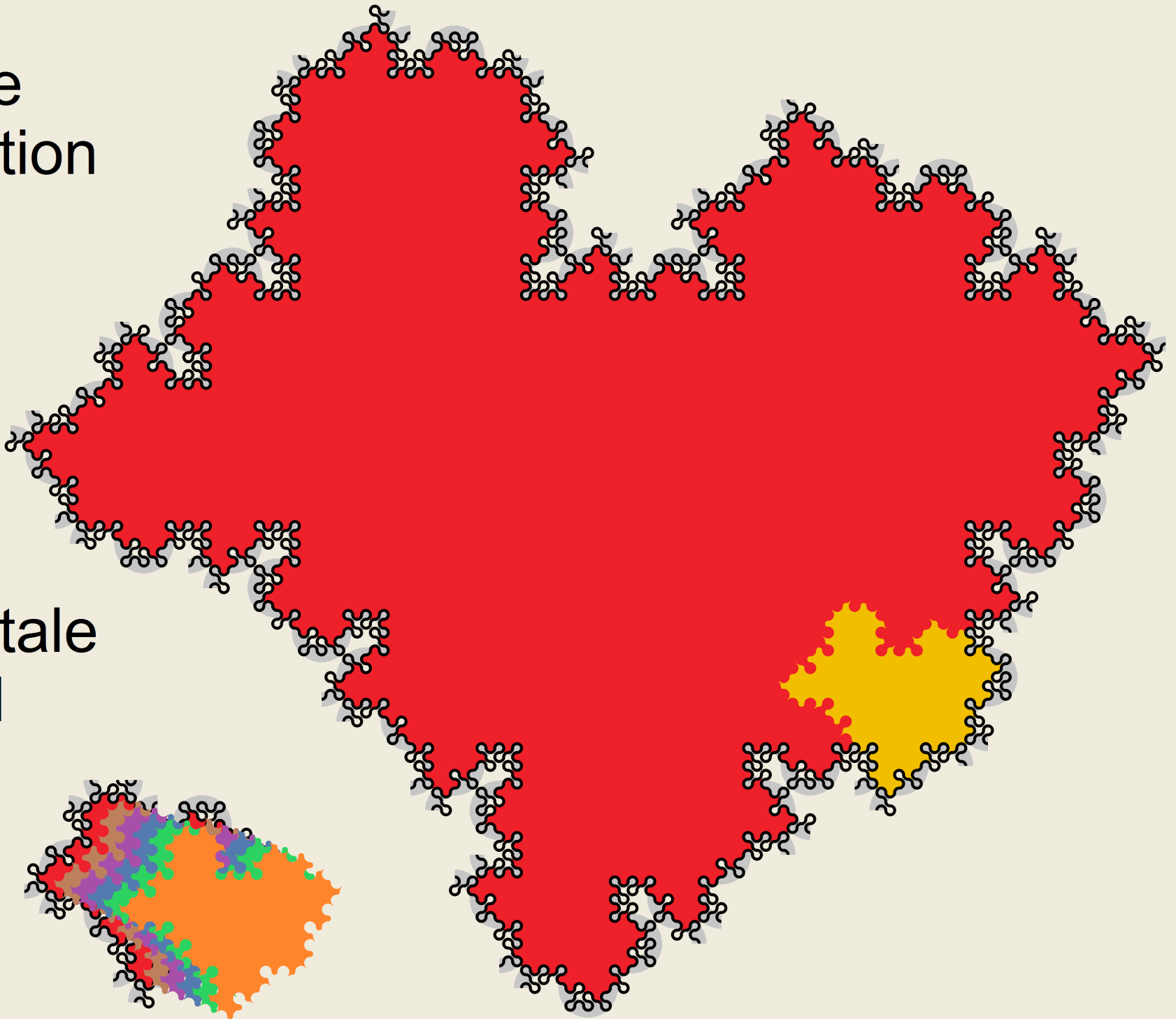


Dritte
Iteration

R''''

Fraktale
Insel

R'''

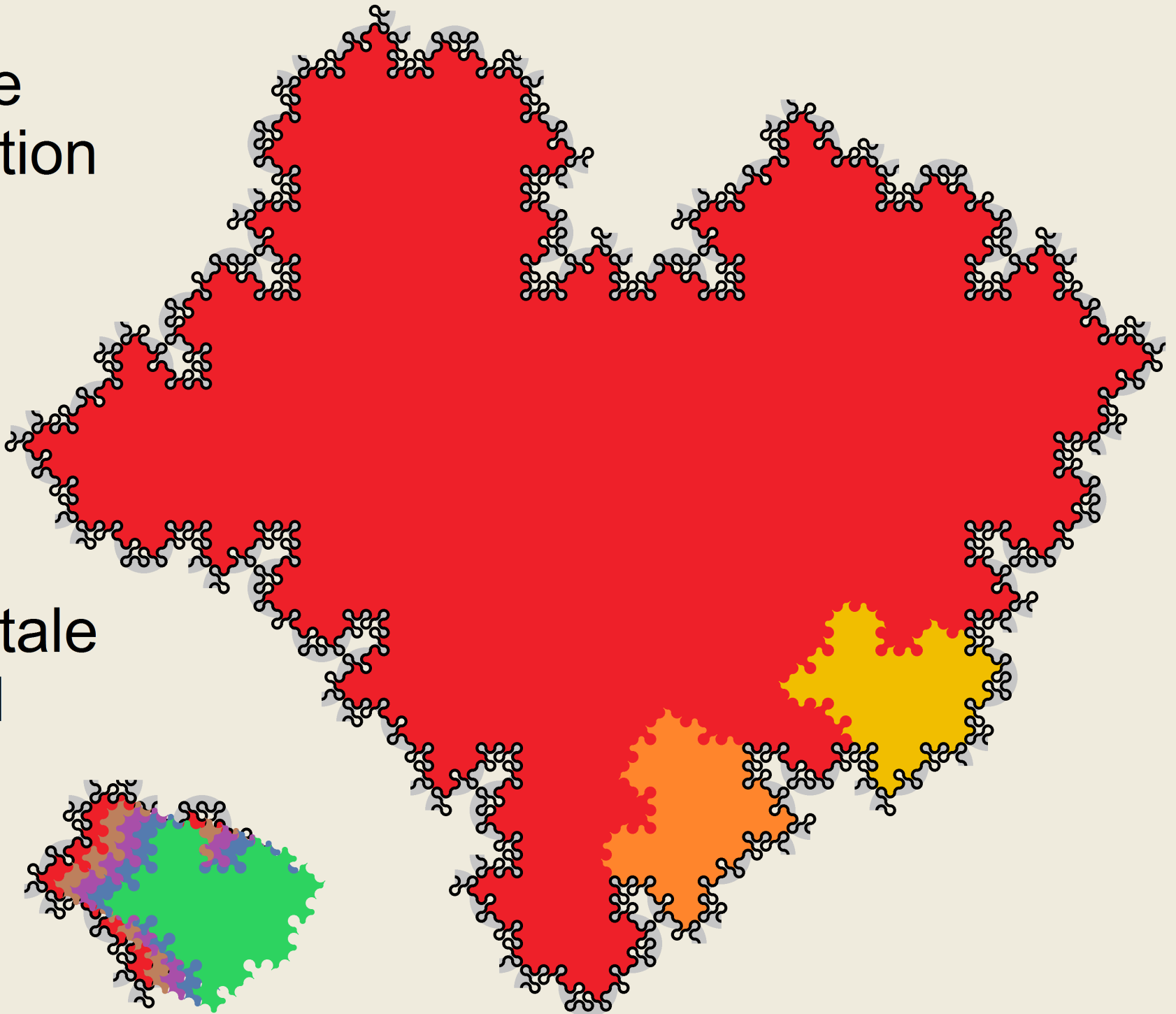


Dritte
Iteration

R''''

Fraktale
Insel

R'''

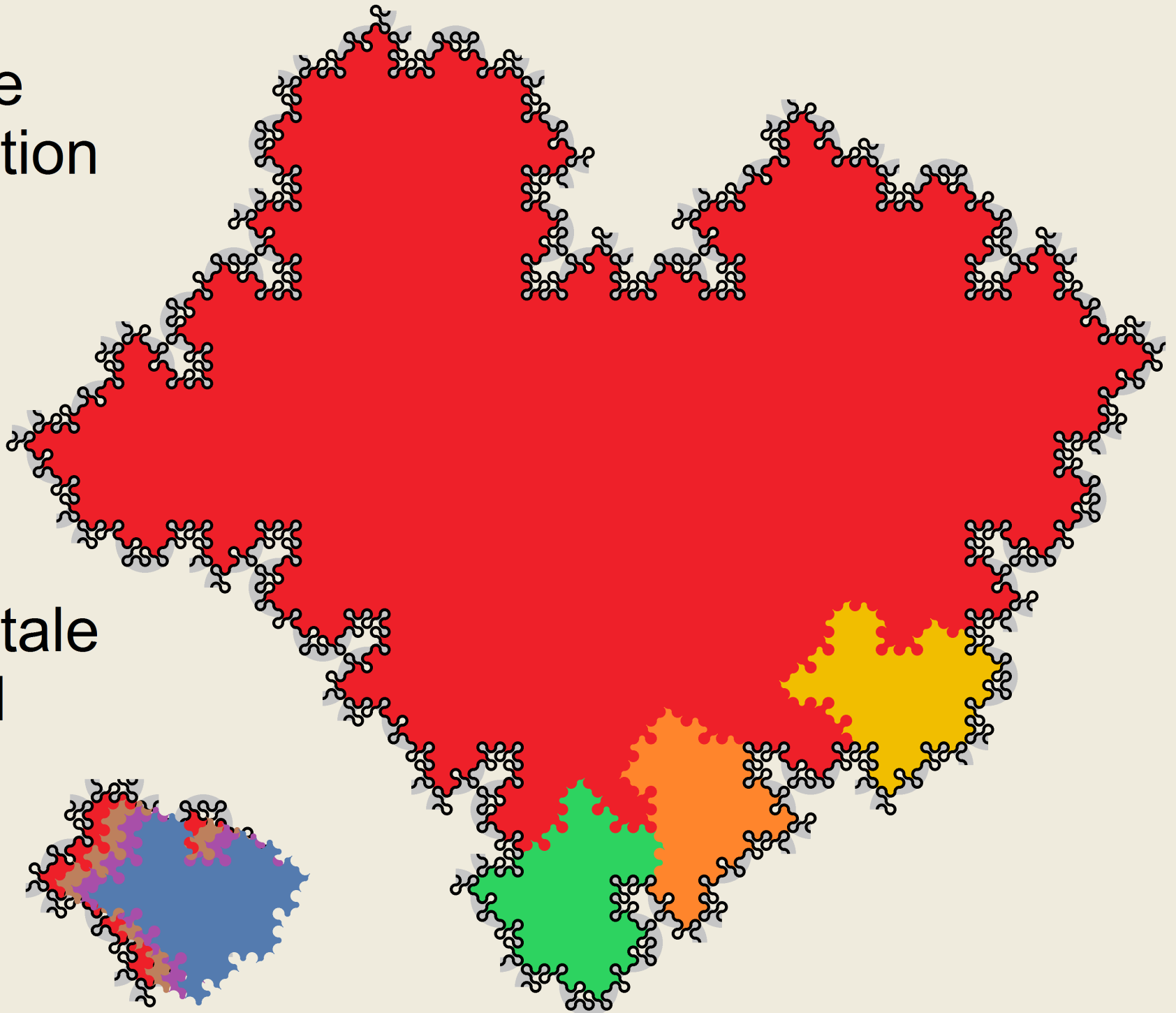


Dritte
Iteration

R''''

Fraktale
Insel

R'''

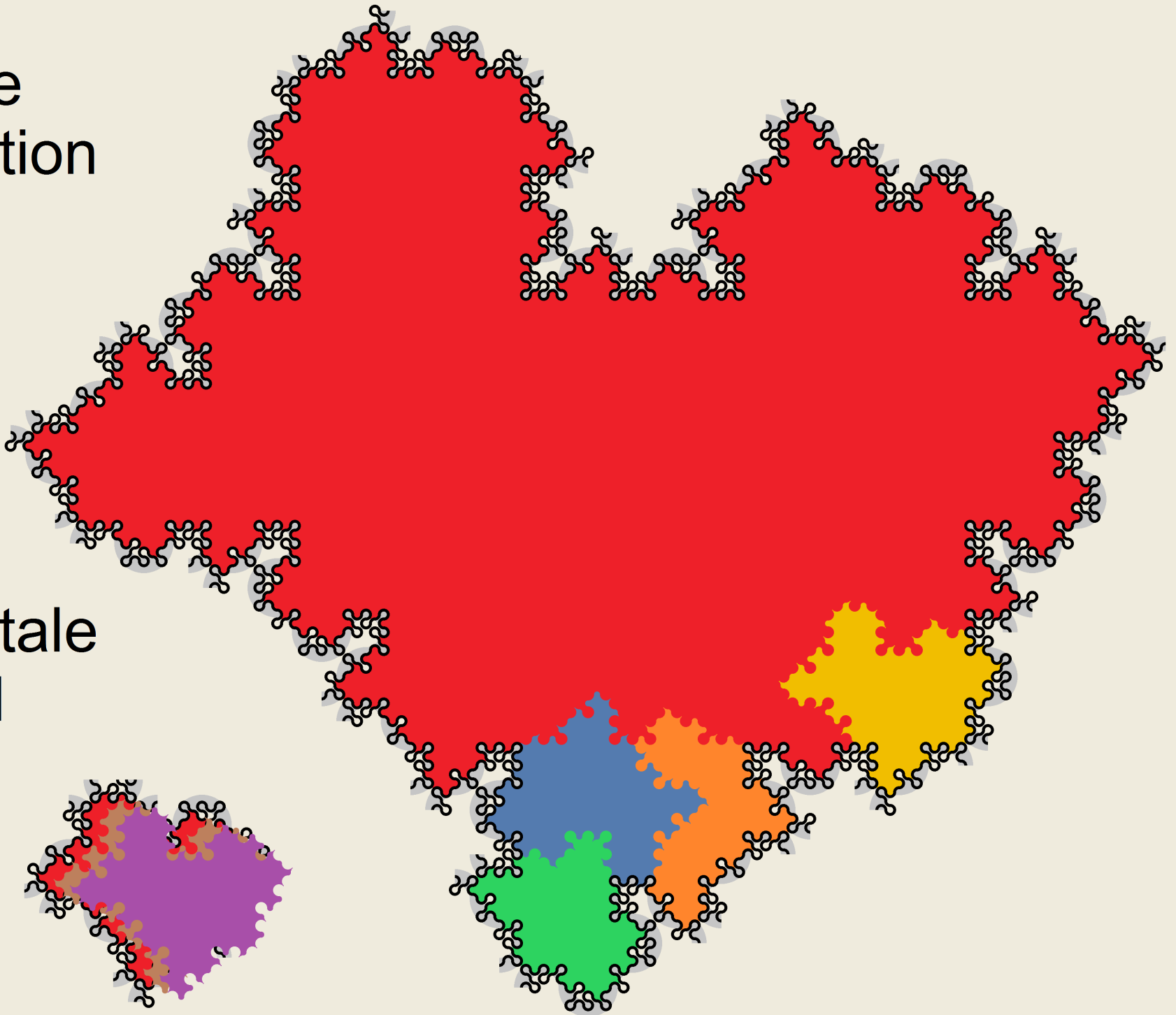


Dritte
Iteration

R''''

Fraktale
Insel

R'''

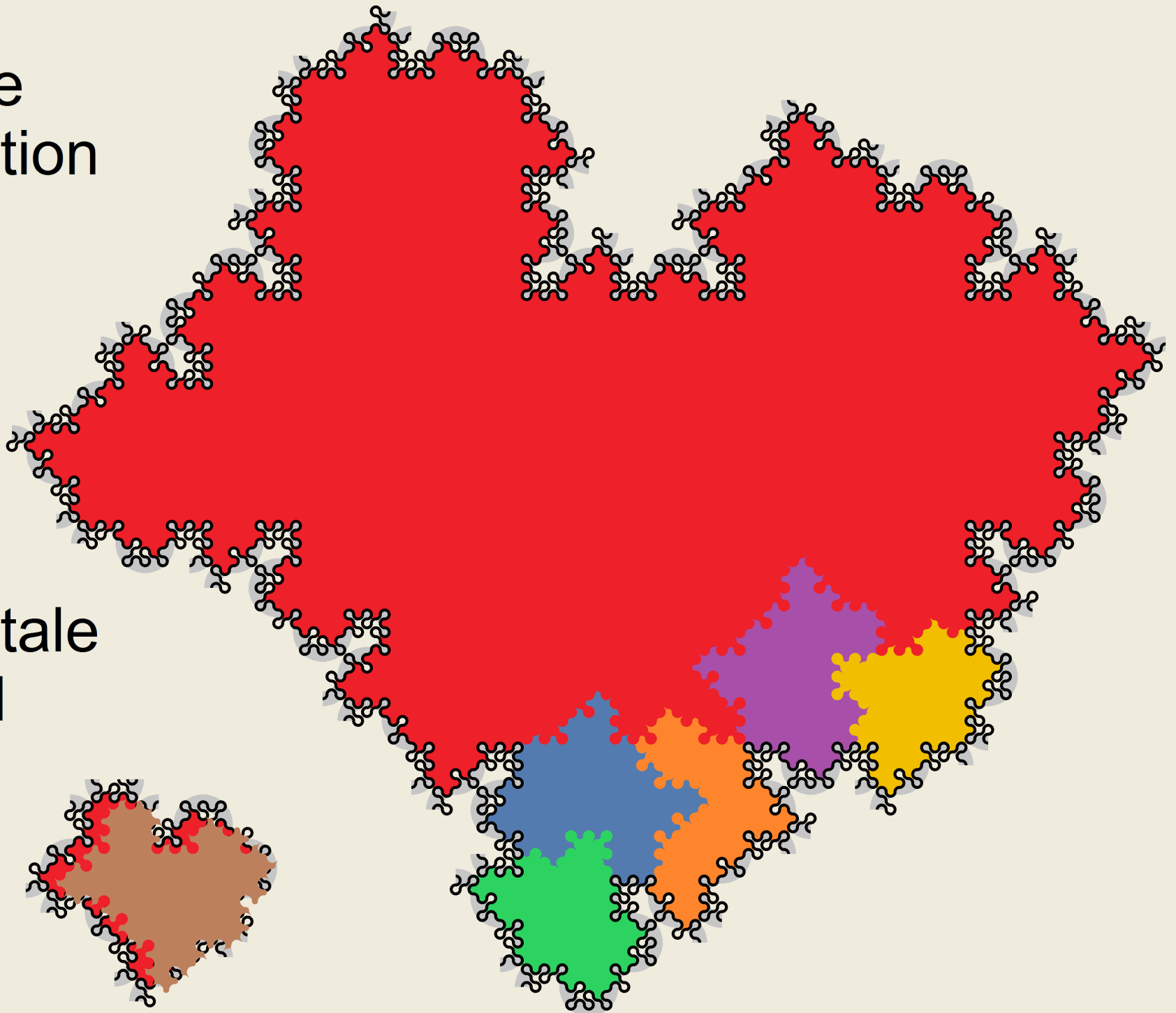


Dritte
Iteration

R''''

Fraktale
Insel

R'''

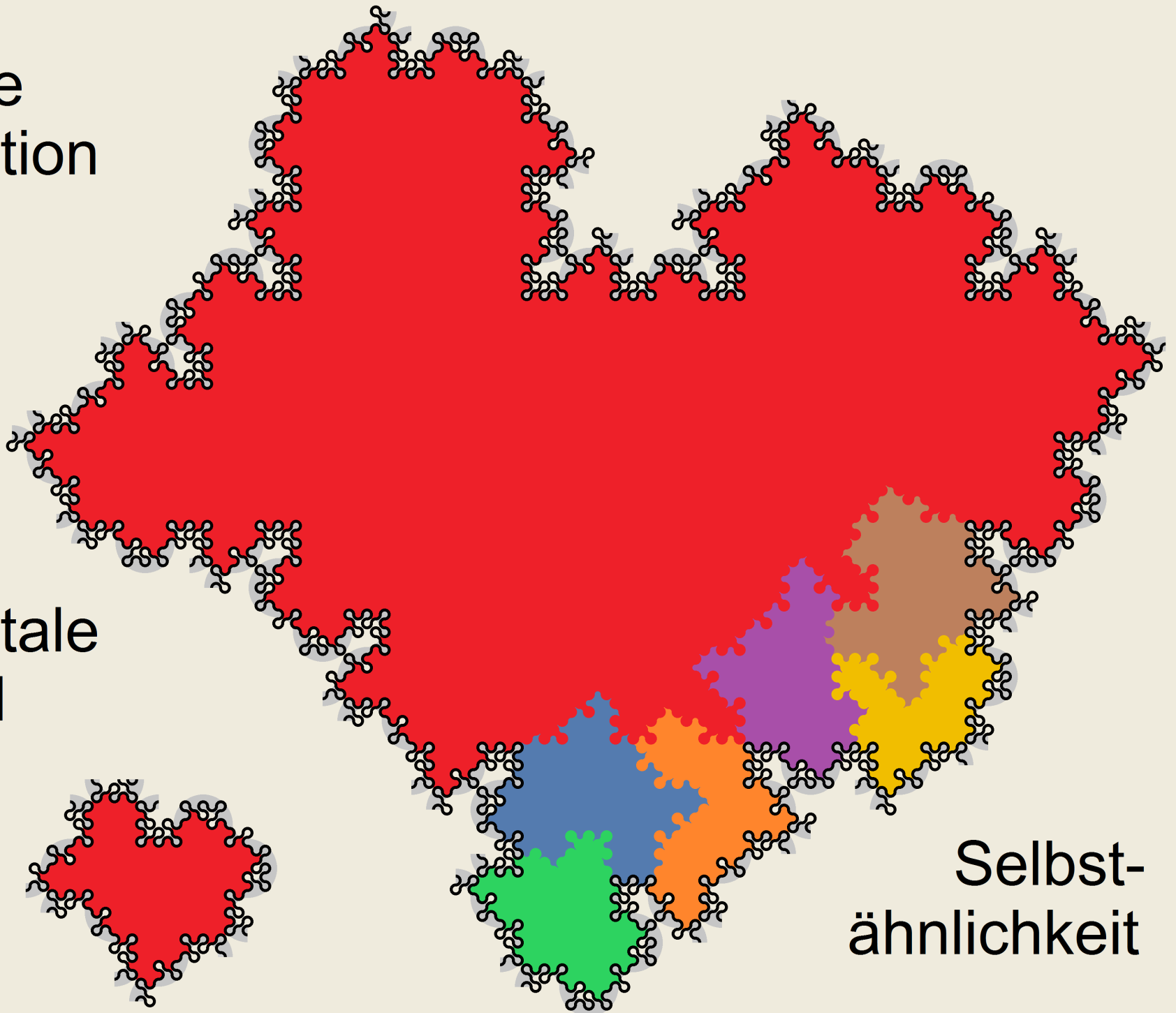


Dritte
Iteration

R'''

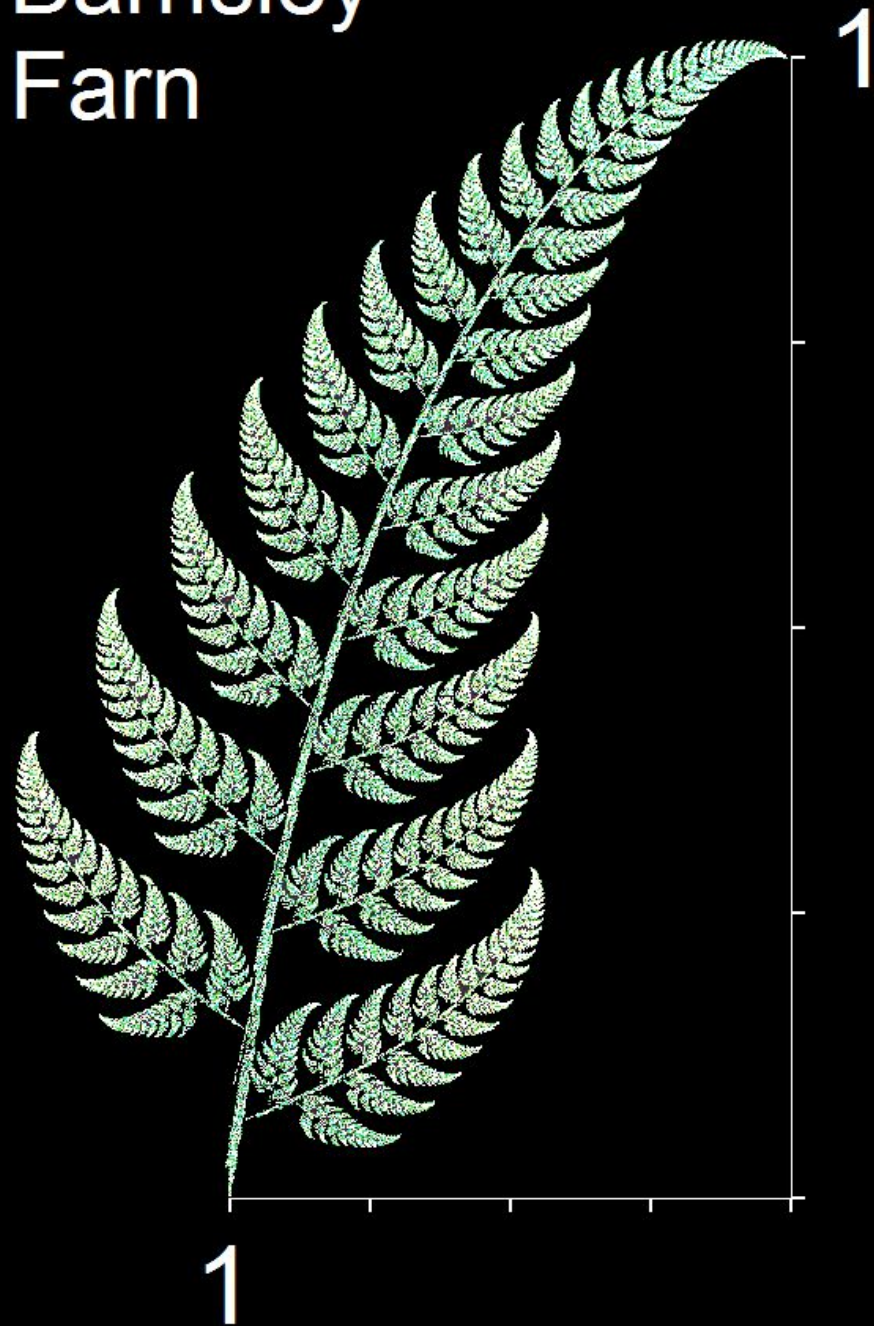
Fraktale
Insel

R'''

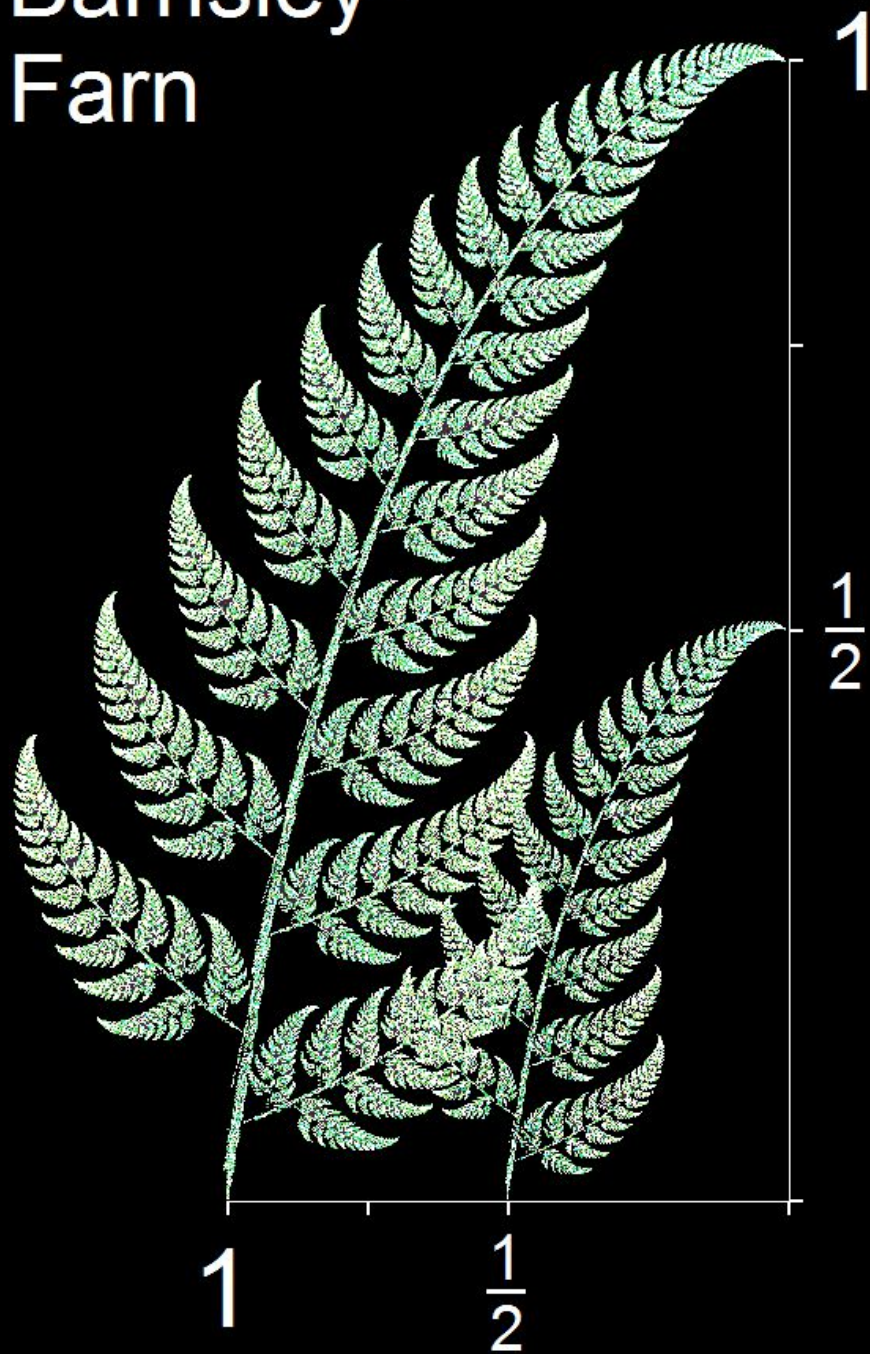


Selbst-
ähnlichkeit

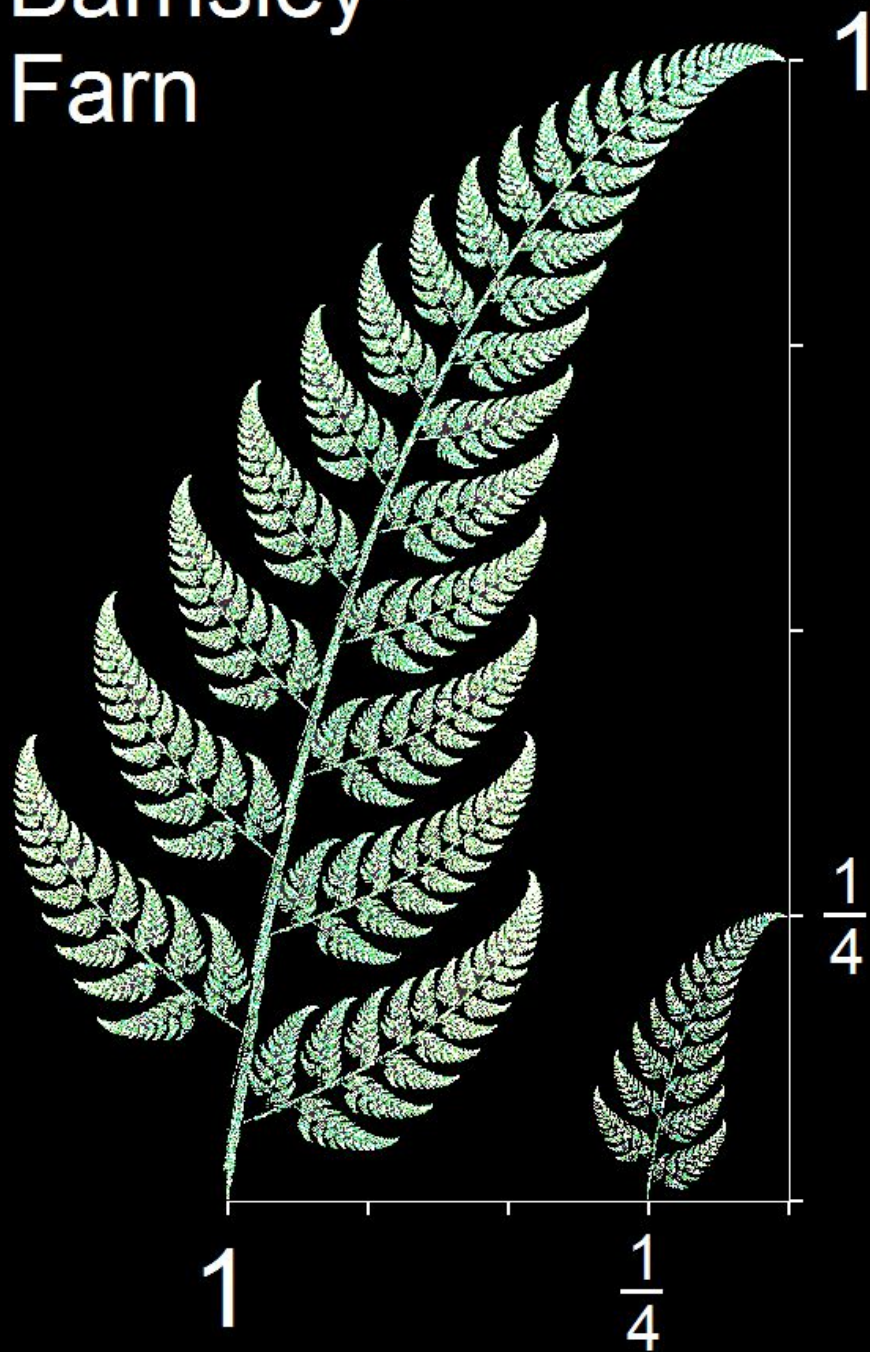
Barnsley- Farn



Barnsley- Farn



Barnsley- Farn



Barnsley- Farn

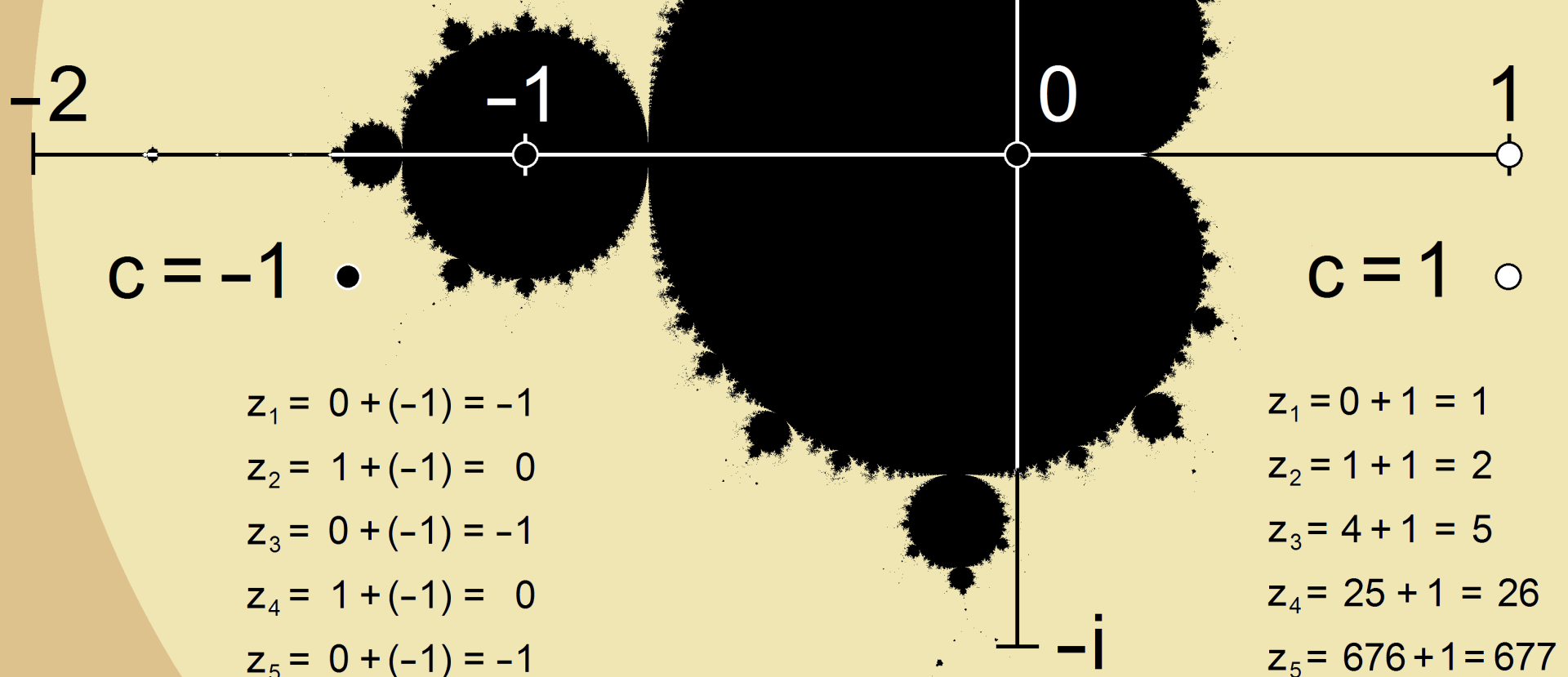


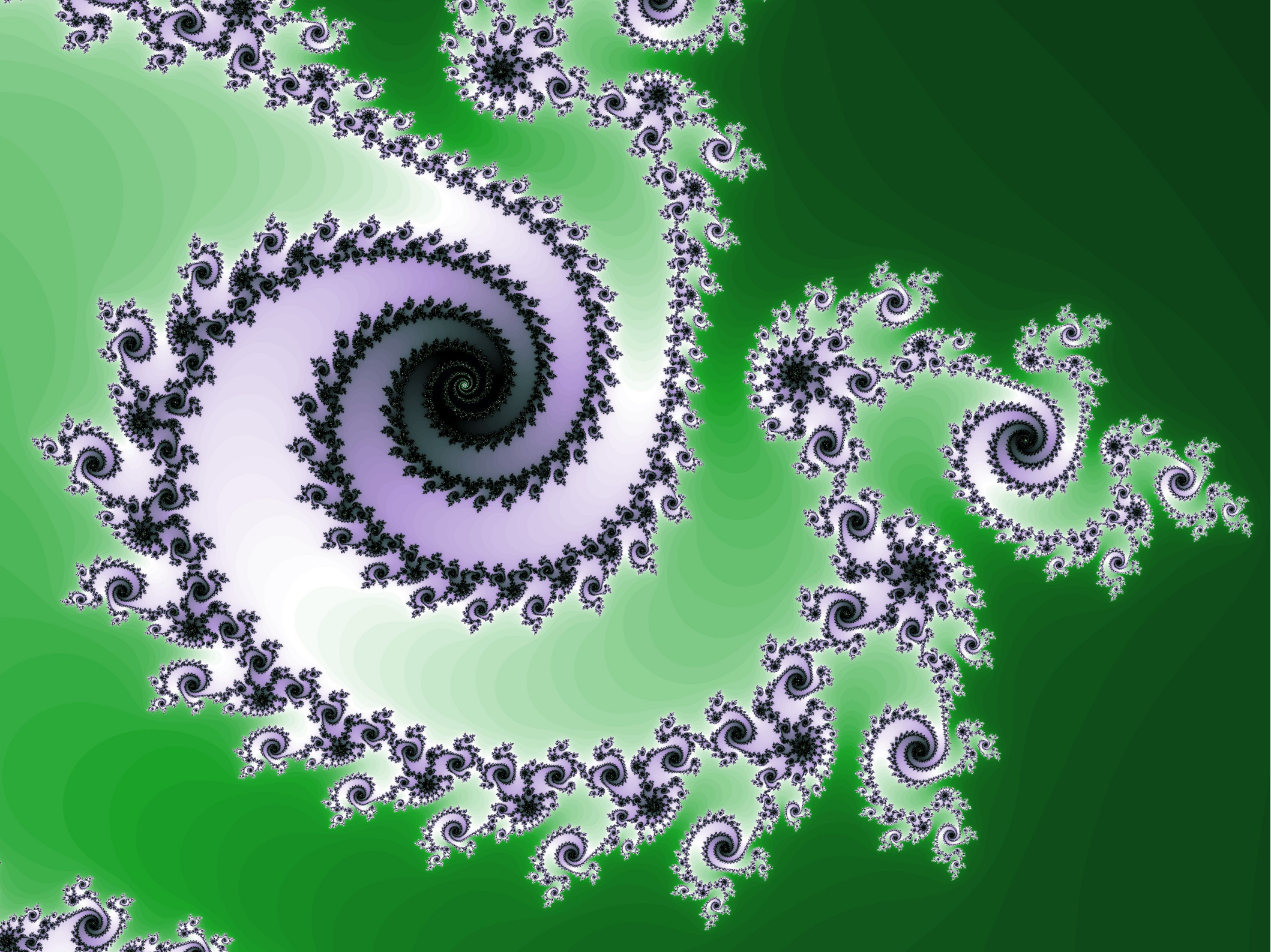
Mandelbrotmenge

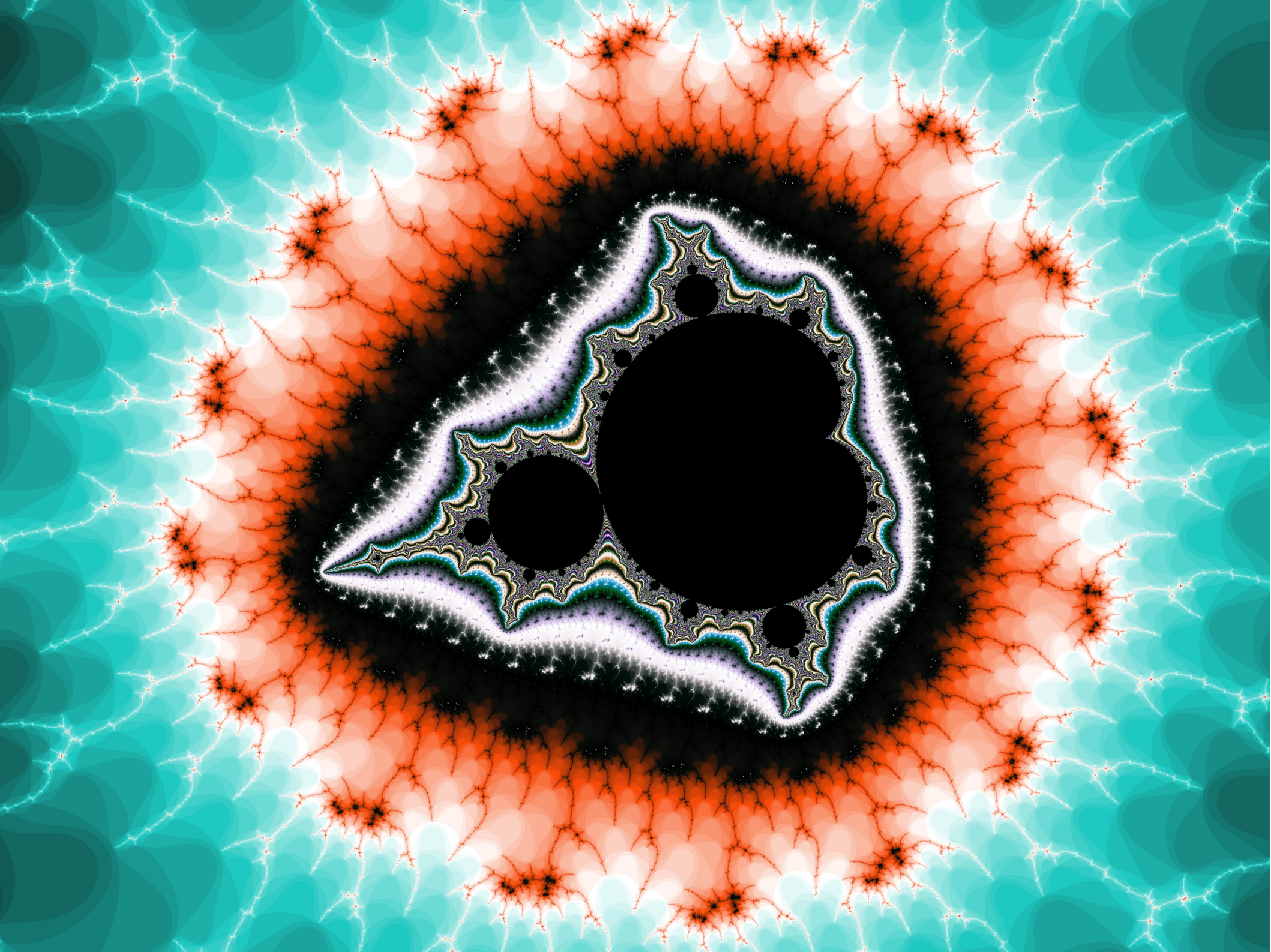
$$z_{n+1} = z_n^2 + c$$

$$|z_n| \leq 2$$

$$\begin{aligned} z_0 &= 0 \\ z_1 &= z_0^2 + c \\ z_2 &= z_1^2 + c \\ z_3 &= z_2^2 + c \\ z_4 &= z_3^2 + c \\ z_5 &= z_4^2 + c \end{aligned}$$







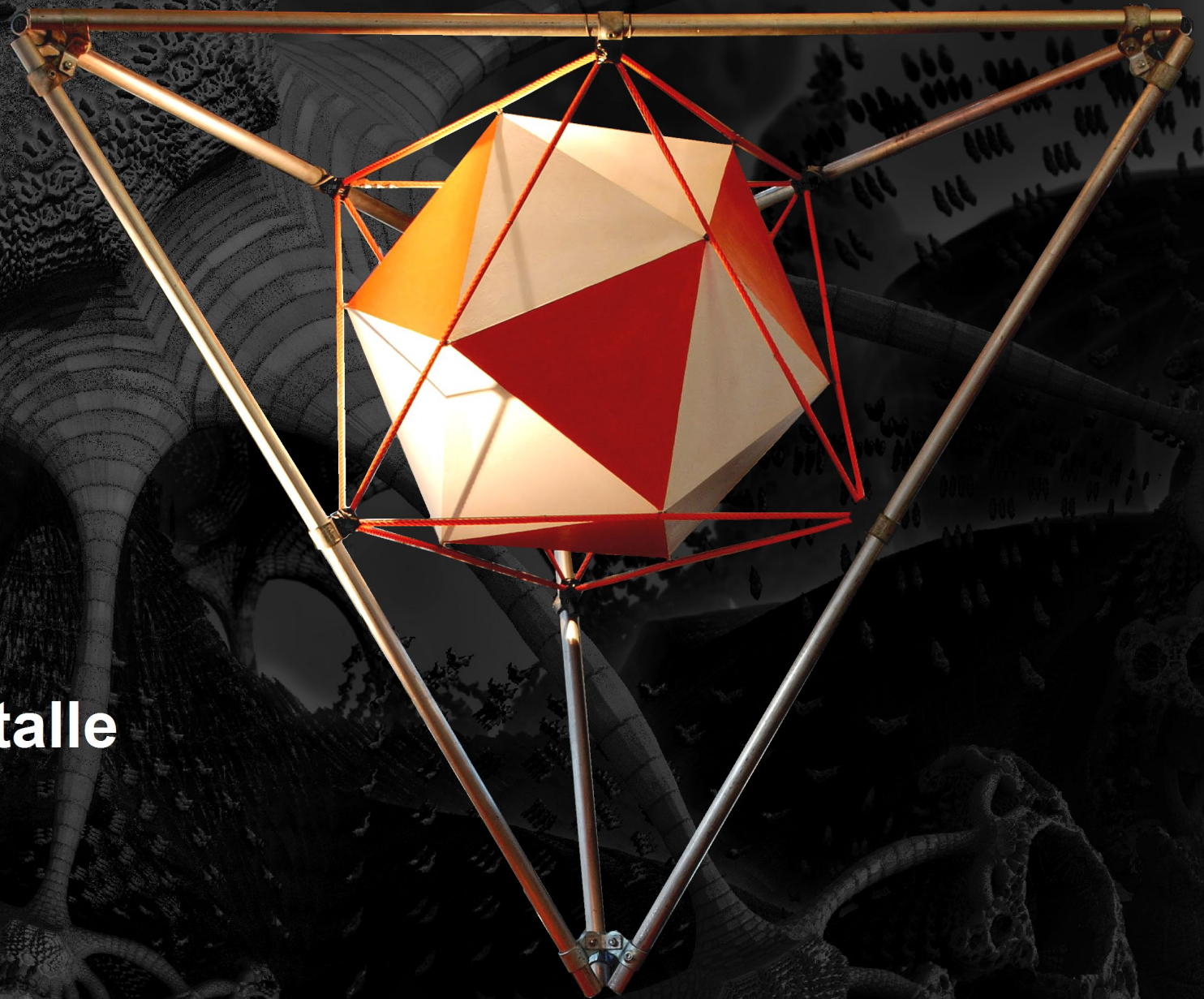


Teil 3

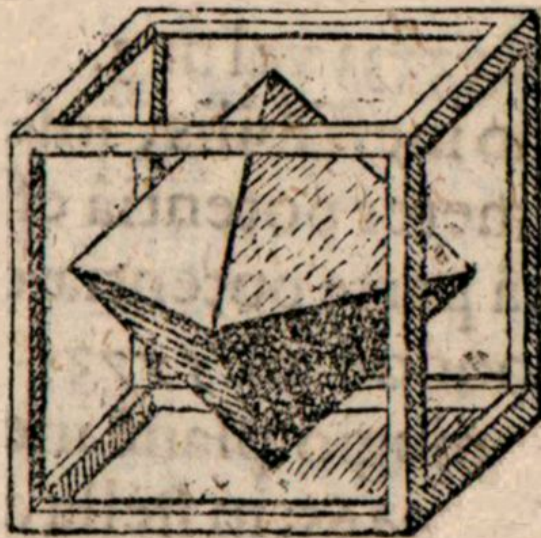
Polyeder

Kristalle

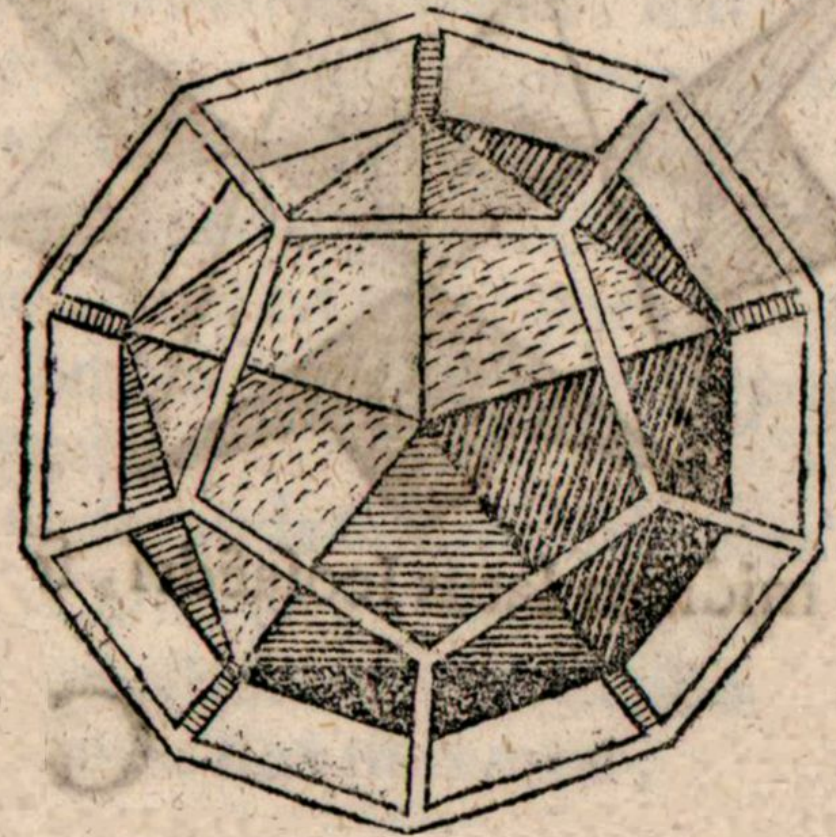
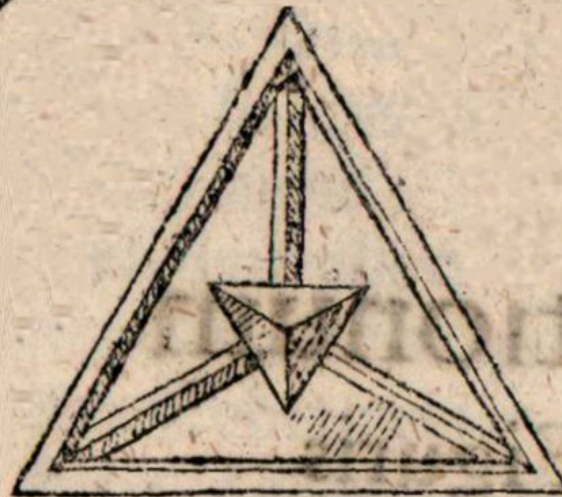
Quasikristalle



Oktaeder im Würfel

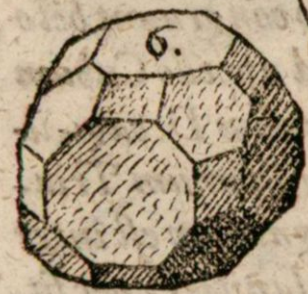
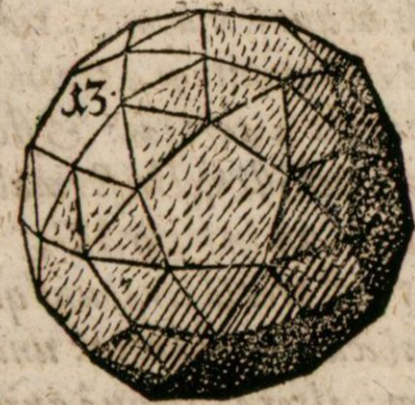
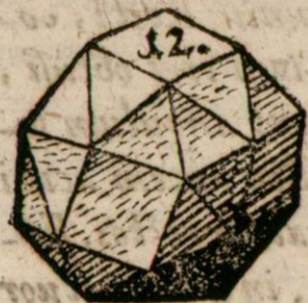
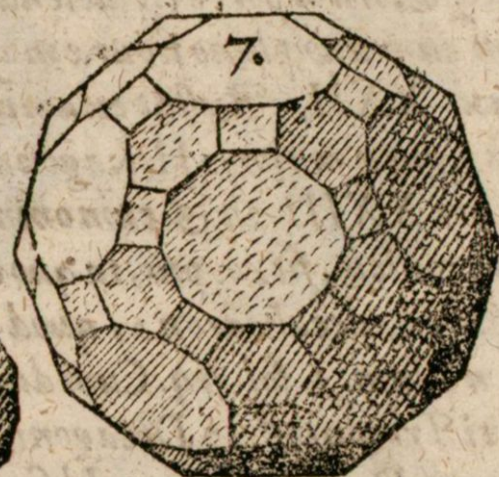
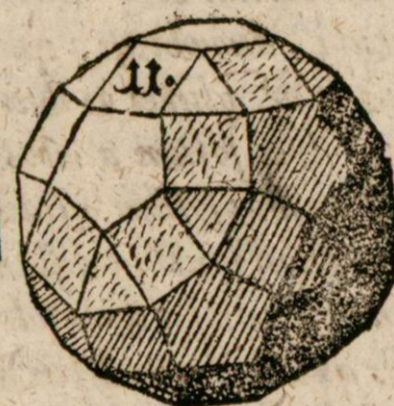
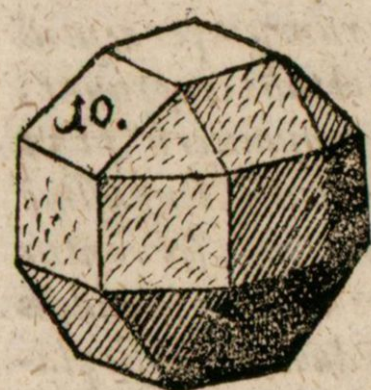
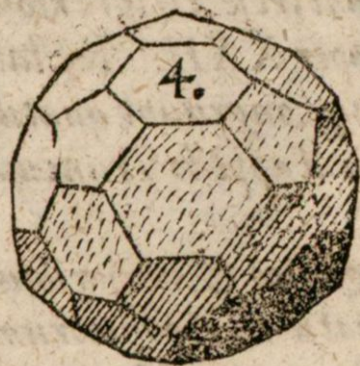
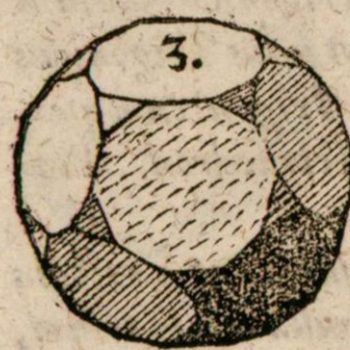
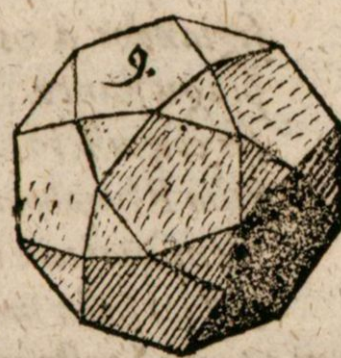
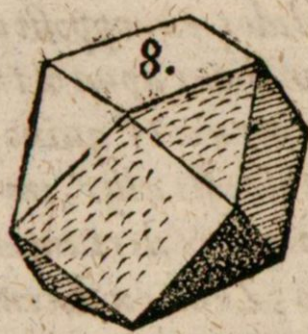
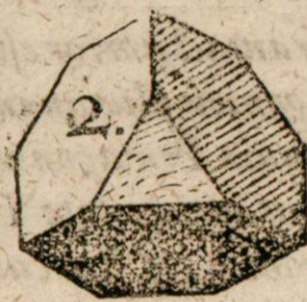
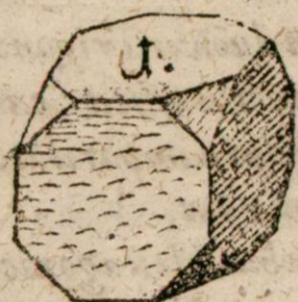


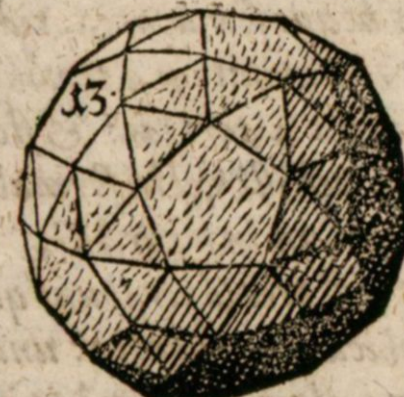
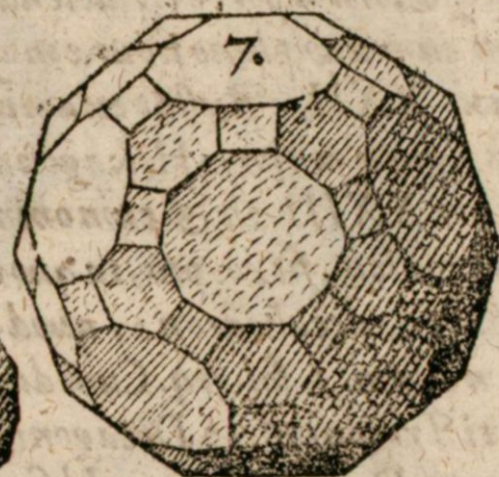
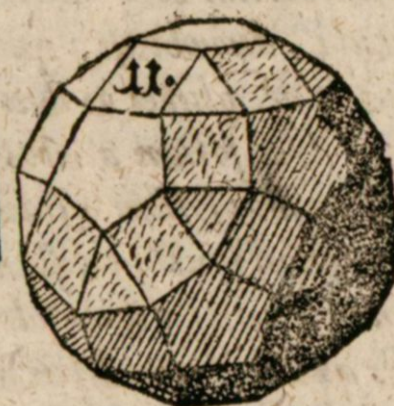
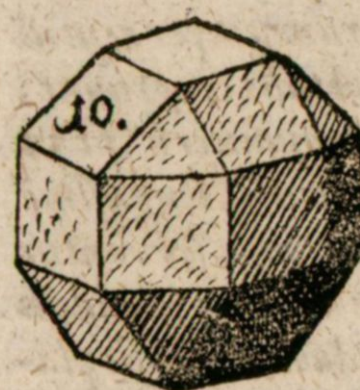
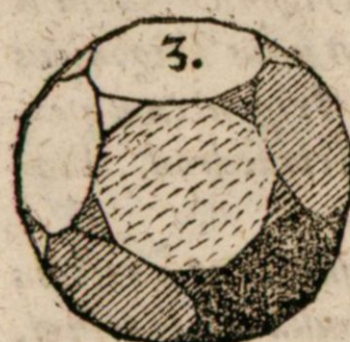
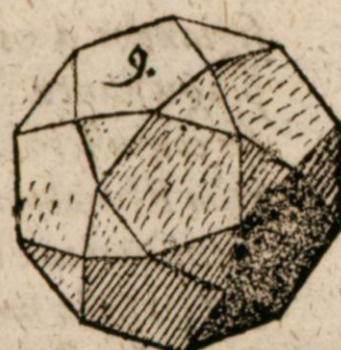
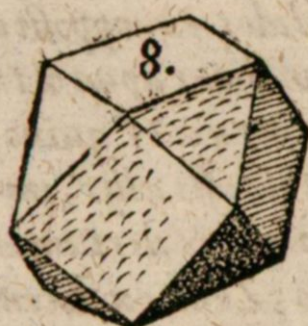
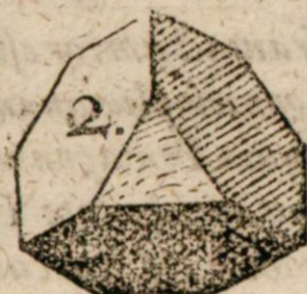
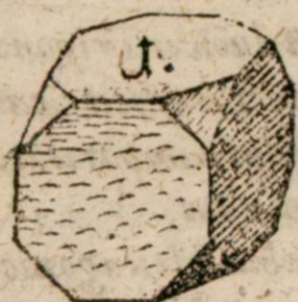
Tetraeder im
Tetraeder

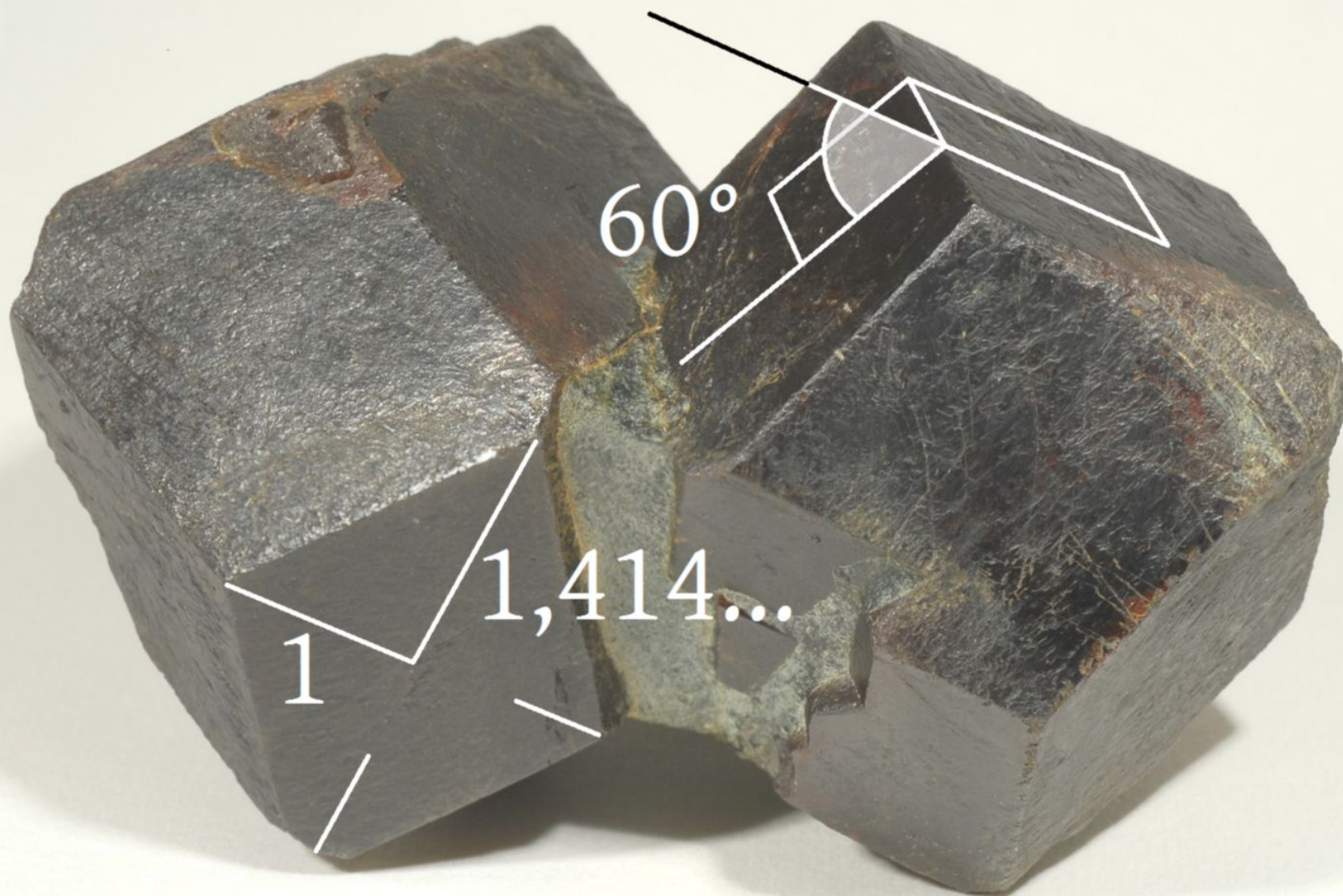


Ikosaeder im
Dodekaeder

Die Dualitäten der fünf Platonischen Körper
Holzschnitte von Johannes Kepler (1571 - 1630)

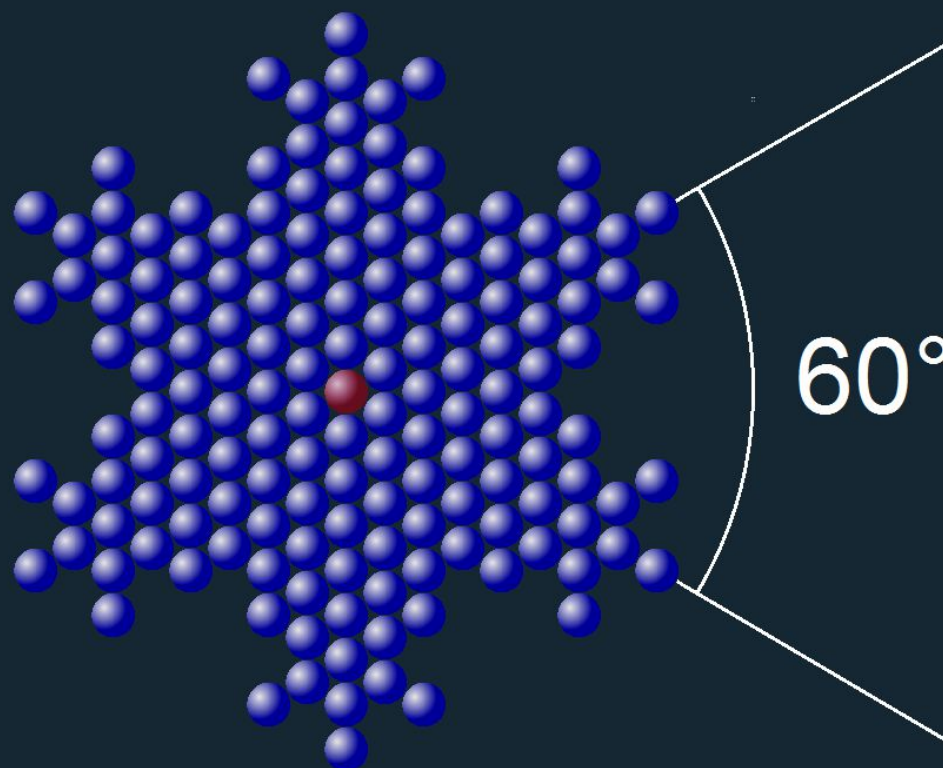
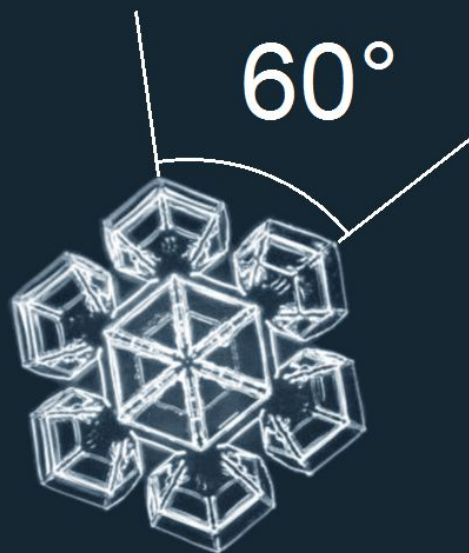






Granat-Rhombendodekaederzwilling aus dem Oetztal (www.kristallin.de)

1 cm



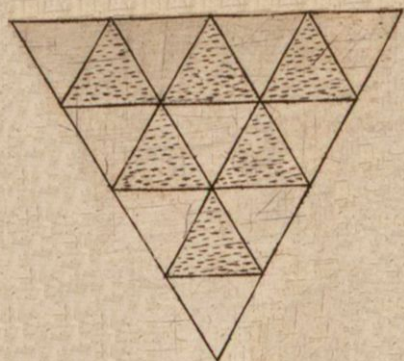


Fig. D

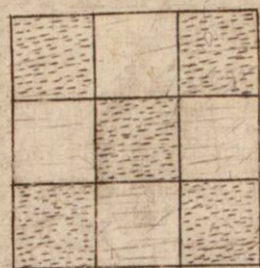


Fig. E

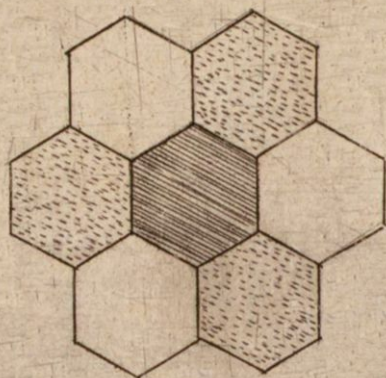


Fig. F

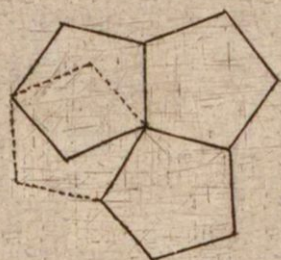


Fig. H

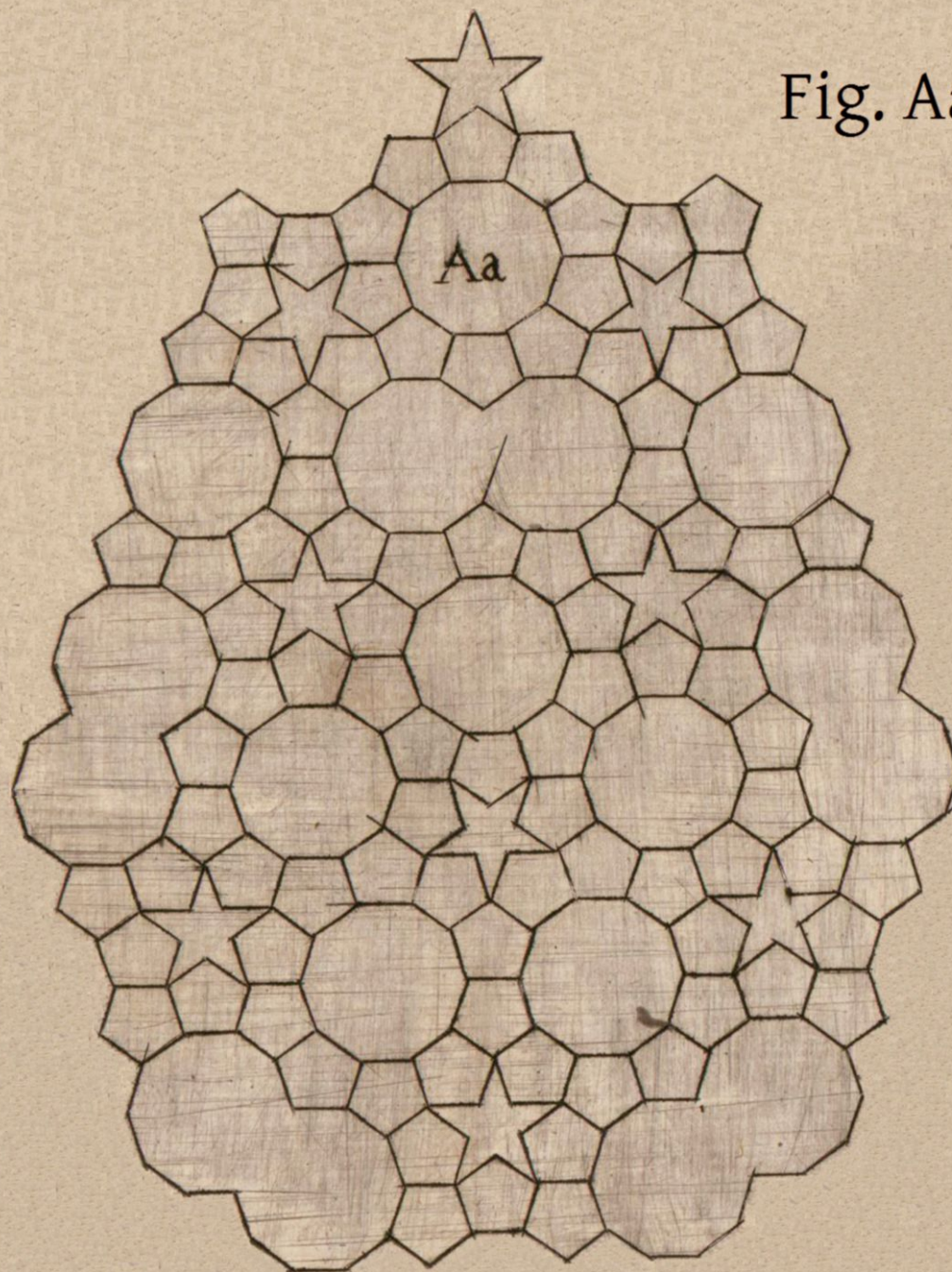


Fig. Aa

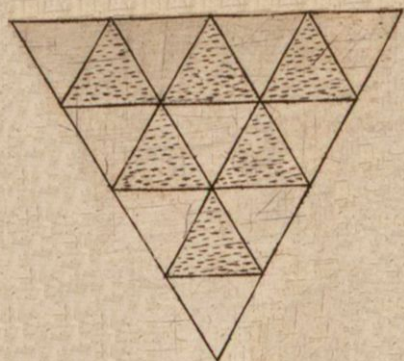


Fig. D

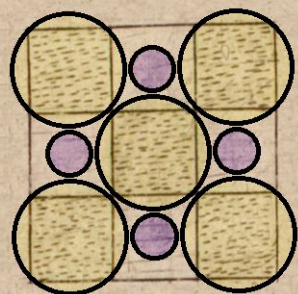


Fig. E

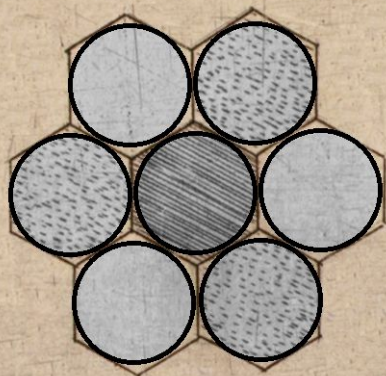


Fig. F

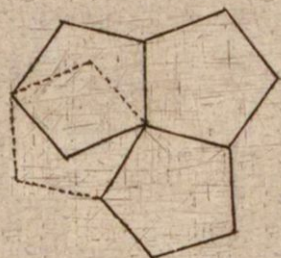


Fig. H

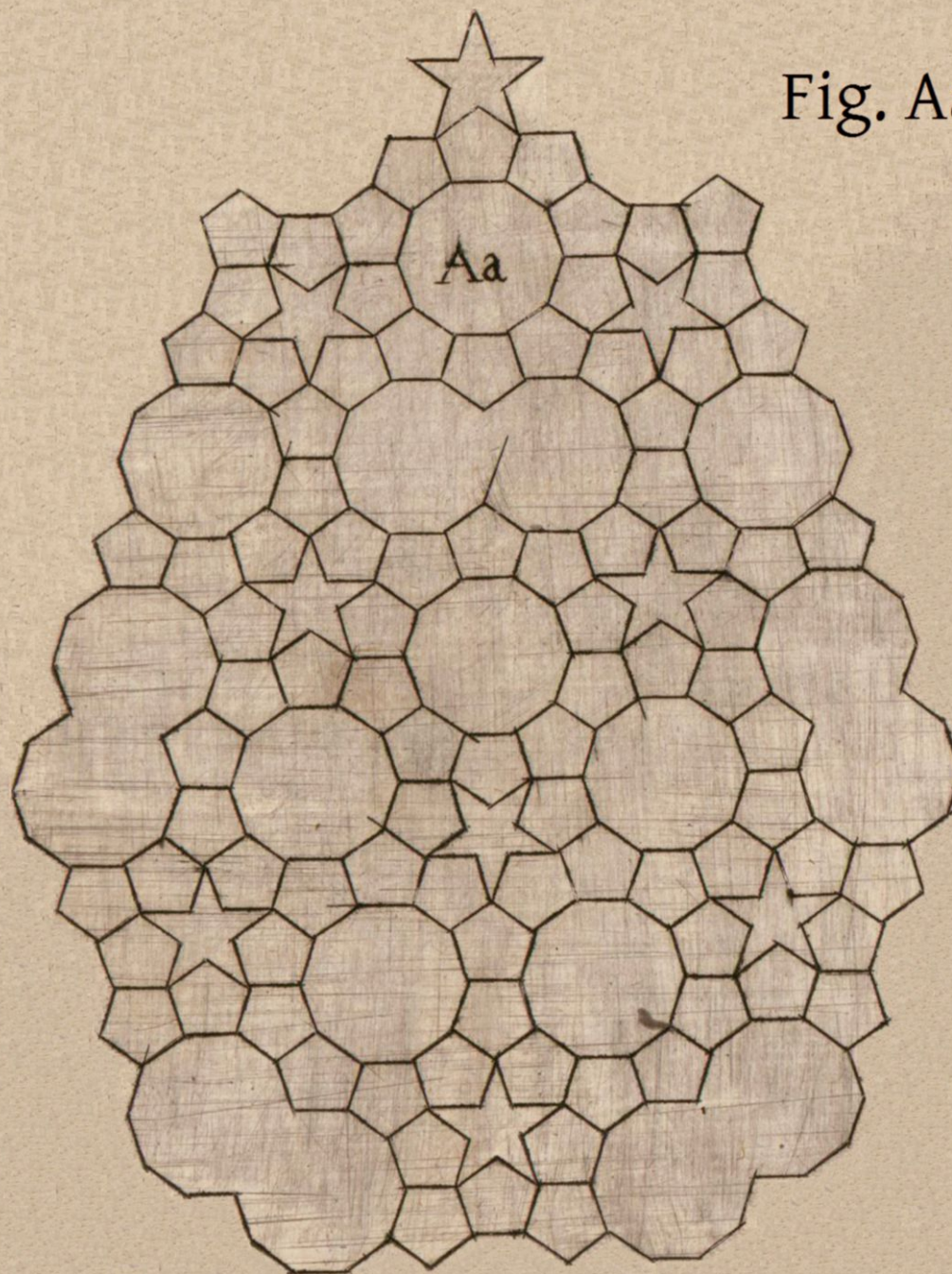


Fig. Aa

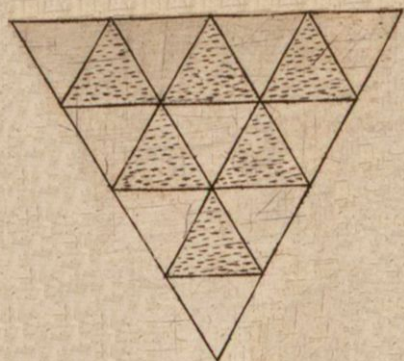


Fig. D

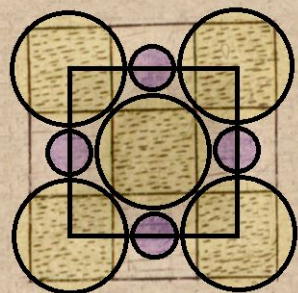


Fig. E

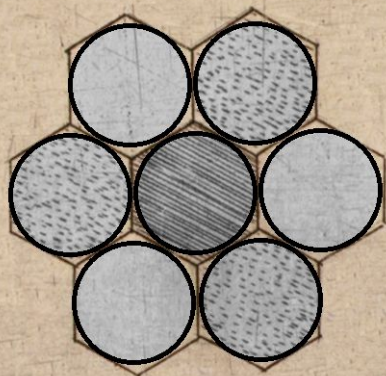


Fig. F

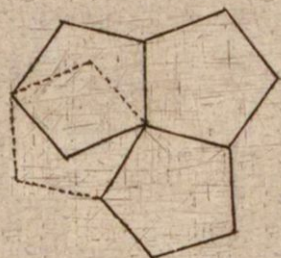


Fig. H

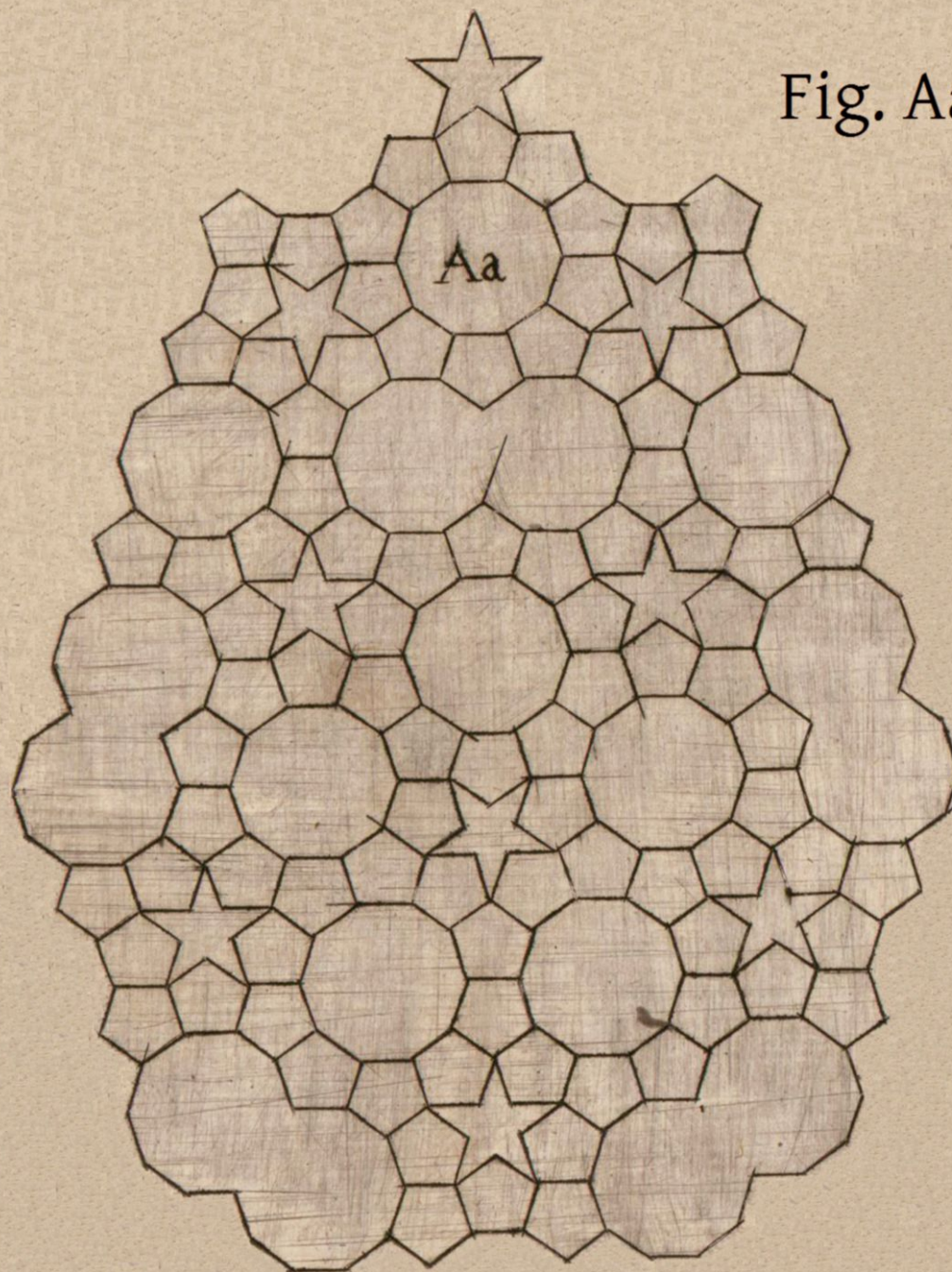


Fig. Aa

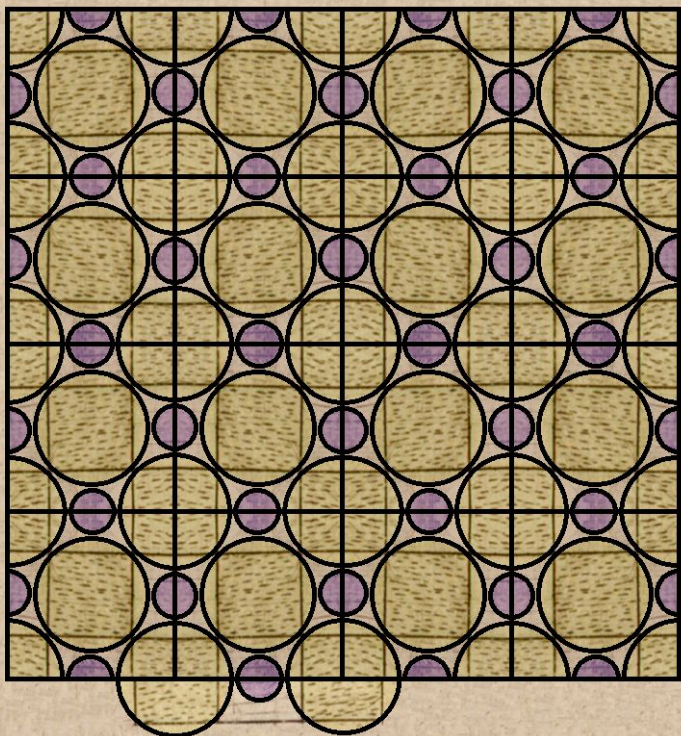


Fig. Aa

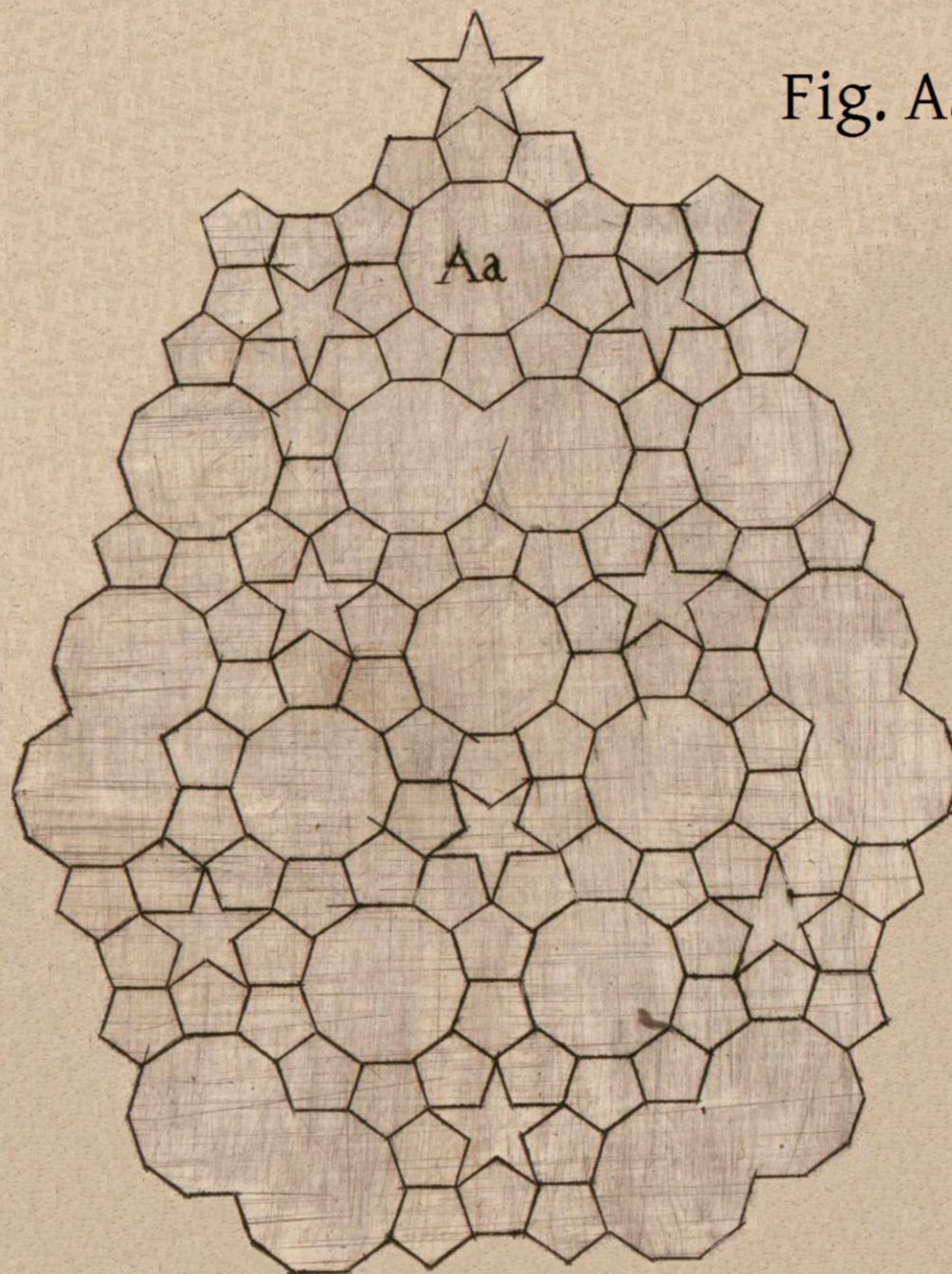


Fig. F

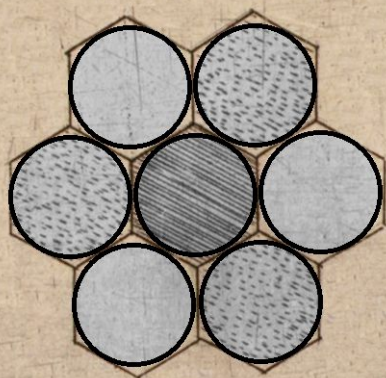
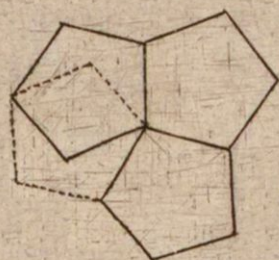


Fig. H



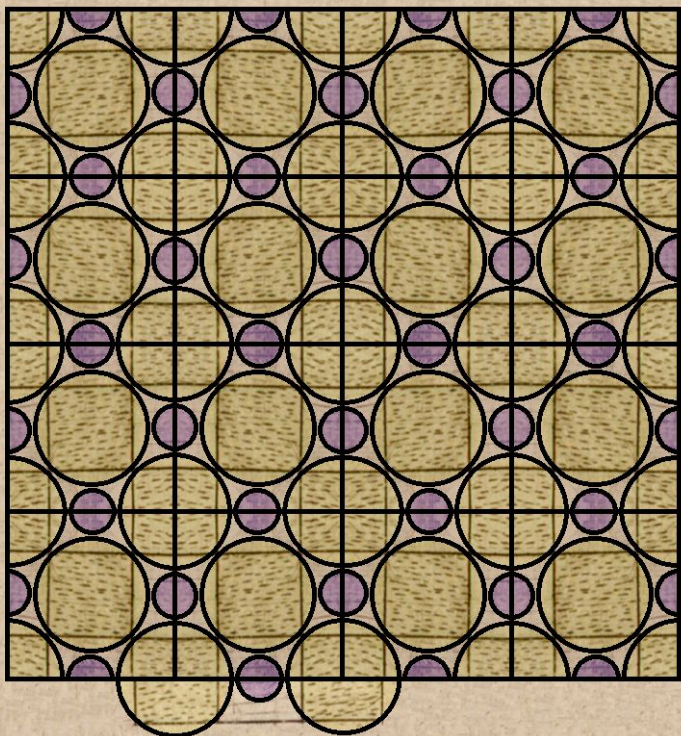


Fig. Aa

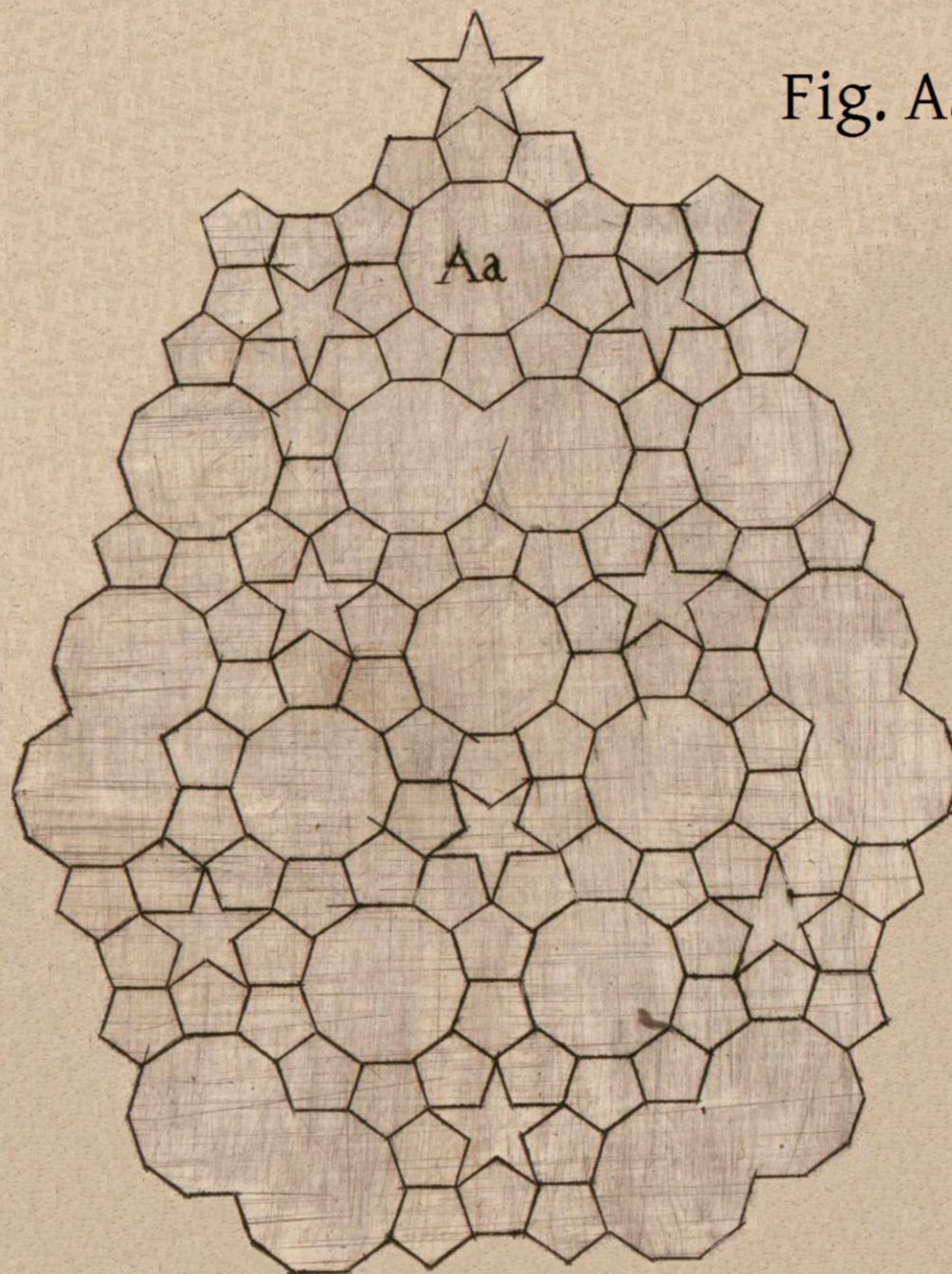


Fig. F

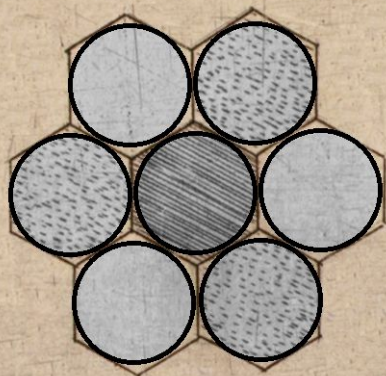
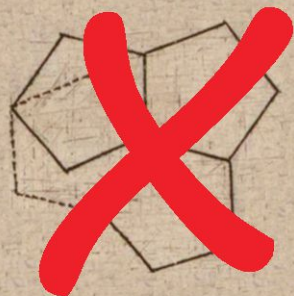
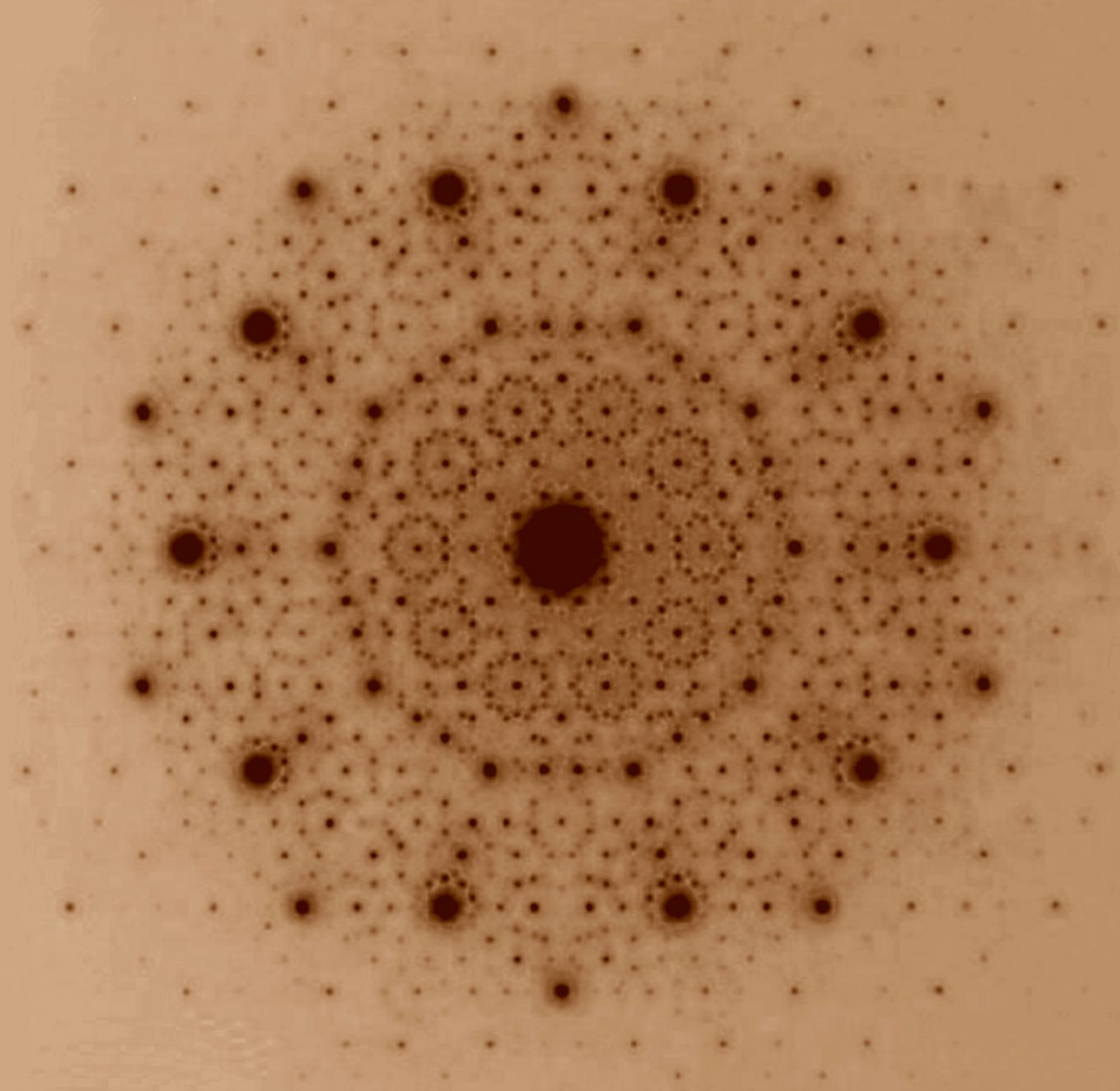


Fig. H





Röntgenbeugungsbild eines AlNiCo-Quasikristalls



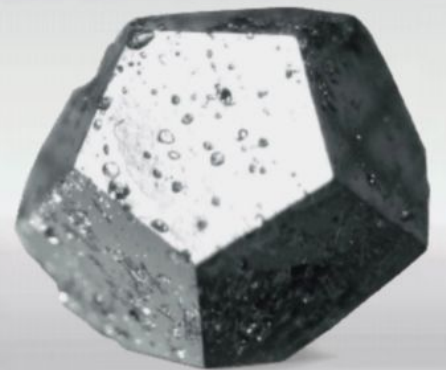
Physiker

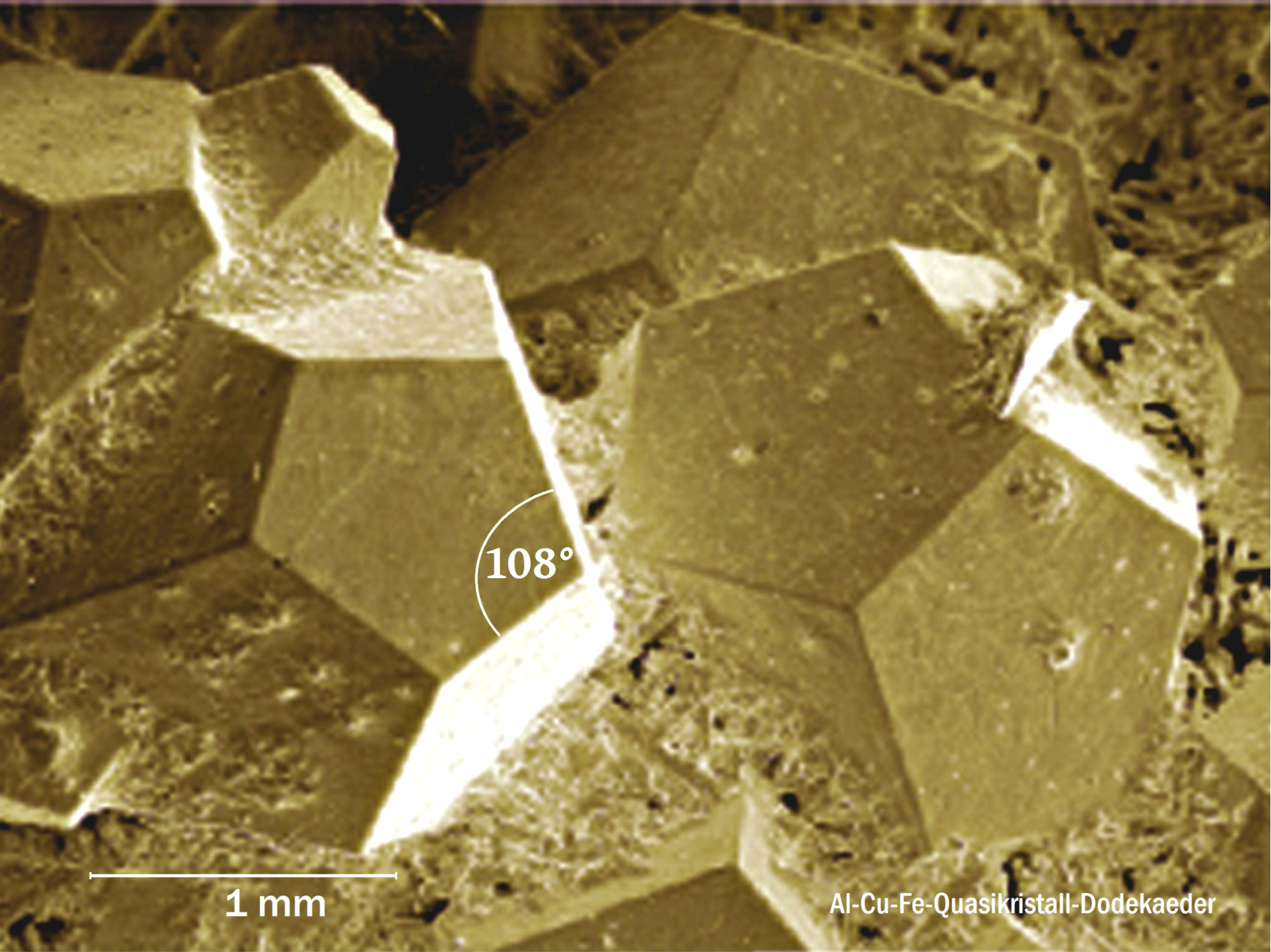


Chemiker



Kristallograf



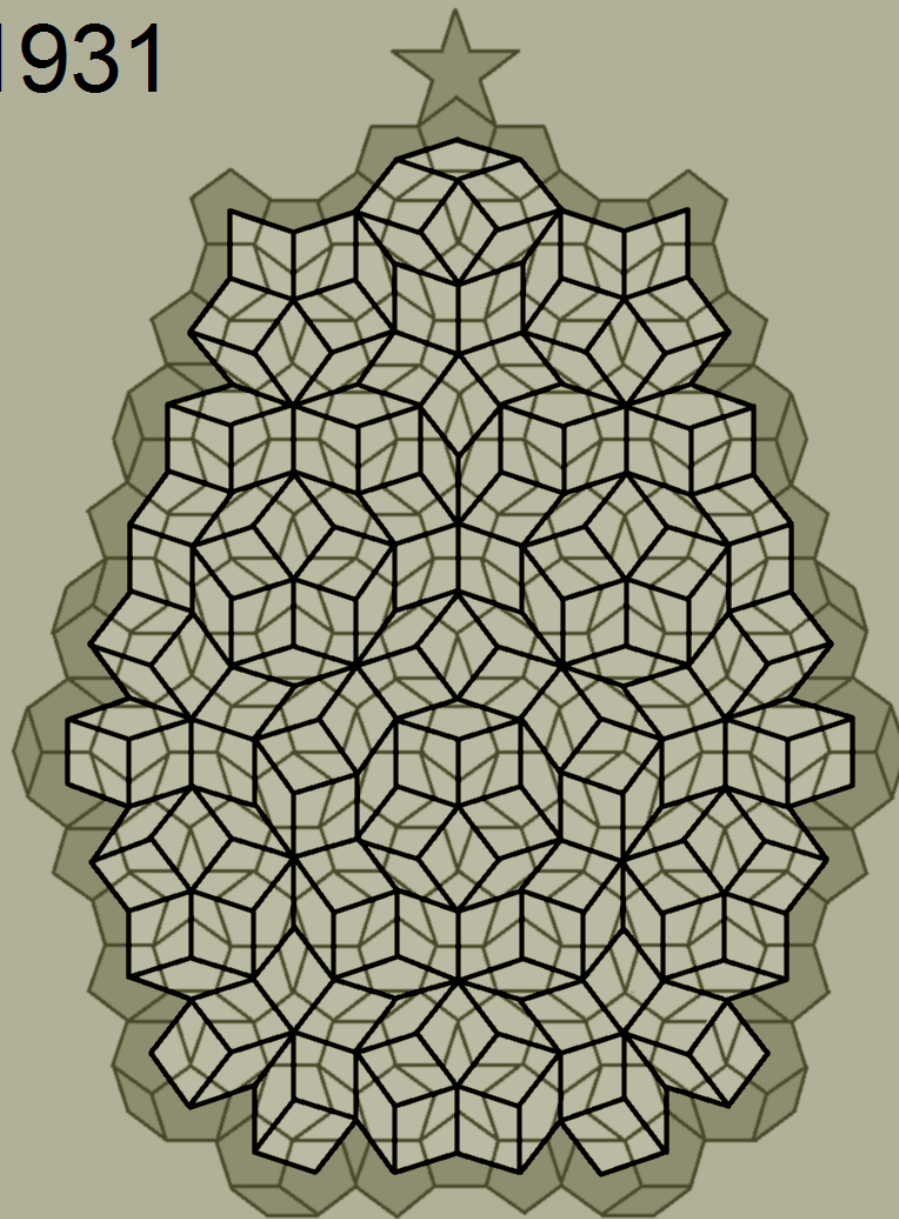
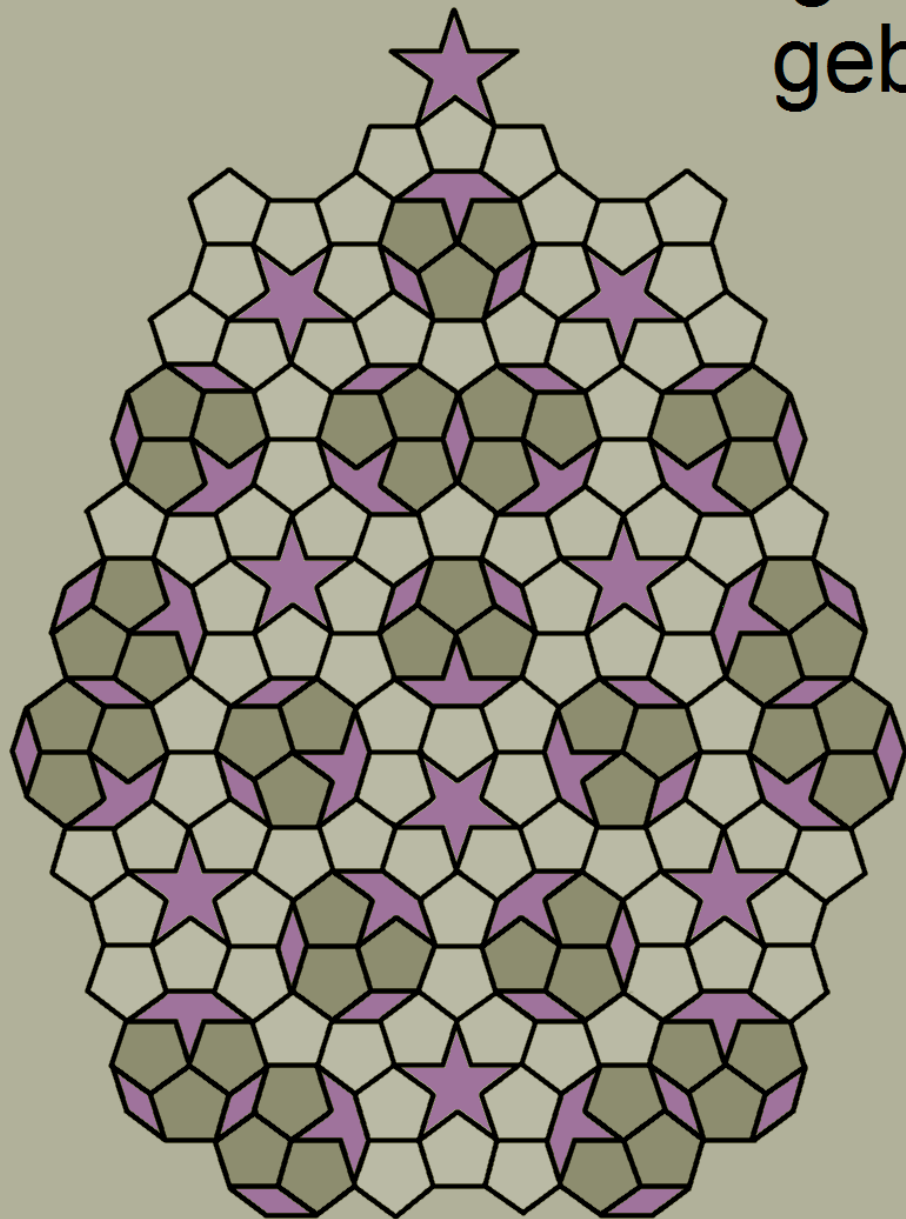


108°

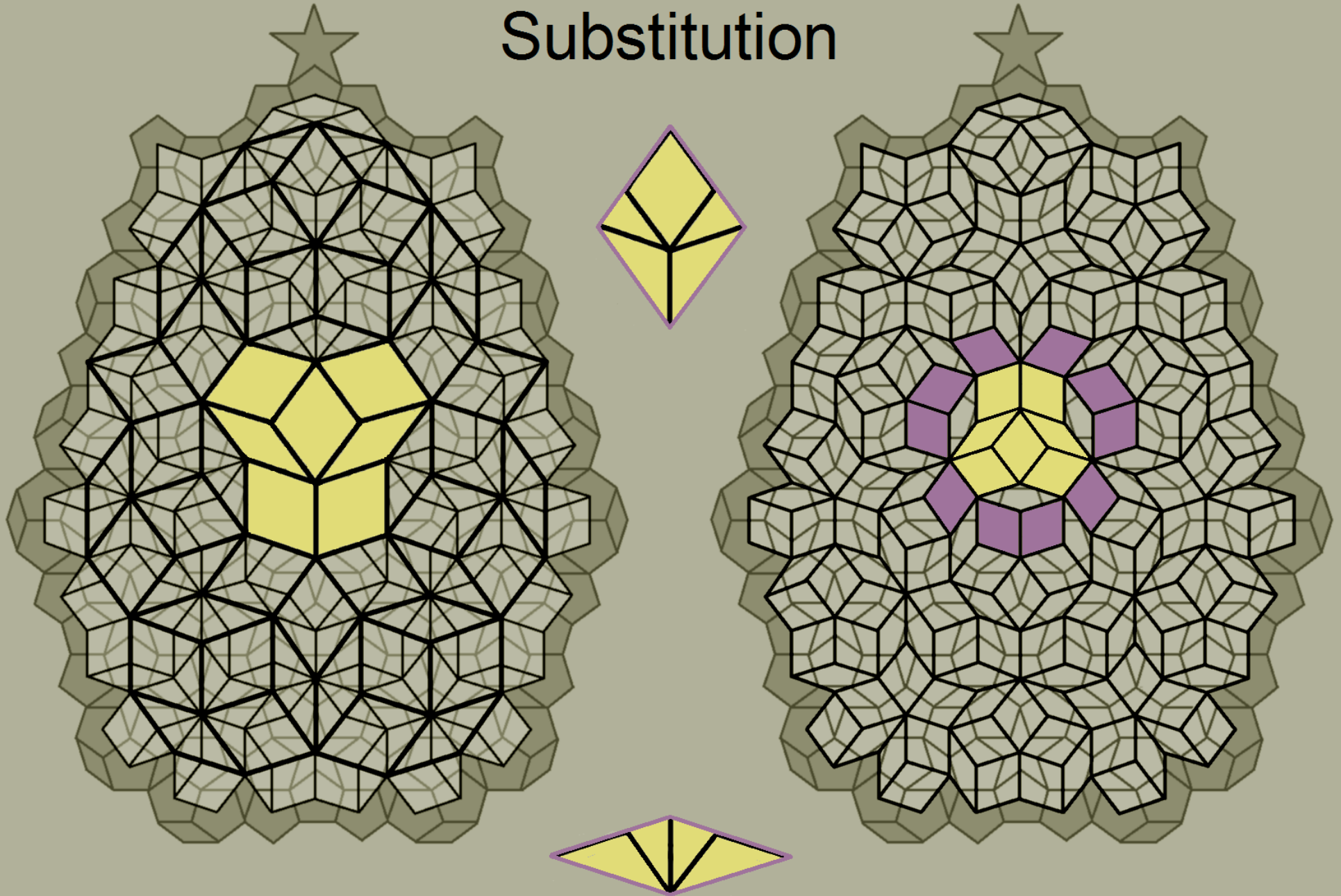
1 mm

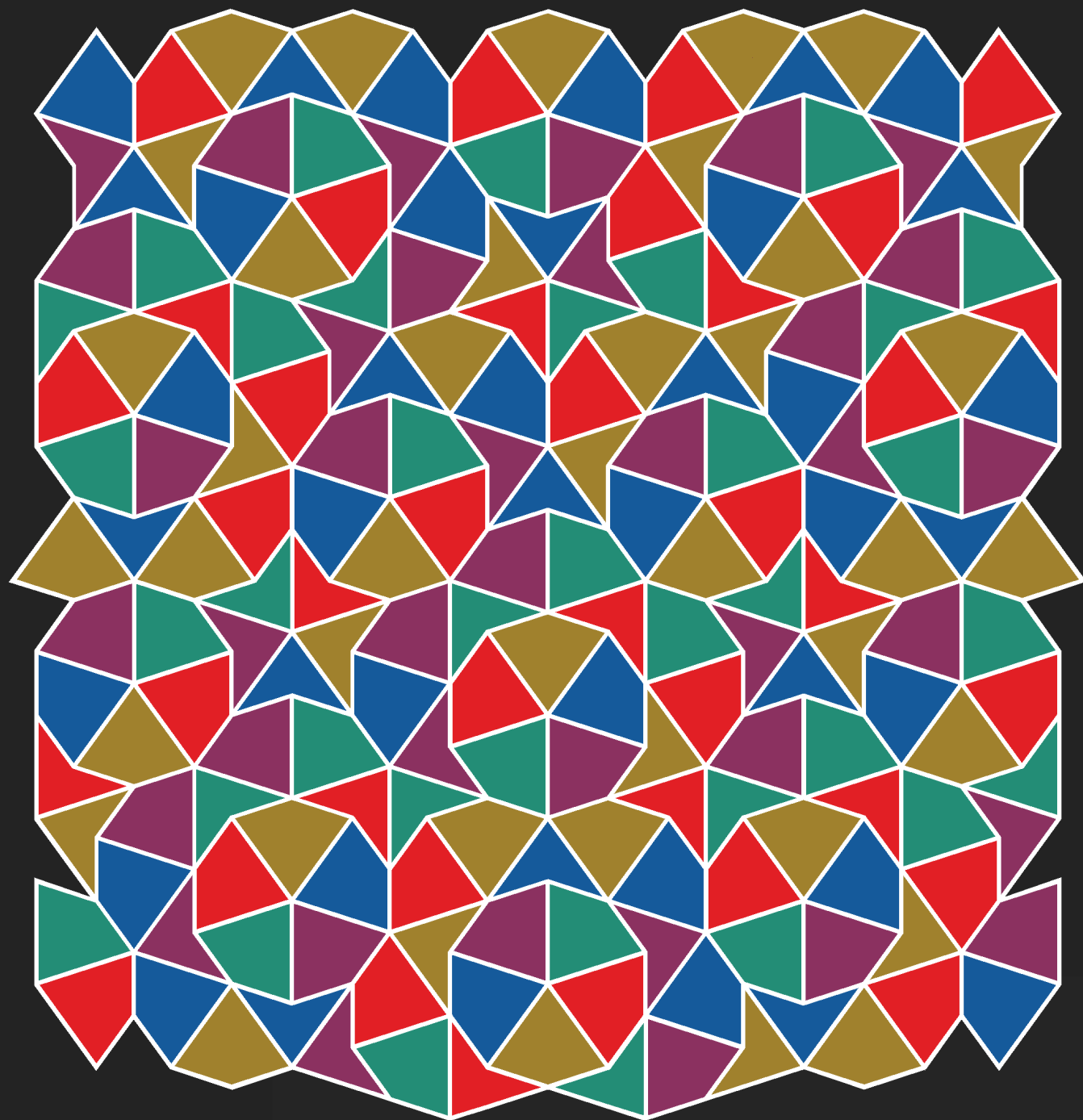
Al-Cu-Fe-Quasikristall-Dodekaeder

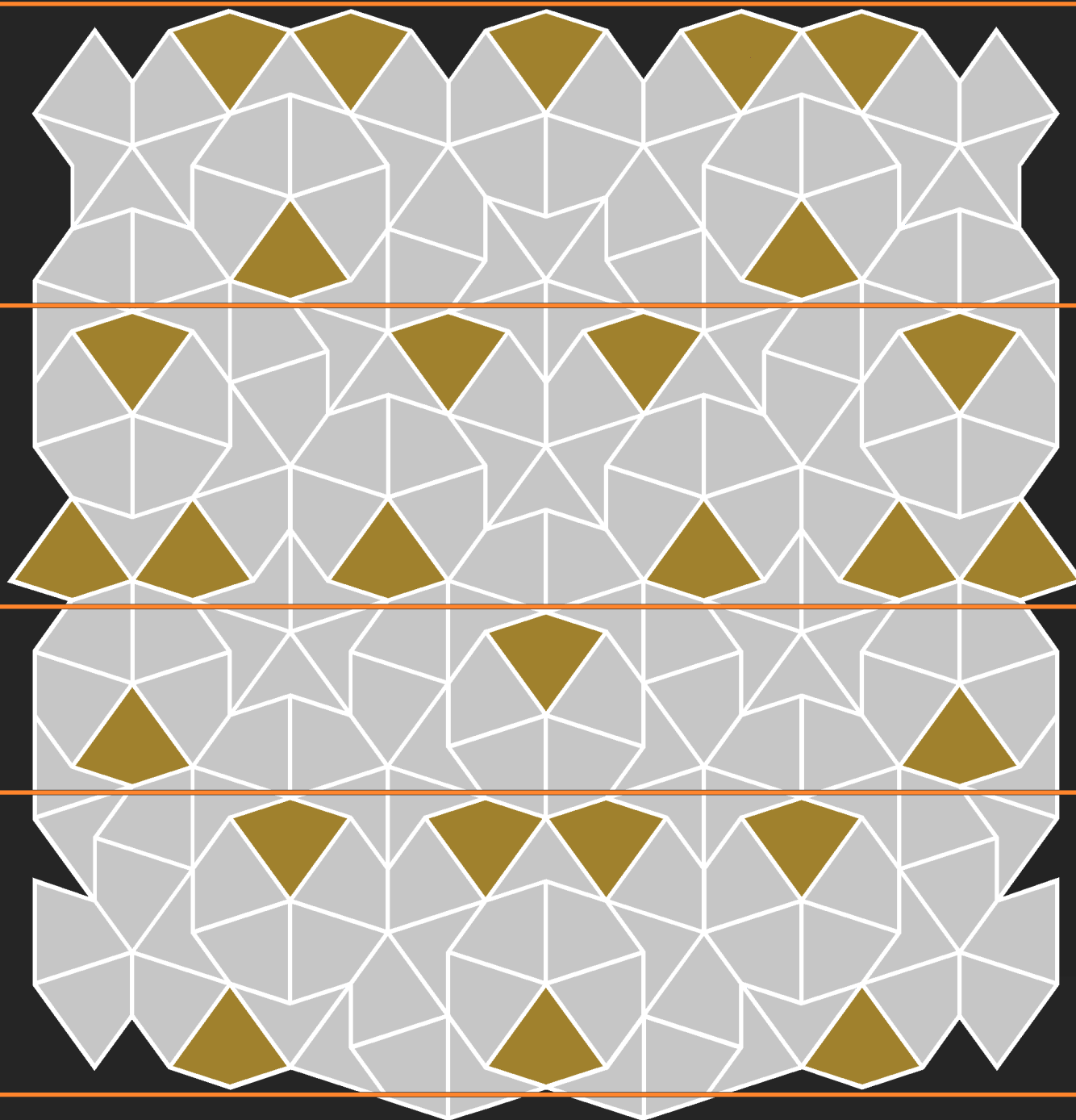
Roger Penrose
geb. 1931

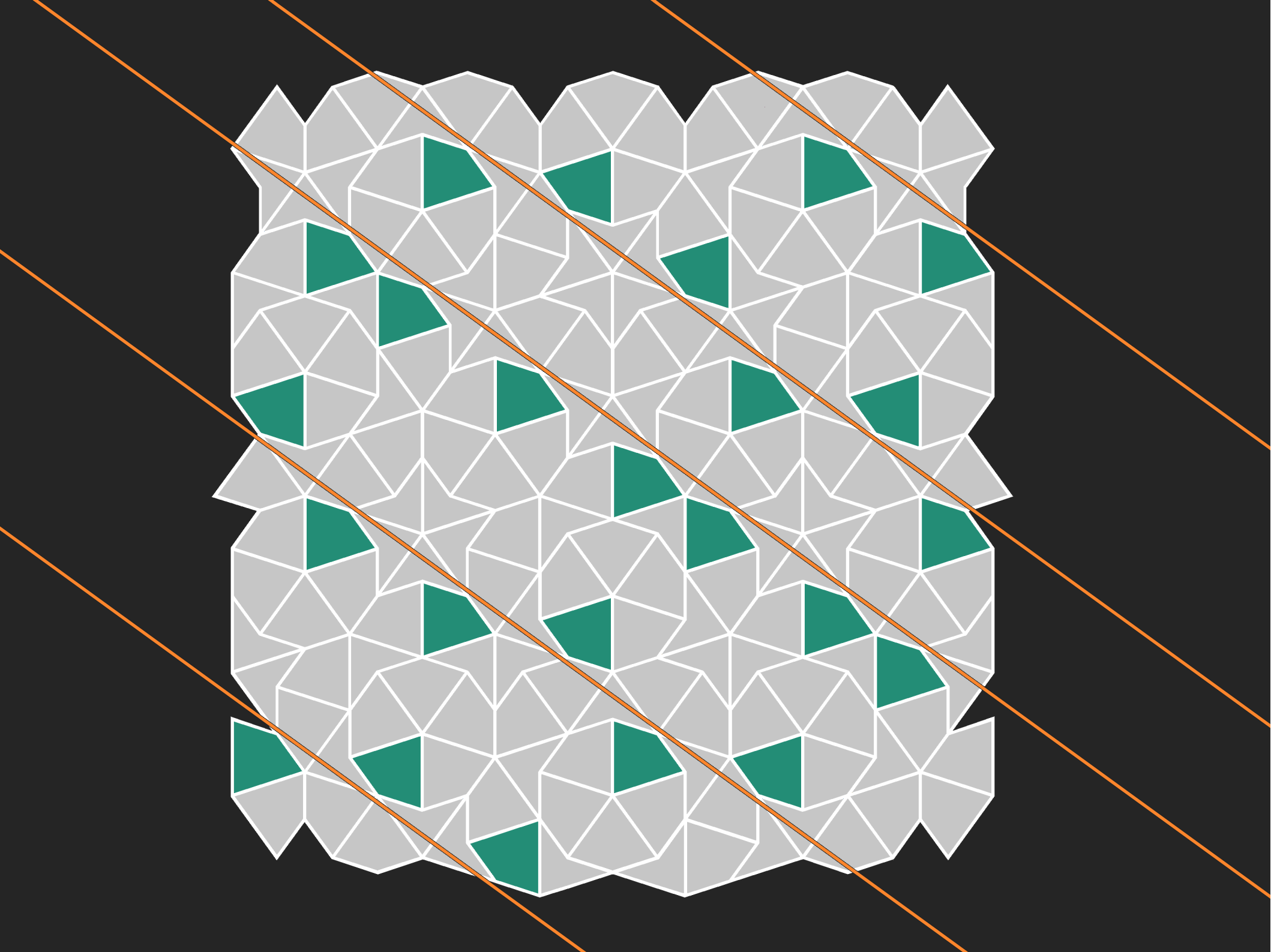


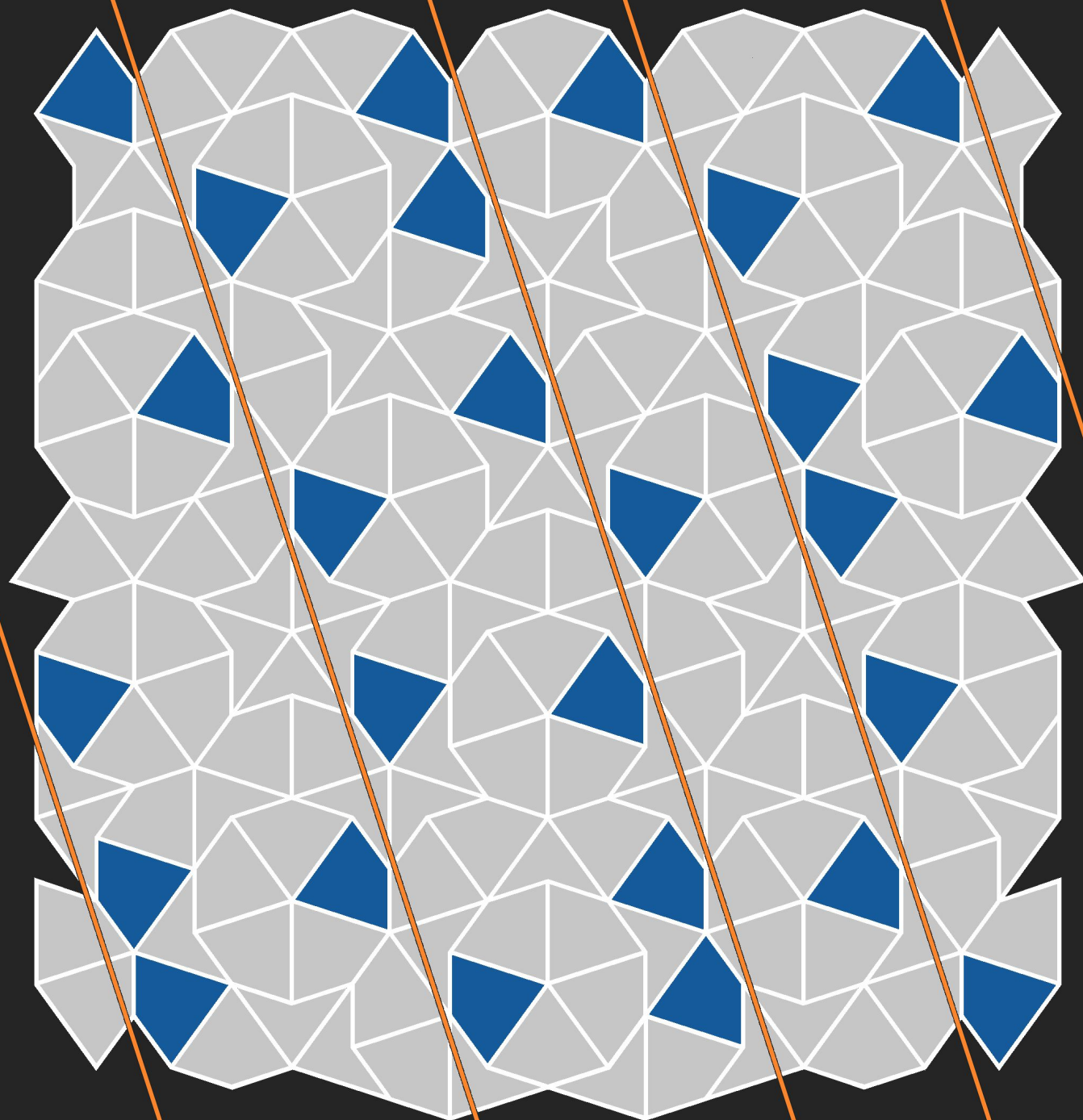
Rhomben-Parkett Substitution

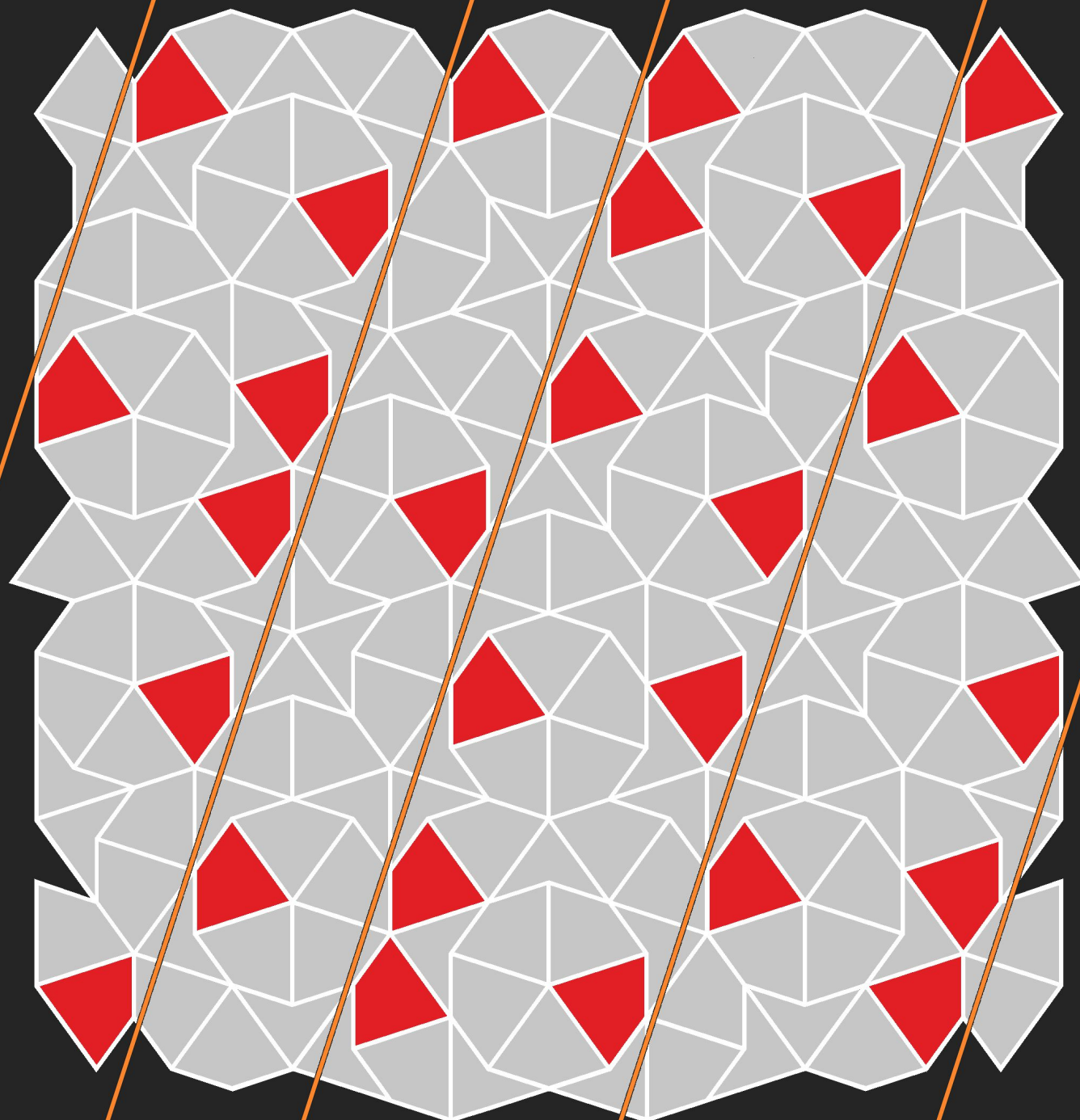


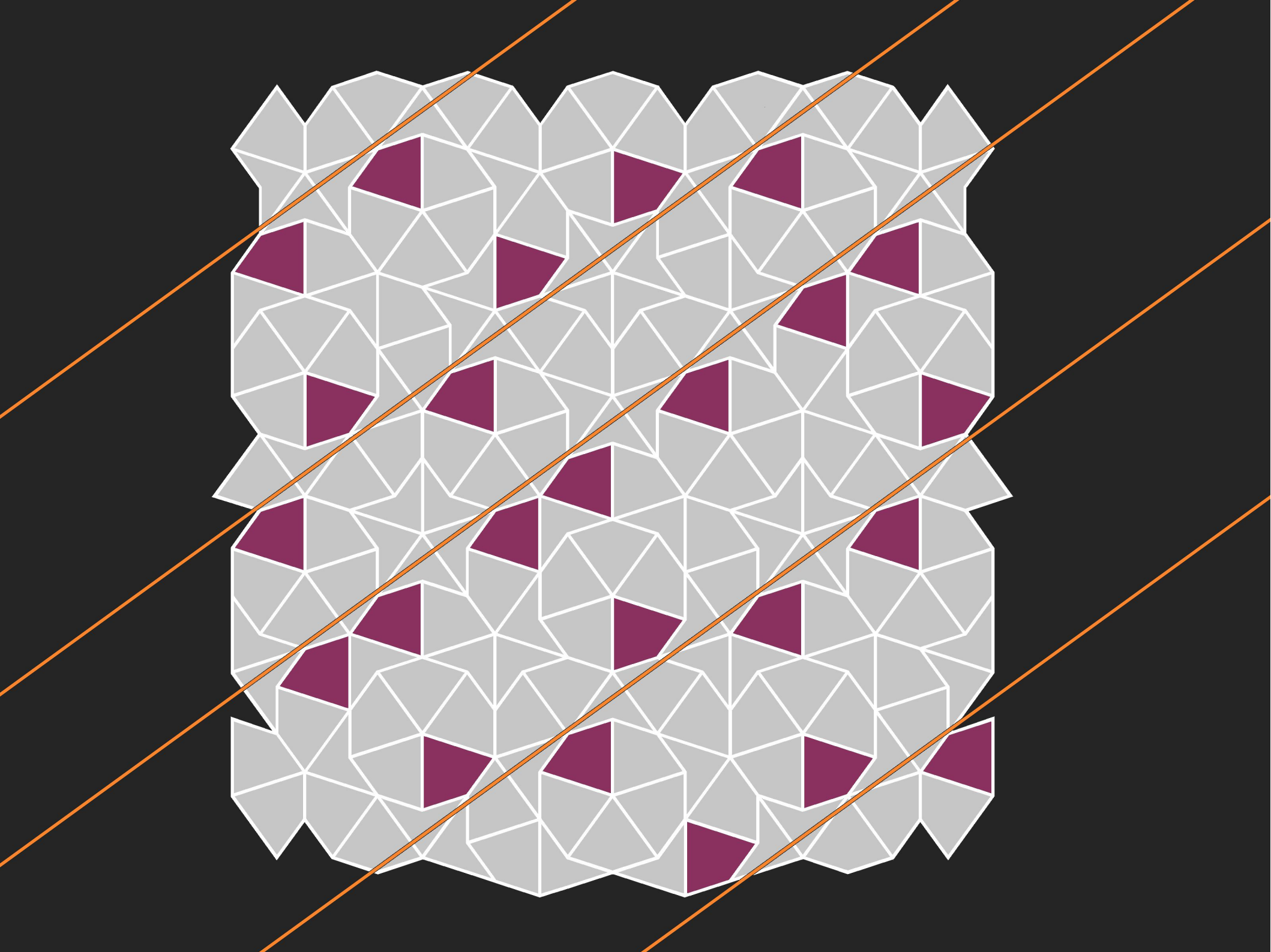


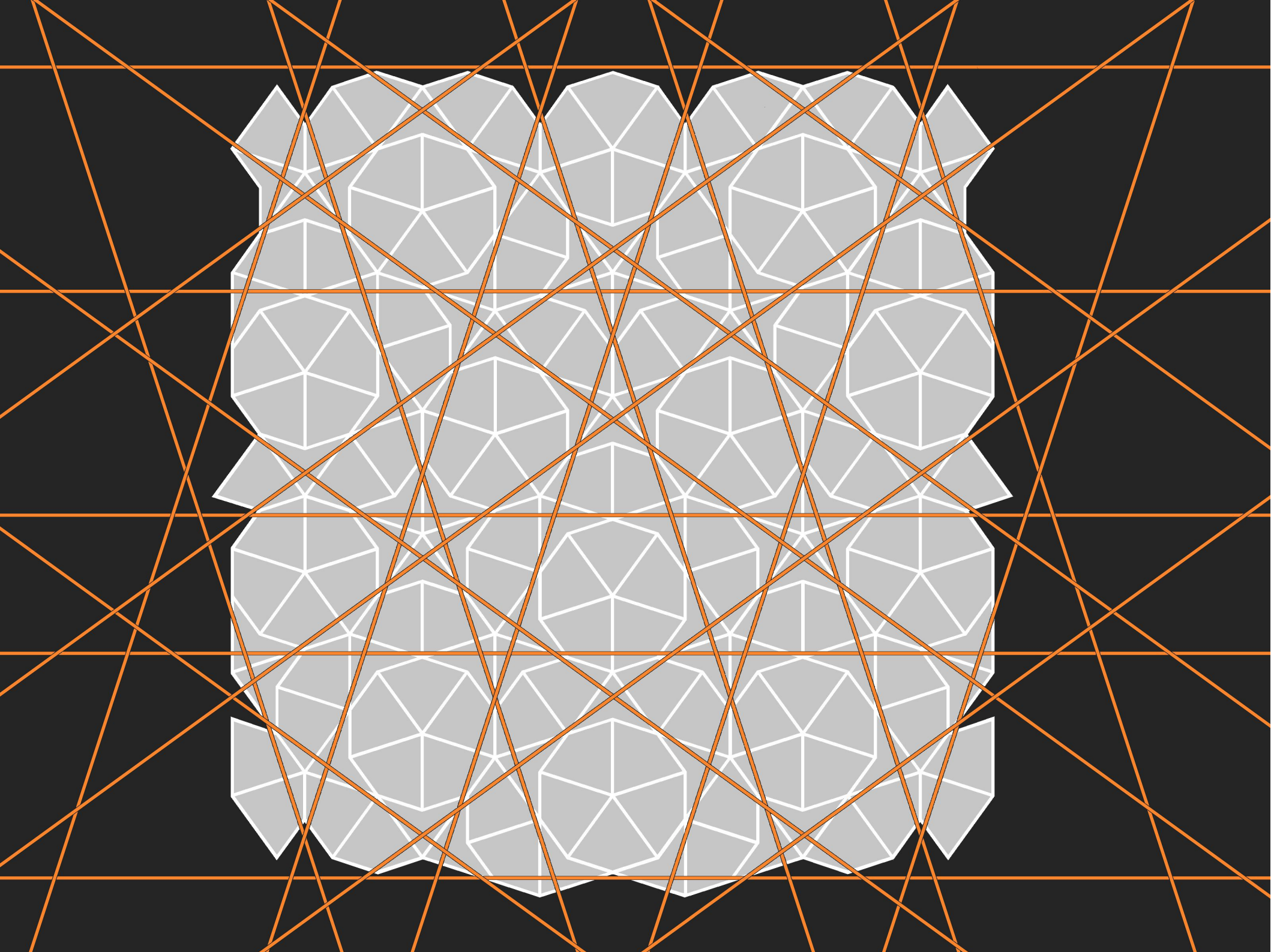


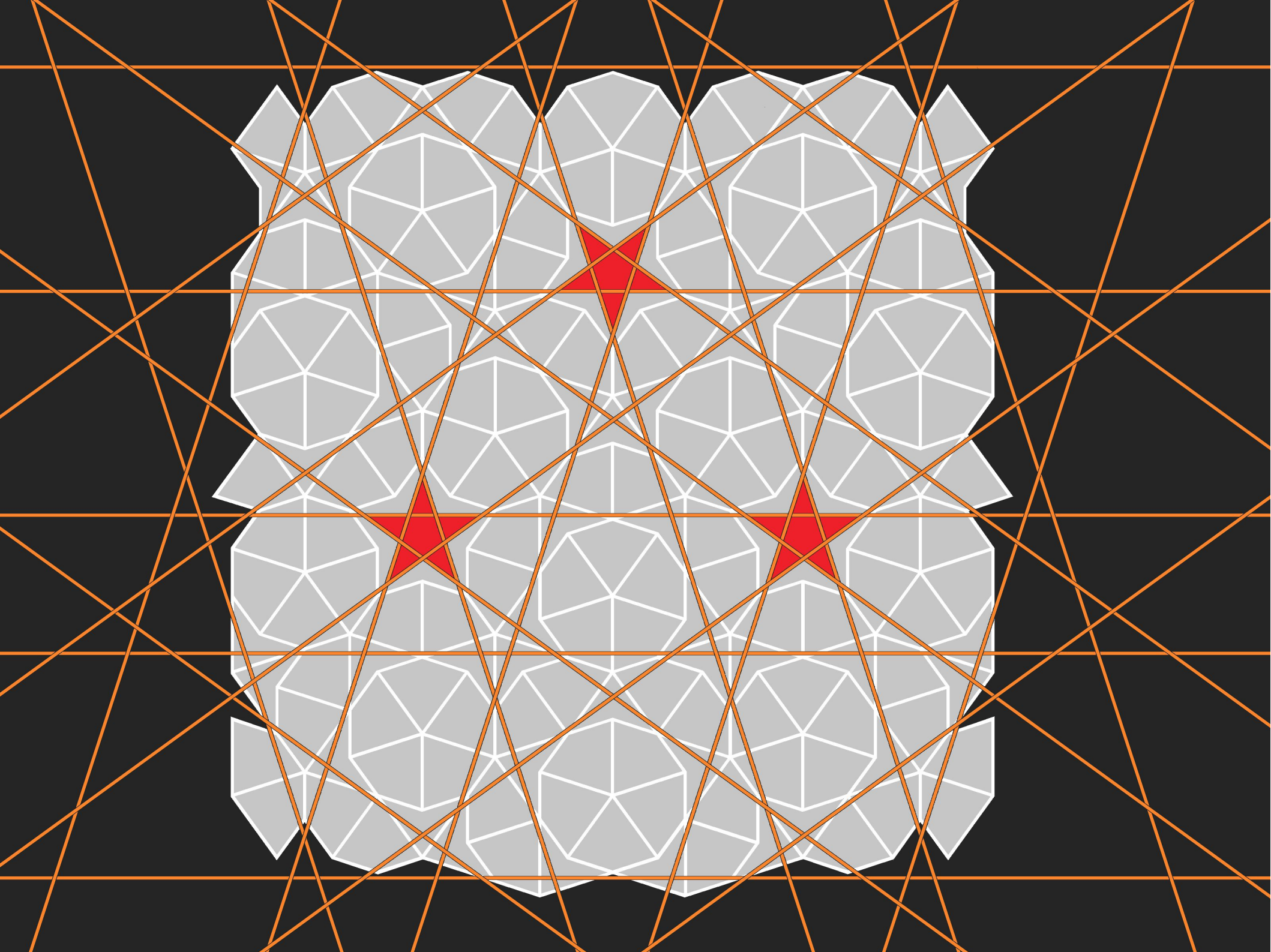


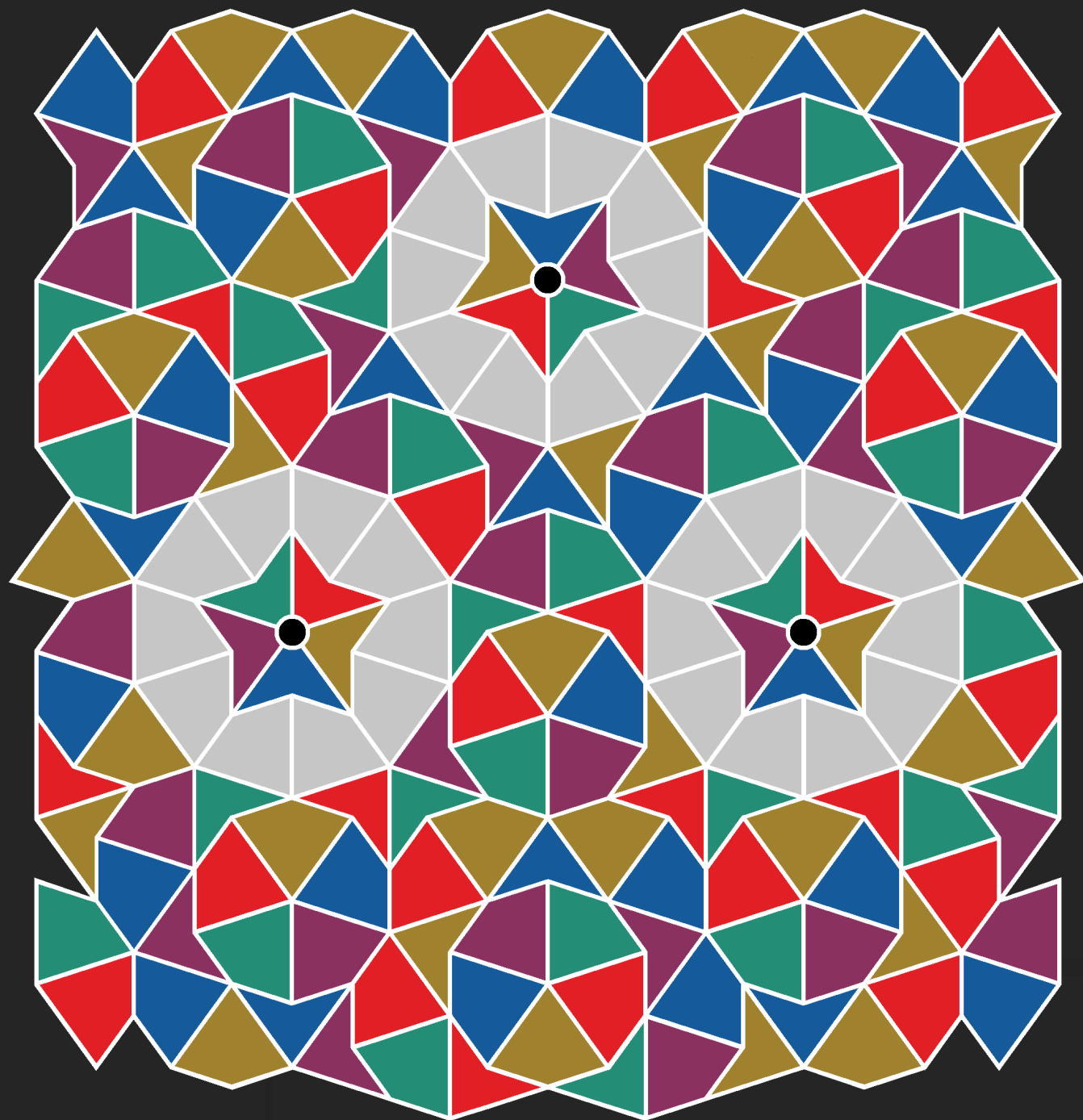


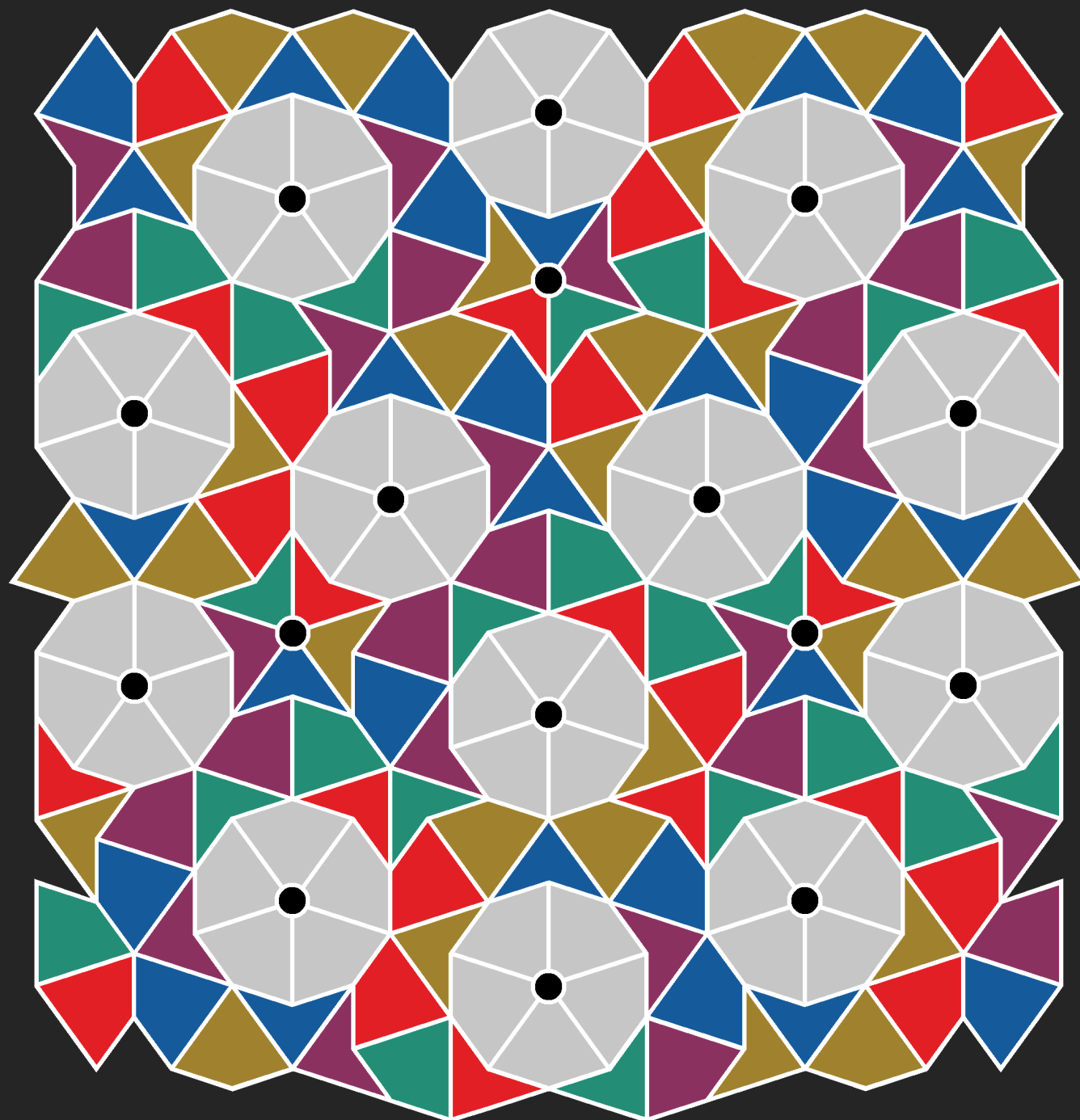


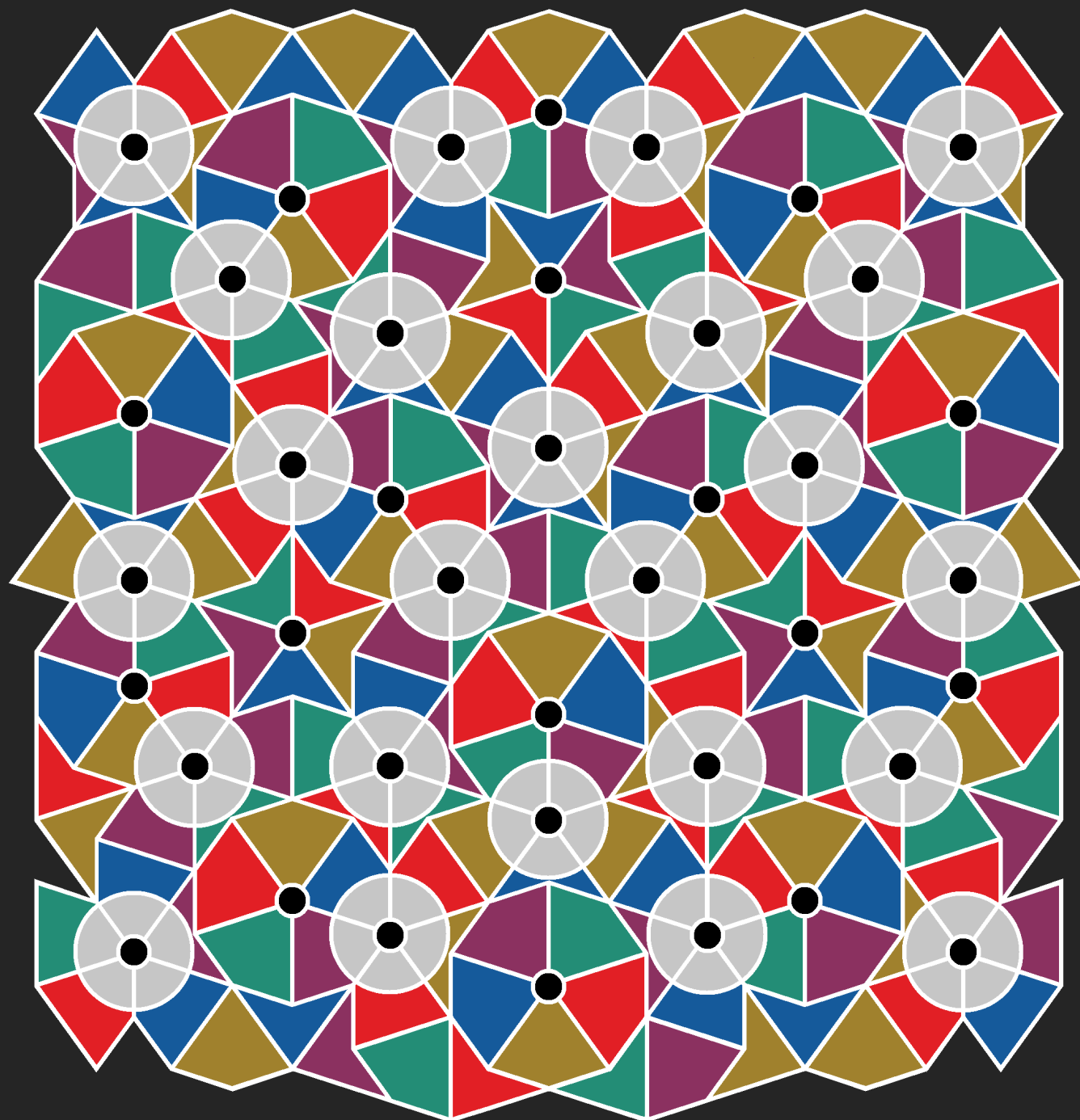


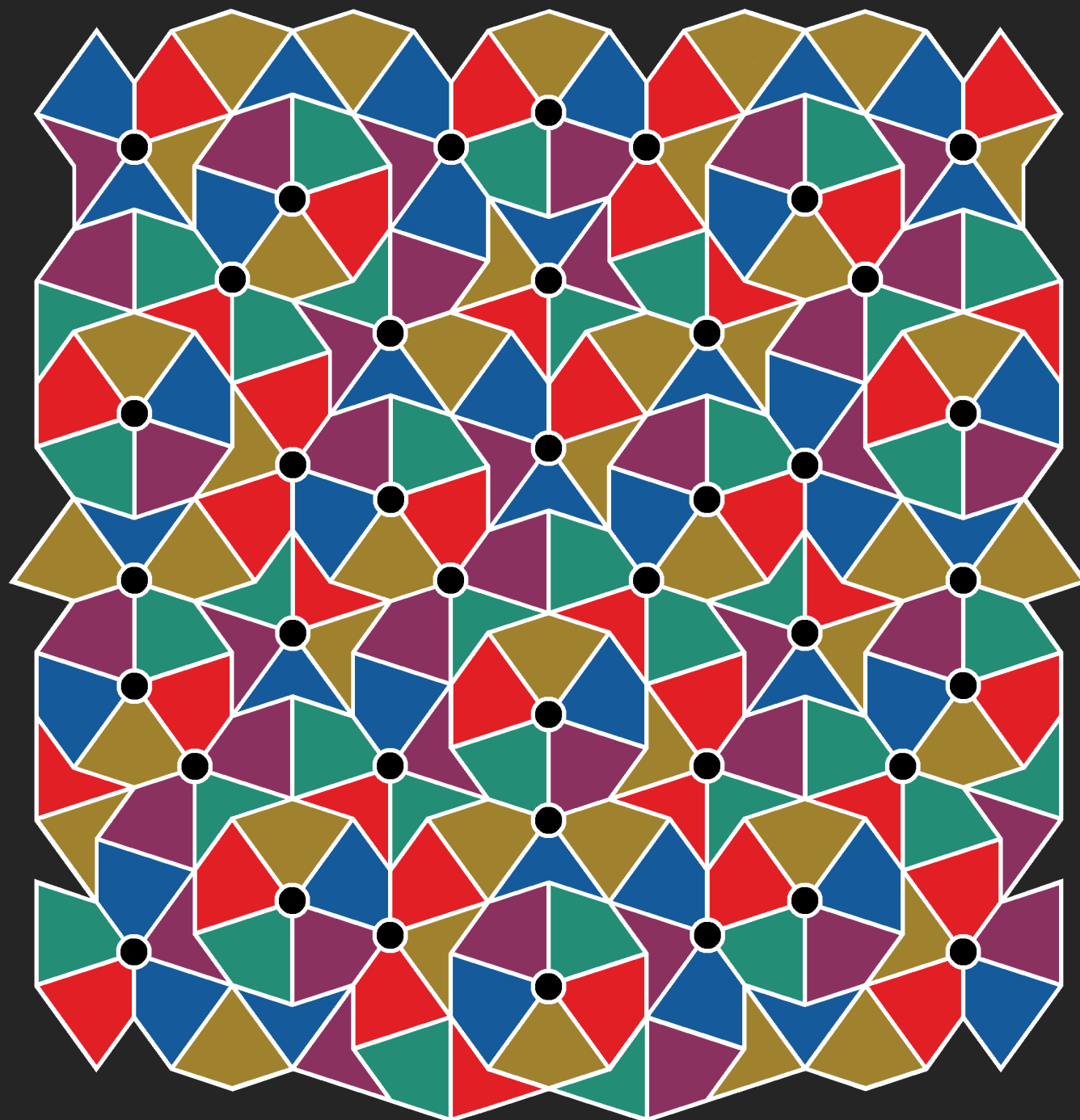


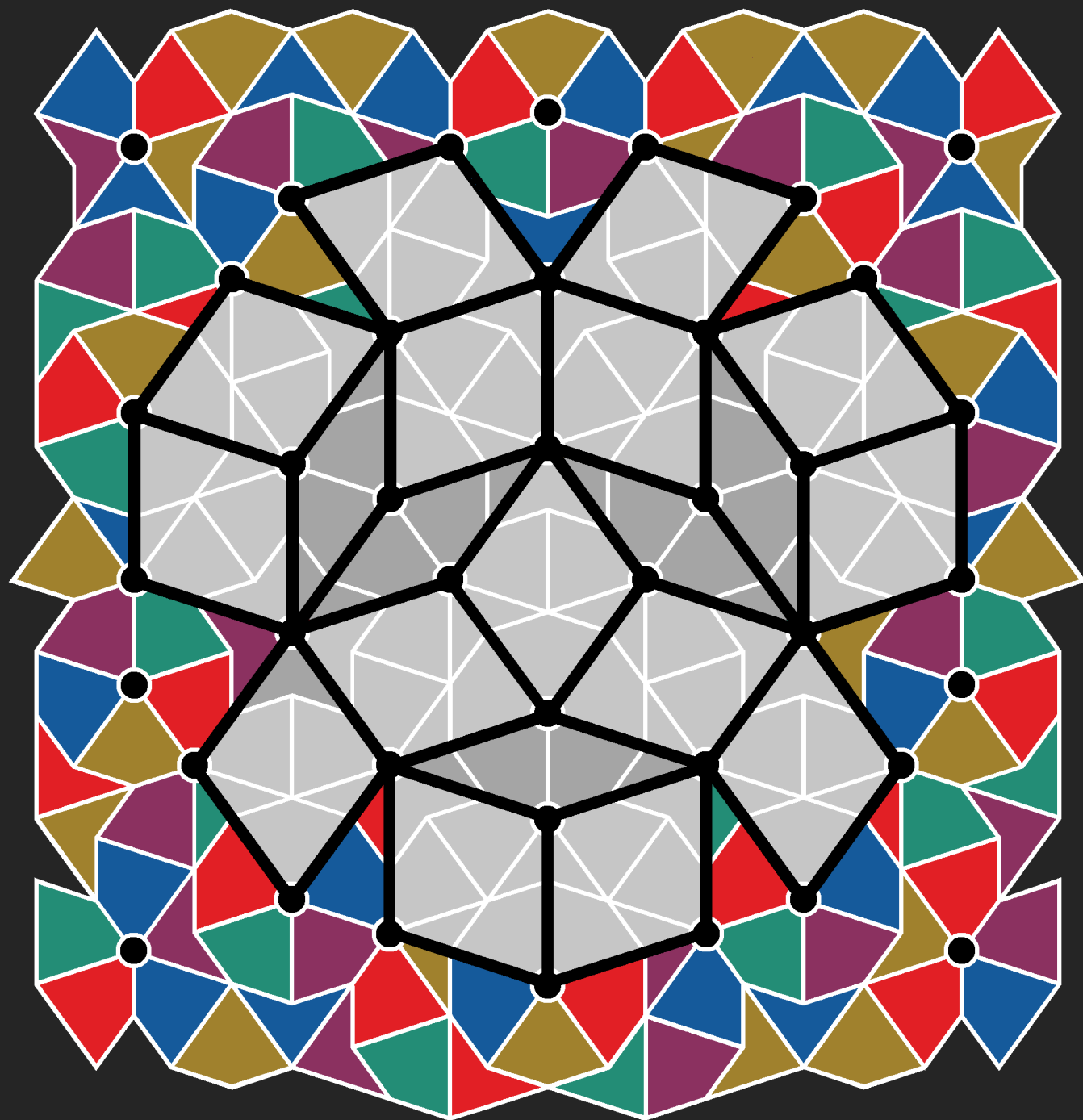


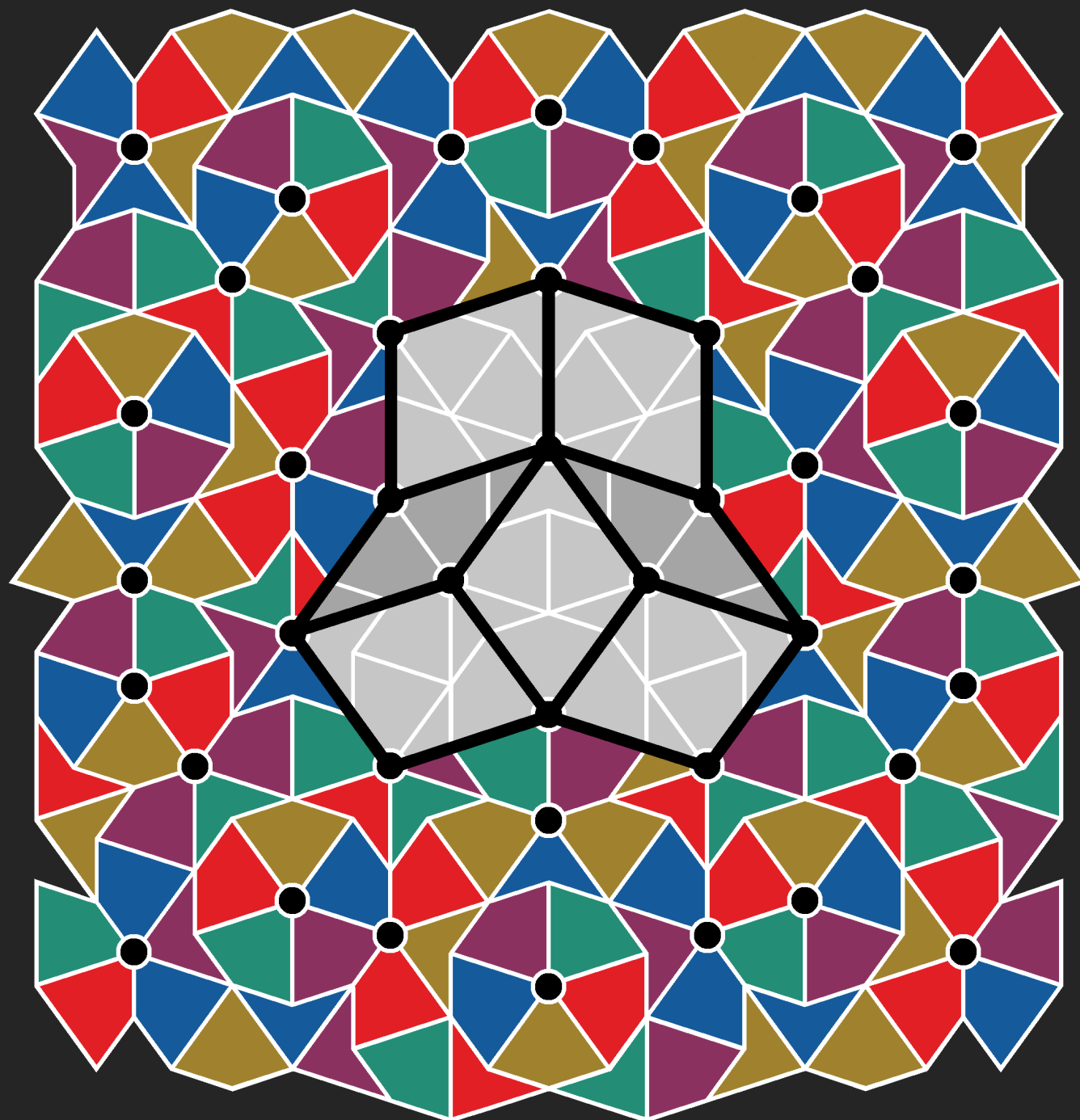


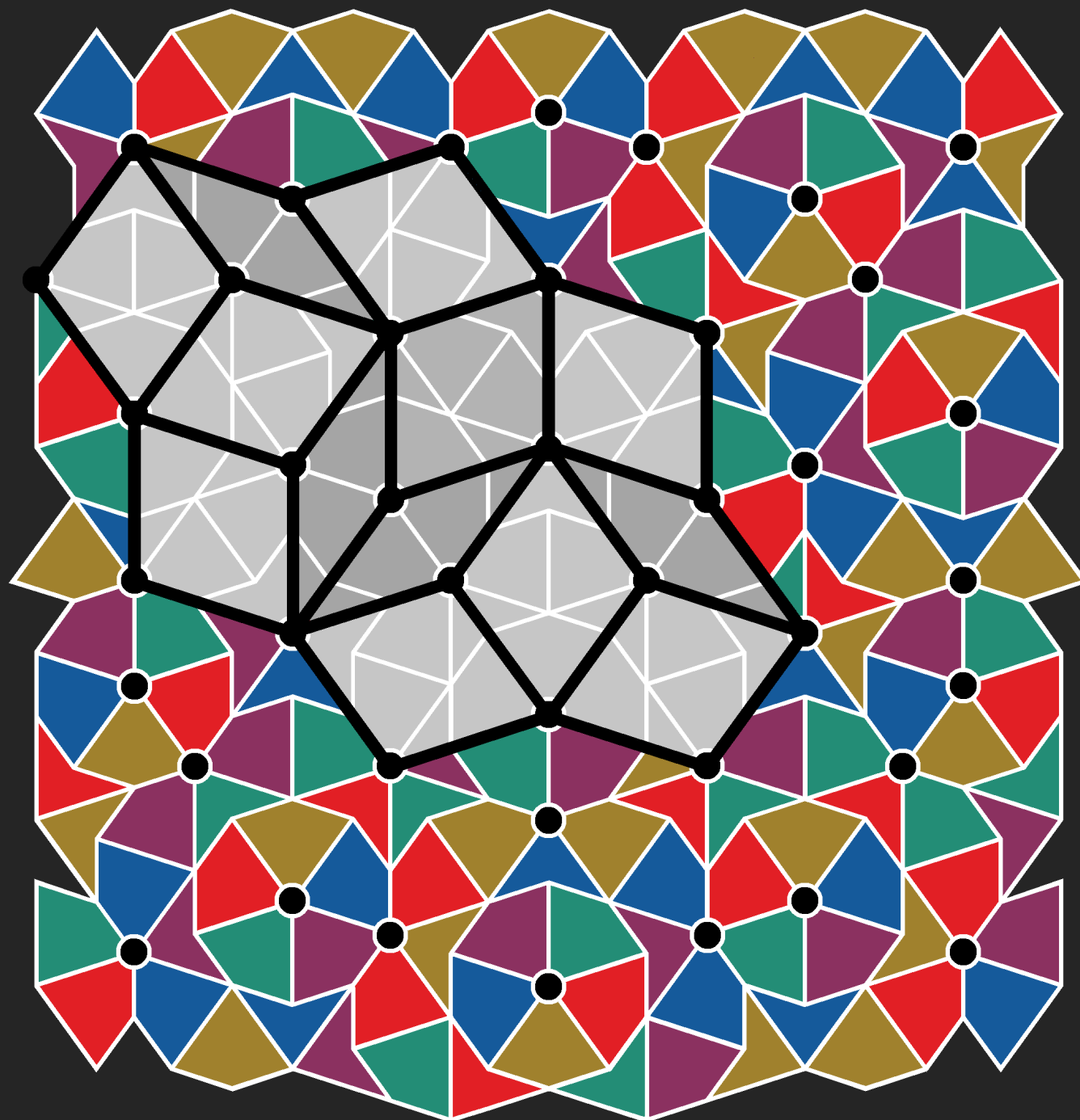


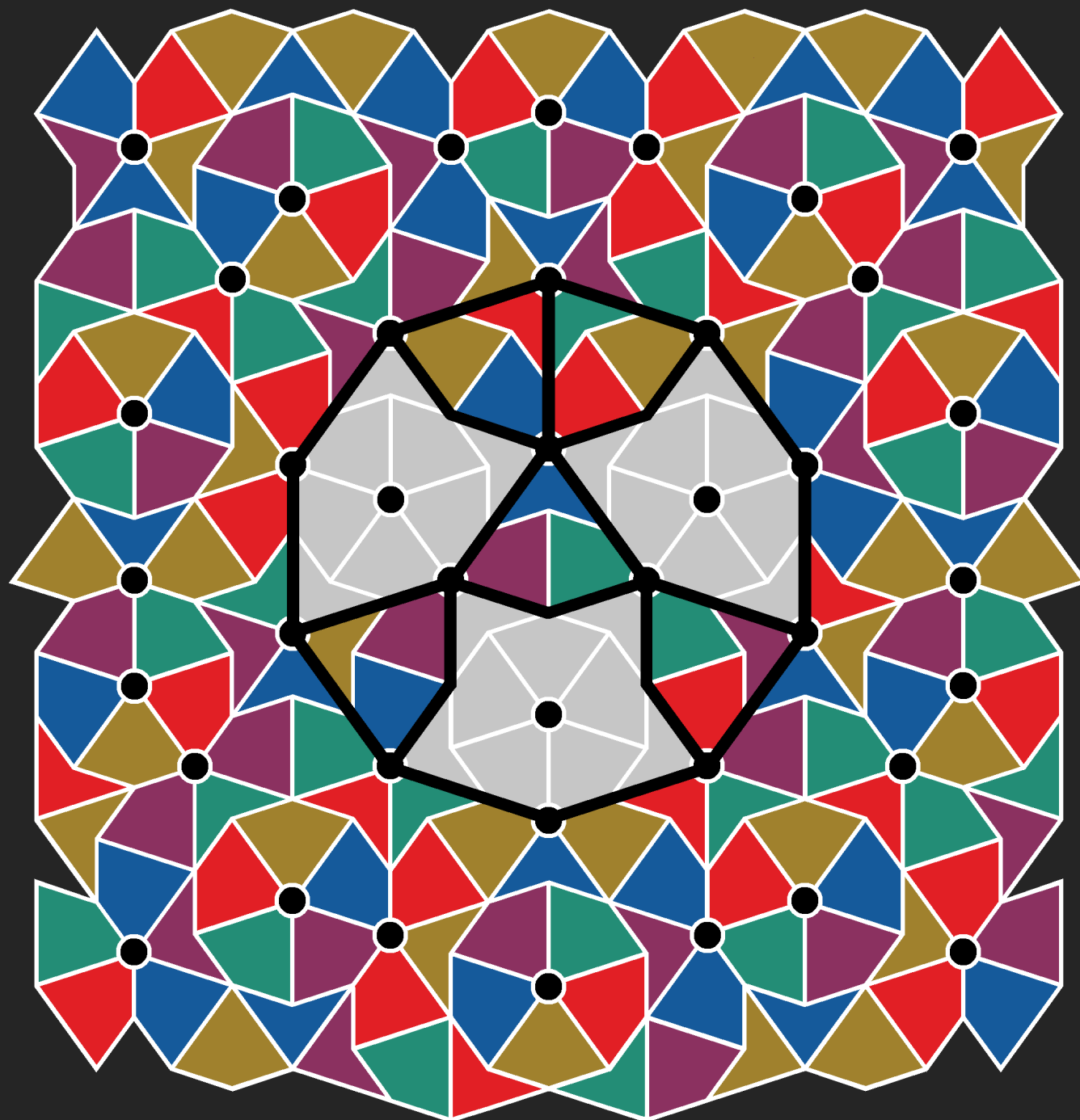


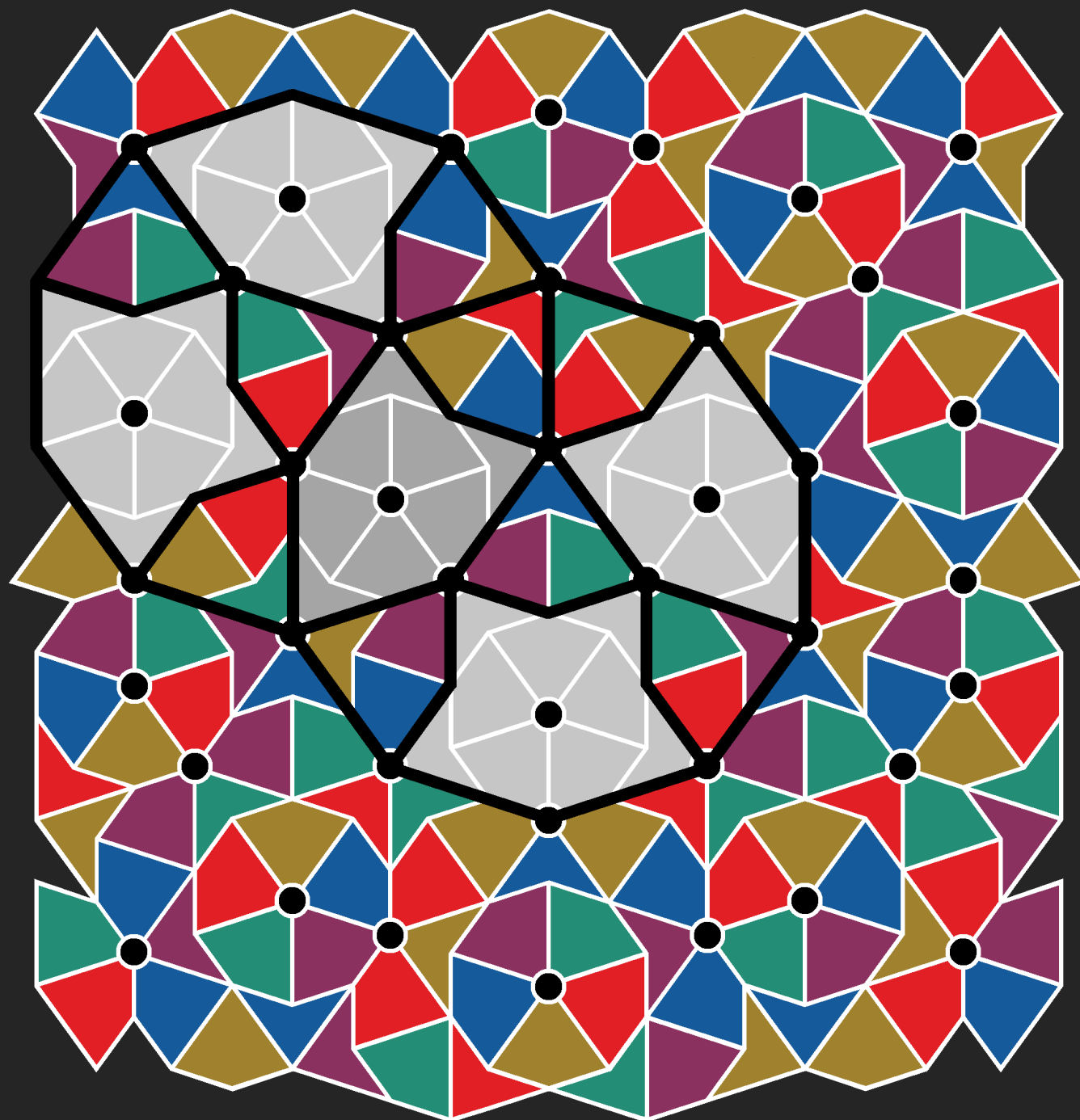


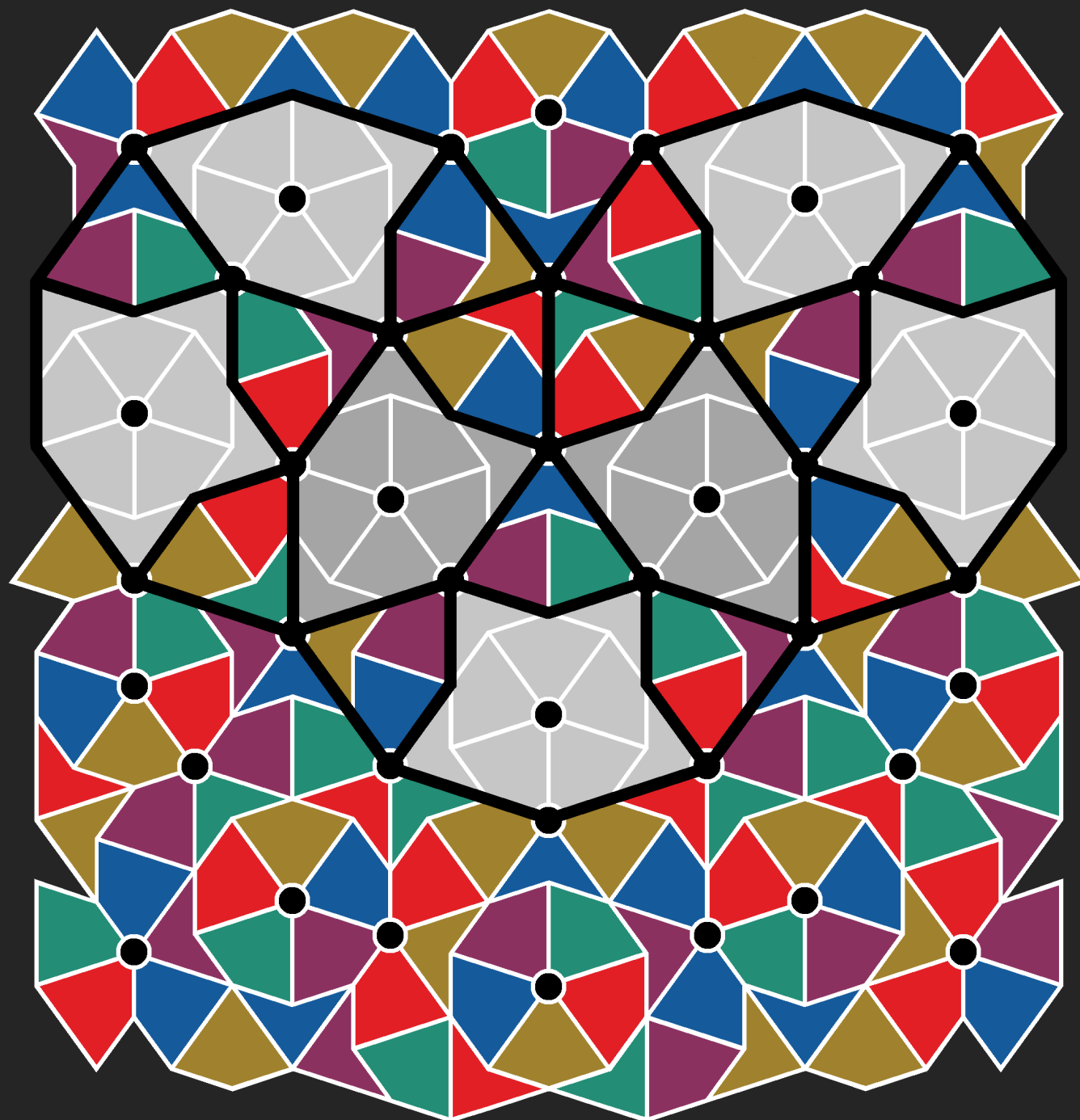


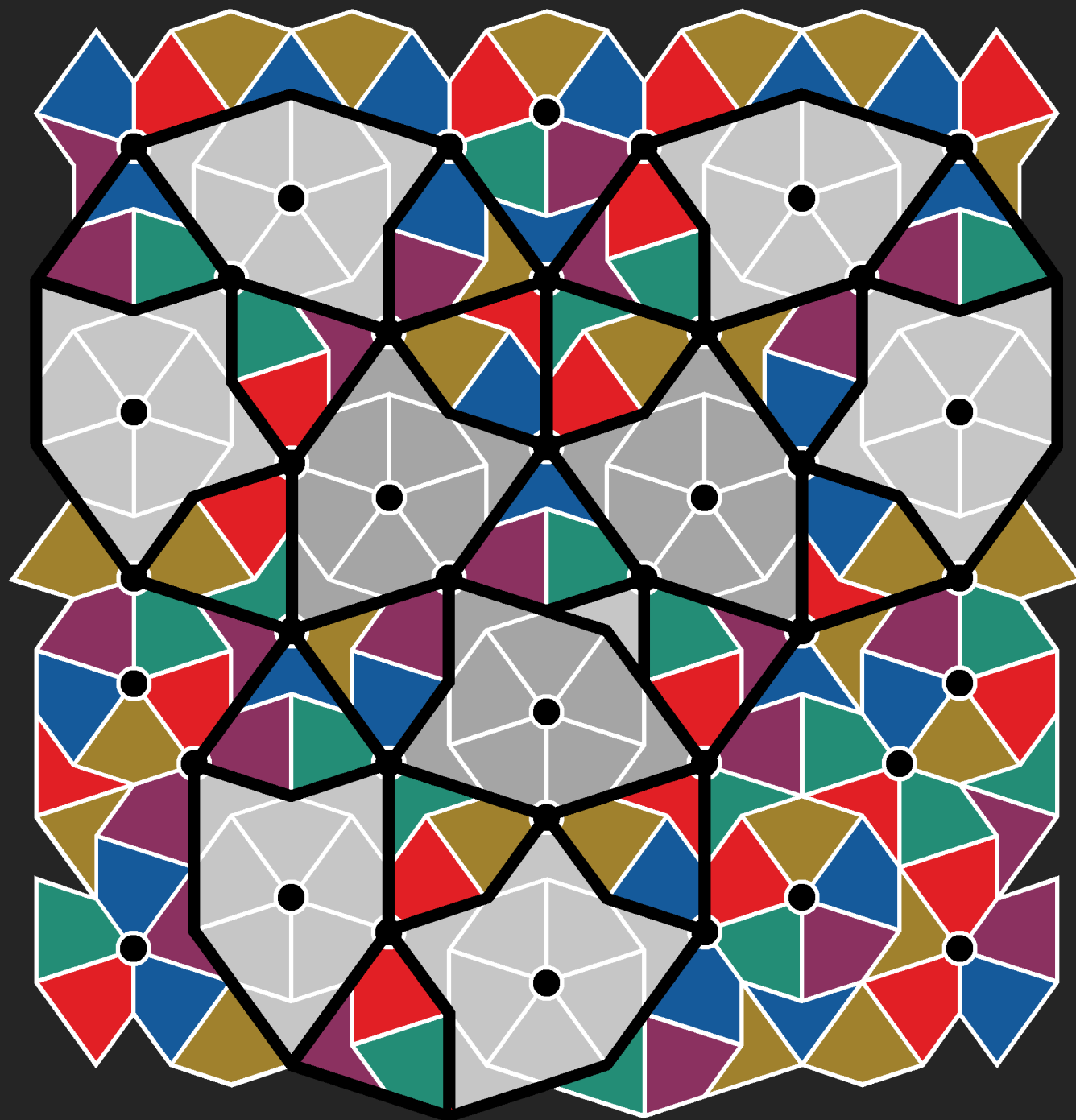


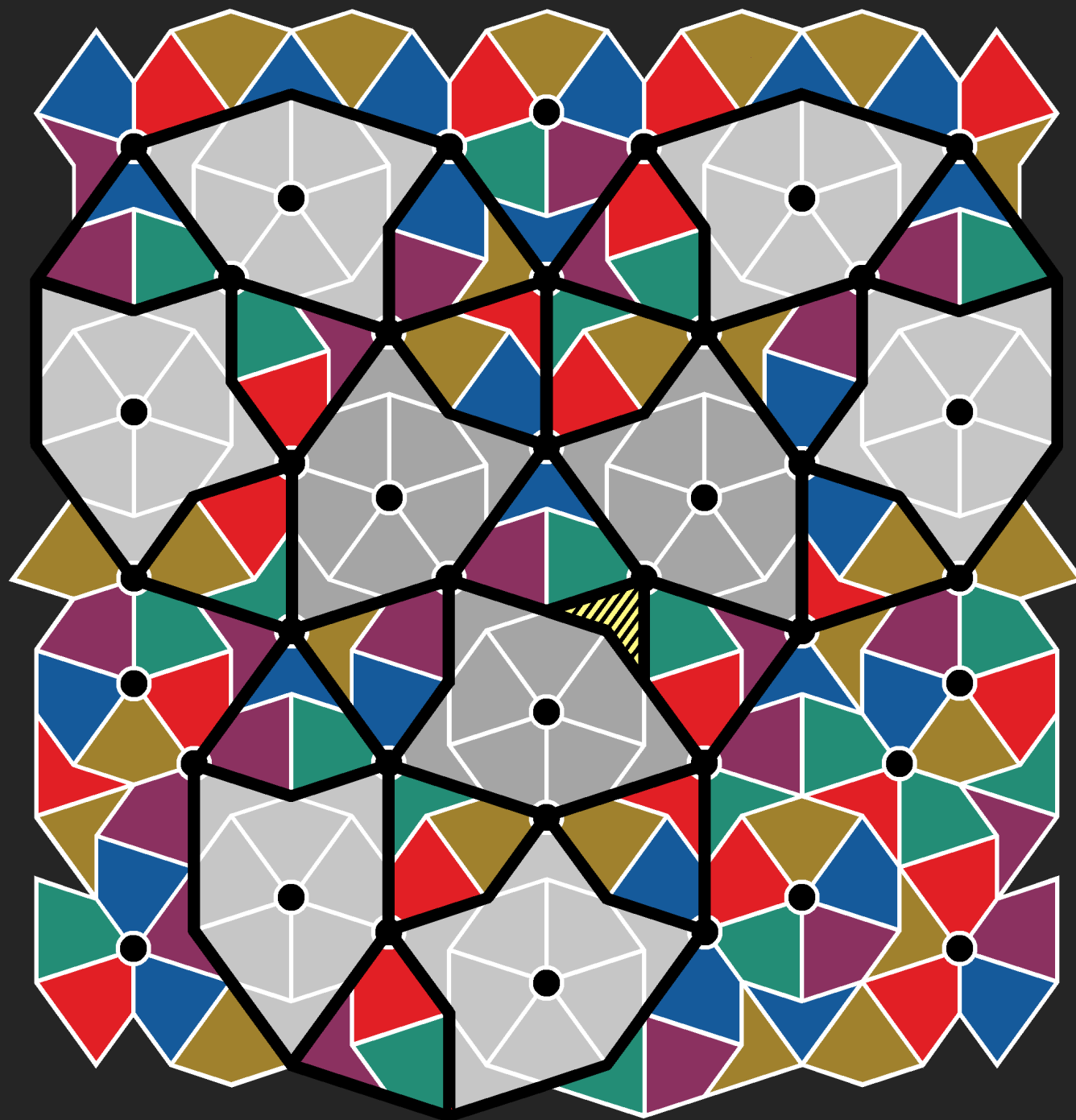


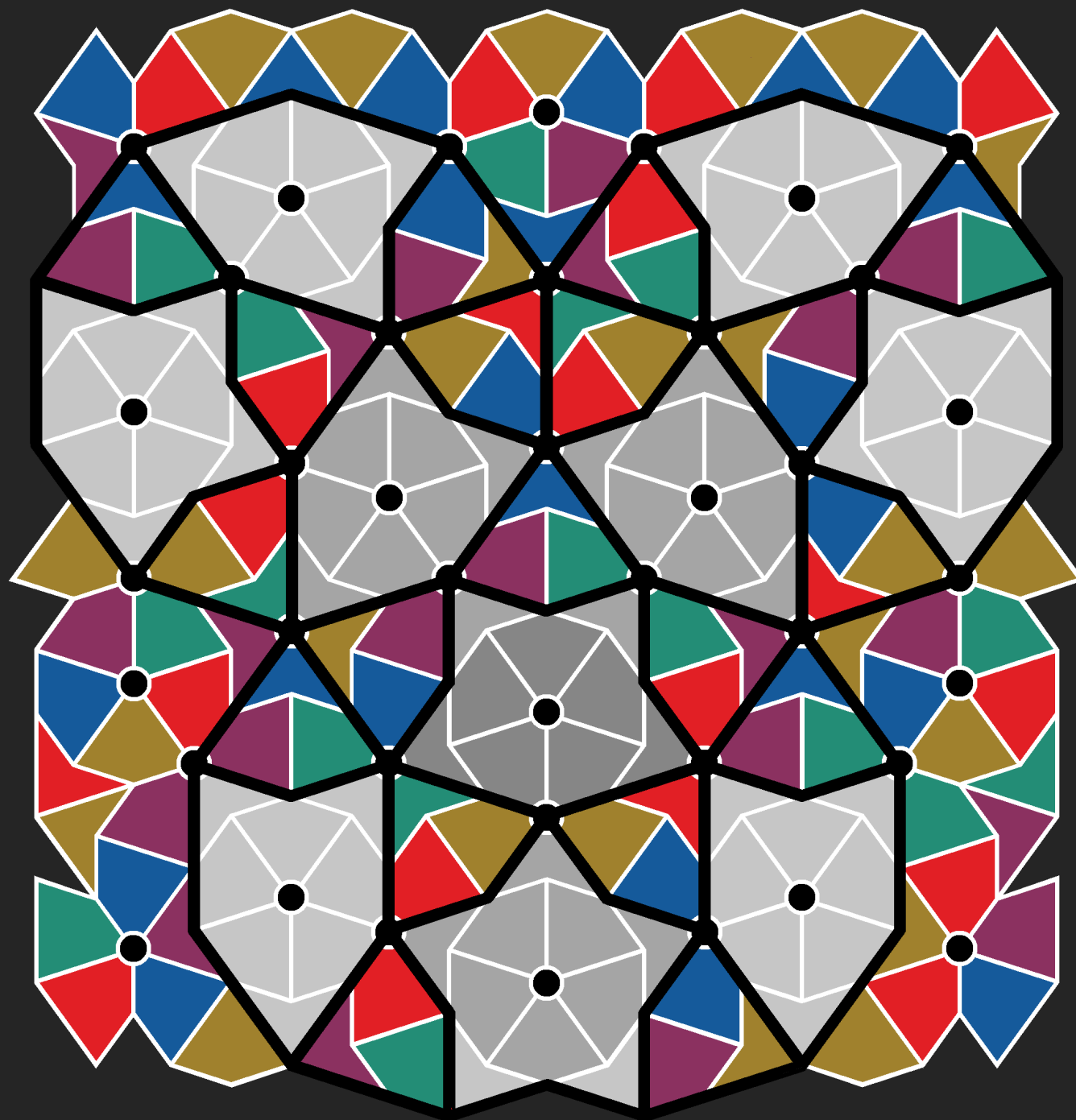


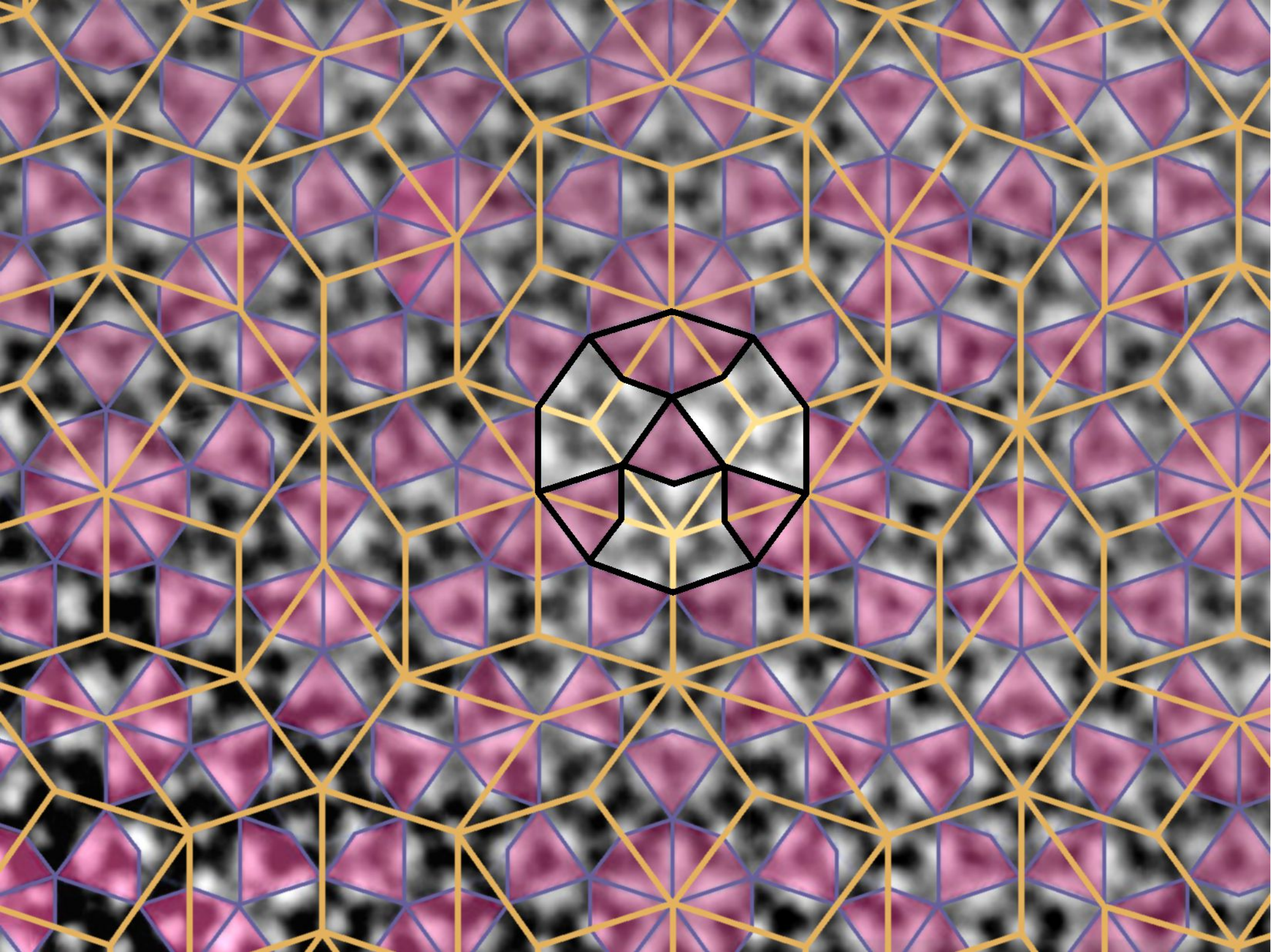


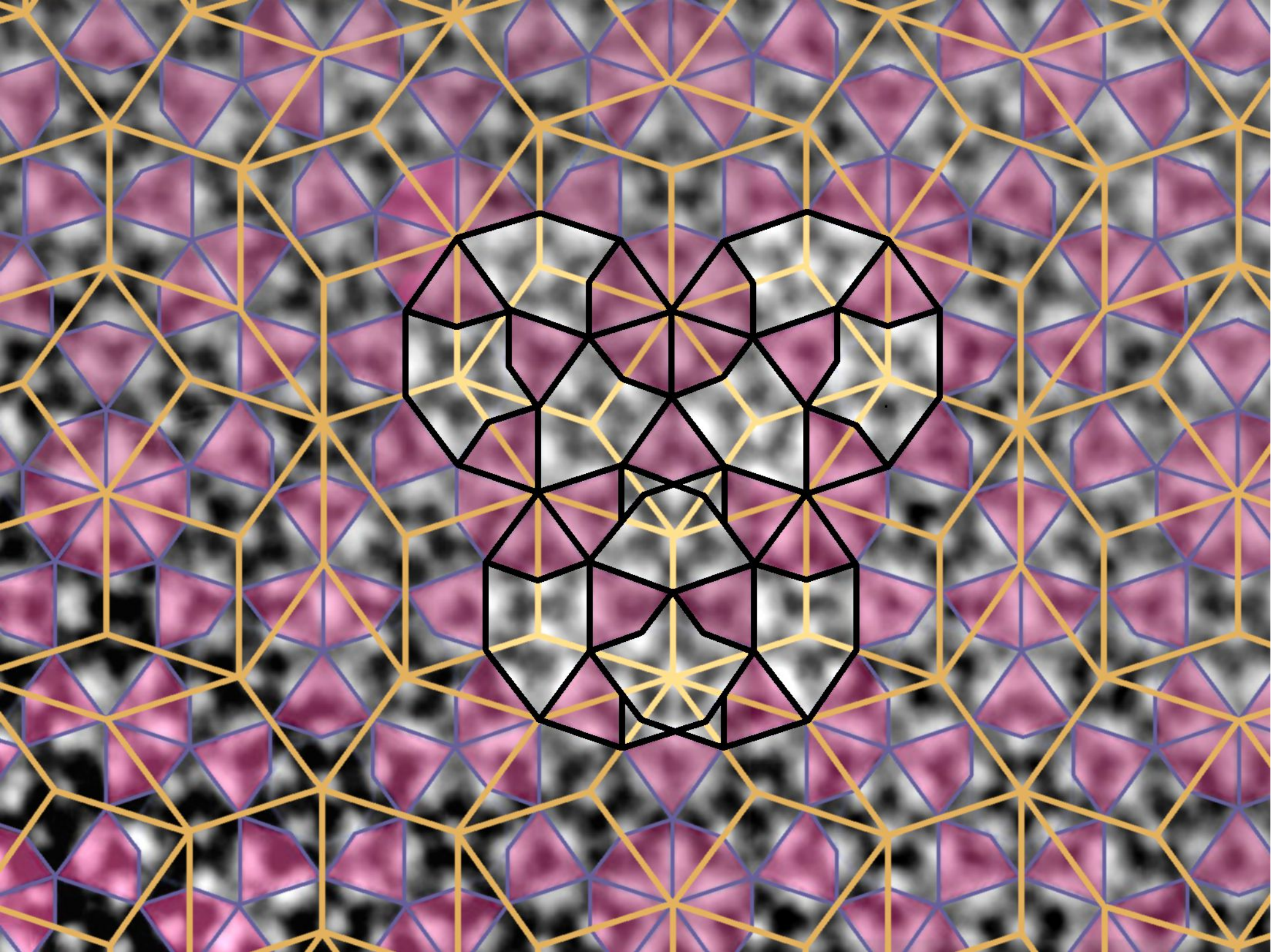


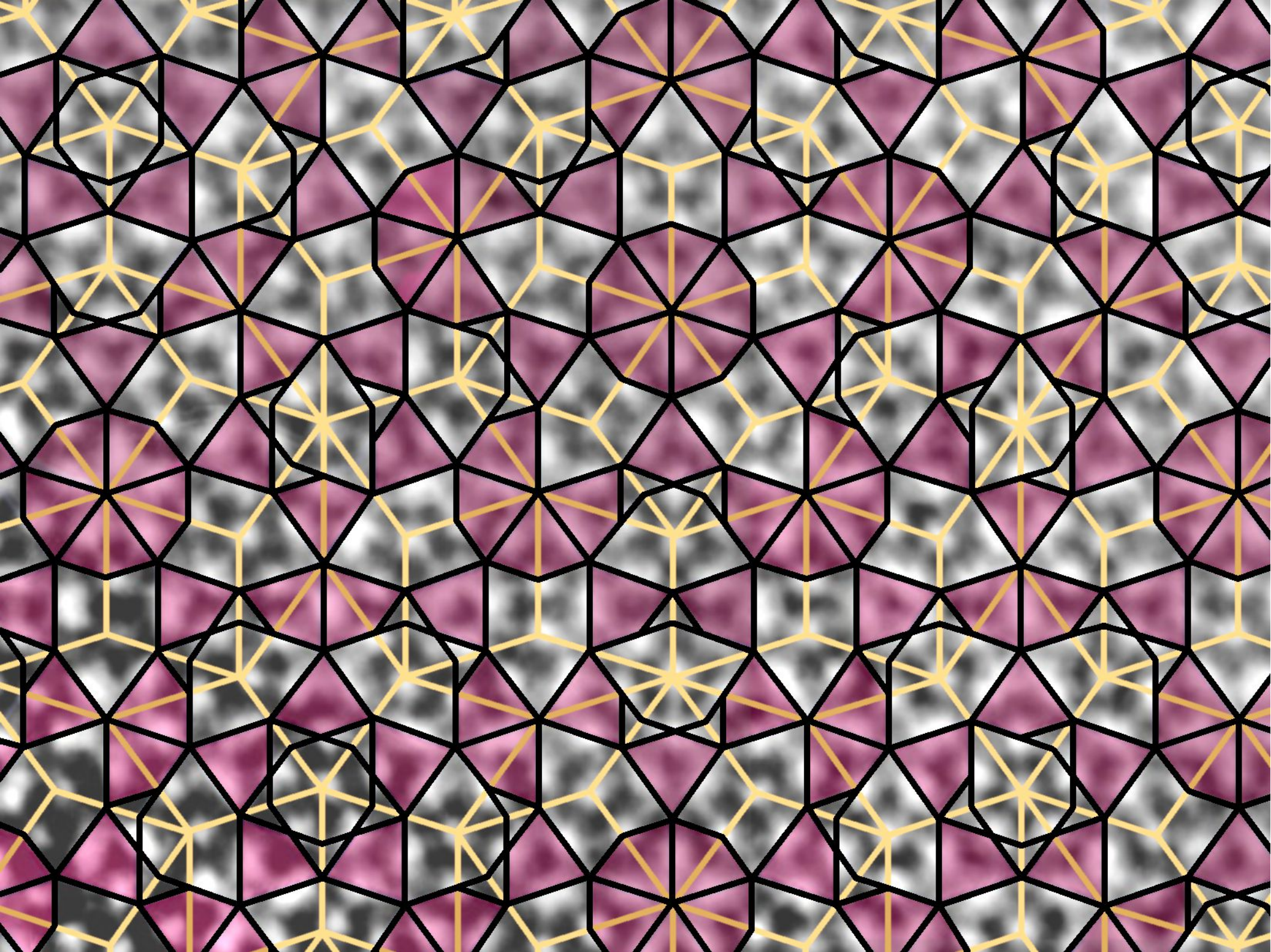


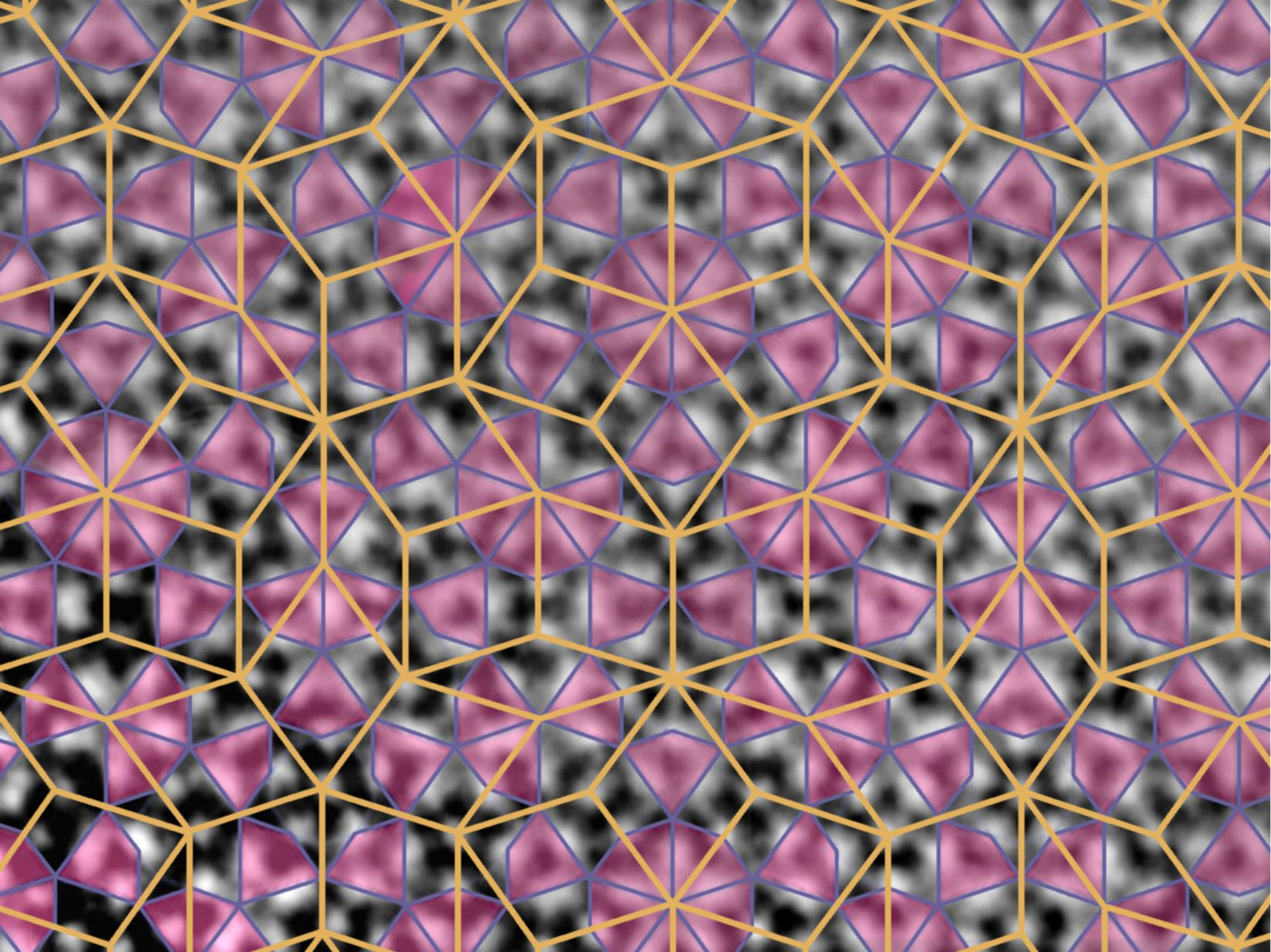


















36°

72°

72°







$a_{0...i\bar{1}} = 1 - d_{0...i}$	$\in a^{\text{def}}$
$b_{0...i\bar{1}} = e_{0...i}$	$\in b^{\text{def}}$
$c_{0...i\bar{1}} = 1 - a_{0...i}$	$\in c^{\text{def}}$
$d_{0...i\bar{1}} = \tau^{-1} - b_{0...i}$	$\in d^{\text{def}}$
$e_{0...i\bar{1}} = \tau^{-1} - c_{0...i}$	$\in e^{\text{def}}$

$$Q_{0...i} = T, Q_{0...ij} = T \vee F$$

$$i, j \in \{\bar{1}, \bar{4}, \bar{3}, \bar{2}, \bar{5}, 5, 4, 3, 2, 1\}$$

$a_{0...i1} = 1 - c_{0...i}$	$\in a^{\text{def}}$
$b_{0...i1} = \tau^{-1} - d_{0...i}$	$\in b^{\text{def}}$
$c_{0...i1} = \tau^{-1} - e_{0...i}$	$\in c^{\text{def}}$
$d_{0...i1} = 1 - a_{0...i}$	$\in d^{\text{def}}$
$e_{0...i1} = b_{0...i}$	$\in e^{\text{def}}$



$a_{0...i\bar{4}} = \tau^{-1} - b_{0...i}$	$\in a^{\text{def}}$
$b_{0...i\bar{4}} = -\tau^{-1} + c_{0...i}$	$\in b^{\text{def}}$
$c_{0...i\bar{4}} = 1 - d_{0...i}$	$\in c^{\text{def}}$
$d_{0...i\bar{4}} = e_{0...i}$	$\in d^{\text{def}}$
$e_{0...i\bar{4}} = 1 - a_{0...i}$	$\in e^{\text{def}}$

$a_{0...i2} = \tau^{-1} - e_{0...i}$	$\in a^{\text{def}}$
$b_{0...i2} = 1 - a_{0...i}$	$\in b^{\text{def}}$
$c_{0...i2} = b_{0...i}$	$\in c^{\text{def}}$
$d_{0...i2} = 1 - c_{0...i}$	$\in d^{\text{def}}$
$e_{0...i2} = -\tau^{-1} + d_{0...i}$	$\in e^{\text{def}}$



$a_{0...i\bar{3}} = \tau - c_{0...i}$	$\in a^{\text{def}}$
$b_{0...i\bar{3}} = 1 - d_{0...i}$	$\in b^{\text{def}}$
$c_{0...i\bar{3}} = 1 - e_{0...i}$	$\in c^{\text{def}}$
$d_{0...i\bar{3}} = \tau - a_{0...i}$	$\in d^{\text{def}}$
$e_{0...i\bar{3}} = b_{0...i}$	$\in e^{\text{def}}$

$a_{0...i3} = \tau - d_{0...i}$	$\in a^{\text{def}}$
$b_{0...i3} = e_{0...i}$	$\in b^{\text{def}}$
$c_{0...i3} = \tau - a_{0...i}$	$\in c^{\text{def}}$
$d_{0...i3} = 1 - b_{0...i}$	$\in d^{\text{def}}$
$e_{0...i3} = 1 - c_{0...i}$	$\in e^{\text{def}}$



$a_{0...i\bar{2}} = 1 - b_{0...i}$	$\in a^{\text{def}}$
$b_{0...i\bar{2}} = c_{0...i}$	$\in b^{\text{def}}$
$c_{0...i\bar{2}} = 1 - d_{0...i}$	$\in c^{\text{def}}$
$d_{0...i\bar{2}} = \tau^{-1} + e_{0...i}$	$\in d^{\text{def}}$
$e_{0...i\bar{2}} = \tau^{-1} - a_{0...i}$	$\in e^{\text{def}}$

$a_{0...i} =$	$\in a^{\text{def}}$
$b_{0...i} =$	$\in b^{\text{def}}$
$c_{0...i} =$	$\in c^{\text{def}}$
$d_{0...i} =$	$\in d^{\text{def}}$
$e_{0...i} =$	$\in e^{\text{def}}$

$a_{0...i4} = 1 - e_{0...i}$	$\in a^{\text{def}}$
$b_{0...i4} = \tau^{-1} - a_{0...i}$	$\in b^{\text{def}}$
$c_{0...i4} = \tau^{-1} + b_{0...i}$	$\in c^{\text{def}}$
$d_{0...i4} = 1 - c_{0...i}$	$\in d^{\text{def}}$
$e_{0...i4} = d_{0...i}$	$\in e^{\text{def}}$



$a_{0...i\bar{5}} = \tau^{-1} + e_{0...i}$	$\in a^{\text{def}}$
$b_{0...i\bar{5}} = -\tau^{-1} + a_{0...i}$	$\in b^{\text{def}}$
$c_{0...i\bar{5}} = 1 - b_{0...i}$	$\in c^{\text{def}}$
$d_{0...i\bar{5}} = c_{0...i}$	$\in d^{\text{def}}$
$e_{0...i\bar{5}} = 1 - d_{0...i}$	$\in e^{\text{def}}$

$$0 < a^{\text{def}}(c^{\text{def}}, d^{\text{def}}) < 1$$

$$0 < b^{\text{def}}(e^{\text{def}}) < \tau^{-1}$$

$$\tau = 1,618... , \tau^{-1} = 0,618...$$

$a_{0...i5} = \tau^{-1} + b_{0...i}$	$\in a^{\text{def}}$
$b_{0...i5} = 1 - c_{0...i}$	$\in b^{\text{def}}$
$c_{0...i5} = d_{0...i}$	$\in c^{\text{def}}$
$d_{0...i5} = 1 - e_{0...i}$	$\in d^{\text{def}}$
$e_{0...i5} = -\tau^{-1} + a_{0...i}$	$\in e^{\text{def}}$



The background of the slide is a vibrant, abstract sculpture. It features a central, light blue, textured, dome-like structure with a grid-like pattern. From this central point, several long, yellow, ribbed tubes extend outwards, some curving and others straight. These tubes are decorated with red and orange bands. The entire sculpture is set against a background of red, branching, coral-like structures and a blue sky with soft, white clouds. The overall aesthetic is one of mathematical complexity and organic form.

Vielen Dank für Ihre Aufmerksamkeit!

Die Folien für diesen Vortrag wurden für die Ausstellung "IMAGINARY - Form und Formel mathematischer Fantasie" von Uli Gaenshirt erstellt.

Ausführliche Informationen und Dokumente zu dieser Ausstellung, die im Juni 2016 erstmals in Nürnberg gezeigt wurde, finden Sie unter imaginary.org/events#222.

Die Ausstellung, die für April 2020 im Sigena Gymnasium in Nürnberg angekündigt war (imaginary.org/events#397), musste wegen dem Covid 19 Lockdown leider ausfallen.