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Weaving Mathematics

MA. LOUISE ANTONETTE N. DE LAS PEÑAS, PHD
DEPARTMENT OF MATHEMATICS
ATENEO DE MANILA UNIVERSITY

Weaving Mathematics

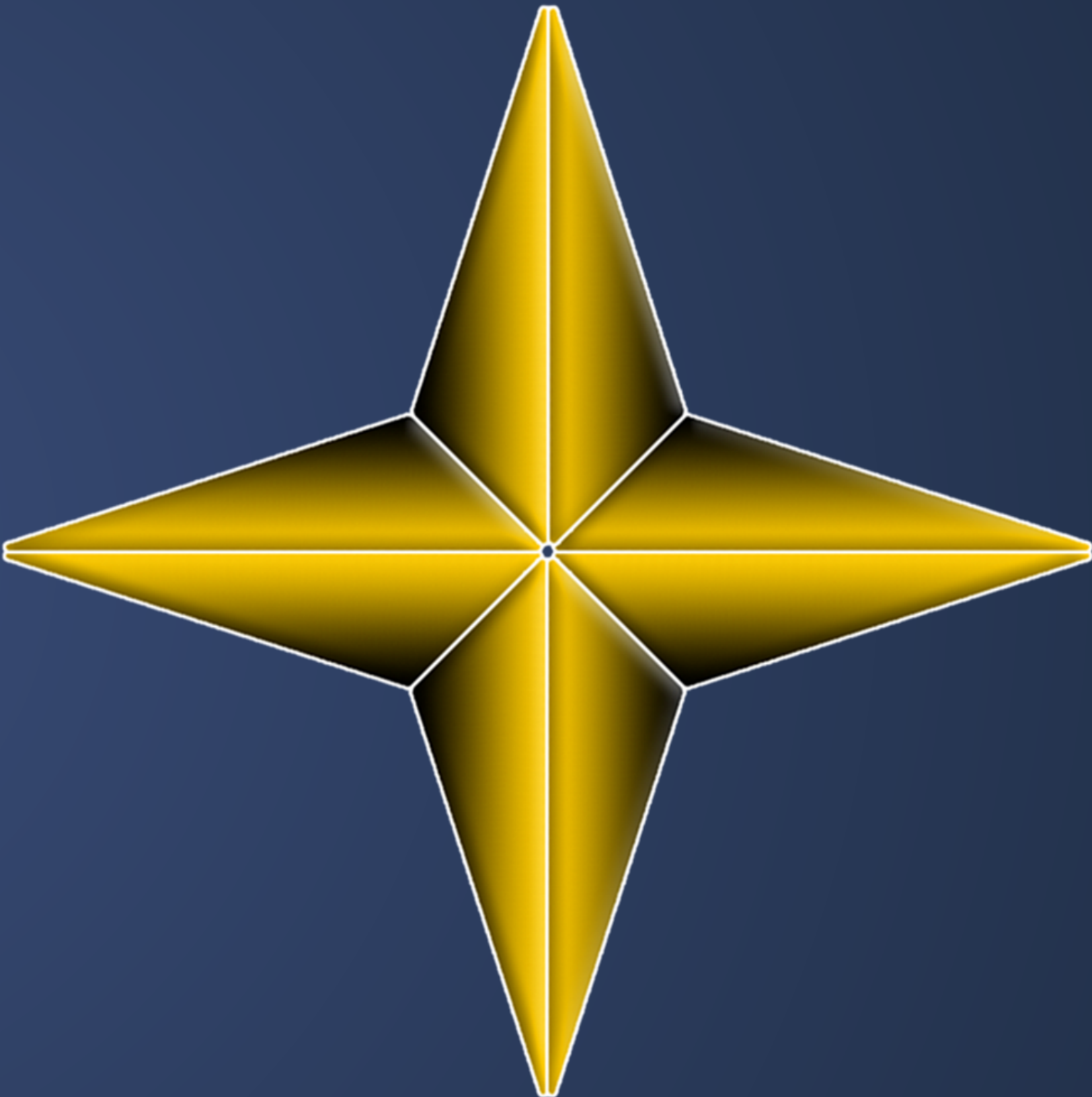
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BED KEKEM



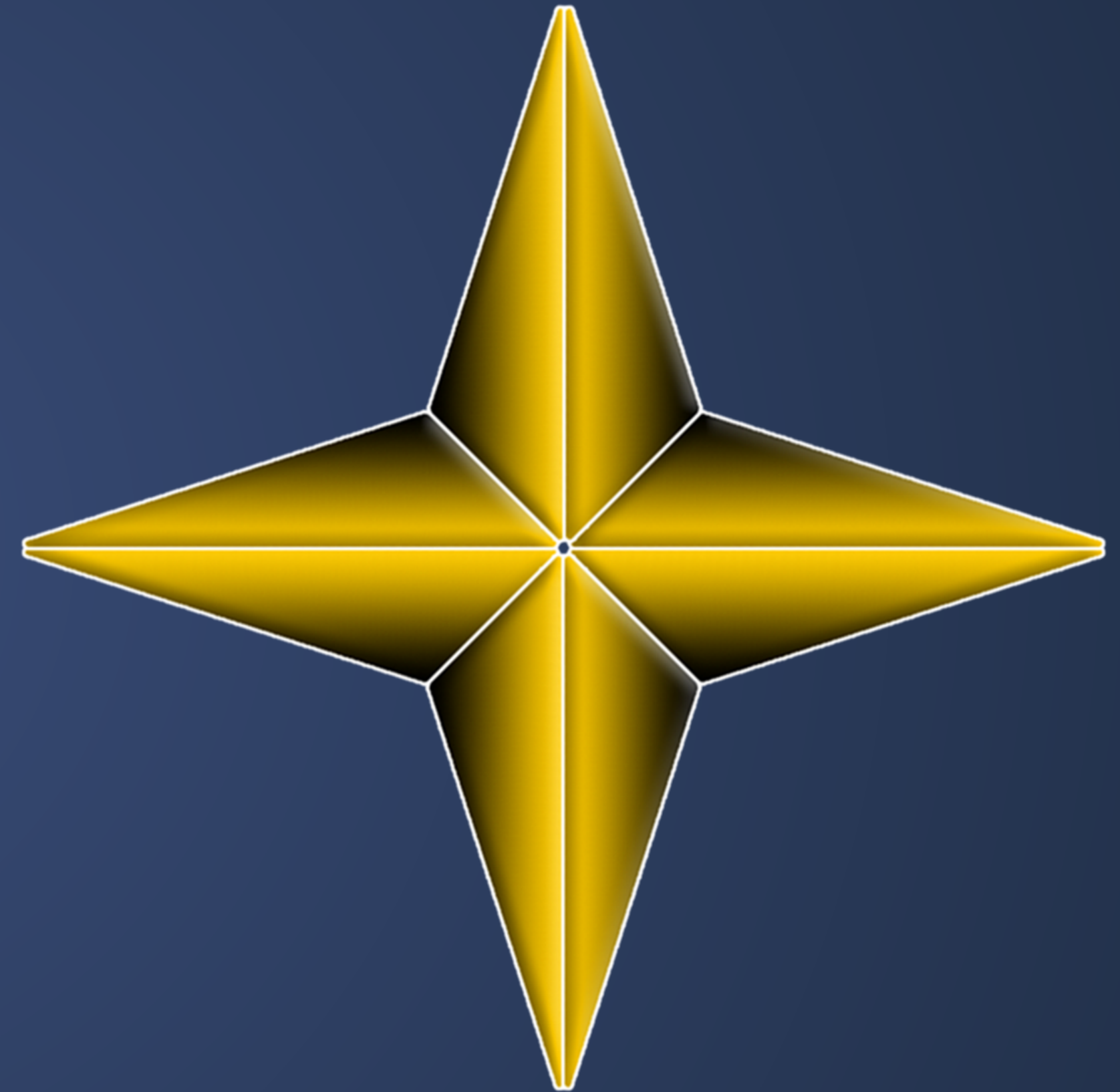
Image from Paterno et al (2001)

SYMMETRY



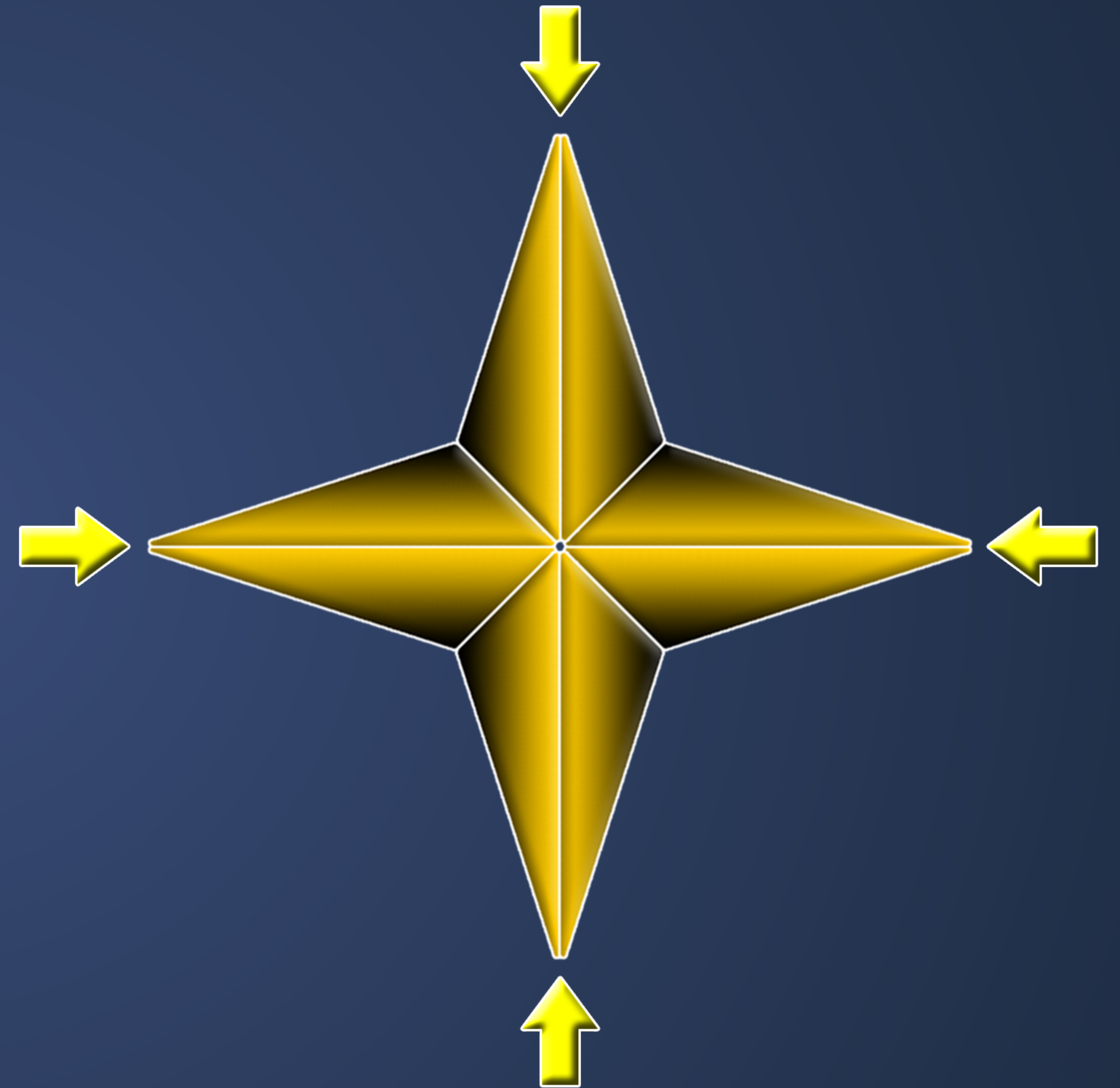
SYMMETRY

This star is symmetric.



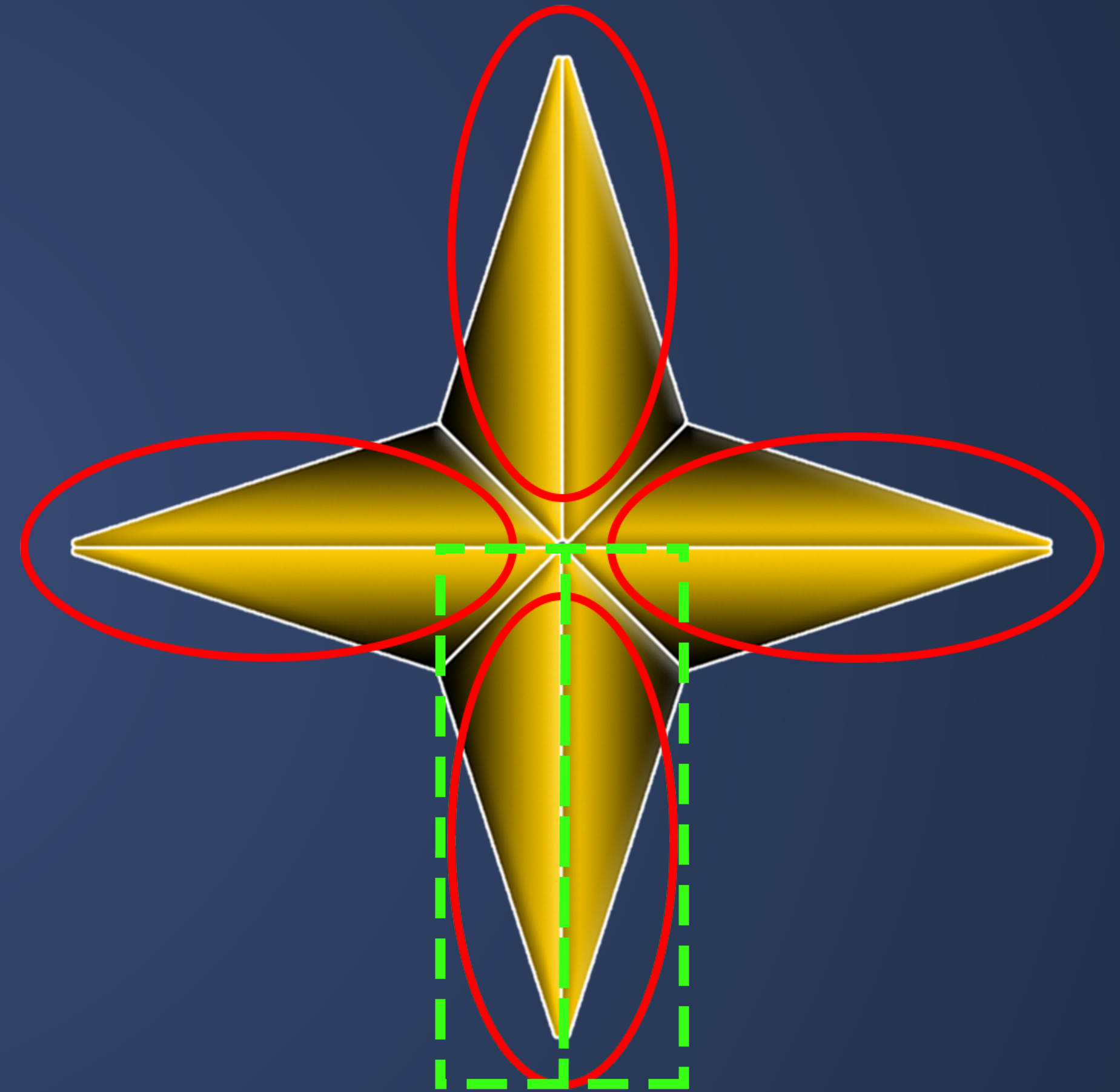
SYMMETRY: THIS STAR IS SYMMETRIC

It looks the same from
different positions.



SYMMETRY: THIS STAR IS SYMMETRIC

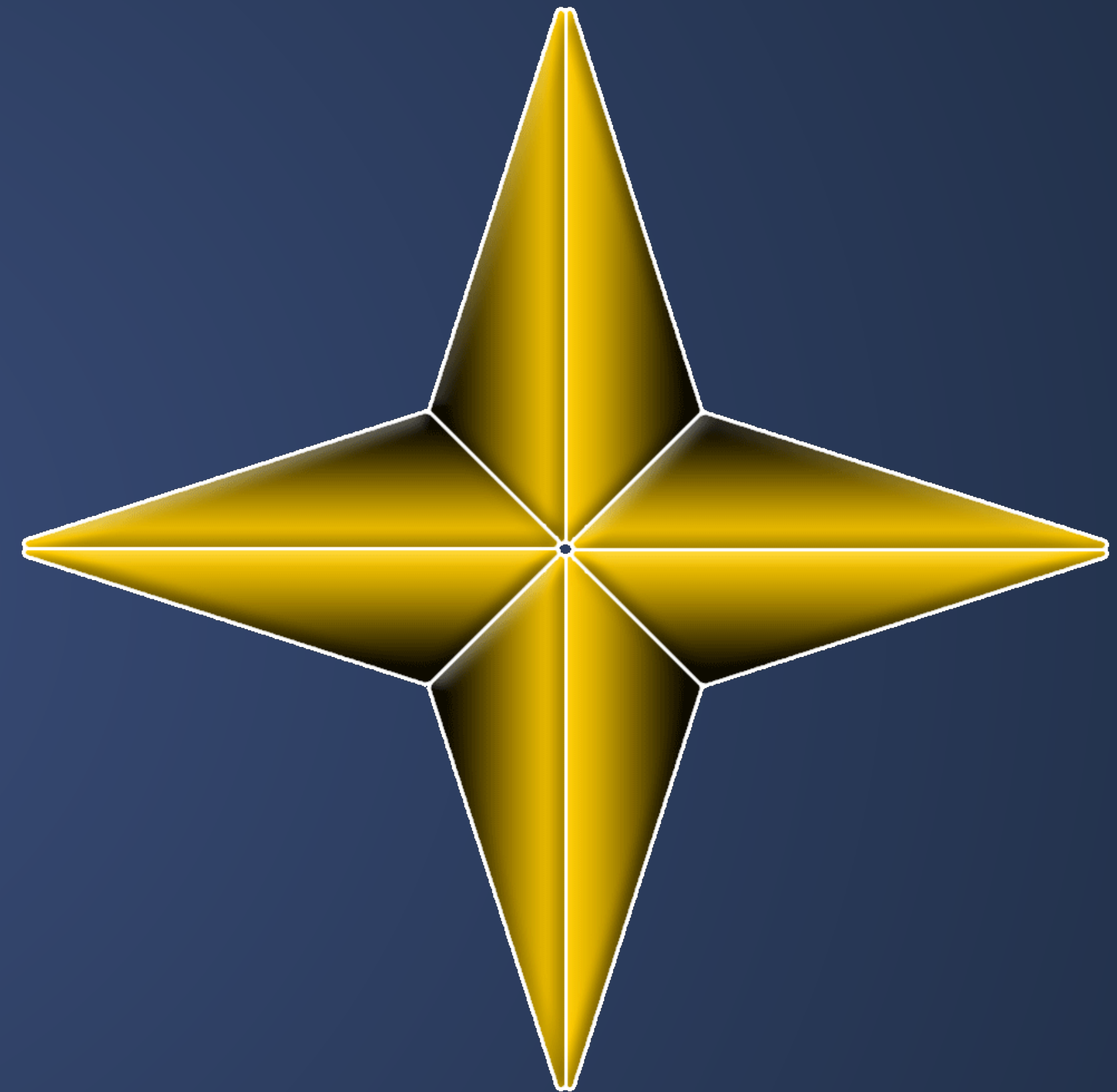
- It looks the same from different positions.
- Some of its parts are repeated.



SYMMETRY: THIS STAR IS SYMMETRIC

- It looks the same from different positions.
- Some of its parts are repeated.

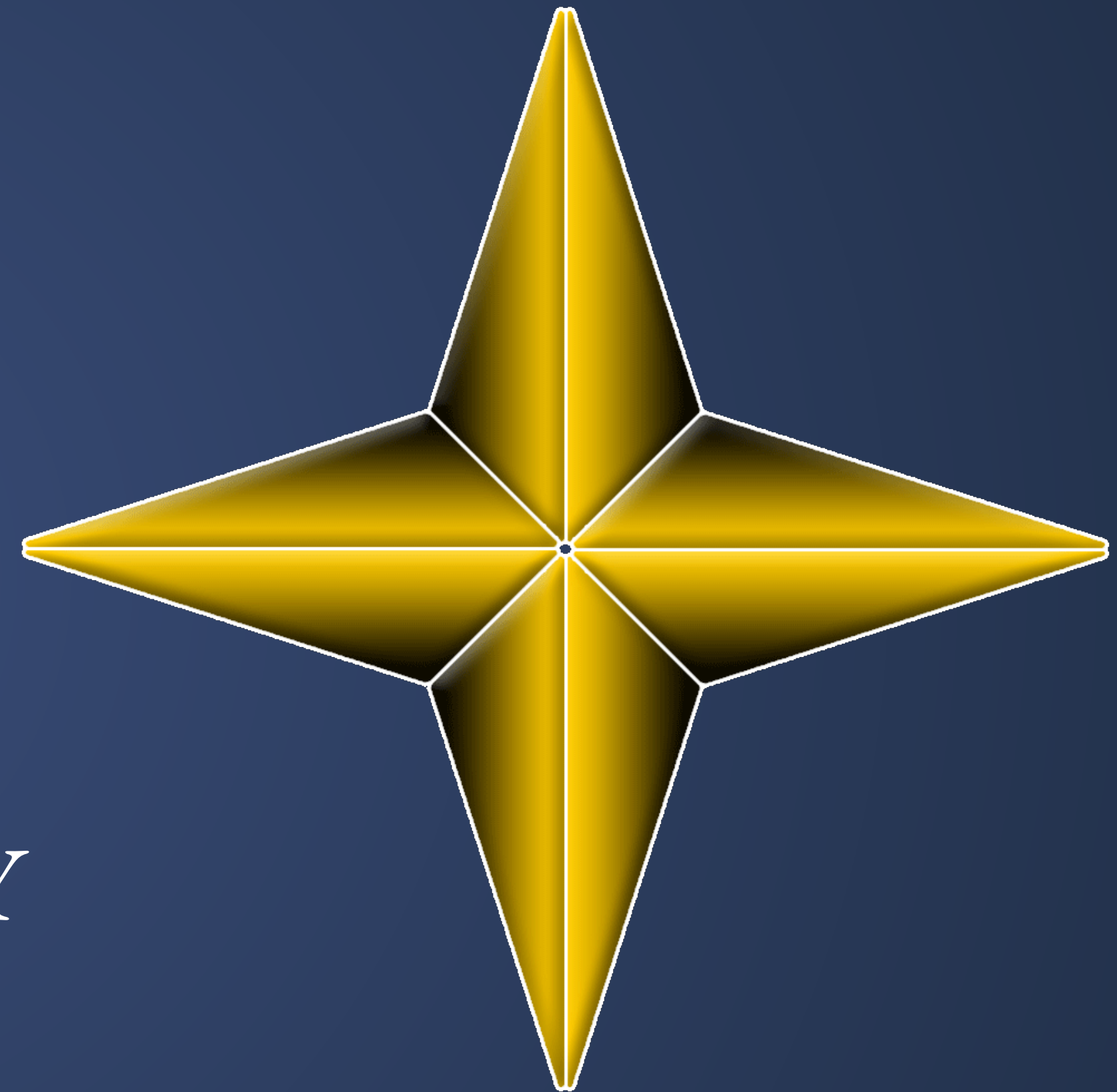
Rotating the star 90° clockwise sends the star to itself.



SYMMETRY: THIS STAR IS SYMMETRIC

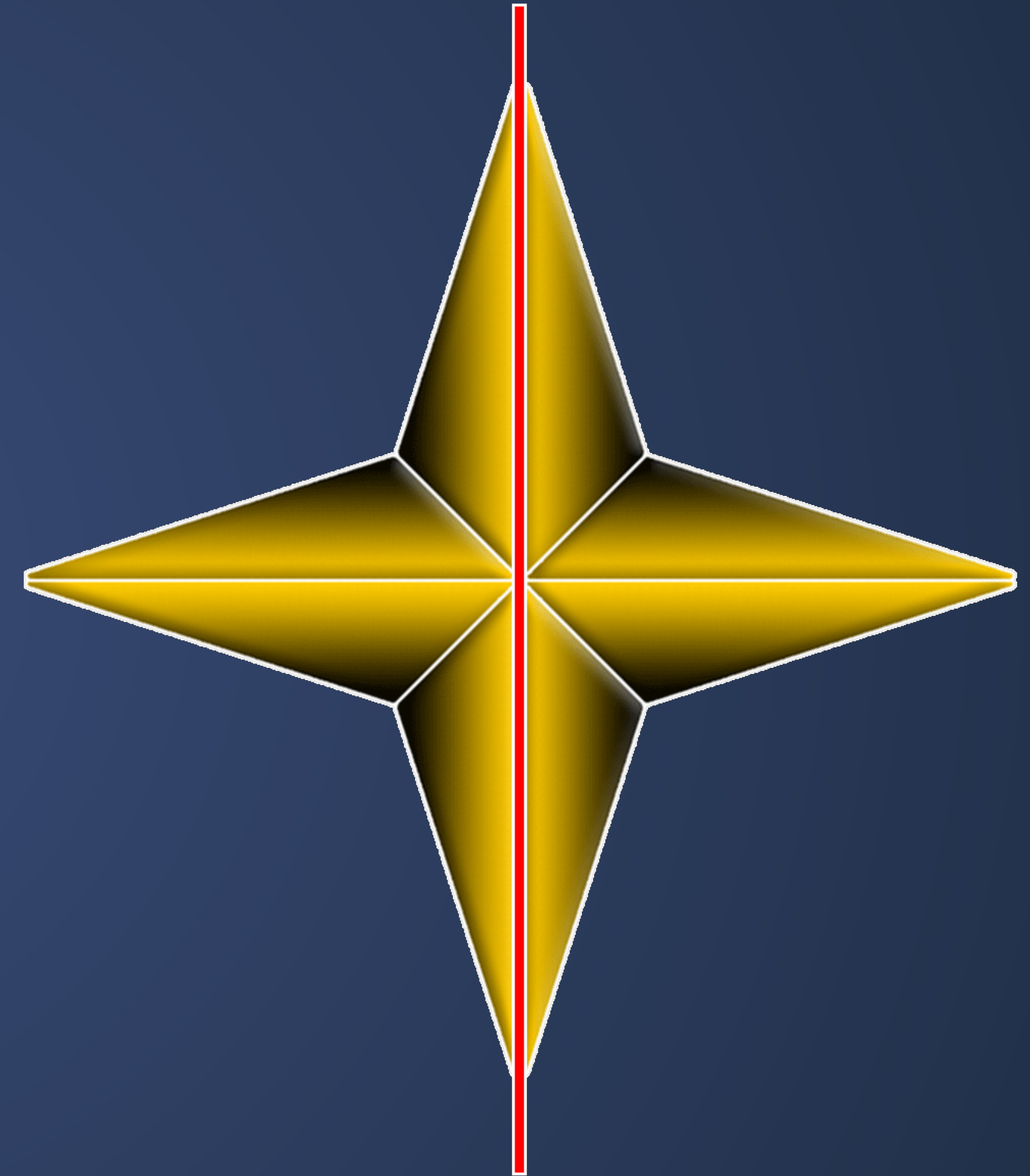
- It looks the same from different positions.
- Some of its parts are repeated.

The 90° rotation is called a *SYMMETRY* of the star.



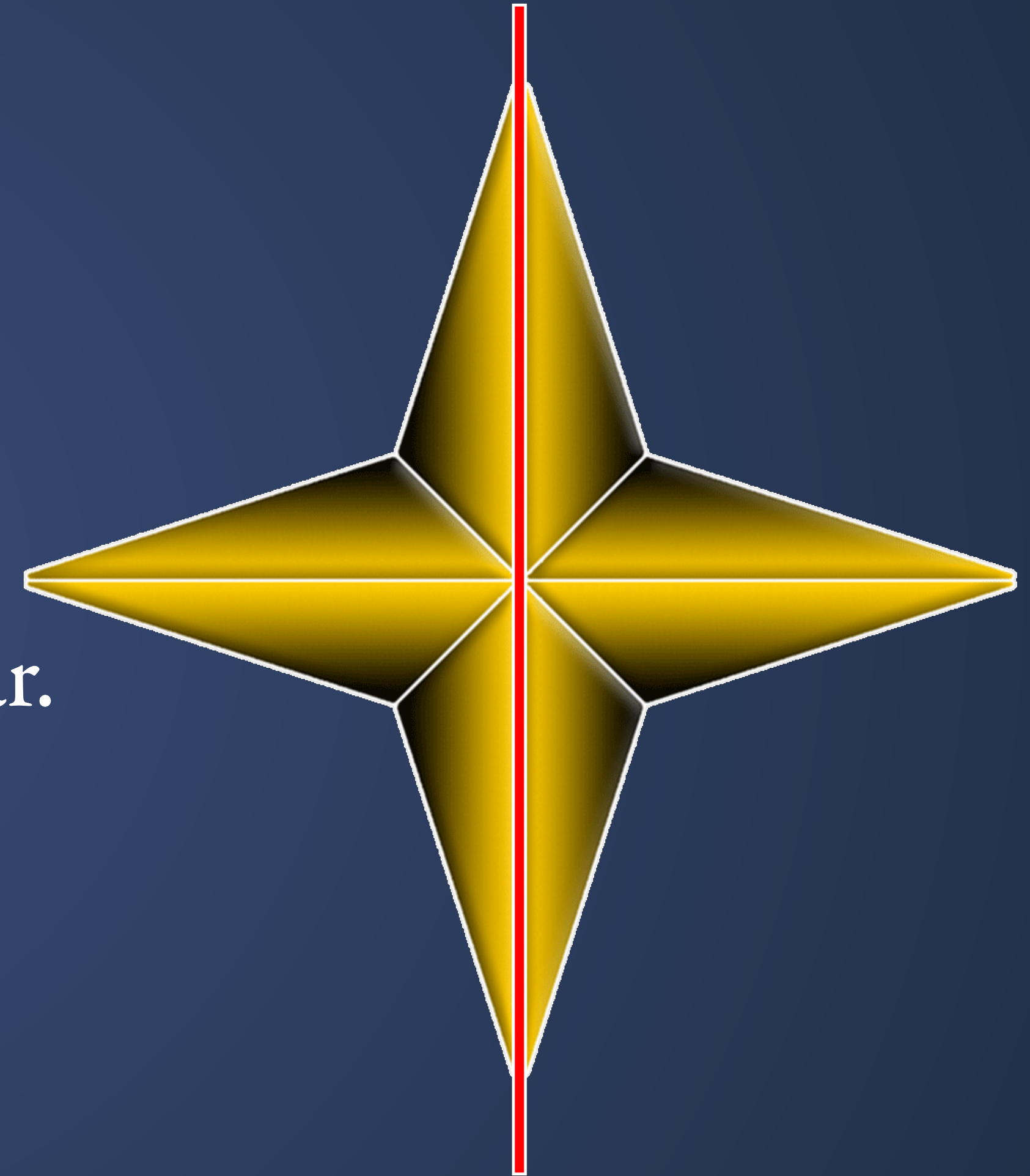
SYMMETRY: THIS STAR IS SYMMETRIC

Reflecting the star about the vertical axis
sends the star to itself.



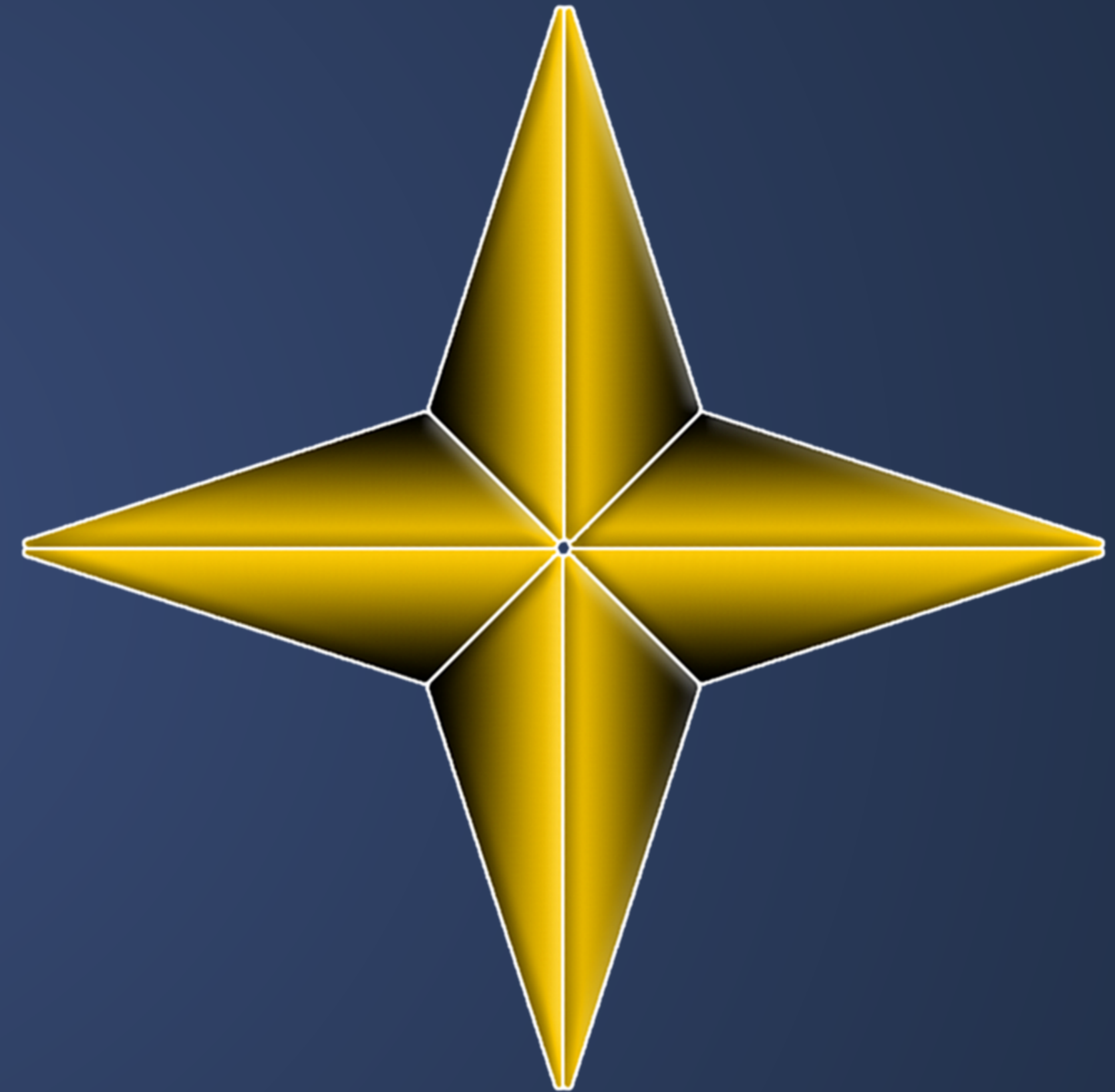
SYMMETRY: THIS STAR IS SYMMETRIC

Reflecting the star sends the star to itself.
The reflection is also a *SYMMETRY* of the star.



SYMMETRY

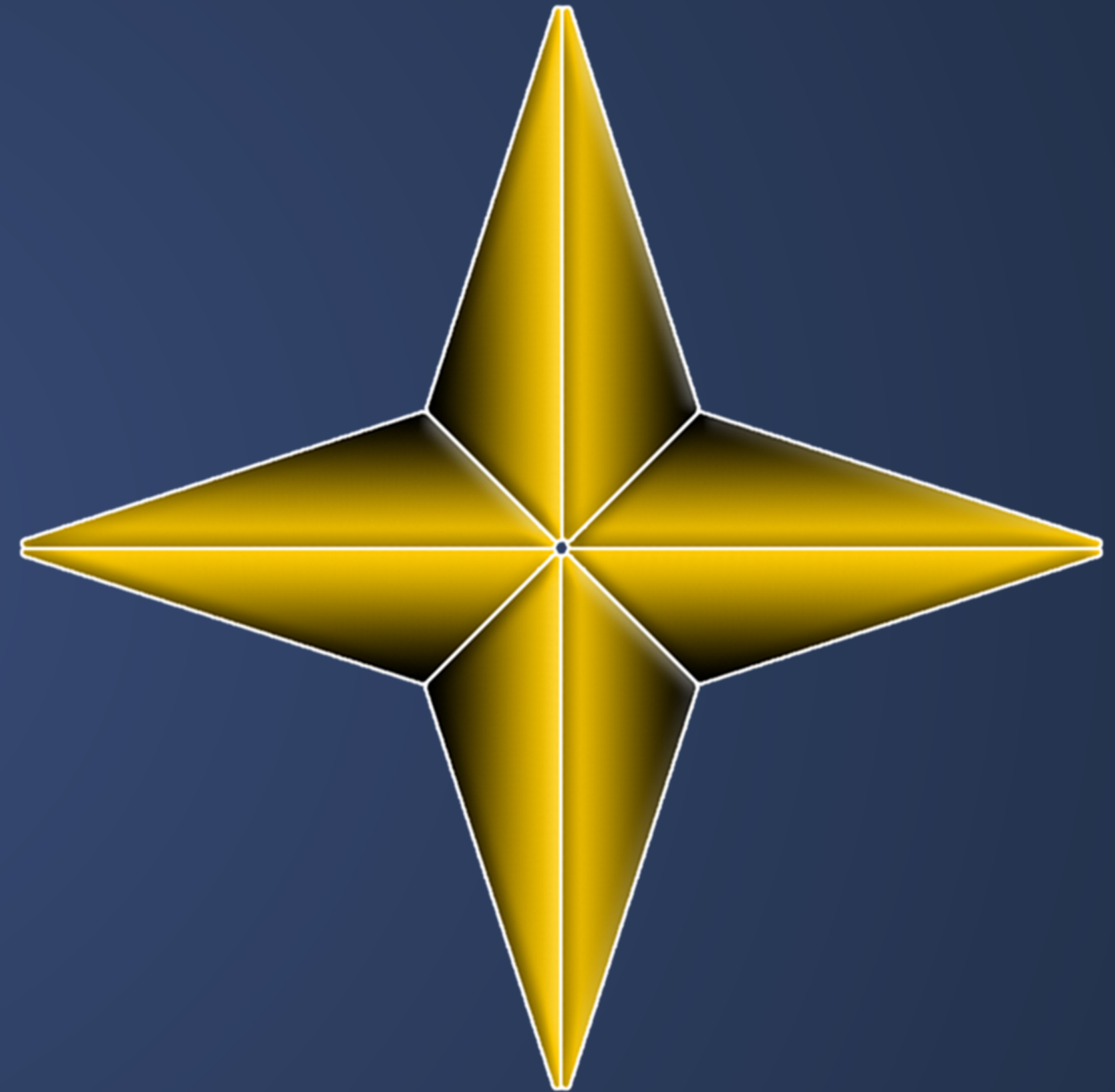
A symmetry of an object in the plane is an isometry of the plane that sends the object to itself.



SYMMETRY

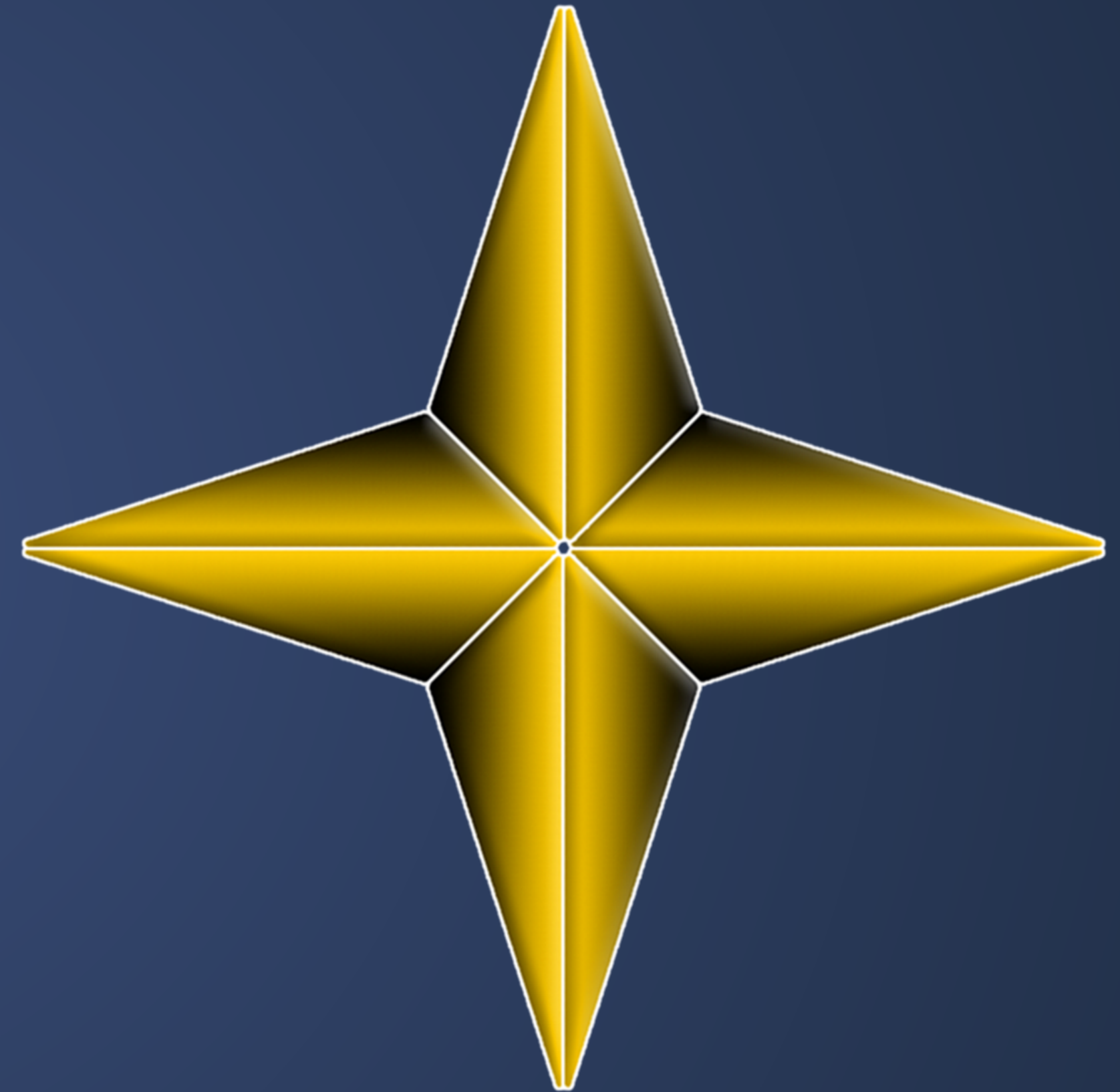
A symmetry of an object in the plane is an isometry of the plane that sends the object to itself.

How many symmetries does the star have?



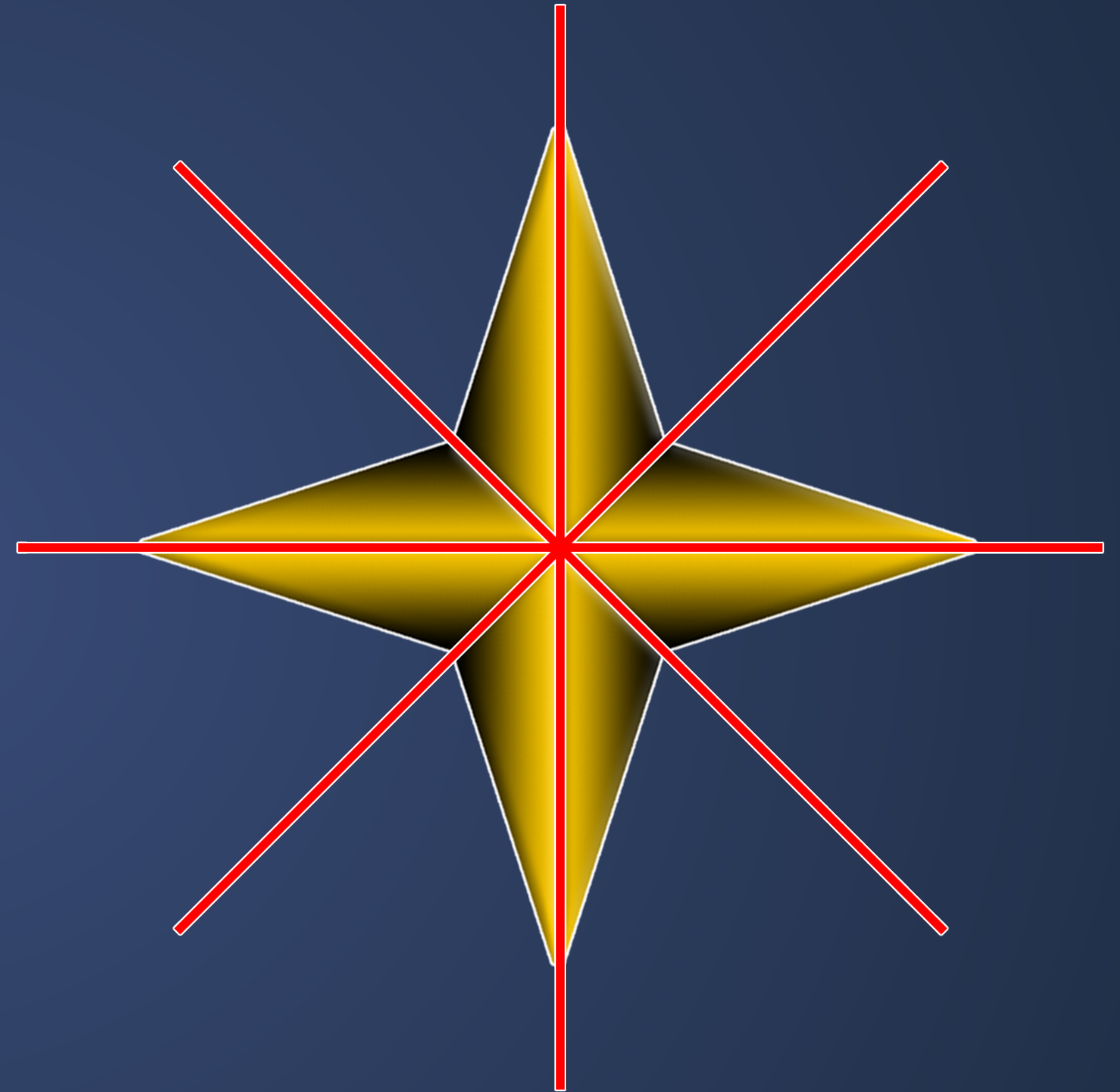
HOW MANY SYMMETRIES DOES THE STAR HAVE?

It has 4 rotational symmetries. There is the rotation about its center by 0° , 90° , 180° , and 270° .



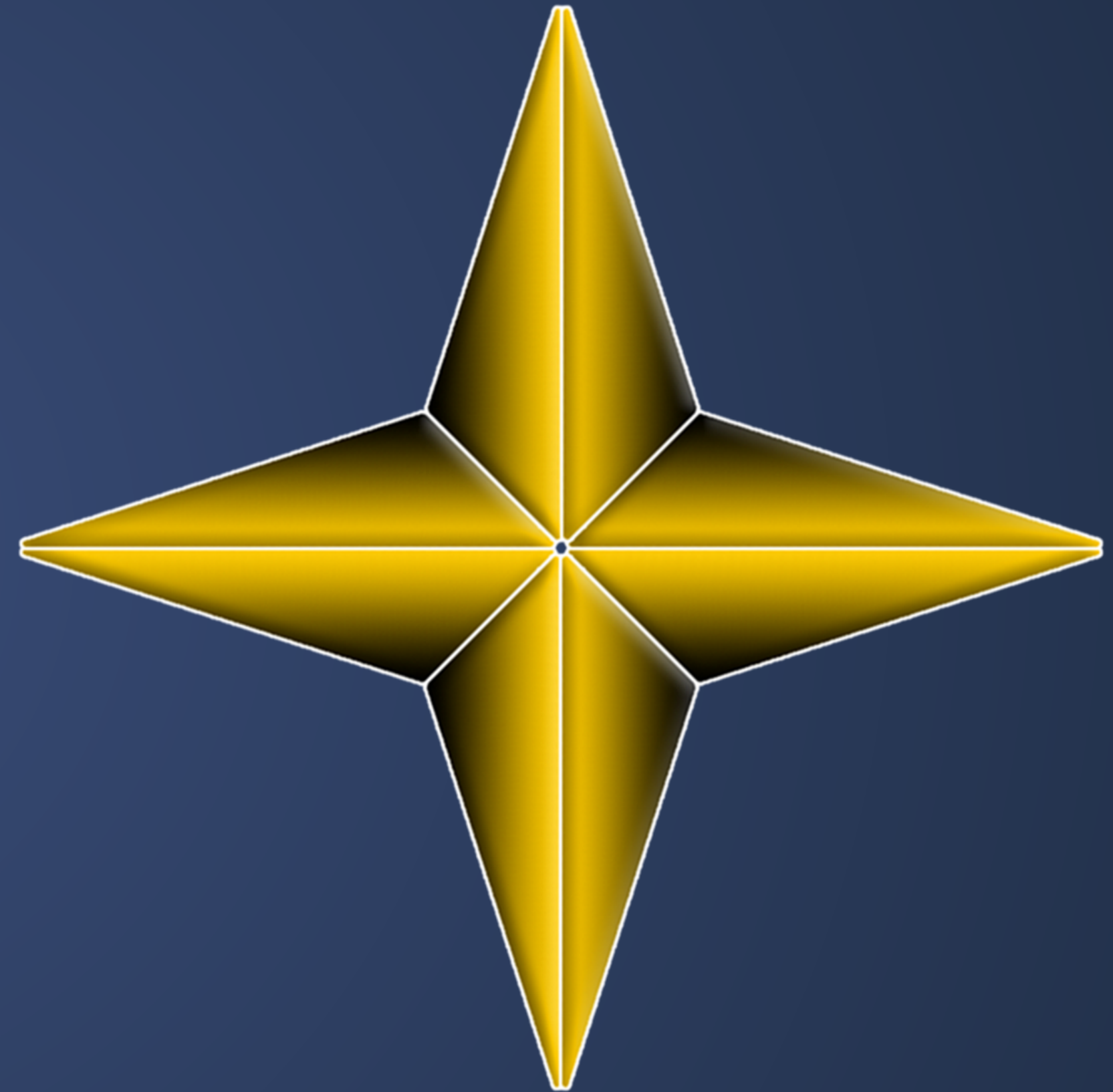
HOW MANY SYMMETRIES DOES THE STAR HAVE?

It also has 4 reflection symmetries.



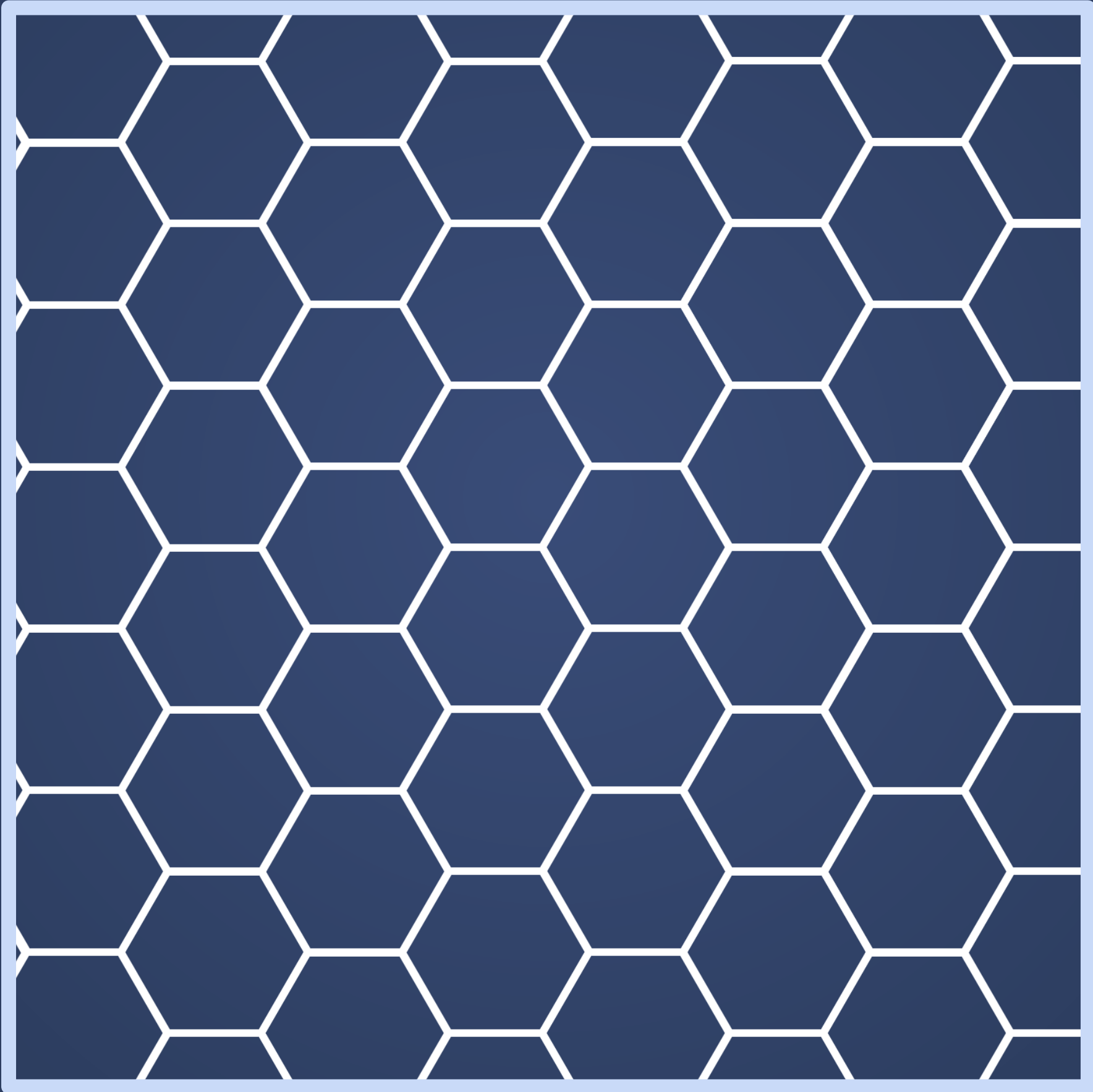
HOW MANY SYMMETRIES DOES THE STAR HAVE?

The four rotations and 4 reflections form a group, the **symmetry group** of the star.

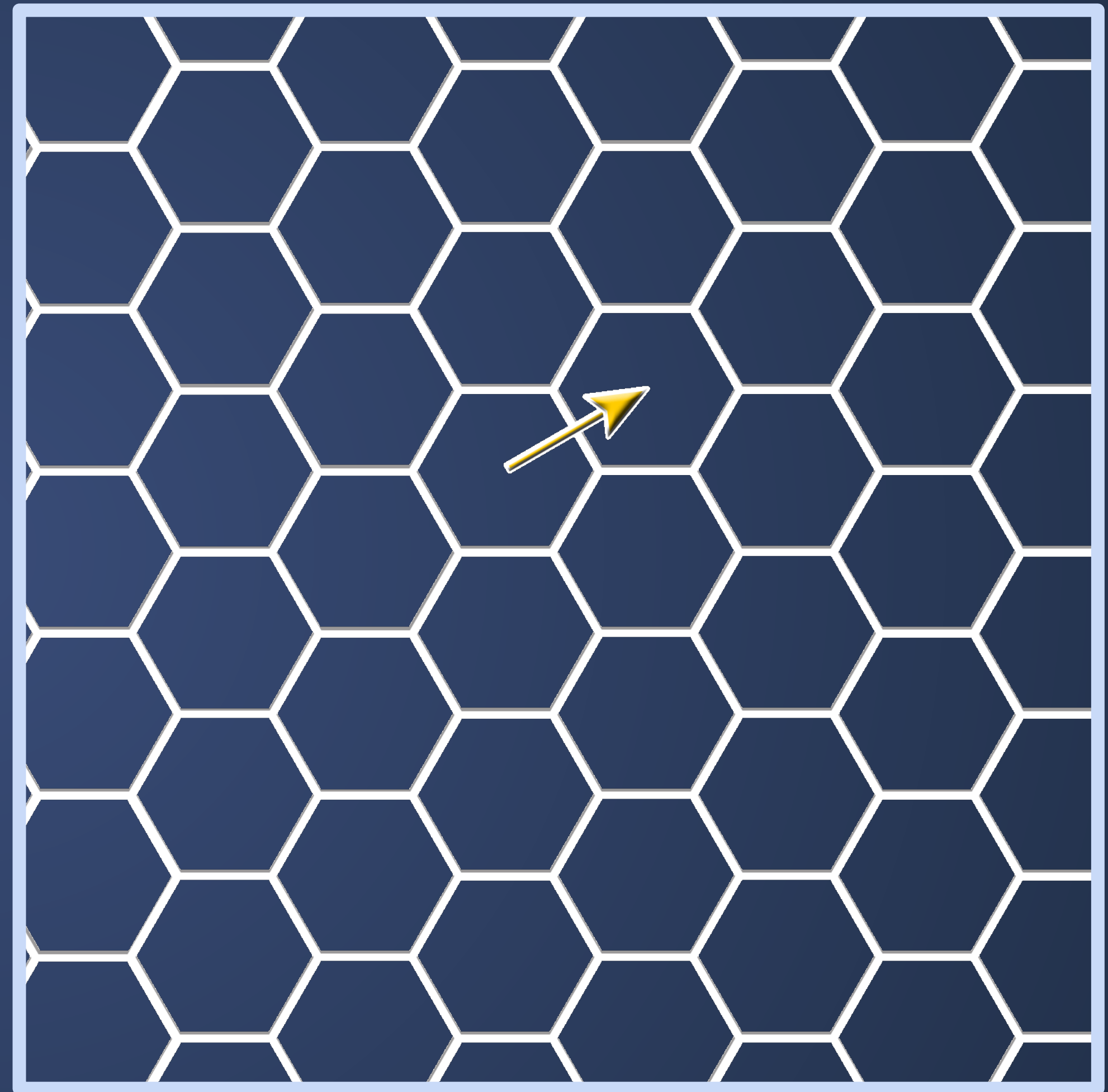


A repeated pattern in the plane has translational symmetries in two directions.

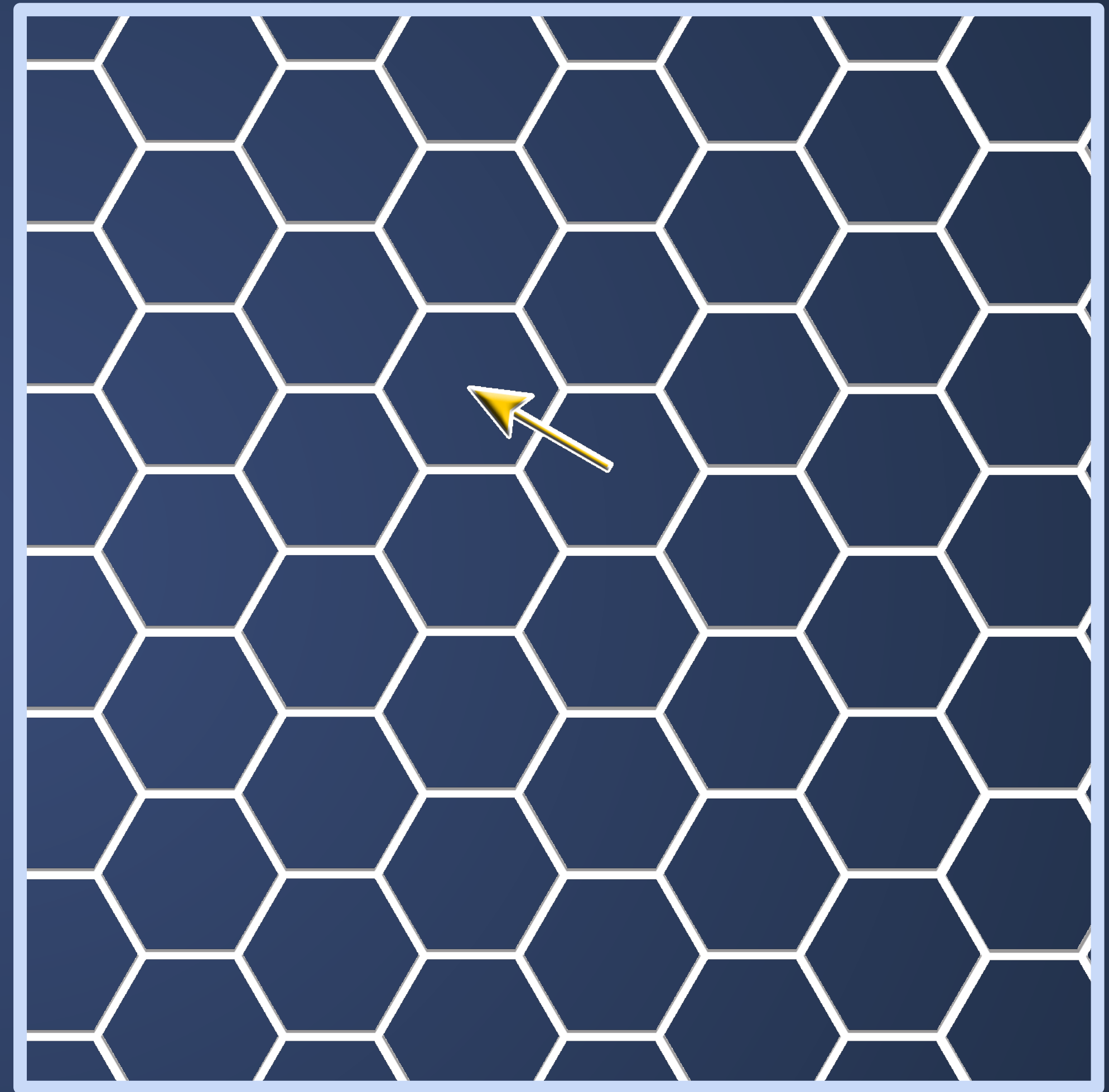
THE HONEYCOMB TILING



A repeated pattern in the plane has translational symmetries in two directions.

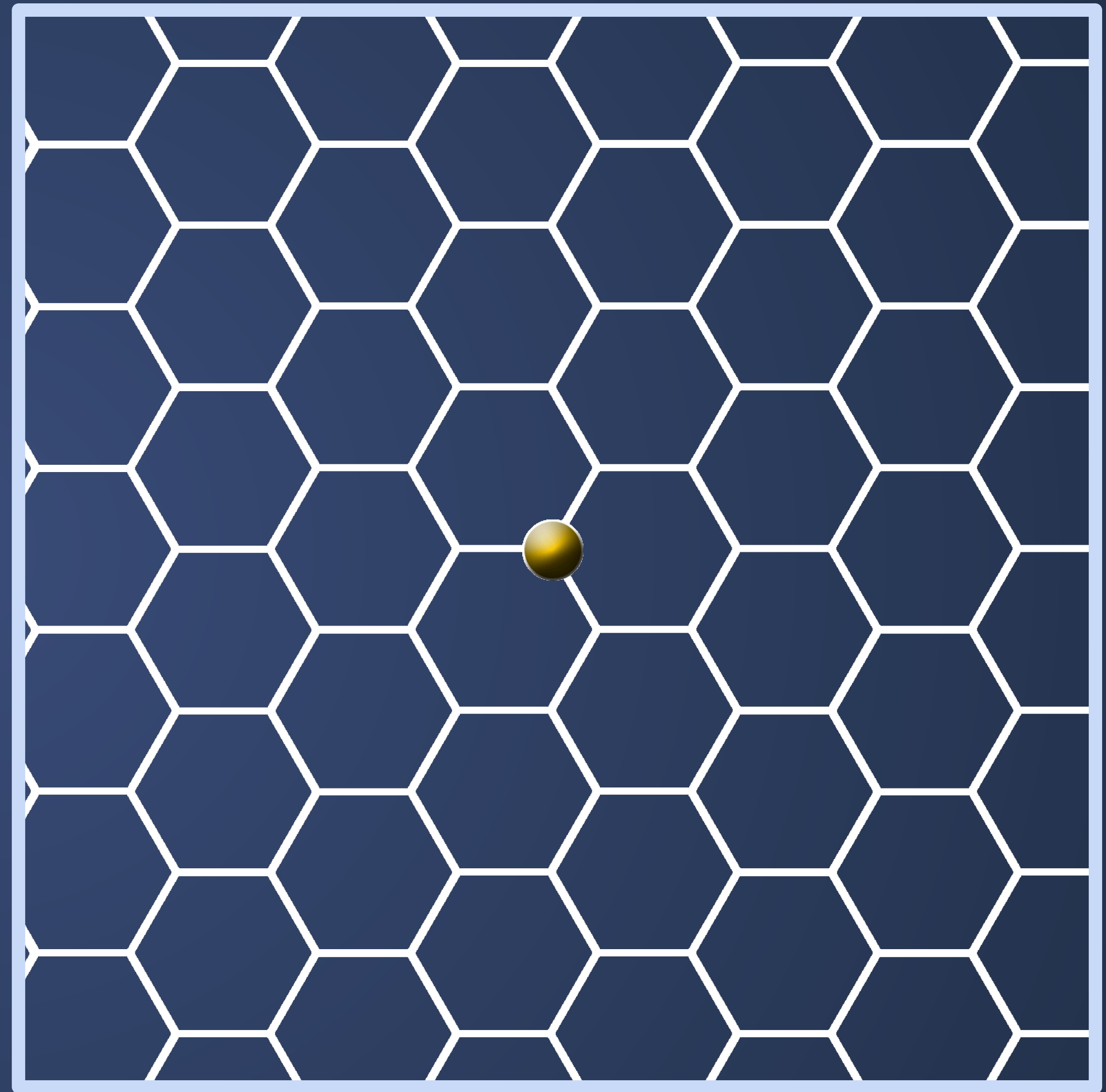


A repeated pattern in the plane has translational symmetries in two directions.



A REPEATED PATTERN IN THE PLANE
HAS TRANSLATIONAL SYMMETRIES IN
TWO DIRECTIONS.

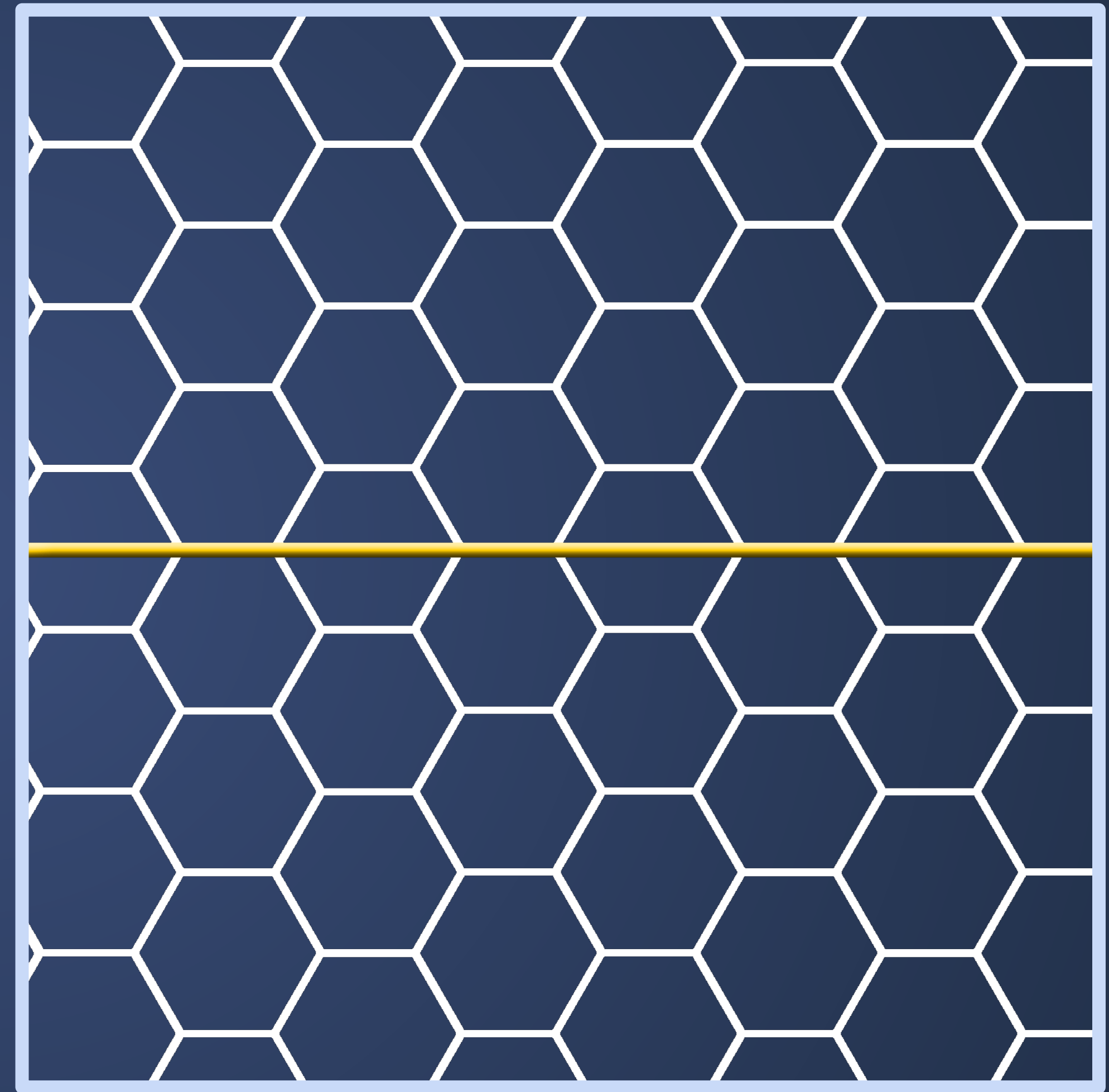
This pattern also has
rotation symmetries.



A REPEATED PATTERN IN THE PLANE
HAS TRANSLATIONAL SYMMETRIES IN
TWO DIRECTIONS.

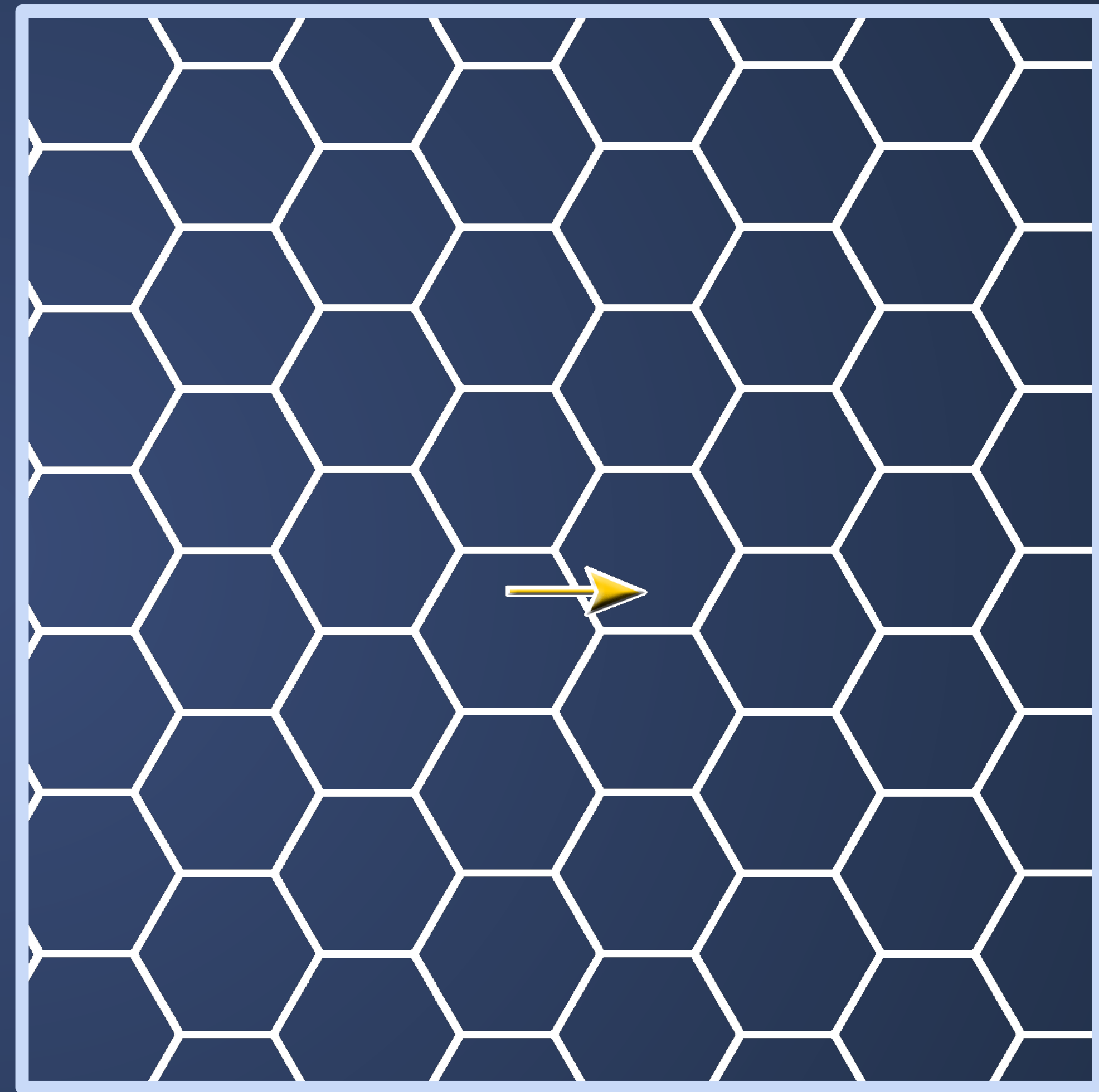
This pattern also has

- rotation symmetries
- **reflection** symmetries

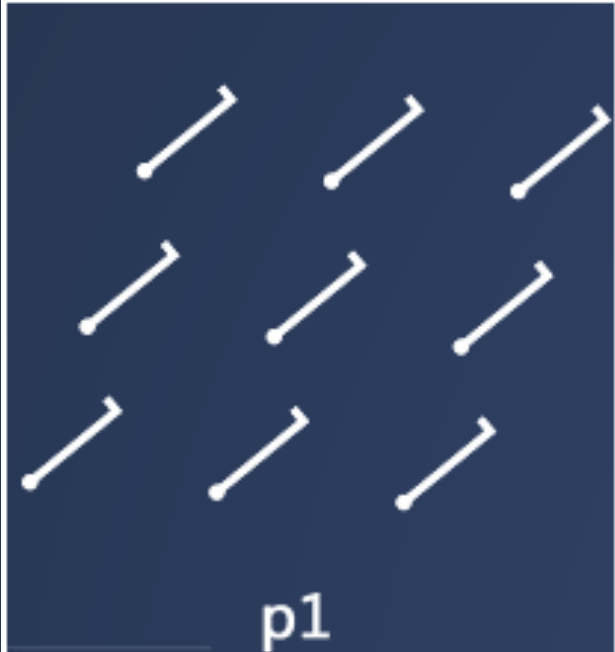








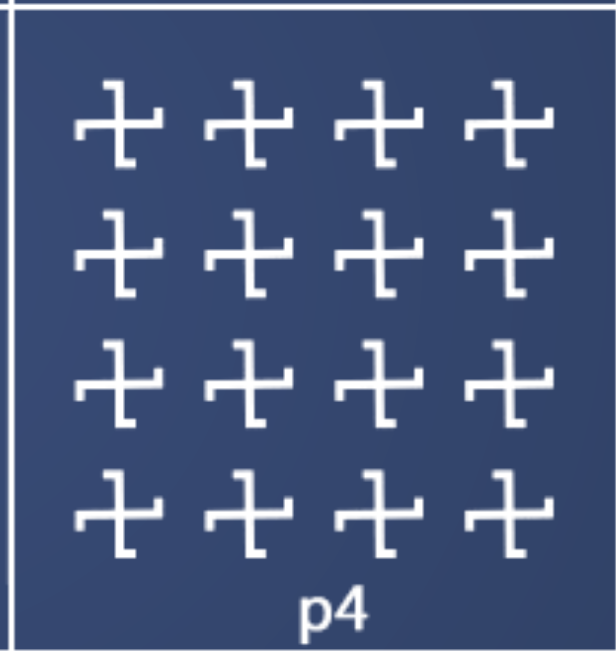
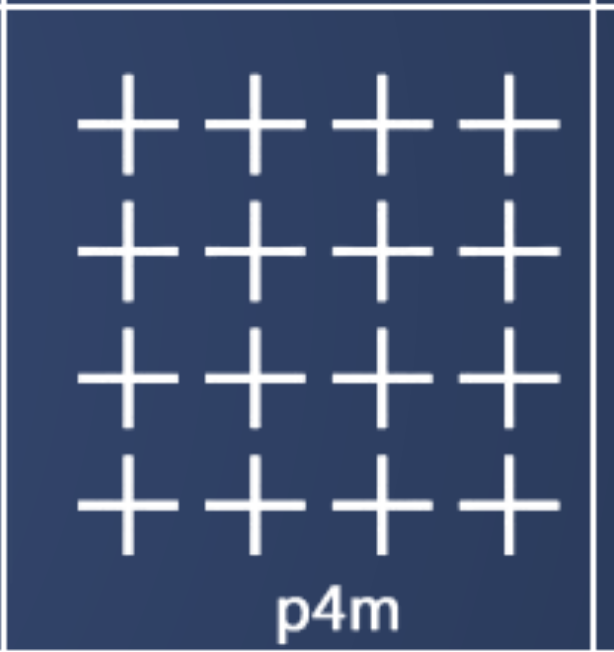




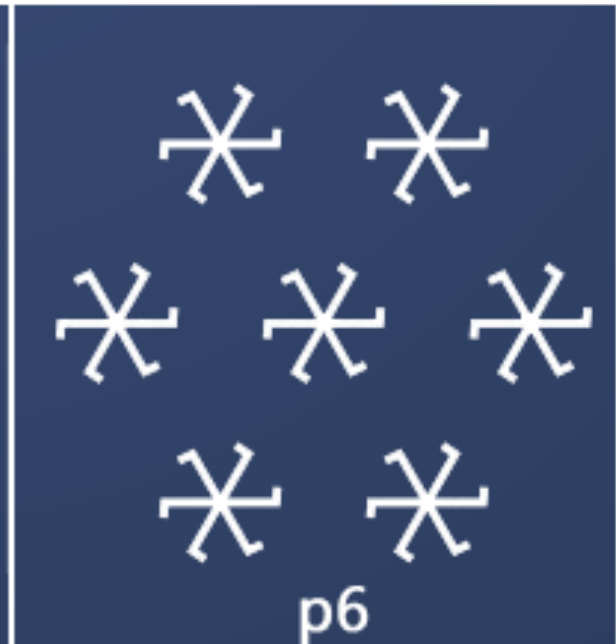
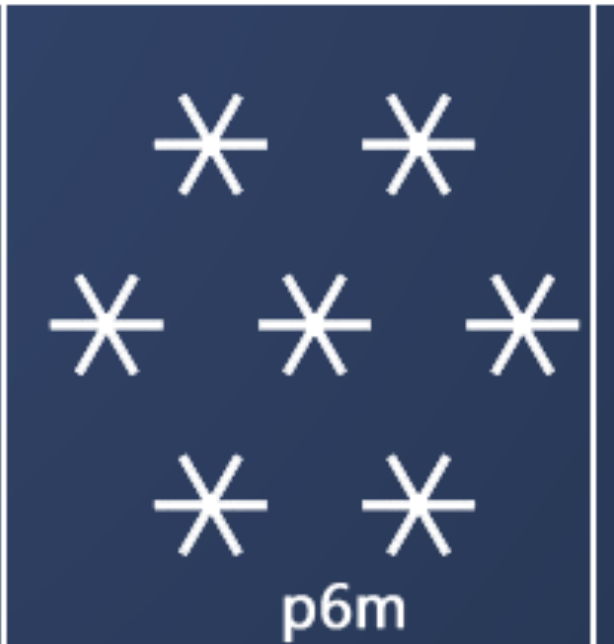


A REPEATED PATTERN IN THE PLANE
HAS TRANSLATIONAL SYMMETRIES IN
TWO DIRECTIONS.

- This pattern has
- rotation symmetries
- reflection symmetries
- glide reflection symmetries



THE SEVENTEEN REPEATED PATTERNS

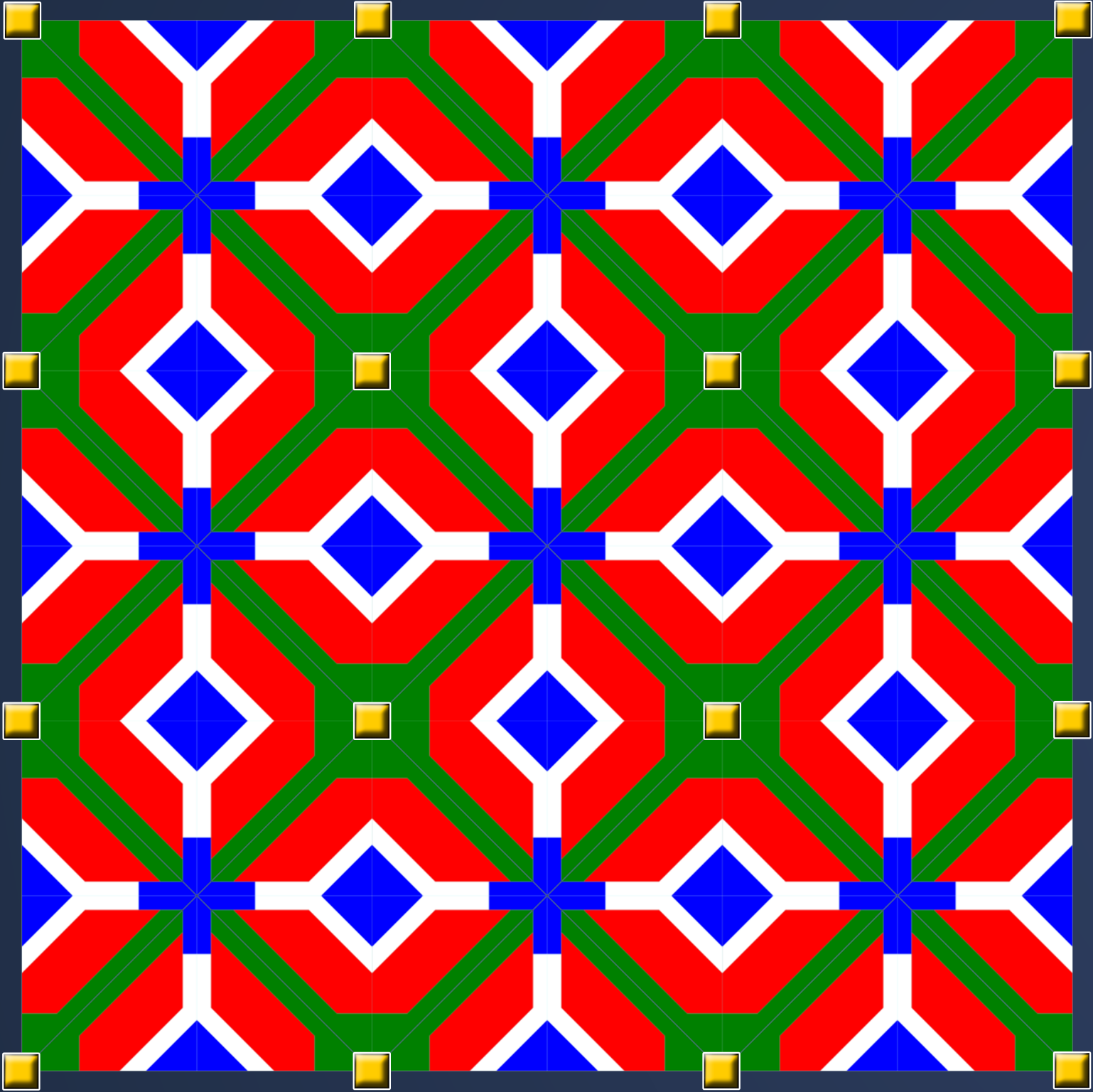
 p1	 pg	 pm	 cm	 cmm	 p2
 pgg	 pmg	 pmm	 p4	 p4m	 p4g
 p3	 p3m1	 p31m	 p6	 p6m	From Speiser, 1973 Reproduced with Artlandia SymmetryWorks

blog.artlandia.com

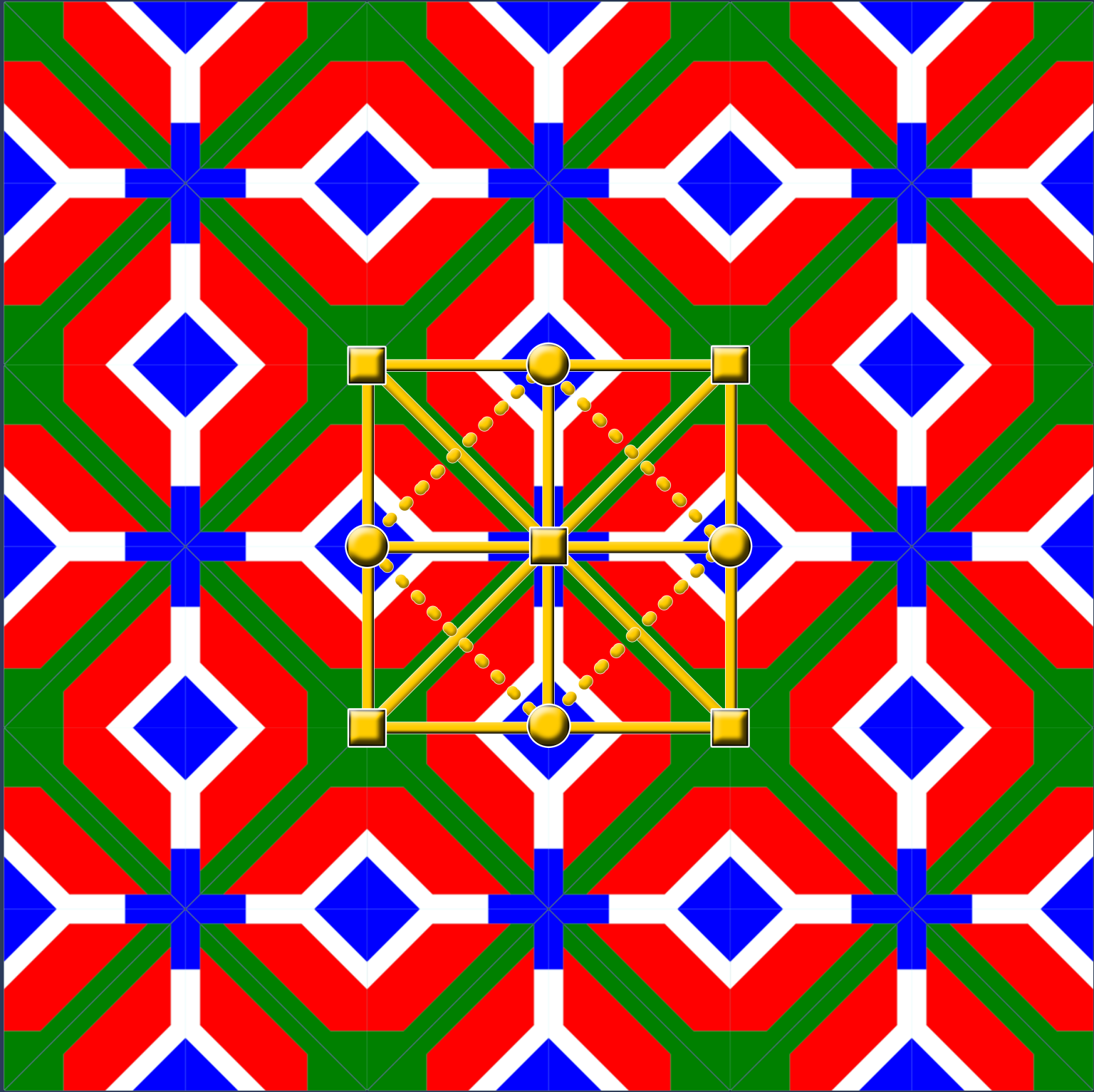
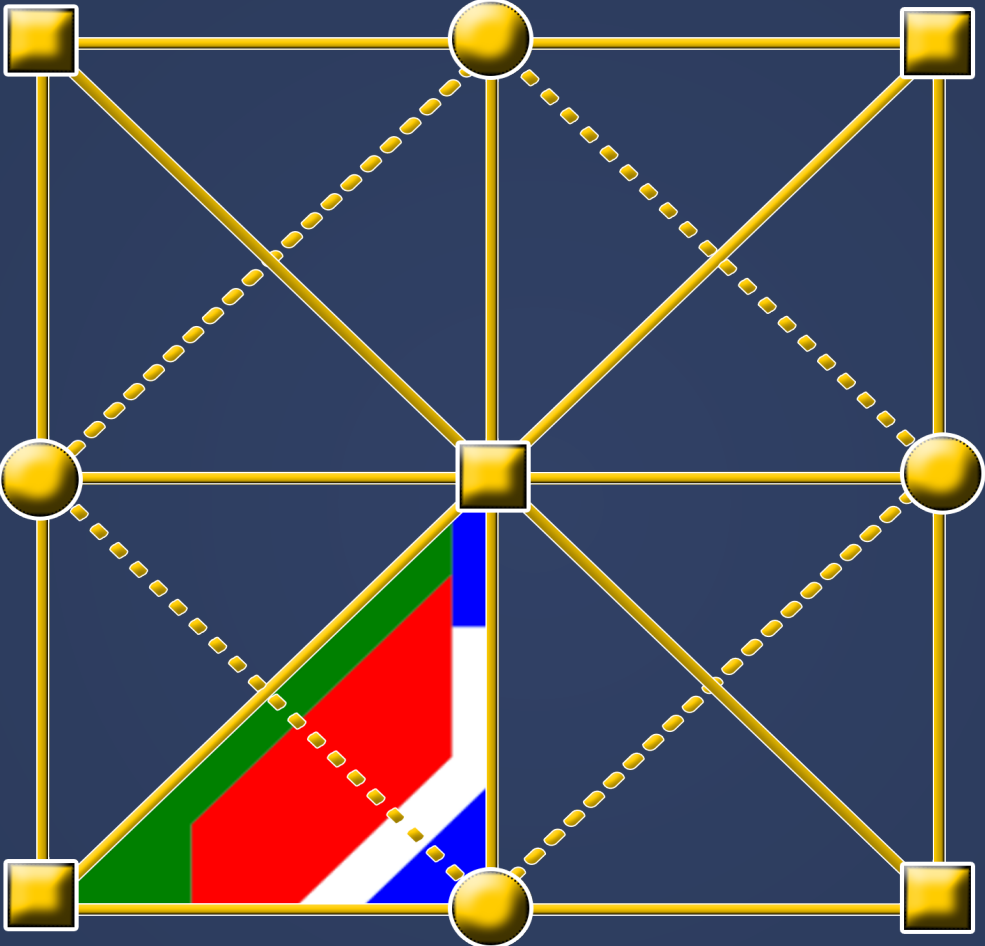
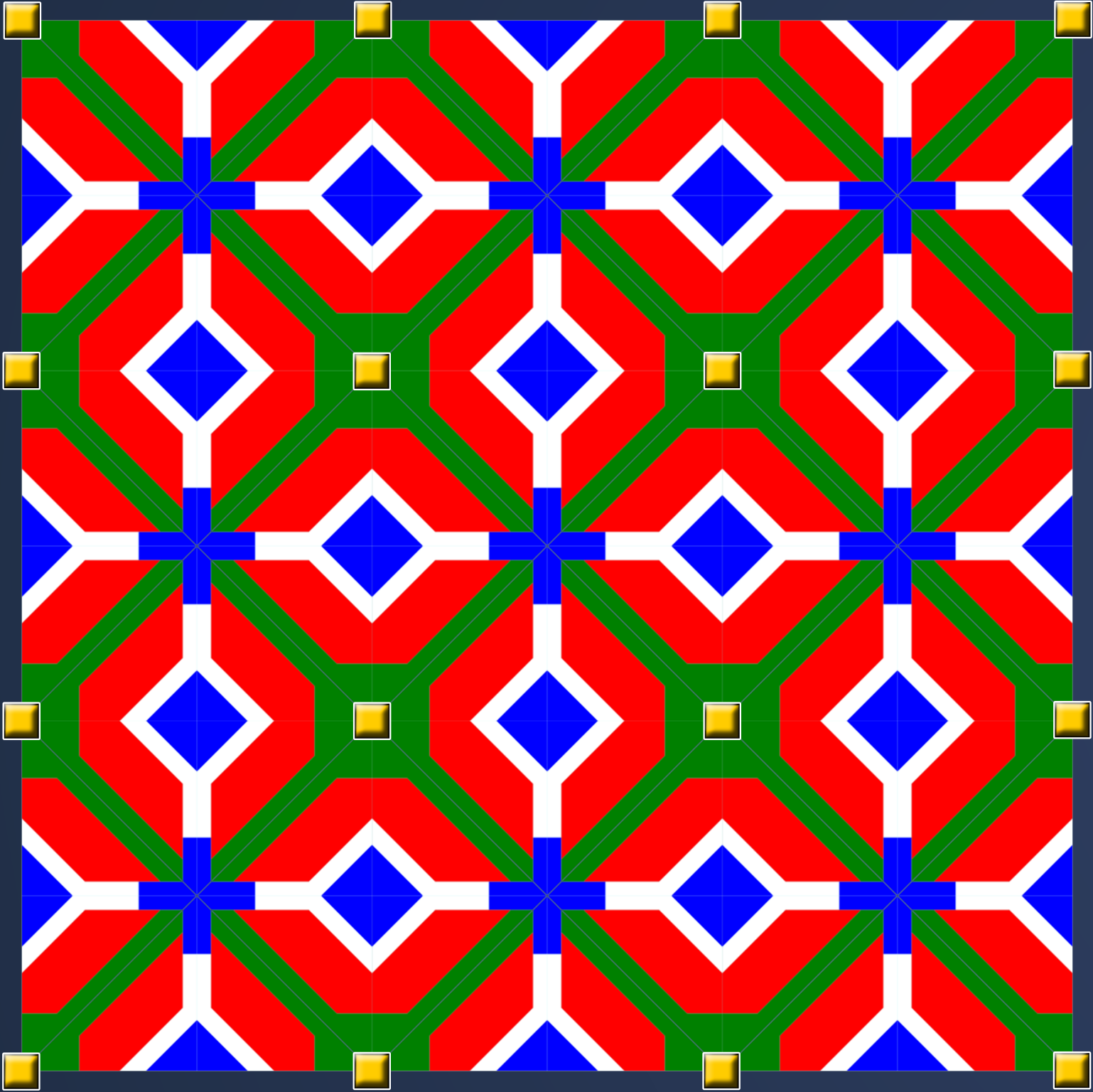
A REPEATED PATTERN WITH SYMMETRY GROUP P4M



LATTICE OF A REPEATED PATTERN



LATTICE AND UNIT CELL OF A REPEATED PATTERN



LAKE SEBU, COTABATO



THE T'NALAK



THE T'BOLI, THE DREAMWEAVER



IKAT, A DECORATIVE DYEING METHOD OF WEAVING



THE TYING PROCESS



THE WEAVING PROCESS





The Bed Kekem has

- reflection symmetries
- 180° rotation symmetries

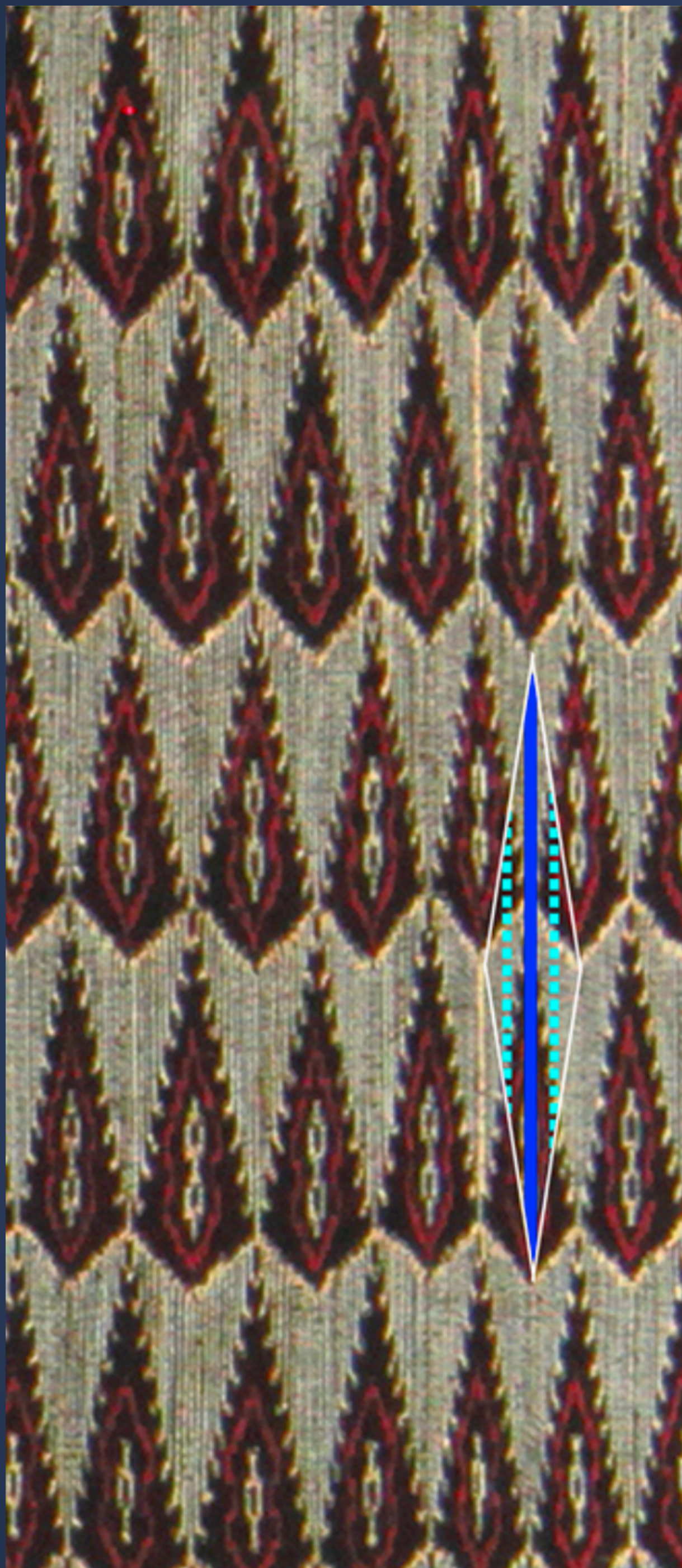
Its symmetry group is the plane crystallographic group pmm.



The Tofi Kemmu has:

- reflection symmetries
- 180° rotation symmetries
- glide reflection symmetries

Its symmetry group is the plane crystallographic group pmg.



The Doun Basag Senko has:

- reflection symmetries
- glide reflection symmetries

Its symmetry group is the plane crystallographic group cm .

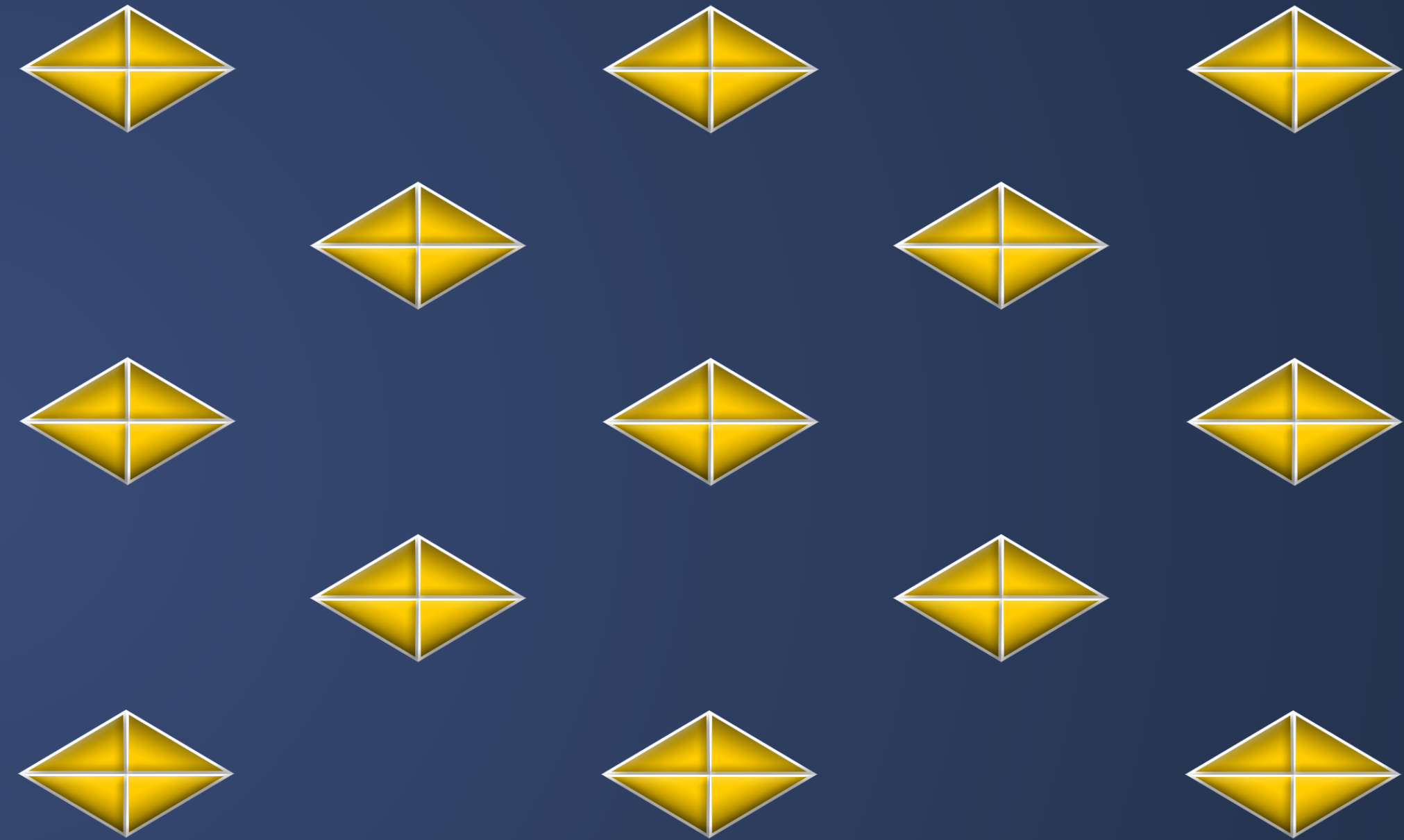


The Gondong Tahu has:

- reflection symmetries
- 180° rotation symmetries
- glide reflection symmetries

Its symmetry group is the plane crystallographic group cmm .

PATTERNS WITH A RHOMBIC LATTICE



THE KNOTTING PROCESS



Photo by Jojo Vito from happytrip.com

TWO GENERATIONS OF DREAMWEAVERS: LANG AND SEBULAN DULAY



Image from Paterno et al (2001)



WEAVERS OF MATHEMATICS



May 26, 2019, Lake Sebu Cotabato

References

- De las Peñas, M.L.A., Garciano, A. and Verzosa, D. (2018). Crystallographic Patterns in Philippine Indigenous Textile. *Journal of Applied Crystallography* 51: 456-469.
- Paterno, M., Castro, S., Javellana, R. & Alvina, C. (2001). *Dreamweavers*. Makati City: Bookmark.
- Schattschneider, D. (1978). The Plane Symmetry Groups: Their and Recognition and Notation. *The American Mathematical Monthly* 85-6: 439-450.
- Tapp, K. (2012). *Symmetry, a Mathematical Exploration*. Springer.