Decagonal Tilings in Medieval Islamic Architecture
Outline

Introduction
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► Introduction
   ▪ Plane Tilings
   ▪ Regular Tilings
   ▪ Periodic Tilings
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  ▪ Regular Tilings
  ▪ Periodic Tilings

► Aperiodic Tilings
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  ▪ Plane Tilings
  ▪ Regular Tilings
  ▪ Periodic Tilings

► Aperiodic Tilings
  ▪ Penrose Tilings
  ▪ Girih Tilings
Plane Tilings
Plane Tilings

- Collection of plane figures
Plane Tilings

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- Covers plane entirely
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- No gaps or overlap
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Regular Tilings
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- Plane tiling of congruent regular polygons
Regular Tilings

► Plane tiling of congruent regular polygons

► Only three exist
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Periodic Tilings
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- Tiling of the plane with translational symmetry
Periodic Tilings

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- Only 2-fold, 3-fold, 4-fold and 6-fold rotational symmetry is allowed
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Penrose Tiling
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- Has no translational symmetry and is therefore aperiodic
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- Has no translational symmetry and is therefore aperiodic
- Is quasi-periodic (in physics this property is called quasi-crystalline)
Penrose Tiling

- Made up of two rhombi
Penrose Tiling

- Made up of two rhombi
  - $\{72, 108, 72, 108\}$ degrees
Penrose Tiling

Made up of two rhombi

- \{72, 108, 72, 108\} degrees
- \{36, 144, 36, 144\} degrees
Penrose Tiling

- Made up of two rhombi
  - $\{72, 108, 72, 108\}$ degrees
  - $\{36, 144, 36, 144\}$ degrees
- Only one rule: no two adjacent tiles can form a parallelogram
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- Made up of two rhombi
  - $\{72, 108, 72, 108\}$ degrees
  - $\{36, 144, 36, 144\}$ degrees

- Only one rule: no two adjacent tiles can form a parallelogram

- Ratio between number of each tiles is golden ratio
Penrose Tiling
Girih Tiling
Girih Tiling
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► Very complex patterns that appear throughout Islamic art and architecture
Girih Tiling

- Very complex patterns that appear throughout Islamic art and architecture
- Locally display 10-fold rotational symmetry, and therefore cannot be periodic
Girih Tiling

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- Locally display 10-fold rotational symmetry, and therefore cannot be periodic
- Initially thought to have been created using compass and straight edge method
Girih Tiling

Peter J. Lu at Harvard and Paul J. Steinhardt at Princeton found that Girih Tilings exhibit advanced decagonal quasicrystal geometry like that of Penrose Tilings.
Girih Tiling

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- Girih Tilings used five different tiles.
Girih Tiling

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- Girih Tilings used five different tiles.
- Can be mapped to Penrose Tilings.
Girih Tiling
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Examples

http://www.sciencemag.org/cgi/content/full/315/5815/1106/DC1c
References

