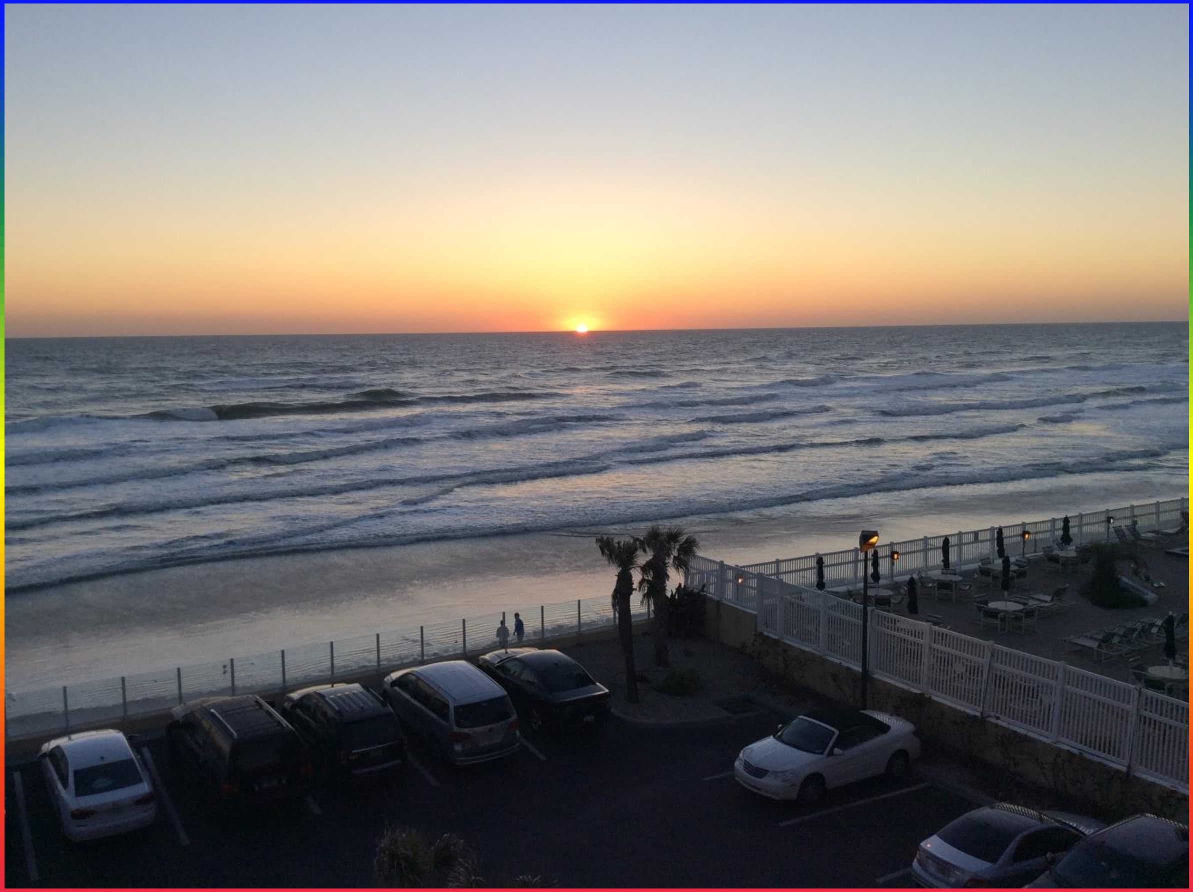
CPS Geometry

Part 6 – Lines in CPS

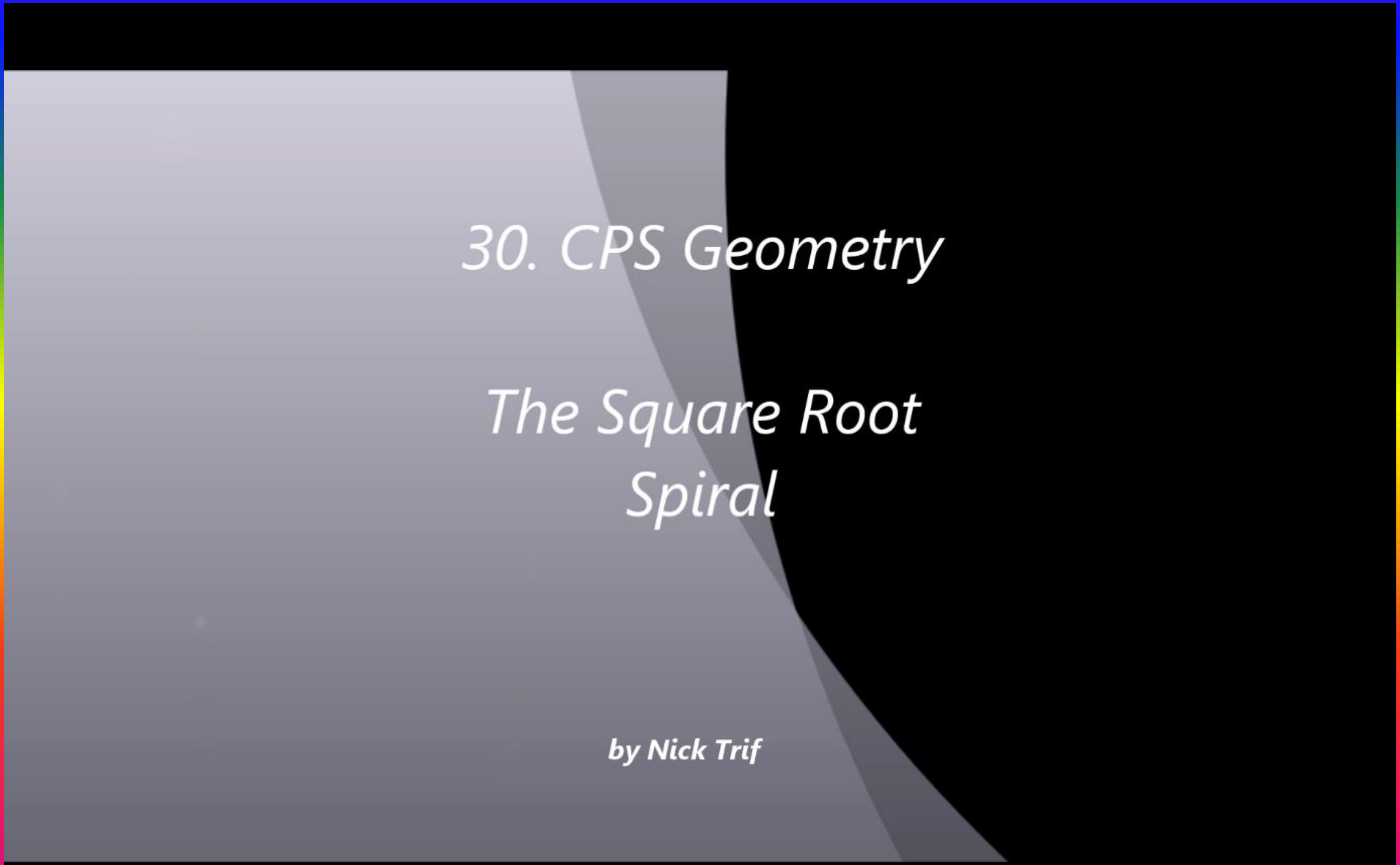


Nick Trif

Ottawa, Ontario, Canada – 2018
www.platonicstructures.com

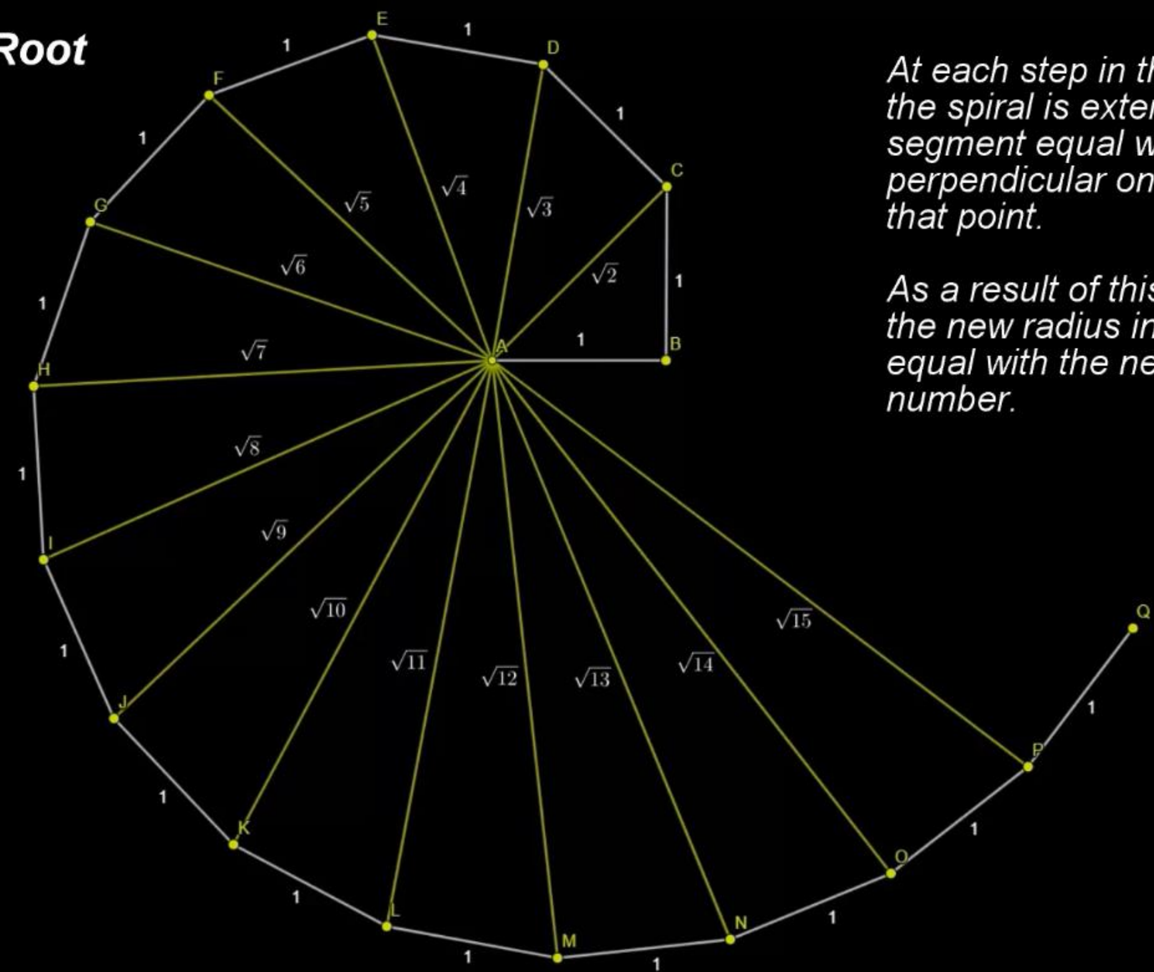
CPS Geometry

Part 6 – Lines in CPS – 30: The Square Root Spiral



YouTube: https://youtu.be/9-c_yb4MnhY

The Square Root Spiral

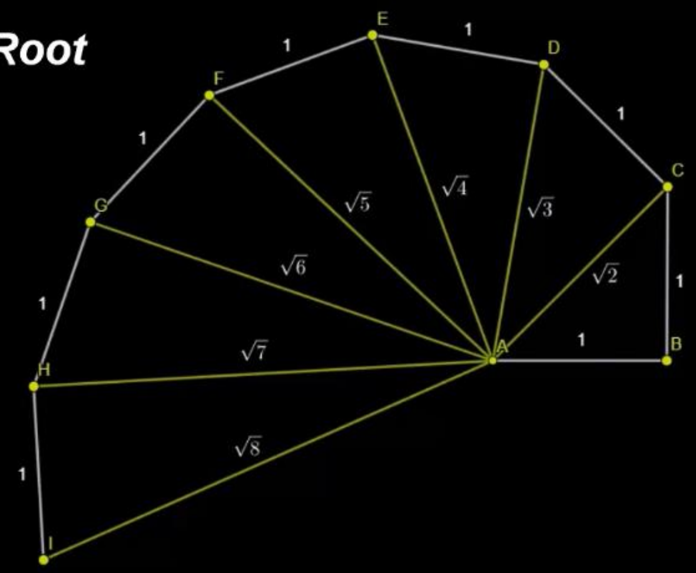


At each step in the development, the spiral is extended with a segment equal with one and perpendicular on the radius in that point.

As a result of this construction, the new radius increases, and is equal with the next square root number.

As we have seen in the previous presentation, the diagonal and the size of a square are incommensurables with each other.

The Square Root Spiral

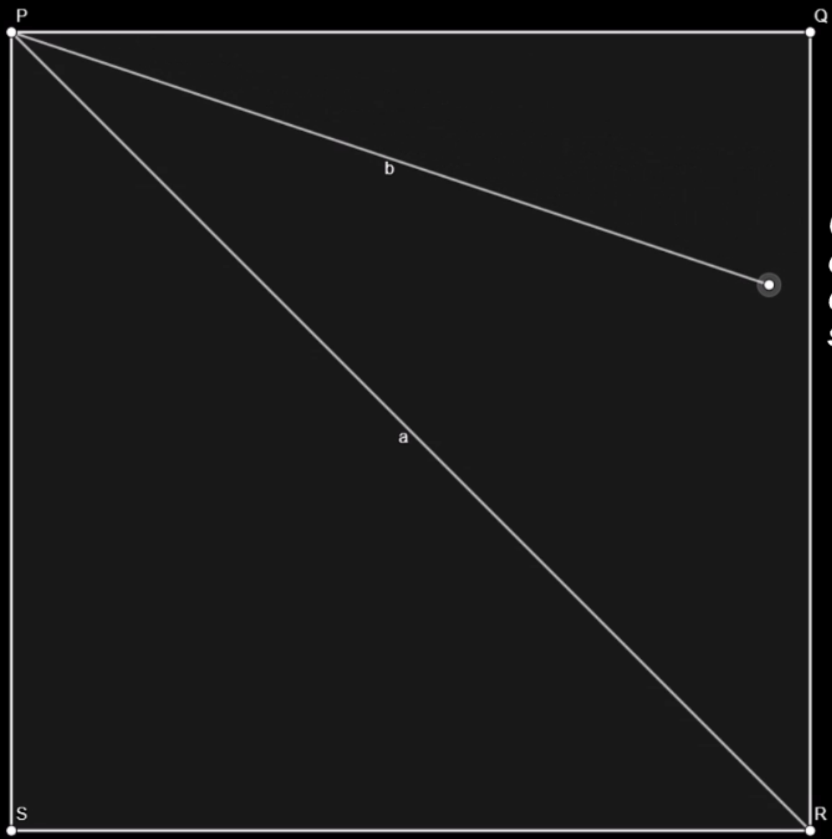


At each step in the development, the spiral is extended with a segment equal with one and perpendicular on the radius in that point.

As a result of this construction, the new radius increases, and is equal with the next square root number.

This geometrical statement is equivalent to the following arithmetical statement:
The number one and the number square root of 2 are two incommensurable magnitudes.

The Concept Of Incommensurability

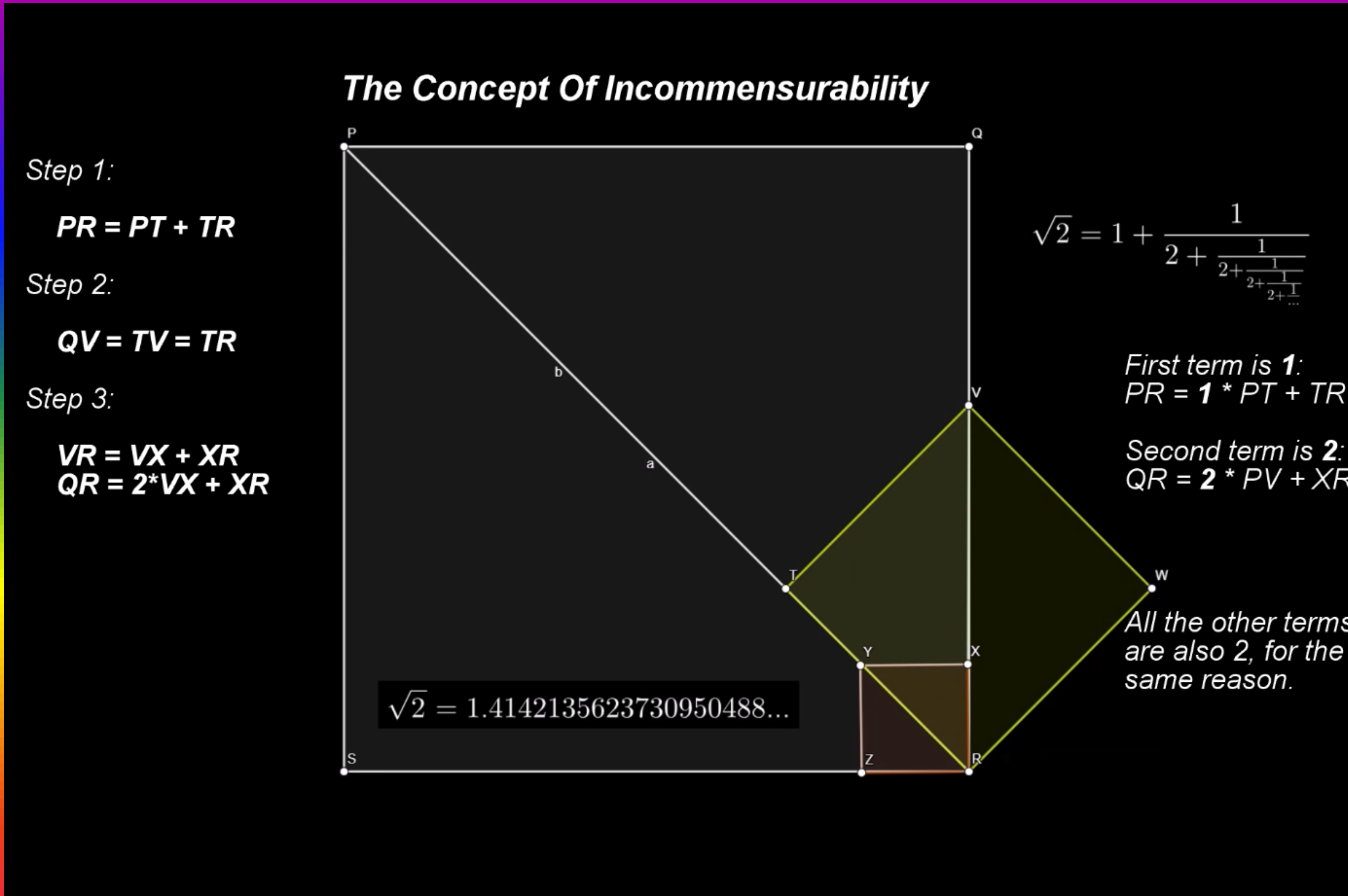


One can never find a common unit between the diagonal and the size of a square.

The diagonal and the size of a square are incommensurable.

This fact can also be stated in the following way:

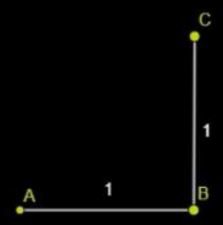
There is no way to express the number square root of two as a ratio between two integer numbers.



The next logical question one might ask is:

Are 1 and the square root of 2 the only set of incommensurable magnitudes?

The Square Root Spiral



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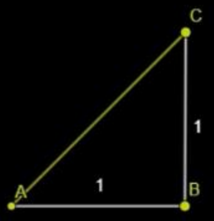
As a result of this construction, the new radius increases, and is equal with the next square root number.

Plato told us that Theodorus has discovered a full set of incommensurable magnitudes.

The Square Root Spiral



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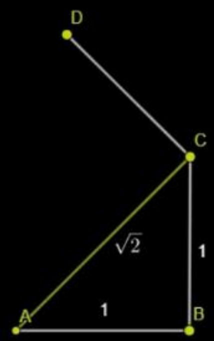
Plato told us that Theodorus has discovered a full set of incommensurable magnitudes.
We will follow his approach and visualize these magnitudes using the square root spiral.

The Square Root Spiral



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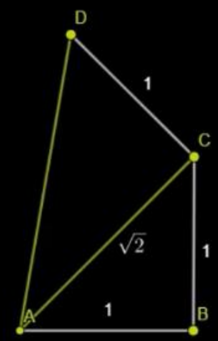
At each step in the development the spiral is extended with a segment equal with one, perpendicular on the radius in that point.

The Square Root Spiral



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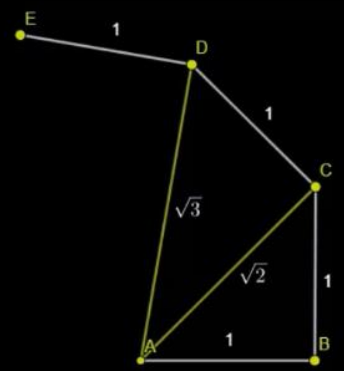

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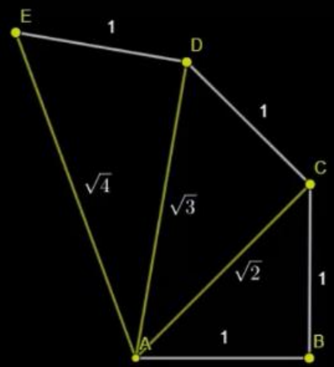

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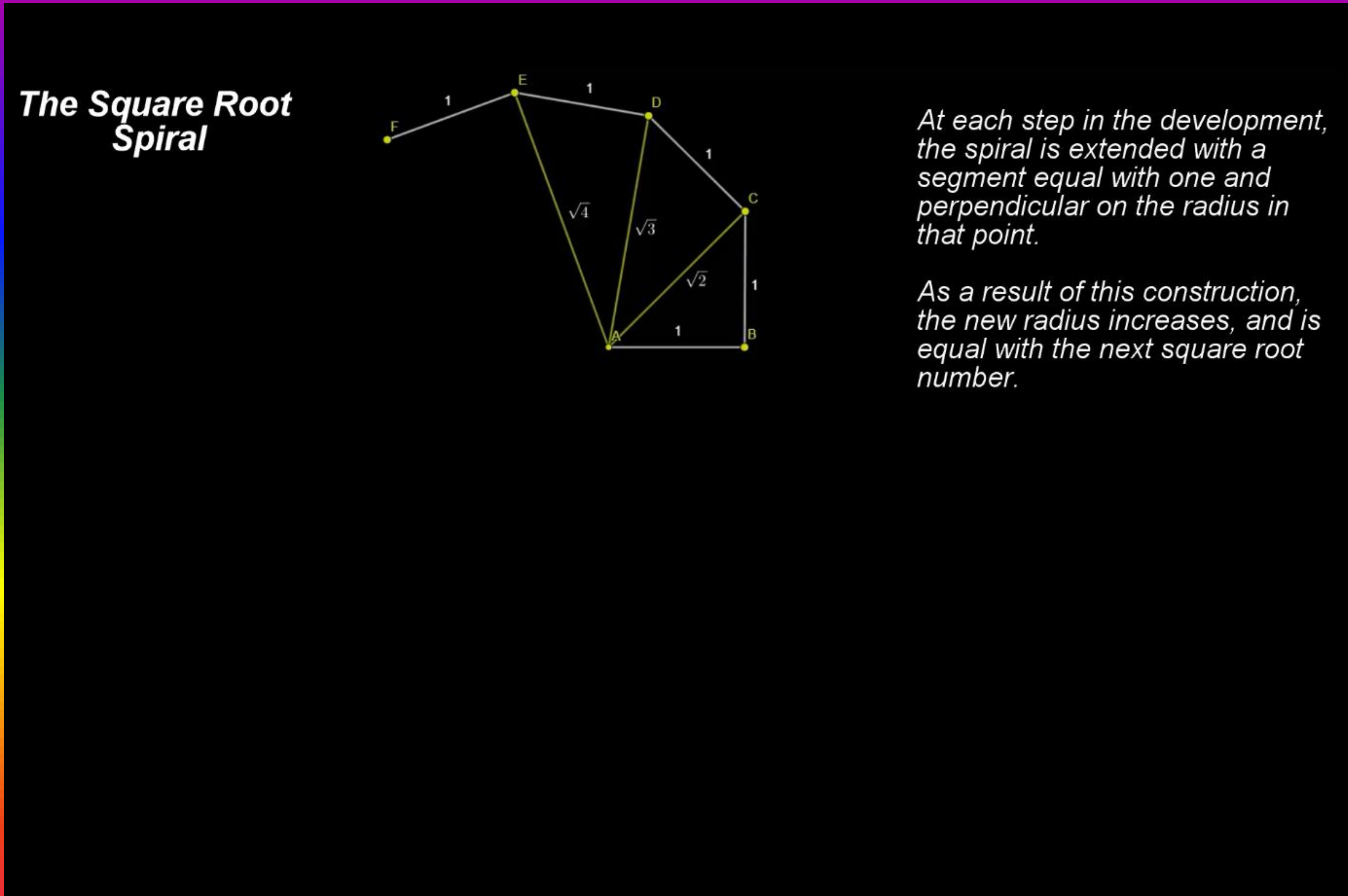

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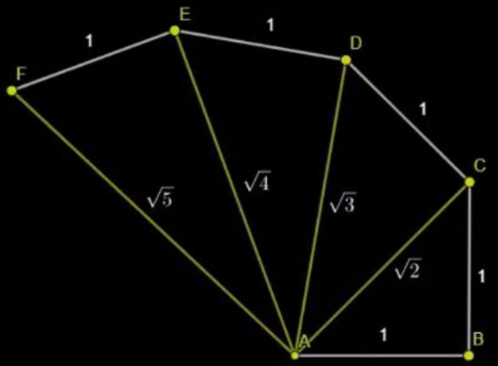

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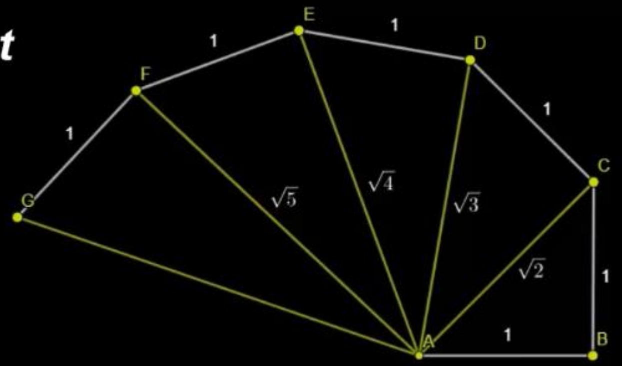
The square root of a perfect square number is always an integer.

The Square Root Spiral



At each step in the development, the spiral is extended with a segment equal with one and perpendicular on the radius in that point.

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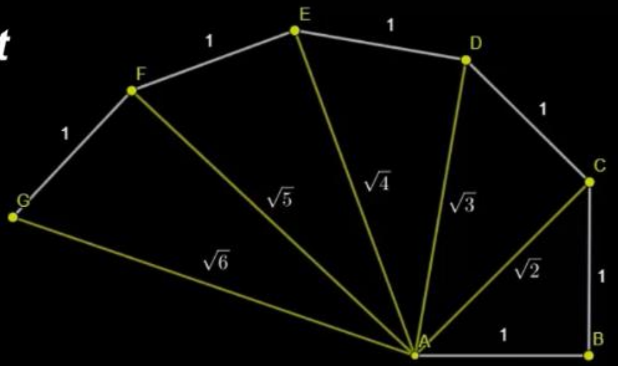
The integer numbers are also incommensurable with the square root of numbers mentioned above.

The Square Root Spiral



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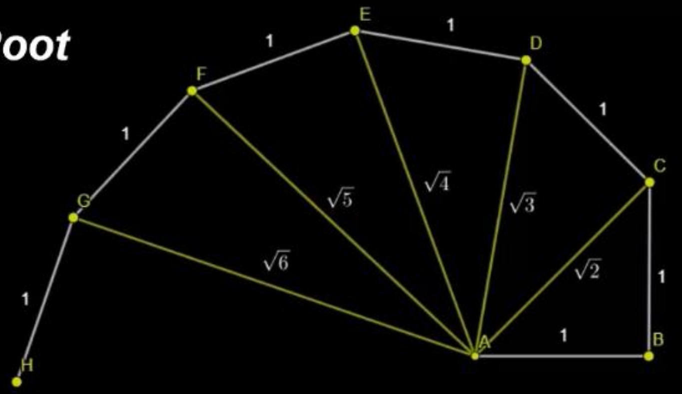

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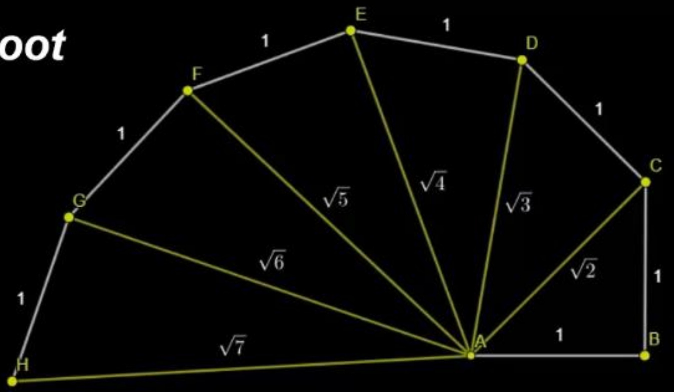

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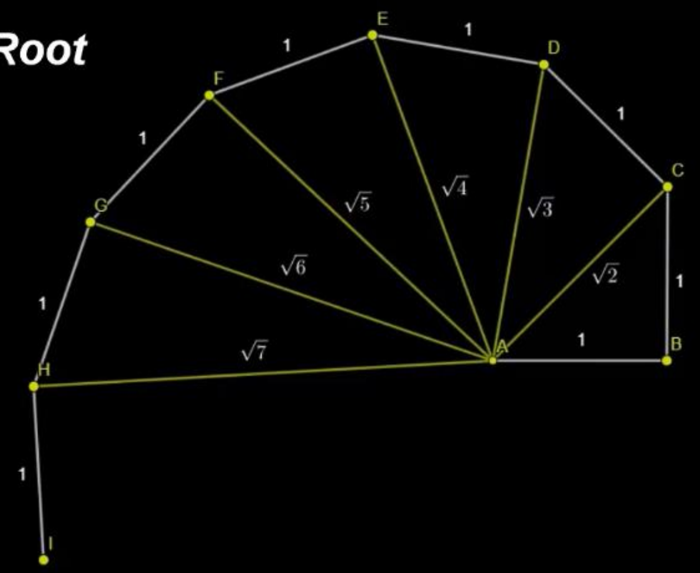

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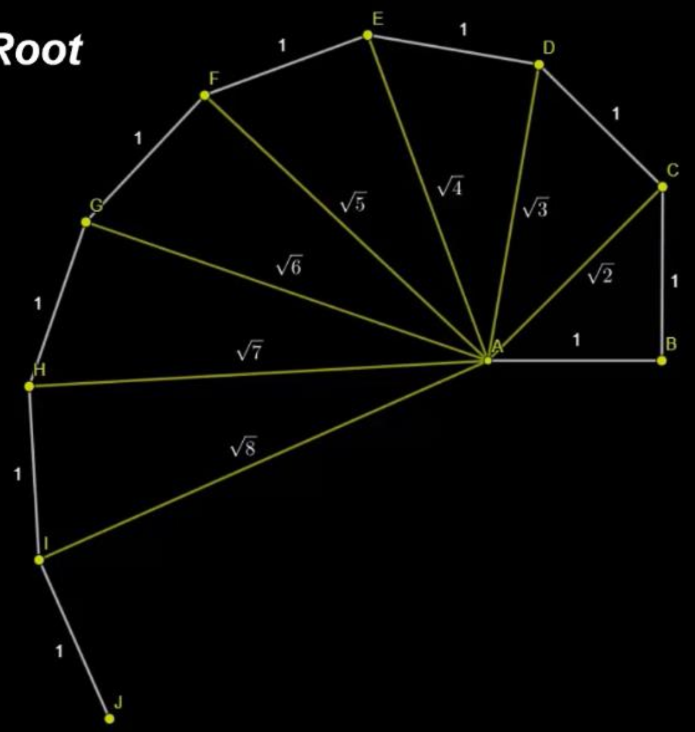

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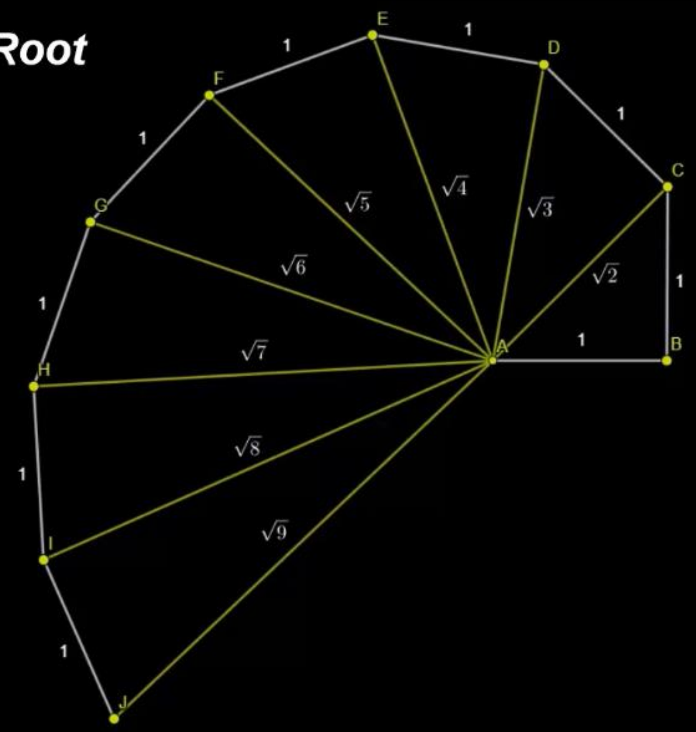

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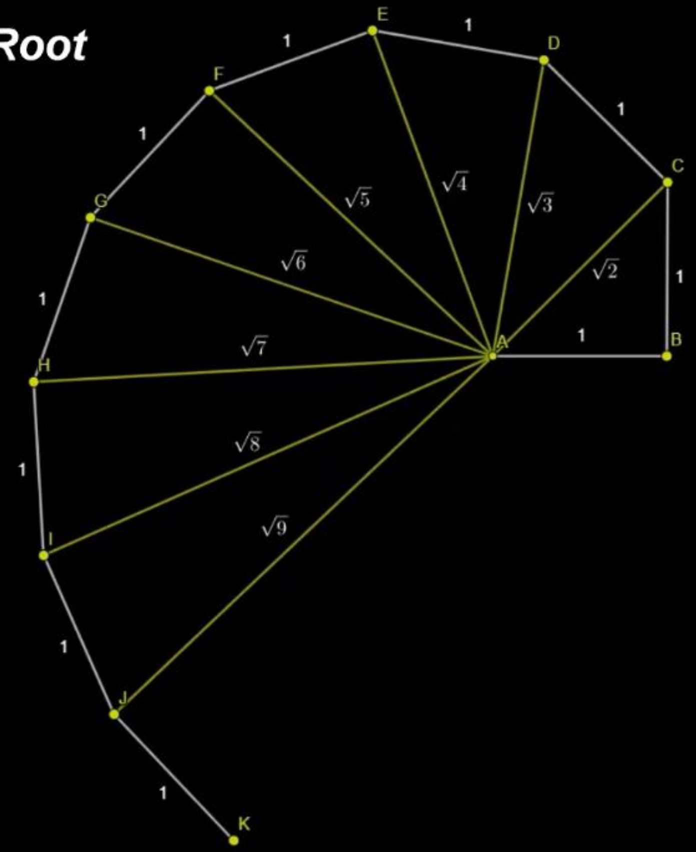

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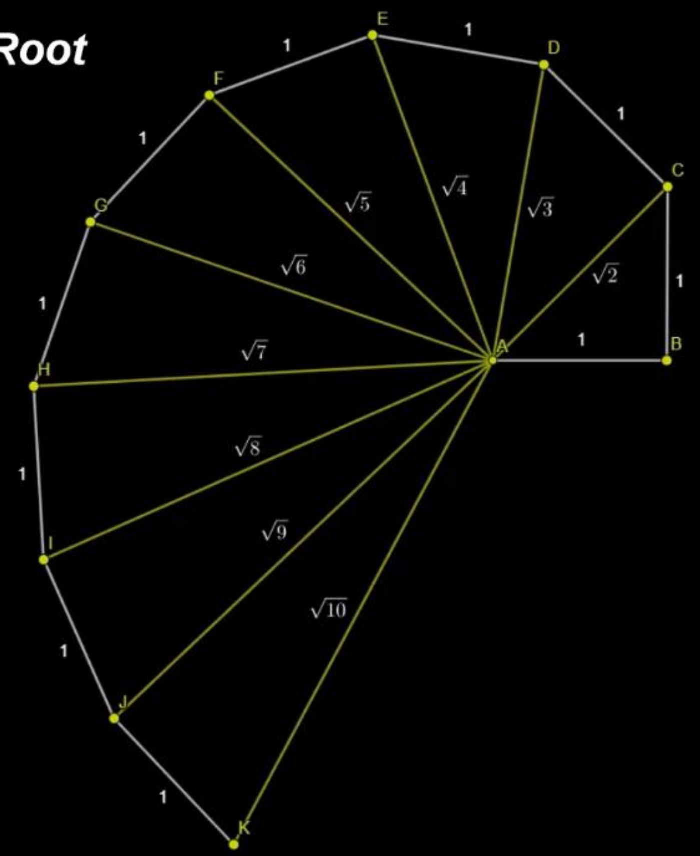

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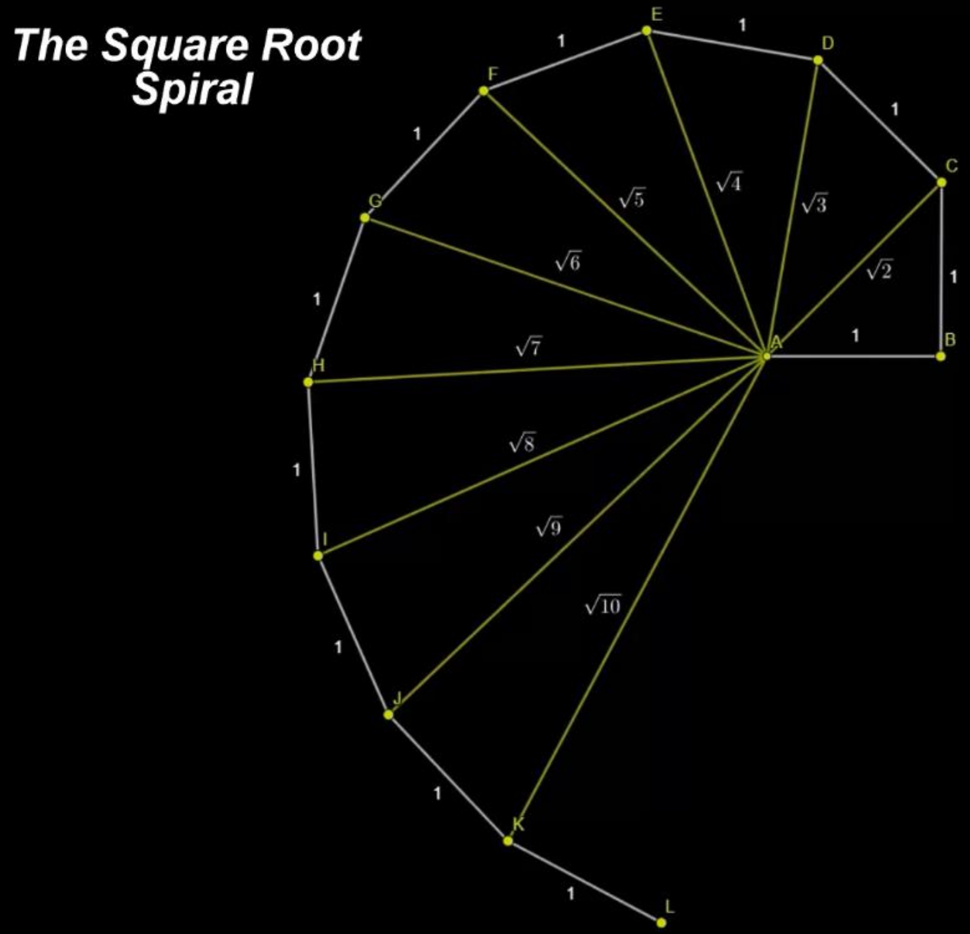

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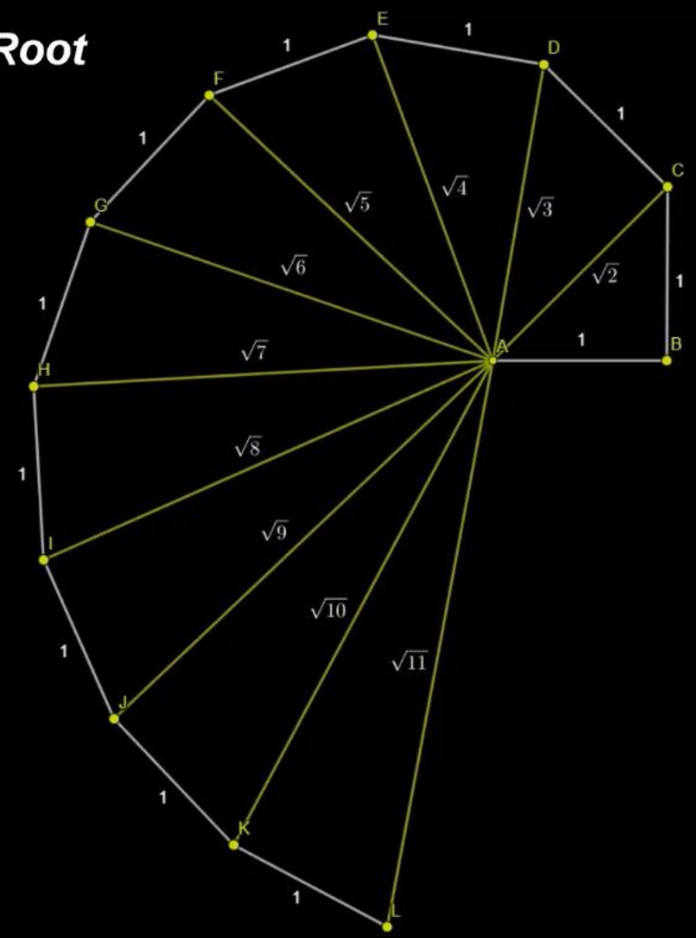

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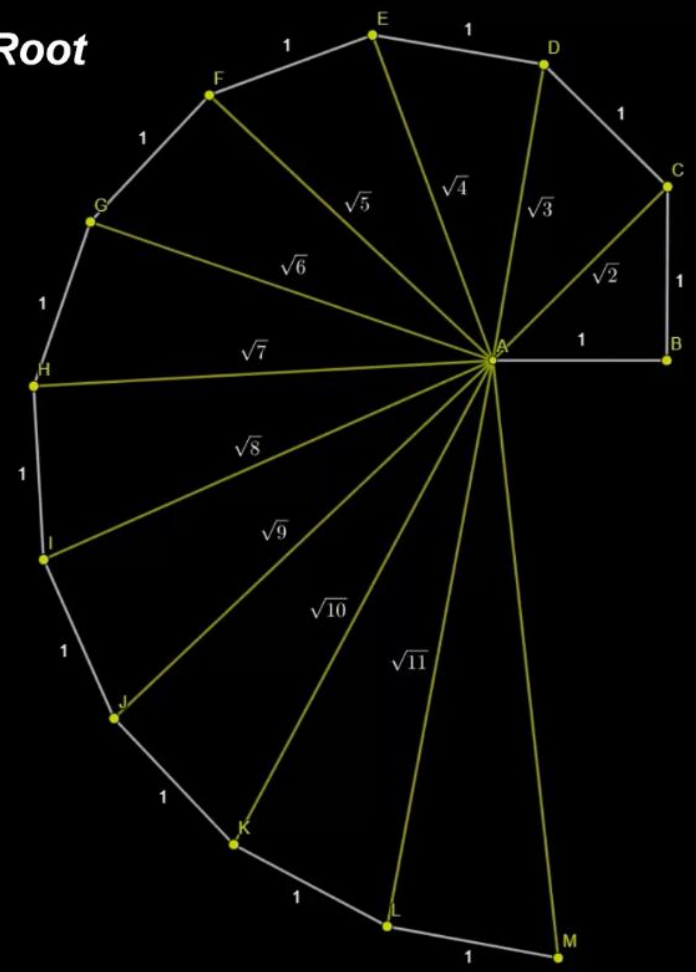

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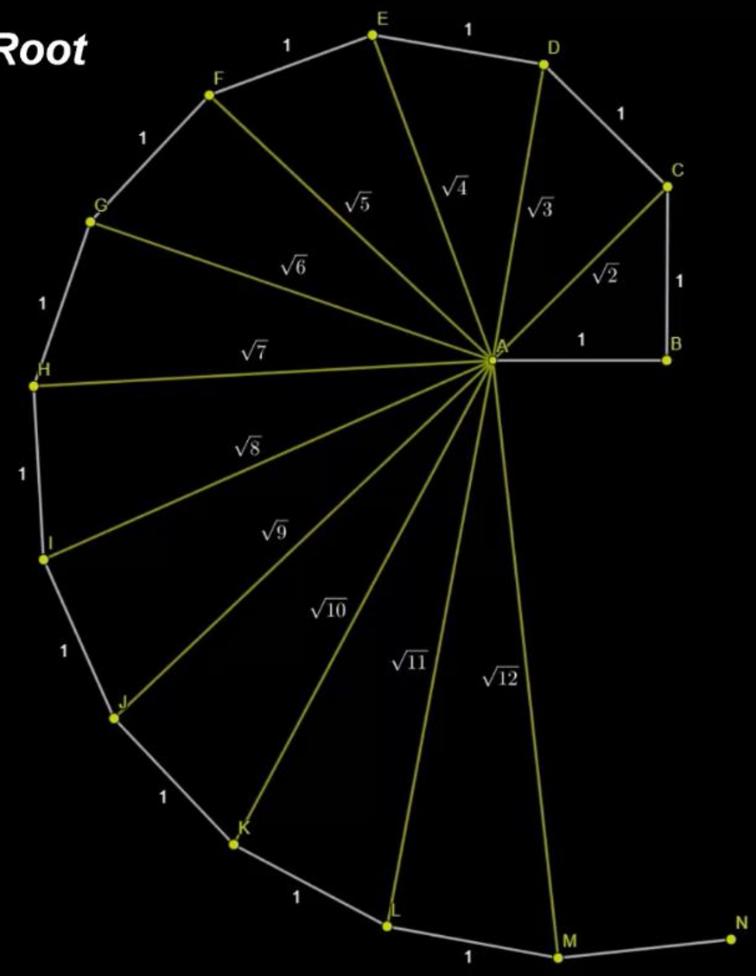

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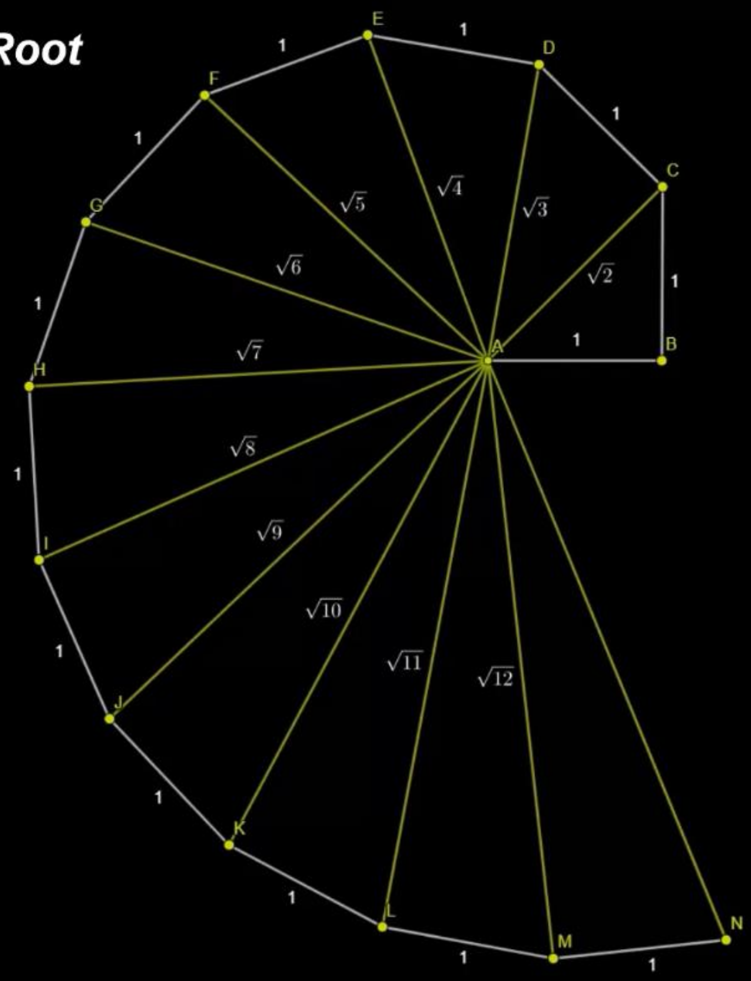

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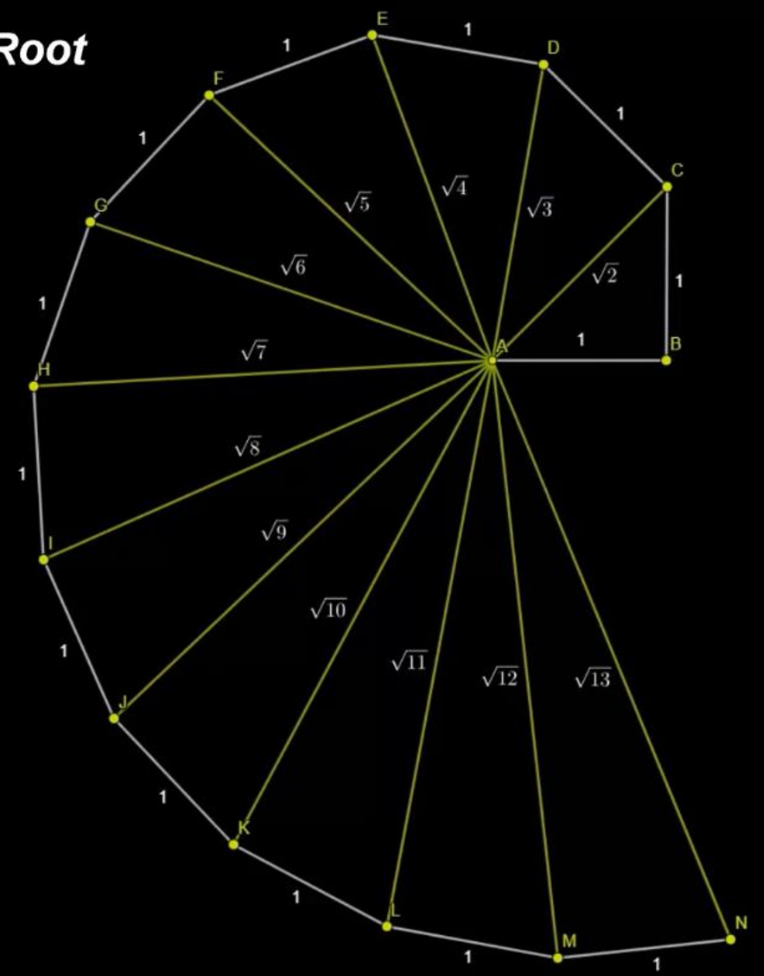

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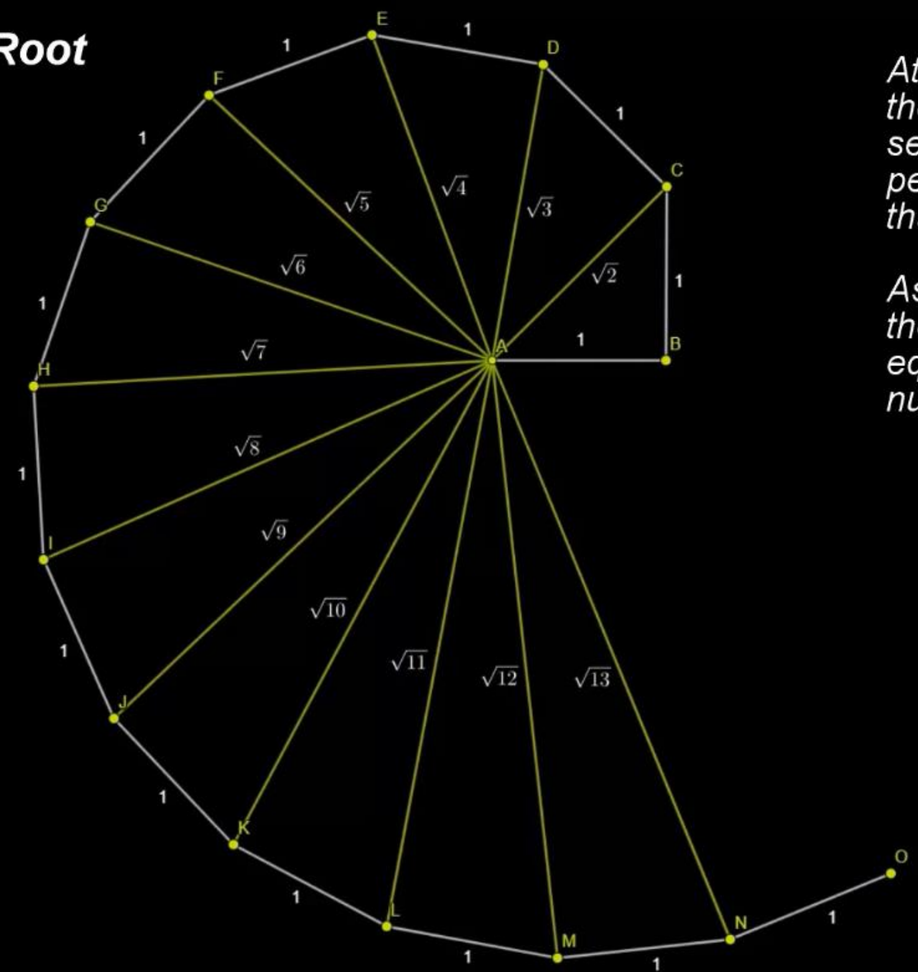

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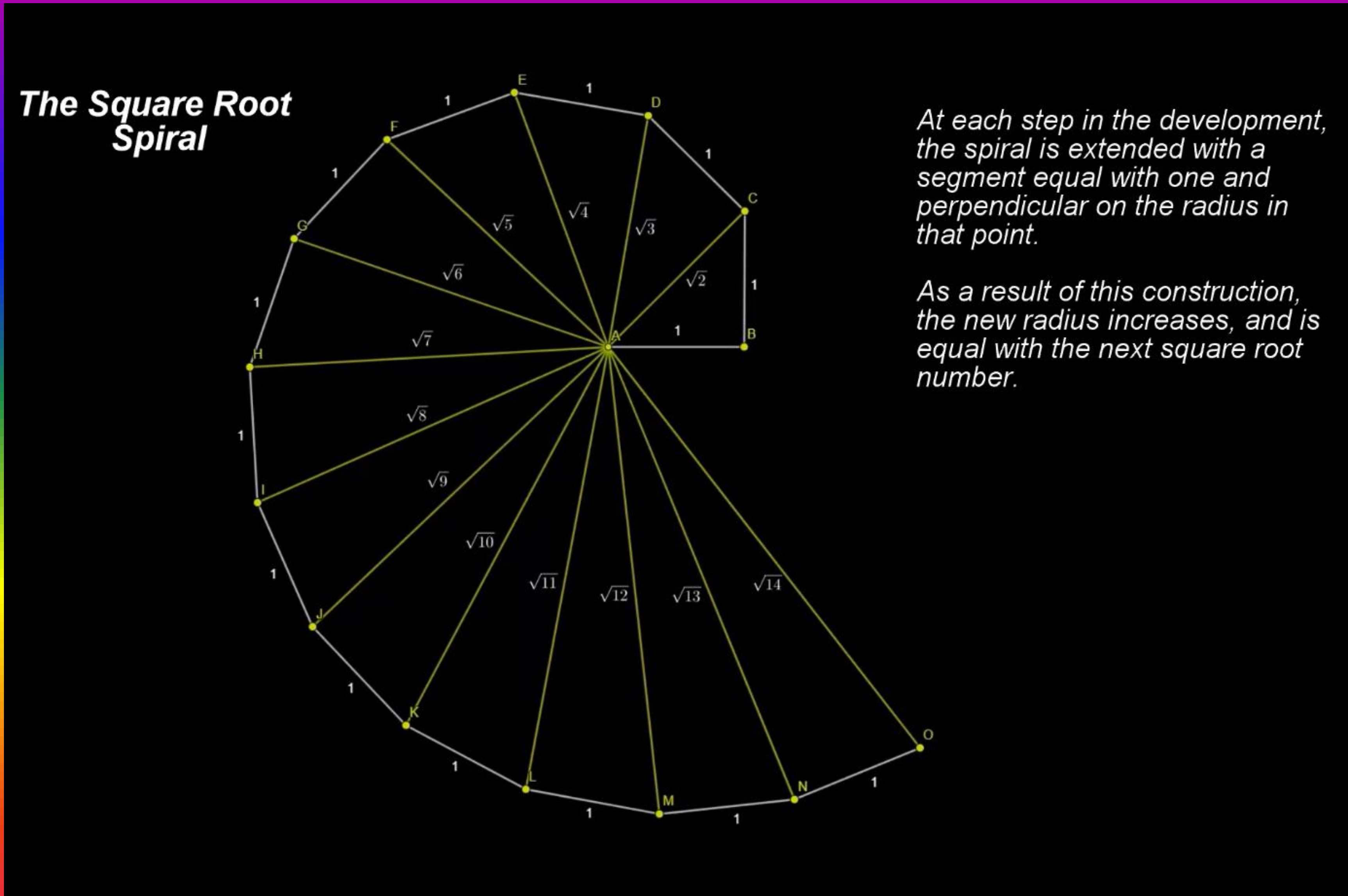

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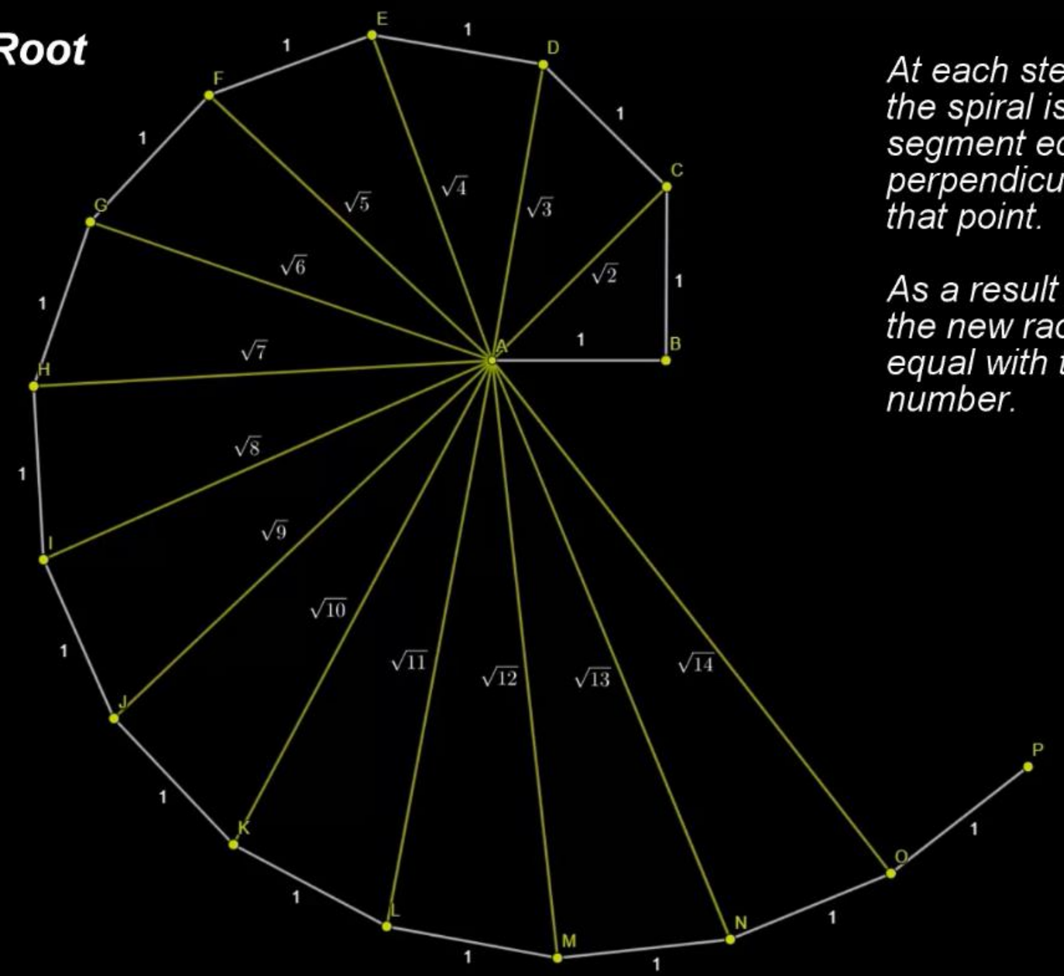

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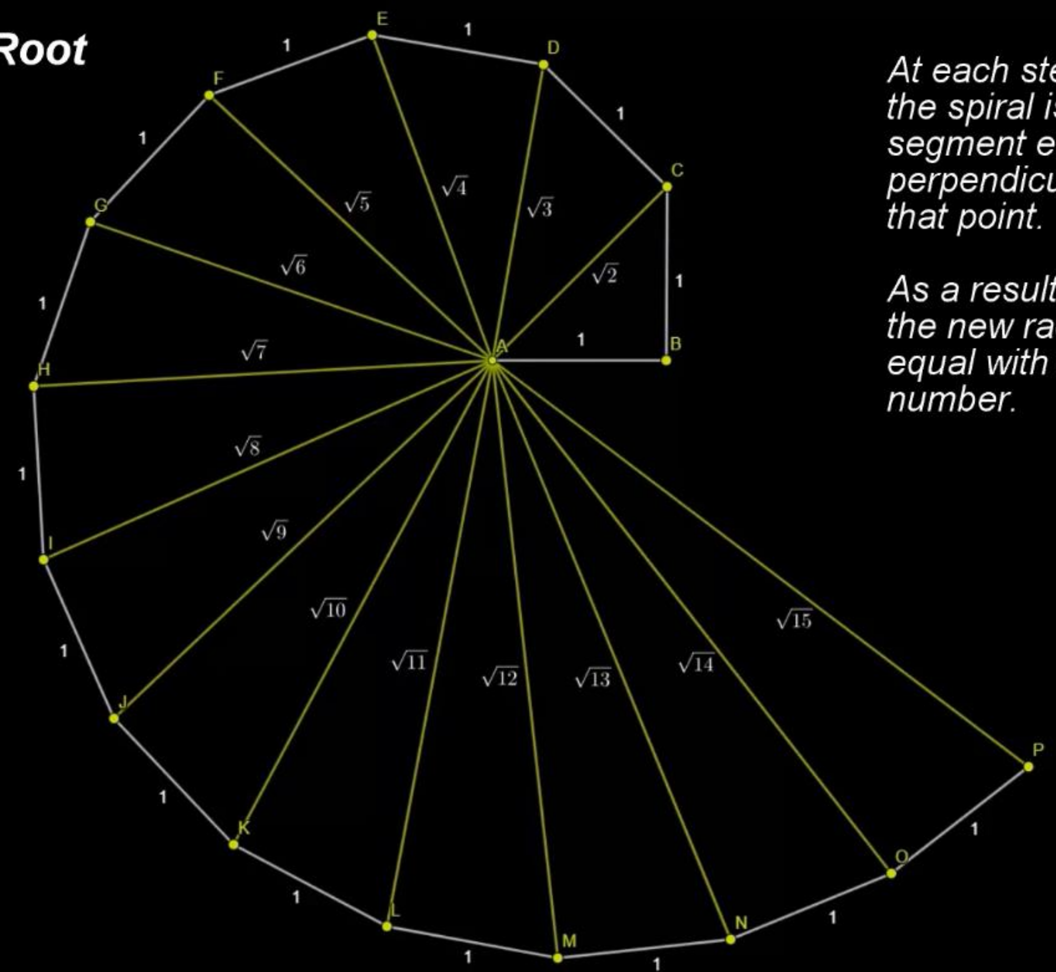

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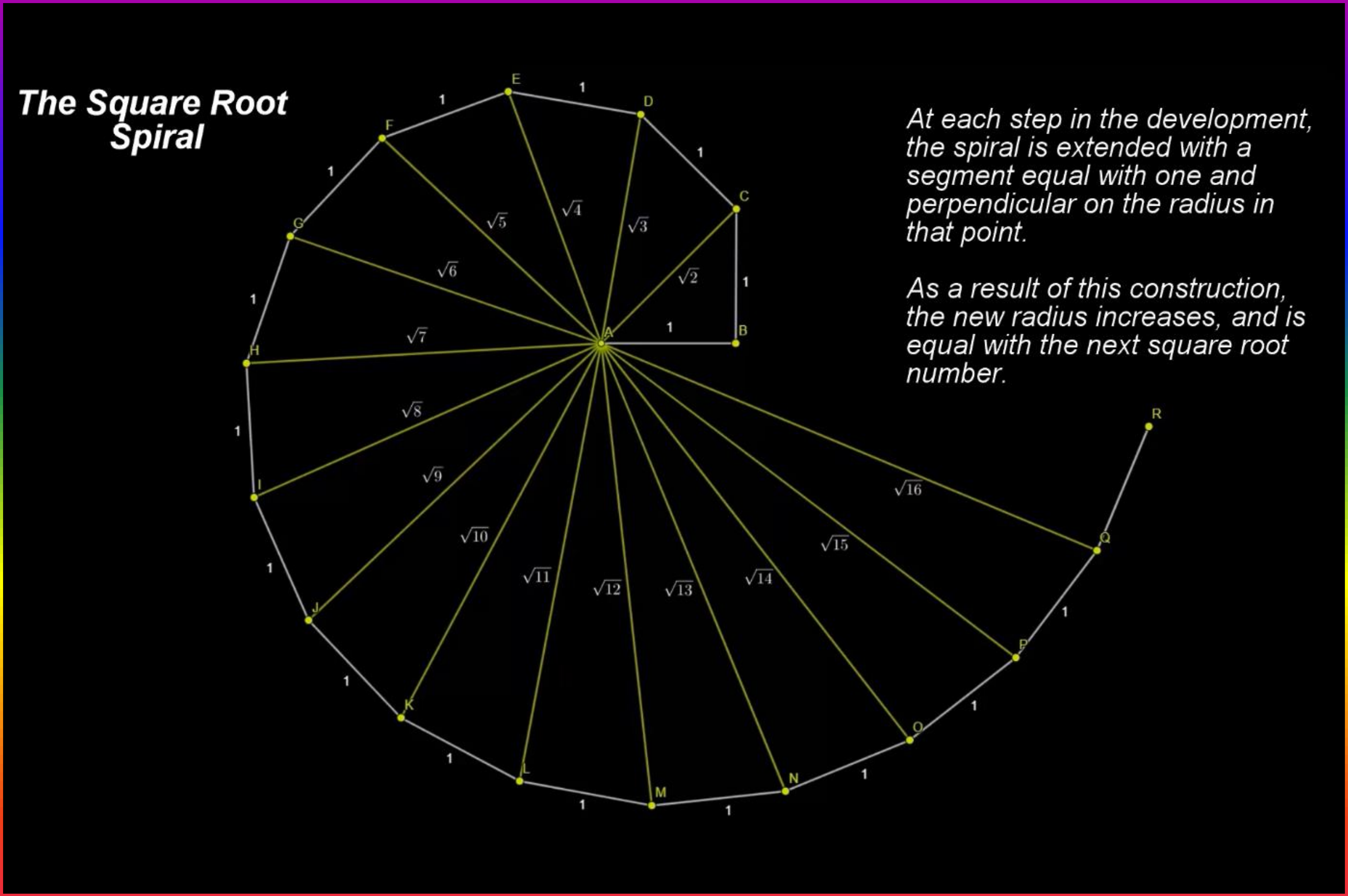

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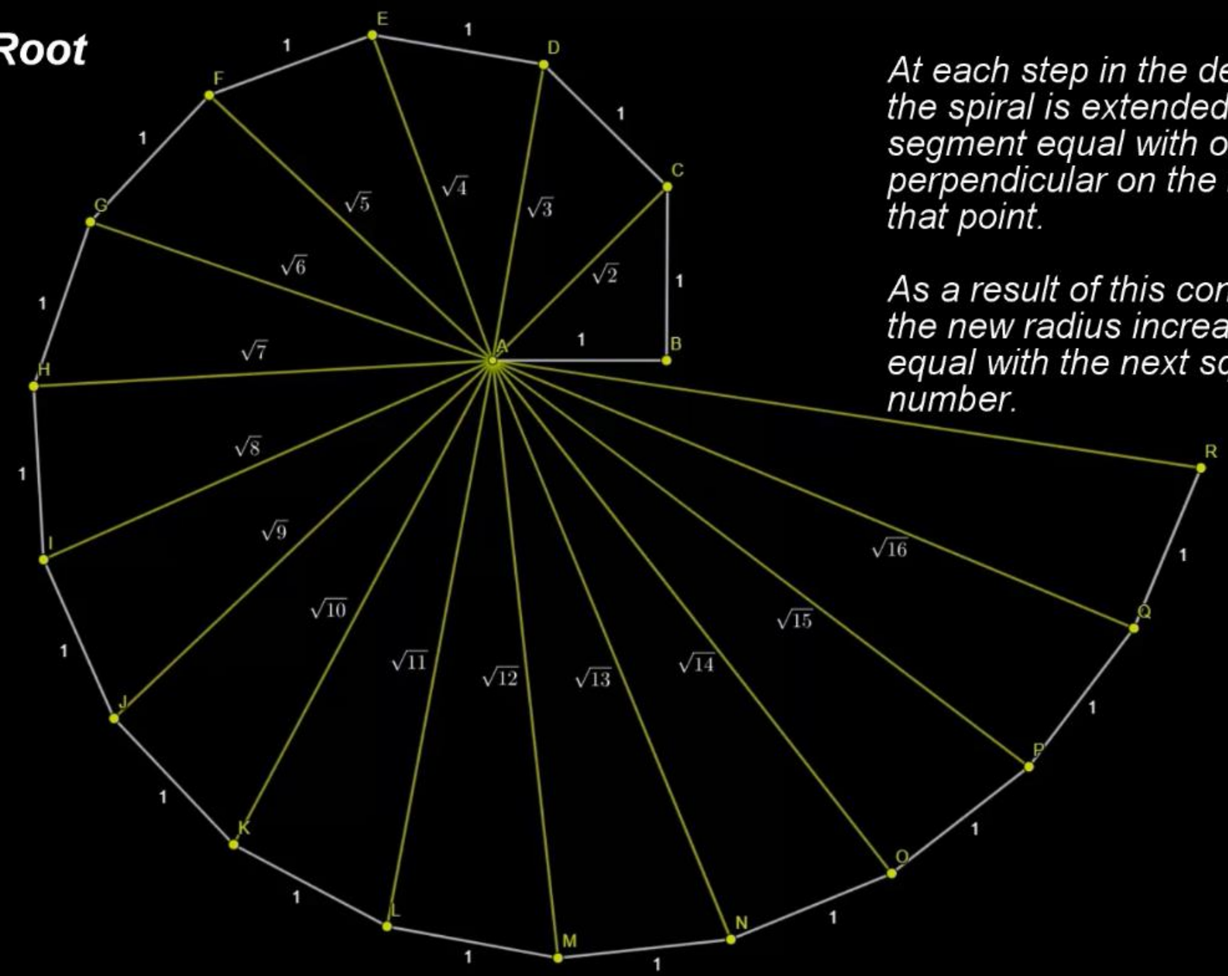

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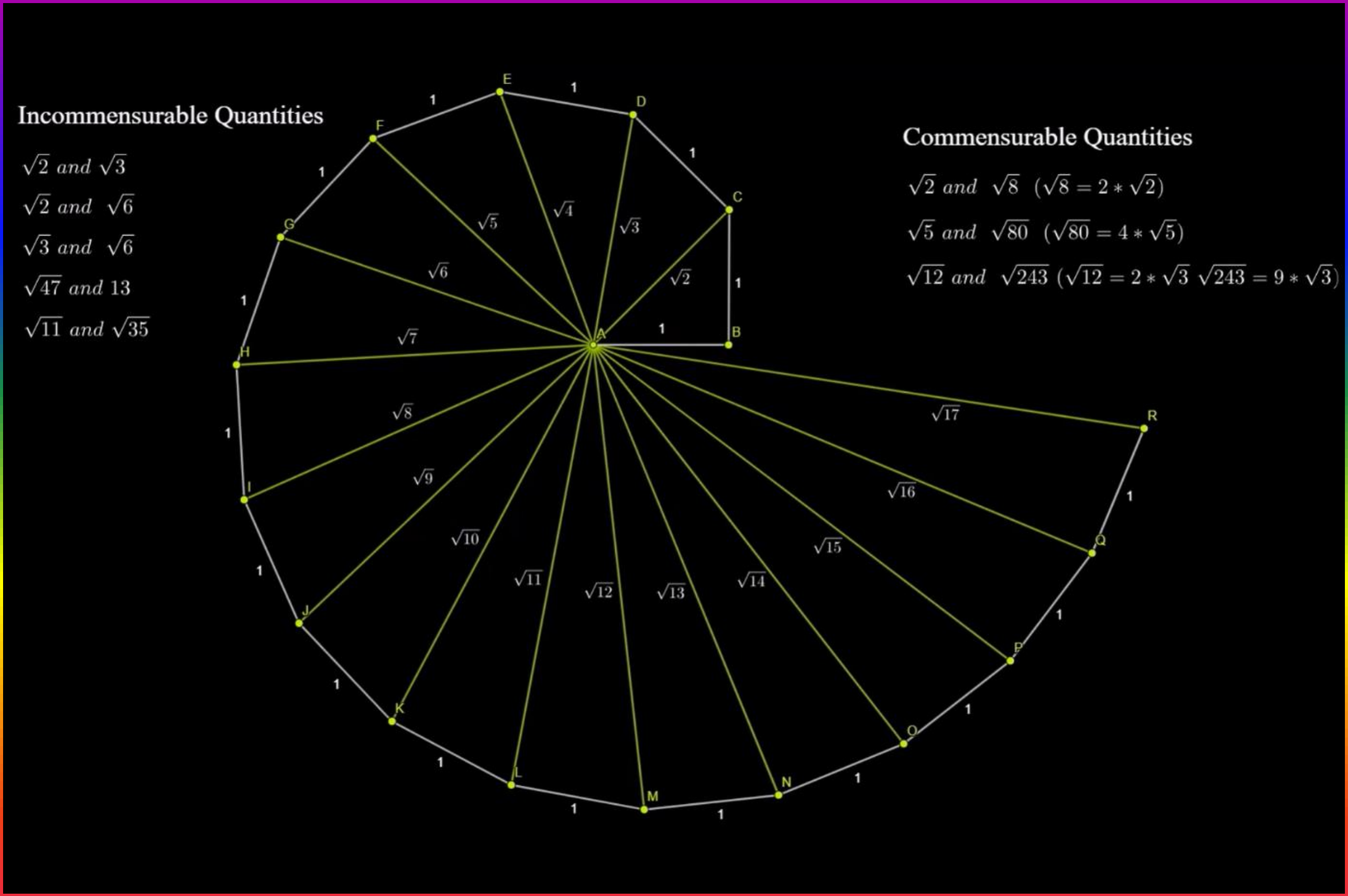


For example the following quantities are incommensurable:

$\sqrt{2}$ and $\sqrt{3}$; or

$\sqrt{2}$ and $\sqrt{6}$; or

$\sqrt{3}$ and $\sqrt{6}$;

Incommensurable Quantities

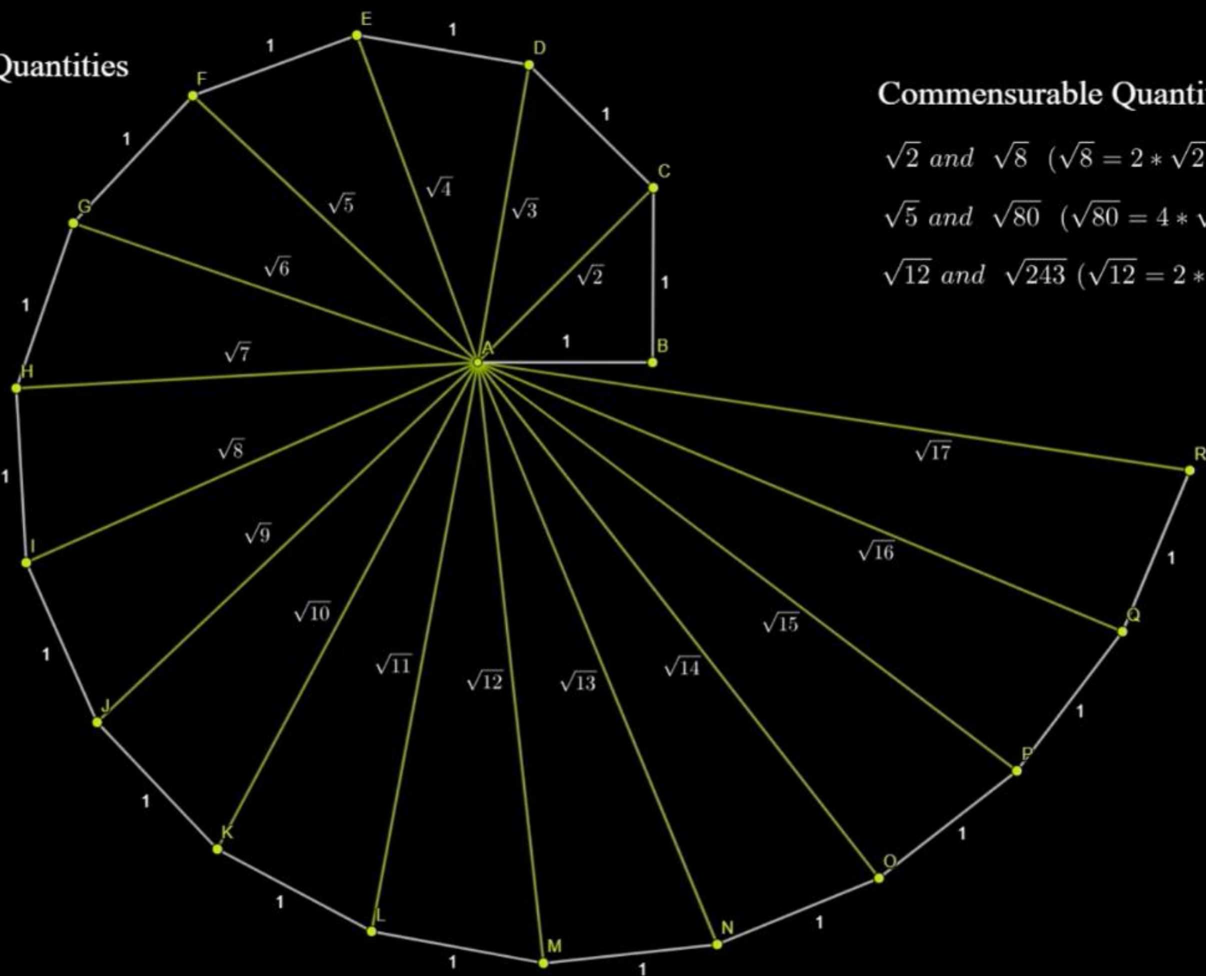
$\sqrt{2}$ *and* $\sqrt{3}$

$\sqrt{2}$ *and* $\sqrt{6}$

$\sqrt{3}$ *and* $\sqrt{6}$

$\sqrt{47}$ *and* 13

$\sqrt{11}$ *and* $\sqrt{35}$



Commensurable Quantities

$\sqrt{2}$ *and* $\sqrt{8}$ $(\sqrt{8} = 2 * \sqrt{2})$

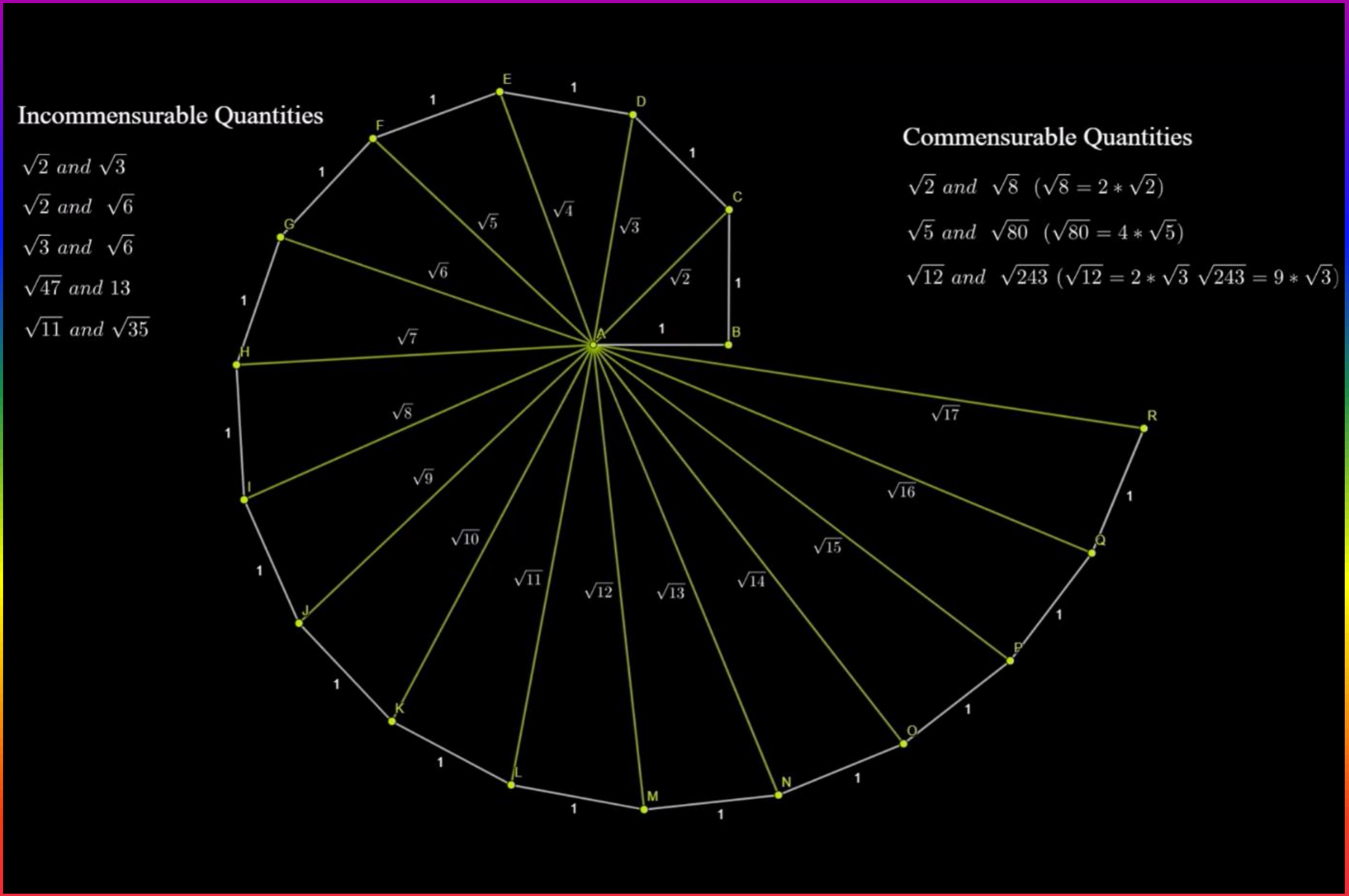
$\sqrt{5}$ *and* $\sqrt{80}$ $(\sqrt{80} = 4 * \sqrt{5})$

$\sqrt{12}$ *and* $\sqrt{243}$ $(\sqrt{12} = 2 * \sqrt{3}\ \sqrt{243} = 9 * \sqrt{3})$

Also, we can include here:

$\sqrt{47}$ and 13; or

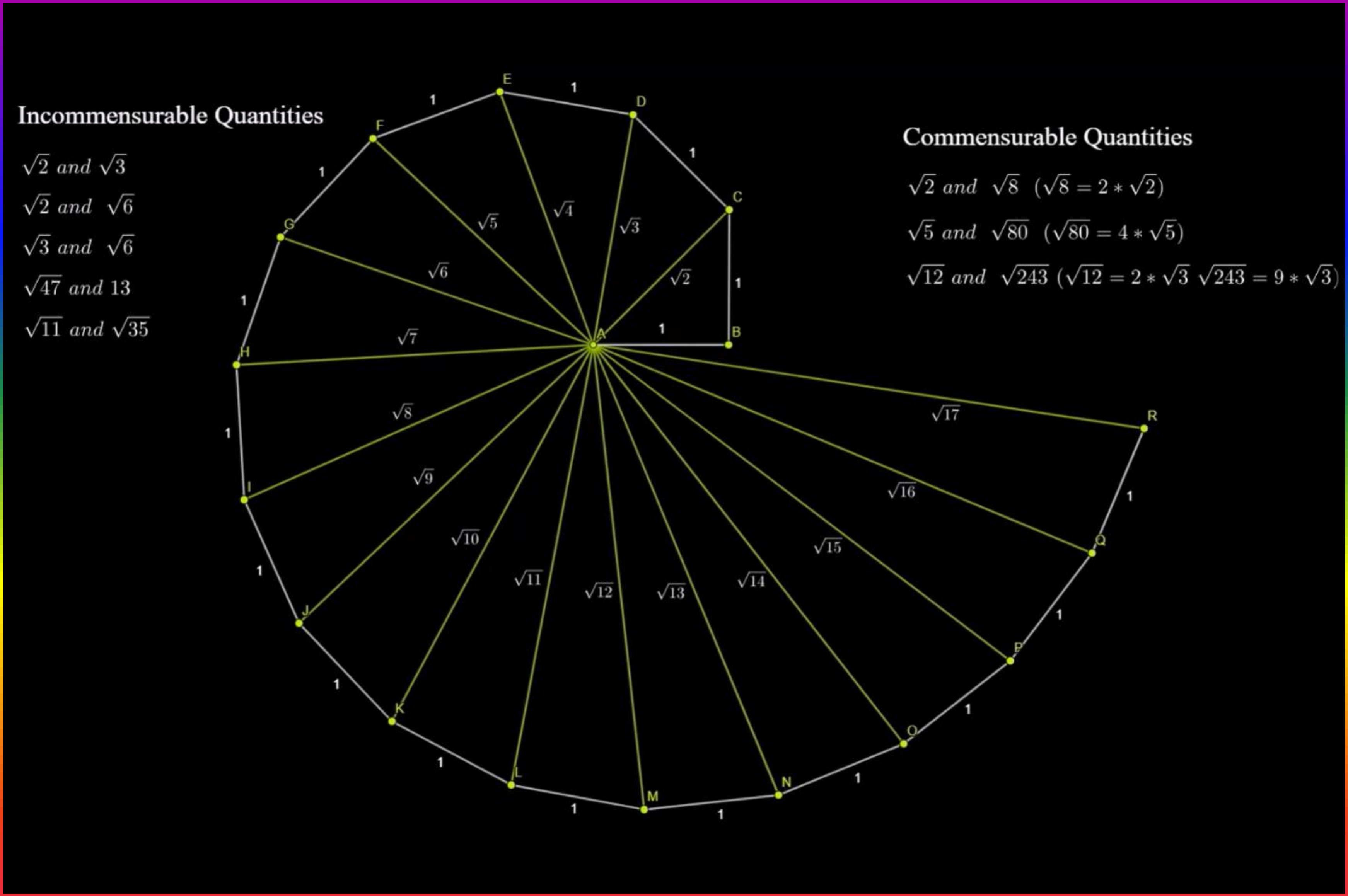
$\sqrt{11}$ and $\sqrt{35}$



So, the number of incommensurable magnitudes is infinite.

The existence of incommensurable magnitudes ***is not some kind of very rare exception***.

In fact ***this is the rule***.



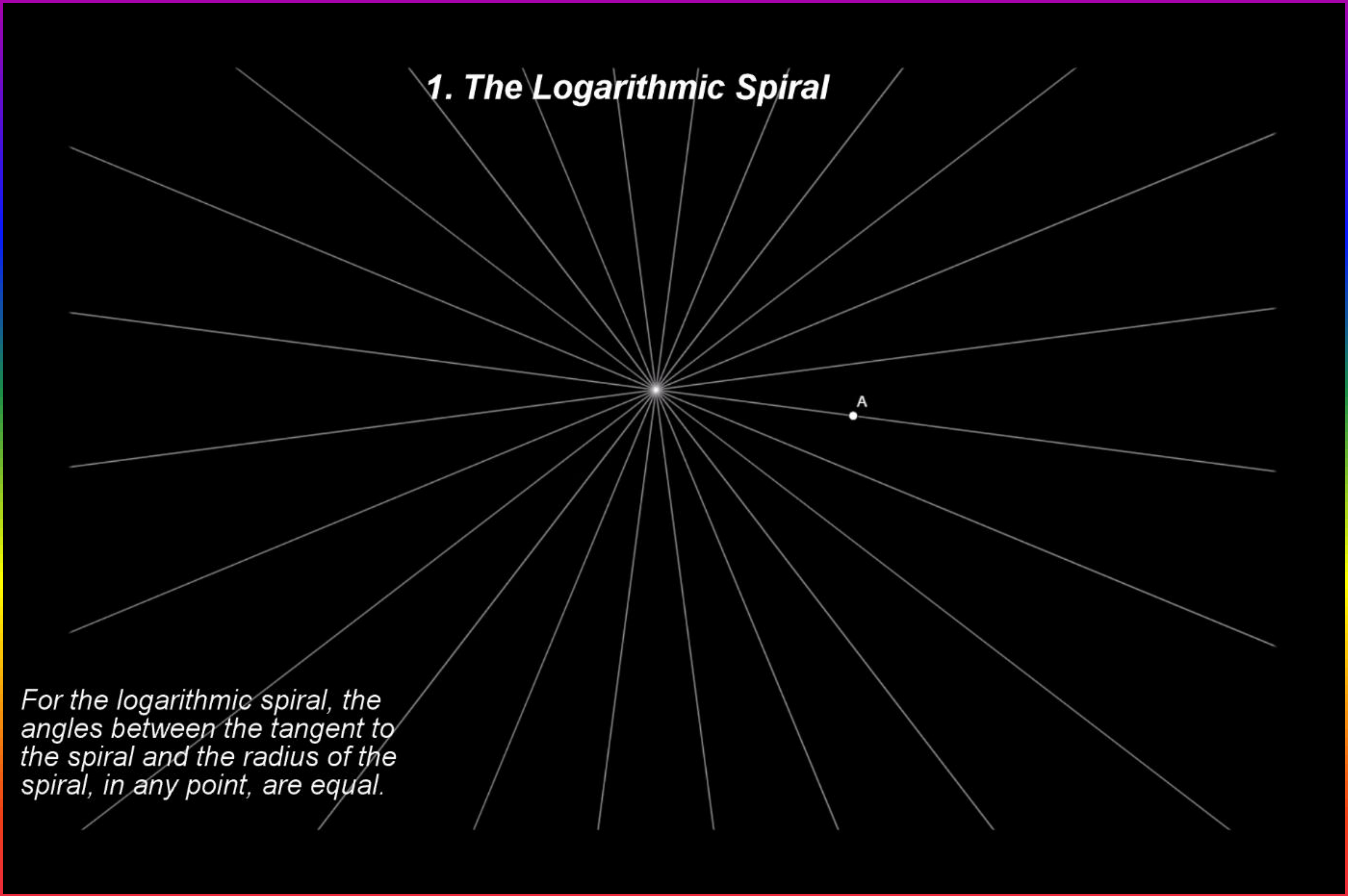
We also shall note that quantities like:

$\sqrt{2}$ and $\sqrt{8}$; or

$\sqrt{5}$ and $\sqrt{80}$; or

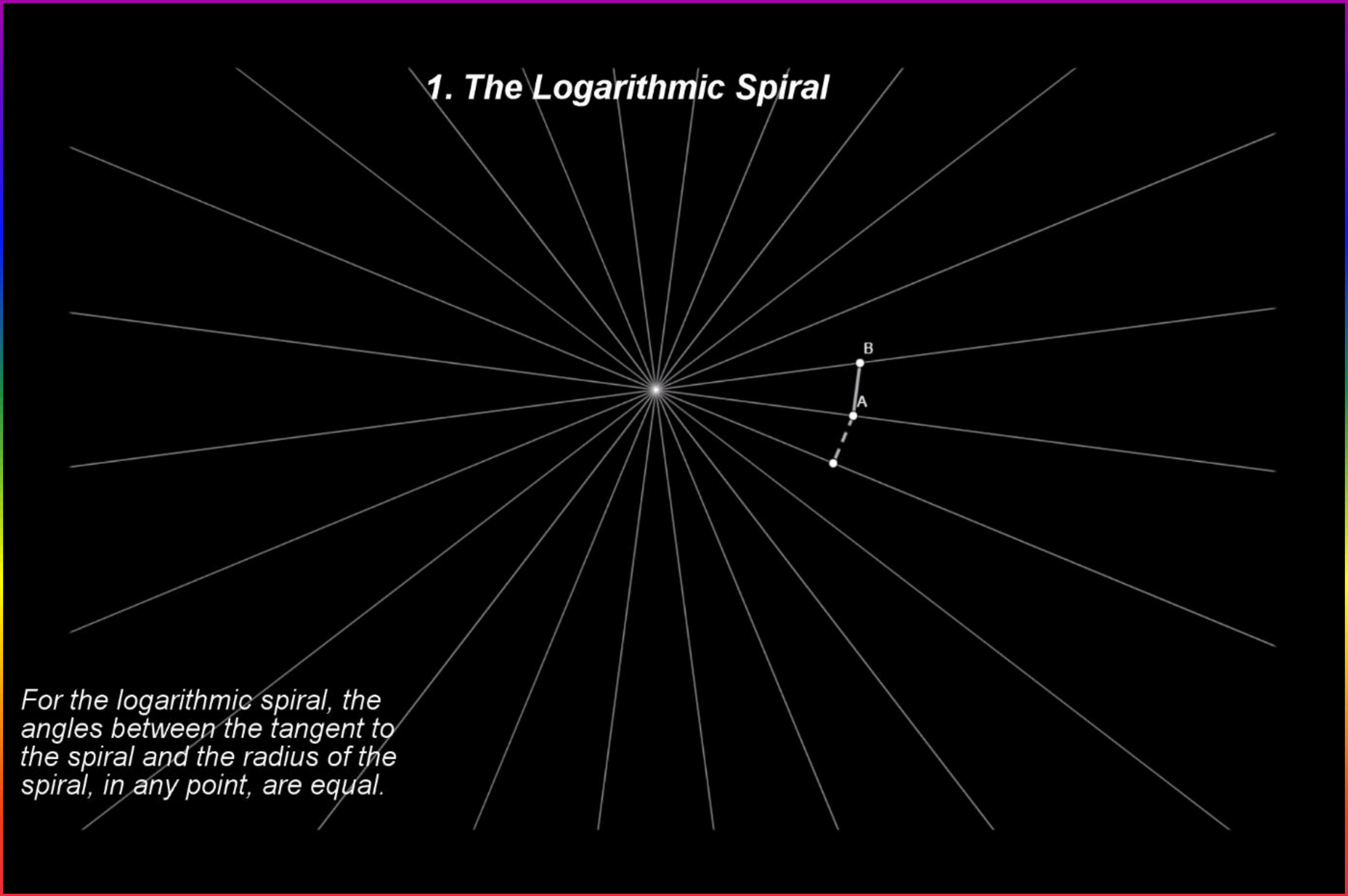
$\sqrt{12}$ and $\sqrt{243}$;

are commensurable Quantities.

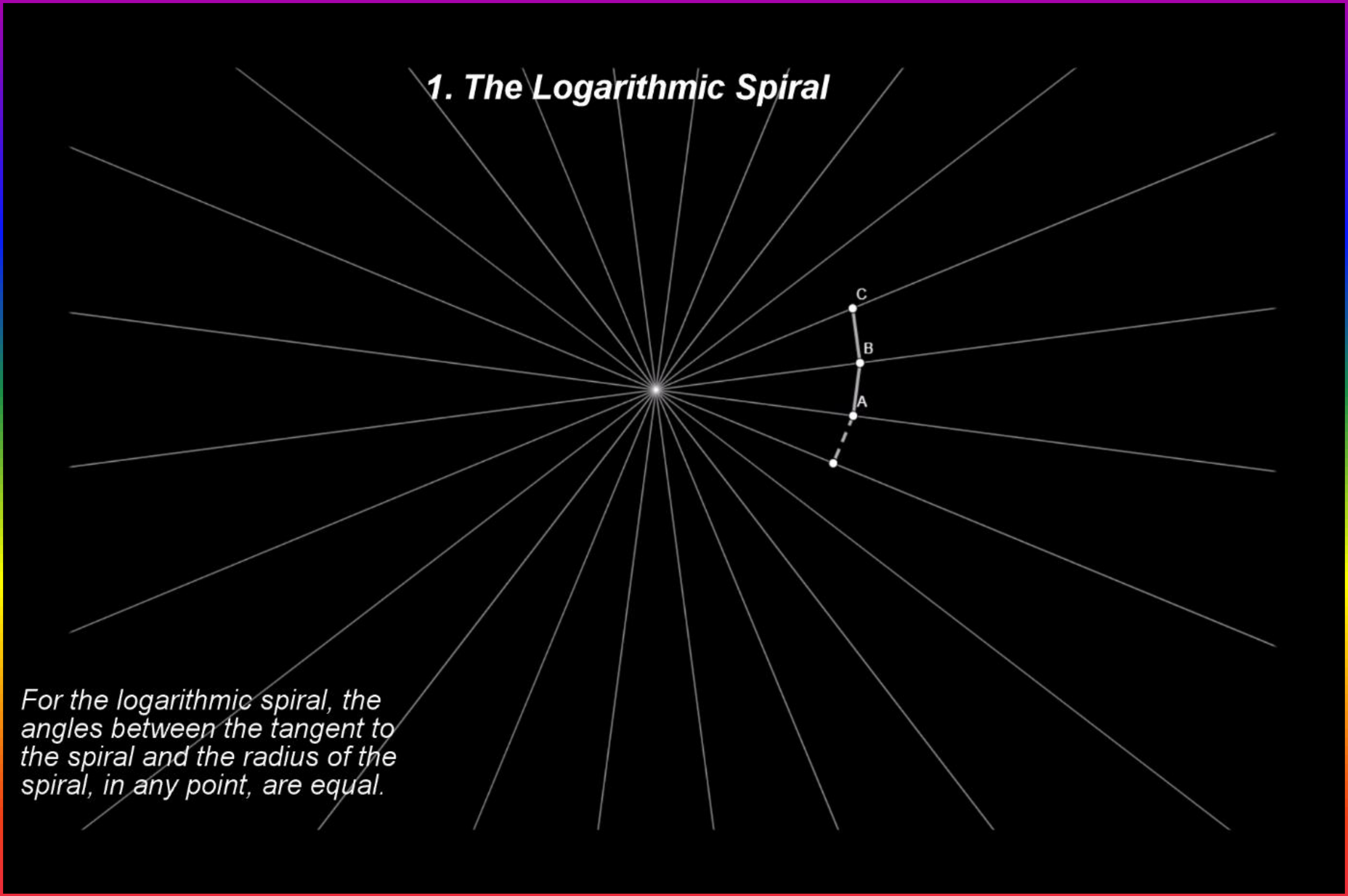


Let's look next into two other well known spirals in mathematics, namely ***the logarithmic spiral*** and the Archimedean spiral.

More precisely, let us look to the methods of constructing these two spirals, based on their definitions.



1. For the ***logarithmic spiral*** the angles between the tangent to the spiral and the radius of the spiral, in any point, are equal.



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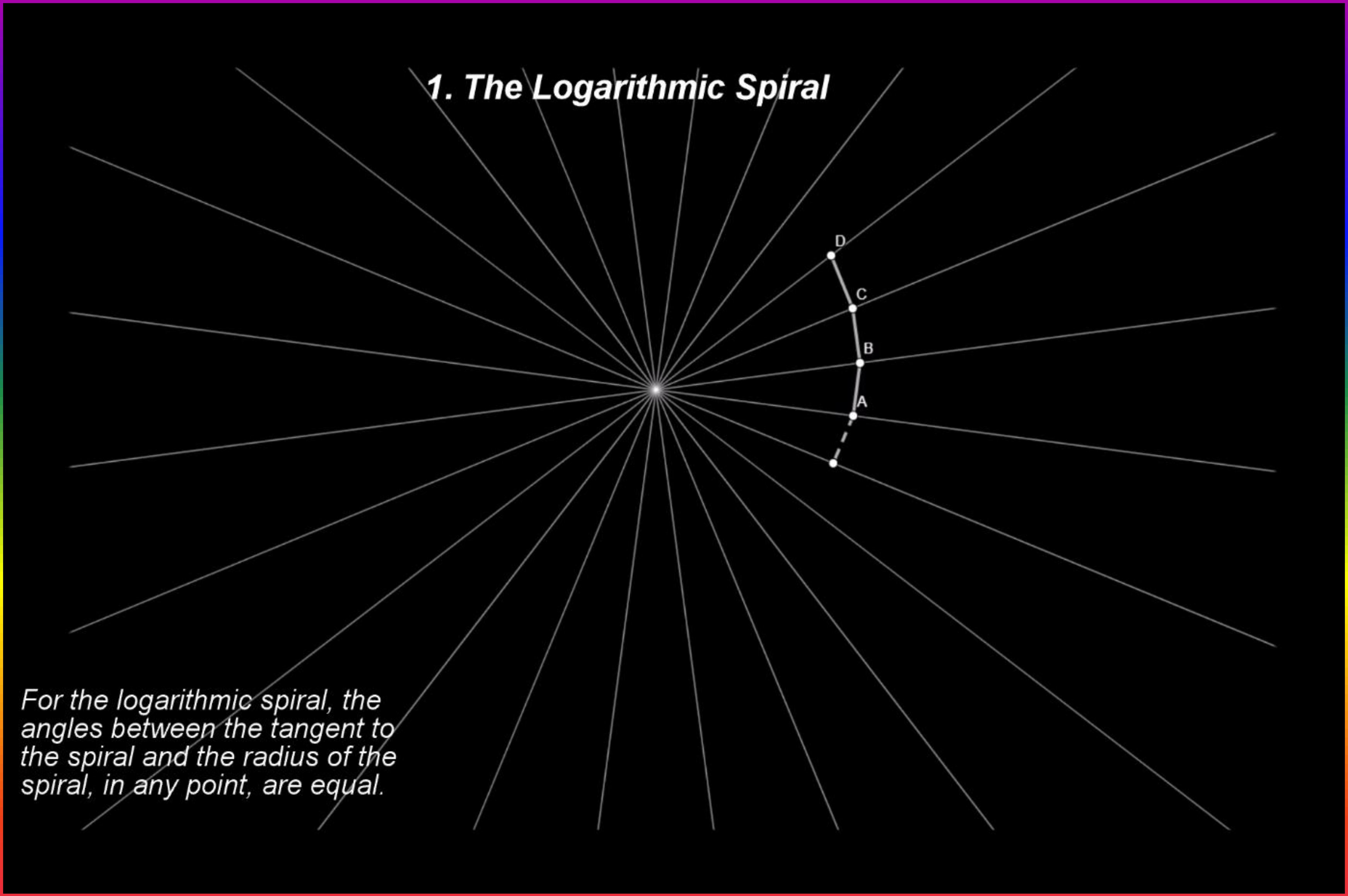
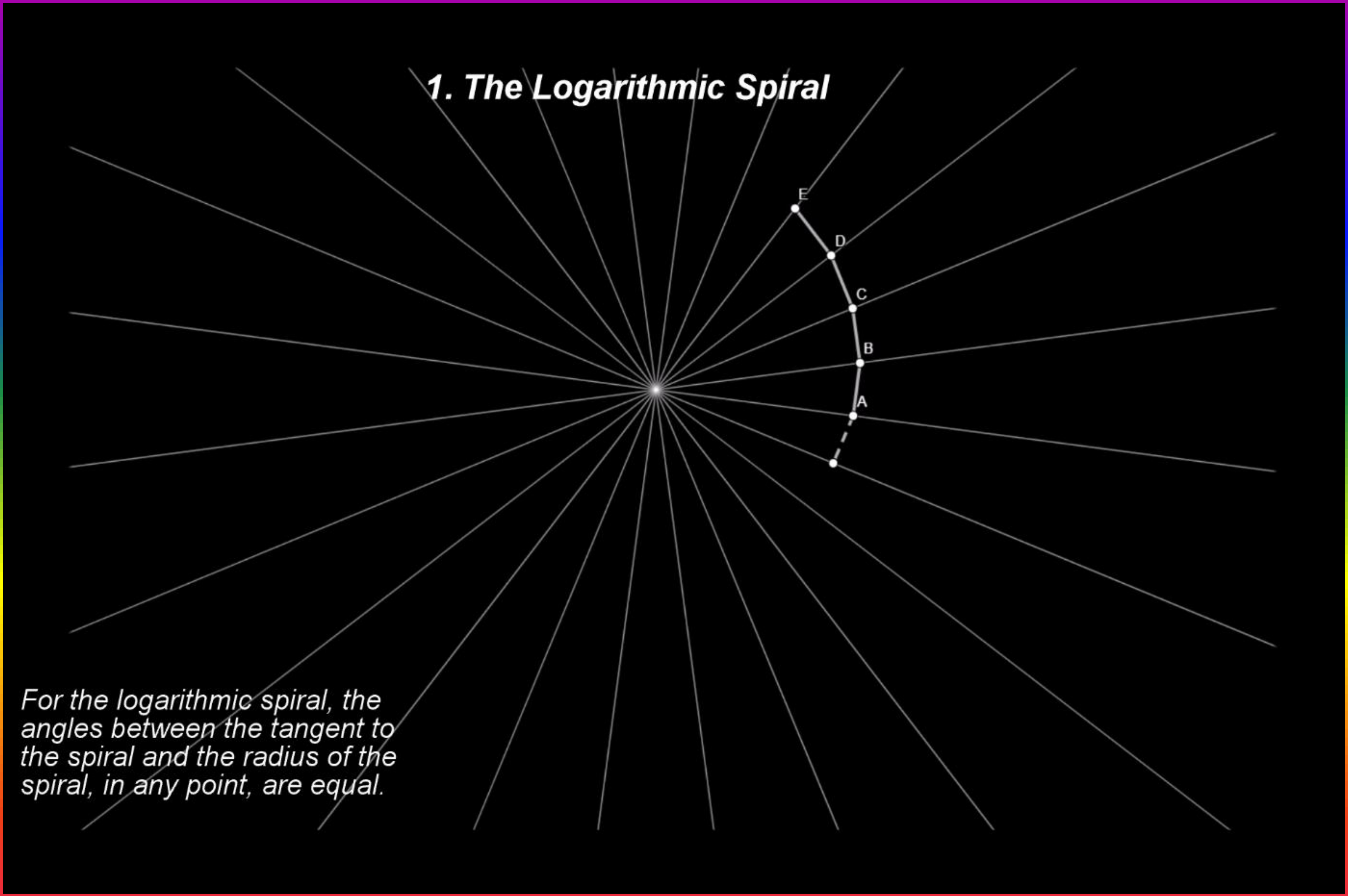
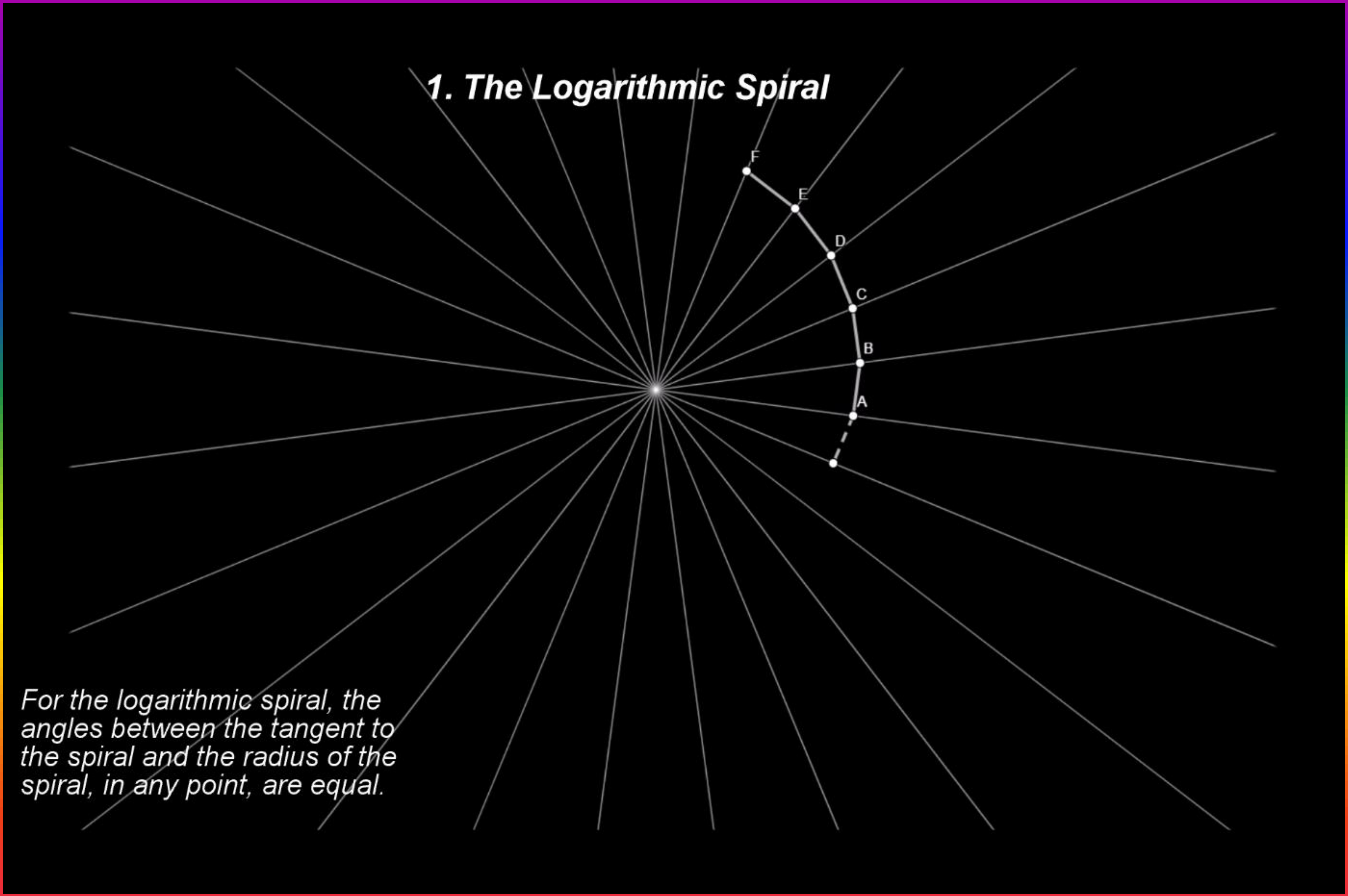


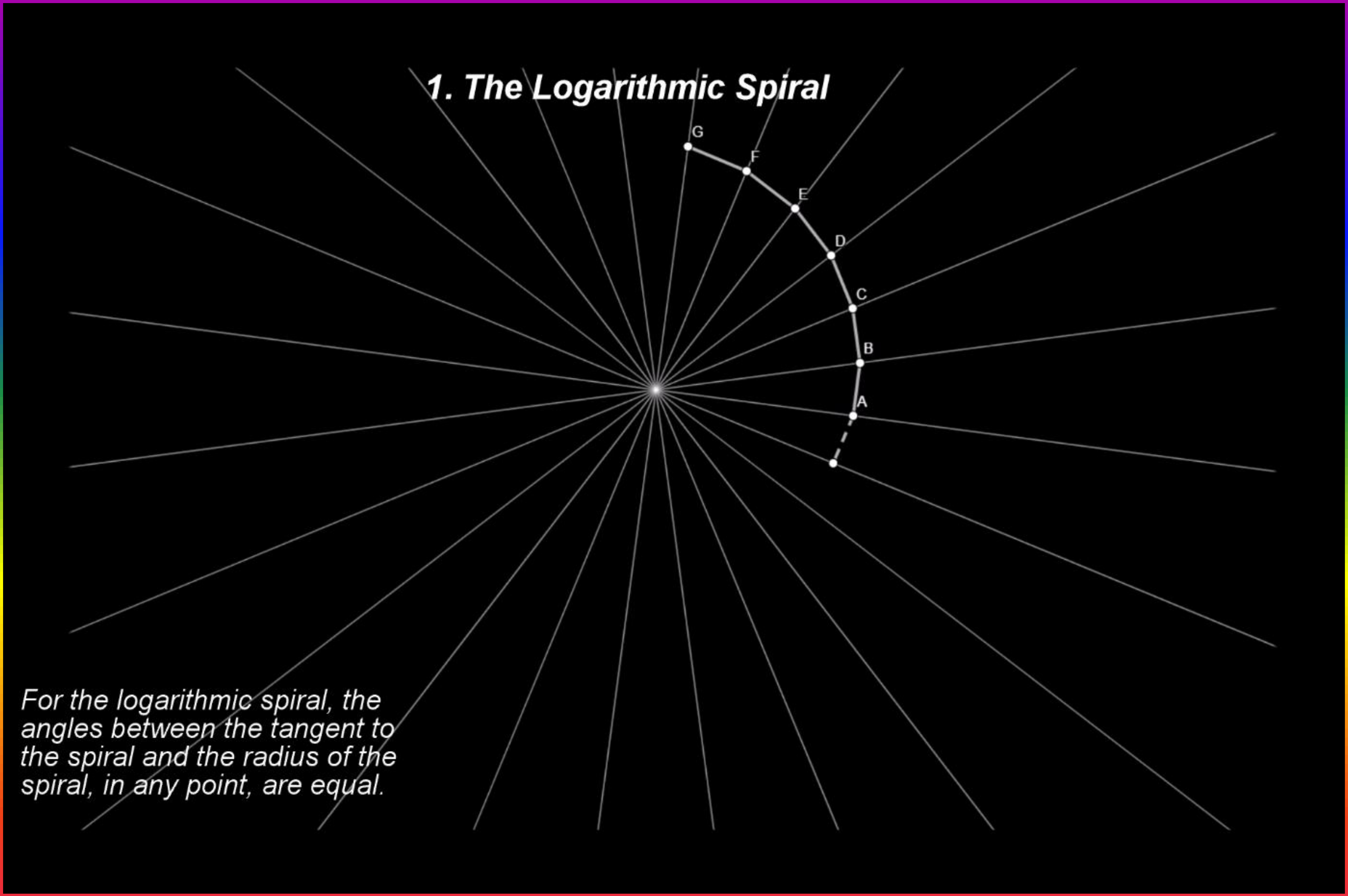
Let’s consider the specific logarithmic spiral with the angles between the tangents and the radius equal with 90 degrees.



Let's consider the specific logarithmic spiral with the angles between the tangents and the radius equal with 90 degrees.



When the angles between all the radiuses are equal one can show that intersection points, between any radius and the spiral, are distributed in geometrical progression.



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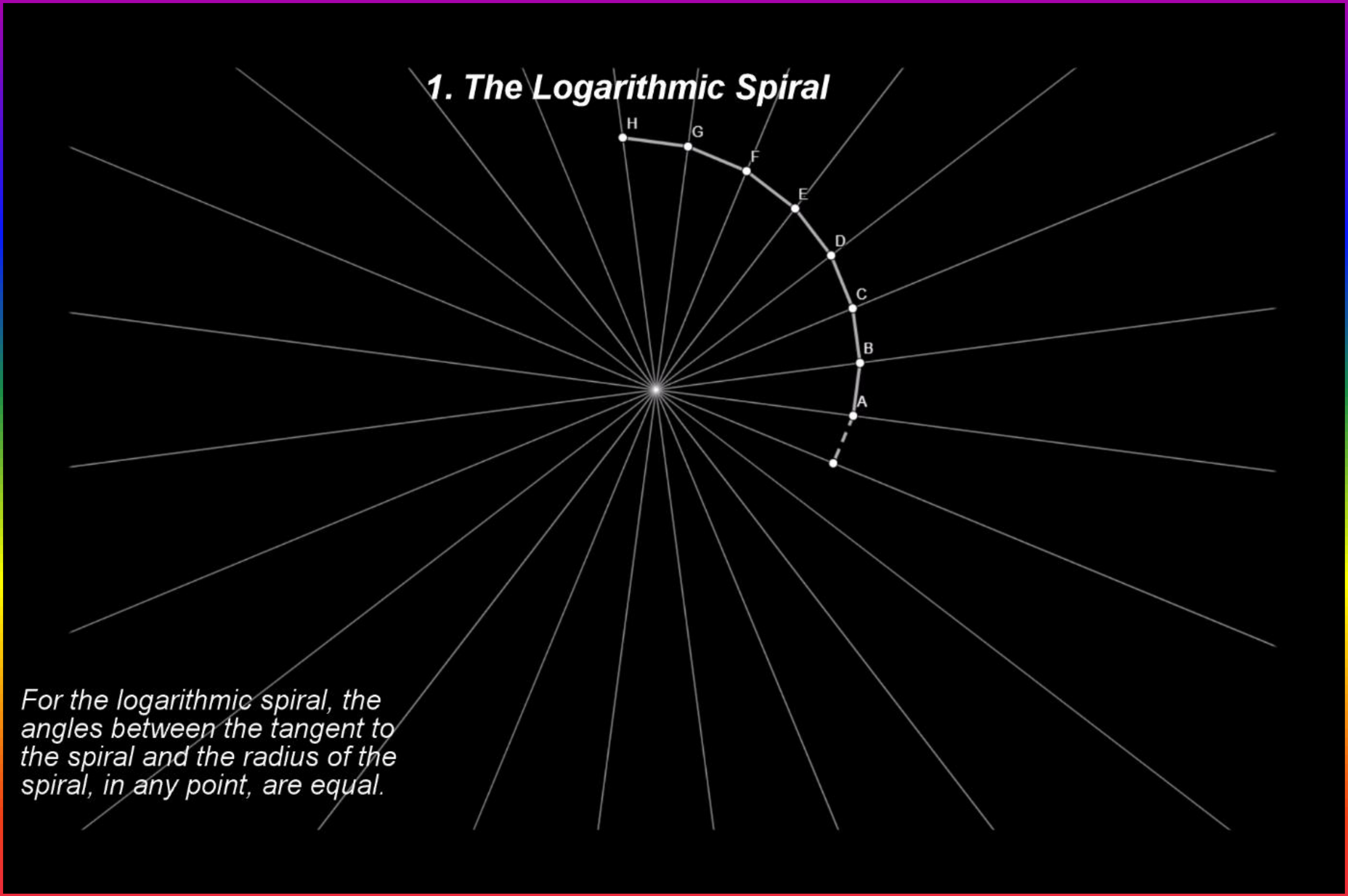

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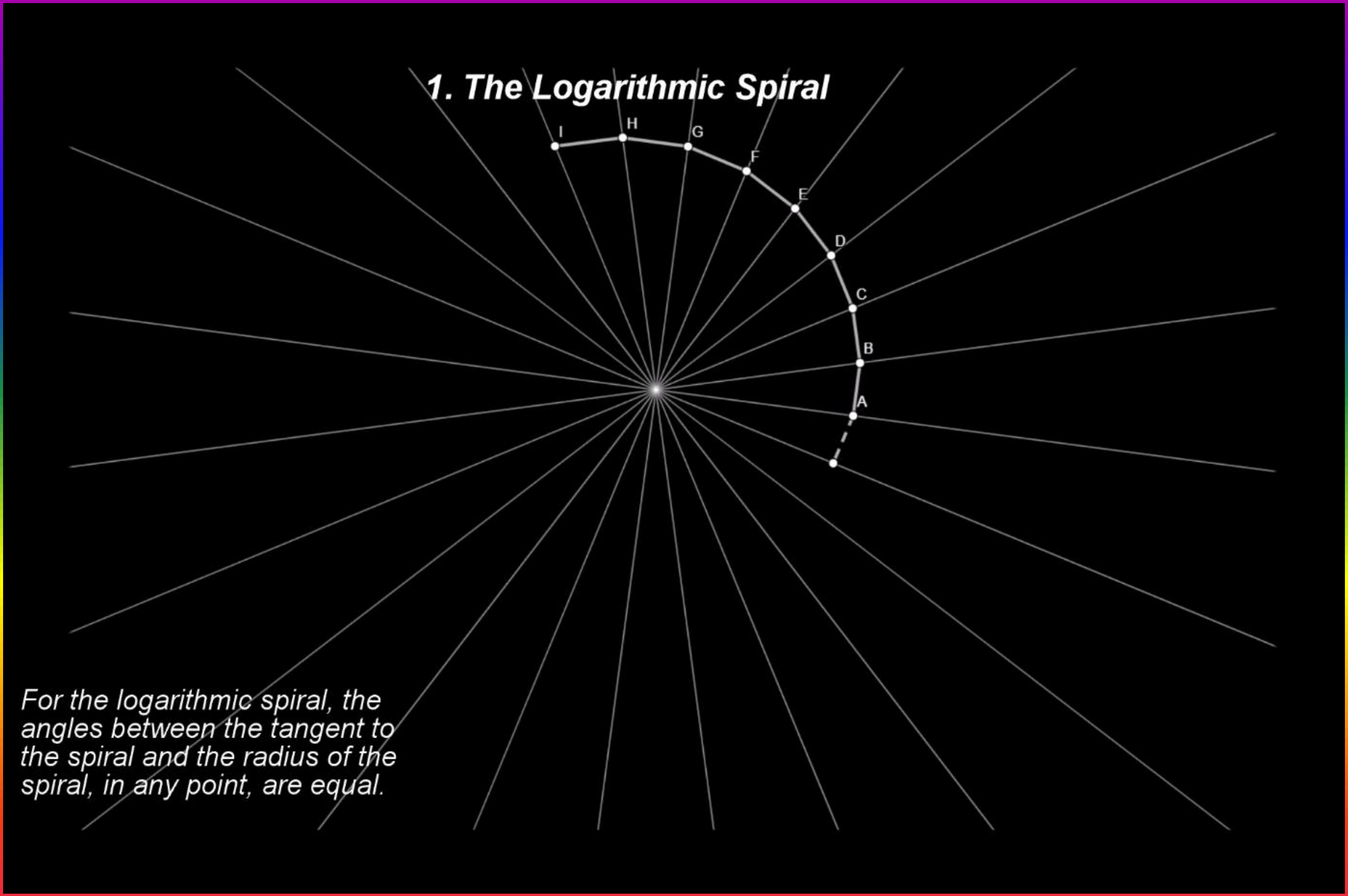

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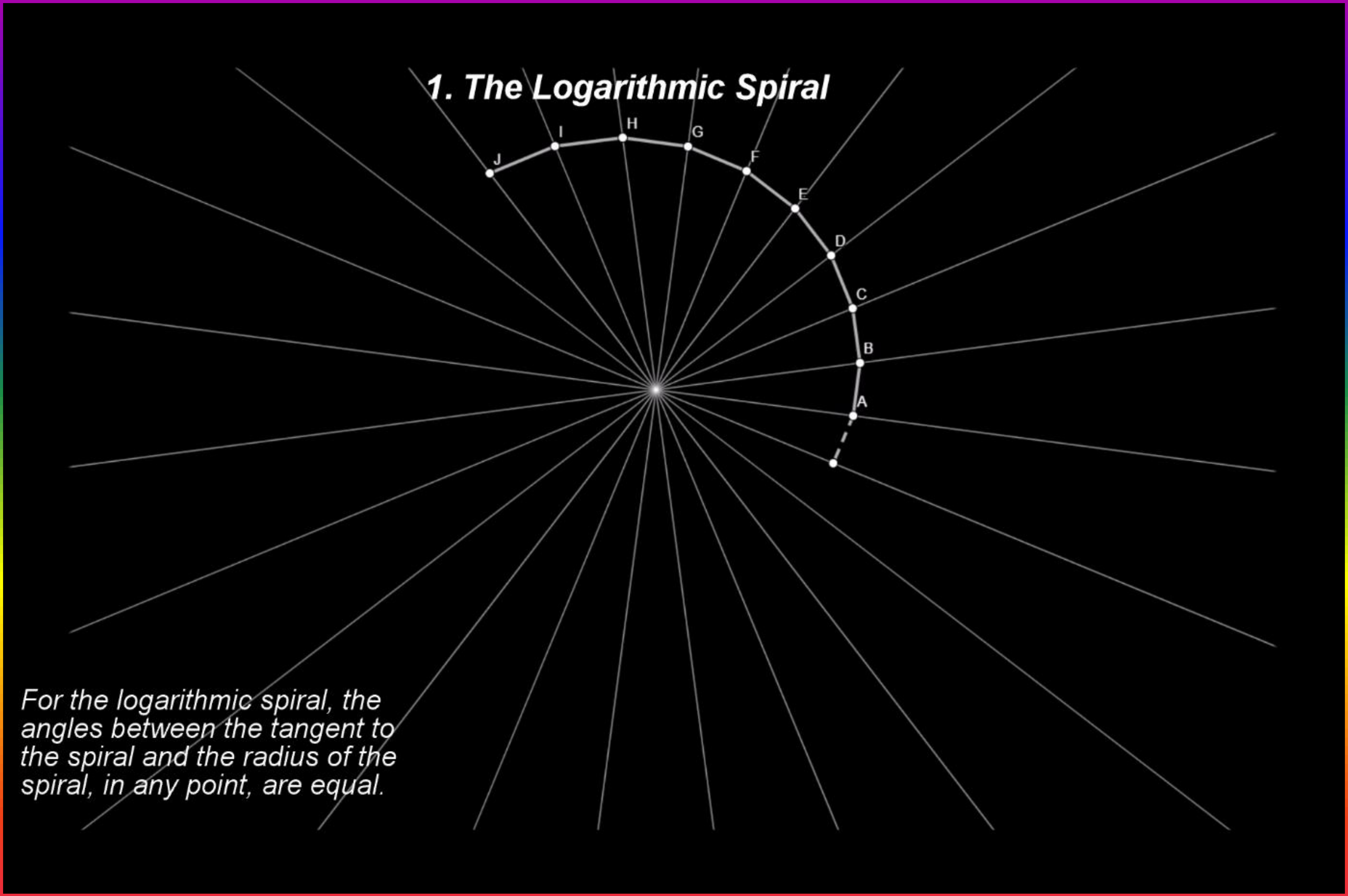

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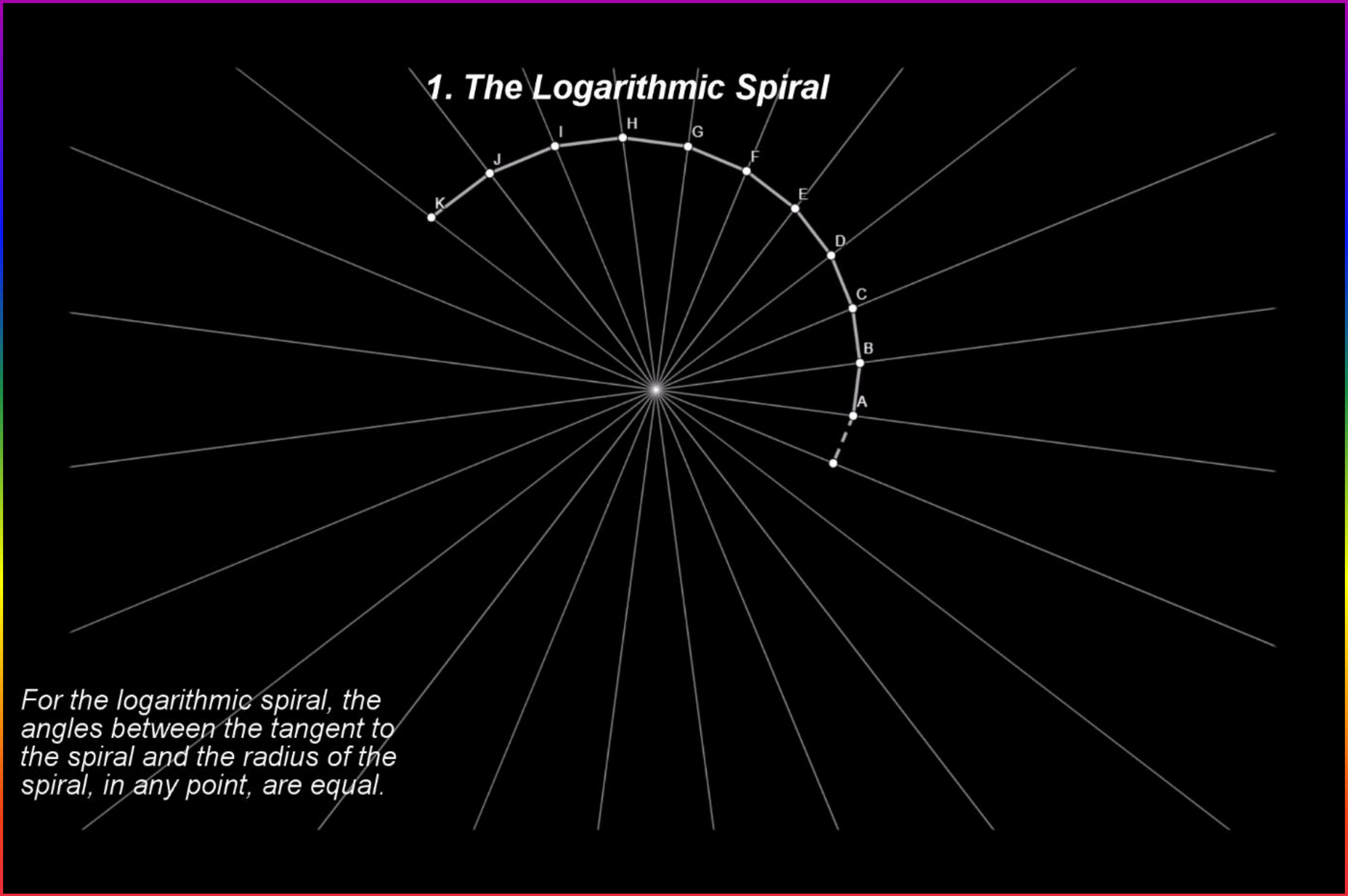

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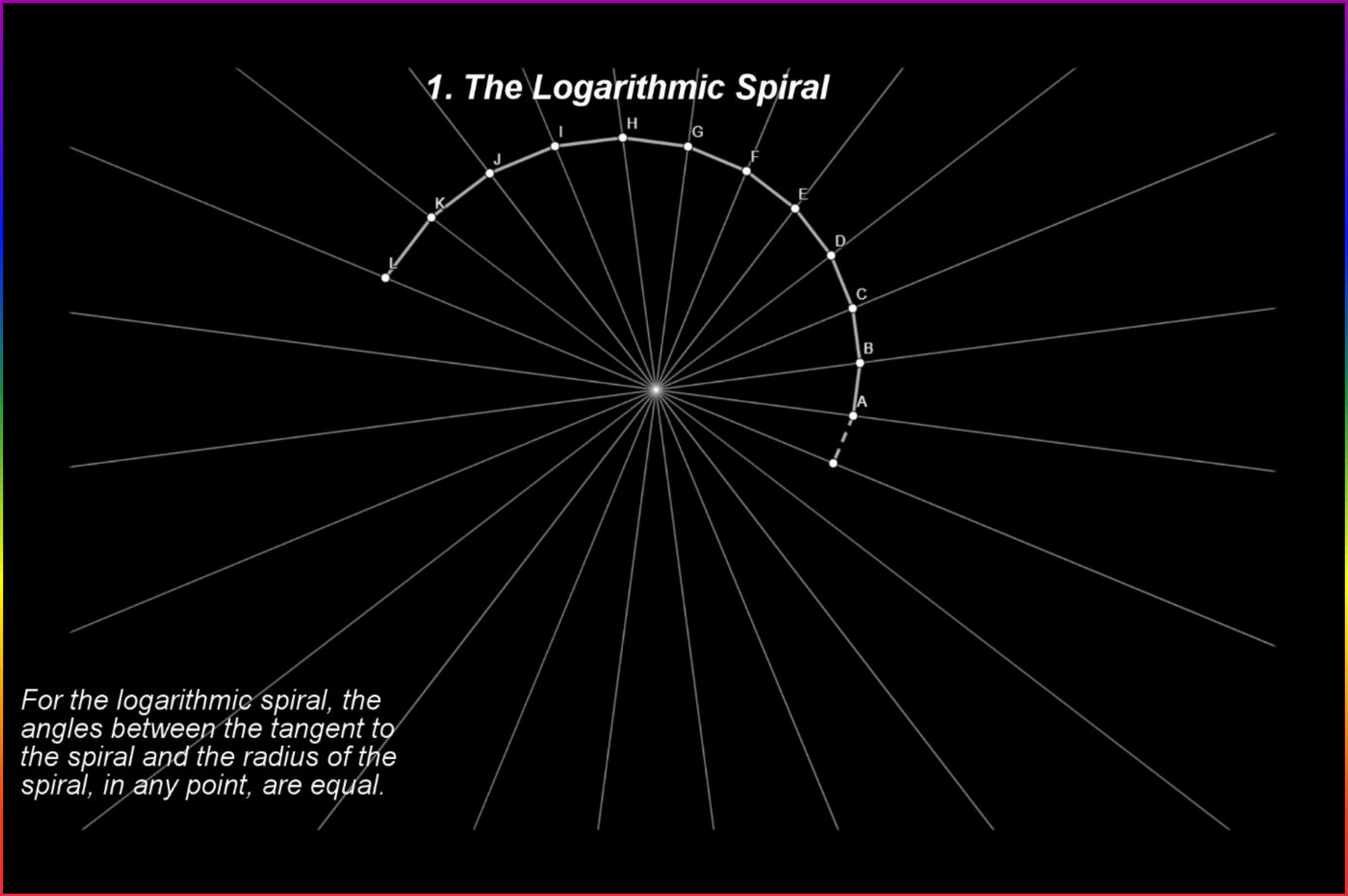

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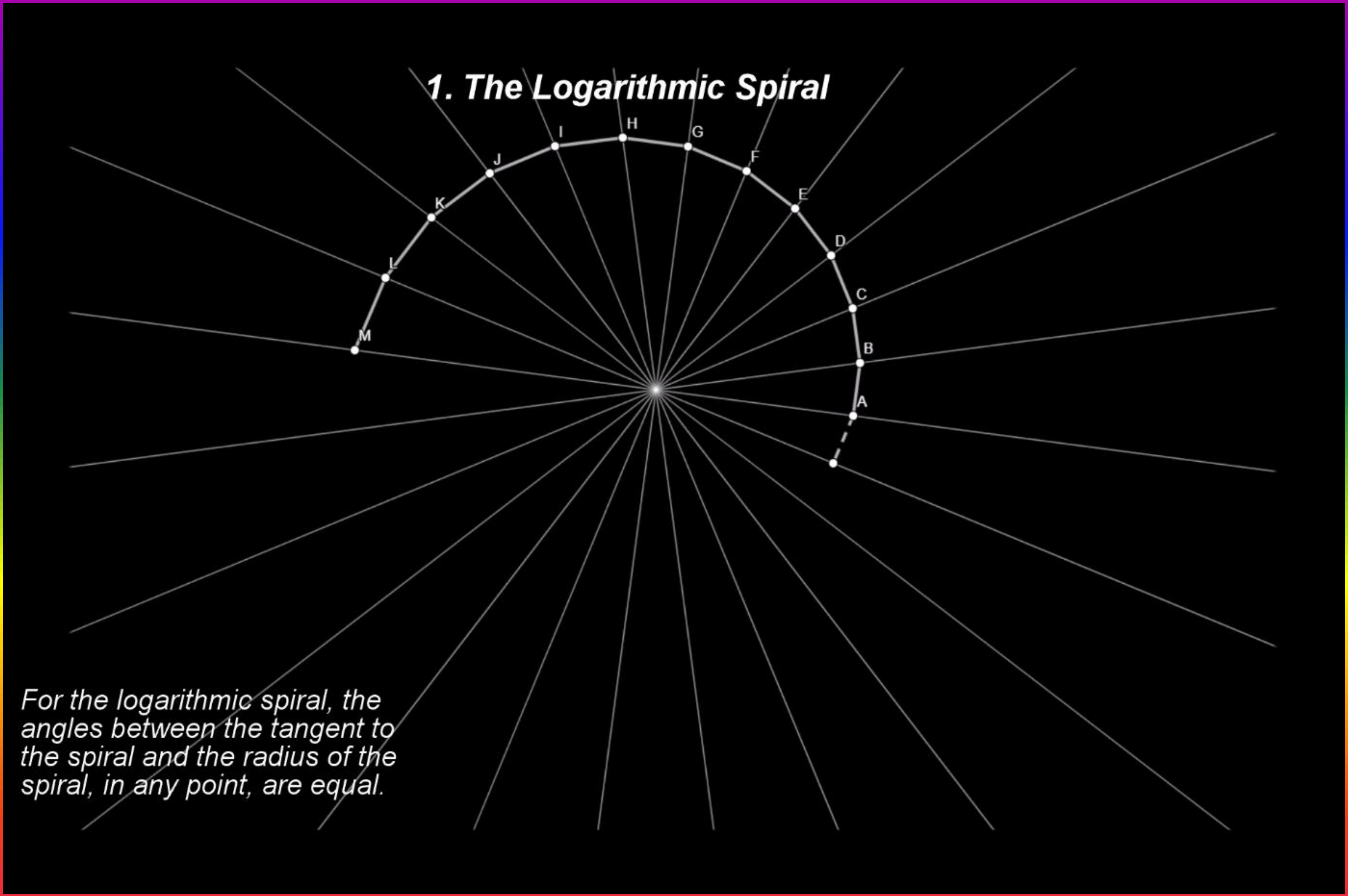

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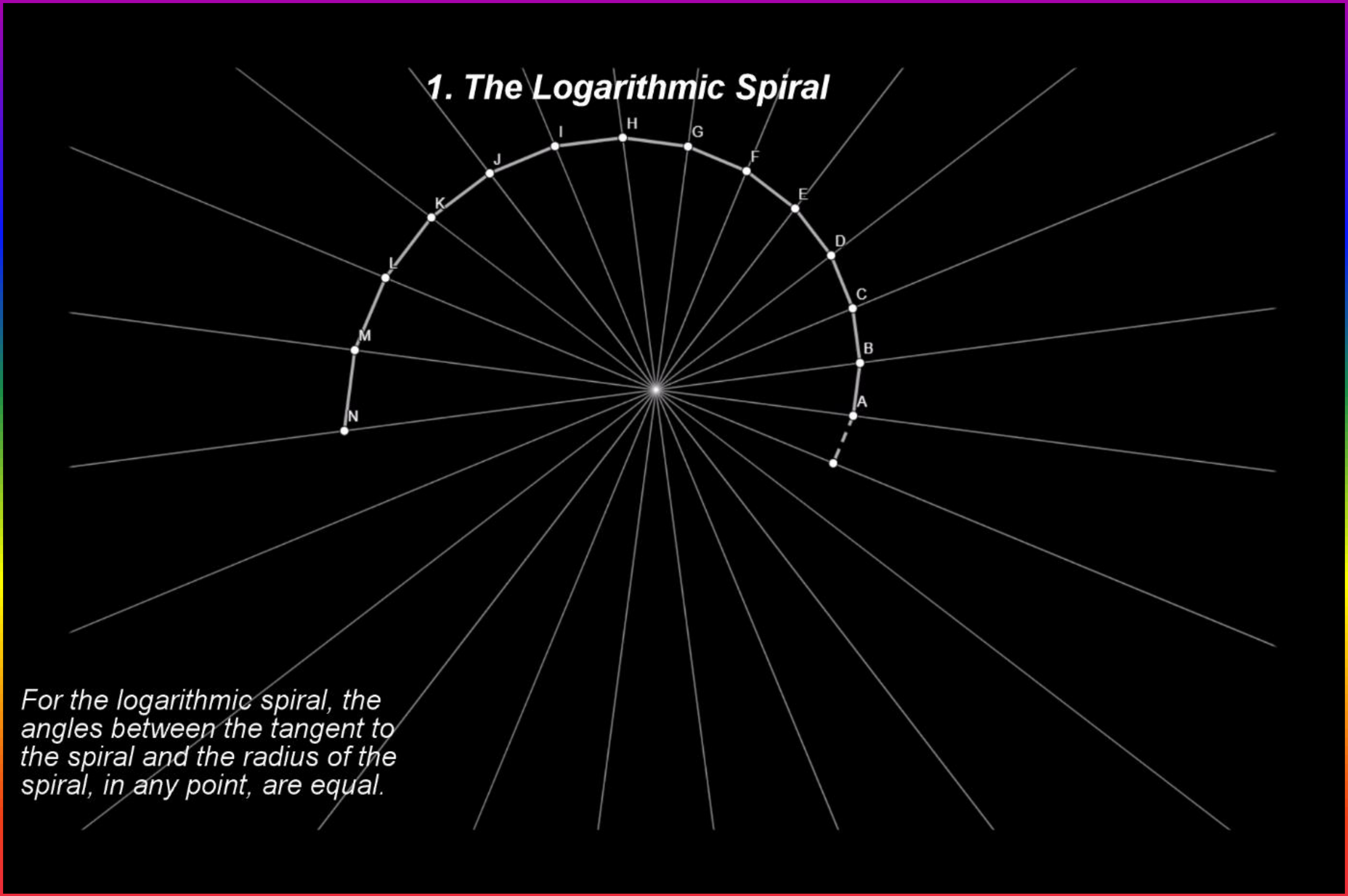

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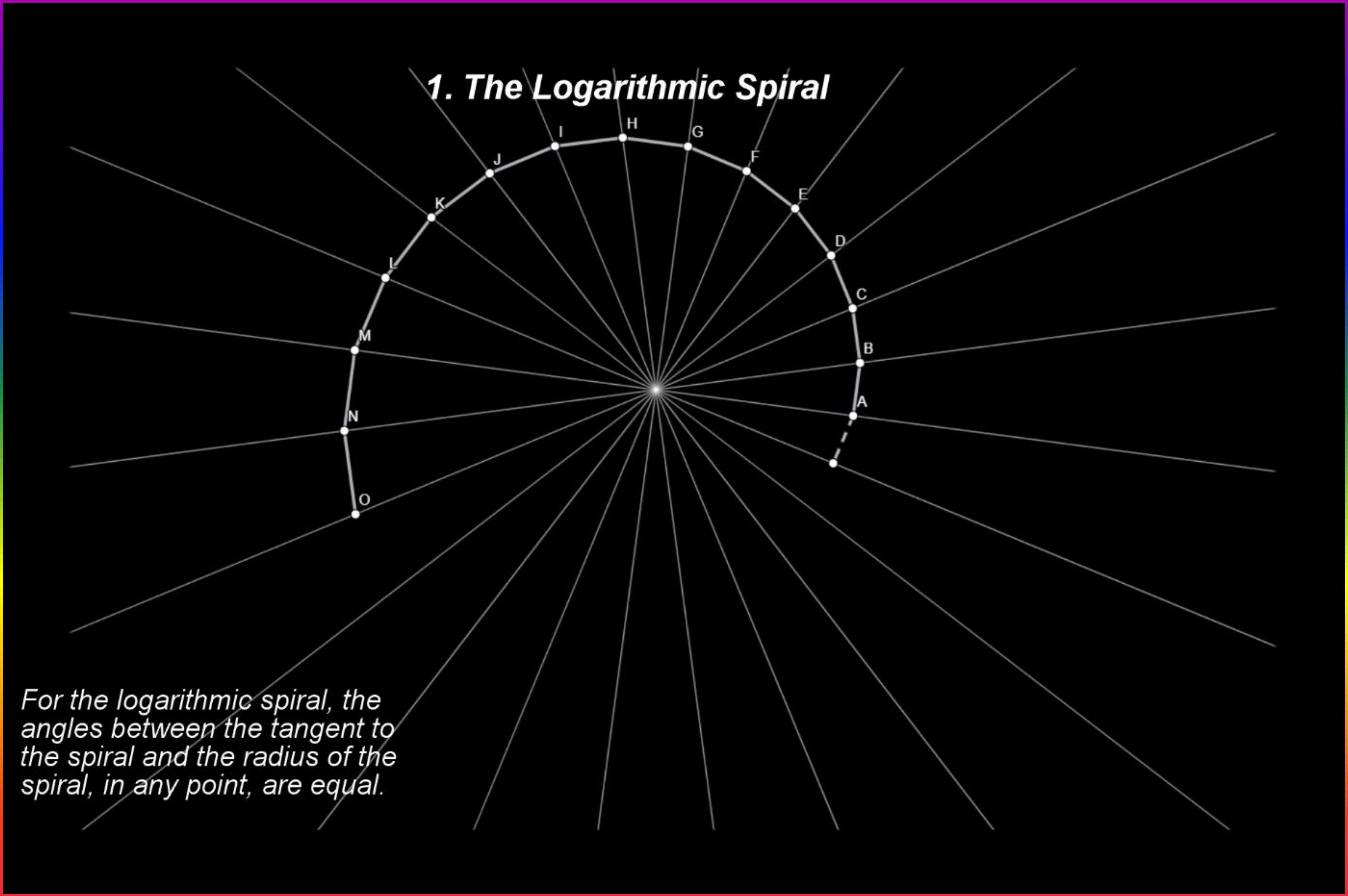

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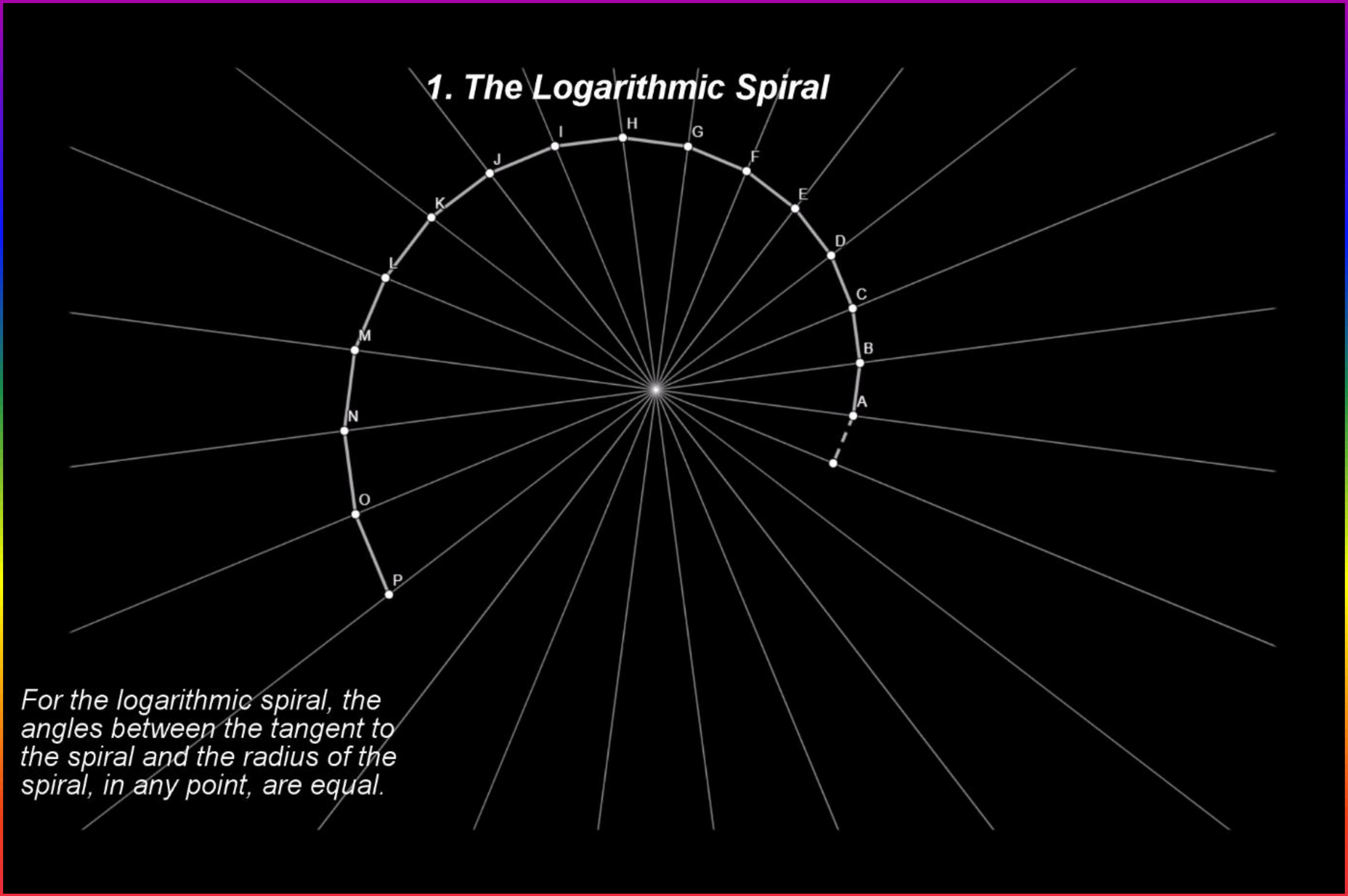

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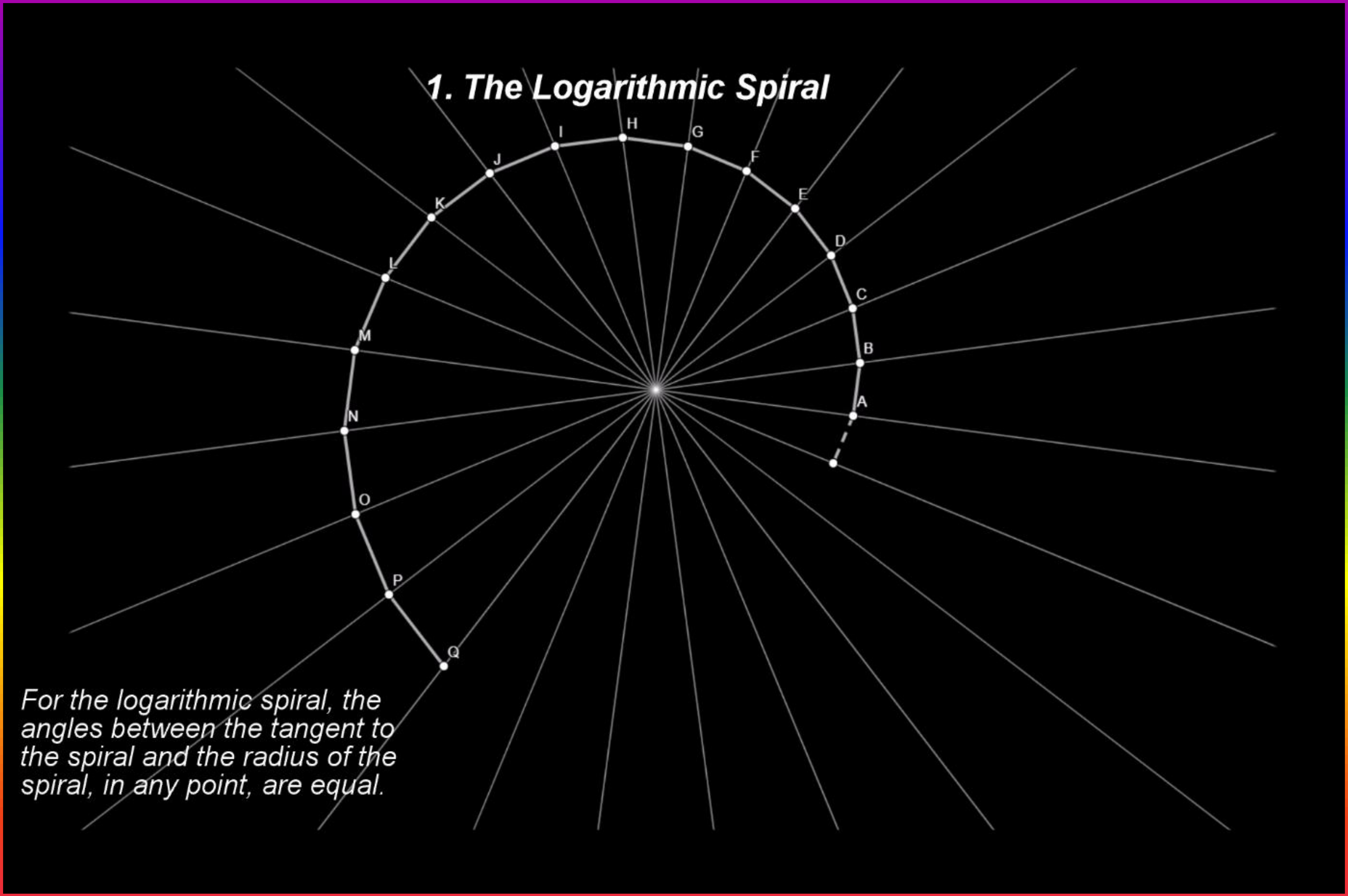

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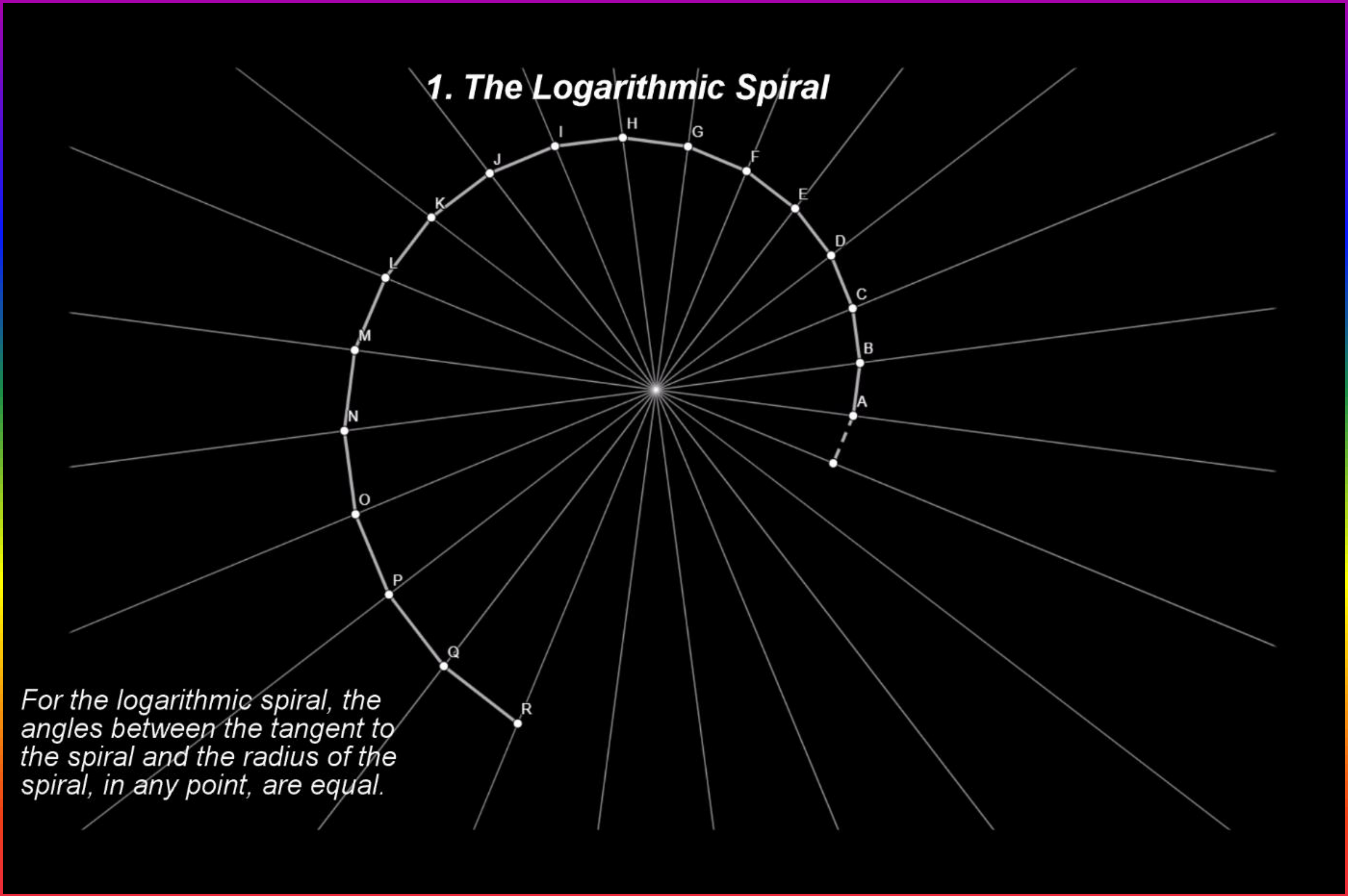

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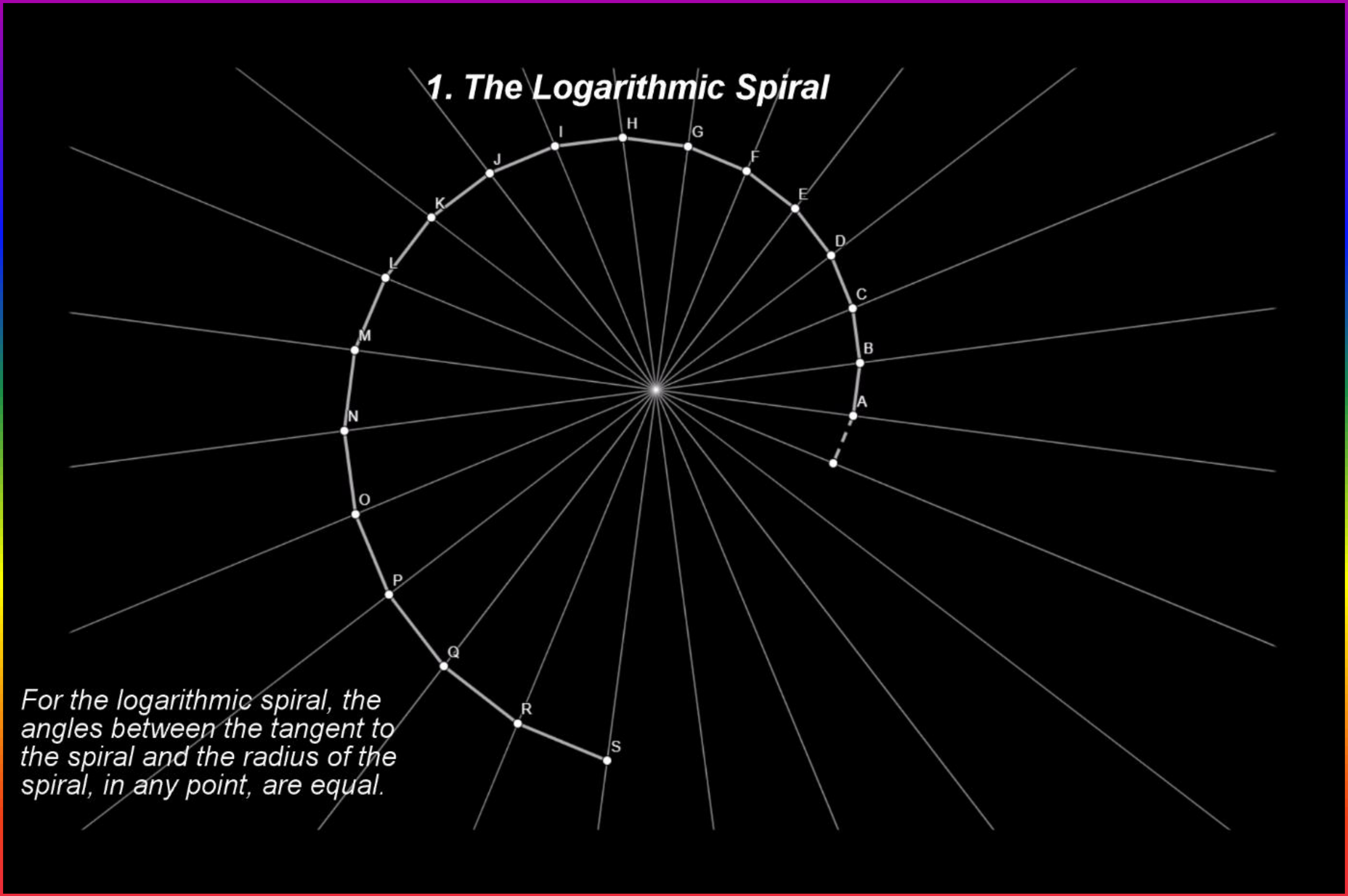

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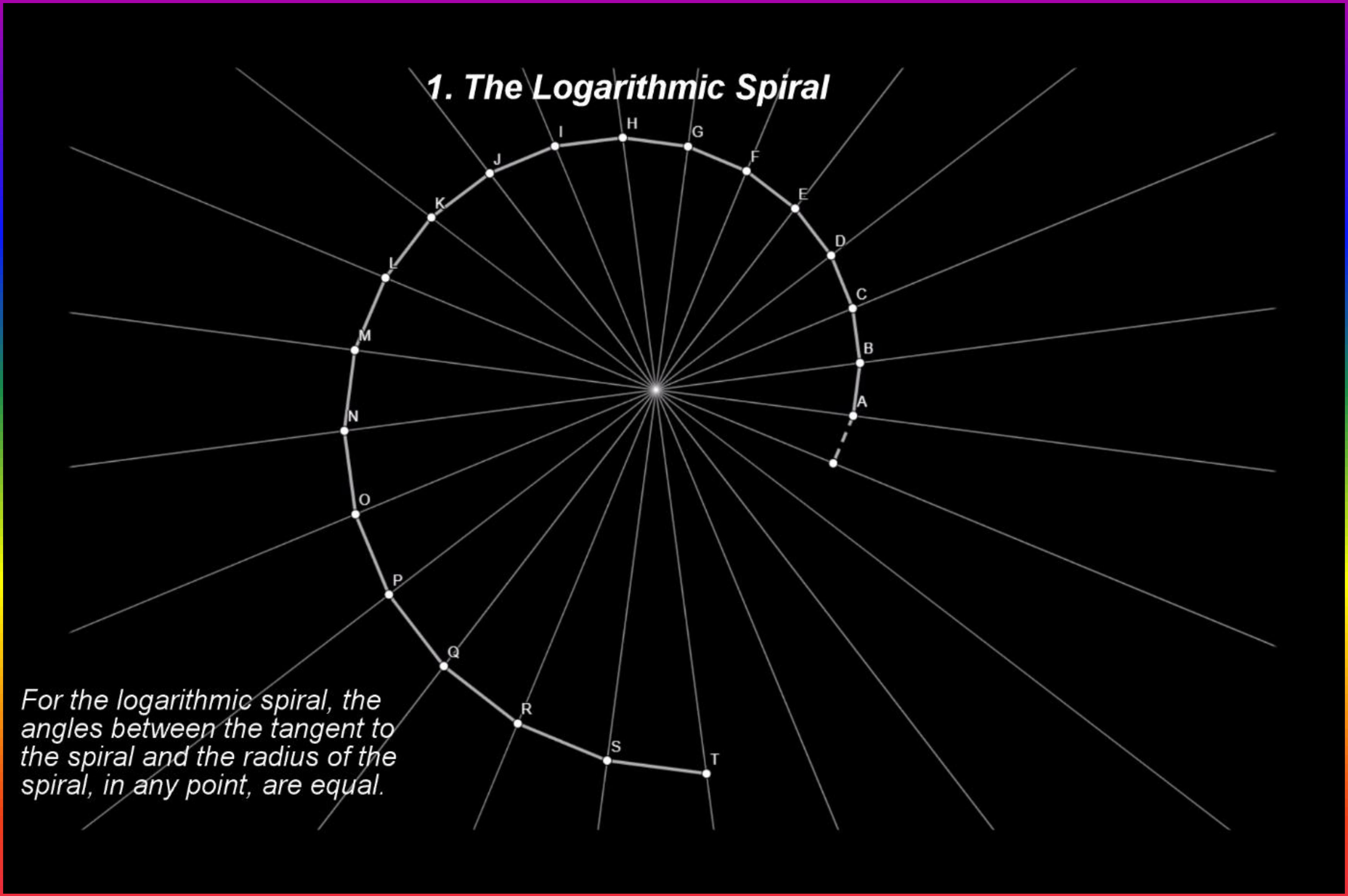

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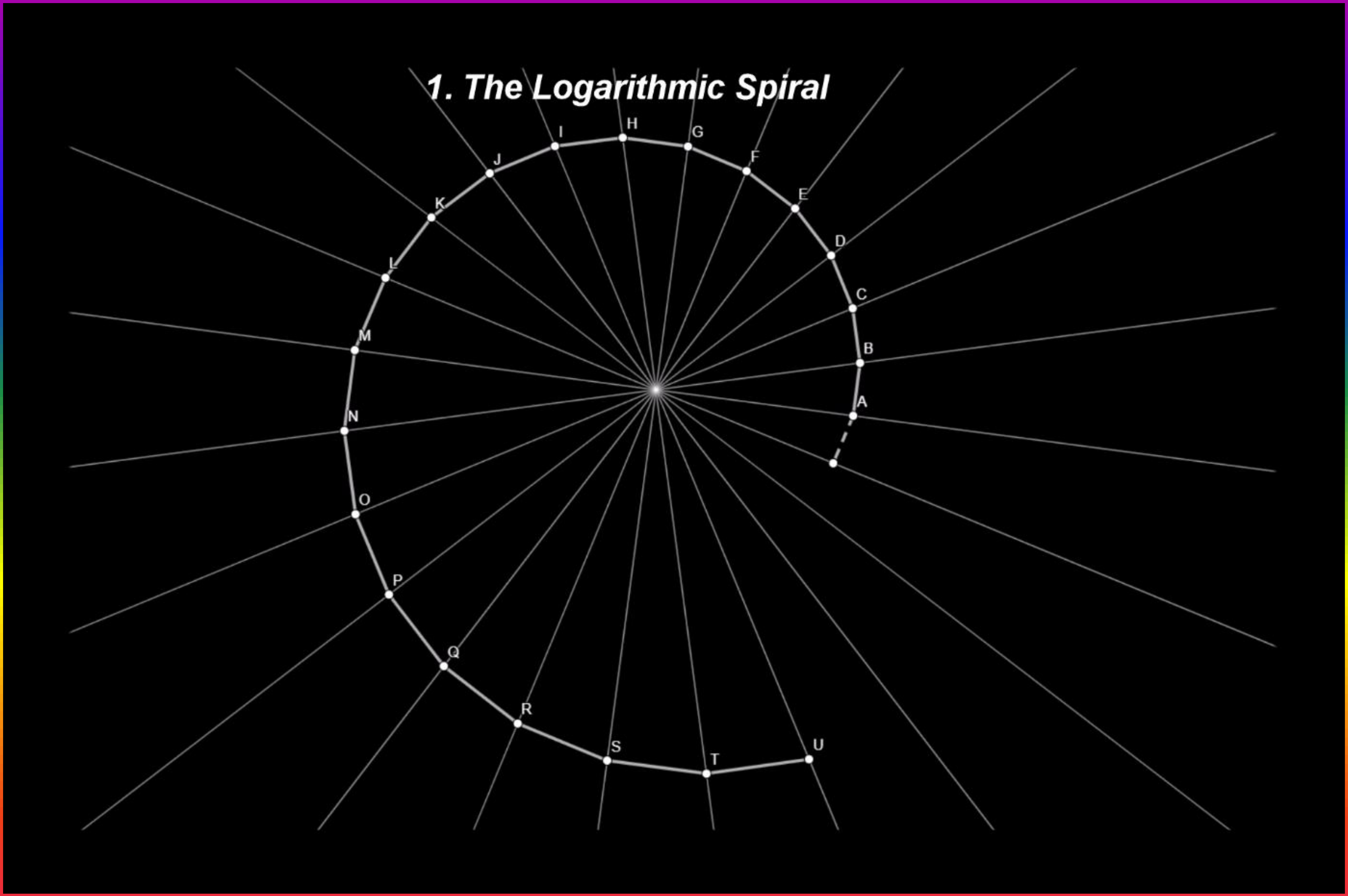

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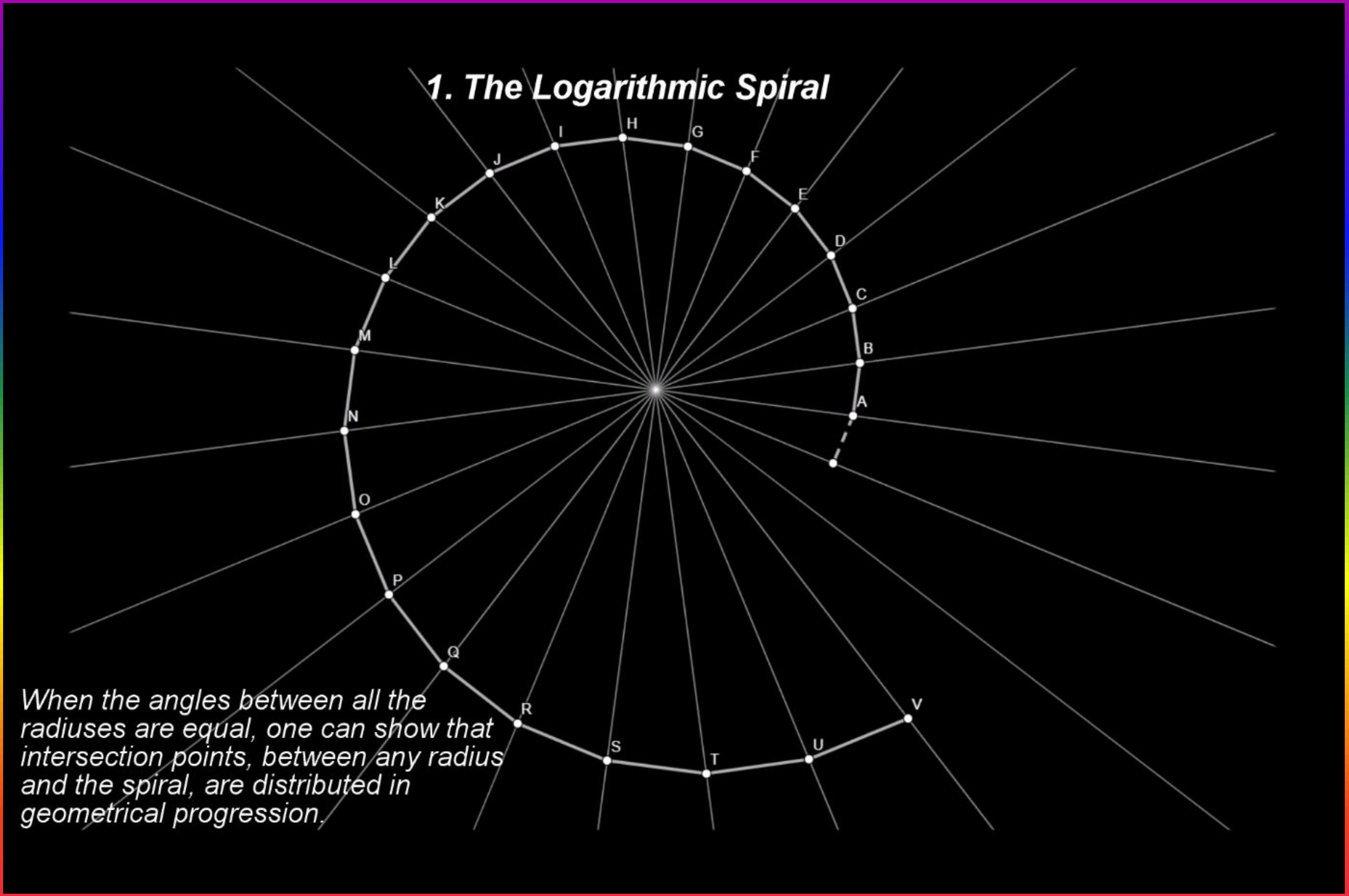

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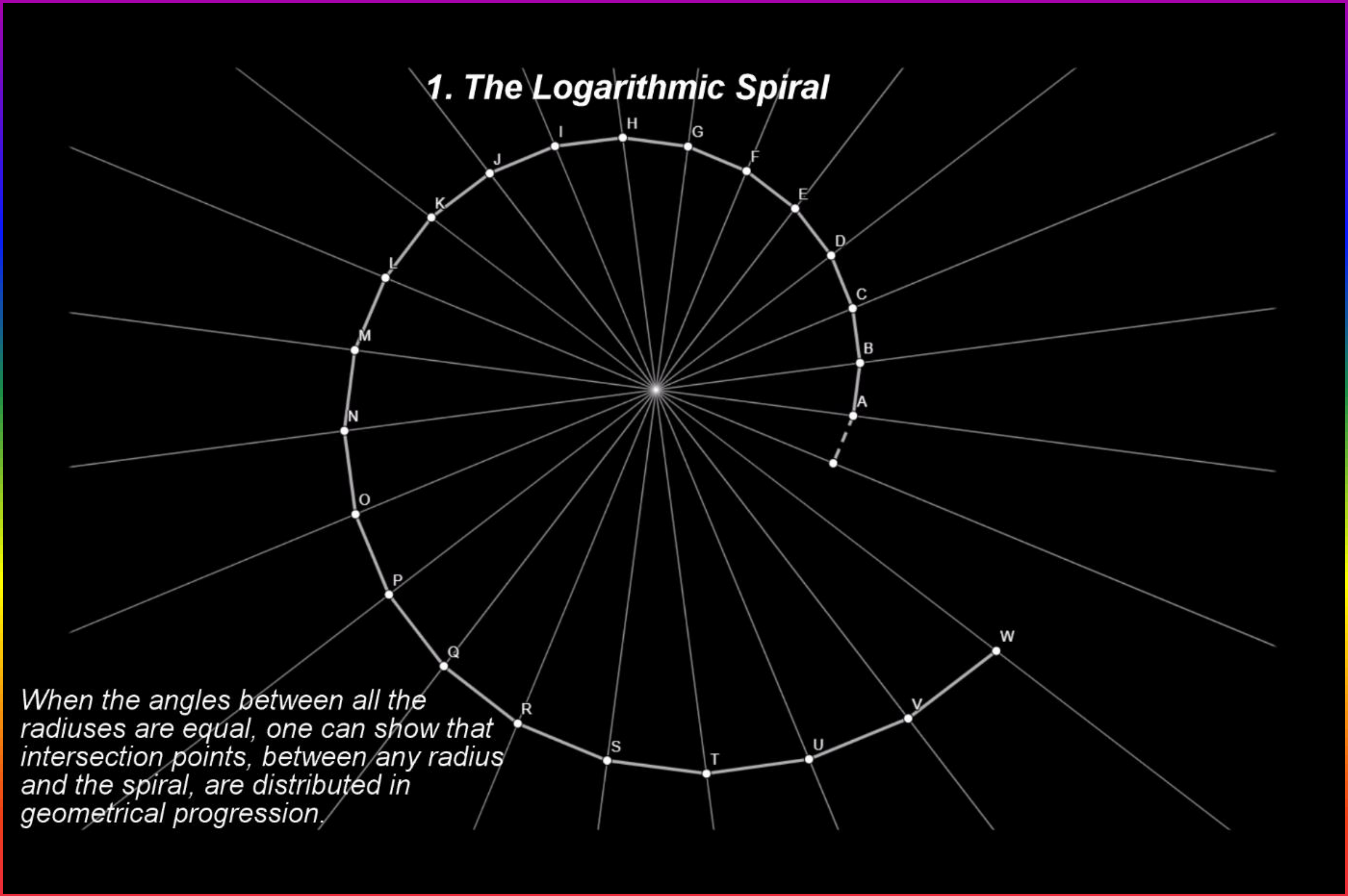

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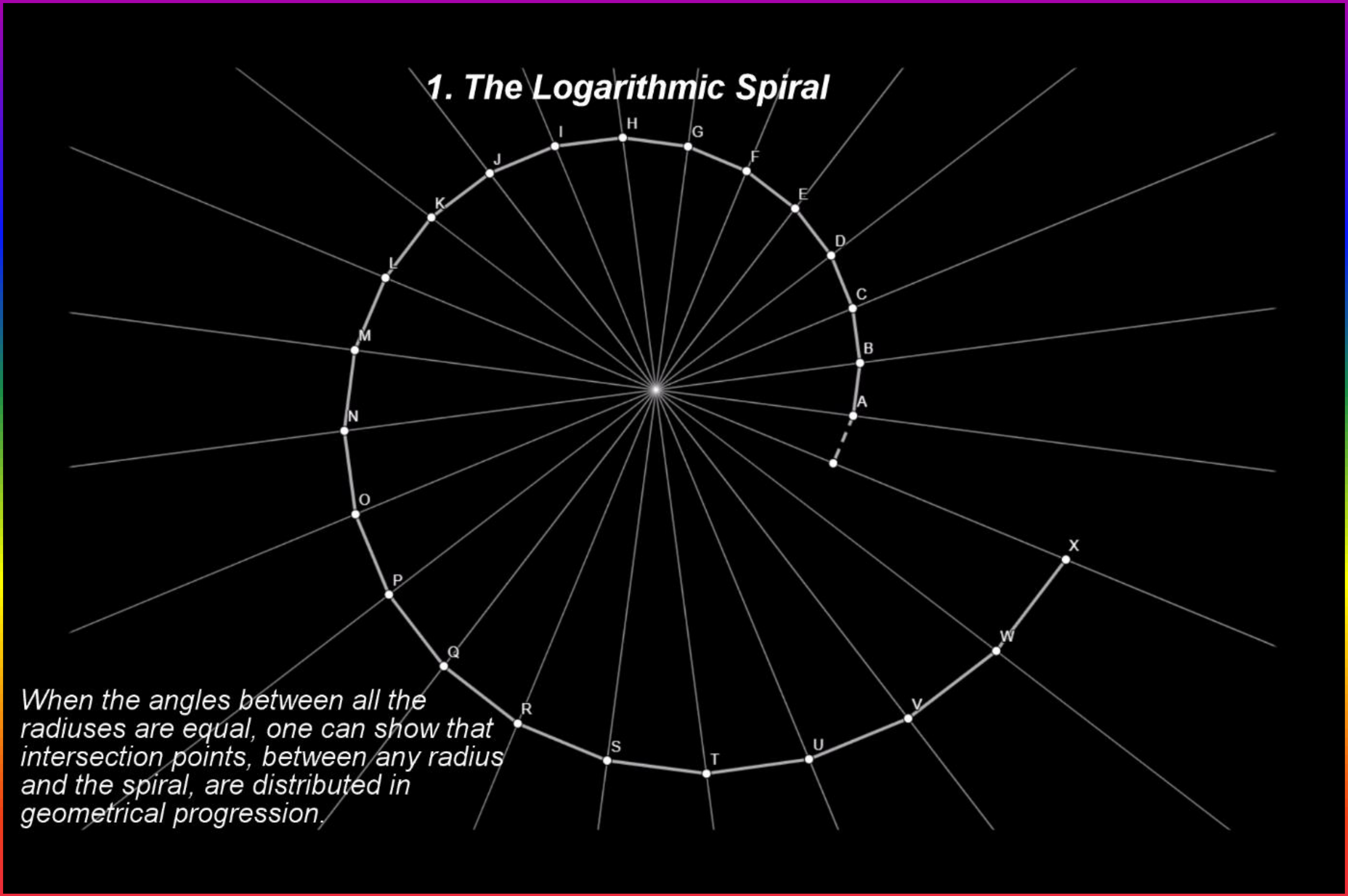

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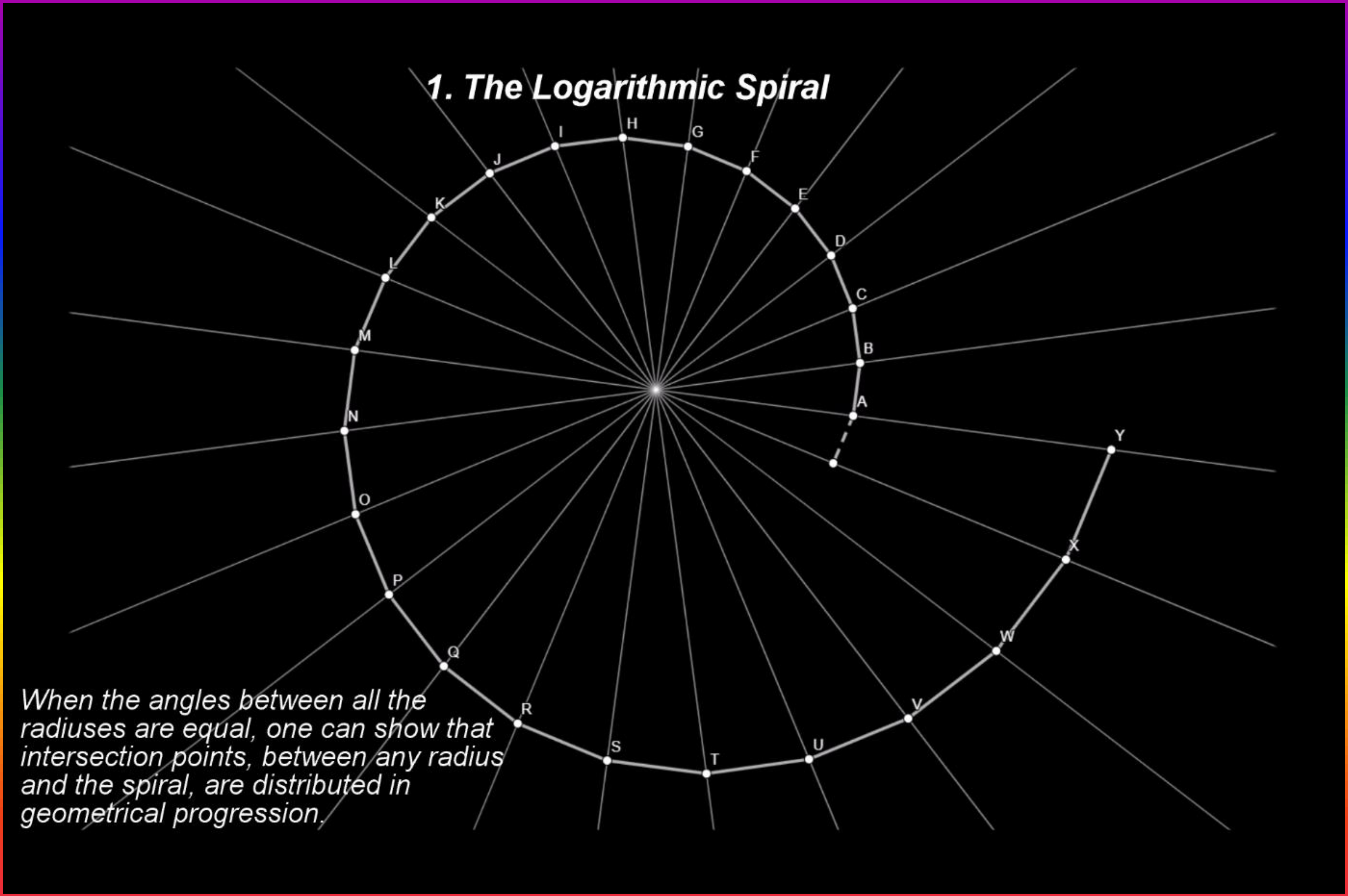

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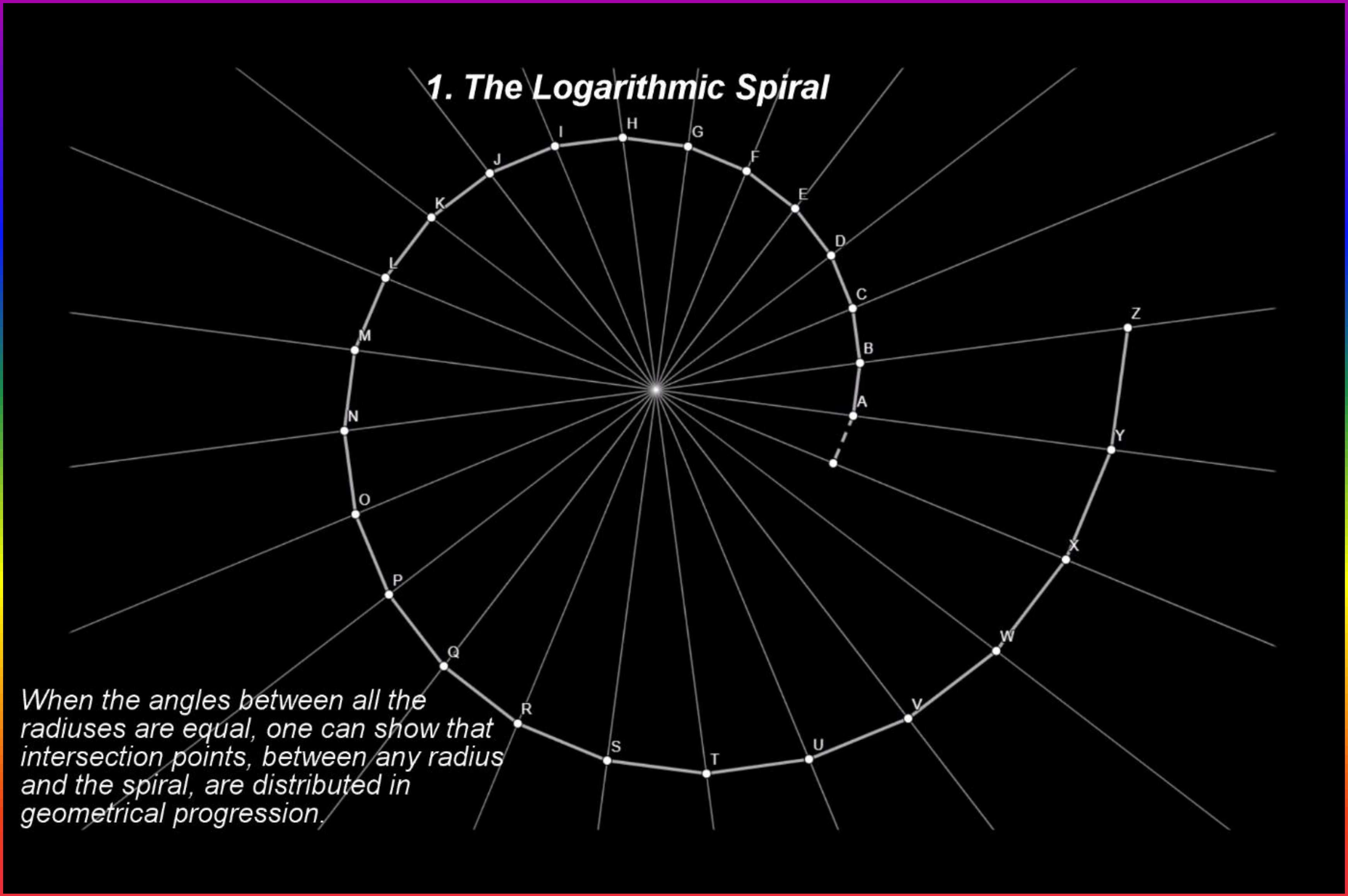
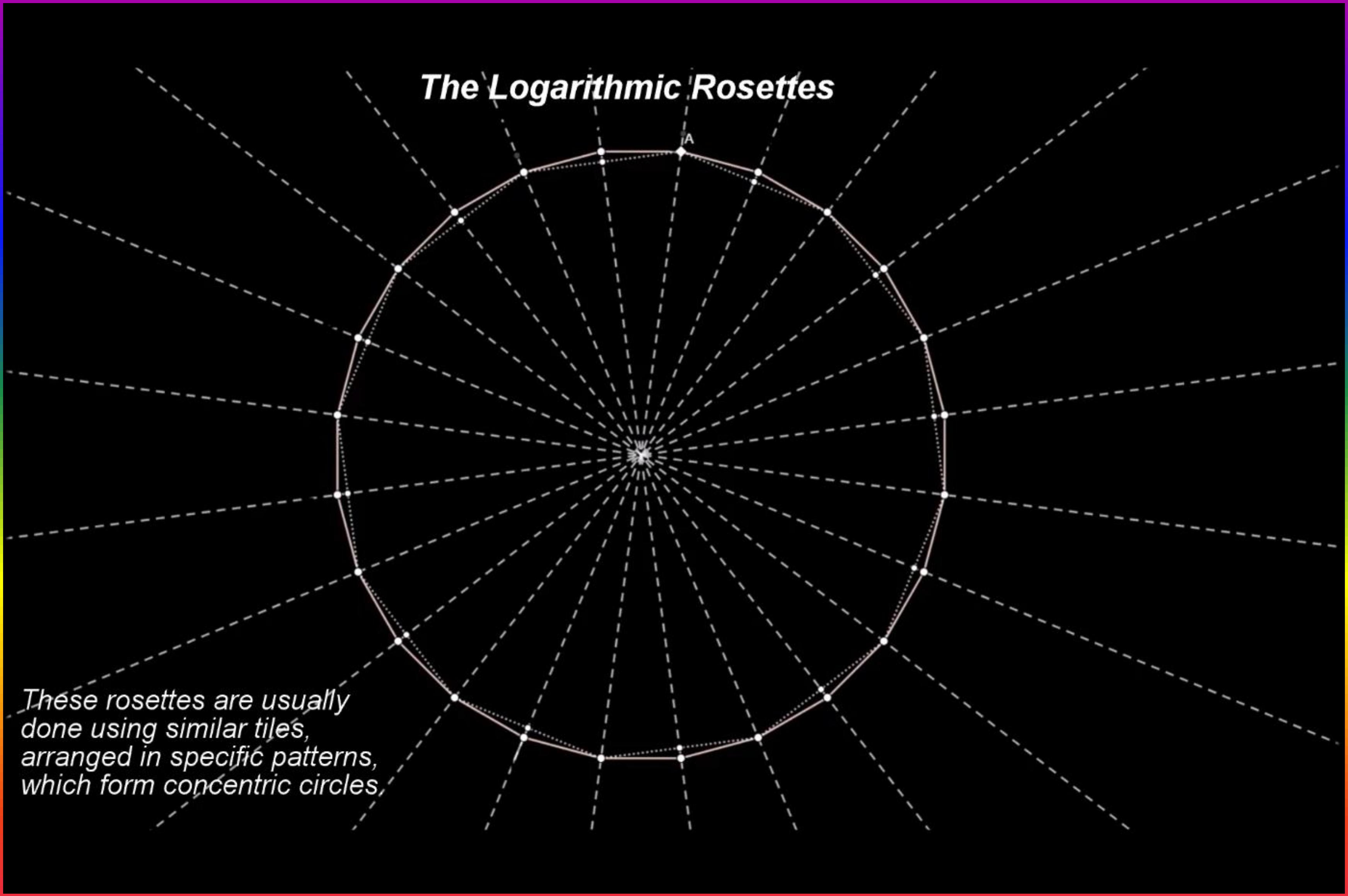


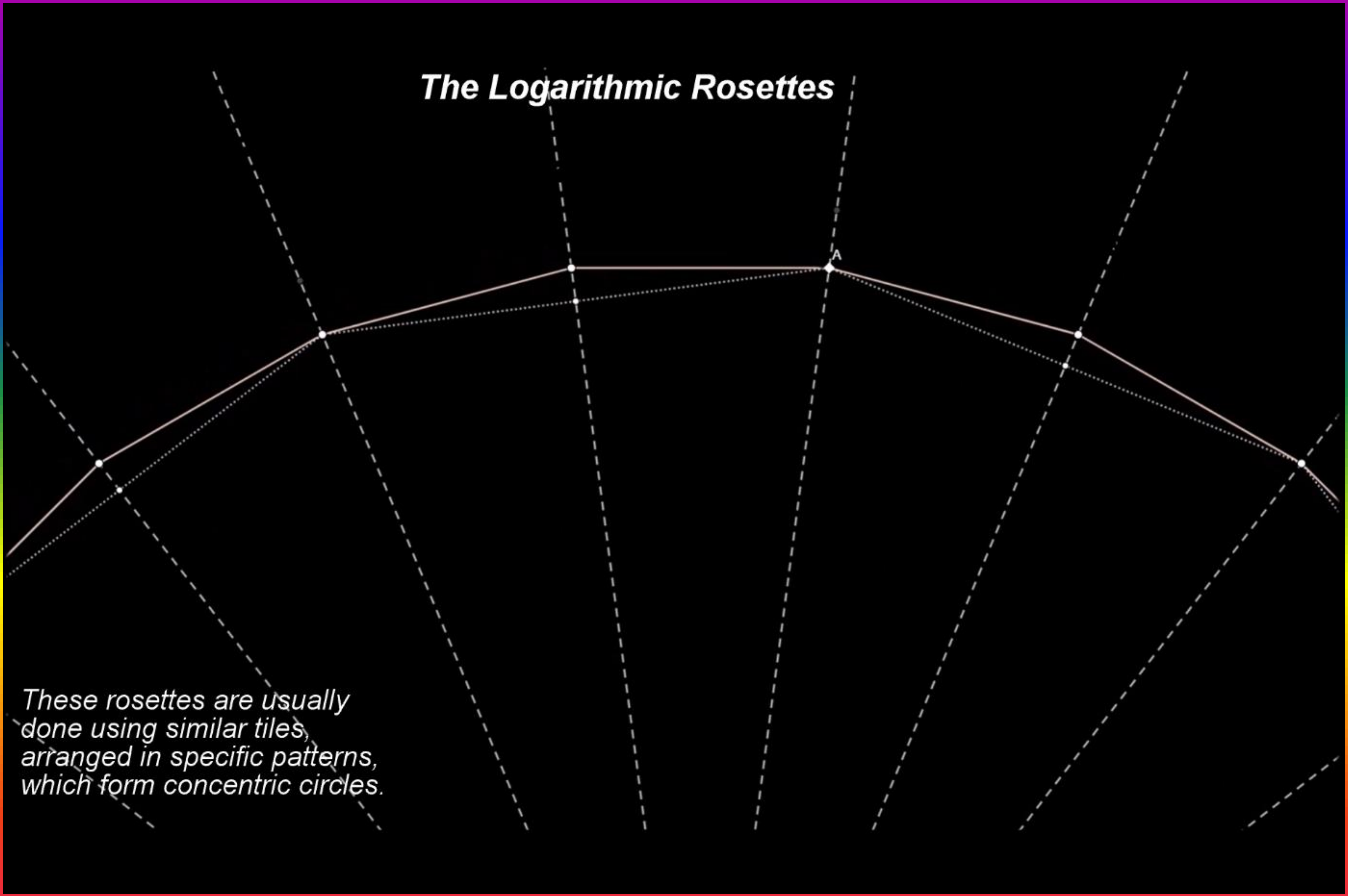
When the angles between all the radiuses are equal one can show that intersection points, between any radius and the spiral, are distributed in geometrical progression.

In the ancient Greece and the Roman Empire the rich people used to cover the floors of their houses with mosaic designs and images.

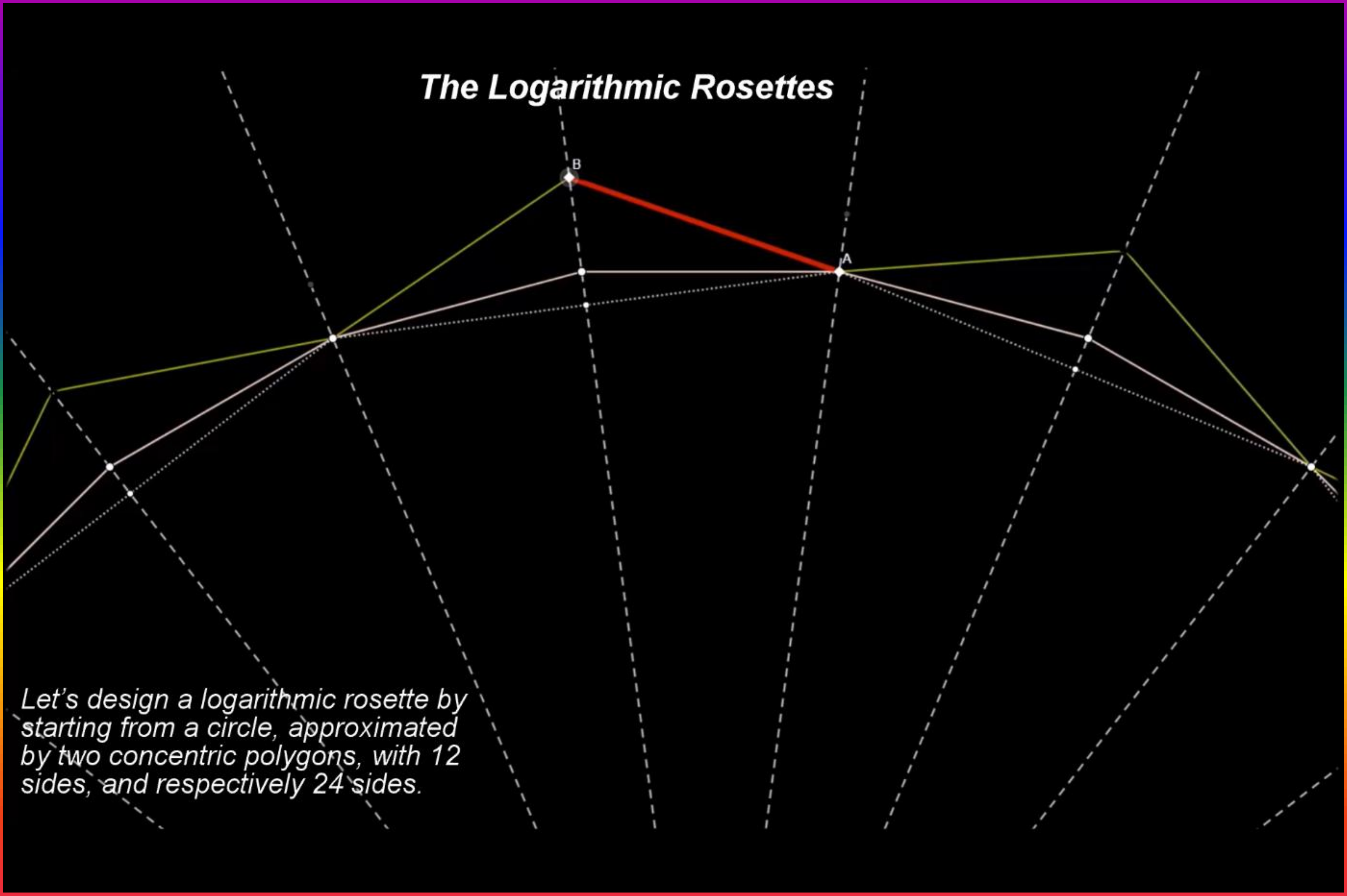
These designs are known as ***rosettes***.



To understand better the logarithmic spirals we will look next into the logarithmic rosettes.
These rosettes were usually done using similar tiles, arranged in specific patterns, which form concentric circles.

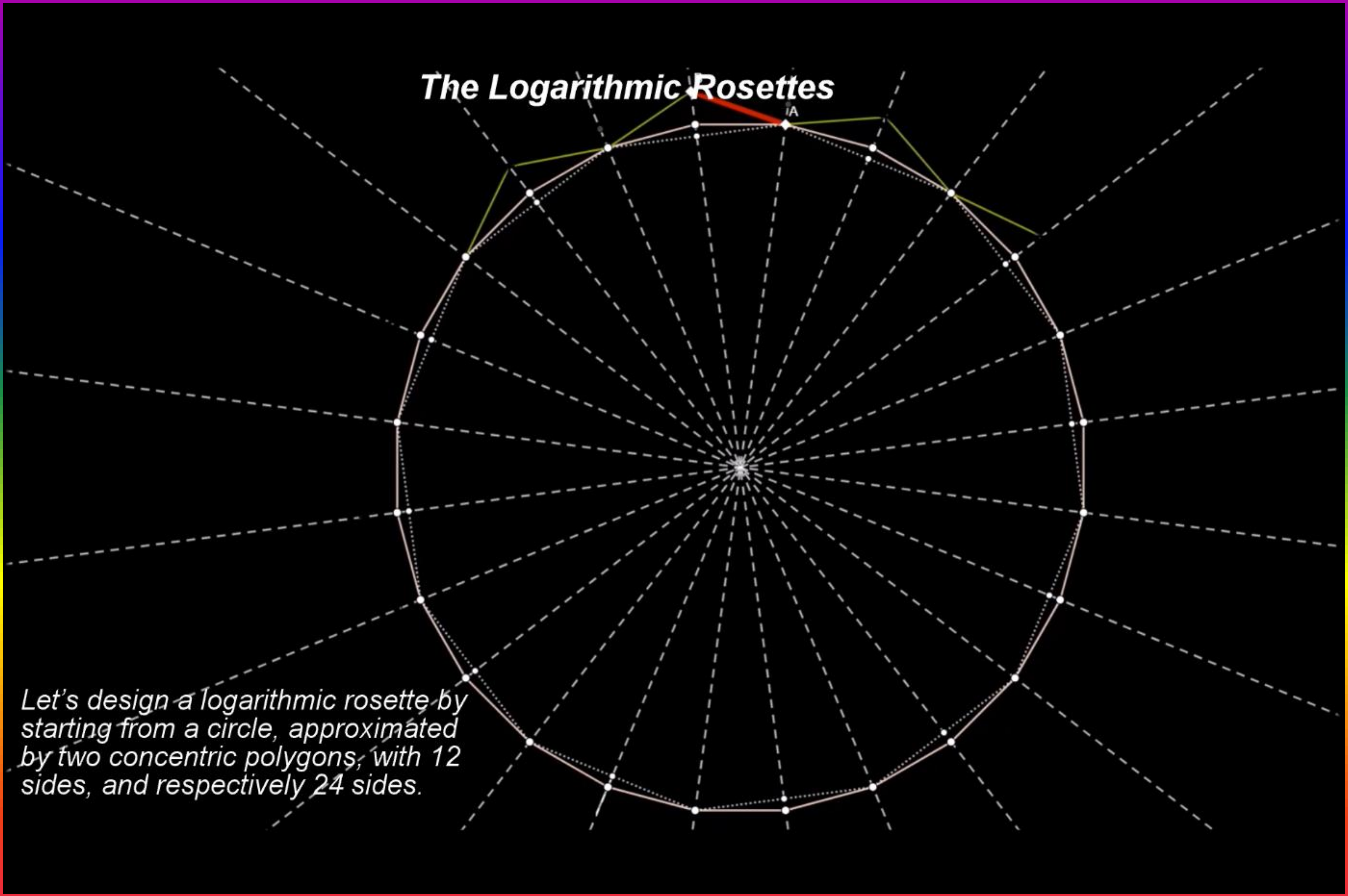


As an example, let’s design a logarithmic rosette by starting from a circle approximated by two concentric polygons with 12 sides and respectively 24 sides.

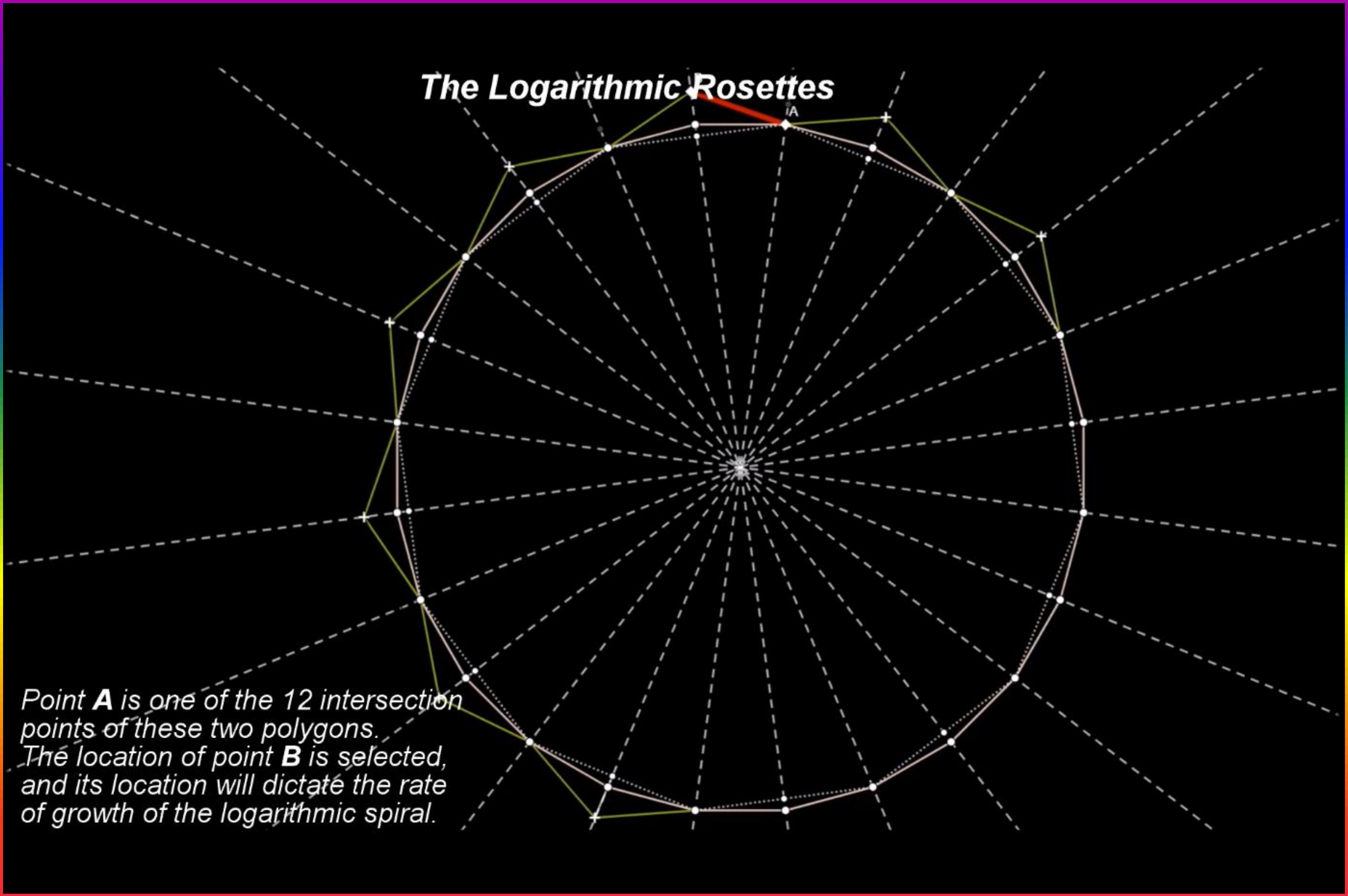


Point **A** is one of the 12 intersection points, of these two polygons.

The location of point **B** is selected at this stage of the design and its location will dictate the rate of growth of the logarithmic spiral.



Now, if we connect all 12 points similar with point **B** we get another 12-side polygon which approximates a new circle, concentric to the initial circle.



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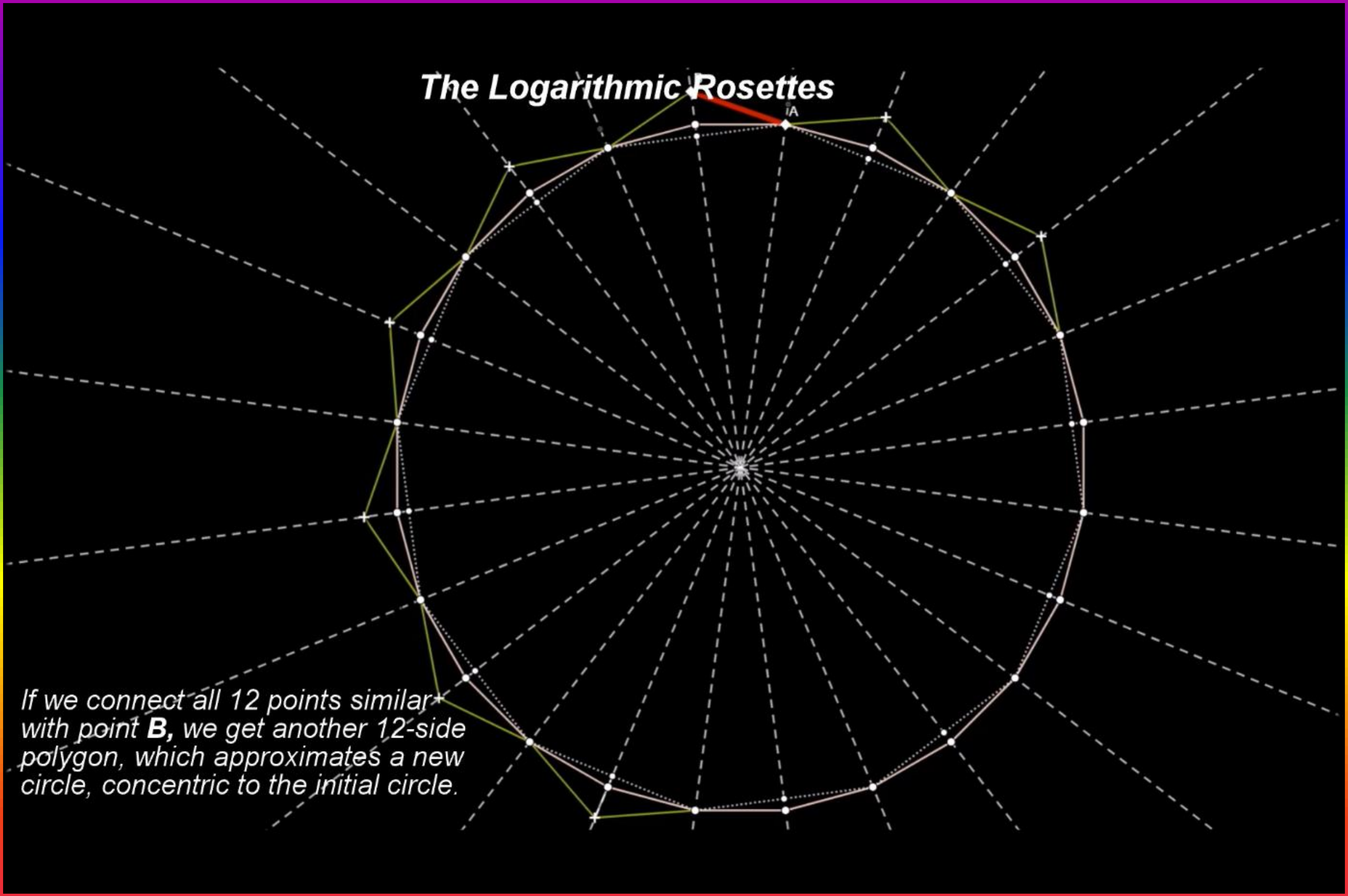

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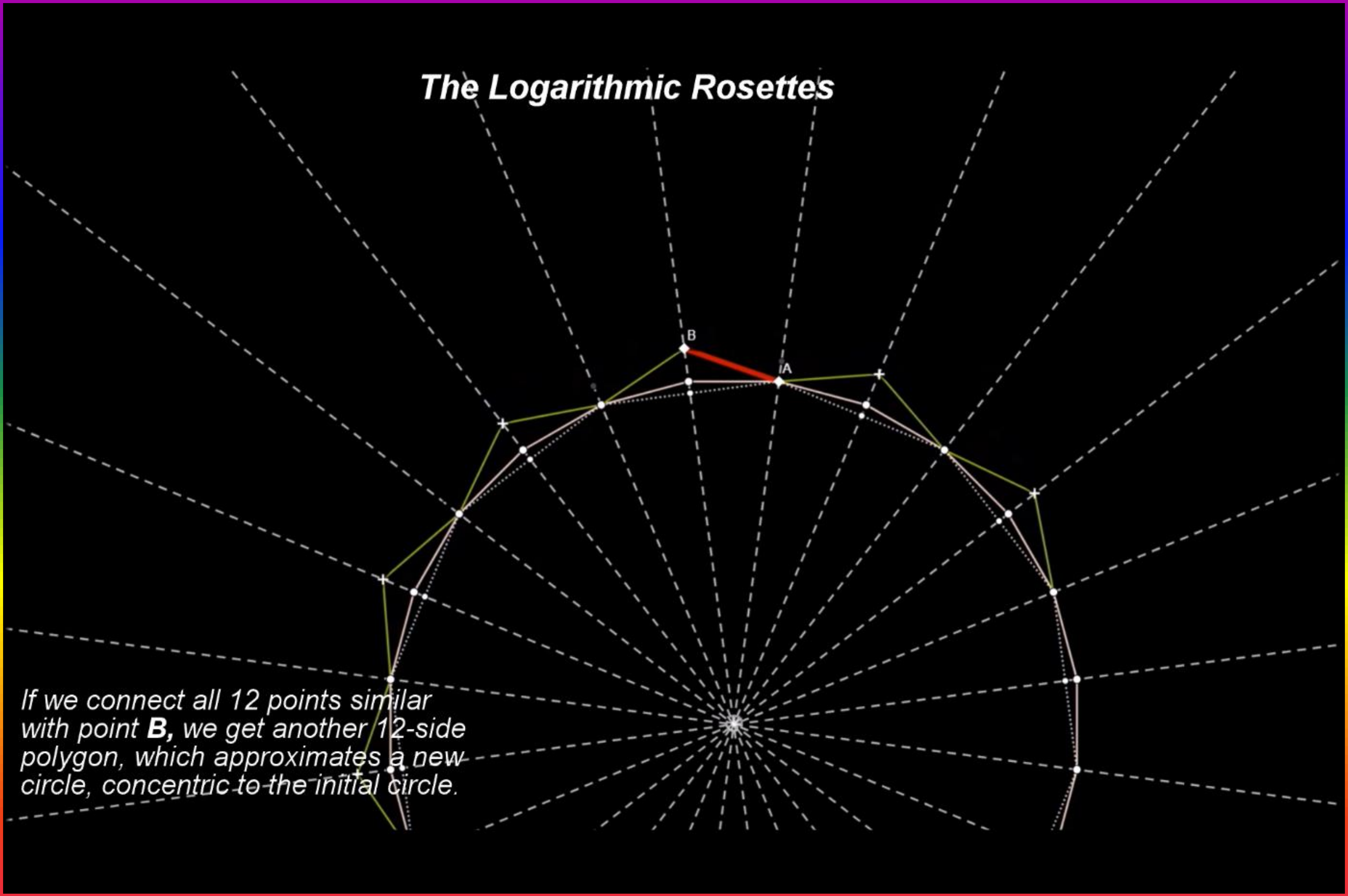

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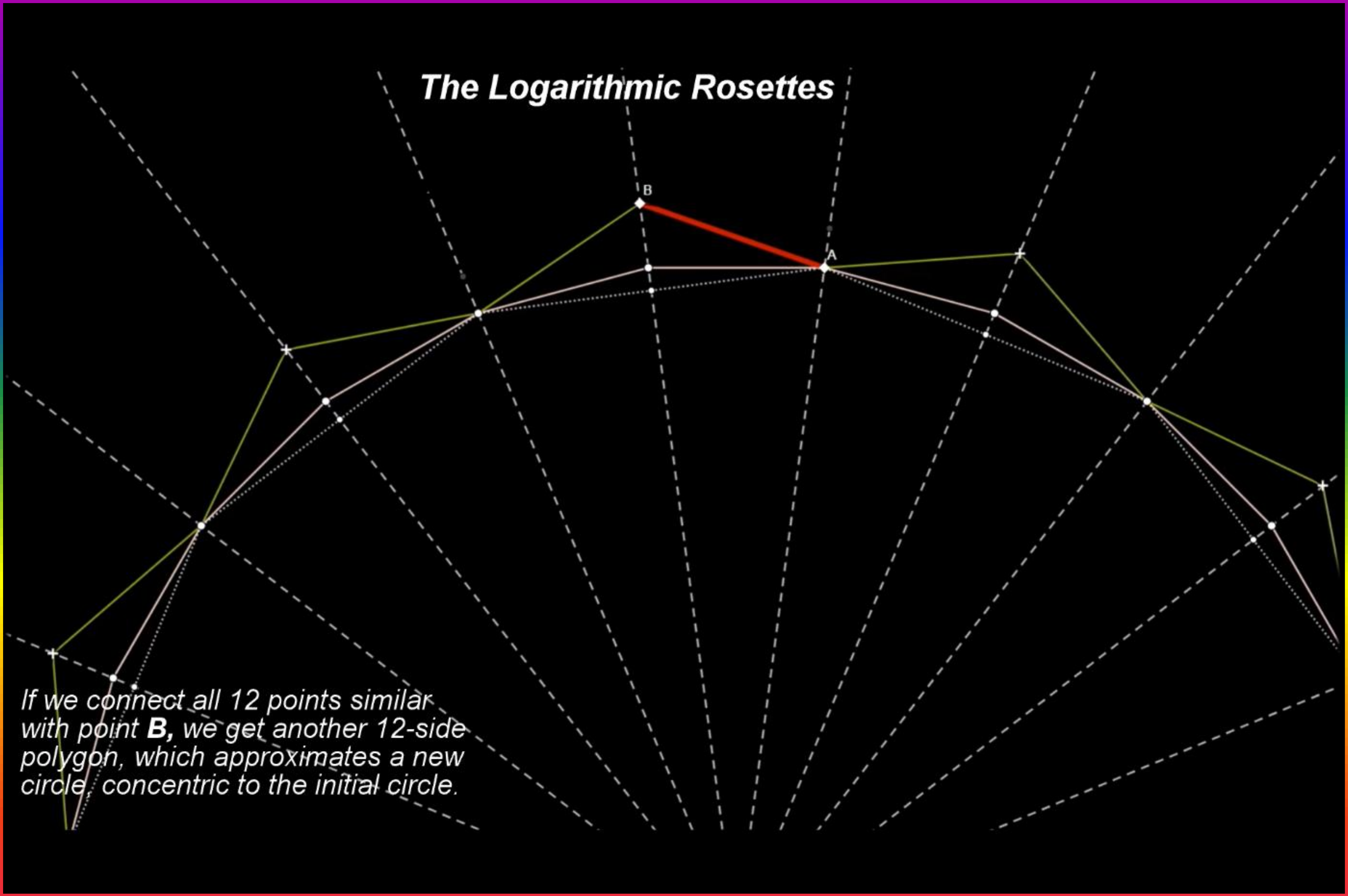

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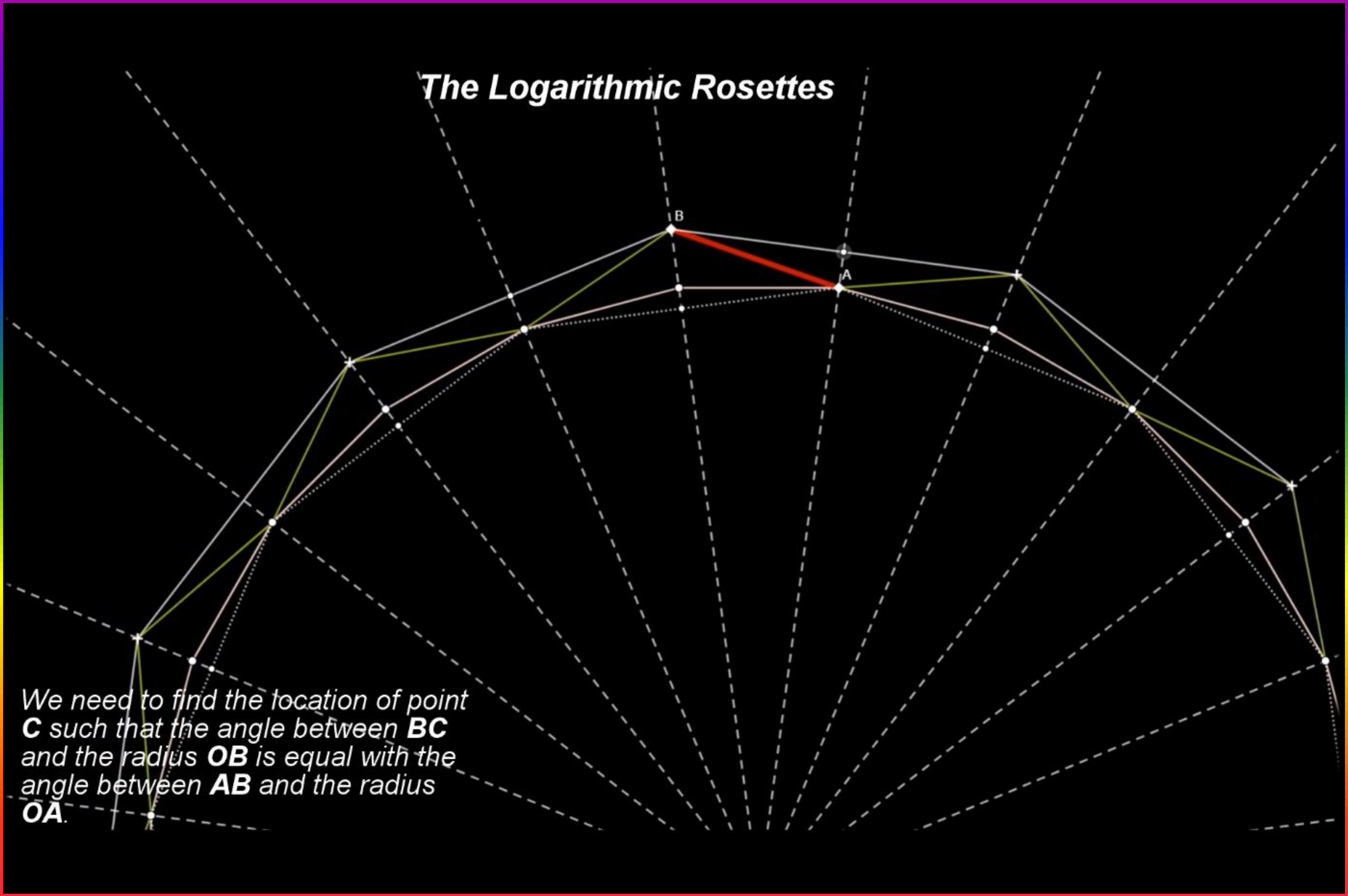
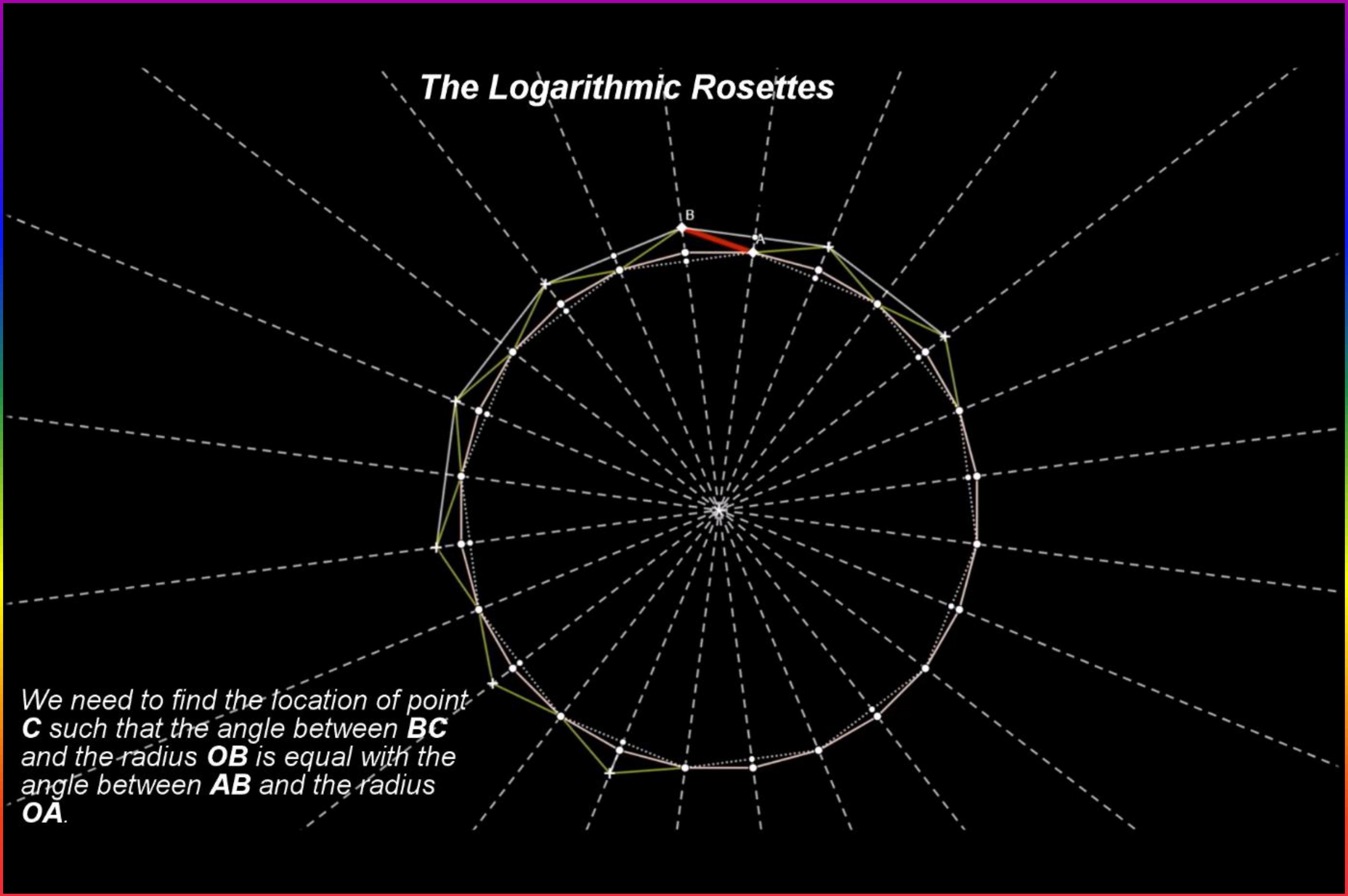
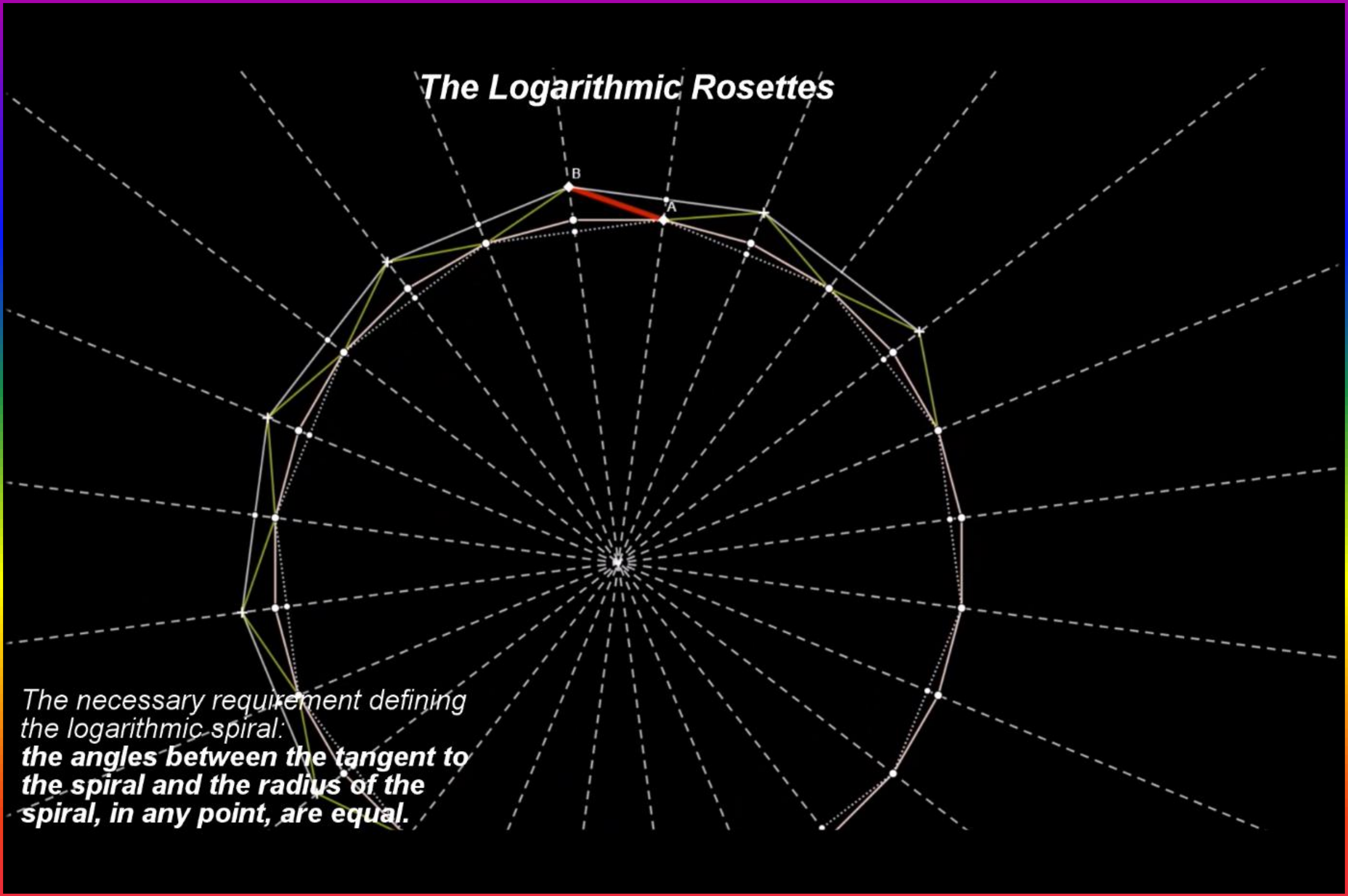


We continue the process started above, in a similar way, for this new circle.



We need to find the location of point **C** such that the angle between **BC** and the radius through **B** is equal with the angle between **AB** and the radius through **A**.



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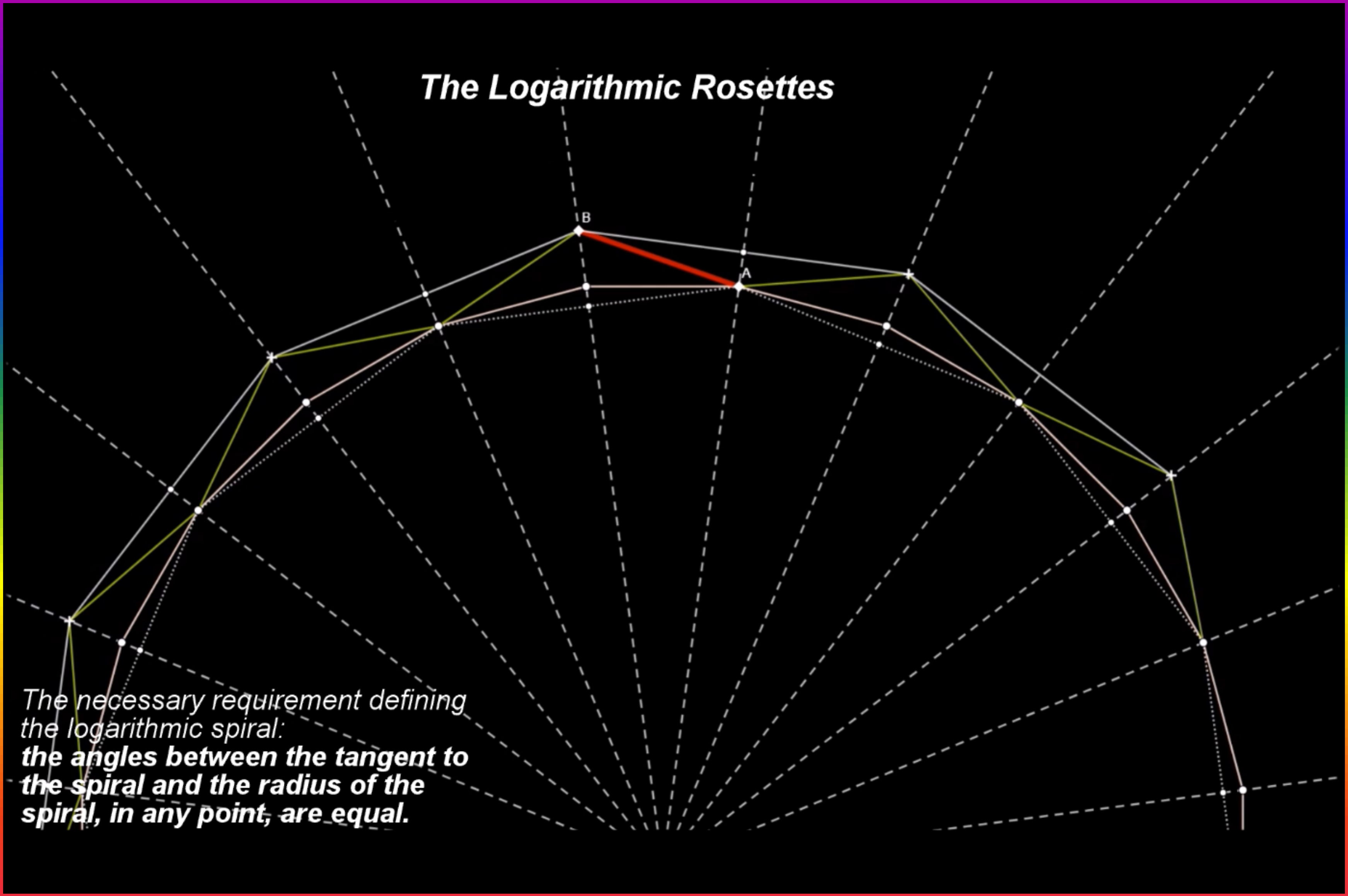
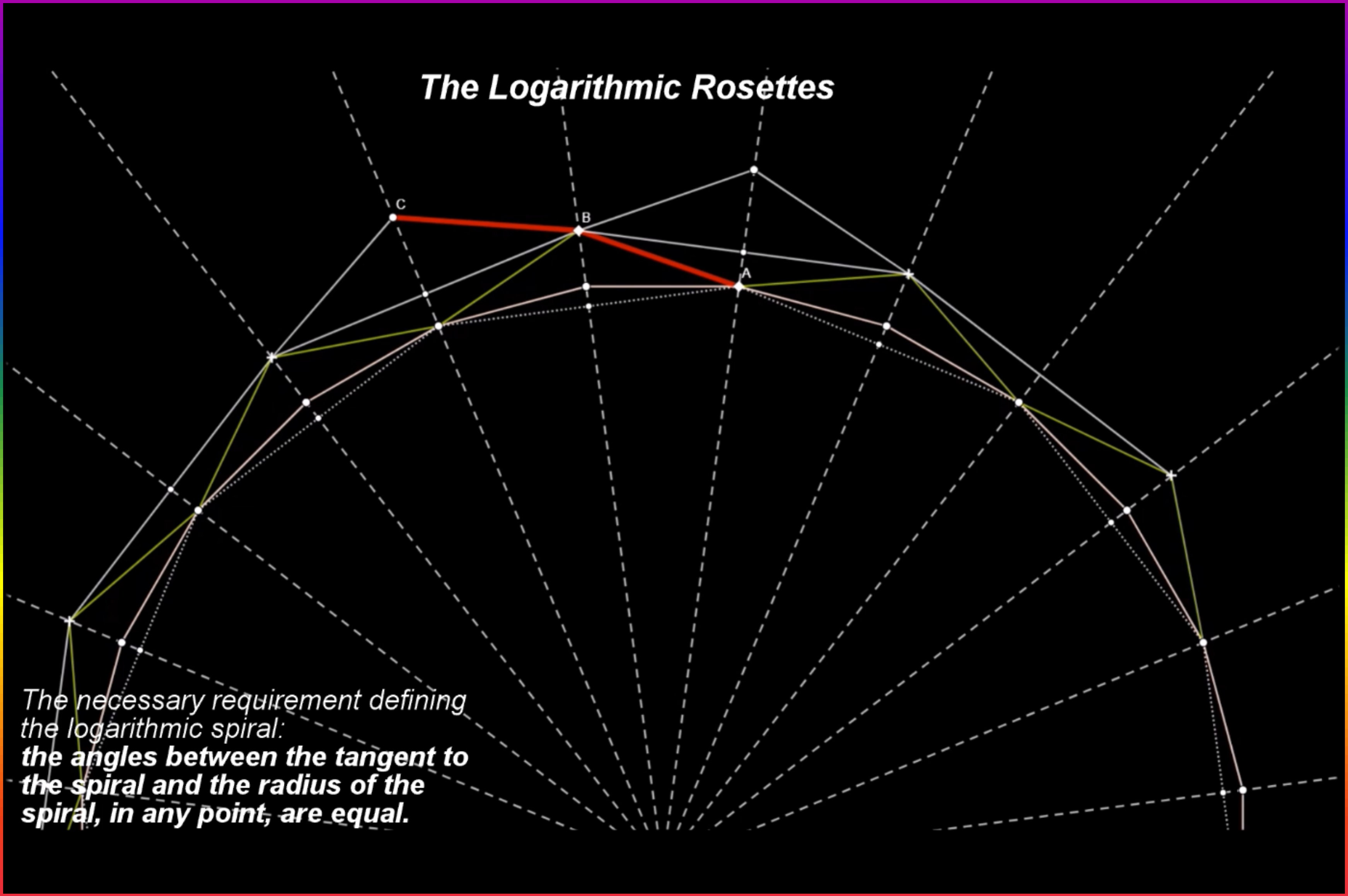


This is the necessary requirement defining the logarithmic spiral:

"the angles between the tangent to the spiral and the radius of the spiral, in any point, are equal."



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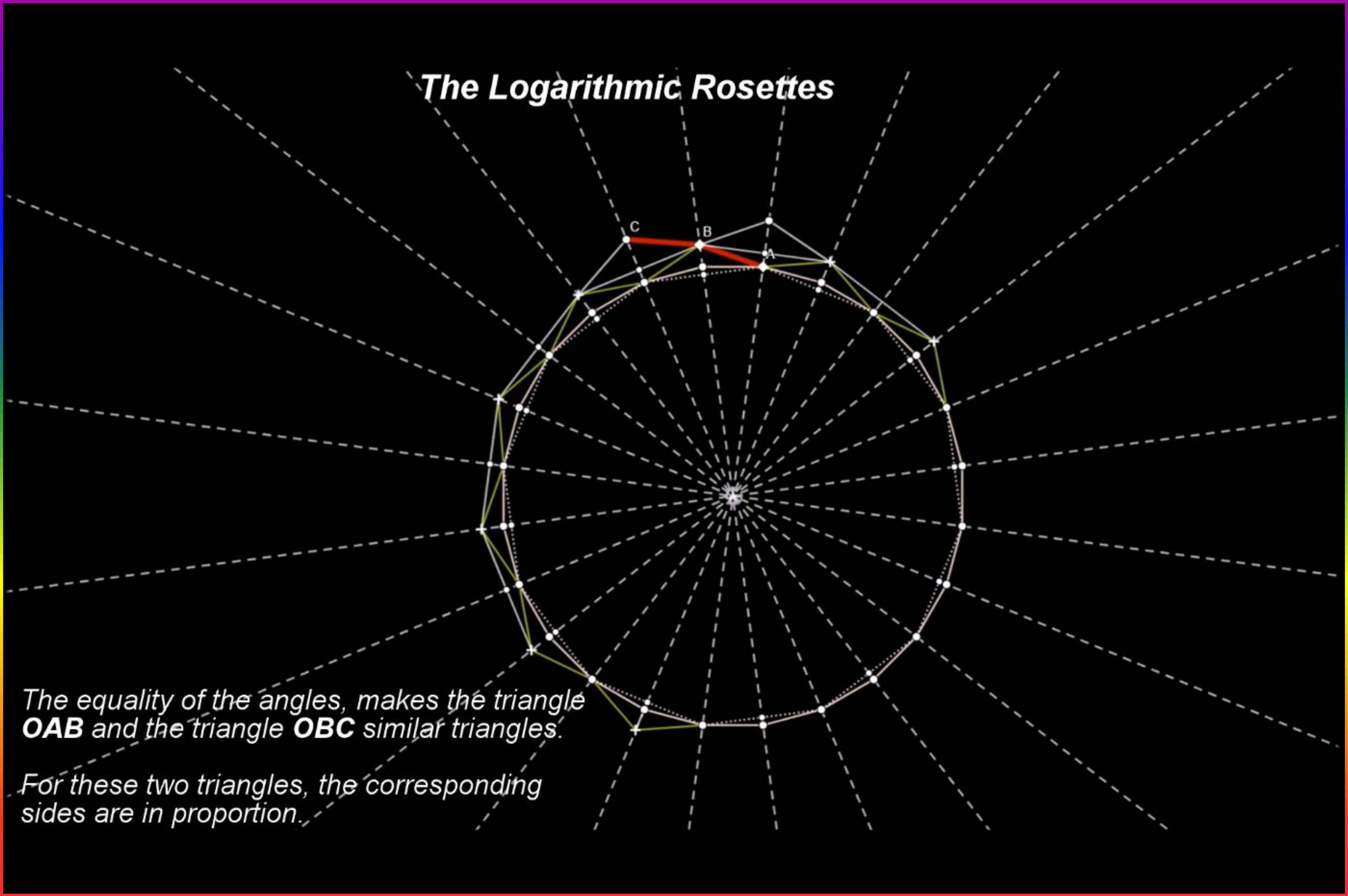
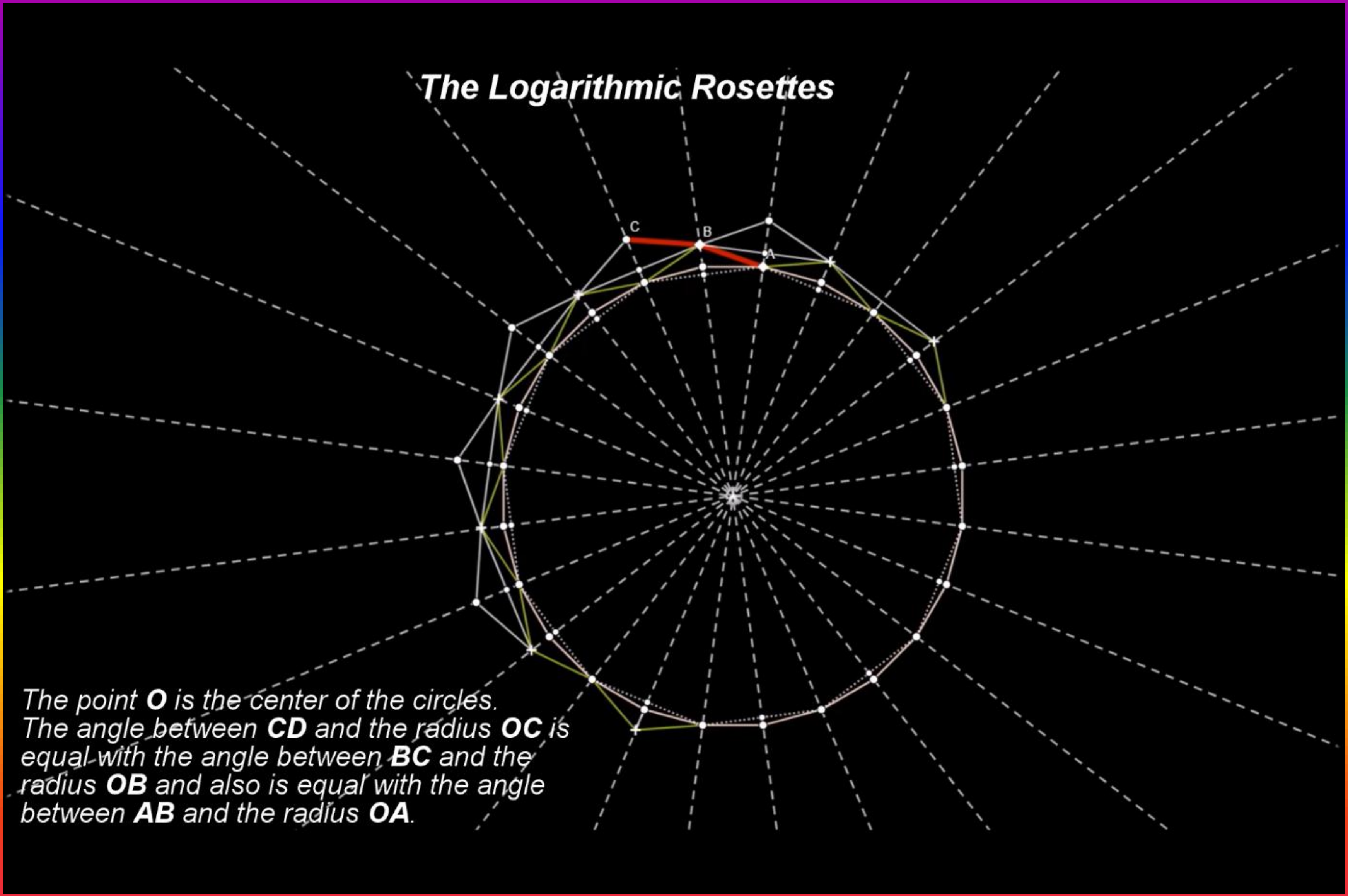


The equality of the angles, mentioned above, makes the triangle **OAB** and the triangle **OBC** similar triangles.
For these two triangles the corresponding sides are in proportion.
The point **O** is the center of the circles.



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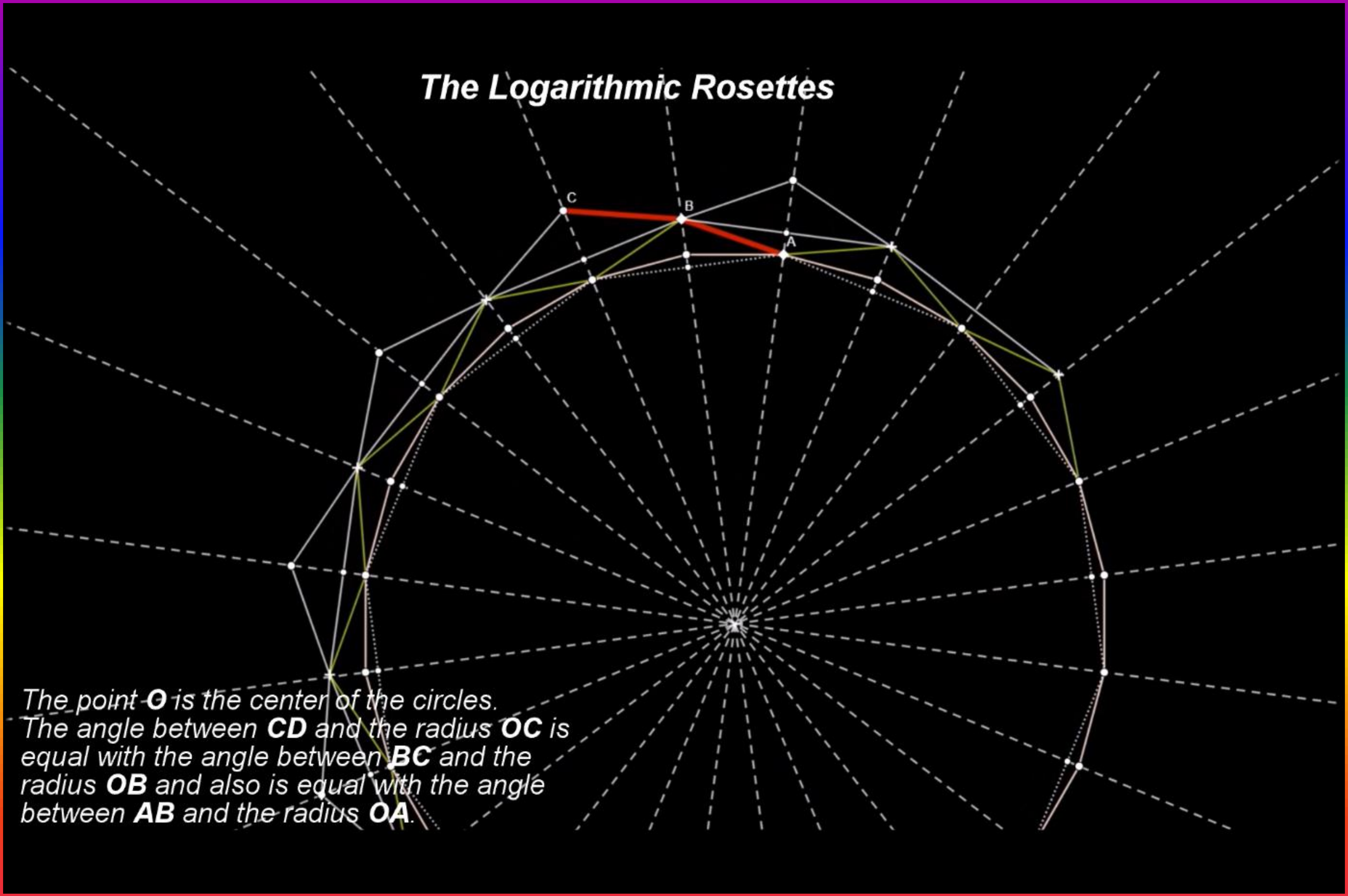
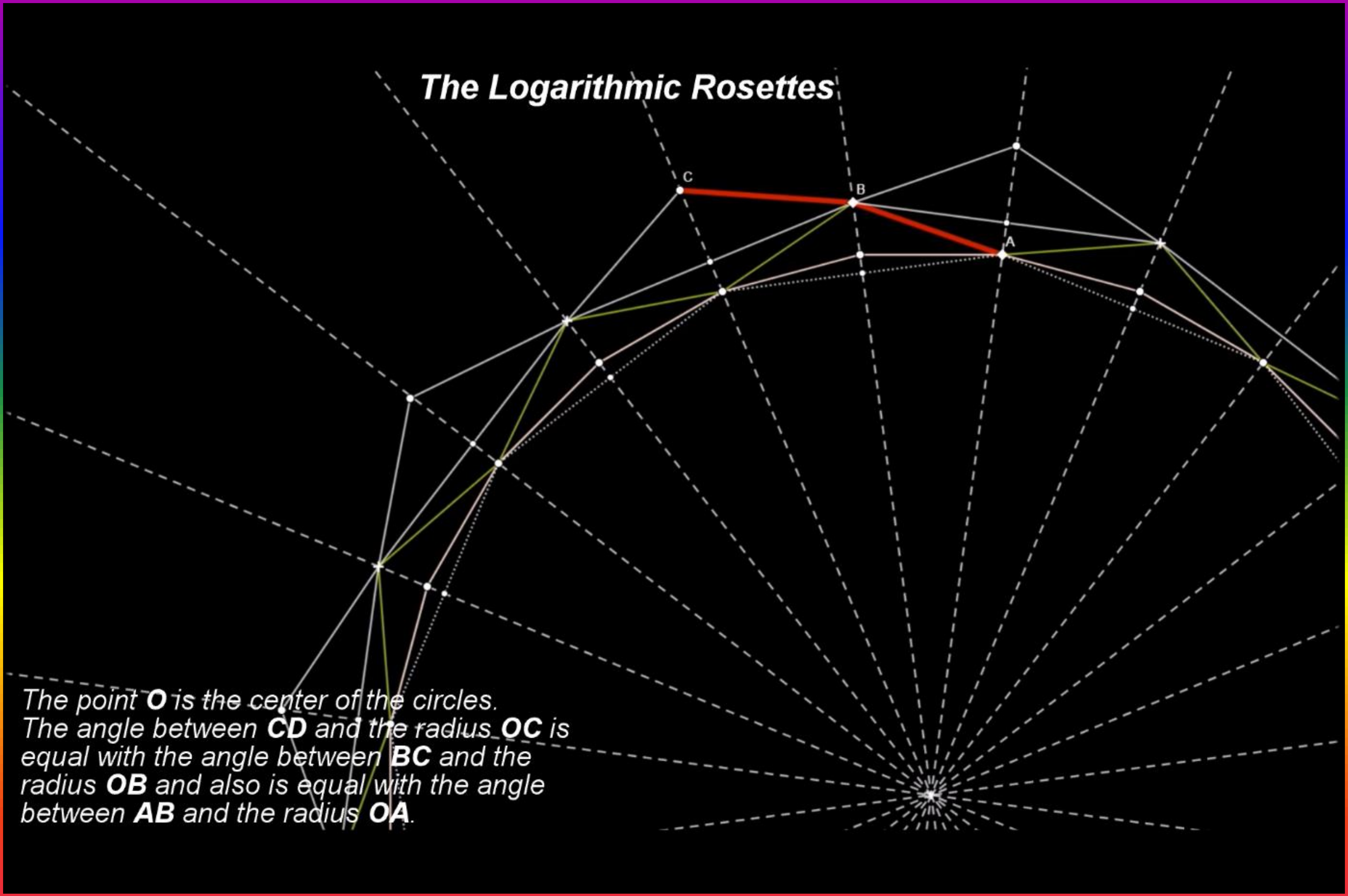


Let us continue our construction, and add a new circle, following a similar approach.

First, we need to find the location of a new point **D**.



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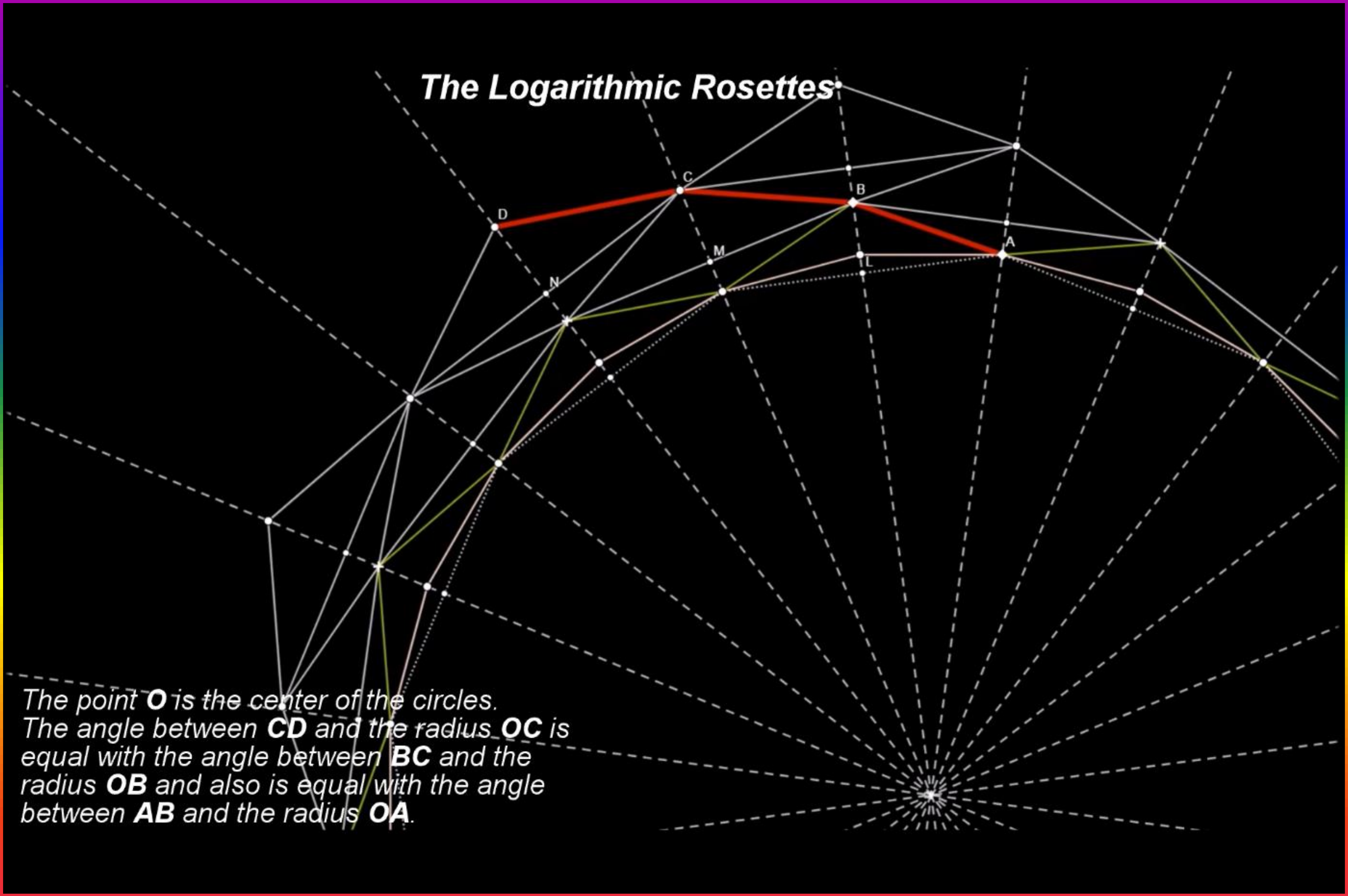

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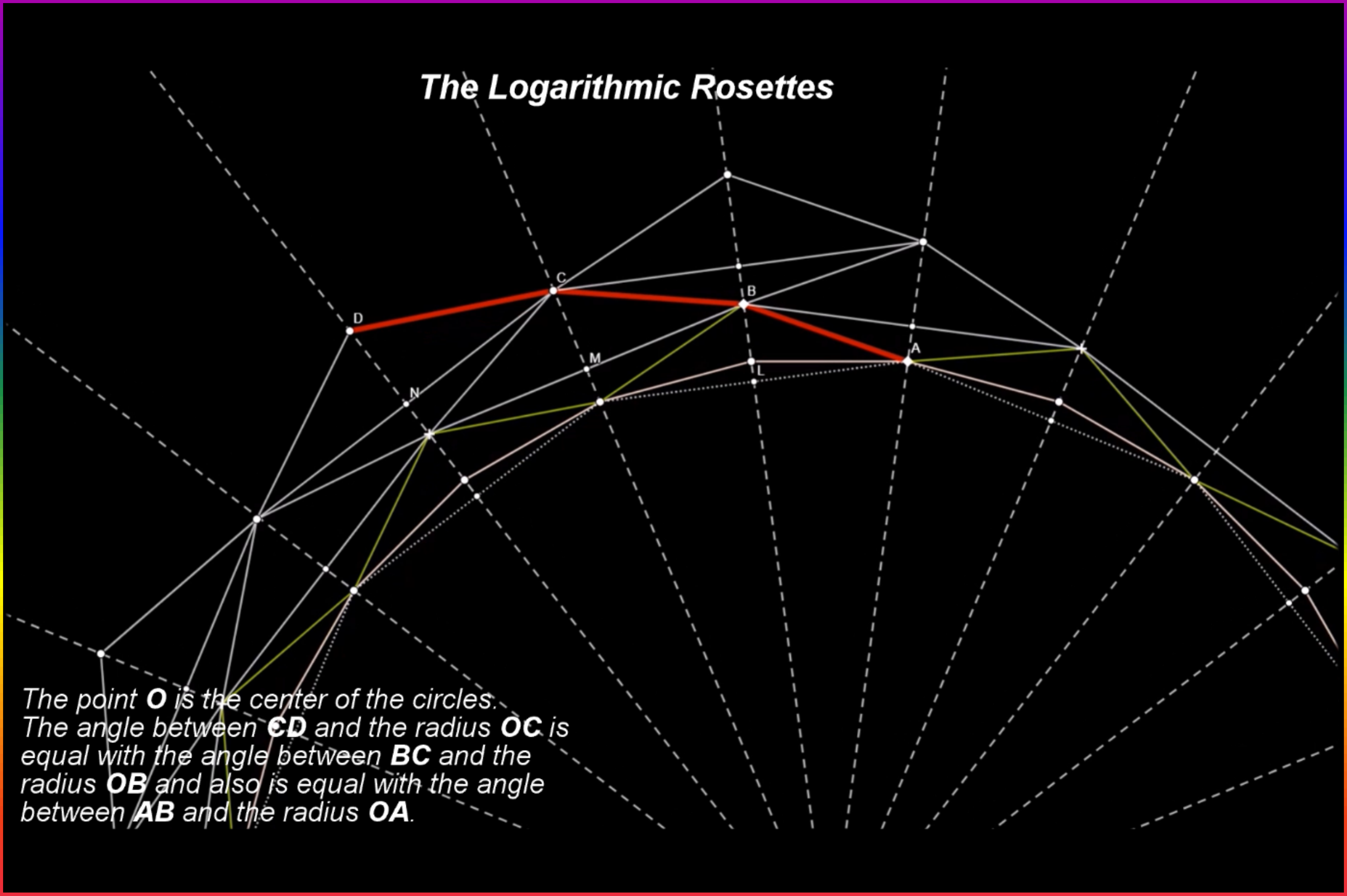
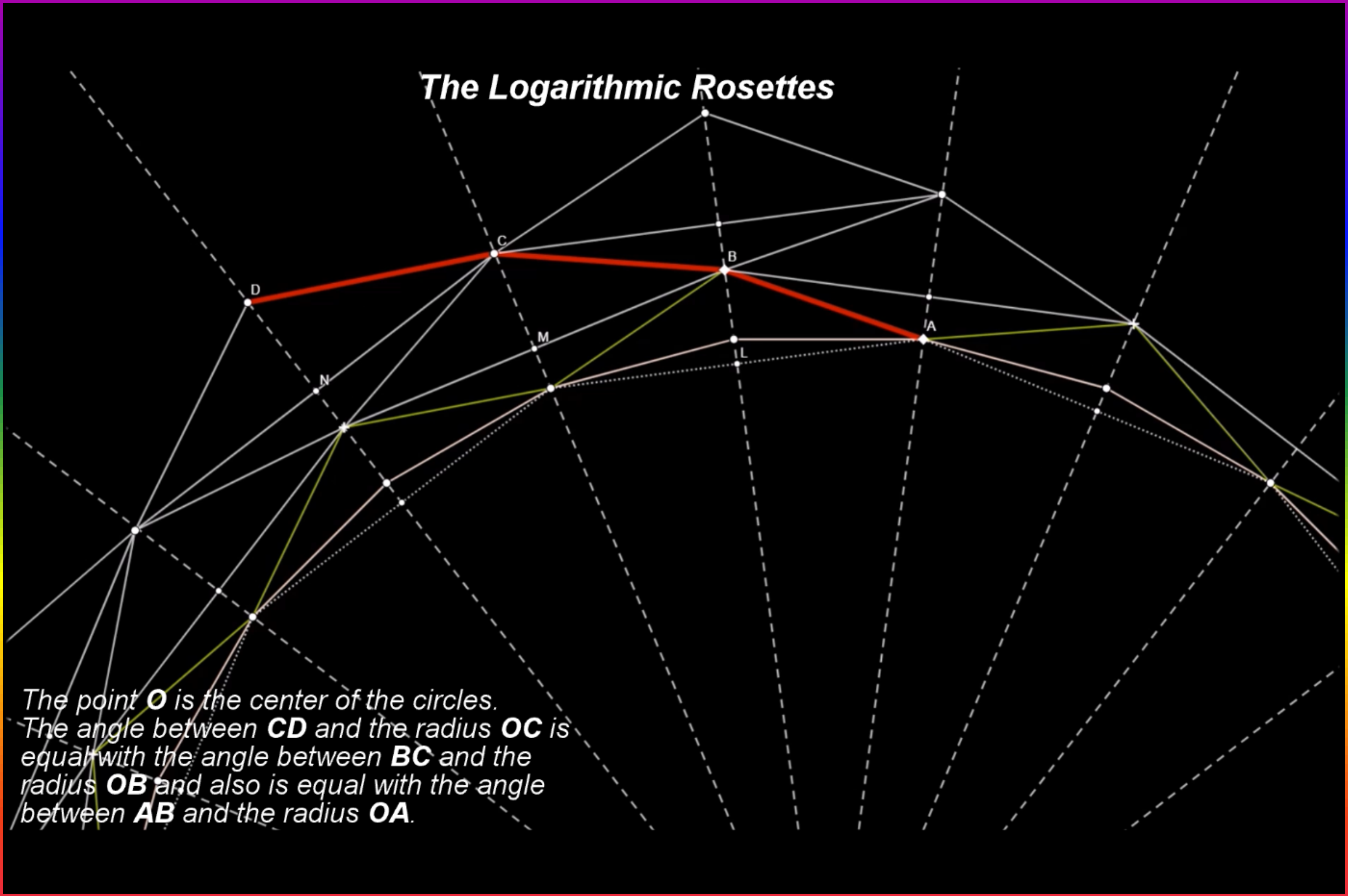


Again, the angle between **CD** and the radius **OC** is equal with the angle between **BC** and the radius **OB** and also is equal with the angle between **AB** and the radius **OA**.



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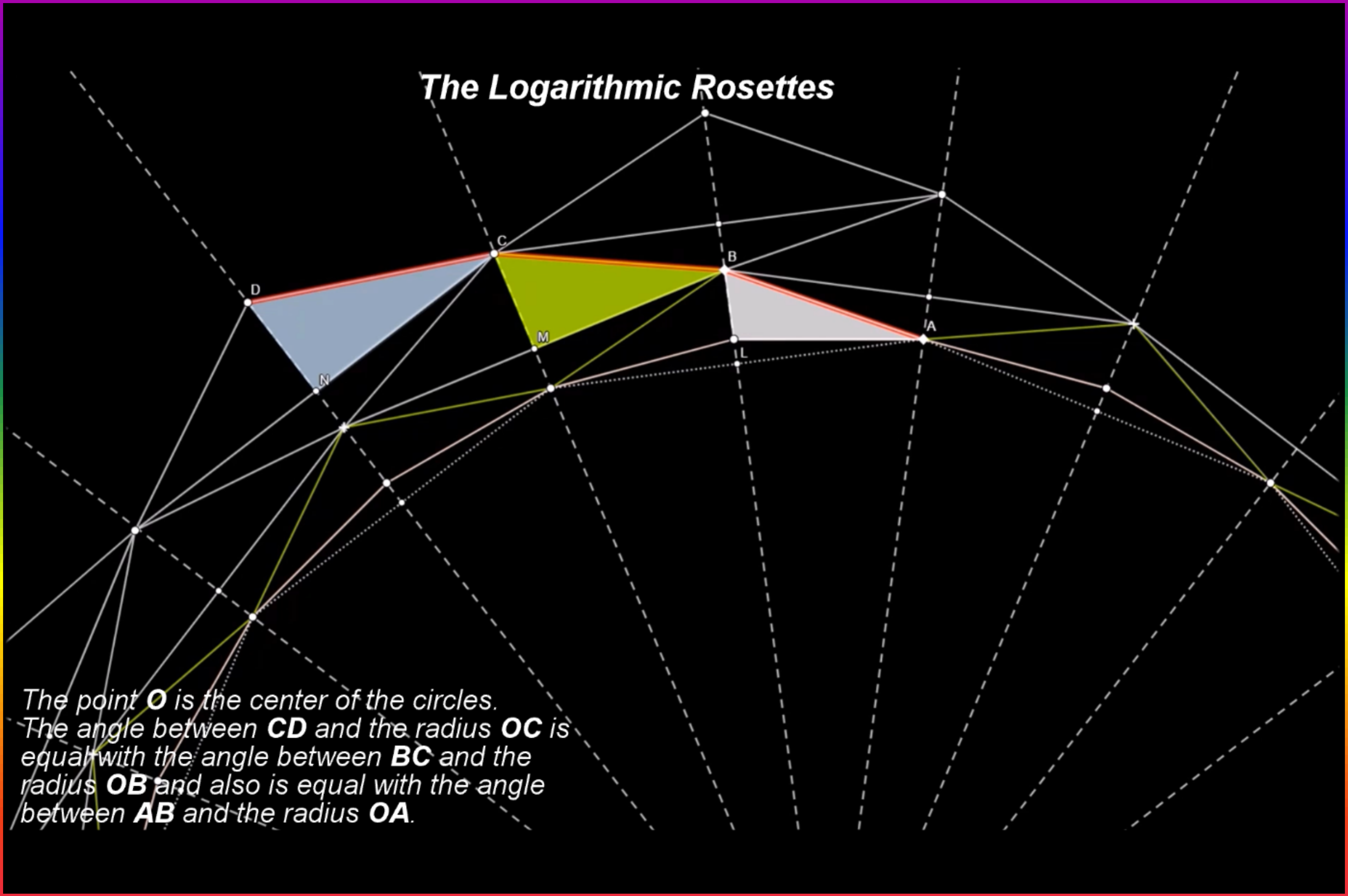
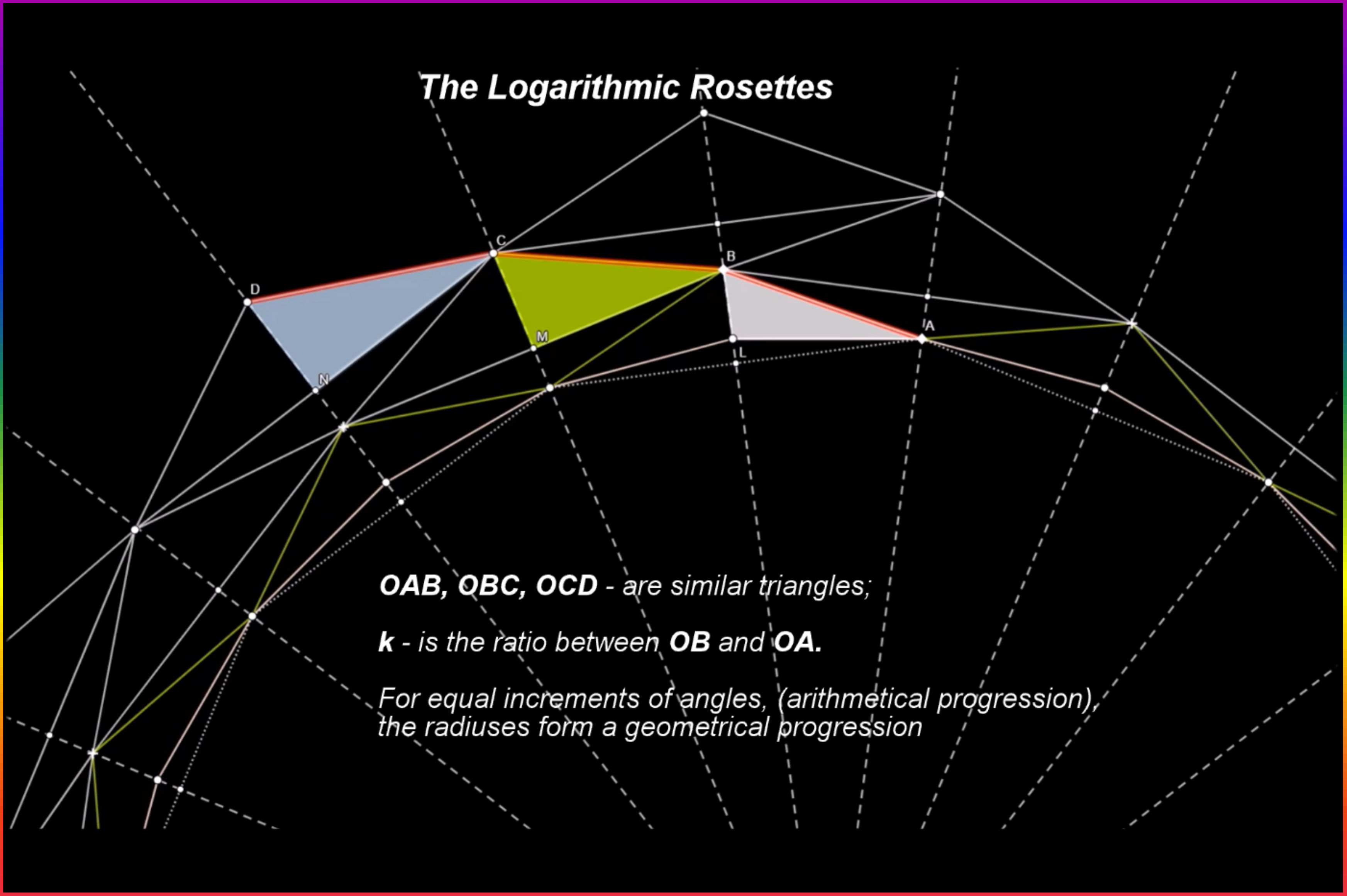


There are now three similar triangles:

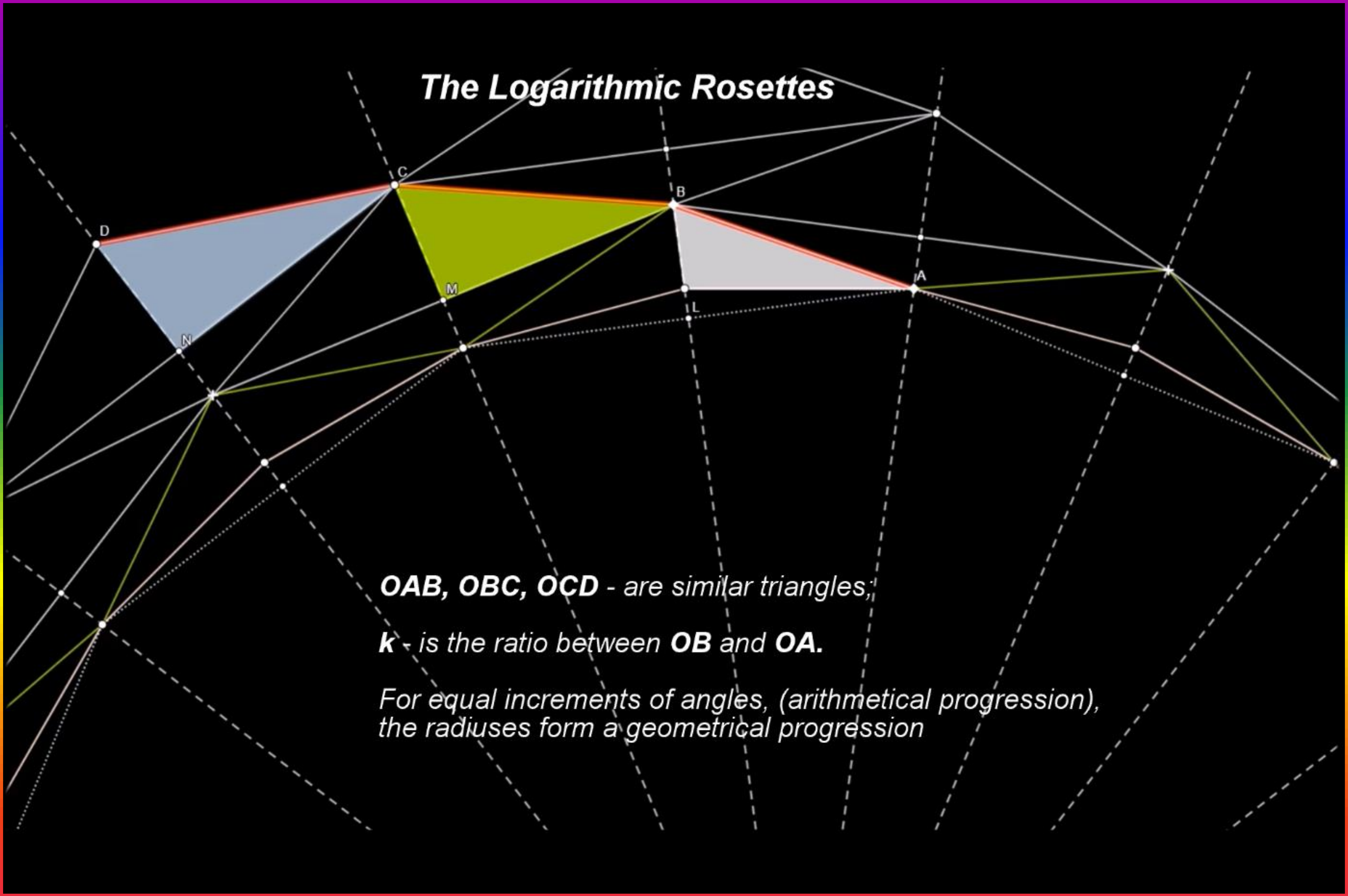
OAB, **OBC** and **OCD.**



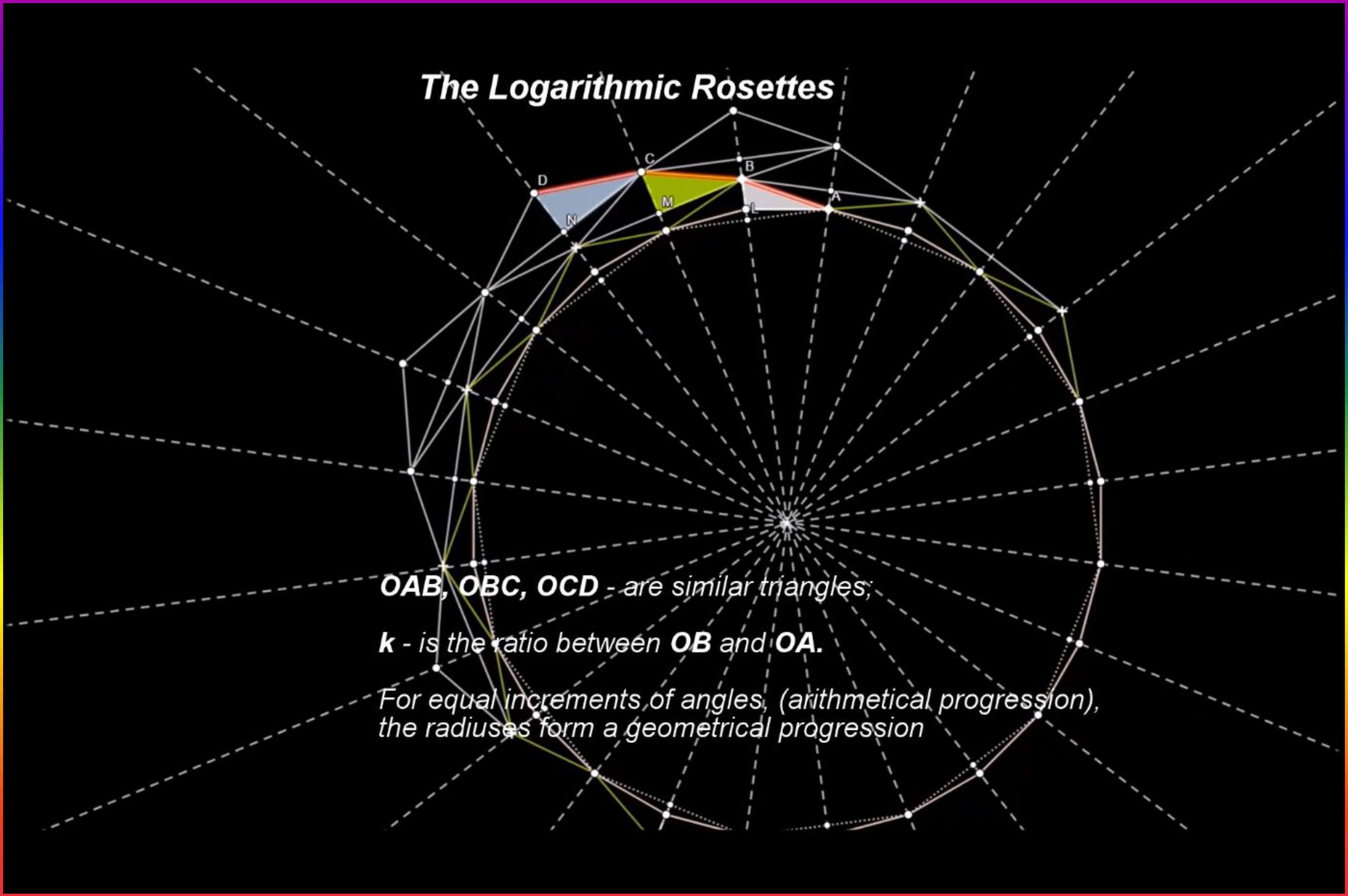
There are now three similar triangles:

OAB, **OBC** and **OCD.**

If **k** is the ratio between the radiuses **OB** and **OA** then from the similarity mentioned above we have:

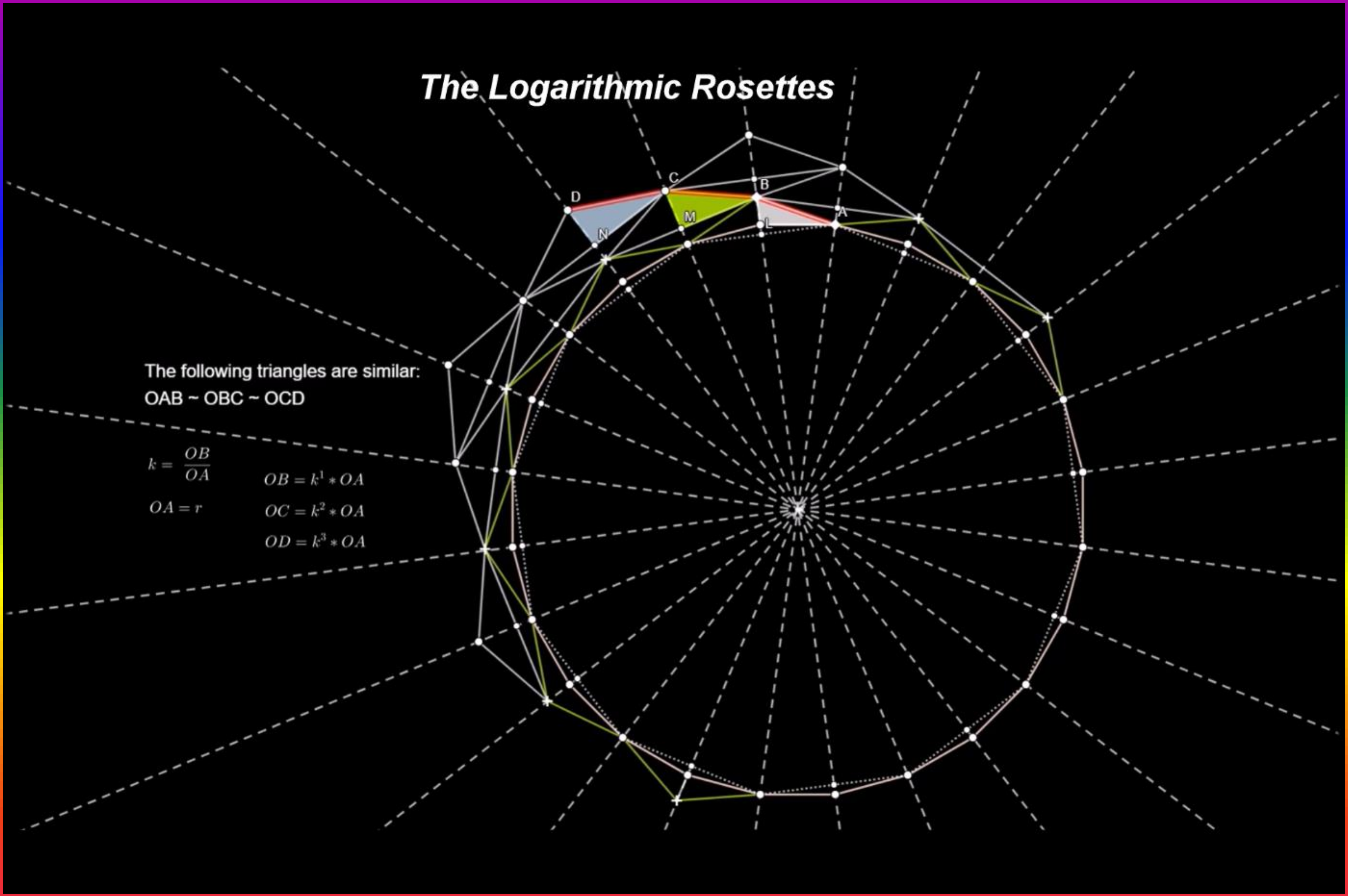


For equal increments of angles (arithmetical progression), the radiuses form a geometrical progression:



For equal increments of angles (arithmetical progression), the radiuses form a geometrical progression:

$\boldsymbol{OA, k \times OA, k^2 \times OA, k^3 \times OA}$ and so on.



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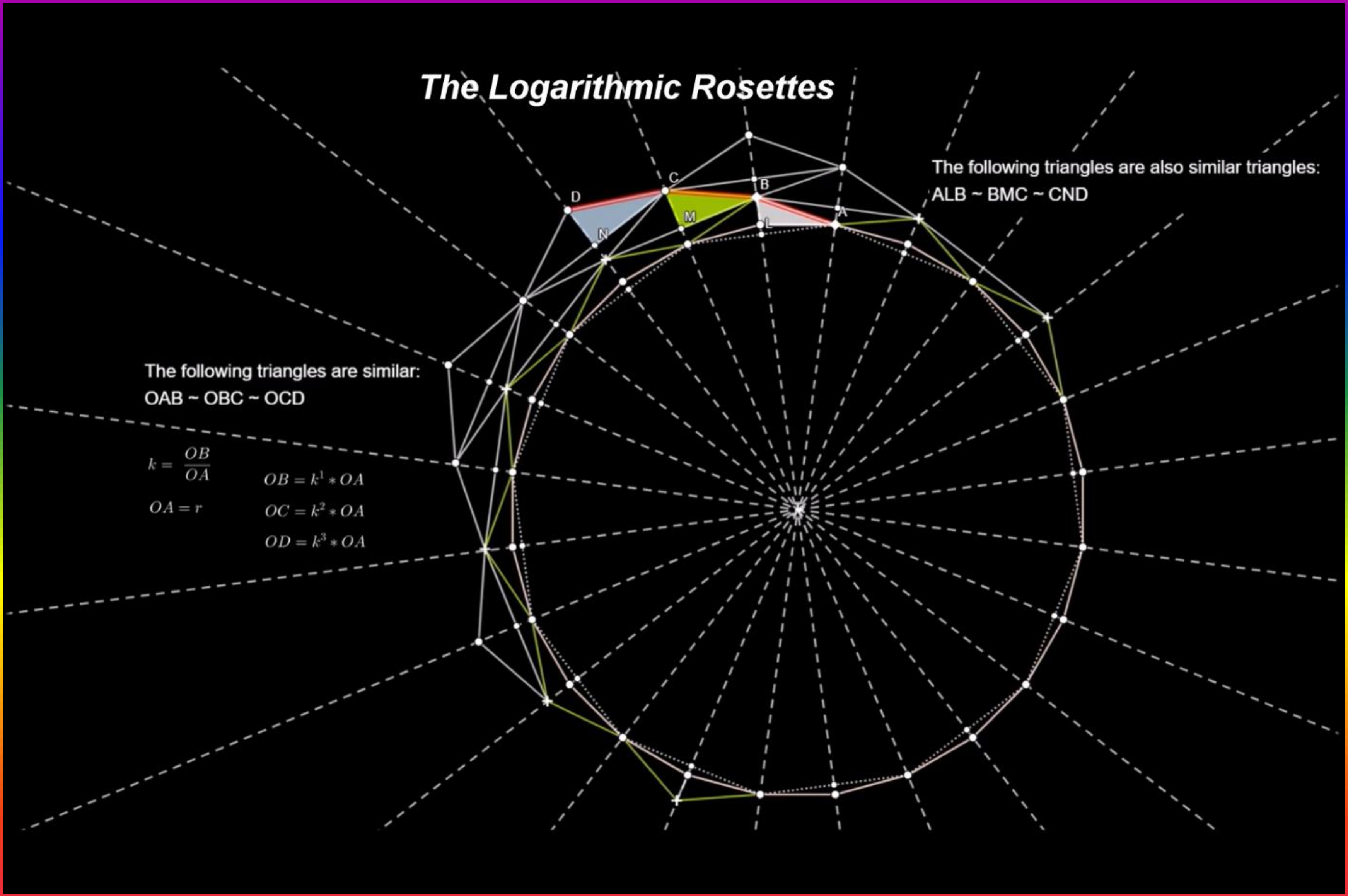

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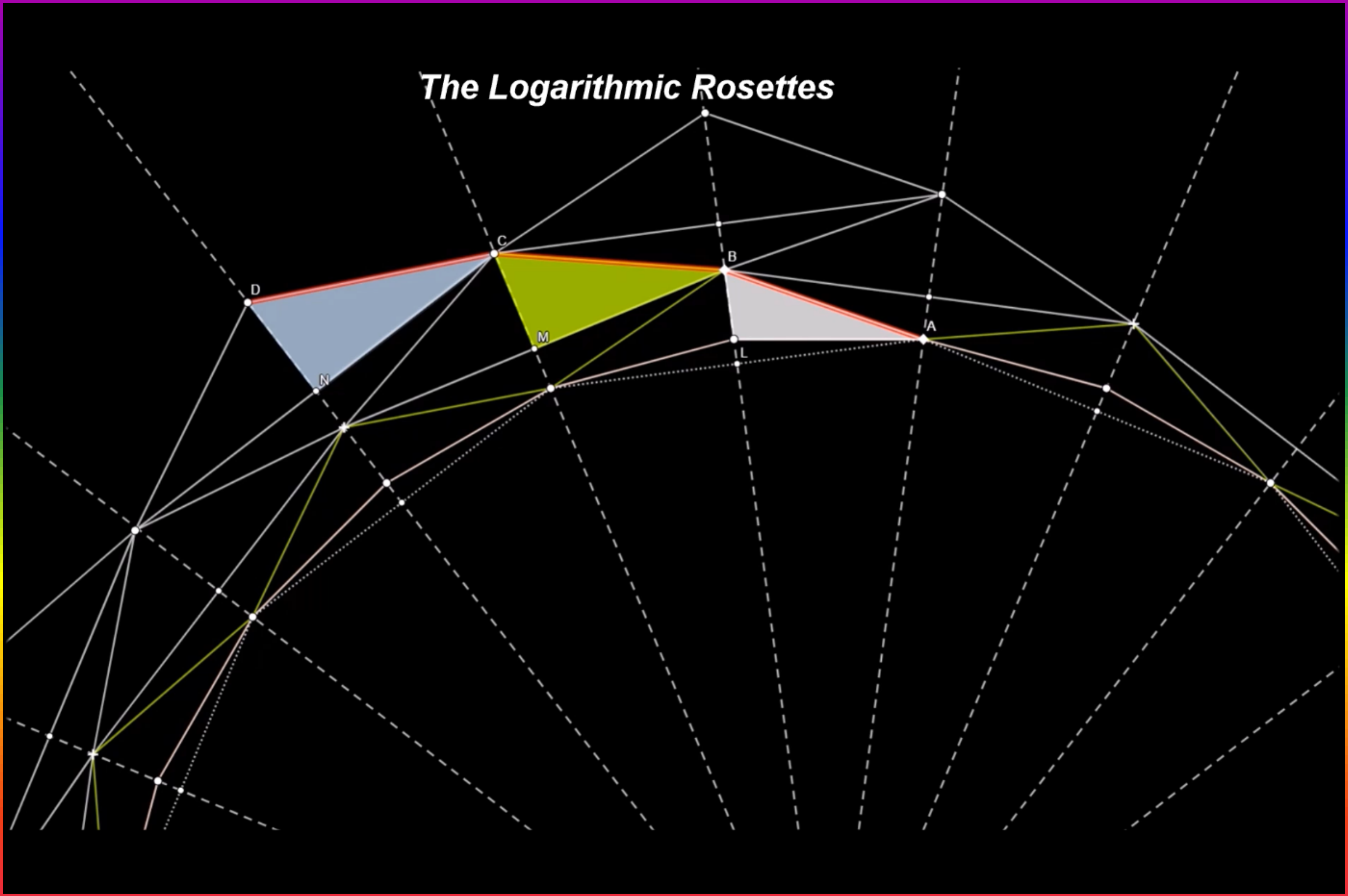
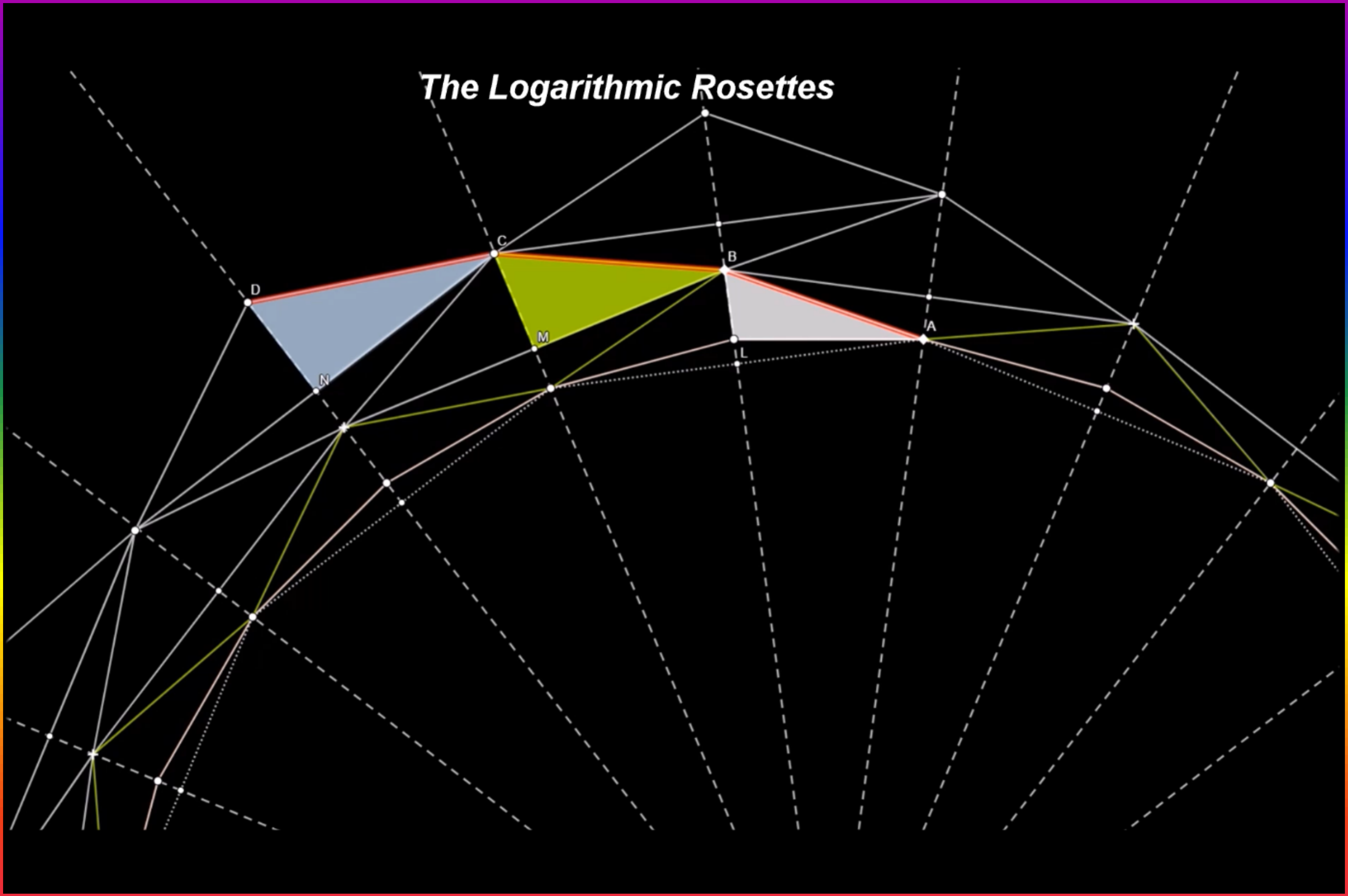


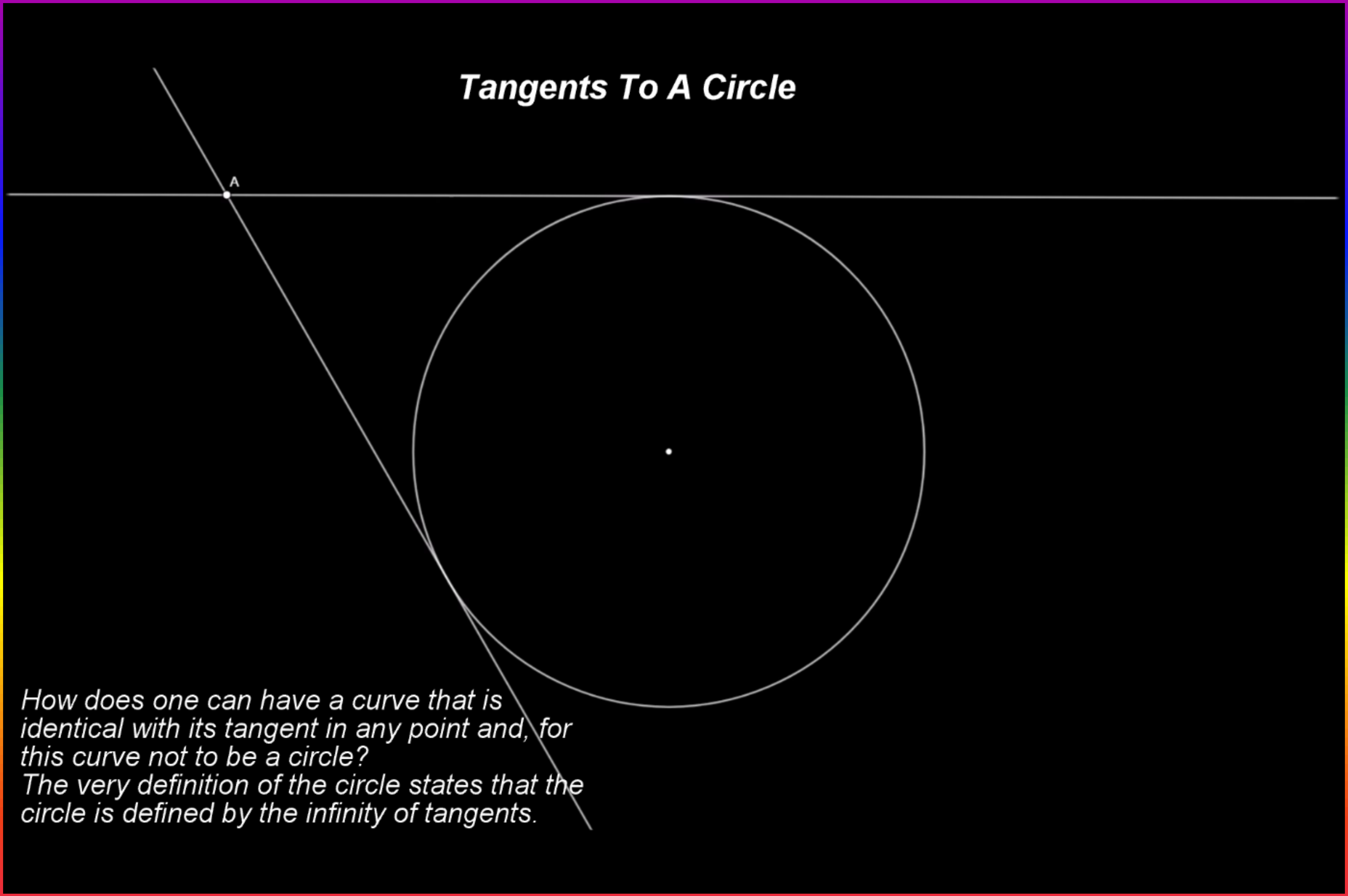
The logarithmic rosette is constructed from tiles, shaped as similar triangles.

The following triangles are similar triangles: **ALB**, **BMC**, and **CND**.

By changing the location of the point **B** one changes the angle between **BA** and the radius **OA**.

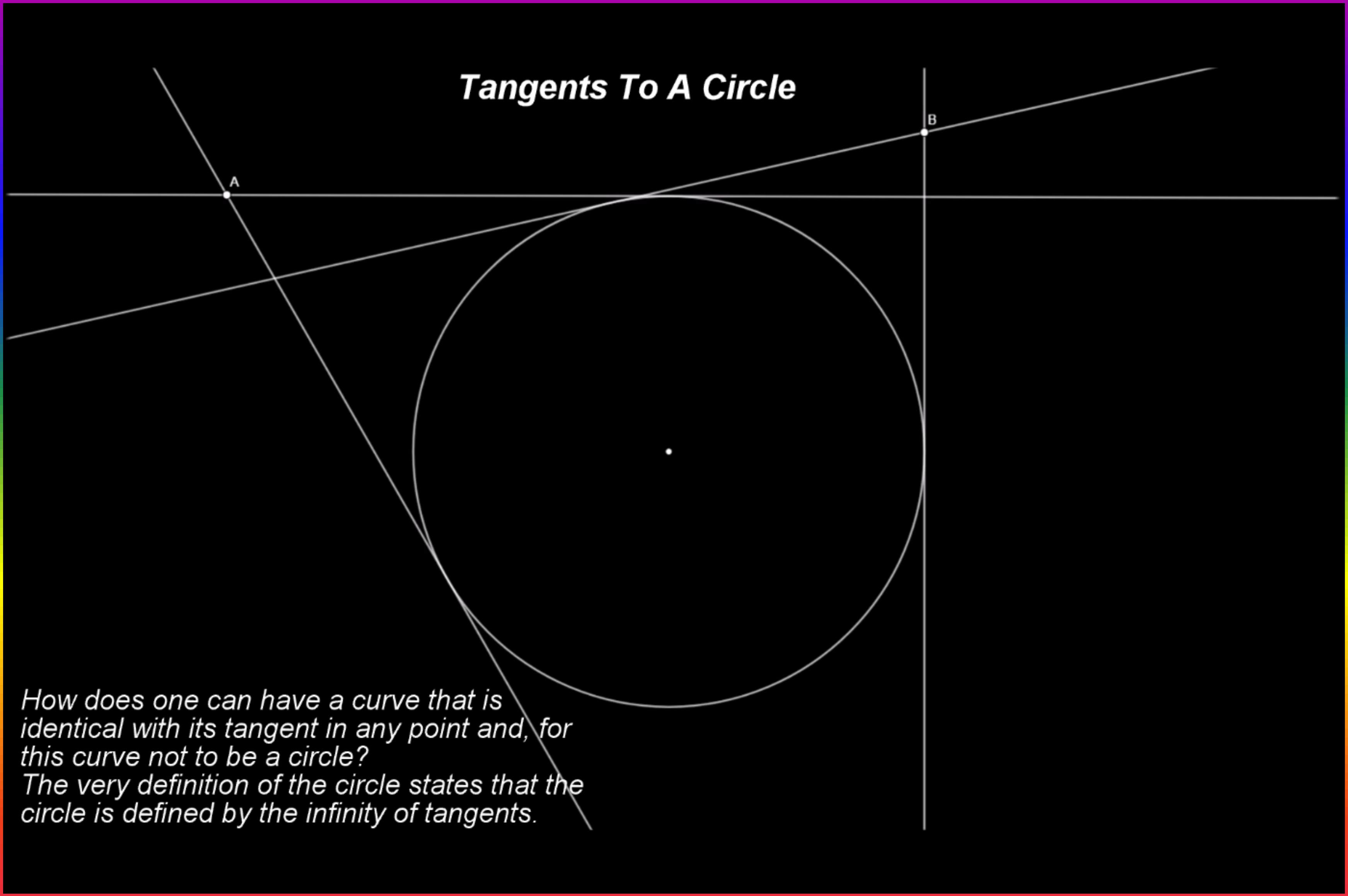


How does then one can have a curve that is identical with its tangent in any point and for this curve not to be a circle? The very definition of the circle states that the circle is defined by the infinity of tangents.



Let's start by stating a well known fact:

A sphere can be completely surrounded by exactly twelve others identical spheres, in only one way.



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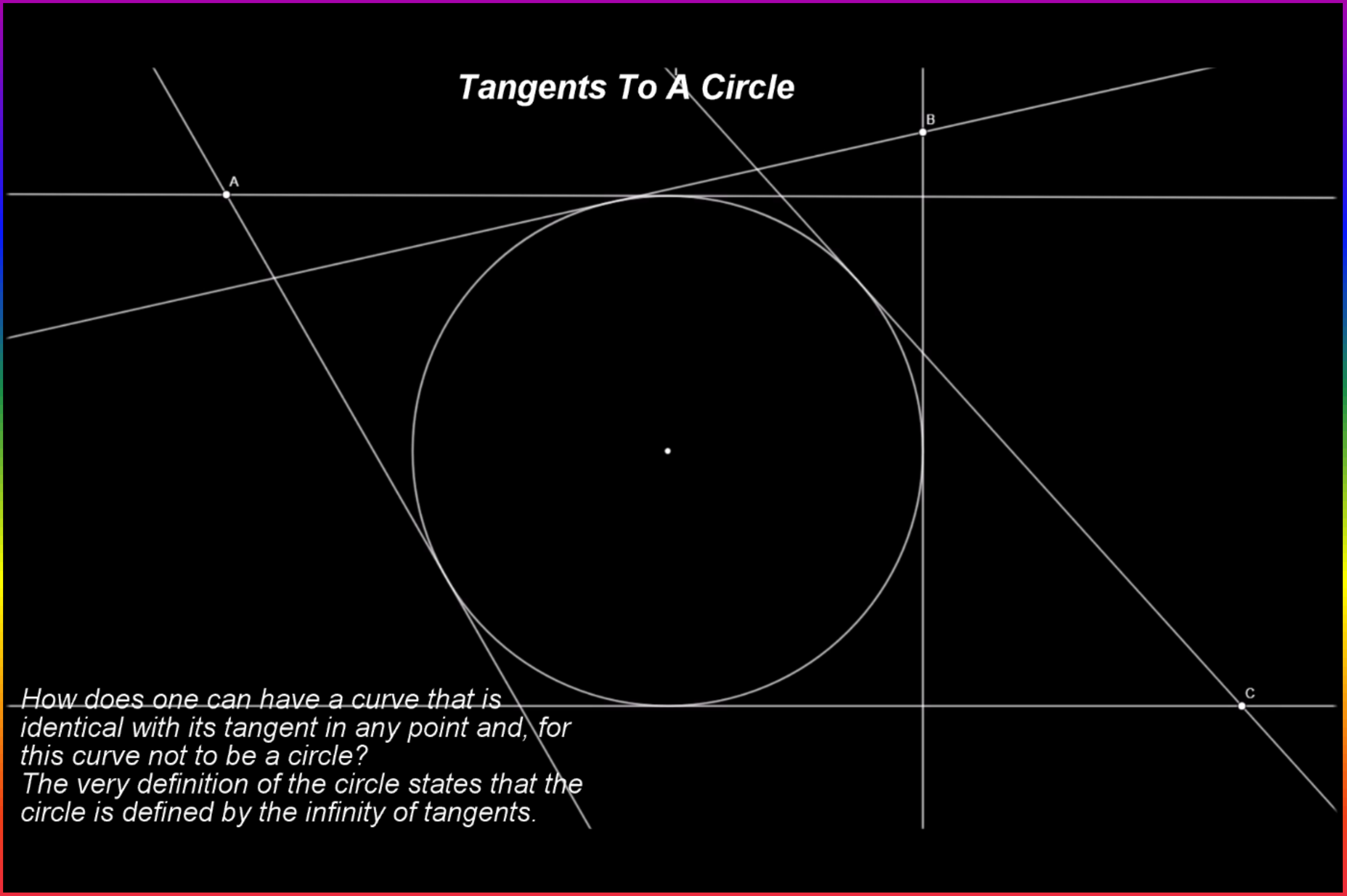

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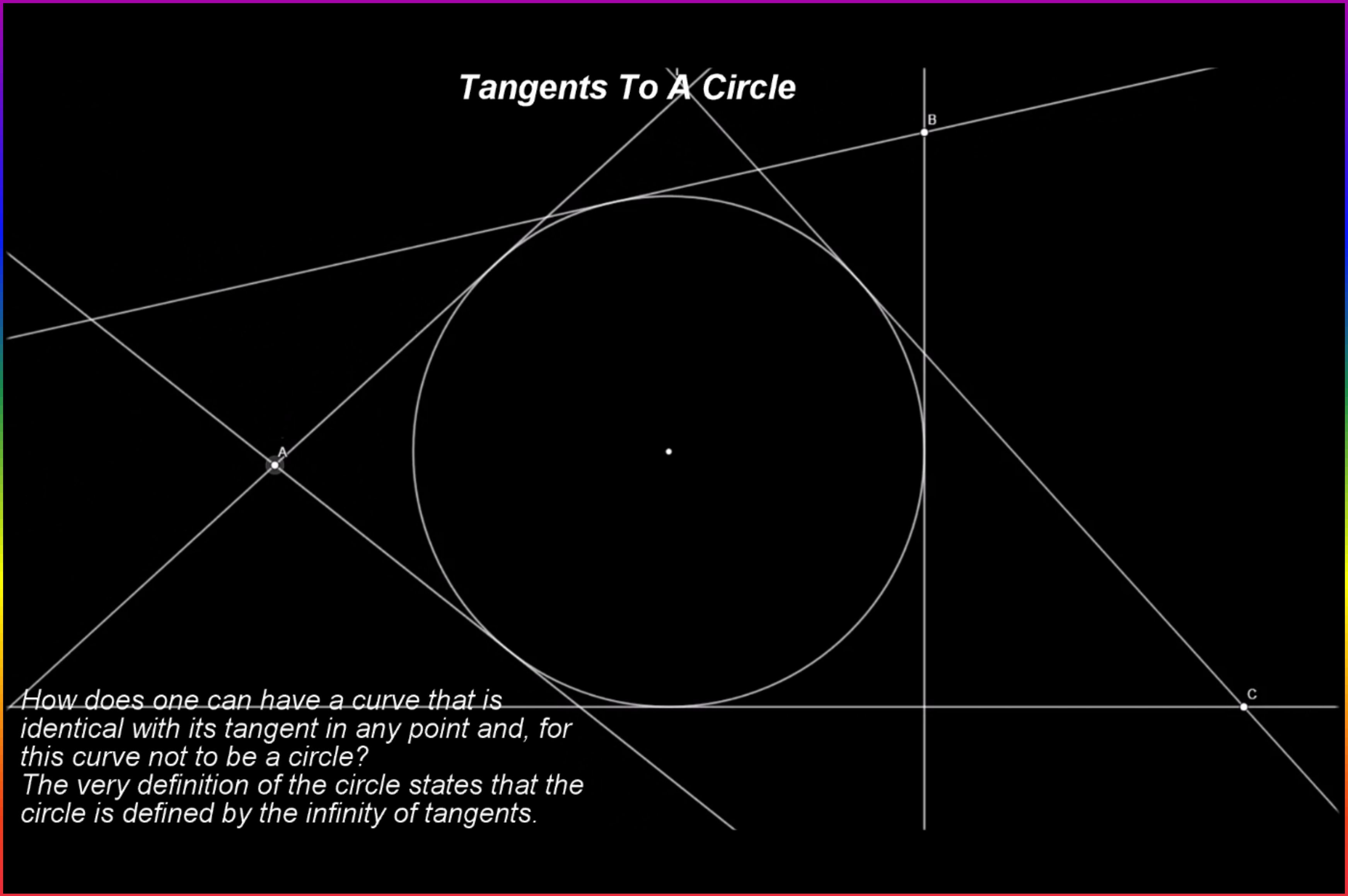

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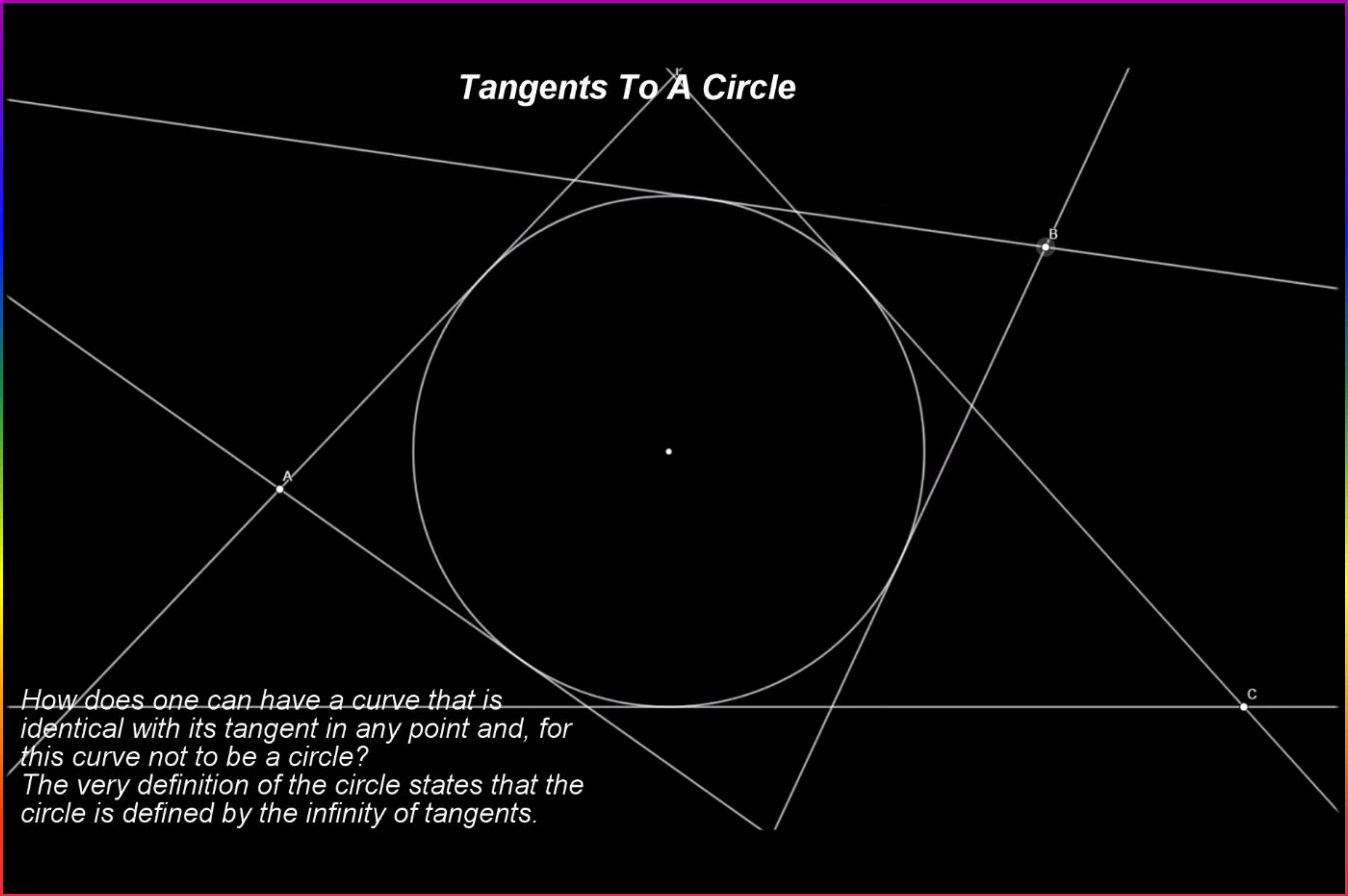

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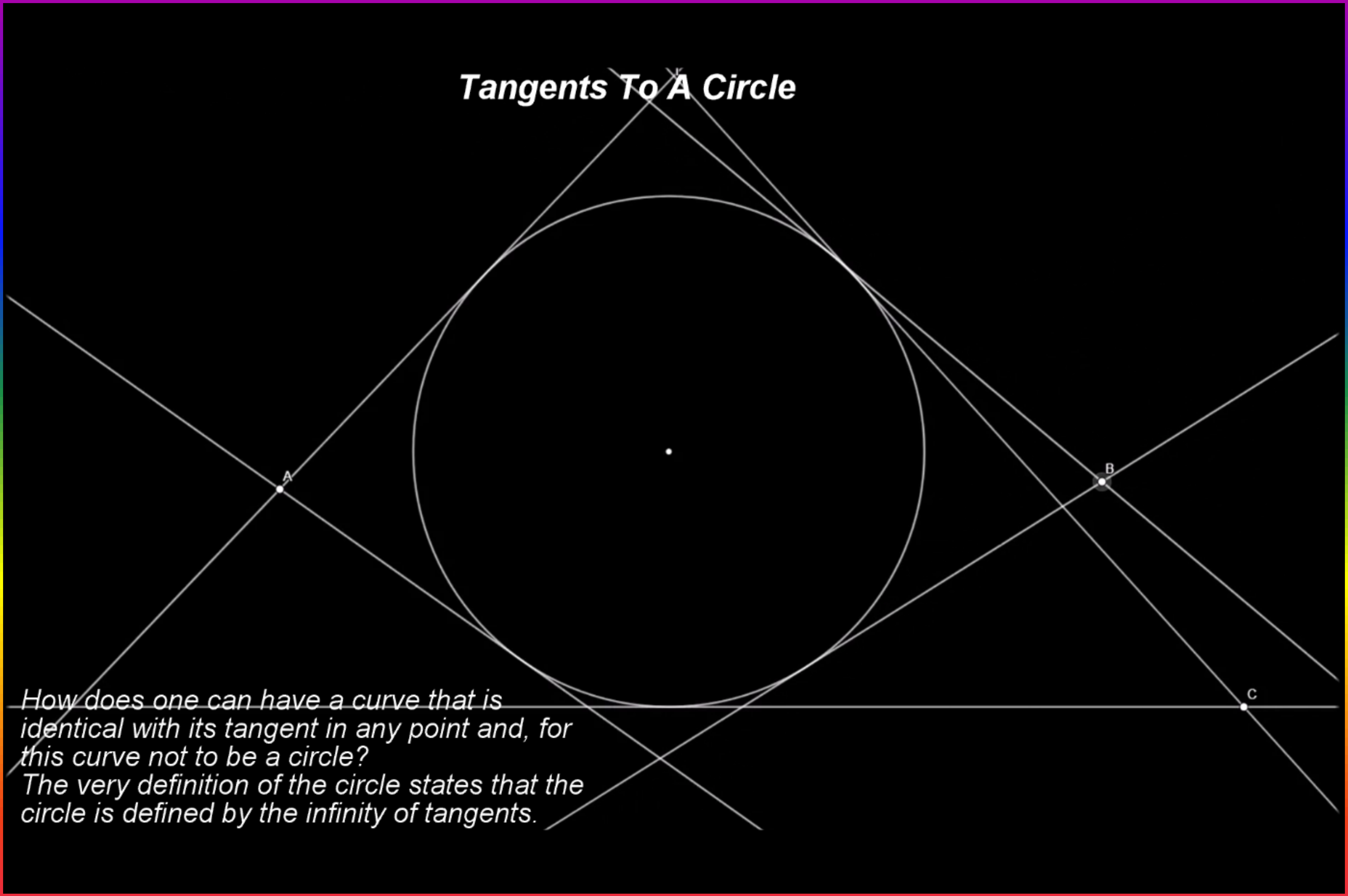

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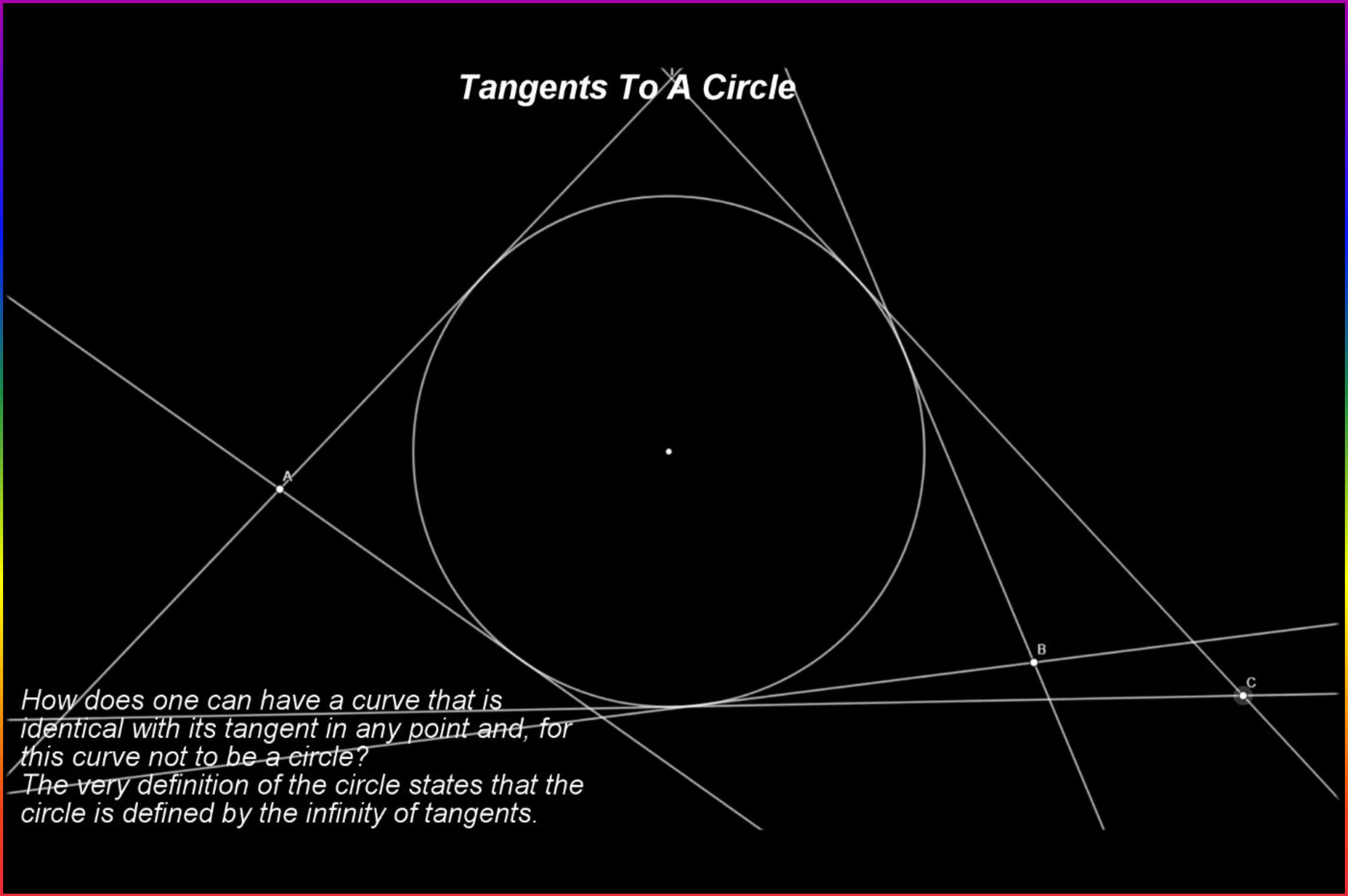

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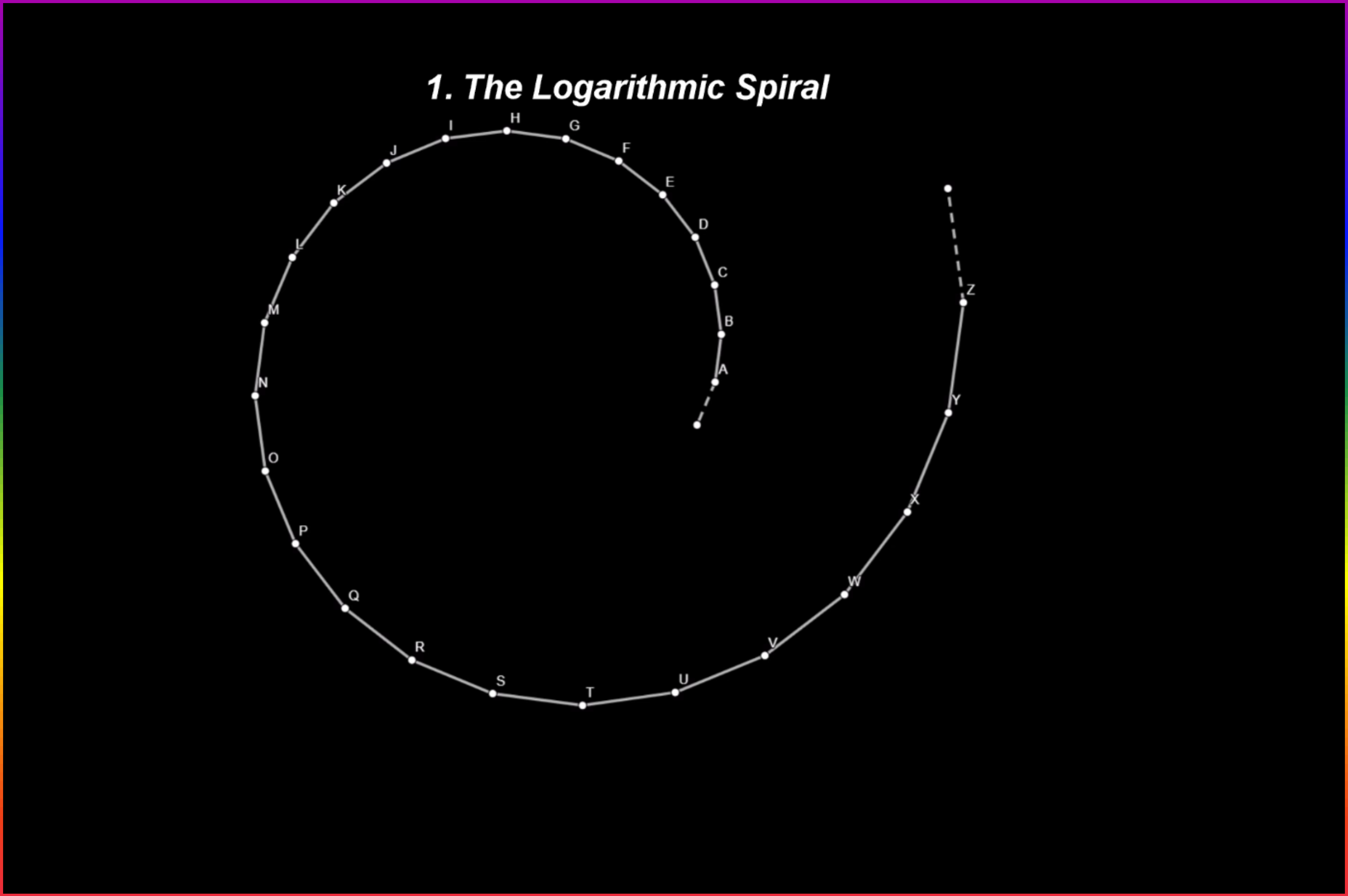
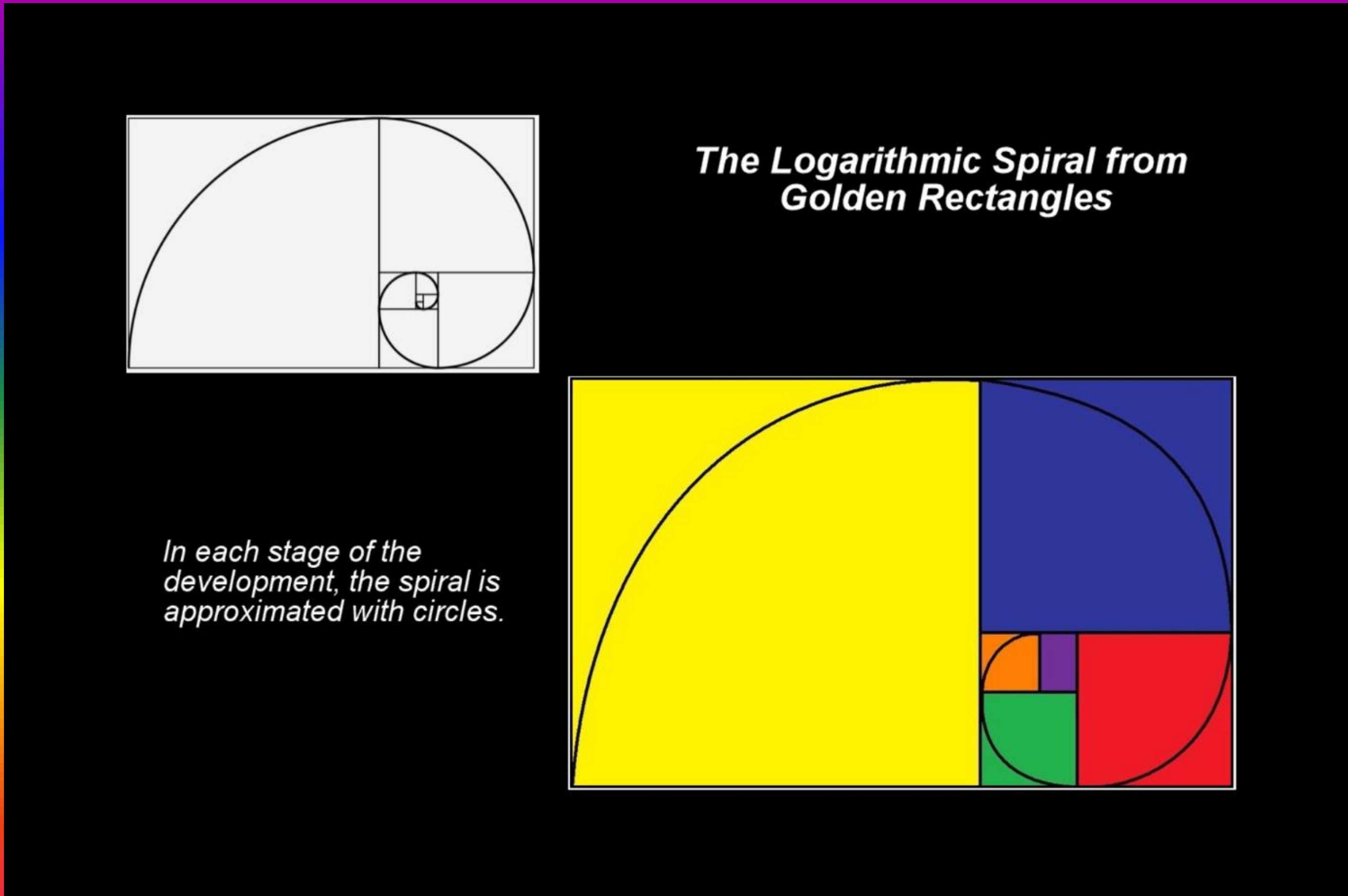
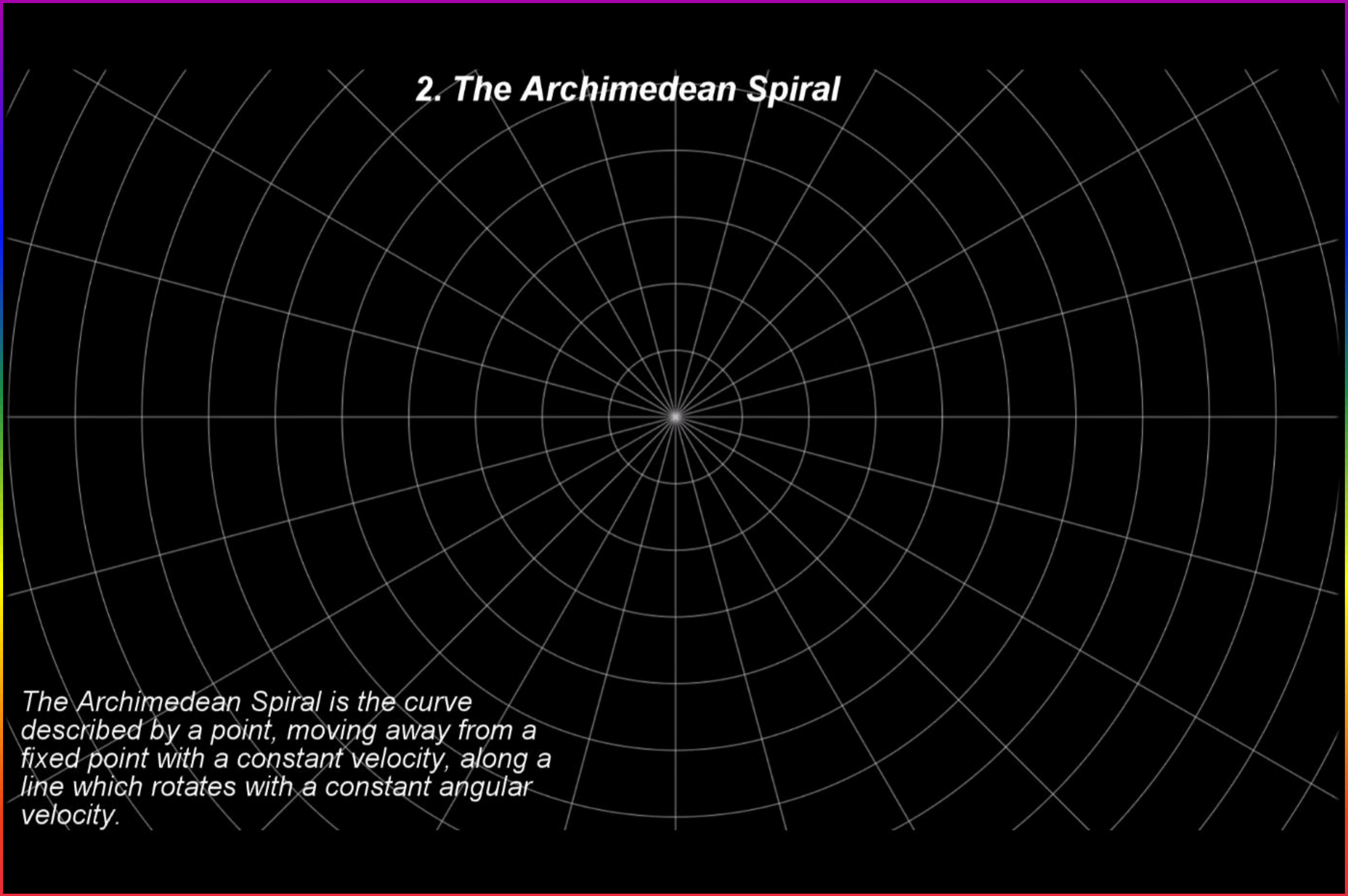


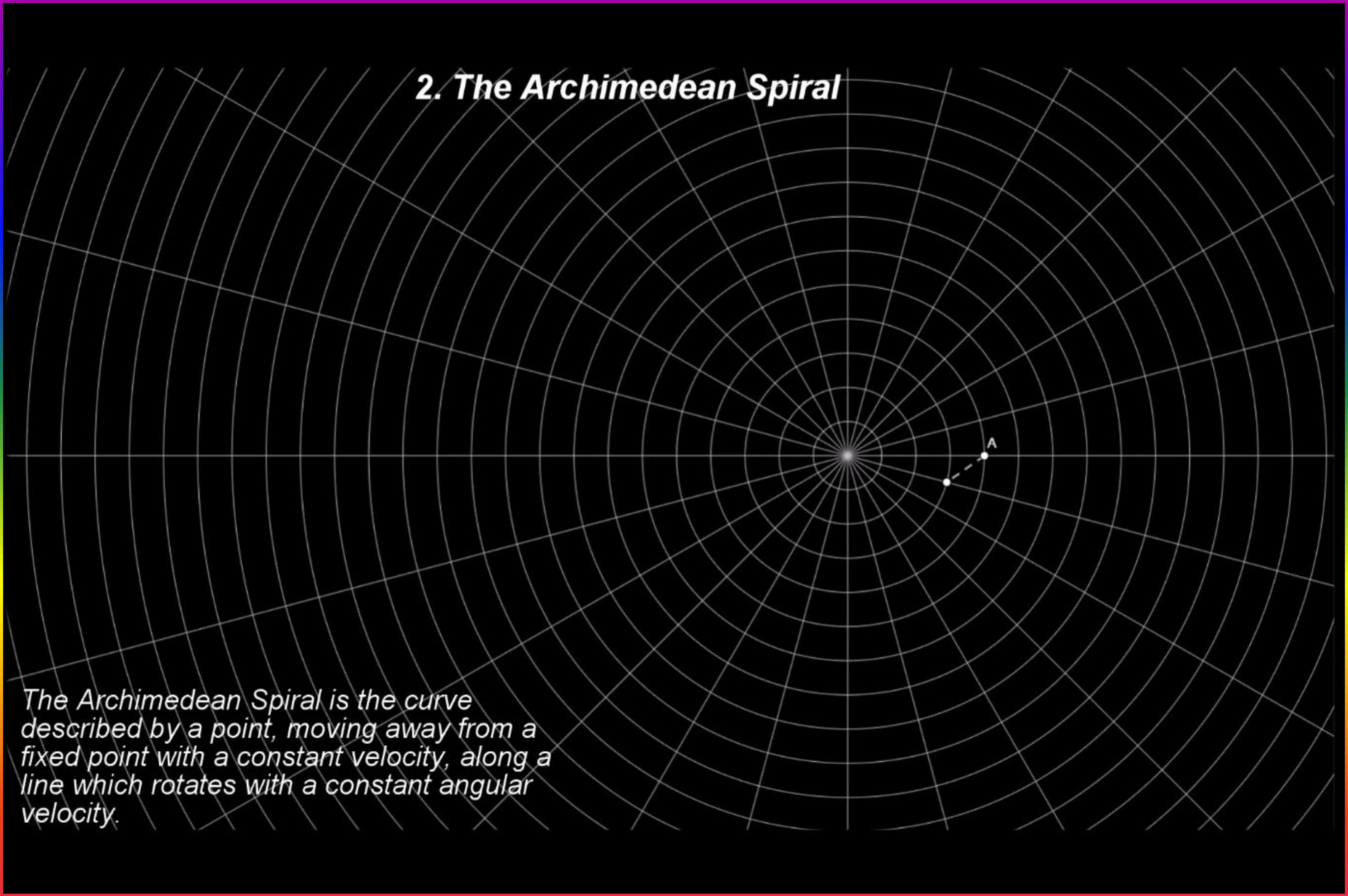
Another way, of constructing a logarithmic spiral is to use the Golden Rectangles.



Another way, of constructing a logarithmic spiral is to use the Golden Rectangles.
Here again, in each stage of the development, the spiral is approximated with circles.

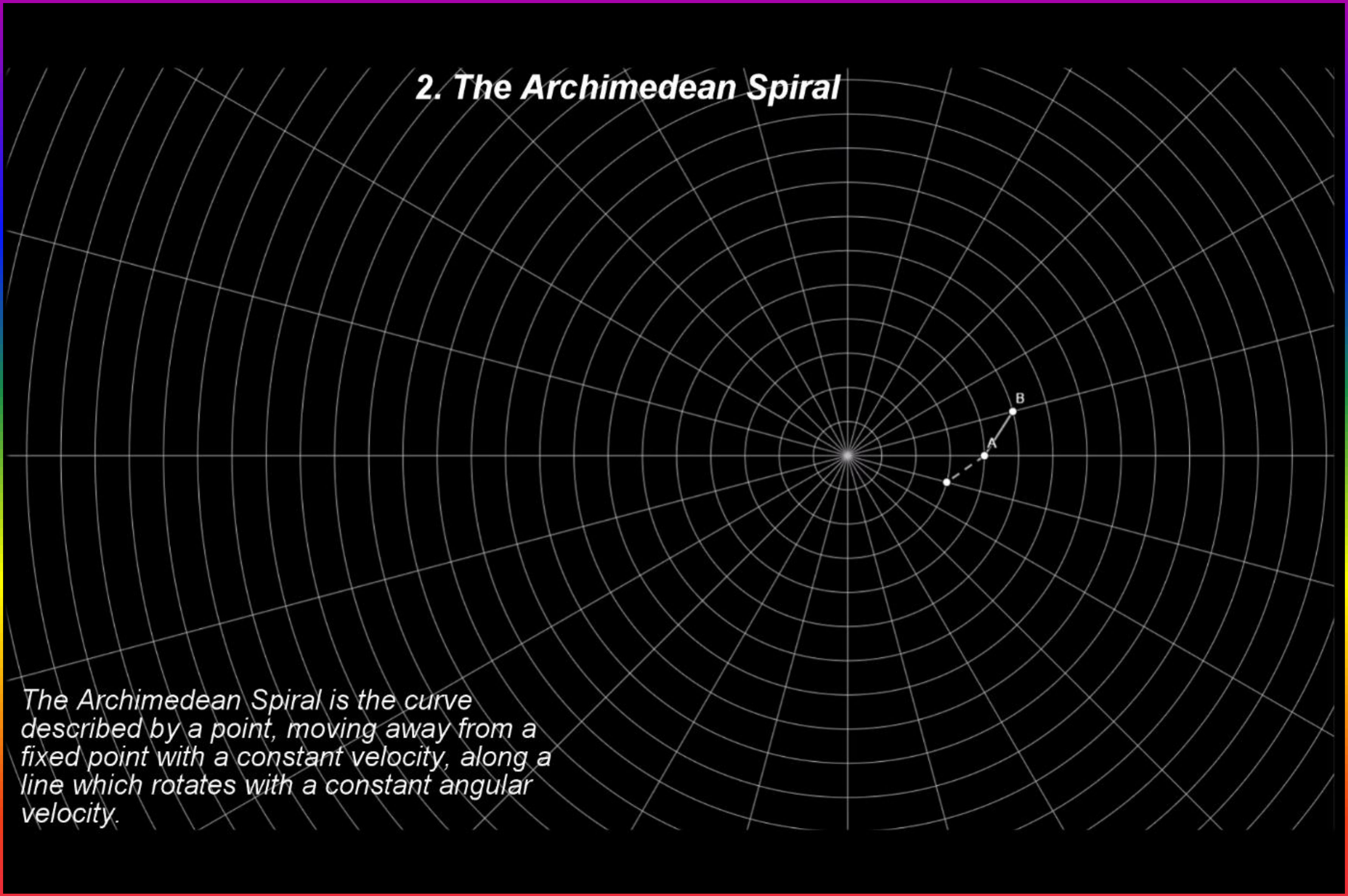


2. The other well known spiral we need to mention now is the ***Archimedean Spiral*** also known as the ***arithmetic spiral***.

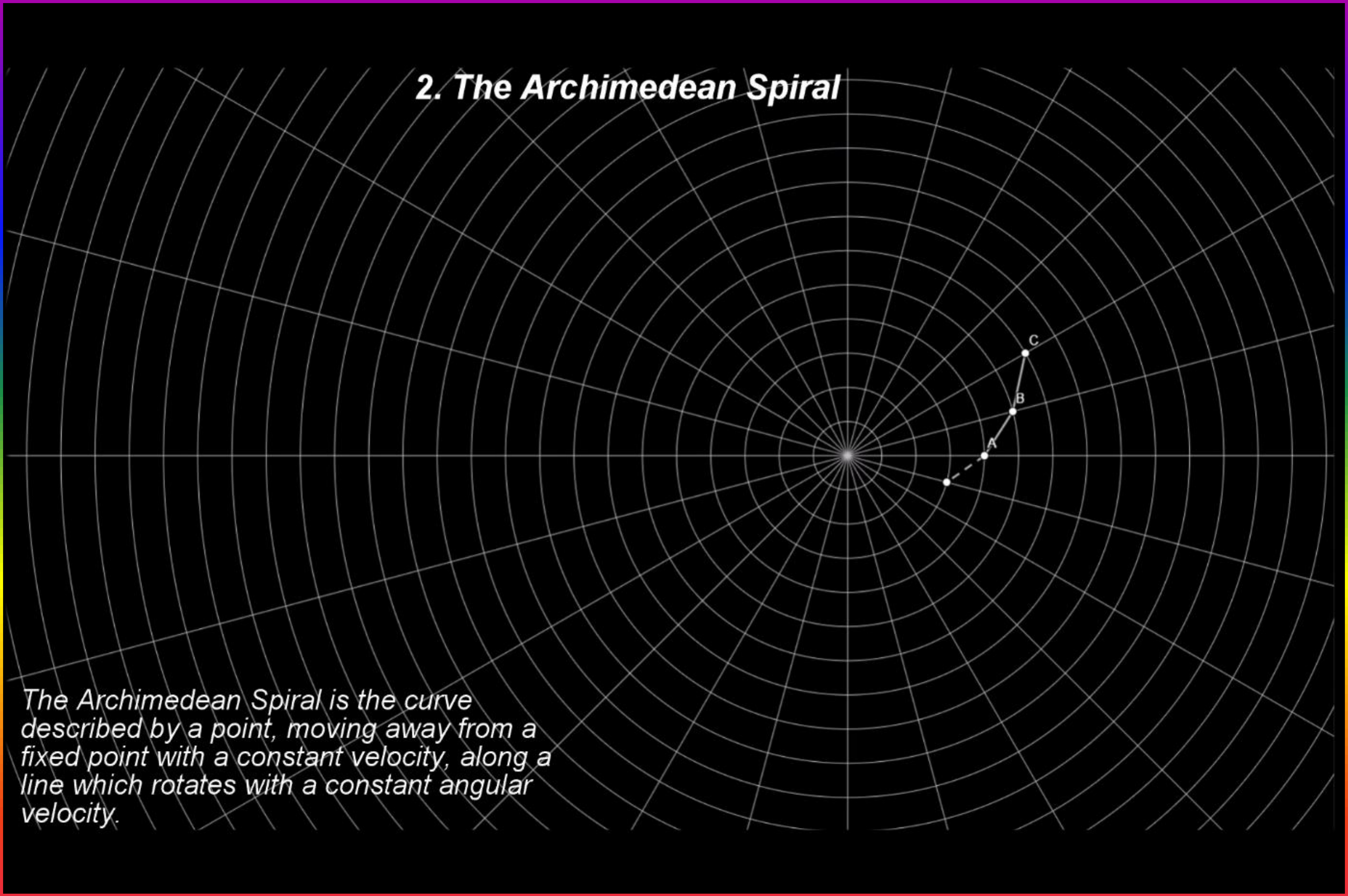


Let's start by stating a well known fact:

A sphere can be completely surrounded by exactly twelve others identical spheres, in only one way.



This spiral is the curve described by a point, moving away from a fixed point with a constant velocity, along a line which rotates with a constant angular velocity.



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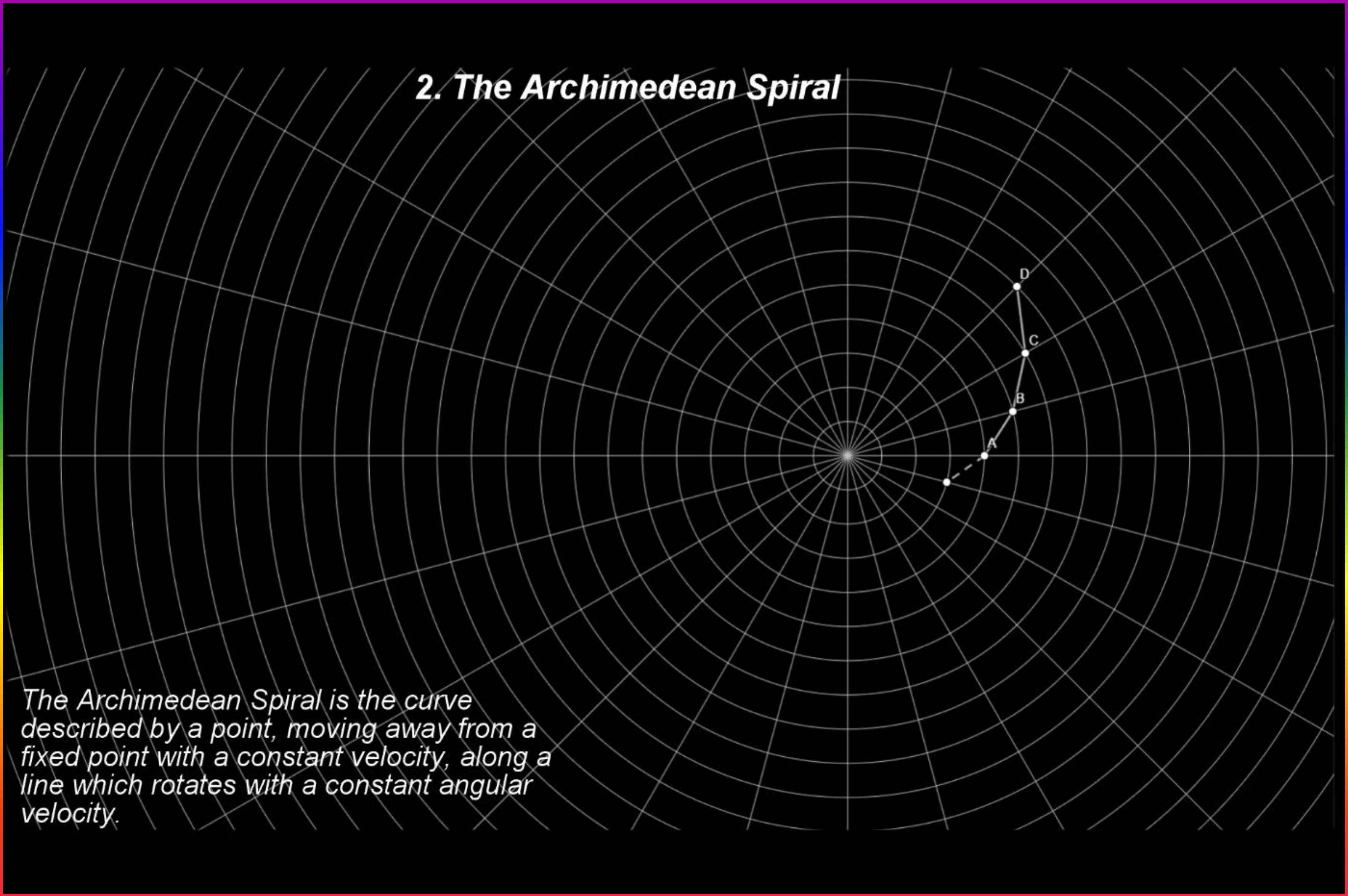

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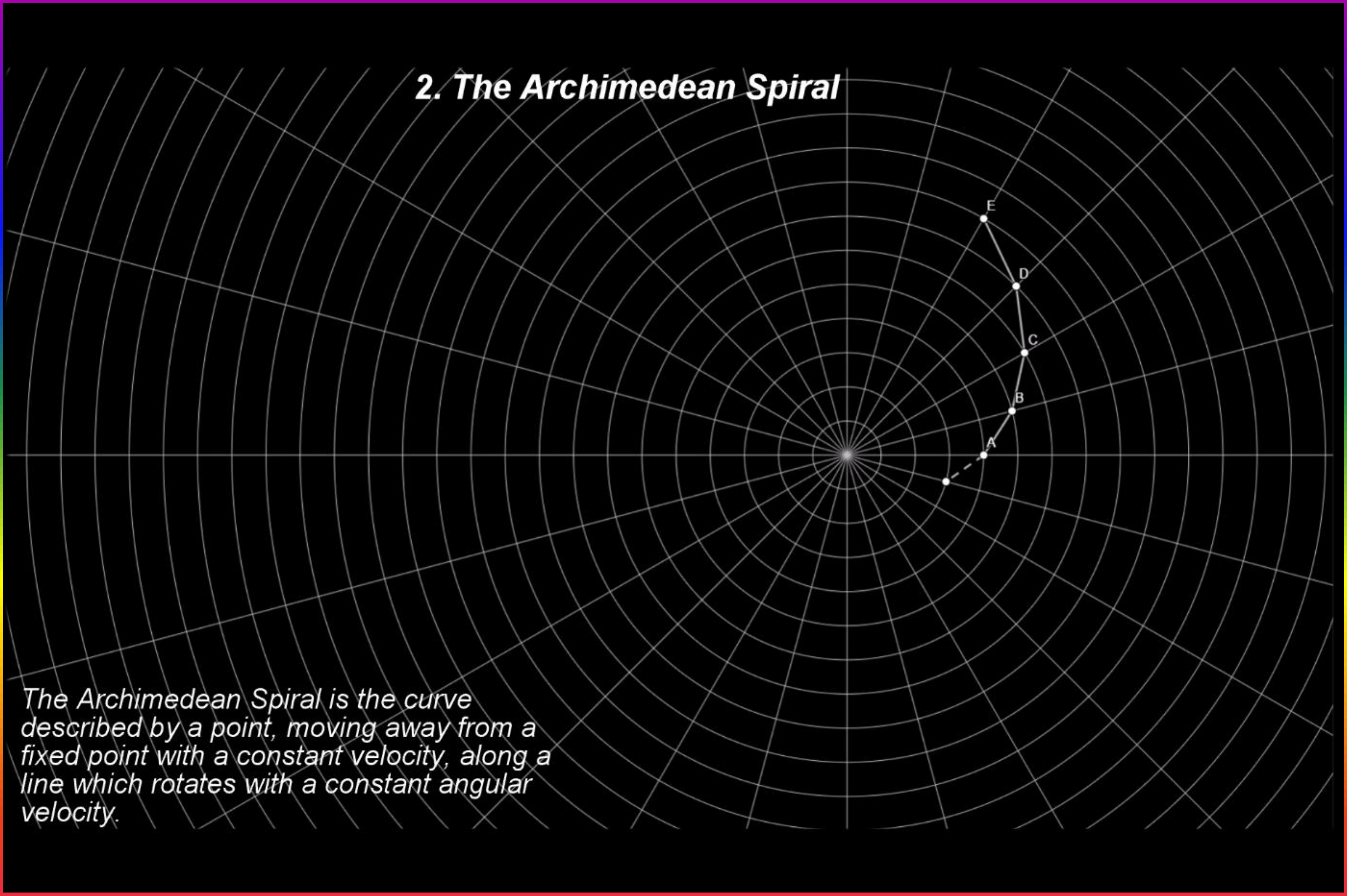

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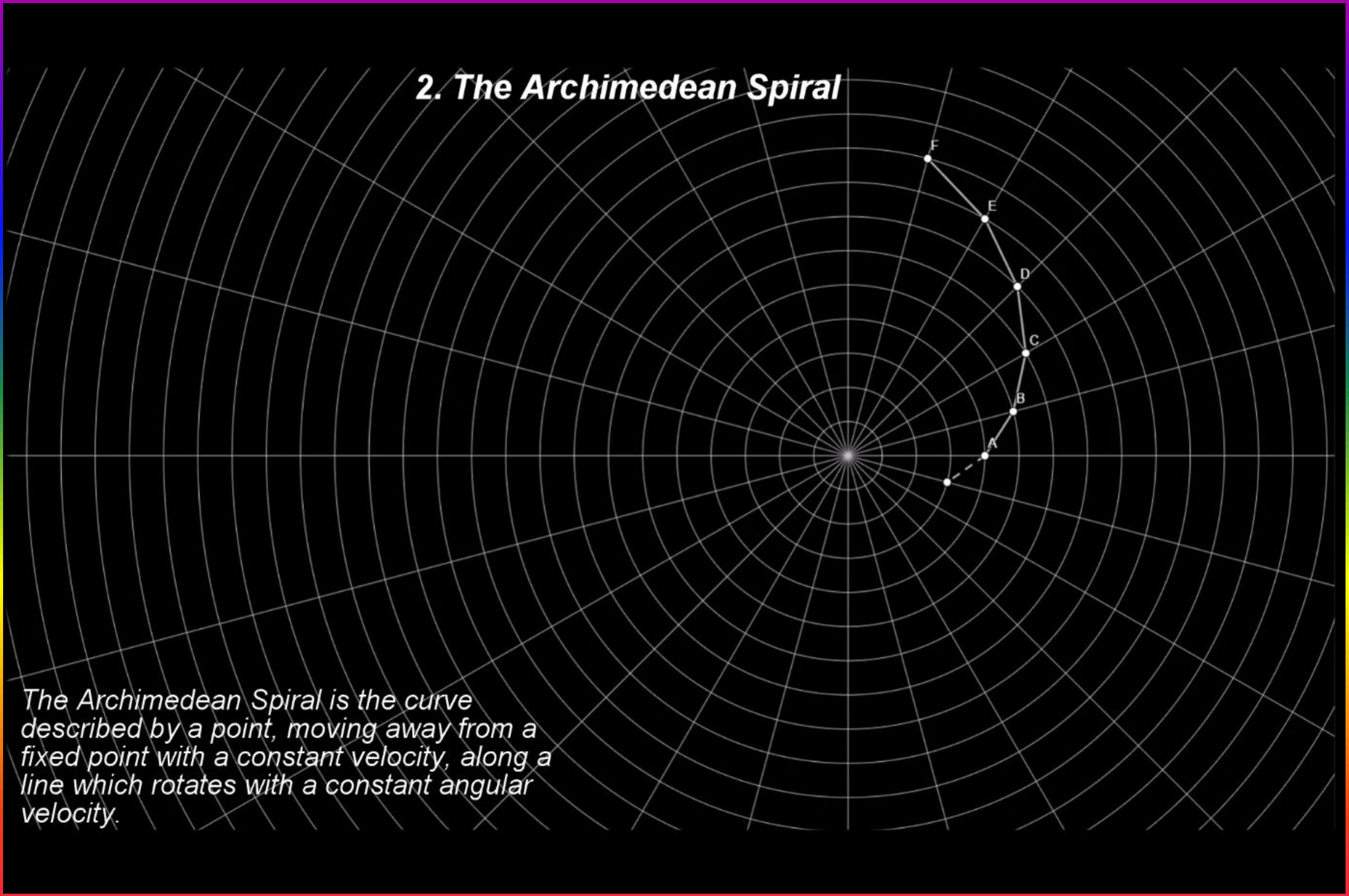
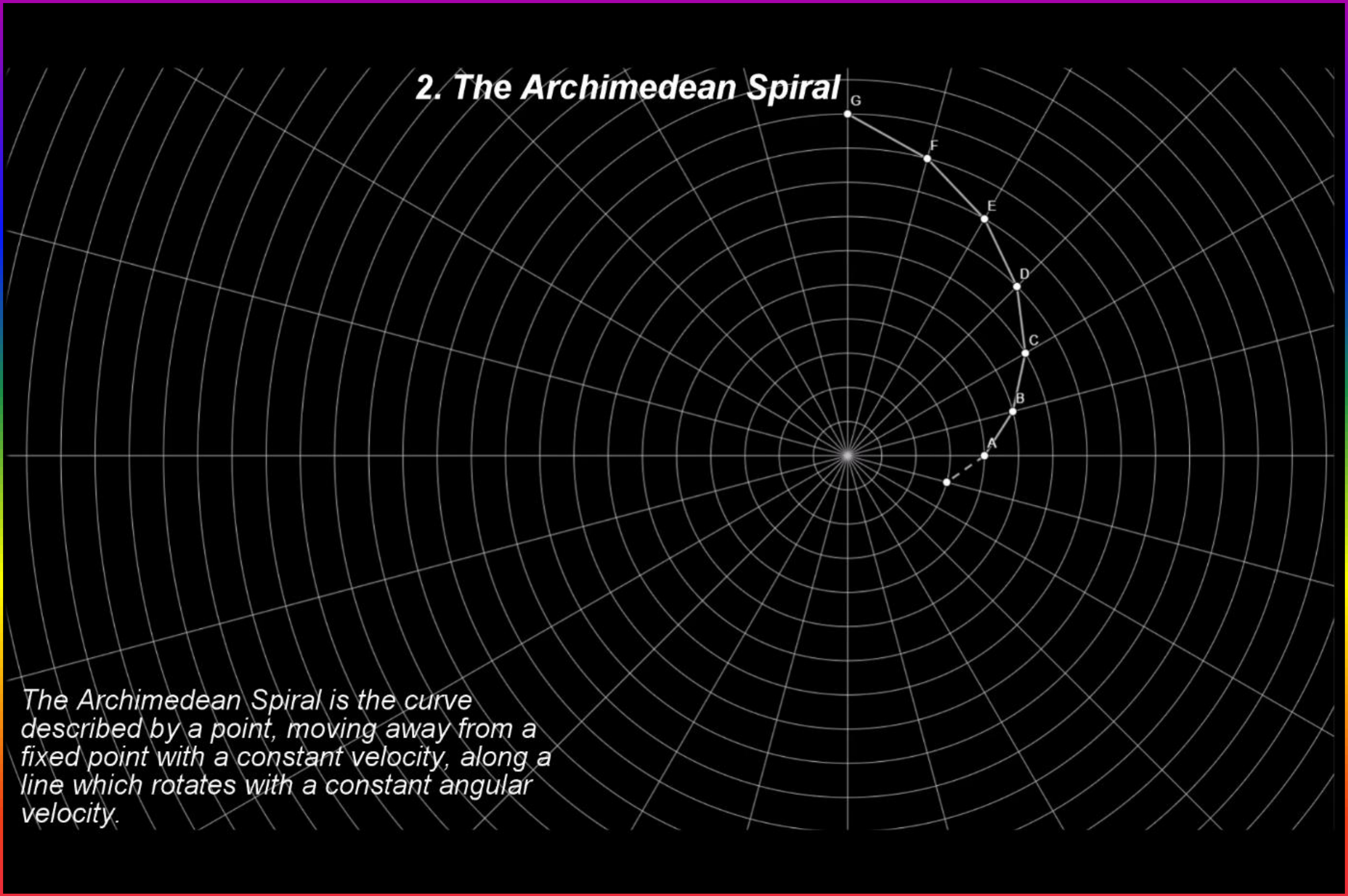


The ***logarithmic spiral*** is distinguishable from the ***Archimedean spiral*** by the fact that the distances between the turnings of a logarithmic spiral increase in ***geometric progression***, while in an Archimedean spiral these distances increase in ***arithmetical progression***.



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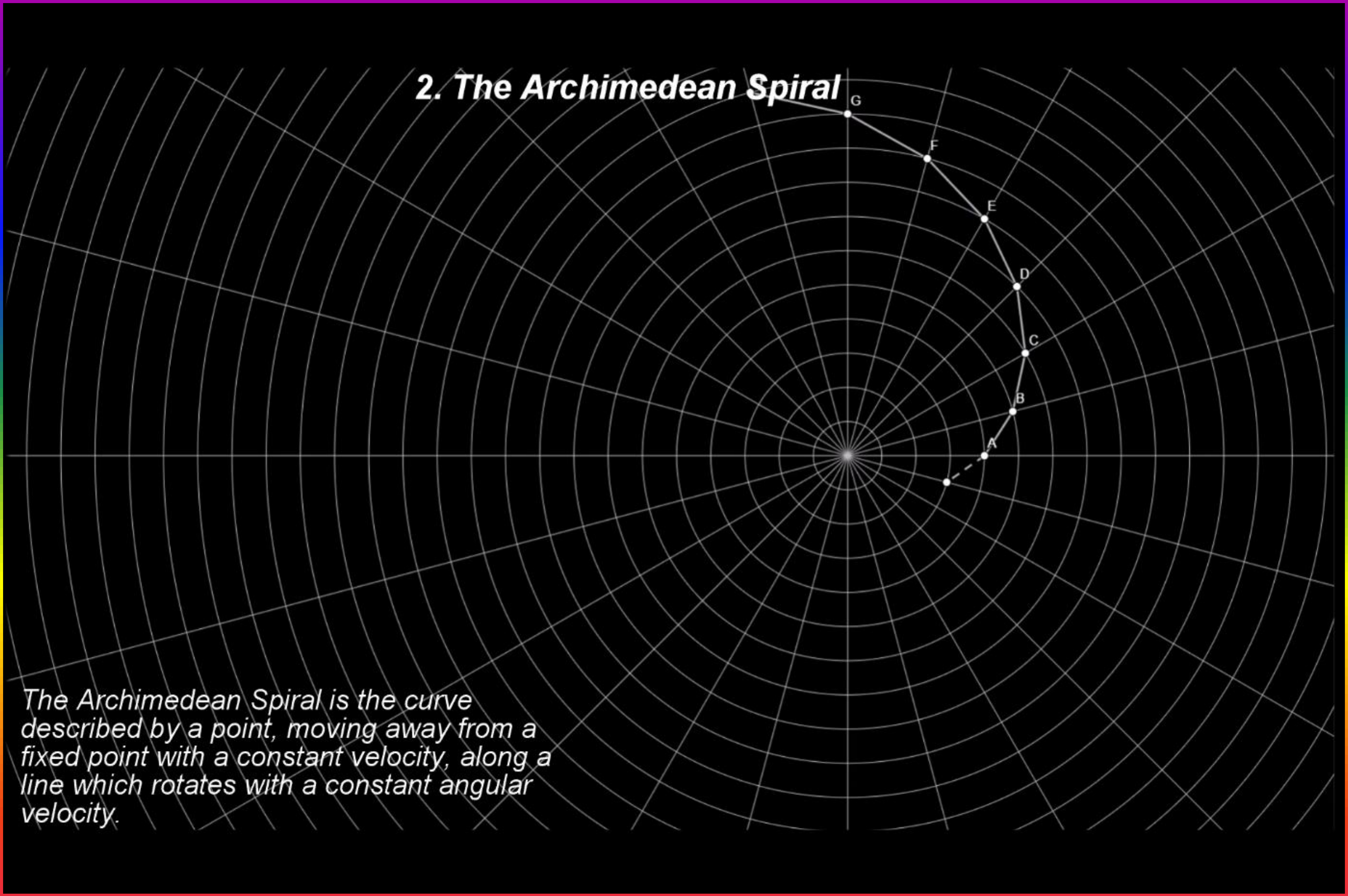

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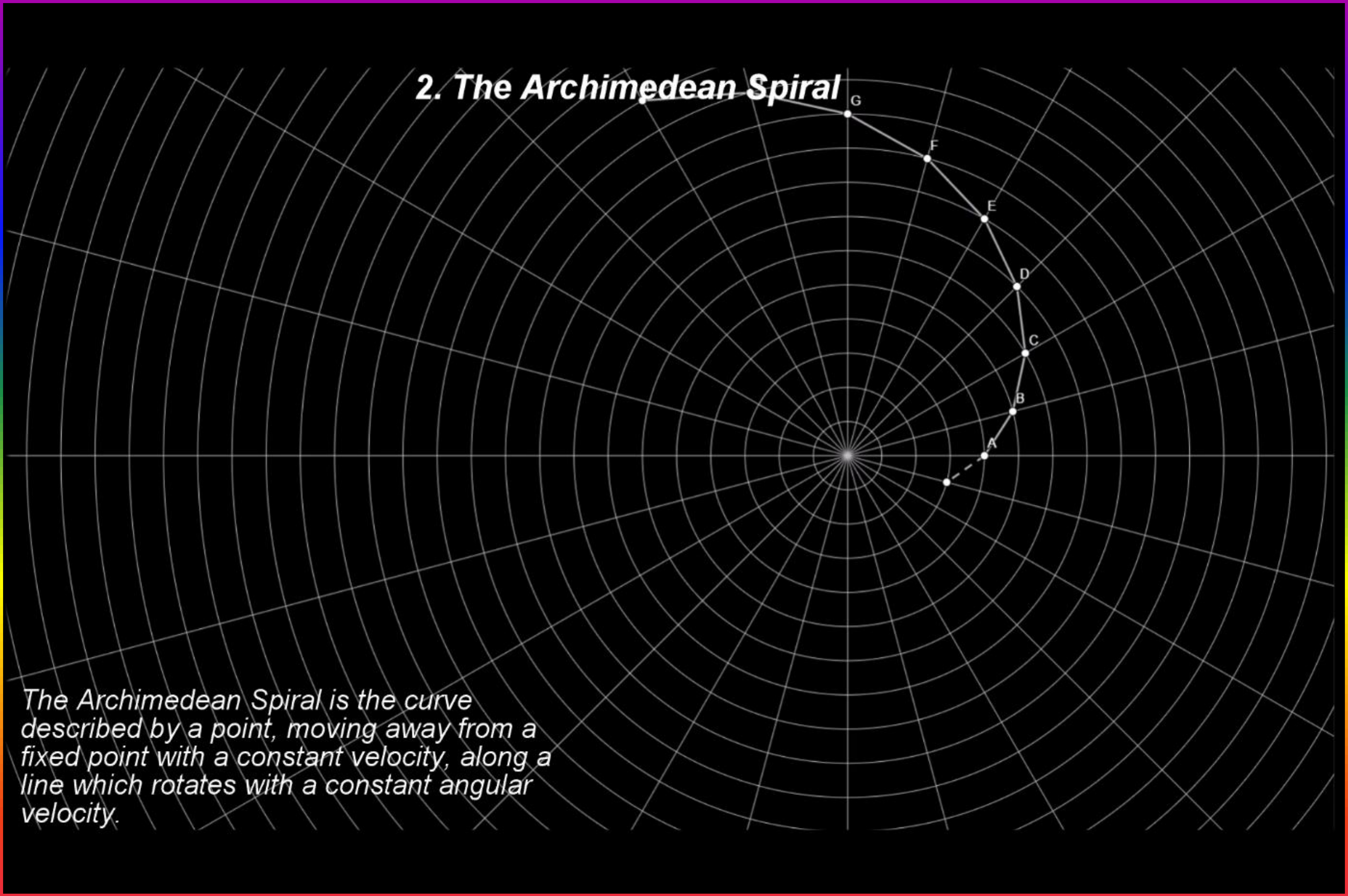

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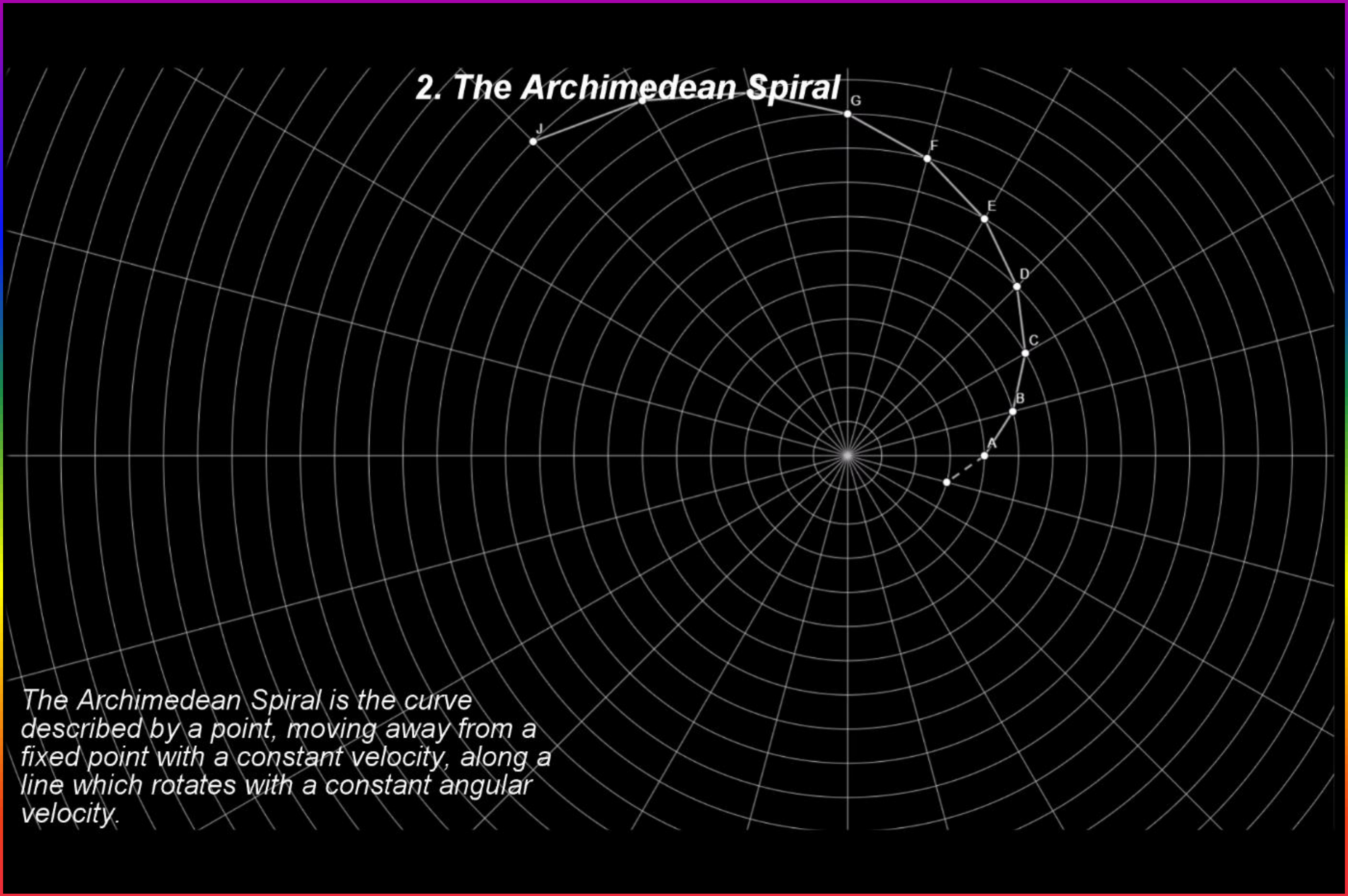

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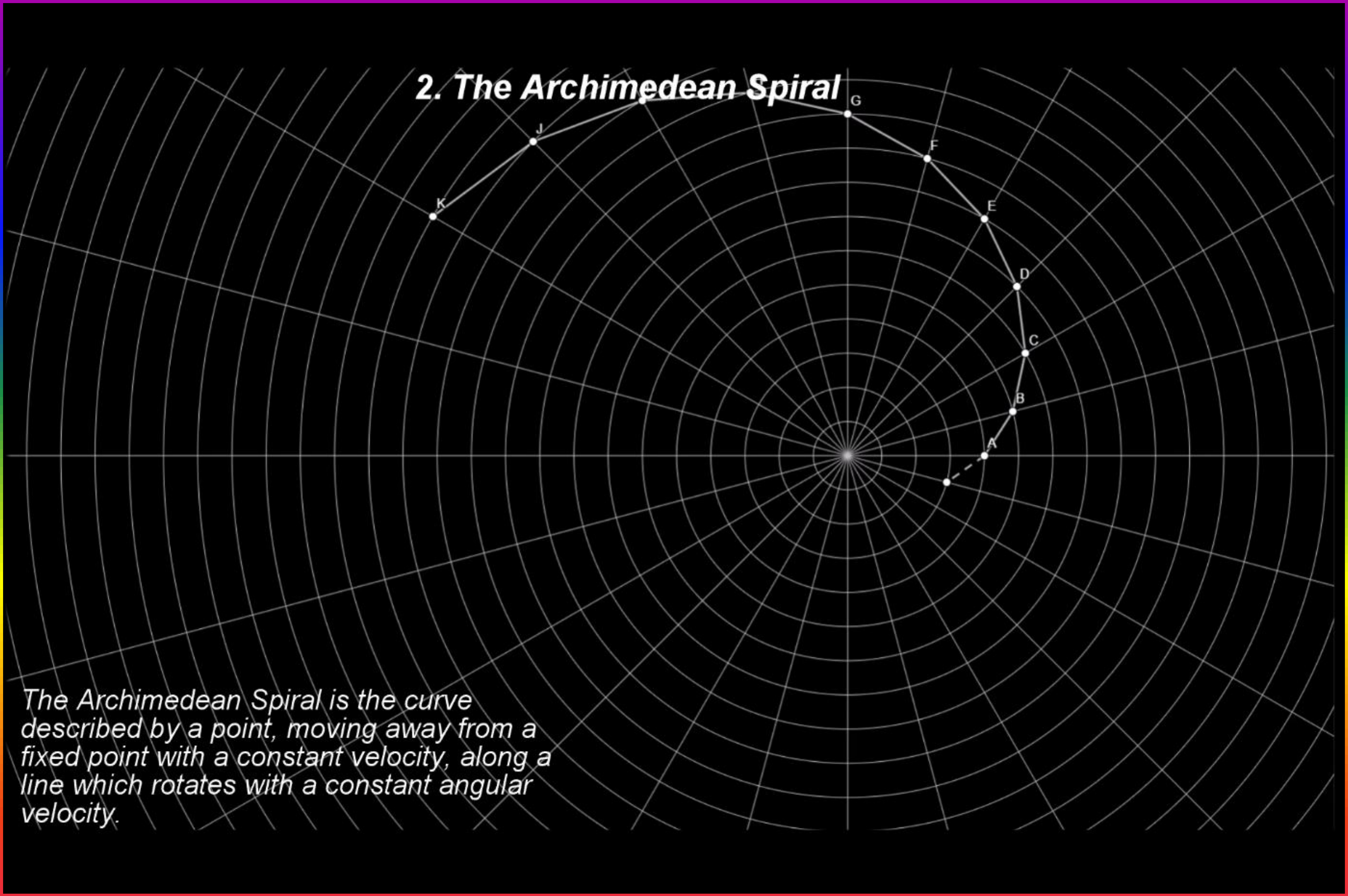

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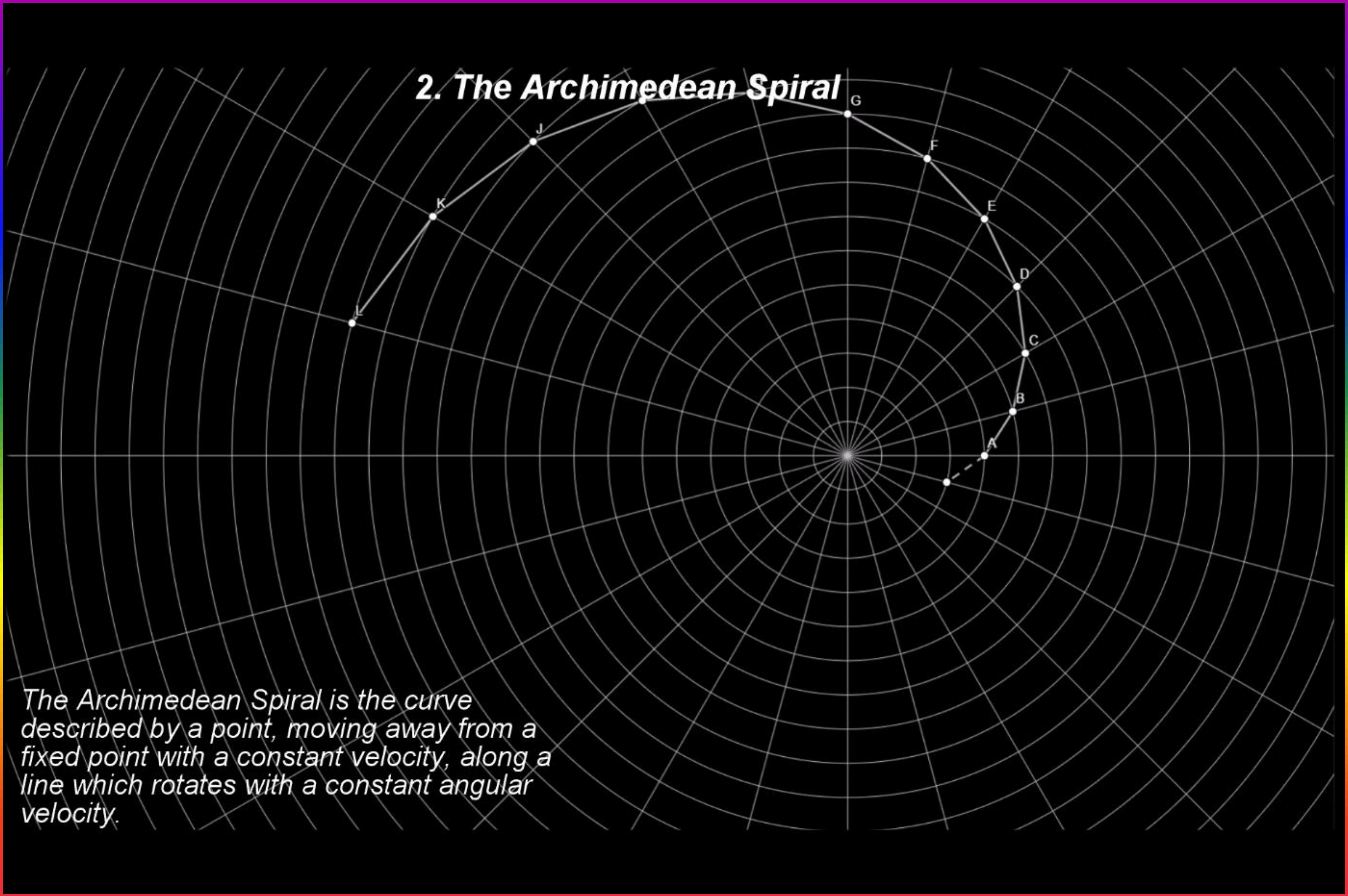

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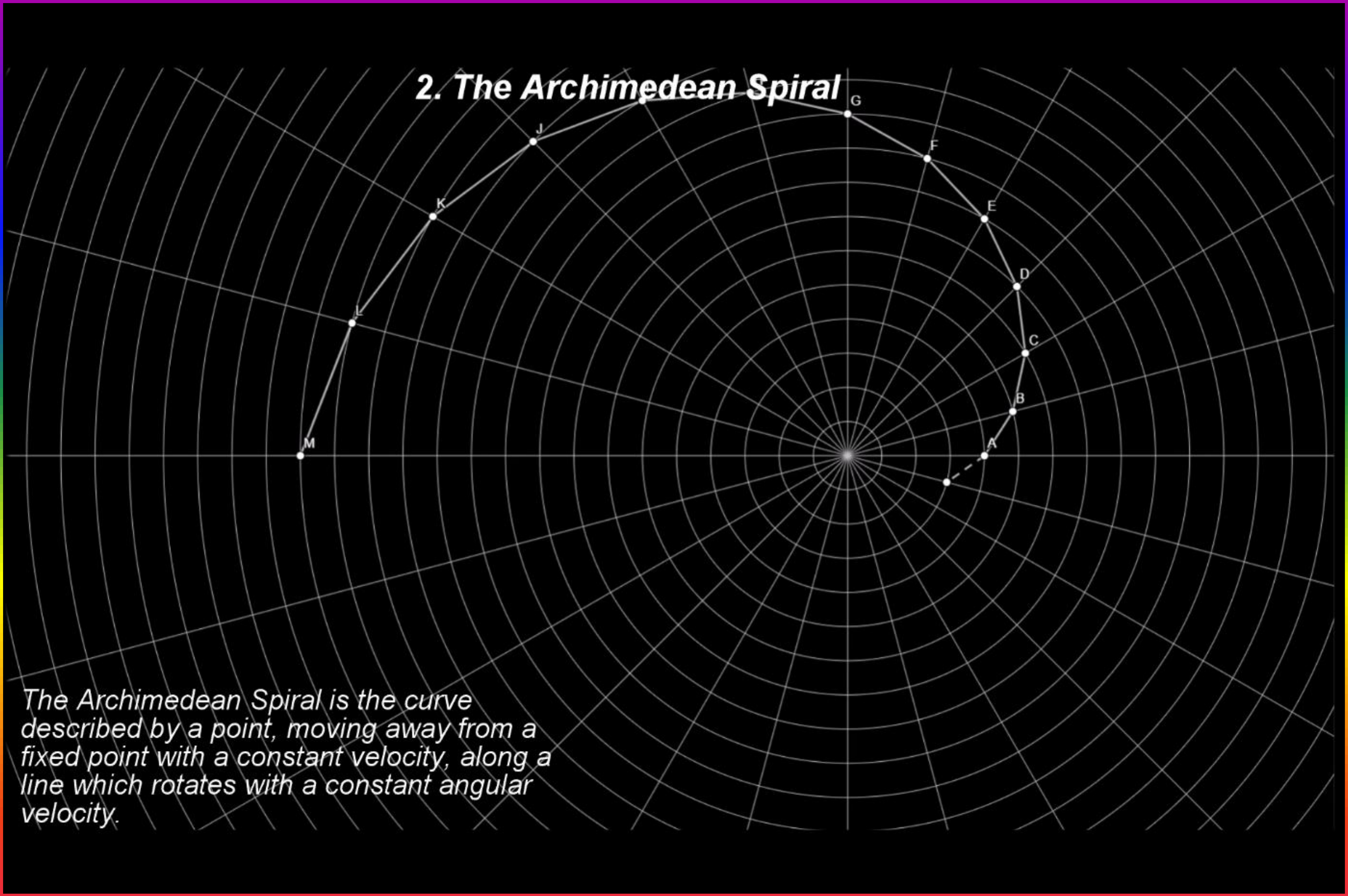

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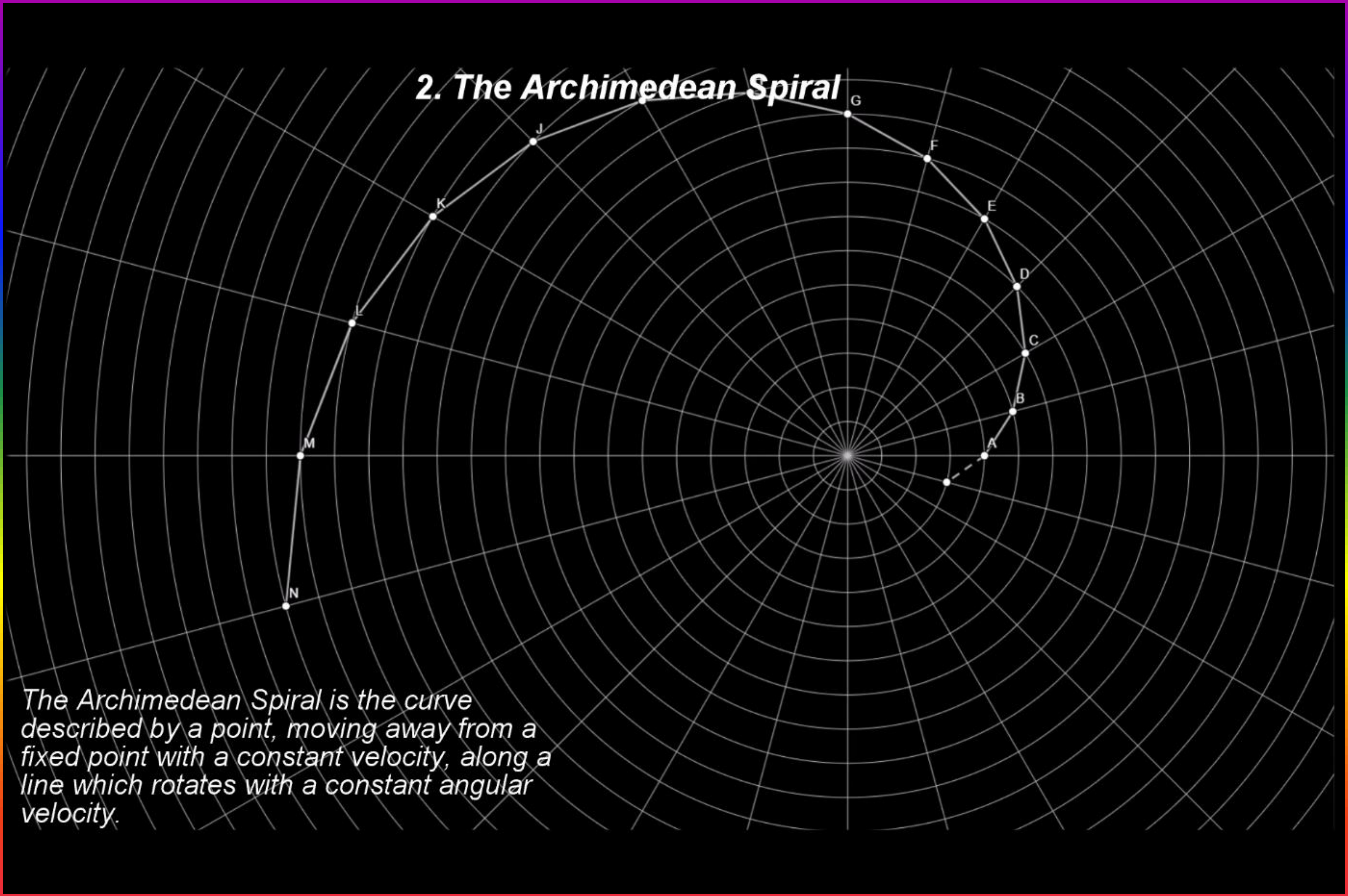

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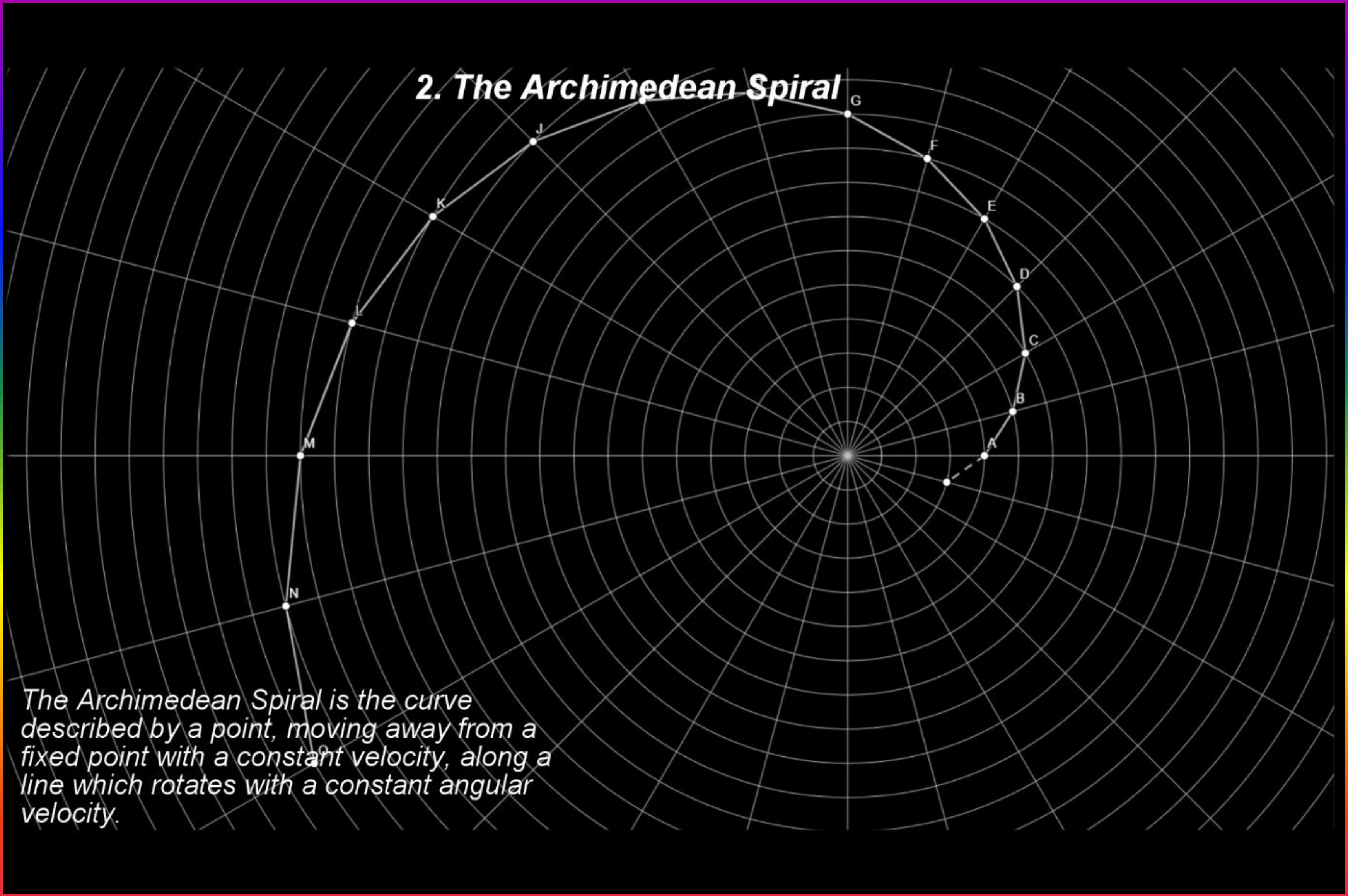

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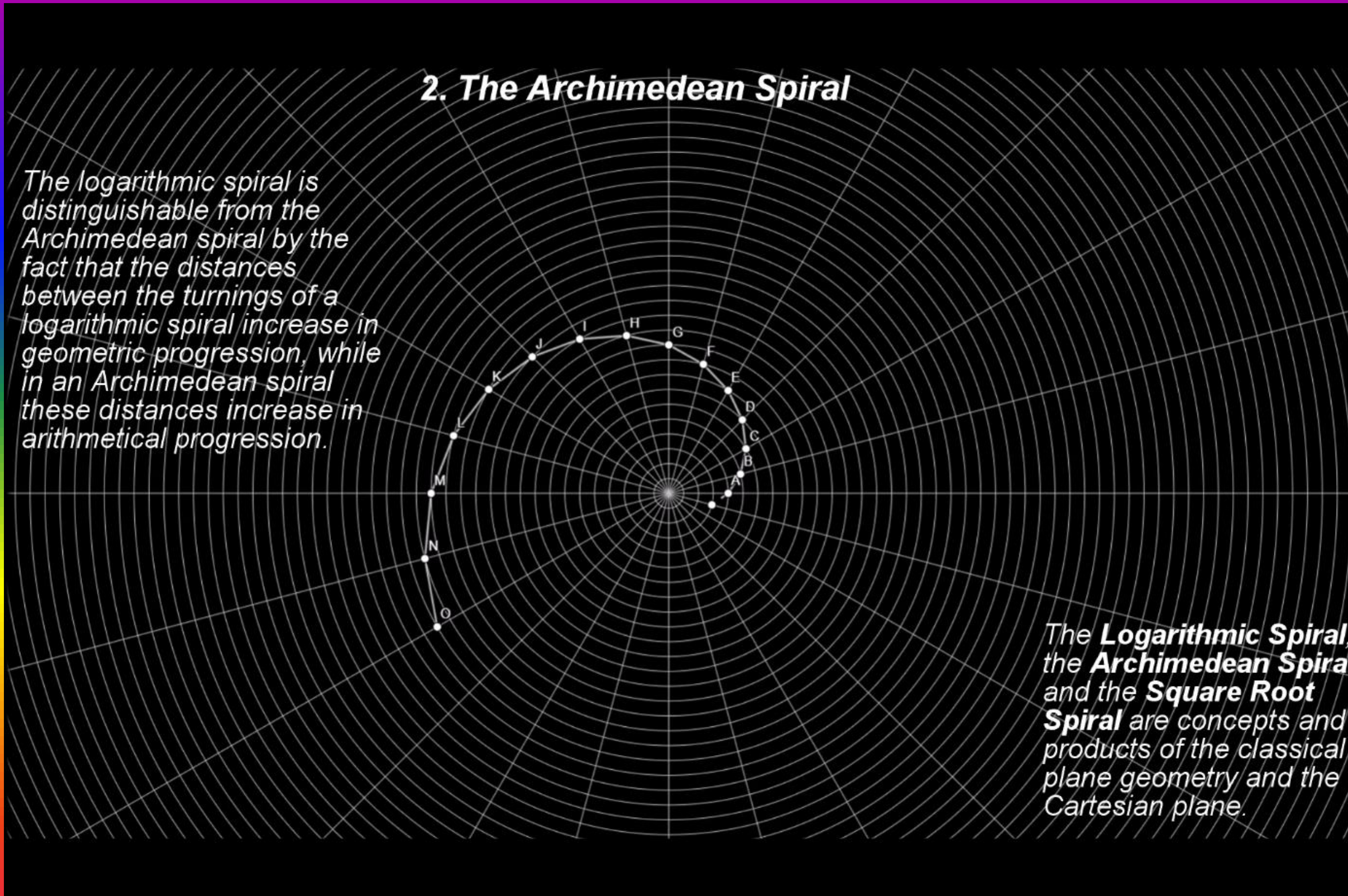
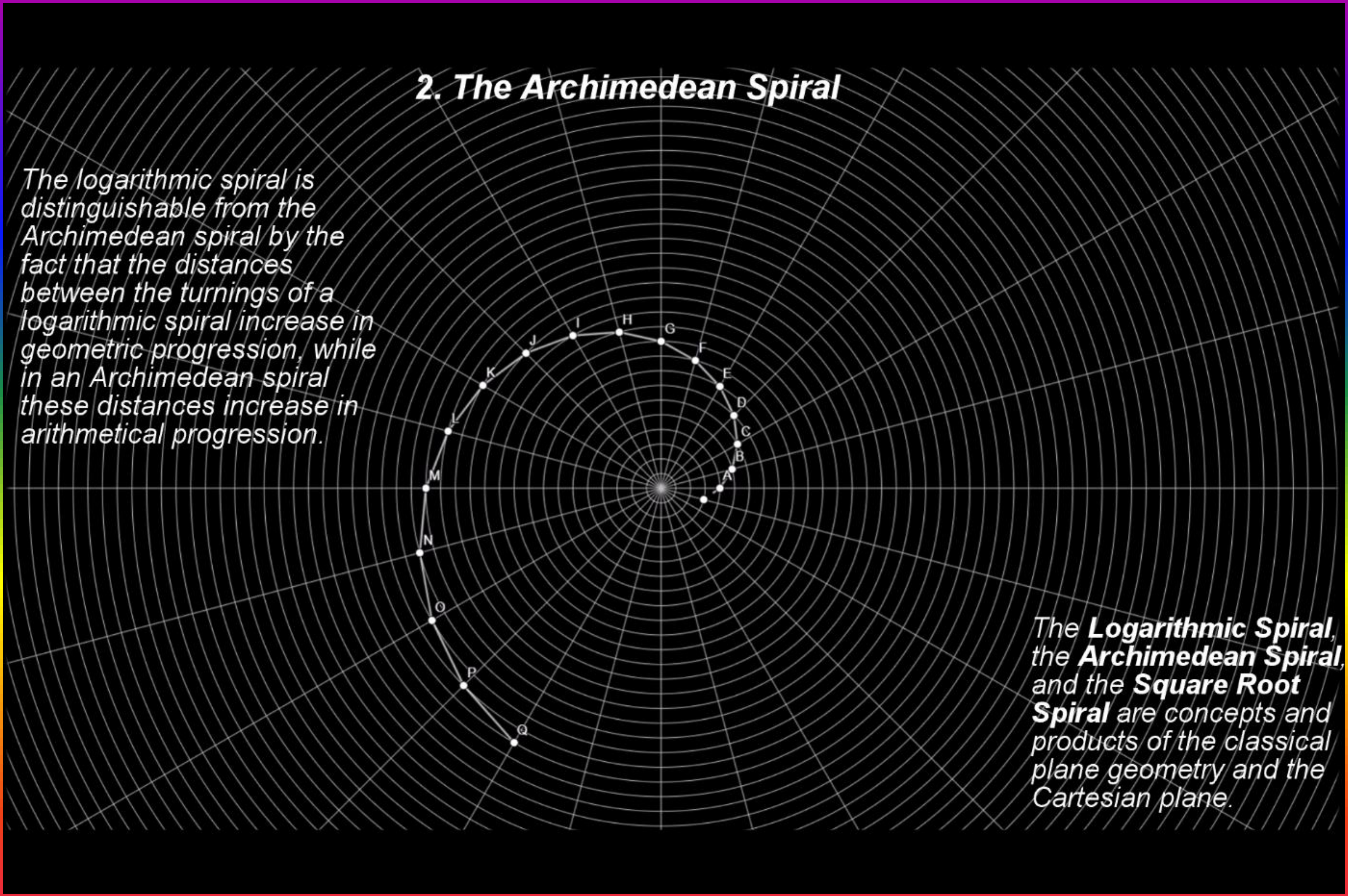


The ***logarithmic spiral***, the ***Archimedean spiral***, and the ***square root spiral*** are concepts and products of the classical plane geometry and the Cartesian plane.



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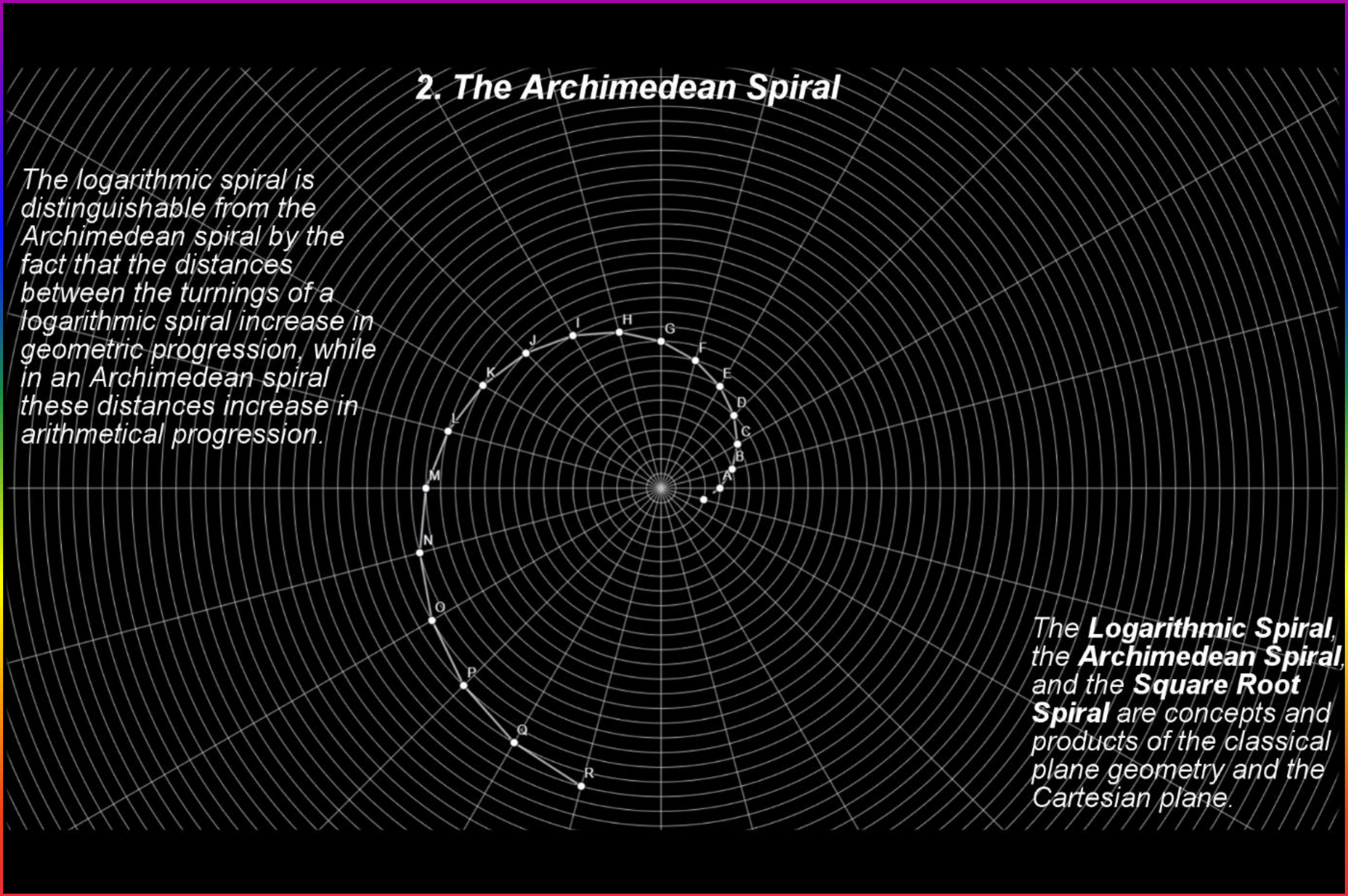

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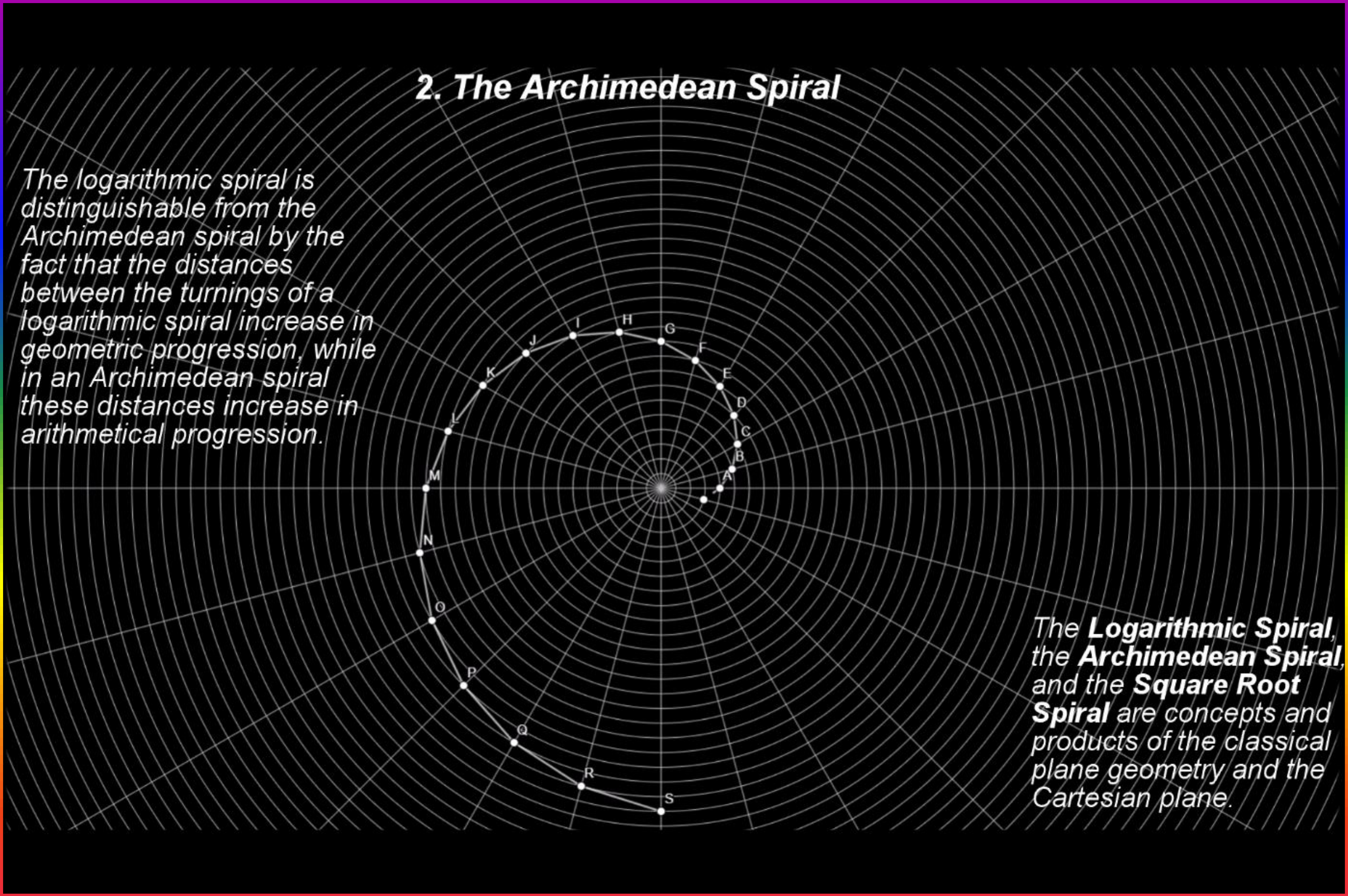

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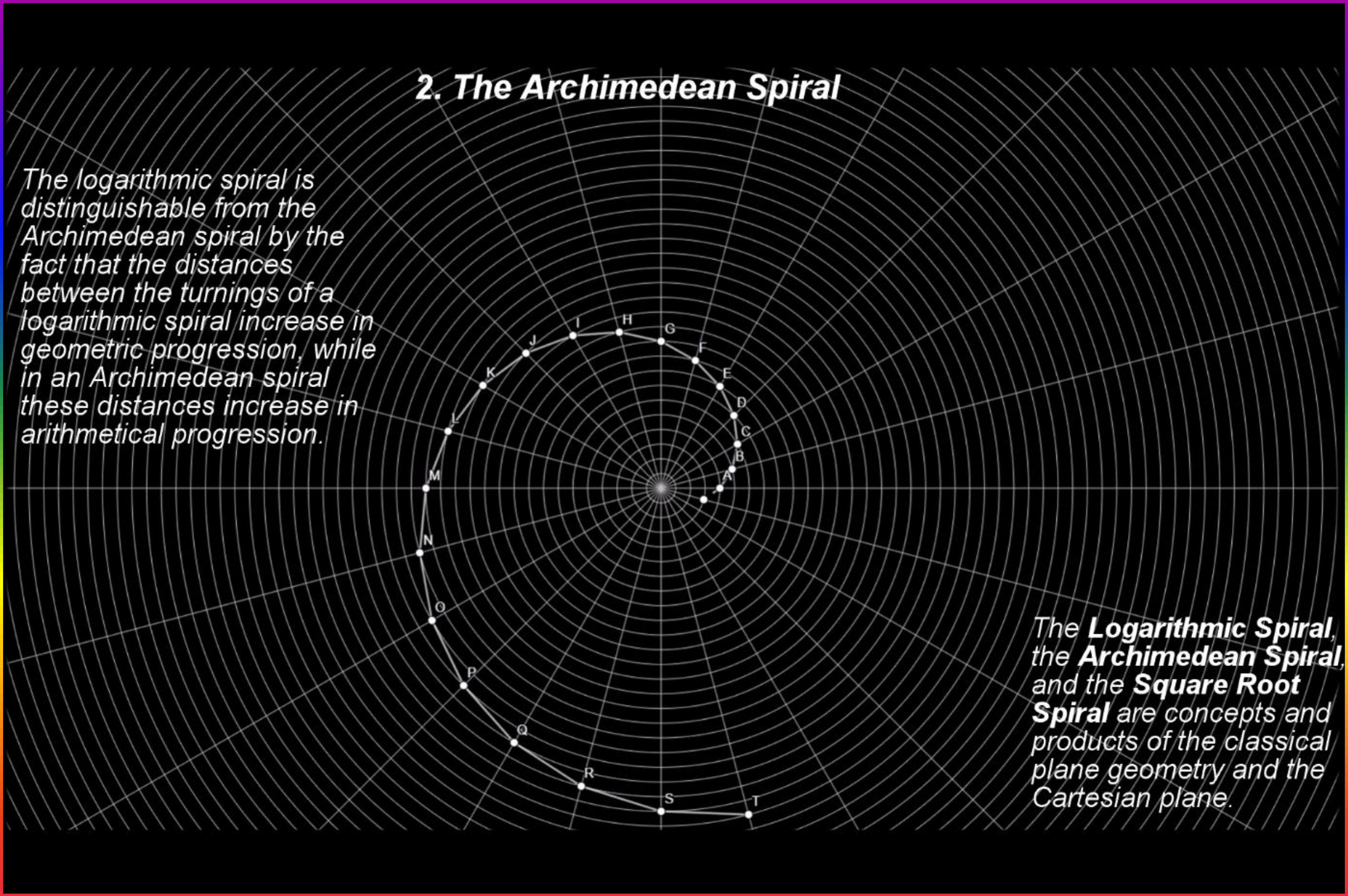

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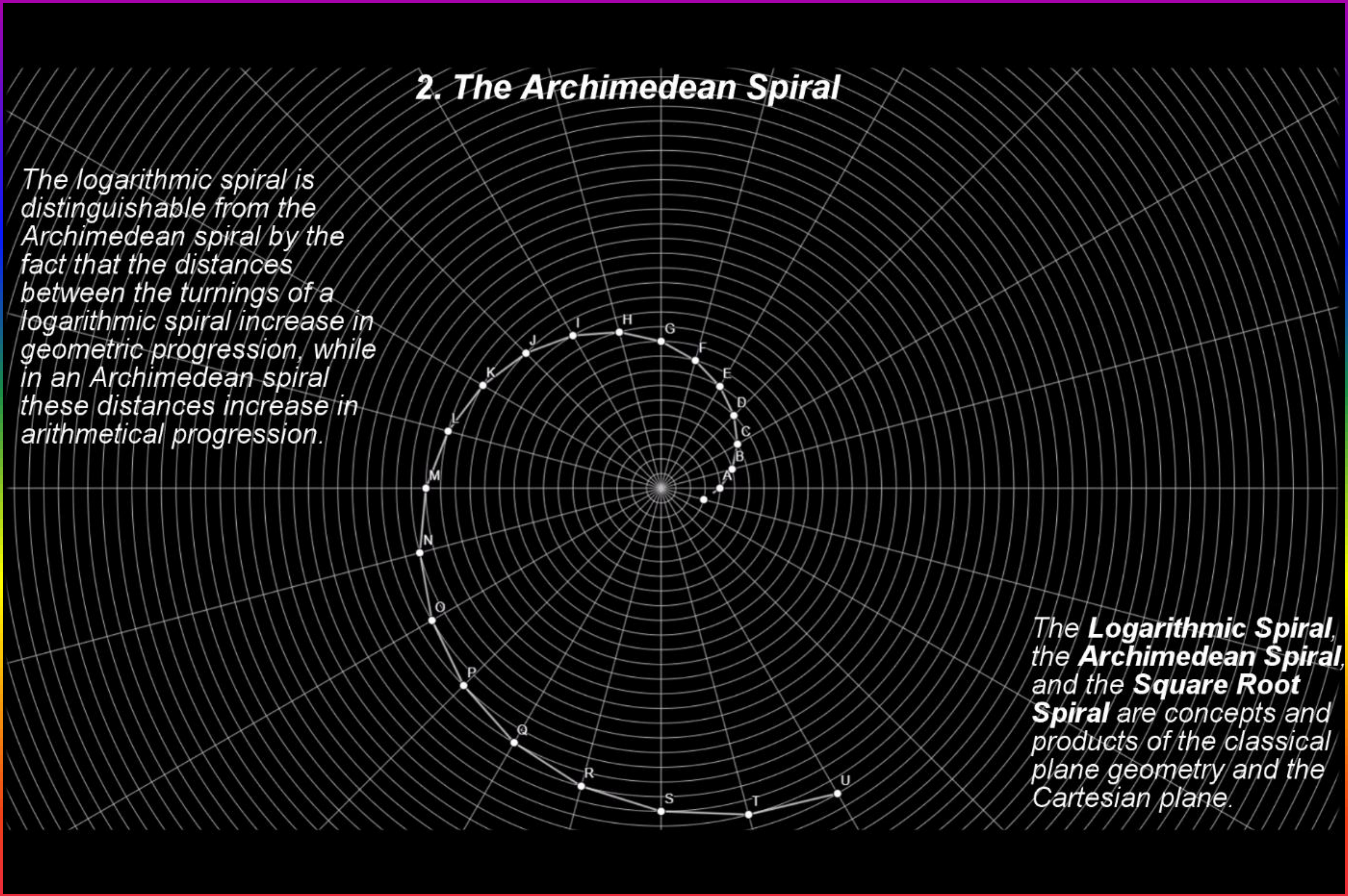

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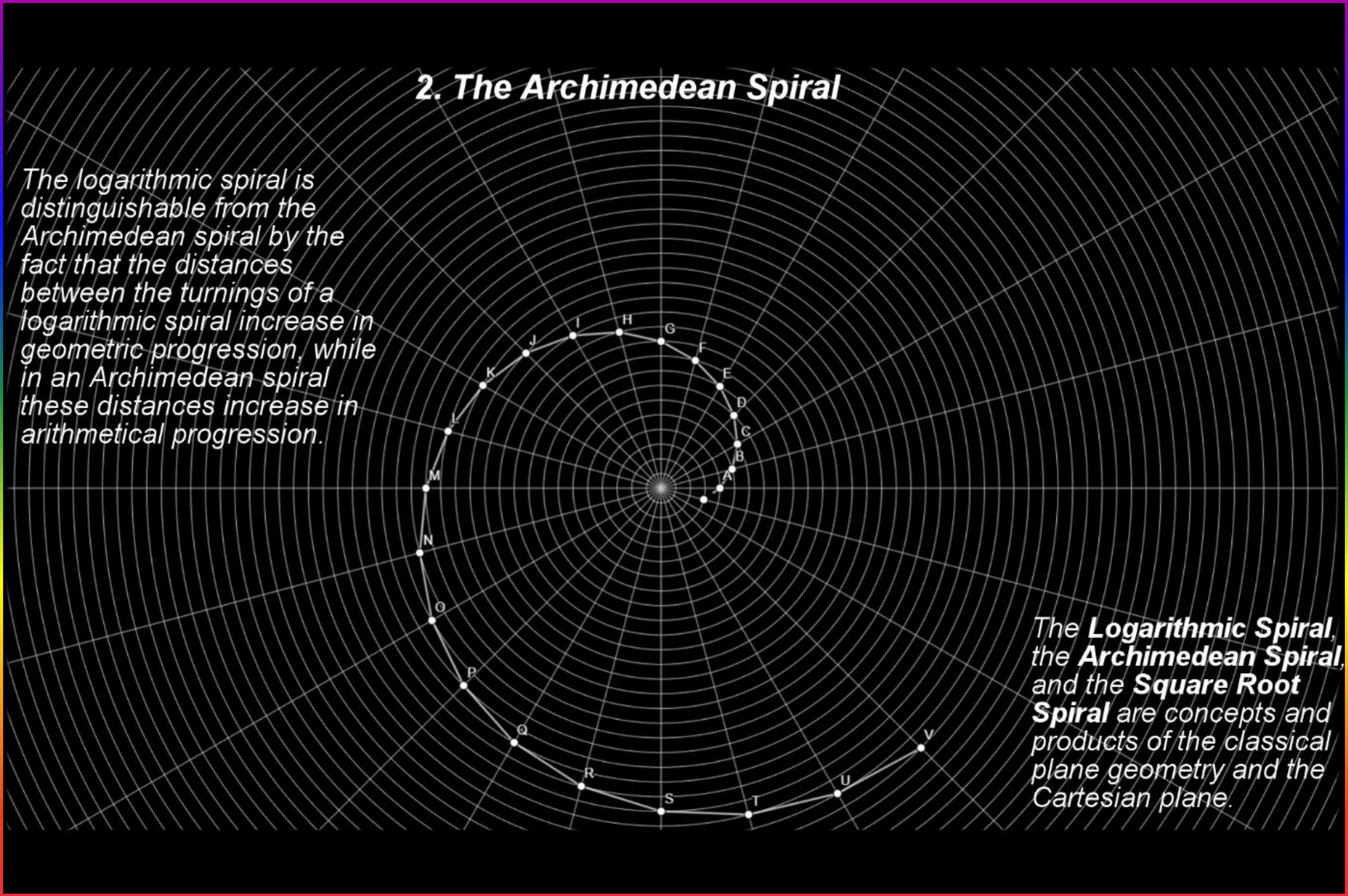

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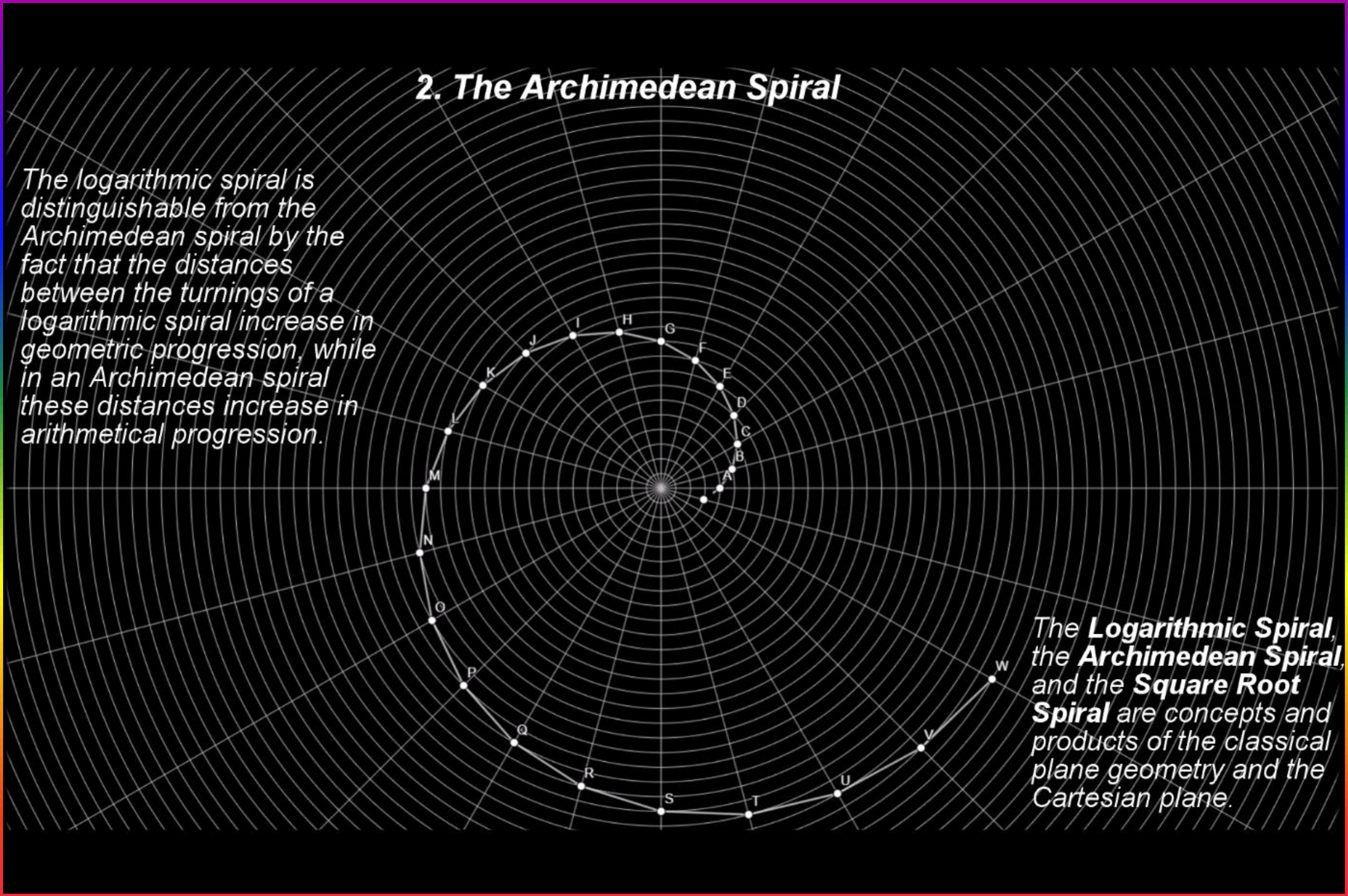

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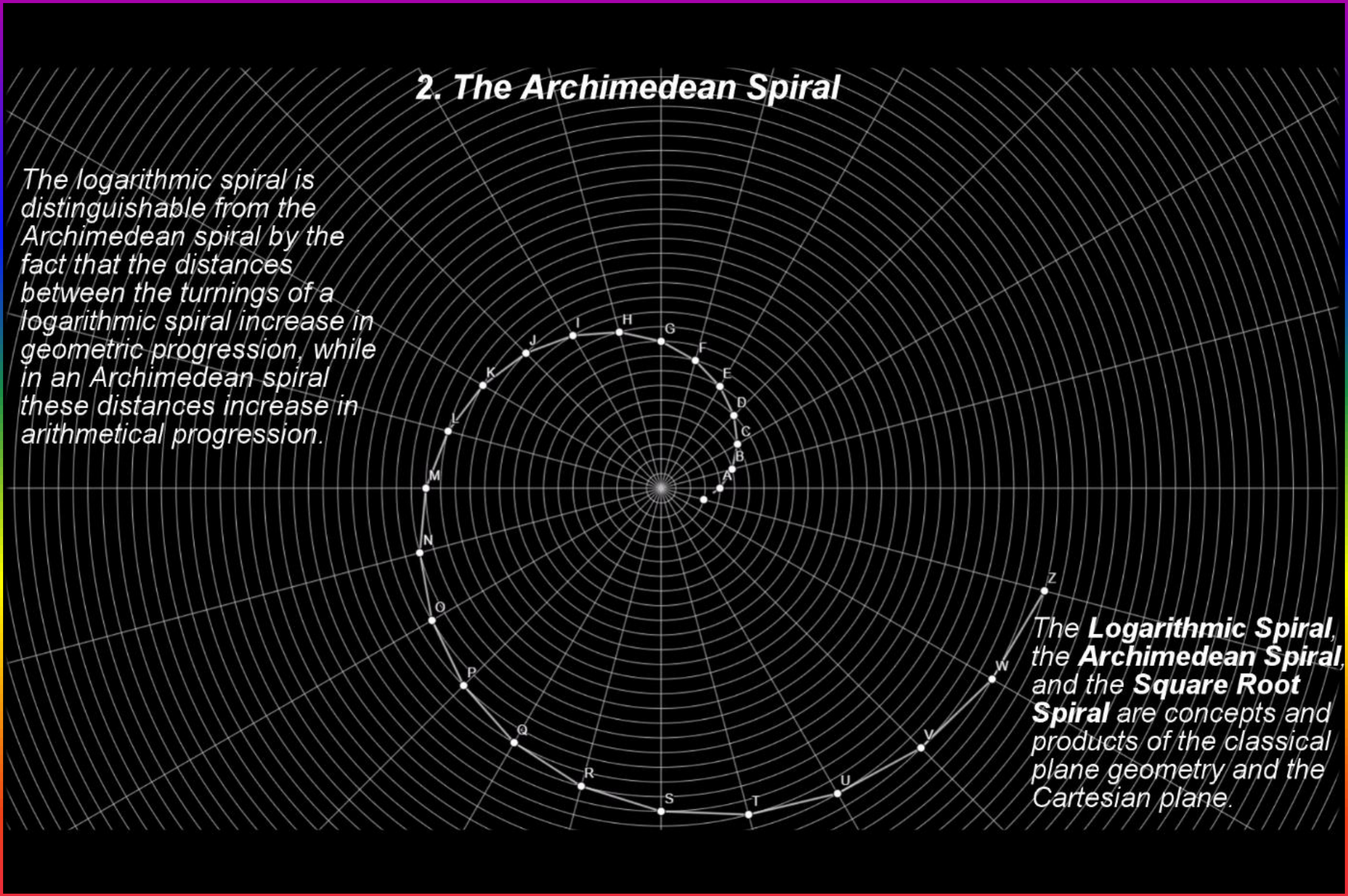

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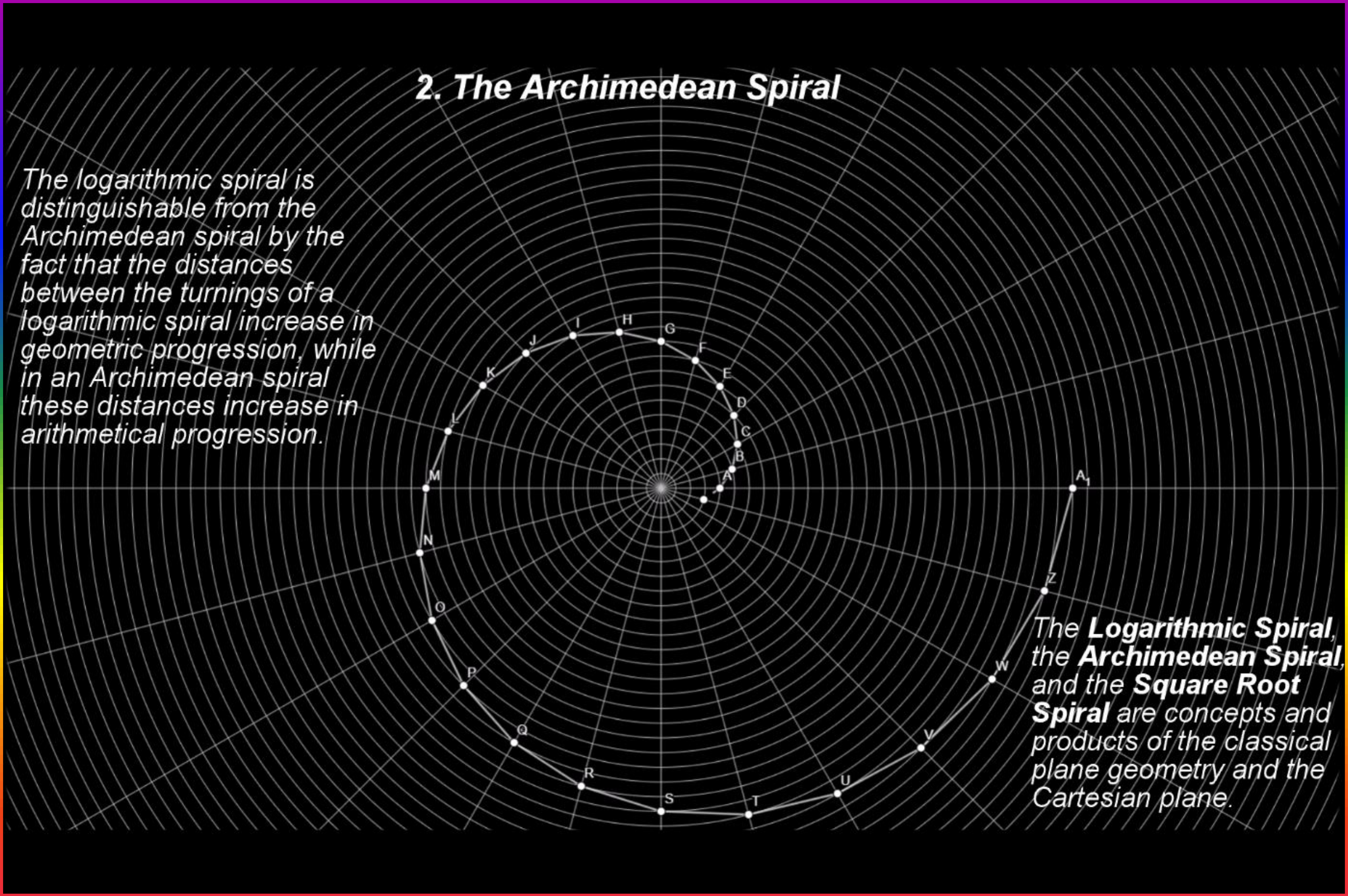

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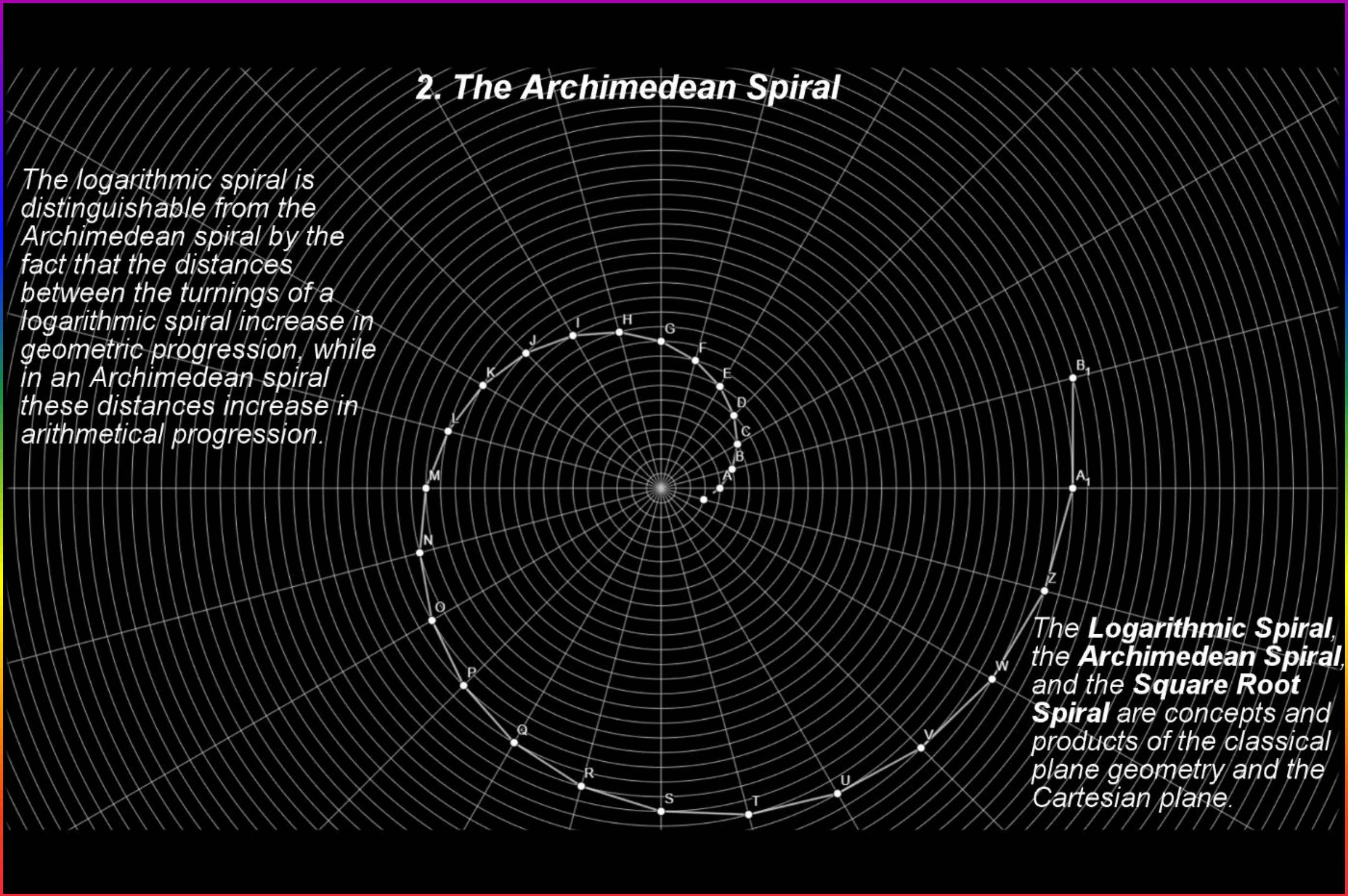

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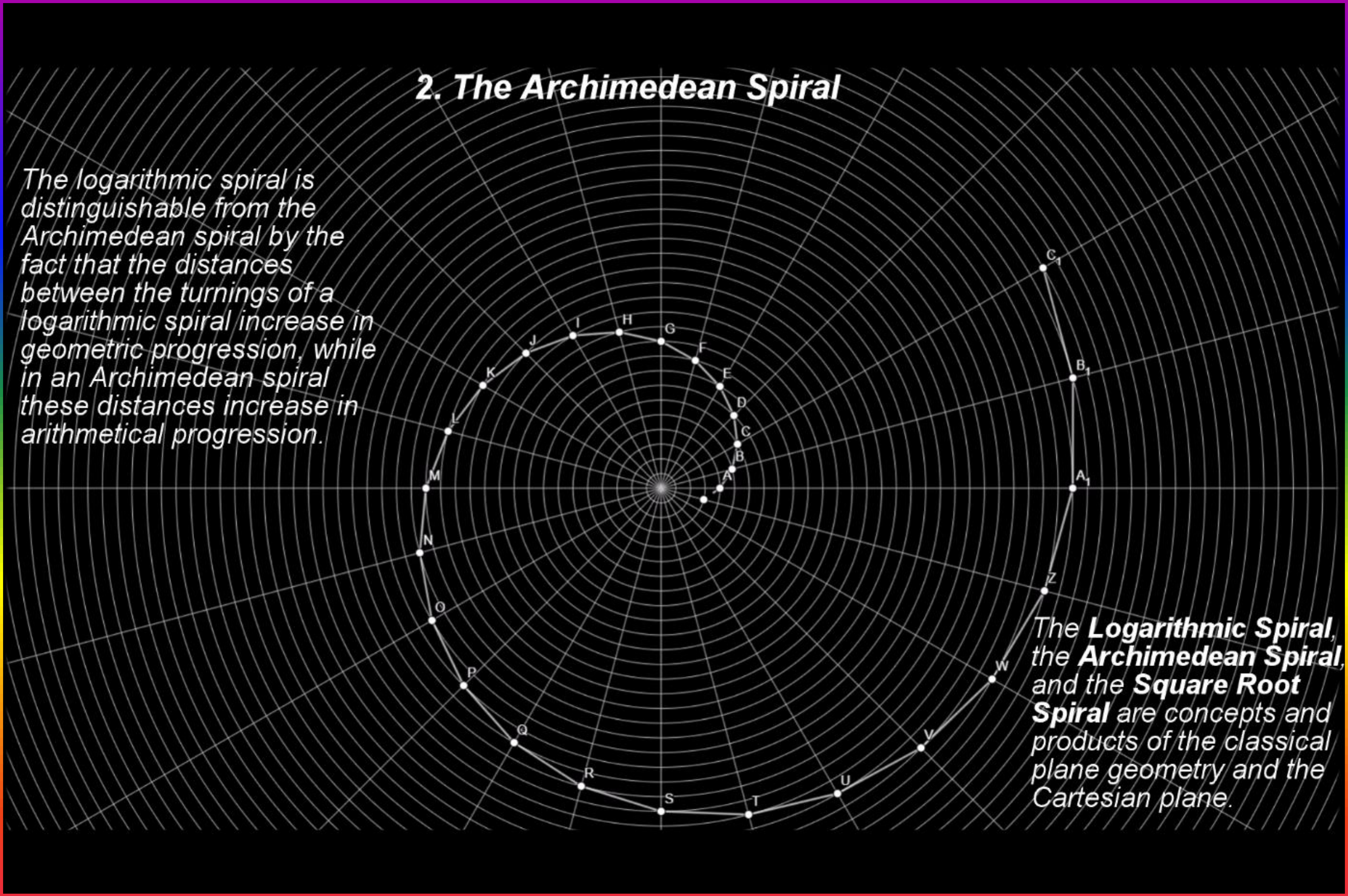

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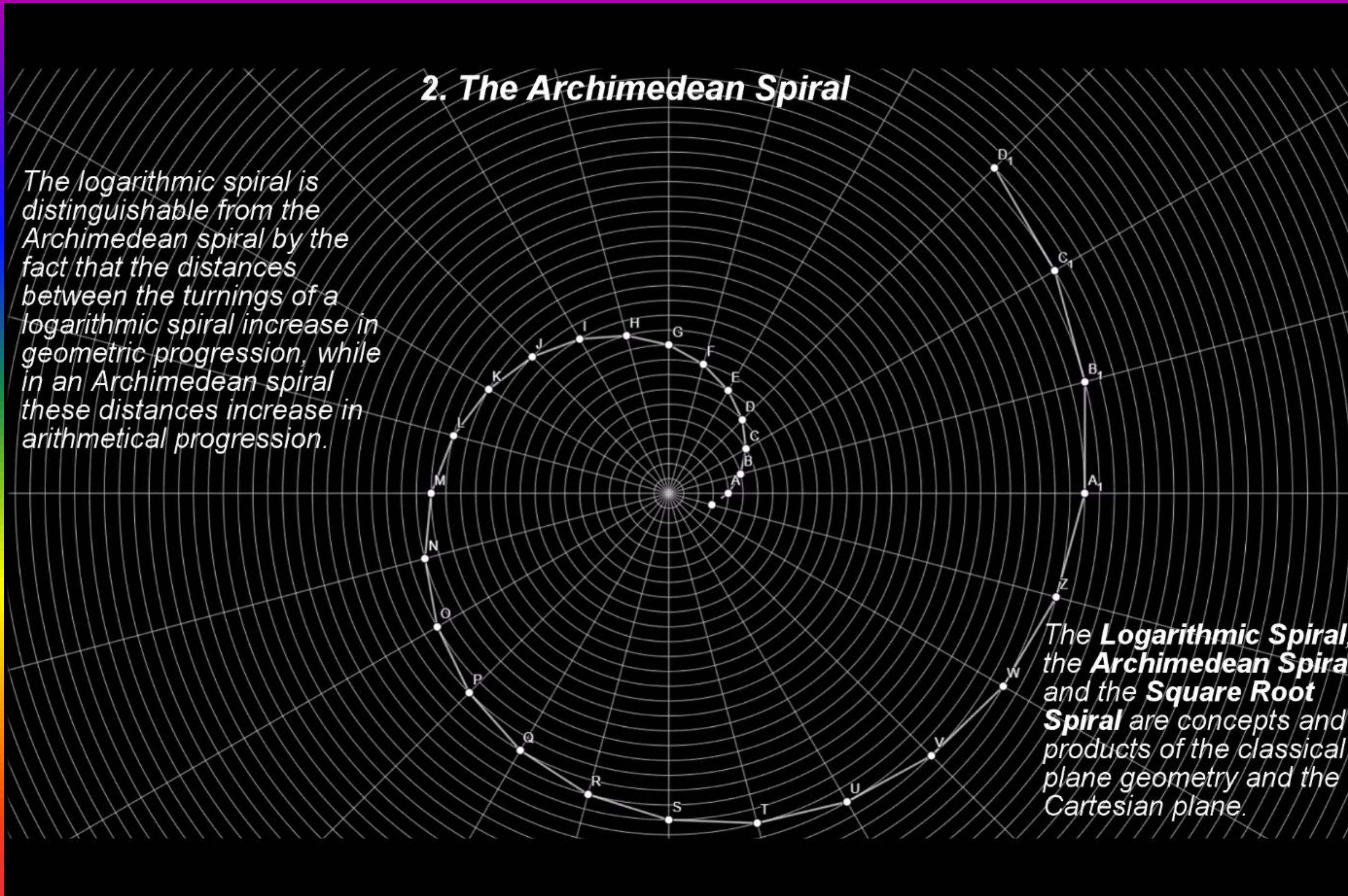

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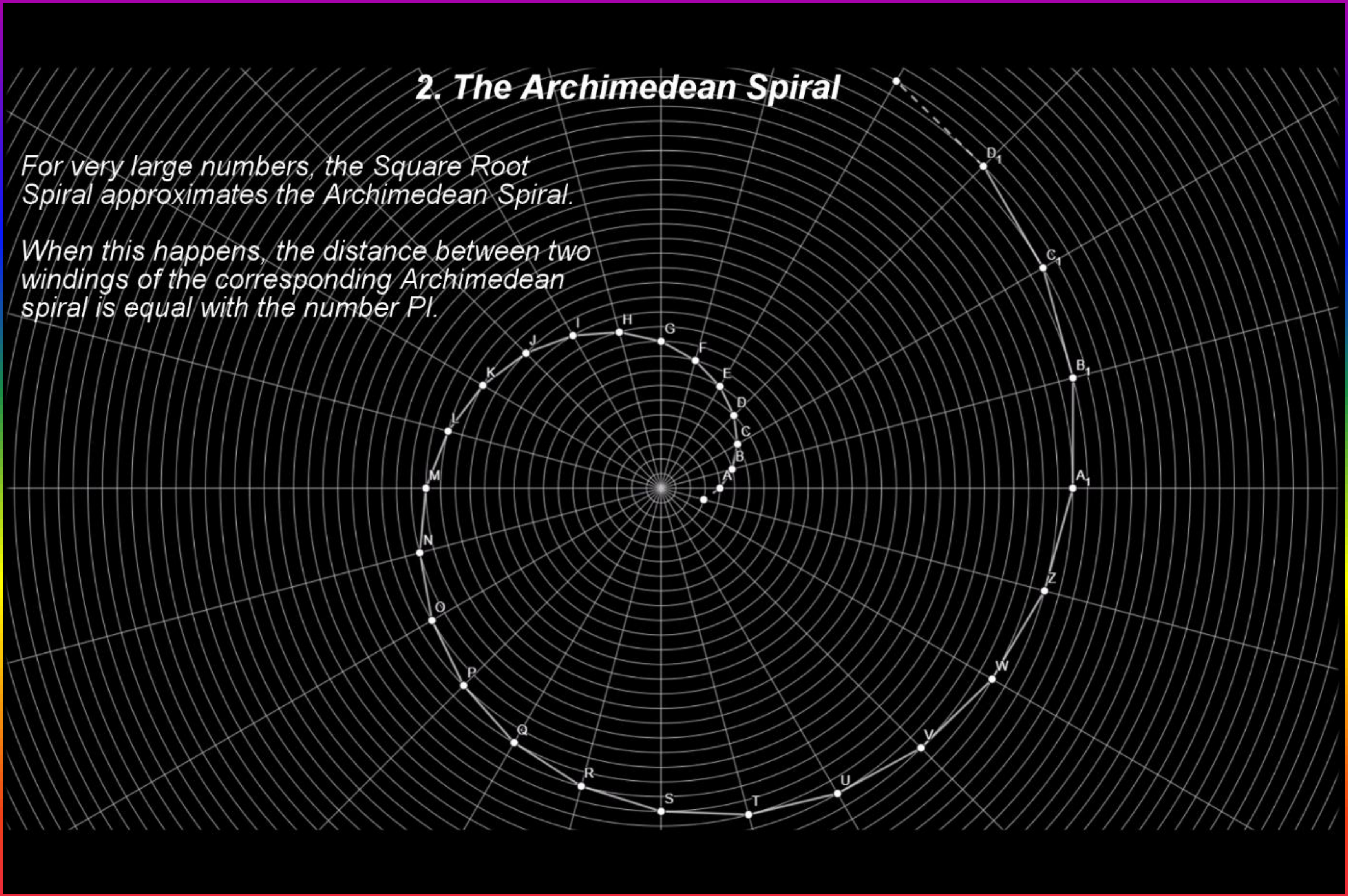
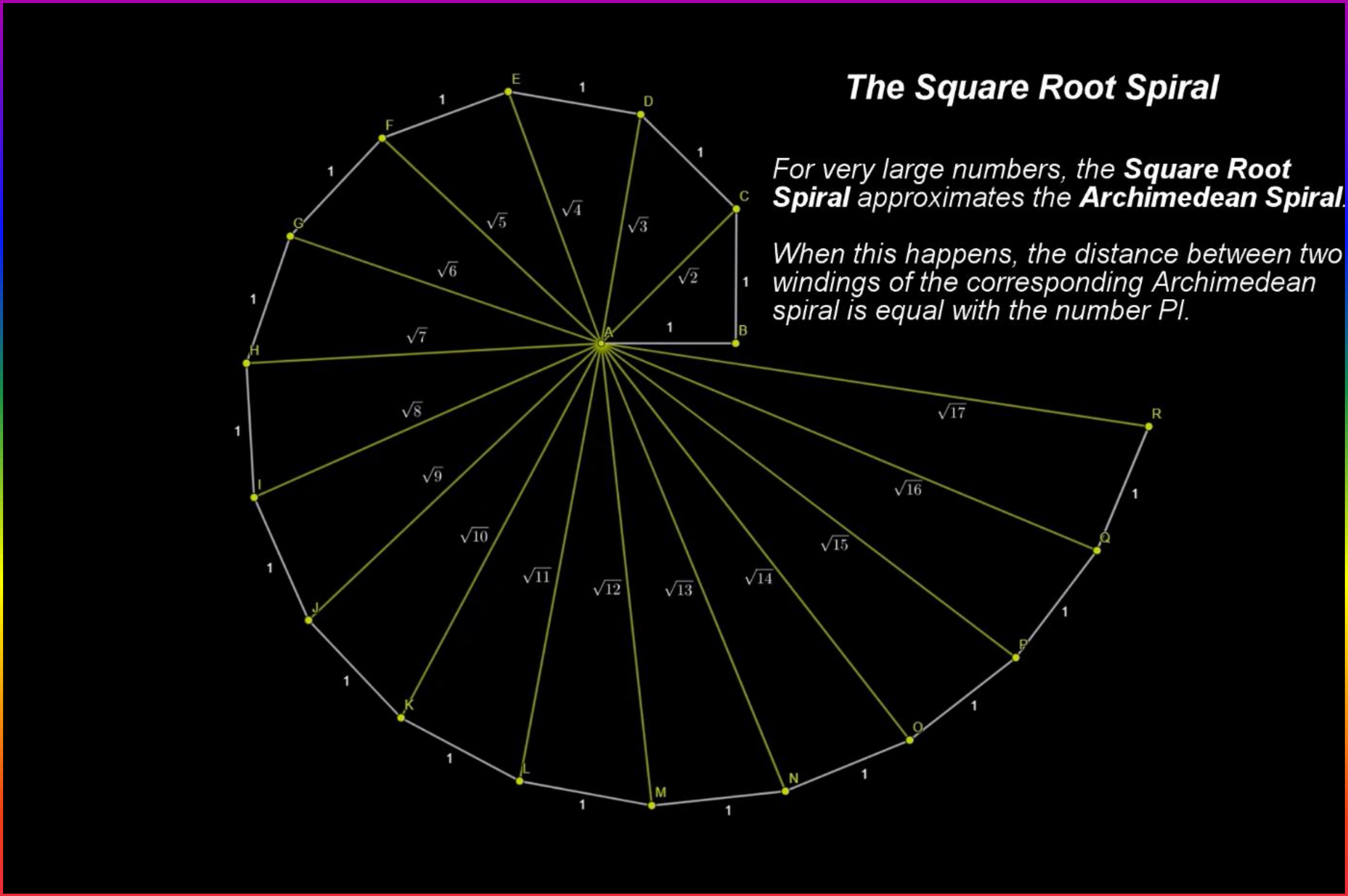


Let us mention few similarities among these three spirals:

a. For very large numbers, the square root spiral approximates the Archimedean Spiral.



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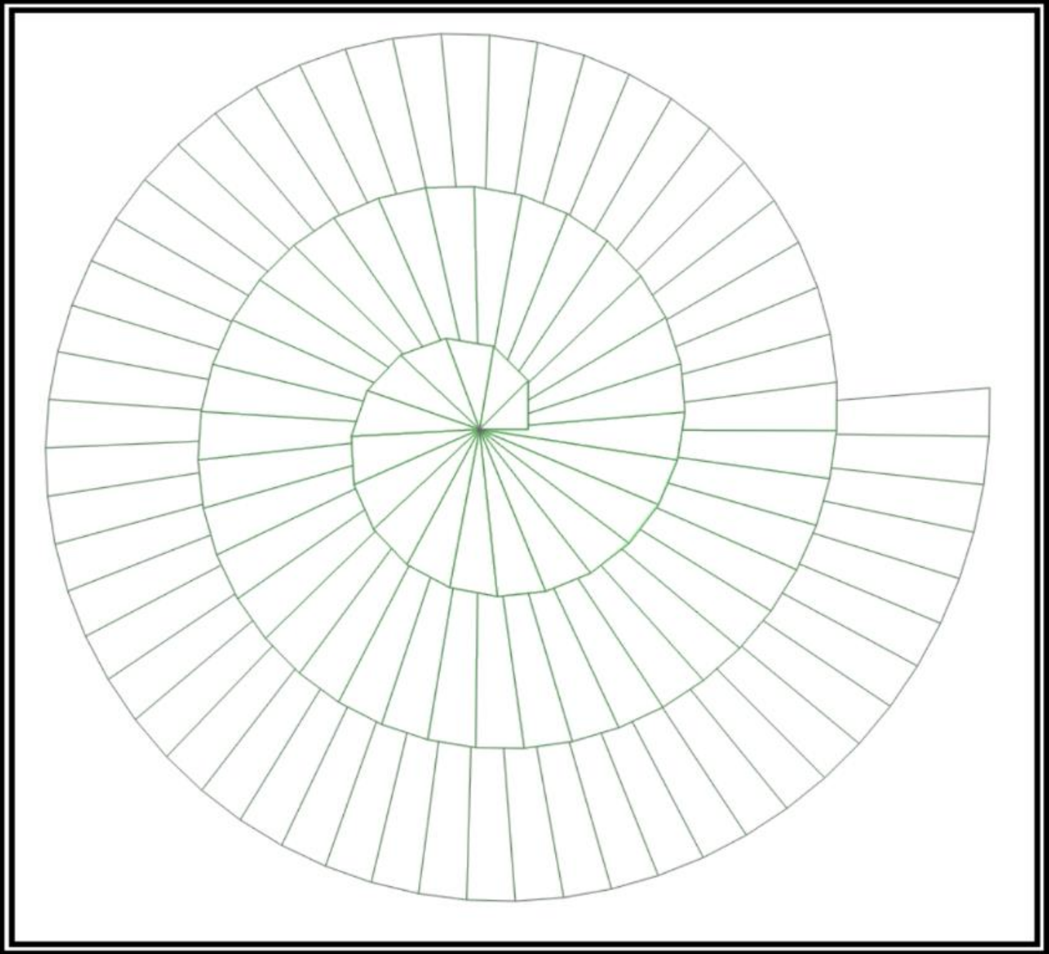
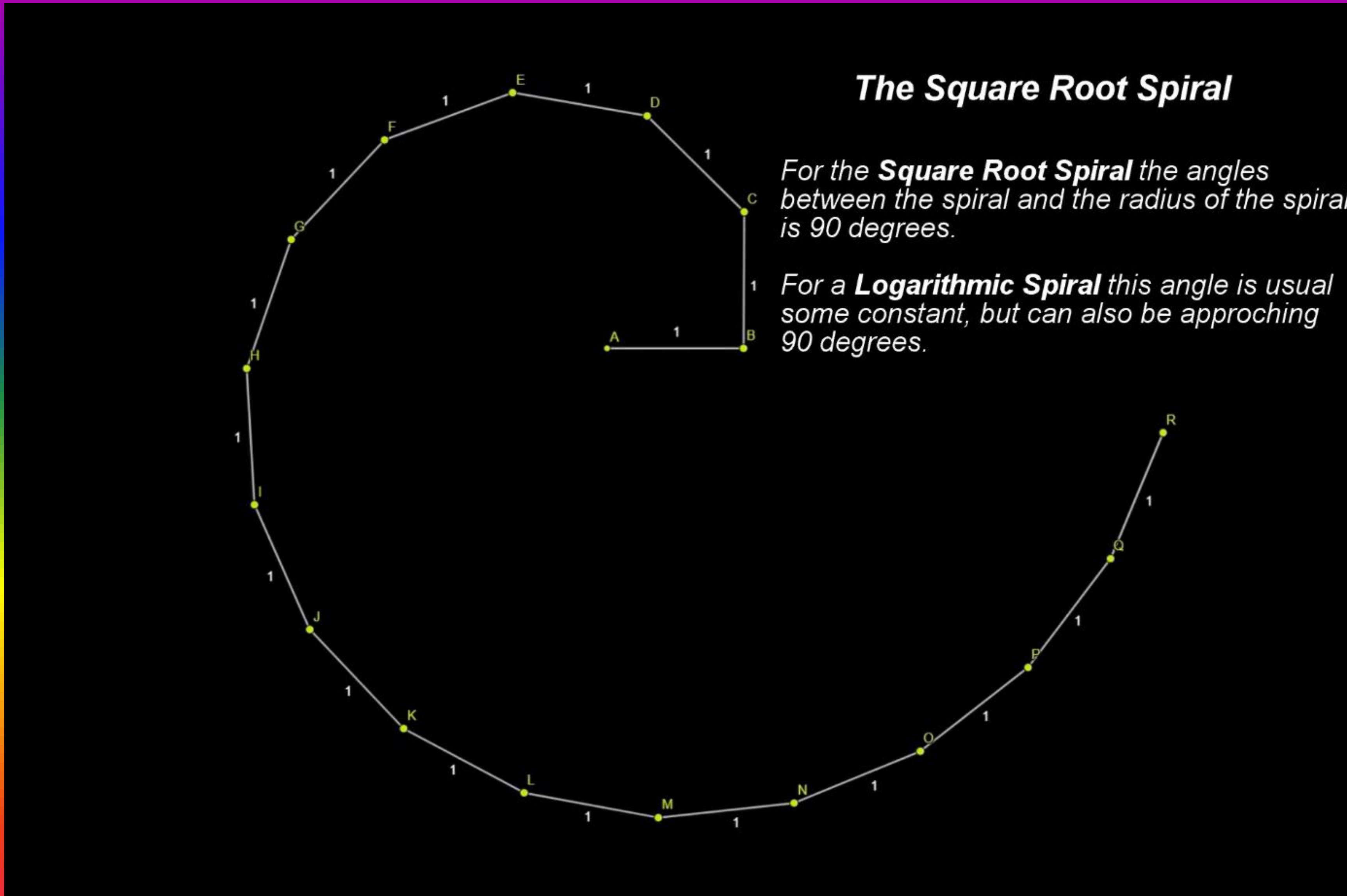
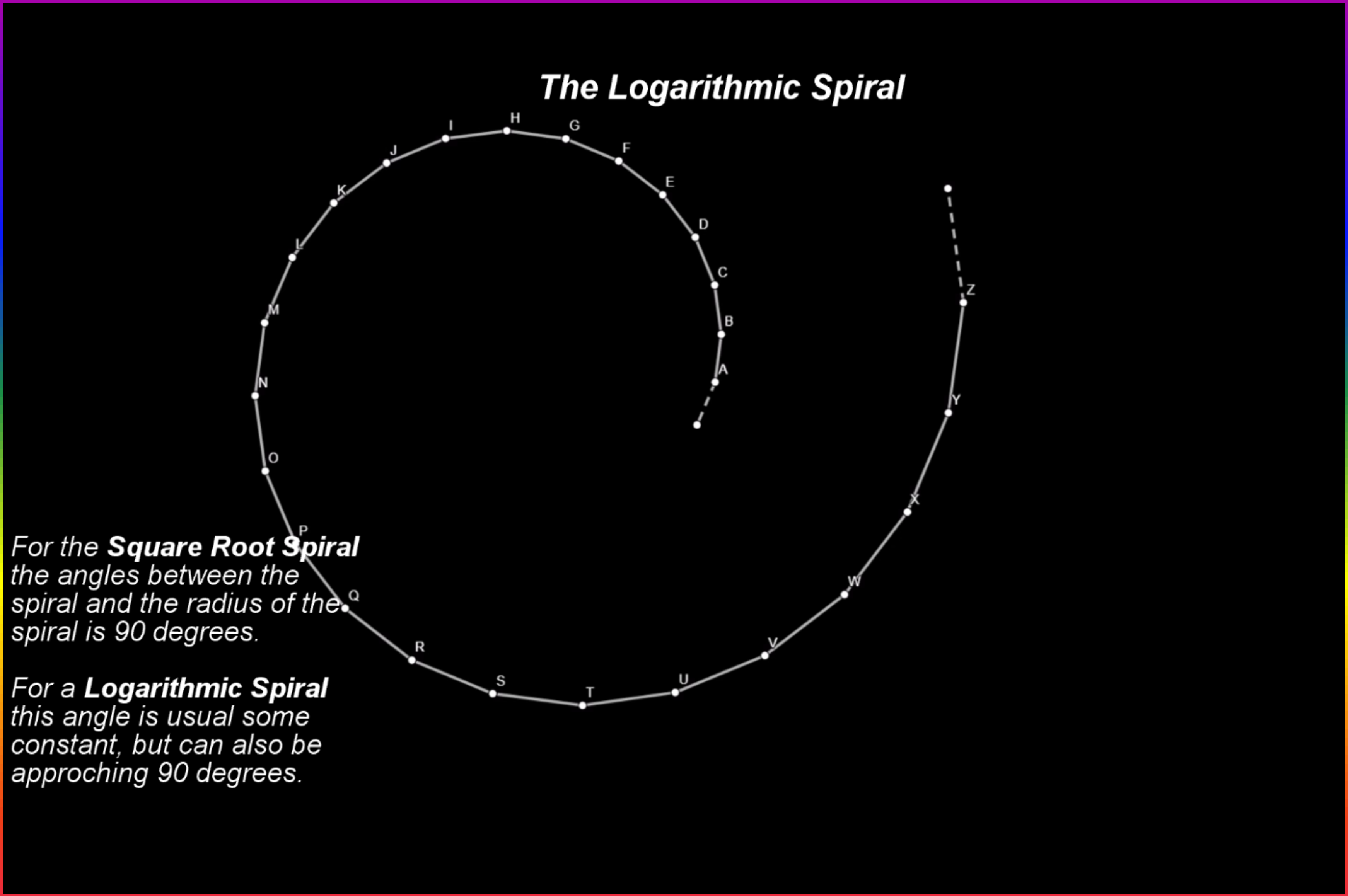


When this happens, the distance between two windings of the corresponding Archimedean spiral is equal with the number PI.



b. For the square root spiral the angles between the spiral and the radius of the spiral is 90 degrees.
For a logarithmic spiral this angle is usual some constant, but can also be 90 degrees.



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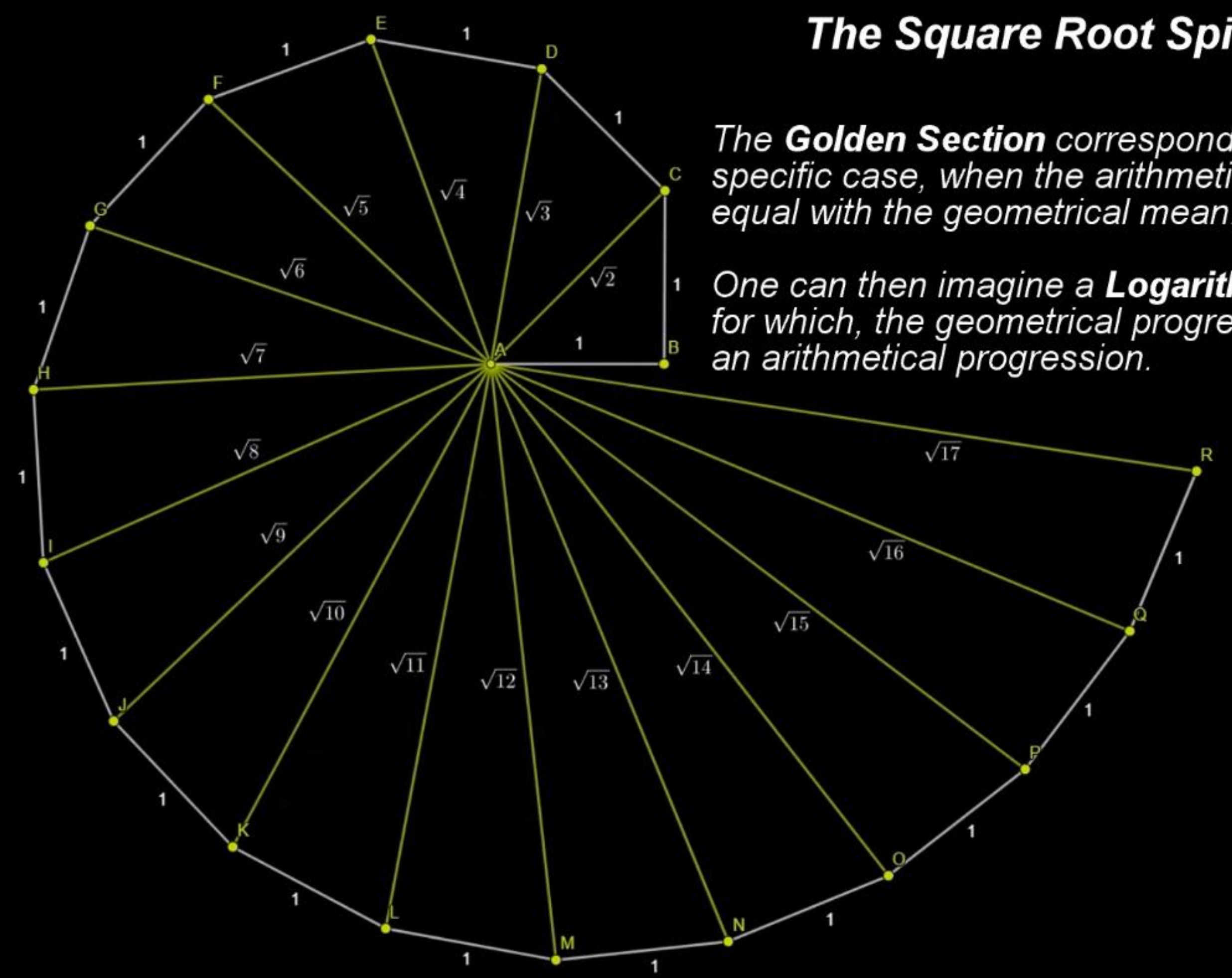

*The **Golden Section** corresponds to the specific case, when the arithmetical mean is equal with the geometrical mean.*

*One can then imagine a **Logarithmic Spiral**, for which, the geometrical progression is also an arithmetical progression.*

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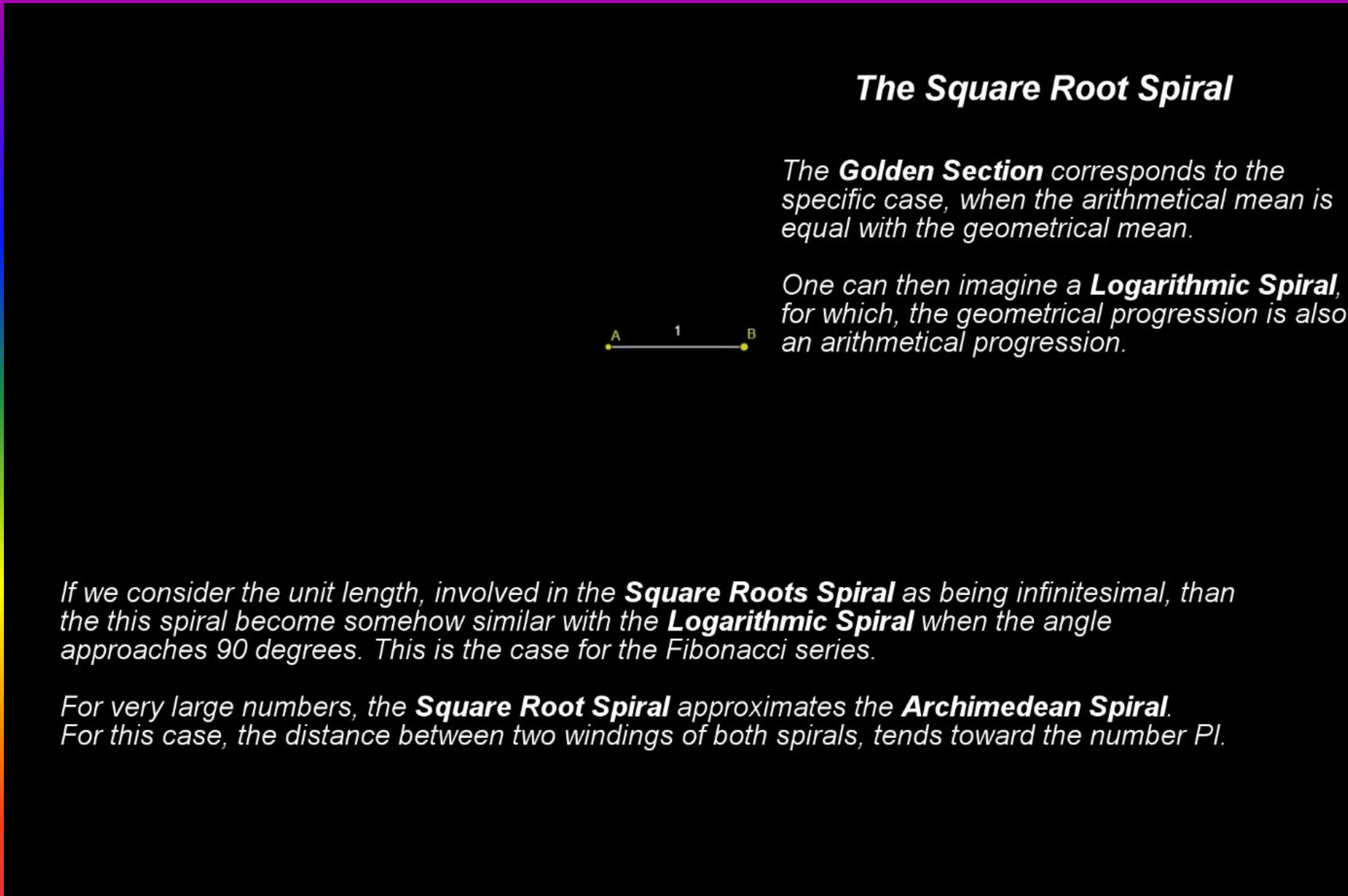
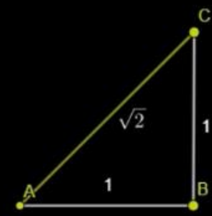


Now, if we consider the unit length, involved in the square roots spiral, as being infinitesimal, than the two spirals are similar.

The Square Root Spiral



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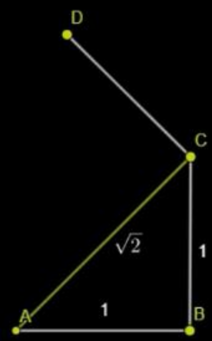
*If we consider the unit length, involved in the **Square Roots Spiral** as being infinitesimal, than the this spiral become somehow similar with the **Logarithmic Spiral** when the angle approaches 90 degrees. This is the case for the Fibonacci series.*

*For very large numbers, the **Square Root Spiral** approximates the **Archimedean Spiral**. For this case, the distance between two windings of both spirals, tends toward the number PI.*

As we have seen in a previous presentation, the Golden section corresponds to the specific case, when ***the arithmetical mean is equal with the geometrical mean***.

The Square Root Spiral



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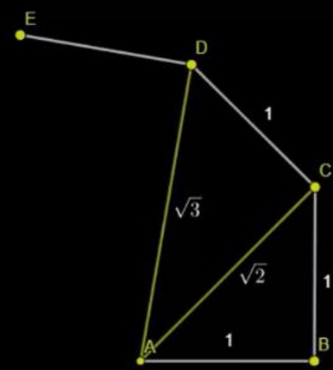
One can then imagine a logarithmic spiral for which the geometrical progression is also an arithmetical progression. This is already the case for the Fibonacci series.

The Square Root Spiral



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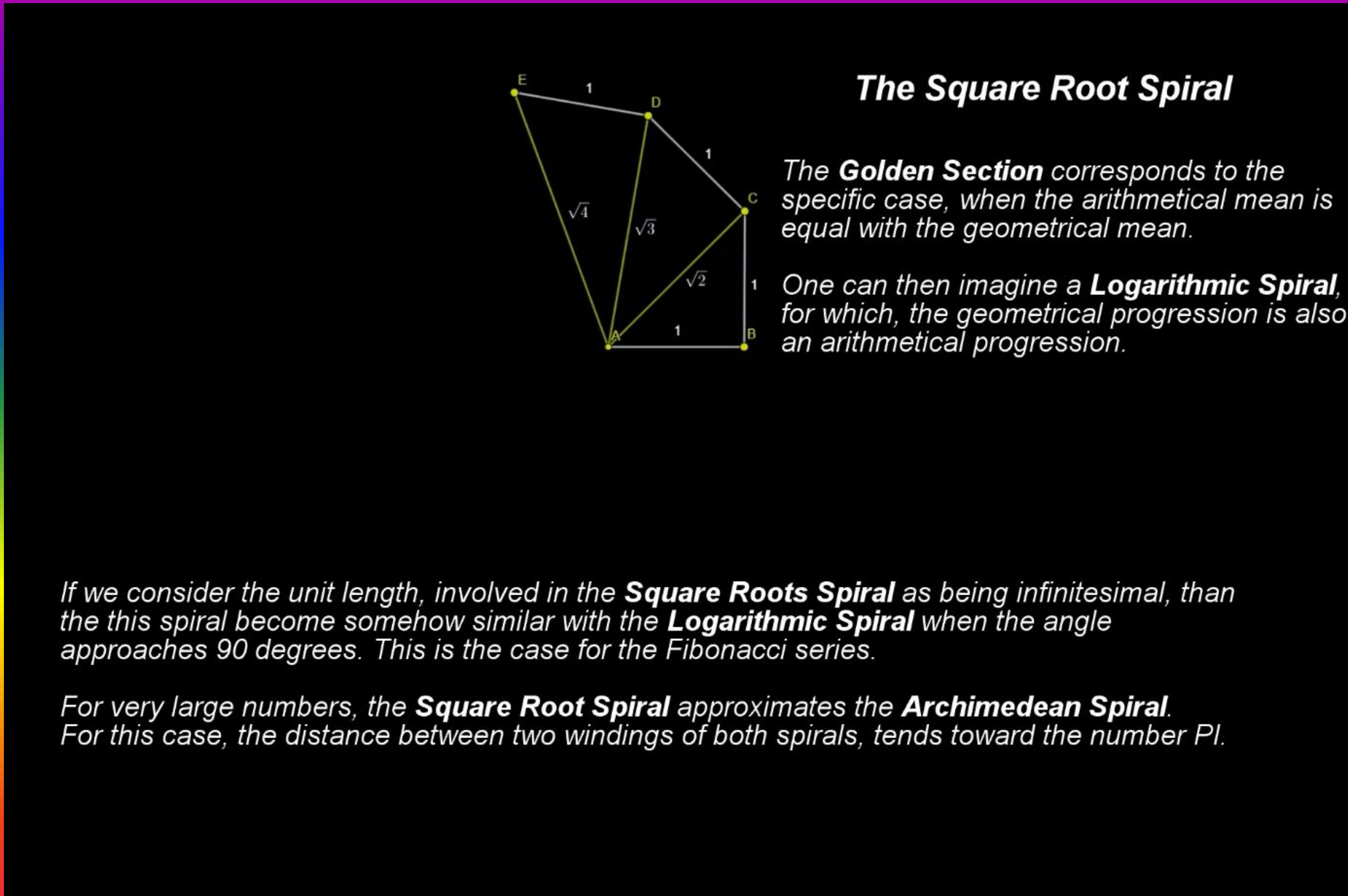

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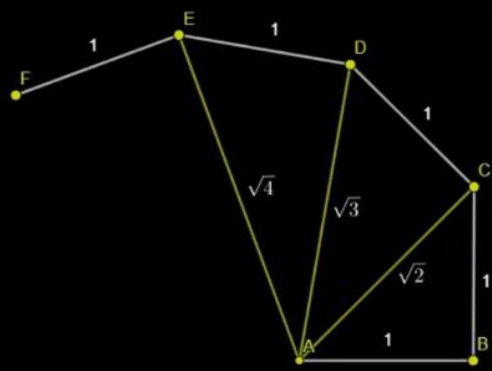

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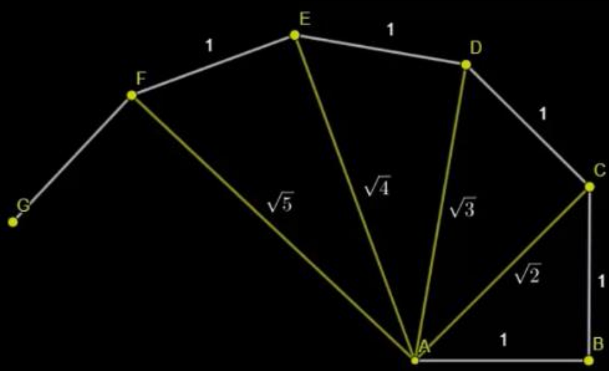

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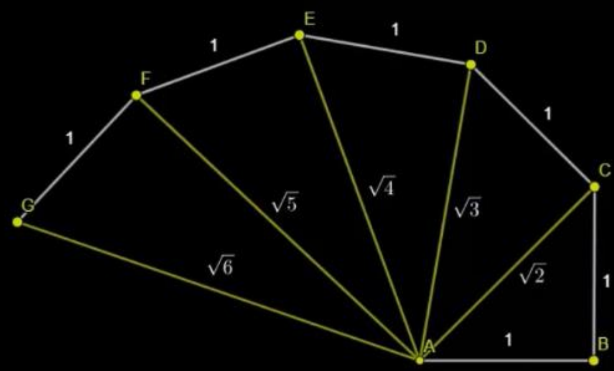

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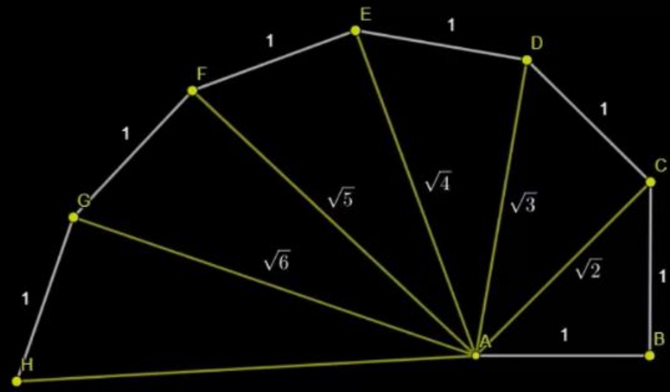
In the next few presentations we will use the facts presented in this video to introduce a metric relationship to characterize the distances between points in the CPS Geometry.



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*One can then imagine a **Logarithmic Spiral**, for which, the geometrical progression is also an arithmetical progression.*

*If we consider the unit length, involved in the **Square Roots Spiral** as being infinitesimal, than the this spiral become somehow similar with the **Logarithmic Spiral** when the angle approaches 90 degrees. This is the case for the Fibonacci series.*

*For very large numbers, the **Square Root Spiral** approximates the **Archimedean Spiral**. For this case, the distance between two windings of both spirals, tends toward the number PI.*

In the next few presentations we will use the facts presented in this video to introduce a metric relationship to characterize the distances between points in the CPS Geometry.

Few surprises are waiting for us just around the corner.

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Beauty makes beautiful things beautiful!