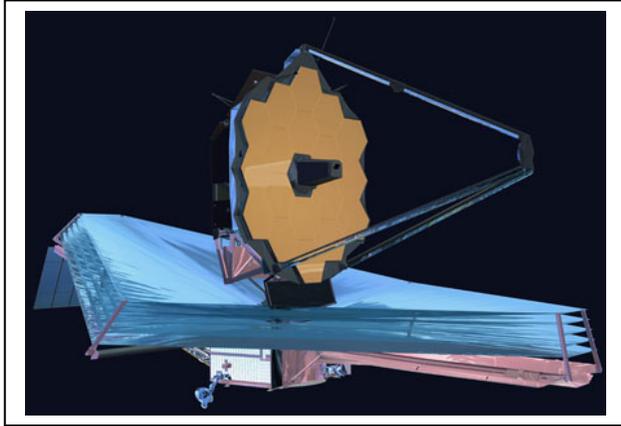# Scaling the Webb Space Telescope Mirror -III

The James Webb Space Telescope, to be launched by NASA in 2014, is a telescope designed to explore galaxies and stars that formed soon after the Big Bang. Its unique design features a large mirror that consists of 18 hexagonal tiles; each tile is its own mirror.

Many of the largest telescope mirrors now being built for ground-based observatories use the hexagonal 'segmented' design. A single 1-meter wide hexagon, replicated dozens of times, is a lot easier to make than a single large mirror!


Suppose that in the problems below, the length of a side of the hexagon is L = 0.76 meters. New mirror designs are created from the Webb Space Telescope design by adding enough mirror tiles to complete a new outer ring. For example, the Webb Space Telescope mirror consists of two complete rings of hexagonal tiles.

Problem 1 - Using the sketch to the left as a guide, how many tiles will be in the assembled mirror if 1, 2 or 3 additional rings of hexagonal tiles are added?

Problem 2 - What is the total area of each mirror design if the area of a single hexagon is
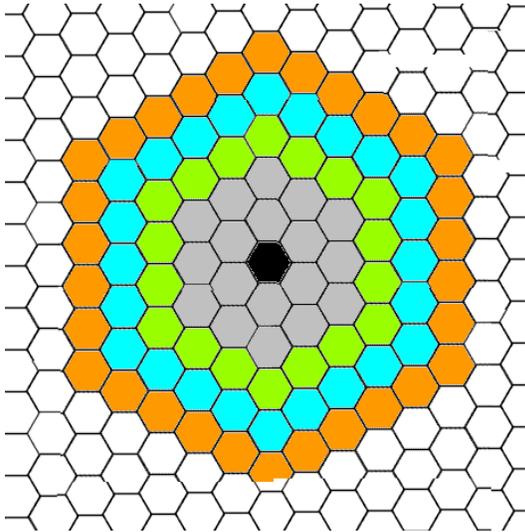
$$A = \frac{3}{2}\sqrt{3}L^2$$

Compared to the Webb Space Telescope design of 18 tiles, by what factor do the three new mirror designs exceed the Webb Space Telescope collecting area?

Space Math   http://spacemath.gsfc.nasa.gov
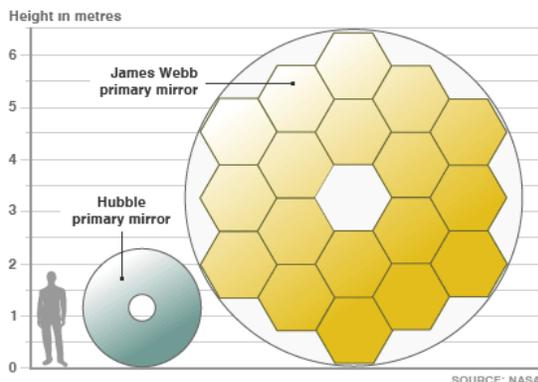
Problem 1 - Using the sketch to the left as a guide, how many tiles will be in the assembled mirror if 1, 2 or 3 additional rings of hexagonal tiles are added?

Answer: From the shaded rings indicated below: One additional ring (green) = 18 + 18 = **36 tiles**.   Two rings = 36 + 24 = **60 tiles**. Three rings = 60 + 30 = **90 tiles**.

Problem 2 - What is the total area of each mirror design if the area of a single hexagon is

$$A = \frac{3}{2}\sqrt{3}L^2$$

Compared to the Webb Space Telescope design of 18 tiles, by what factor do the three new mirror designs exceed the Webb Space Telescope collecting area?

Answer: The hexagon area is A = 1.5 (1.732) $(0.76)^2$ = 1.5 meters^2.
Webb Space Telescope Mirror: 18 tiles, Area = 18 x 1.5 = 27 meters^2.

One additional ring: Area = 36 x 1.5 =   **54 meters^2.**
Two additional rings: Area= 60 x 1.5 =   **90 meters^2.**
Three additional rings: Area = 90 x 1.5 = **135 meters^2.**

The areas increase by factors of **2.0, 3.3 and 5.0 times** the area of the Webb Space Telescope design.