Flipping Physics Lecture Notes:
"Pillars of Creation" Explanation for Kate
http://www.flippingphysics.com/pillars-of-creation.html

I am currently reading *The Disordered Cosmos: A Journey into Dark Matter, Spacetime, and Dreams Deferred* by Chanda Prescod-Weinstein[1] and I got to the part where she talks briefly about the "Pillars of Creation" photo taken by the Hubble Space Telescope. There is a picture of the photo in the book which I showed to my wife. I attempted an impromptu explanation of the photo and pretty much completely failed. I think my wife, who has a degree in opera and social work, essentially said, "I understand all the words you are using, however, when you put them into sentence format, they make absolutely no sense to me."

Pillars of Creation from NASA
http://hubblesite.org/image/3471/news_release/2015-01

Here is my attempt to explain to my wife, Kate, what the Pillars of Creation are. My main goals are to explain where, how far away, how big, and what the Pillars of Creation are.

Starting with, "*Where are they?"*
They are located near the constellation Sagittarius which looks like a teapot. The spout of the teapot points towards the center of our galaxy, the milky way galaxy. The top of the teapot points towards Messier 16 or M16. Inside M16 is the Eagle Nebula. And Inside the Eagle Nebula are the Pillars of Creation.

"How far away are they?"
The answer is roughly 7,000 light-years. That's it.
The Pillars of Creation are 7,000 light-years away.
Unfortunately, that did not help my wife know how far away they are, and if I am completely honest, doesn't really give me a good idea of how far away they are either. So, let's try again.

One light-year is the distance light travels in a year. So, realize a light-year is a distance measurement, not a time measurement. Light travels at roughly 3.00×10^8 meters per second or 186,000 miles per second. The Earth is, on average, roughly 93 million miles from the Sun. That means we can calculate how long it takes, on average, for light to travel from the Sun to the Earth.

$$\text{speed} = \frac{\text{distance}}{\text{time}} \Rightarrow \text{time}_{S\to E} = \frac{\text{distance}}{\text{speed}} = \frac{93{,}000{,}000\text{miles}}{186{,}000\frac{miles}{second}} = 500\text{seconds}$$

$$\Rightarrow \text{time}_{S\to E} = 500\text{seconds}\left(\frac{1\text{minute}}{60\text{seconds}}\right) = 8\frac{1}{3}\text{minutes}$$

But, that evidently was not overly helpful for Kate's understanding. So, let's try something different. Let's determine how far a light-year is in miles. To do that, first we need to determine how many seconds there are in a year.

$$1\text{year}\left(\frac{365.242\text{days}}{1\text{year}}\right)\left(\frac{24\text{hours}}{1\text{day}}\right)\left(\frac{3600\text{seconds}}{1\text{hour}}\right) \approx 31{,}560{,}000\text{seconds}$$

[1] I definitely recommend reading the book. It is quite good.

$$\text{speed} = \frac{\text{distance}}{\text{time}} \Rightarrow \text{distance} = (\text{speed})\,(\text{time})$$

$$\Rightarrow \text{distance}_{\text{ly}} = \left(186{,}000\frac{miles}{second}\right)(31{,}560{,}000\text{seconds}) \approx 5{,}870{,}000{,}000{,}000\text{miles}$$

Remember that our goal was to figure out how far 7,000 light-years is, the distance to the Pillars of Creation.

$$\Rightarrow (7{,}000)\,\text{distance}_{\text{ly}} = (7{,}000)\,(5{,}870{,}000{,}000{,}000\text{miles}) \approx 41{,}100{,}000{,}000{,}000{,}000\text{miles}$$

$$\Rightarrow \frac{(7{,}000)\left(\text{distance}_{\text{ly}}\right)}{\text{distance}_{S\to E}} = \frac{(7{,}000)\left(5{,}870{,}000{,}000{,}000\text{miles}_{\text{ly}}\right)}{93{,}000{,}000\text{miles}_{S\to E}} \approx 440{,}000{,}000$$

In other words, the Pillars of Creation are 440 million times farther away than the Sun is from the Earth. In summary, it's really, really far away.

But, *"How big are they?"*
The "pillar" on the far left from base to tip is roughly 4 light-years in length. In other words, it takes light four years to travel from the base to the tip of that "pillar", and it's roughly 250,000 times farther than the Sun is from the Earth.

$$\Rightarrow \frac{(4)\left(\text{distance}_{\text{ly}}\right)}{\text{distance}_{S\to E}} = \frac{(4)\left(5{,}870{,}000{,}000{,}000\text{miles}_{\text{ly}}\right)}{93{,}000{,}000\text{miles}_{S\to E}} \approx 250{,}000$$

But, *"What are they?"*
The reason they are called the Pillars of Creation is because:

1) They look like pillars.
2) Stars are created here.

The Pillars of Creation are clouds of hydrogen gas and dust that are clumping together to form stars. However, unfortunately, there is evidence that a supernova, a giant exploding star, occurred 6,000 years ago near the Pillars of Creation and that they have already been destroyed. That's right, it is likely that the Pillars of Creation no longer exist. But, how then is it that we are seeing them?

The Pillars of Creation are roughly 7,000 light-years away.

A light-year is the distance light travels in a year.

That means the light we are currently receiving to see the Pillars of Creation left there 7,000 years ago. We are looking 7,000 years into the past. That means that, roughly 1,000 years from now, we will get to see the Pillars of Creation be destroyed by the supernova. I don't know about you, however, I am definitely going to set a calendar reminder for that one. I'm thinking January 1st, 3001. See you then!

In case you were interested, here are two good articles about the Pillars of Creation:

- *The "Pillars of Creation" Have Been, Are Being, and Will Be Destroyed* from Discover Magazine.
  - https://www.discovermagazine.com/the-sciences/the-pillars-of-creation-have-been-are-being-and-will-be-destroyed
- *The Pillars Of Creation Haven't Been Destroyed, After All* from Forbes
  - https://www.forbes.com/sites/startswithabang/2018/02/21/the-pillars-of-creation-havent-been-destroyed-after-all/