**LESSON 1: SCALE OF THE LARGE**

**Video transcript**

The purpose of this video is to just begin to appreciate how vast and enormous the universe is. And frankly, our brains really can't grasp it. What we'll see in this video is that we can't even grasp things that are actually super small compared to the size of the universe. And we actually don't even know what the entire size of the universe is. But with that said, let's actually just try to appreciate how small we are. So this is me right over here. I am 5 foot 9 inches, depending on whether I'm wearing shoes-- maybe 5 foot 10 with shoes. But for the sake of this video, let's just roughly approximate around 6 feet, or around roughly-- I'm not to go into the details of the math-- around 2 meters. Now, if I were to lie down 10 times in a row, you'd get about the length of an 18-wheeler. That's about 60 feet long. So this is times 10. Now, if you were to put an 18-wheeler-- if you were to make it tall, as opposed to long-- somehow stand it up-- and you were to do that 10 times in a row, you'll get to the height of roughly a 60-story skyscraper. So once again, if you took me and you piled me up 100 times, you'll get about a 60-story skyscraper. Now, if you took that skyscraper and if you were to lie it down 10 times in a row, you'd get something of the length of the Golden Gate Bridge. And once again, I'm not giving you the exact numbers. It's not always going to be exactly 10. But we're now getting to about something that's a little on the order of a mile long. So the Golden Gate Bridge is actually longer than a mile. But if you go within the twin spans, it's roughly about a mile. It's actually a little longer than that. But that gives you a sense of a mile. Now, if you multiply that by 10, you get to the size of a large city. And this right here is a satellite photograph of San Francisco. This is the actual Golden Gate Bridge here. And when I copy and pasted this picture, I tried to make it roughly 10 miles by 10 miles just so you appreciate the scale. And what's interesting here-- and this picture's interesting. Because this is the first time we can relate to cities. But when you look at a city on this scale, it's starting to get larger than what we're used to processing on a daily basis. A bridge-- we've been on a bridge. We know what a bridge looks like. We know that a bridge is huge. But it doesn't feel like something that we can't comprehend. Already, a city is something that we can't comprehend all at once. We can drive across a city. We can look at satellite imagery. But if I were to show a human on this, it would be unbelievably, unbelievably small. You wouldn't actually be able to see it. It would be less than a pixel on this image. A house is less than a pixel on this image. But let's keep multiplying by 10. If you multiply by 10 again, you get to something roughly the size of the San Francisco Bay Area. This whole square over here is roughly that square right over there. Let's multiply by 10 again. So this square is about 100 miles by 100 miles. So this one would be about 1,000 miles by 1,000 miles. And now you're including a big part of the Western United States. You have California here. You Nevada here. You have Arizona and New Mexico-- so a big chunk of a big continent we're already including. And frankly, this is beyond the scale that we're used to operating. We've seen maps, so maybe we're a little used to it. But if you ever had to walk across this type of distance, it would take you a while. To some degree, the fact that planes goes so fast-- almost unimaginably fast for us-- that it's made it feel like things like continents aren't as big. Because you can fly across them in five or six hours. But these are already huge, huge, huge distances. But once again, you take this square that's about 1,000 miles by 1,000 miles, and you multiply that by 10. And you get pretty close-- a little bit over-- the diameter of the Earth-- a little bit over the diameter of the Earth. But once again, we're on the Earth. We kind of relate to the Earth. If you look carefully at the horizon, you might see a little bit of a curvature, especially if you were to get into the plane. So even though this is, frankly, larger than my brain can really grasp, we can kind of relate to the Earth. Now you multiply the diameter of Earth times 10. And you get to the diameter of Jupiter. And so if you were to sit Earth right next to Jupiter-- obviously, they're nowhere near that close. That would destroy both of the planets. Actually, it would definitely destroy Earth. It would probably just be merged into Jupiter. So if you put Earth next to Jupiter, it would look something like that right over there. So I would say that Jupiter is definitely-- on this diagram that I'm drawing here-- is definitely the first thing that I have I can't comprehend. The Earth, itself, is so vastly huge. Jupiter is-- it's 10 times bigger in diameter. It's much larger in terms of mass, and volume, and all the rest. But just in terms of diameter, it is 10 times bigger. But let's keep going. 10 times Jupiter gets us to the sun. This is times 10. So if this is the Sun-- and if I were to draw Jupiter, it would look something like-- I'll do Jupiter in pink-- Jupiter would be around that big. And then the Earth would be around that big if you were to put them all next to each other. So the Sun, once again, is huge. Even though we see it almost every day, it is unimaginably huge. Even the Earth is unimaginably huge. And the Sun is 100 times more unimaginably bigger. Now we're going to start getting really, really, really wacky. You multiply the diameter of the Sun, which is already 100 times the diameter of the Earth-- you multiply that times 100. And that is the distance from the Earth to the Sun. So I've drawn the Sun here as a little pixel. And I didn't even draw the Earth as a pixel. Because a pixel would be way too large. It would have to be a hundredth of a pixel in order to draw the Earth properly. So this is a unbelievable distance between the Earth and the Sun. It's 100 times the distance of the diameter of the Sun itself. So it's massive, massive. But once again, these things are relatively close compared to where we're about to go. Because if we want to get to the nearest star-- so remember, the Sun is 100 times the diameter of the Earth. The distance between the Sun and the Earth is 100 times that. Or you could say it's 10,000 times the diameter of the Earth. So these are unimaginable distances. But to get to the nearest star, which is 4.2 light years away, it's 200,000 times-- and once again, unimaginable. It's 200,000 times the distance between the Earth and the Sun. And to give you a rough sense of how far apart these things are, if the Sun was roughly the size of a basketball-- if the average star was about the size of a basketball-- in our part of the galaxy in a volume the size of the Earth-- so if you had a big volume the size of the Earth, if the stars were the sizes of basketballs, in our part of the galaxy, you would only have a handful of basketballs per that volume. So unbelievably sparse. Even though, when you look at the galaxy-- and this is just an artist's depiction of it-- it looks like something that has the spray of stars, and it looks reasonably dense, there is actually a huge amount of space that the great, great, great, great, great majority of the volume in the galaxy is just empty, empty space. There's no stars, no planets, no nothing. I mean, this is a huge jump that I'm talking about. And then if you really want to realize how large a galaxy, itself, can be, you take this distance between the Sun, or between our solar system and the nearest star-- so that's 200,000 times the distance between the Earth and the Sun-- and you multiply that distance by 25,000. So if the Sun is right here, our nearest star will be in that same pixel. They'll actually be within-- you'd actually get a ton of stars within that one pixel, even though they're so far apart. And then this whole thing is 100,000 light years. It's 25,000 times the distance than the distance between the Sun and the nearest star. So we're talking about unimaginable, unfathomable distances, just for a galaxy. And now we're going to get our-- frankly, my brain is already well beyond anything that it can really process. At this point, it almost just becomes abstract thinking. It just becomes playing with numbers and mathematics. But to get a sense of the universe, itself, the observable universe-- and we have to be clear. Because we can only observe light that started leaving from its source 13.7 billion years ago. Because that's how old the universe is. The observable universe is about 93 billion light years across. And the reason why it's larger than 13.7 billion is that the points in space that emitted light 13.7 billion years ago, those have been going away from us. So now they're on the order of 40 billion light years away. But this isn't about cosmology. This is just about scale and appreciating how huge the universe is. Just in the part of the universe that we can theoretically observe, you have to get-- and that we can observe, just because we're getting electromagnetic radiation from those parts of the universe-- you would have to multiply this number. So let me make this clear. 100,000 light years-- that's the diameter of the Milky Way. You would have to multiply not by 1,000. 1,000 would get you to 100 million light years. This is 100,000 times 1,000 is 100 million. You have to multiply by 1,000 again to get to 100 billion light years. And the universe, for all we know, might be much, much, much, much, larger. It might even be infinite. Who knows? But to get from just the diameter of the Milky Way to the observable universe, you have to multiply by a million. And already, this is an unfathomable distance. So in the whole scheme of things, not only are we pretty small, and not only are the things we build pretty small, and not only is our planet ultra small, and not only is our Sun ultra small, and our solar system ultra small, but our galaxy is really nothing compared to the vastness of the universe.

VOCABULARY:

Purpose: Maksat, amaç, gaye

Appreciate: Takdir etmek, kıymetini (değerini) bilmek

Vast: Geniş, çok büyük, uçsuz bucaksız

Enormous: Çok büyük, muazzam, kocaman, azman

Frankly: Açıkça, açıkçası, dürüstçe, samimiyetle, dobra dobra, doğrusu

Grasp: Kavramak, anlamak, kapmak, tutmak

Compare: Karşılaştırmak, mukayese etmek

Compared to: Nazaran, ---- ile kıyaslandığında

Size: Beden, boy, ölçü

Entire: Tam, bütün, tüm, hepsi

Depend: Bağlı olmak,tabi olmak

Wear: Giymek, elbise, giysi, yıpranma, aşınma (Hardware, Software)

Sake: Hatır

Approximate:yaklaşmak, yaklaşık, yakın

Lie down; yere yatmak, uzanmak

An 18-wheeler: !8 tekerlekli bir kamyon

About: hakkında, yaklaşık

Oppose: Muhalefet etmek, karşı olmak

Opposed to: karşı, zıt

Skyscraper: Gökdelen

A 60-story skyscraper: 60 katlı bir gökdelen

Pile up: Birikmek, yığmak, üst üste koymak, istiflemek

Row; Sıra

On the order of: Mertebesinde

Span: Karış, bir köprünün iki desteği arasındaki mesafe

Sense: Duygu,his, anlam, yön, algı, sezme, hissetme

Satellite: Uydu

Paste: macun, yapıştırmak

Scale: ölçek, ölçü, skala, pul(balık), kefe, terazi gözü

Relate to: alakalandırmak, ilişkilendirmek, ilgili olmak

To be used to: alışık olmak

Process: işlem, süreç, yöntem, usul, işlemek, muameleye tabi tutmak

Look like: benzemek

Comprehend: idrak etmek

At once, Derhal, hemen

İmagery: Görüntü, fotoğraf

Unbelievable: İnanılmaz

Include: ihtiva etmek, içermek

Across: Boyunca, karşısında

Plane, düzlem, uçak

Huge: kocaman, muazzam, çok büyük

Pretty: Oldukça, sevimli

Kind of: Bir bakıma

Horizon: Ufuk

Curvature: Büküklük, eğiklik

Even though: Rağmen

Obvious: Apaçık, aşikar, besbelli

Destroy: İmha etmek

Merge: Birleşmek, kaynaşmak

Massive: Kütlevi, kütleli

Per: başına

Depict: Çizmek, resmetmek, göstermek, tasvir etmek

Realize: Farketmek, farkında olmak

Apart: Ayrı, uzağa

To be apart: Ayrı olmak, uzakta olmak

Fathom: Kavramak, anlamak

Unfathomable: Anlaşılmaz, kavranılamaz

Ultra: Aşırı, aşkın

Scheme: Plan, düzen,