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Ghosts of the Night Sky

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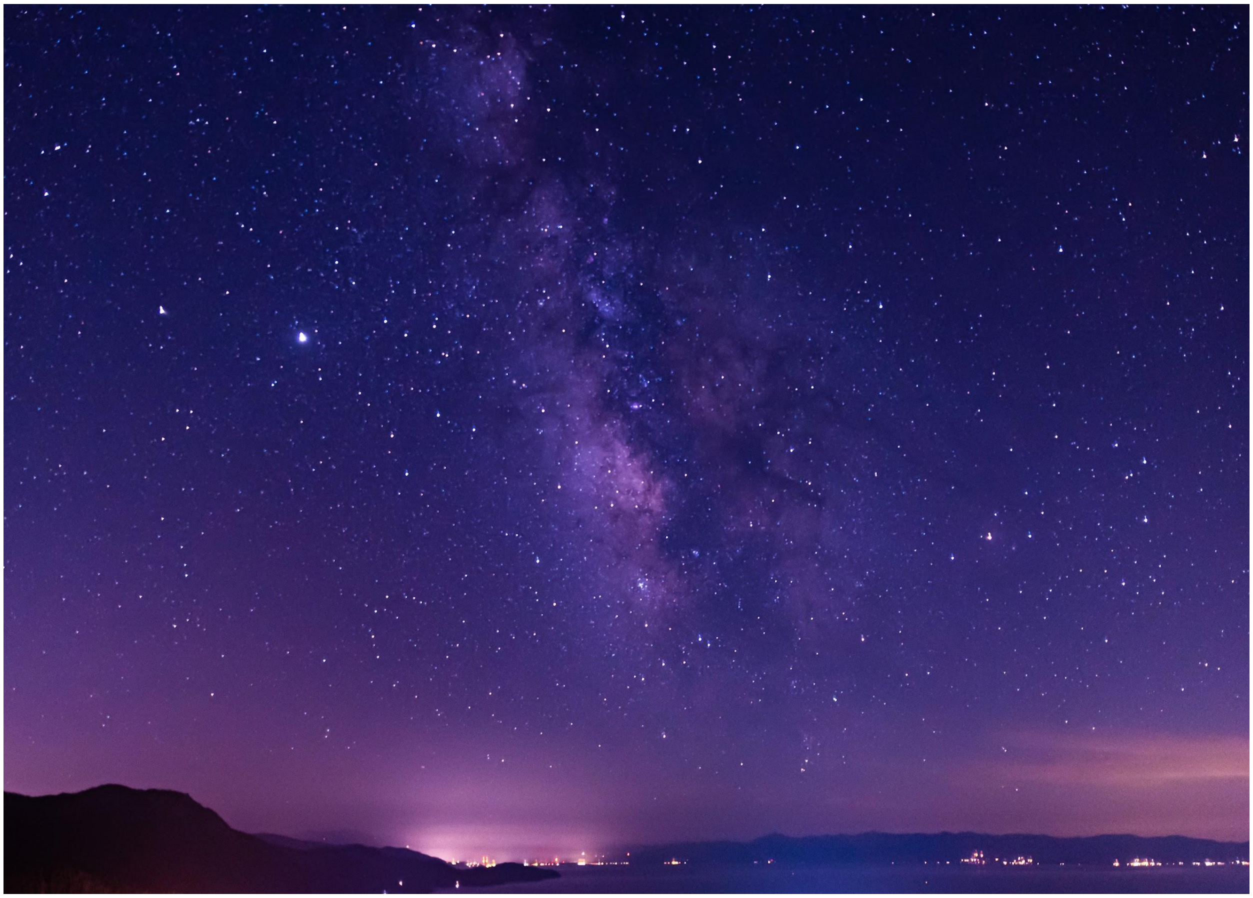

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¶ Do you believe in ghosts? Or do you think it is possible to look back in time? Well, it turns out if your answer to both of these questions is positive, then you won't be disappointed. For a long time, humans have looked up to the night sky & have wondered in awe seeing the vastness of space & the dim & bright twinkling stars. Writers & poets also have romanticised & admired the brightly lit starry night skies in their literary works. There are tourist spots & places, even in India, where you can see the entire Milky Way Galaxy at night. But what if you would get to know that actually whatever stars you see in the night sky, most of them are technically dead? And what you're seeing are actually the "ghosts" of those stars? Intrigued? Let's try to understand by diving deeper into the time & space. Even if you're not much into science — with a basic understanding of general rules of mathematics & physics — by the end of this text you'll be able to look back in time every single time you'll look up to the night sky witnessing the moon & the stars. Well, in actuality, you were doing that all along ever since you first looked up into the night sky — you weren't just aware of it! But that's what a discovery looks like, isn't it? So, Here we go.

Every star is a Sun as big as bright as our own, and some are even way much bigger. Just imagine how far away from us you'd have to move the Sun to make it appear as small & as faint as a little star you see in the night sky, other than the Sun itself. The light from the stars travels very fast, faster than anything, but not infinitely fast. It takes time for their light to reach us. For the nearest ones, it takes years, but for others — centuries. Some stars are so far away, it takes eons for their light to get to us. By the time the light from some stars gets here — they are already dead. For those stars, we see only their 'ghosts'. We see their lights, but their bodies perished long, long ago. The 18th century German-born British astronomer, great William Herschel was the very first person to discover this fact. He saw further back in time than anyone before him — millions of years into the past. He was the first person to understand that a telescope is a time machine! We can't look out into space, without seeing back in time. In one second, light travels 300,000 kms, or 186,000 miles. That's nearly the distance from the Earth to the Moon. So, we can say that the Moon is about one light-second away from us. Next time you look at the Moon, you'll be seeing one second — into the past. Similarly, it takes around 8 minutes for the light from the Sun to reach Earth, so every time you look at the Sun — you look 8 minutes back in time. Still not convinced? Don't worry if all of this doesn't make sense yet, we'll use some basic mathematics & physics to understand what's going on. Warning: geeky stuff ahead! ;)

Let's start by getting an idea of some basic scientific principles, starting with the light-year. A light-year is a unit for measuring distance — very, very large distances indeed. Even though the phrase 'light-year' has an 'year' in it, it is certainly not the unit for measuring time, so don't be tricked! A light-year in physics is basically 'the distance travelled by light in an Earth year (i.e., 365 days) with a constant speed of 300,000,000 m/s'. Yes, that's unimaginably fast! Now, using the basic mathematics &

the Distance-Time formula from physics, it turns out that 1 light-year is around 9.5 trillion kms. We'll get into the details of how it's calculated, and what the Distance-Time formula is — in case you're wondering. First, to give you an idea of how far one light-year is, imagine that the distance between the Sun & the Earth — which is around 150 million kms or 91 million miles — is only 'one inch'. Then the distance light travels in a year would stretch almost a mile. It's almost unfathomable how far just one light year is. You might also ask that when we can mention distances in kms or miles, then why do we need another new unit to make things confusing & increase the syllabus? Well, we do it because once you start measuring distances on an astronomical level, like between distant stars & even galaxies, the numbers start adding up so quickly & become too large. Imagine how many zeros you'd have to write to mention the distance between our planet & the farthest star discovered so far — MACS J1149 Lensed Star 1, a.k.a. Icarus — which is around 14 billion light-years away. That would be around 22 zeros after the number 14, if written in kms. It's the same reason actually why we introduced 'a quintal' or 'a tonne' for heavier weights while we still already had kgs or lbs (pounds). Also, in case you're wondering, "why we're talking about 'speed' of light & the 'time' taken by it to cover distances, it doesn't make sense" — then you should know that yes, light *travels* through space from one point to another. Light itself is nothing but a wave - an electromagnetic one to be precise. Even though when you turn on the switch of the light bulb in your room, the entire room so quickly lits up as if something just appeared out of the blue, still there's some really unnoticable & negligible delay that is there between the light originating from the bulb and reaching to the every corner of a room. You'll get a clearer idea & you'll be able to seriously acknowledge the delay once we'll get to understand the mathematics behind it.

It's time for some real high-school physics now. We'll try to understand what the famous (or should we say – infamous) Distance-Time formula is to get one step ahead in our journey. It's quite basic & you might've already used it in your school to calculate the speed of moving trains & cars. So, the formula says that 'the average speed of a moving thing is given by dividing the distance the thing has travelled by the time it took to cover that distance' (mathematically, Speed = Distance ÷ Time). Or you can state the same fact in two other ways as well, you can say — 'the distance travelled by a moving thing can be calculated by multiplying the speed of the thing & the time it took to complete its journey' (Distance = Speed × Time), or it can be mentioned as 'the time taken for a moving thing to cover a certain distance with a certain speed would be given by dividing the distance by the speed' (Time = Distance ÷ Speed). Now you noticed, that's the beauty of mathematics — by a simple tweaking or adjusting of the terms in the equation (well, it's mathematics so 'tweaking' is an oversimplification indeed, but it'll do) & by having the values for two of the three terms — we can calculate the third. So, that's the Distance-Time formula, the same equation used to calculate how much a light-year is in kms or any other unit of distance, as mentioned earlier. You simply put the constant value of the speed of light & the time in question — which is a year — with their suitable units, in the equation Distance = Speed × Time, and you get your answer. Try yourself! Of course, you're going to need a calculator.

Next we'll get into some mathematics. We'll try to learn a concept called 'the concept of proportionality' using the same Distance-Time formula. This basic but interesting rule of mathematics, which is regarding the relationship of different 'variables' in an equation, is going to be our last important tool in this journey. So, we'll use the Distance = Speed × Time form of our equation to understand what proportionality means. You see there are three terms in our equation — distance, speed & time. Now, recall that we mentioned earlier that the speed of light is a constant number, i.e., it doesn't change in any condition no matter what. The number is 300,000,000 m/s. So, when considered for light, our Distance-Time equation holds a constant term — Speed, whose value wouldn't change. But, the other two terms are 'variables', i.e., their values wouldn't be constant, they'd change depending on the conditions. Now, in mathematics it is a general practice that if there's a constant term in an equation, then that term can be eliminated or put out. This is because of the fact that since this term's value wouldn't change, it wouldn't have any effect on the overall equation & have no dependency on the other terms which are variables. When you put out the constant term, you can write the equation with a different symbol between the variables to denote the relationship between them, because after all mathematics is all about denotations & signs to state the universal truths! Therefore, your equation Distance = Speed × Time, becomes Distance ∝ Time. This little twisted sign is called 'the sign of proportionality' in mathematics. And, here comes our concept of proportionality. This newly written form of our Distance-Time formula conveys a different (but not new, it was just hidden deeply) meaning now — it says, "the distance covered by a moving thing is directly proportional to the time taken by the thing to cover that distance." In much simpler words, it basically means that 'the larger the distance a thing has to cover, the longer the time it will take to cover it'. And, that's the concept of proportionality in mathematics (in terms of the quantities Distance & Time). Quite simple, isn't it? Mathematically speaking, the proportionality is basically about the dependence of variables on the two sides of the equation (LHS & RHS) on each other. If value of one will increase, the value of the other will increase as well (and by the same amount, if there's no coefficient or, we should say a number attached to the variables like 2 × time) and, if the value of one will decrease, the value of the other will also decrease. By value here we mean the numerical value we put in place of the terms or variables in the equation to calculate the results. It is to be noted here that the relationship of proportionality still stays true when the equation is written in its original form, the form Distance ∝ Time is just more standard way to state the fact, and also for a clearer understanding. Also, it's a general observation of day-to-day life that if some moving object has to cover large distances, it's going to take more time to cover that obviously, and if the distance would be small, it will take less time to cover it. So, without the mathematics as well we can see that we're dealing with the correct facts & truths, and we're on the right track! But still it's always a good idea to back-up your proofs & claims by mathematics, especially when you're dealing with sciences.

Now that we have all our tools in one place, we can finally get to understand the very conundrum this is all about. As we just saw through the concept of proportionality, in the equation Distance ∝ Time, the values of both the terms will increase with each other. So, if you apply the equation for the light coming from the stars that reaches us in the night when we look up to the sky, you can clearly conclude that further the star would be & hence the more distance the light has to travel, the more time it will take to reach us — while the speed never changes, it remains constant during the entire journey. Now, when it comes to the stars that are millions & billions of light-years away from us, this time surpasses the very age of those stars themselves. Typically, a star the size of the Sun tends to have a lifespan of about 5 billion years, then they run out of fuel to burn and eventually die. Thus, when the light that originated from them reaches us, it makes us see back in time. We see only an image from the past of those stars, sort of a photograph of the dead taken billions of years ago — we see 'ghosts'. Now, even if the time a light beam took to travel from a star (or any other celestial object originating or reflecting light such as moons) would be less than the age of the object itself, & the light reaches us before the object is dead — still there will be a considerable delay that we can say we are actually looking into the past, if not witnessing the 'ghosts' at least. And, it's not the case with celestial objects or stars only. Imagine a planet billions of light-years away which has life, other than the Earth. Now, when someone (yes, an alien of course) would capture the light originated from Earth through their telescopes to look at us, he/she/it (not really sure which pronoun to use, it's about aliens after all!) would see only our 'ghosts'! Obviously, the age of an average human being is nowhere close to a billion years, right? So, you see — the rules of physics do not discriminate between humans & stars, very societal. You get the idea. Well, here the only difference is that instead of we travelling back in time to look at the past, the past comes to us & we take a look. The light waves bring the past to us, to have a look at — every single night. The Hubble Space Telescope has allowed astronomers to look back in time to when galaxies were forming. And now the recently launched James Webb Space Telescope will complement & extend the discoveries of the Hubble Space Telescope, by looking deeper into space & hence further back in time. If you finally got the understanding about our 'ghosts of the night sky' & the idea of looking back in time, then congratulations! It surely will change the way you'll look up to the night sky from now onwards.

One more thing before we wrap up. It is a folk tradition, or more of a children's thing that we assign our ancestors or loved ones who passed away, a star from the night sky. We used to believe, or at least we were told that our grandparents or others who die, become stars & look upon us when we sit under the starry night. It's really a beautiful thought, and also a way to keep cherishing the memories of those who left us, no doubts. But, a little piece of advice: as now you've learned that most of the stars that we see at night are already dead, so make sure you assign a bigger & brighter star to your 'dear departed'. After all, symbolising someone dead with something that's already dead itself doesn't seem like a good idea! Well, that became a bit morbid, wasn't it? Anyways, the next time you sit under a starry night, take a moment to admire the fact that you're actually seeing some of the 'ghosts', and looking back into the time itself.