Hot Spacetime (Queen and Philosophy)

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Hot Spacetime

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You knew you wanted to be an astronaut since you were five years old. Your biggest historical role model, who obviously wanted it all, was Brian May, both a rock star and a scientist with a PhD in astrophysics. After years of education and training, you accept to go on a one-year mission in search of a new planet. You return after a year only to realize that everybody you knew has grown old and died. In order to figure out what has happened, we must first visit the most fundamental concepts of them all: time and space.

Time Waits for Nobody

Newton's mechanics was essentially unchallenged until the twentieth century, both from physical and philosophical standpoints. At that time, what we today know as science was actually *natural philosophy*: the philosophical study of nature and the universe around us. So, Isaac Newton wasn't a physicist back then, he was actually a natural philosopher.

In his *Principia*, Newton stated that time, space, and motion exist both as absolute and relative phenomena. Being *absolute* meant that there was nothing external

to it. If space is absolute, that means that there exists a phenomenon *independent* of bodies inside it, like a certain container. It's there even if you empty it. The same goes for time, it exists *independently* of any observers. The fact that 'time waits for nobody', in Mercury's words, would be an accurate description of absolute time: we as observers aren't important, it has its own reality and its own pace.

For Newton, therefore, space was something distinct from objects inside it: there is space and there are bodies. Philosopher and polymath Gottfried Leibniz was one of the first to argue that space only makes sense if we take the relative location of bodies into account. The main criticism was often directed towards the inability to conceive absolute space as something completely independent of anything else. If you go right in absolute space, that's *right* to what exactly?

Soon, Ernst Mach, physicist and philosopher, proposed the so-called Mach's principle. Imagine this: you're standing in a field, looking at the night sky. Maybe expecting a shooting star. You see the stars above you're not moving, and you've been waiting for this meteor shower for quite a while. You're standing still, eagerly, with your arms resting at your side. "Okay, I'll create my own shooting stars!", you say, and start spinning. The stars seem to be whirling around you and your arms are pulled from your body (and we won't stop you now!). But why would this happen, why aren't your arms still, or why aren't your arms being pulled away when you're not spinning?

Mach states that we can only talk about rotation in terms of things that are *in* the universe. If everything was spinning, we wouldn't call that spinning, since that would be normal. So, Mach's idea was that everything in physics and philosophy is based on *relative* motion, space and time. This paved the way to modern relativistic theories. Until Einstein, concepts of time

and space were distinct and separate phenomena. It was the advent of special relativity theory that merged the two into a single notion of *spacetime*. However, at first, there was light.

At the Speed of Light

Einstein's special theory of relativity is a theory regarding the relationship between space and time, the same question that has been bugging philosophers for decades. He proposed that the laws of physics should obey *the principle of relativity*: the laws of physics must be the same for all of the observers. It doesn't matter whether I'm spinning in a star field, riding a train, or sleeping in my bed, the laws of physics are identical or *invariant*.

The second big postulate of the special theory of relativity is that the speed of light in vacuum is also the same for all observers. Light will travel at the same speed in vacuum, no matter what I'm doing now. The speed of light in vacuum is defined as approximately three hundred thousand kilometers per second, and what Einstein has proposed is that this is the upper limit at which *anything* can travel through space. So, when Mr. Fahrenheit is 'travelling at the speed of light' in *Don't Stop Me Now*, he's actually at his maximum. In order to stop him, we would have to be faster since we don't want to use violence. And that's impossible. But we might join him if we can travel at the speed of light as well.

For centuries, philosophers have theorized that the light was moving in a certain medium. If sound travels in air, if waves travel through the water, then the light must travel through *something,* so let's call it *aether*. After decades of arguments and discussion about qualities of such a medium, its properties became practically magical. It had to be a certain type of a fluid in

order to fill space, but it also had to be stronger than steel to support the physics and high frequencies of light waves.

And this monstrous thing was nowhere to be found. Do you see anything like that around? No, but what's interesting is that all the philosophers and natural scientists were taking the existence of aether for granted. It just had to be there. There was even a decades-long experiment that tried to find it, and it was first performed by physicists Albert Michelson and Edward Morley. They didn't find any magical substance, and the only logical answer was to repeat the experiment since they had obviously done something wrong. 'There's no aether' simply wasn't a valid statement.

The experiment continued for decades, and it has been called the most famous failed experiment in history. In 1905, Einstein noticed the lack of evidence for the existence of aether and thought: hey, maybe it just isn't there. But in order to fully develop his theory, time and space had to merge into an inconceivable monster called *spacetime*.

"'39"

Back in the nineteenth century, there was space and there was time. And there it was, the twentieth century stating: no, they're actually the same thing. Einstein saw them as two different sides of the same coin. Mathematically, it's the same if you travel at a certain velocity as if you're rotating in a four-dimensional spacetime. Space has four dimensions now: up/down, left/right, forward/backward and one time dimension. In a Newtonian universe, if all the things disappeared from the universe, time and space would still remain. In Einstein's spacetime, they would disappear as well without any matter inside.

Imagine you want to join our old friend Mr. Fahrenheit. You power up your spaceship and want to disturb

him a bit, maybe using a laser to satisfy your inner child. If you were traveling at a constant speed of say, half the speed of light, you wouldn't even be able to tell you were moving, the same way it might seem the other trains are moving when your train starts to exit the station. If you had a mirror on top of your ceiling and a detector on the floor, you might test that laser and shoot a beam up, which would come back down and be detected. You have to try out your weapon first.

But behold, Mr. Fahrenheit was way smarter, and he called Dr. May to help and observe whether there are any villains in spaceships around. May would see your laser light travel upward diagonally, strike the mirror, and travel downward, diagonally again. Dr. May isn't slow or drunk, it's just physics. Not only that the light paths of your laser light were different, according to our spacetime equivalence, that means the time passed must be different as well. Such a phenomenon is called *time dilation*. If a ship is moving very quickly, traveling close to the speed of light, the time would appear to pass slower than on Earth.

In "Dead on Time," written by May, a person can "leave on time," but "never can tell." The fact that you left at a certain time might not mean anything since there's nothing like absolute time. It might go slower or faster for you, depending on your velocity. Maybe the guy in the song has a ticket for a spaceship, in that case you really cannot tell how and, more importantly, *when* you'll end up.

In a 1983 interview for BBC Radio One, May has stated that the song "'39" is a science-fiction story about a person who goes away to visit a new planet, but then time gets in the way. The time dilation effect makes the traveler age a year, and his loved ones back on his home planet age more than 100 years. In "'39," we find out that a group of volunteers used interstellar travel to find a new world, perhaps in 2139, or maybe May was

optimistic and thought of 2039. A hundred years later, in another "'39," they return home with the good news of finding a habitable planet. He looks at his daughter, presumably an old lady now, seeing her mother's eyes in her eyes. Even though "many years have gone," the narrator finds himself just "older but a year."

Many Years Away

Well, if there was one thing that philosophers thought was the same for everyone, that was time. It had been inconceivable even for an ordinary layman to think that there was some funny business here. Why don't race car drivers age slower than couch potatoes like most of us? They're going faster all the time, right!

Actually, they do. But the effect is so negligible since they barely even move compared to the speed of light. Astronauts who spend a great deal of time in space age more slowly, but it's barely measurable. After six months on the International Space Station, an astronaut would have aged about 0.005 seconds less than her family on Earth. A Nascar driver is going to experience a third of a nanosecond less time than its audience. Don't stock up on fast cars in order to get younger, such an effect becomes only important when you're approaching the speed of light.

May also wrote another song, "Long Away," haunted by the same feelings of loss and nostalgia as "'39." Both time and space are of the essence here: "who know when now" and "who know where" are two sides of the same coin. If you pack your suitcase and leave this place, you might end up as a 'new child'. I see this song as a certain twin to "'39," talking about a long way behind the people who embarked on a sad sacrificial journey. The same can be said for "All Dead, All Dead": if the "'39" narrator's wife is long dead, he's really "old but still a child."

Traveling close to the speed of light made the space travelers age just around a year, while everybody else had grown old and died. Like *Interstellar* (Christopher Nolan, 2008), "'39" tells a story about an astronaut leaving everything behind, and coming back still young, while everybody else has grown old. Communication was probably impossible because of weak signals, which meant that everything they could have sent would just end up as "letters in the sand,"

For everything mentioned to work, science needs to treat space and time like a single phenomenon or entity: spacetime. The narrator in "'39" is aware of that, telling his loved one she's *many years away*. This might be taken both literally, since light years are measures of astronomical *distances*, or as the other side of the coin, being aware that time passes differently for her and for his daughter.

Keep Yourself Alive

What if the astronauts were away for what the people on Earth would perceive as thousands of years? In your lifetime, you don't have proper time to visit the far side of the Milky Way, and go back to report it to your children, since it would take you over one hundred thousand years for such a trip. But who was right, did it take you one hundred thousand years or just a couple of months?

It seems that there's no correct answer. However, there's one important question here: can we talk about them existing at the same time at all? In philosophical *presentism*, it is thought that neither the future nor the past exists. All that exists, all that's physically real is the *present*, a system of events simultaneous to each other. However, even if you were to know everything there is, according to the special theory of relativity, you wouldn't know what that system is. Freddie and Brian

might see events A, B, and C unfolding in different orders, and no one is right here.

On the other side of the ring, there's *eternalism*, which seems to better fit the findings in physics. Such a philosophical approach takes the view that all of existence in time is equally real. There's nothing like an *objective* flow of time. Many philosophers have argued that the special theory of relativity implies eternalism. But the advent of relativity wasn't the first thing to trigger such a philosophical concept.

For example, in some philosophical doctrines of *fatalism*, every statement about the future exists, and it's either true or false. In the words of *Who Wants to Live Forever*, it's all "decided for us." In special relativity, different observers experience the so-called *relativity of simultaneity*. Dr. May spying on us is going to see a different trajectory of a light beam than we would in our spaceship, but neither one of us is in a privileged position.

Even though eternalism is often embraced by physicists, there's something counterintuitive here. You would feel it weird stating that Socrates exists right now. One of the standard answers to this problem is to state that 'exists' means existing in a general sense, without assuming some temporal location.

There's also one philosophical alternative, which seems to be more aligned with our general common sense. The *growing block view* states that the past and present both exist, while the future does not (yet). Imagine as if you had a huge spotlight, and you would gradually increase its range and shine over more and more objects, that is more and more spacetime would come into being.

If you believe in presentism, you'd probably embrace the concept of *endurantism*: if an object persists through time, it needs to exist completely at different times. But if you support eternalism, then if a thing ex-

ists in time, it has to exist in a continuous reality. In a doctrine called *perdurantism*, an object is an aggregation of all your temporal parts: all of your past, present and future selves.

This might seem like a difficult concept, but it's rather intuitive: I consider my past self myself as well, and my identity now is an aggregation of all my previous experiences as well. Rarely would we consider ourselves being just what we are at the moment, but let's leave some hope for turning over a new leaf.

There are some interpretations stating that "'39" is about time travel, which doesn't seem to be the case, but we might see it as an interpretation. We're all familiar with time travel stories, but philosophy was also intrigued whether that's logically possible. If you could go back in time, you would be able to kill your grandfather before your mother was conceived, and that would lead to a famous paradox. Do note, if presentism is true, then neither past nor future objects really exist, so there's no time travel.

One other common argument is the concept of backward causation where an effect precedes its cause in time: your usage of a certain time-travel machine would make you pop out of nowhere somewhere in the past or the future! However, it seems that many physicists and philosophers believe that what we know about the laws of physics is actually *compatible* with time travel.

Another World

May's astrophysical and musical duality does not end with Queen. In his "Another World," there's a main motif of parallel universes, "across time and space," while the single named "New Horizons" was inspired by the eponymous space mission and the man's indomitable spirit eager to explore the universe around him. May has famously stated that music is about

internal life and being able to touch each other, while astronomy is the opposite: instead of looking inwards, we're looking at things beyond our grasp. Our goal is that, after reading this book, you have a strong feeling that philosophy does the same, and notice May's wondrous ability to illustrate the strangest concepts of modern philosophy of science with ease.

Current philosophical theories of time and space need to take physical findings into account. But vice versa should be valid as well. Even though you're just a bunch of elementary particles interacting, we can talk about a *human being* since we perceive a man made of atoms different from the atoms external to it, such as the air around you or the ground you're standing on. Human intuition, perception and experience are also a part of philosophy, no matter what the underlying physical mother theory seems to be.

If one day neuroscience shows with complete accuracy that the human mind is a combination of neurons and that's it, you'd still feel as if you're something other than *just* that. The same goes for fundamental concepts of time and space in physics and philosophy, two disciplines strangely connected, in this case, with music.