No Time Like The Present

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Thanks, Mouse, for the title suggestion!

I can't stand it. It is all over the news. It's exciting to others, but not to me. To me, it's painful, and doubly so. Why did they have to choose today - today of all days - for the first human attempt?

I remember it as if it had indeed happened today. First Mia, then the old man. And it all started with me, some thirty years ago. It's all my fault.

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"Wake up, everyone!"

That was his way of greeting his students. Professor Flintholm was a very funny guy. A great physicist, an amazing instructor, my thesis advisor, father of my future wife and, above all, a good friend. He once told me never to thank someone for his or her friendship, because friendships aren't given - they're earned.

"So, last time we saw how Einstein's field equations are derived from a variational principle by choosing the Lagrangian density to be proportional to the scalar curvature. Today, we'll look at some of their properties."

"From R i k minus one-half of g i k R equals T i k, we can contract the tensor indices to derive a purely scalar result."

"Excuse me, Professor?", I interrupted.

"A question, Will? You know you're not allowed to ask questions. You're supposed to know this stuff already", Flintholm said, with a smile. I blushed.

"Go on, ask it. You know I'm joking. You should know I'm joking."

"Well, I get that the contraction makes the scalar curvature equal the trace of the energy-momentum tensor. Outside of any mass or energy distribution, then, the scalar curvature vanishes. That's the part that always bothers me. I wonder if there's a way to keep it from going to zero in empty space."

“Interesting thought, Will. I suppose...”

And then it happened.

I could see his brain shifting into overdrive, as clearly as if I had X-ray vision. His expression changed from that of a smiling prankster to that of a man deep in thought, absorbed by the realization that he had solved a problem long occupying the recesses of his mind. It took him all of ten seconds. As it often does to people of great intellect, the solution came to him all at once, fully formed. Yes, there were details to be worked out, and it would take time to figure them out, but they were just that, details.

“I am very sorry, everyone, but we will have to adjourn early today. I need to go now.”

And, with that, he left the classroom. The rest of us stared into each other, WTF stamped on our faces. This, it turns out, was a moment to remember. This is where it all started.

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I joined Flintholm in his office a short while later.

“What happened?”, I asked.

“How would you like to teach GR for me?”

“Say again?”

“You’re teaching GR for me. It’s time you challenge yourself with more difficult courses, Will. I’ve seen some of your E-and-M lectures. You’re a good instructor, and you know GR well enough to teach it.”

“Say again?”, I repeated, still in shock.

“Wake up, Will”, he said, snapping his fingers in front of my face. “You’re teaching GR this semester.”

“I... can’t!”, I replied, finally out of my trance. “It’s one thing to teach undergraduate electricity and magnetism but it’s a totally new ballgame to teach graduate intro to general relativity.”

“Nah... You’ll do fine. As I said, you’re a good instructor. I wouldn’t be handing the course to you if I didn’t think you could do it well. It will be good for you.”

“Is it even possible? I mean, legally. I mean, I’m just a grad student.”

“Will, stop blabbering. You’re not just a grad student; you’re almost done with your doctorate. This is intro to GR we’re talking about. It’s not like you’re taking on students under your wing. Besides, I’m the Institute’s director, remember? I can make it happen. And I’ll supervise. Chop, chop now. Much to do.”

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In the months that followed, I did as he had asked. I taught his GR course, and did it well too, to my surprise. The old man was right, as he always was. I did have a gift for teaching and I knew the material well enough.

We continued to meet regularly, of course. It was one thing to pass his course to someone else, but he couldn't just drop me off on the curb. I was working towards my doctorate and Flintholm knew the negative impact it would have on my career if he stopped advising me.

Occasionally, he would bounce ideas off me or I would see some of his work on the board, and I started to understand what it was that he was working on. I couldn't believe it when I put the pieces together.

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I married his daughter, Mia, four years later. Flintholm had already been much of a father to me in many ways, and I always felt that he looked at me as his son, but now it was made official.

On our wedding day, the old man pulled me aside after the cake-slicing ceremony and said the three most amazing words I had ever heard: "I did it."

Just as there was a time before the moon landing and a time after it, I knew that the world had changed once again. Only now we could go back to experience the time before the change, if we so desired.

Flintholm had figured out how to make time-travel possible.

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It took another two decades to complete his work, to verify his equations, to build the device. And then it happened.

On the day of the first full-power test, Mia drove the old man to the facility where the device was being built. She never made it back home alive.

For many years since I kept telling myself that it had just been a stupid accident, but the truth is that had I not asked my question back in that GR lecture so many years ago, no time-machine would have been built, and Mia would not have had to drive the old man to the lab. She would have been safe then. It really was my fault.

Mia's death caused me a great deal of pain, for I loved her with all my heart. She had many of her father's gifts, particularly that of being funny. She made me laugh. She brought light to my soul. However, my pain was not comparable to the old man's. His wife had died years before and Mia was his only daughter. Mia was everything to him. So much so that her death caused him to withdraw from everything and everyone, even from me. He left the project and essentially died along with her, only his body kept breathing.

Not even a year passed and he too was gone.

I was all alone now, and my soul was dark and cold. I remained attached to the project, with only one goal in mind, only one idea consuming me day and night: to go back and prevent her death.

Not for me, of course. I knew I could never have her back. No. If my plan succeeded, I would have saved her for my younger self, and for the old man. Madness? Perhaps. It didn't matter, though. I had a time-machine. All I needed to do was seize the opportunity when the right moment presented itself.

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"Good morning, Dr. Toussand. It's unusual to see you here so early, but I'm not really surprised, not today", said the guard at the gate.

"Good morning, Paul. Yes, a bit early today. Have much to do, much to do, with the big test and all", I replied, trying to keep it casual. Paul seemed none the wiser.

I parked my car in the usual spot, walked calmly to the building, despite my pounding heart, then made my way to the control room. At this early hour, the entire building was deserted. Approaching the main console, and after a quick status check, I entered my calculations and turned on the machine. I had at most two minutes after the alarm sounded. I knew the place would be swarming with guards and I had to act quickly. I took a deep breath, stepped onto the pad, thought of Mia, and waited what felt like an eternity.

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The transition is surprisingly bland, nothing like what movies had repeatedly shown. No sparks, no deafening noises, no shaking. Just a Planck's moment of darkness, like the hand of a clock jumping from one second to the next, without moving in between.

When my consciousness came to itself, I found myself in the wrong place. I had made my calculations so that I'd come to be at our house a few hours before Mia's accident, but I appeared elsewhere. Due to the intertwined nature of space and time, traveling in time also meant traveling in space, and vice-versa, so the fact that I had arrived at the wrong location in space could only mean one thing: I had also arrived at the wrong time.

How could that be? I had checked and rechecked my calculations numerous times. I knew Flintholm's theory as well as he did, I understood all the assumptions, I was intimately associated with the project to build the device. I could not have made a mistake.

The only explanation I can think of is that the universe has a means of interfering to preserve the timeline. The old man and I had discussed that possiblity a few times and we agreed that there might be quantum corrections to his equations that might have that effect. However, all our theoretical models and our tests seemed to indicate that those corrections would be negligible for short time-jumps.

Yet, there I was, at the wrong place and the wrong time. But not all hope was lost.

As it turns out, I had arrived years earlier, in fact just a few hours before that fateful GR lecture that started it all. I could still save Mia, I could still save the old man. All I had to do was to prevent myself from asking him about the scalar curvature in empty space.

I made my way to the Institute and caught up with my younger self just moments before he was entering the building.

“Will? Will Toussand?”, I approached him.

“Yes? Can I help you?”, my younger self replied.

“Hello Will. I’m an old friend of Henry’s, sorry, Professor Flintholm, and he asked me to ask your help with something.”

“Yes, of course. What can I do for you?”, my younger self offered. I knew he would be so helpful. I was always the eager-to-help kind.

“Well, can I ask you to come with me to the Astronomy department? I need a favor.”

“I have a lecture to go to, but I suppose I could skip it. After all, it’s not like I don’t know the material already.”

“Yes, yes, so Henry keeps telling me. He’s very fond of you, you know. In fact, I bet he wants to have you teach his GR course some time.”

“No, no, I couldn’t do that. I’m not ready for it.”

“You’d be surprised, son, you’d be surprised”, I said, with a smile.

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And so it was that I changed the past, by preventing myself from giving the old man the inspiration that culminated in the time device. It came with an unforeseeable side effect, however. I learned some time later that I am now dying of cancer. I don’t expect to live to see the end of the year.

Is this also part of the universe’s way of balancing things out? After all, I am a body of mass and energy that doesn’t belong to this timeline.

No matter. At least I know that my younger self and Mia will have a future together. At least I know that the old man won’t suffer the terrible fate of outliving his daughter.

Besides, who needs a time-machine anyway? No. Life is good, cancer and all.

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“You weren’t in the lecture today”, Professor Flintholm said when I entered his office.

“I was helping your friend Bob.”

“Bob who?”

“Bob, your old pal, you know. You did your undergraduate together.”

“There was never a Bob while I was an undergraduate student, not that I remember anyway. What is this? Are you trying to trick me? You know I’m the prank meister here.”

“No, no, never mind. So, how was the lecture today? Did I miss anything?”

“No, nothing unusual. Covered some properties of the field equations, the Bianchi identity, and started talking about Killing vectors. But I did have a very exciting idea afterwards and, if I’m right, it will change the course of history. How would you like to take over my GR lectures?”

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For the interested: Einstein’s Field Equations

The part of the story at the beginning, where Prof. Flintholm is talking about deriving Einstein’s field equations from a variational principle, is entirely accurate, as are all other technical sections of the text. For the record, though, the fact that the scalar curvature vanishes in empty space has nothing to do with time-travel.

General Relativity, currently our best theory of gravity, is described by ten separate equations. There is this quantity - called the *metric tensor* - which describes the geometry of spacetime, and has ten separate components. It is this quantity that one seeks to solve for when “solving Einstein’s field equations” and it is also this quantity that describes the gravitational field of whatever mass or energy distribution one has.

The field equations themselves (sans the so-called *cosmological-constant term*) look like this:

$$R_{ik} - \frac{1}{2}\, g_{ik}\, R = a\, T_{ik}\,,$$

where g_{ik} represents a particular component of the metric tensor. The i and k are indices that serve to enumerate the various components. Each index runs from 0 to 3, so there are 4 x 4 = 16 components. However, some of these are equal to one another and the end result is that there are only ten independent components.

R_{ik} is a particular component of something called the *Ricci curvature tensor* and R is a number called the *scalar curvature*. They both depend on the metric tensor in complicated ways, so the field equations shown above are actually far more complicated than they look.

T is the so-called *energy-momentum tensor* and T_{ik} is one of its ten components. Finally, a is a constant, a combination of Newton's gravitational constant and the speed of light.

The energy-momentum tensor describes the distribution of mass and energy that causes the gravitational field. For instance, it could describe a source of mass and energy like the Sun.

The gravitational field, in Einstein's theory, is interpreted as a curvature of the spacetime surrounding the distribution of mass and energy in question. That's why the left-hand-side of the field equations has terms involving the curvature tensor and the scalar curvature. In essence, then, Einstein's theory of gravity - General Relativity - states that

$$\text{curvature} = \text{mass and energy distribution}\,,$$

that is, that the presence of mass and/or energy in some region of spacetime causes a particular kind of deformation of the spacetime surrounding that region. Another part of Einstein's theory then describes how other objects move in that deformed region.

For instance, the field equations tell us how the presence of the Sun curves spacetime around it and this other part of Einstein's theory tells us how objects like the Earth and other celestial objects move - their orbits - in that curved region of spacetime.

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