

Albert Einstein's Theory of Relativity

In Words of Four Letters or Less

[0]

So, have a seat. Put your feet up. This may take some time. Can I get you some tea? Earl Grey? You got it.

Okay. How do I want to do this? He did so much. It's hard to just dive in. You know? You pick a spot to go from, but soon you have to back up and and go over this or that item, and you get done with *that* only to see that you have to back up some more. So if you feel like I'm off to the side of the tale half the time, well, this is why. Just bear with me, and we'll get to the end in good time. Okay?

Okay. Let's see....

[1]

Say you woke up one day and your bed was gone. Your room, too. Gone. It's *all* gone. You wake up in an inky void. Not even a star. Okay, yes, it's a dumb idea, but just go with it. Now say you want to know if you move or not. Are you held fast in one spot? Or do you, say, list off to the left some? What I want to ask you is: Can you find out? Hell no. You can see that, sure. You don't need me to tell you. To move, you have to move *to* or *away* from ... well, from what? You'd have to say that you don't even get to use a word like "move" when you are the only body in that void. Sure. Okay.

Now, let's add the bed back. Your bed is with you in the void. But not for long -- it goes away from you. You don't have any way to get it back, so you just let it go. But so now we have a body in the void with you. So does the bed move, or do you move? Or both? Well, you can see as well as I that it can go any way you like. Flip a coin. Who's to say? It's best to just say that you move away from the bed, and that the bed goes away from you. No one can say who's held fast and who isn't.

Now, if I took the bed back but gave you the *sun* -- just you and the sun in the void, now -- I'll bet you'd say that the sun is so big, next to you, that odds are you move and not the sun. It's easy to move a body like ours, and not so easy to kick a sun to and fro. But that isn't the way to see it. Just like with the bed, no one can say who's held fast.

In a word, you can't find any one true "at rest". Izzy was the one who told us that. Izzy said that you can't tell if you move or are at rest at any time. You can say that you go and all else is at rest, or you can say that you are at rest and all else goes. It all adds up the same both ways. So we all knew that much from way back when.

Aha, but now wait! The sun puts off rays! So: why not look at how fast the rays go past you? From that you'd see how fast you move, yes? For you see, rays move just the same if what puts them off is held fast or not. (Make a note of that, now.) Izzy had no way to know that, back then, but it's true. Rays all move the same. We call how fast that is: *c*. So, you can see how fast the rays go by you, and how far off that is from *c* will tell you how fast you move! Hell, you don't even need the sun for that. You can just have a lamp with you -- the one by your bed that you use to read by. You can have that lamp in your hand, and see how fast the rays go by you when you turn it on. The lamp will move with you, but the rays will move at *c*. You will see the rays move a bit more or less than *c*, and that will be how fast you

move. An open-and-shut case, yes?

Well, and so we went to test this idea out. Hey, you don't need to be in a void to do this test. We move all the time, even as we sit here. We spin, in fact. So they shot some rays off and took note of how fast they went east, and how fast they went west, and so on. Well, what do you know? The rays went just as fast both ways. All ways, in fact. They all went at c , just the same. Not an iota more or less.

To say that we were less than glad to find that out is to be kind. It blew the mind, is more like it. "What is up with *that*?" we said. And here is when old Al came in.

[II]

Old Al, he came out the blue and said, "Not only do rays move at c if what puts them out is held fast or not: they move at c even if *you* are held fast or not." Now that may not look like such a big deal on the face of it, but hold on. What this says is that you can move as fast or as slow as you want, and rays will go by you at c all the time. You can have a pal run past you and when you both look at a ray go by at the same time, you will both see the *same* ray go by at c ! That is a bit wild, no? You, back in that void, you just can *not* say if you move or not -- with the lamp or no. Not that you can't tell: it can't be *said*. It's moot!

But for that to be true, then *time* also has to get in on the act. For you and your pal to see the same ray go by at the same clip, her idea of time must be off from your idea of time!

I can hear you say, "No way. That *can't* be!" But I tell you it is. Old Al said so. He said, here, I'll show you. Get a load of this. We have Bert and Dana. Take a bus, and put Bert on the bus. The bus goes down the road. Dana, she sits here, on the side of the road. He's in the bus and she's on her ass. And now take a rock off of the moon, and let it fall at them. It hits the air and cuts in two. The two bits burn, and then land just as Bert and Dana are side by side. One hits the dirt up the road a ways, and one hits down the road a ways. Dana sees each rock at the same time, but Bert sees one rock and *then* sees the next rock. Now: if Bert and Dana both see Dana as the one who is "at rest", they both will say that the two bits came down at the same time. Dana will say, "I am 'at rest', and I saw them both land at the same time, so they both did, in fact, land at the same time." And Bert will say, "I move away from the rock *down* the road, so when I add that fact in, I can see that if I were 'at rest', I'd have seen both land at the same time. So it must be the case that they did land at the same time." Okay, but what if Bert and Dana now see *Bert* as the one who is "at rest"? Eh? You get to pick who is "at rest" and who isn't, no? So make Bert be "at rest". Now Bert will say, "I am 'at rest', so the one up the road beat the one down the road, on the way to the dirt, just the way I saw it." And Dana will say, "I saw them land at the same time, but I move away from the rock *up* the road, so when I add that fact in, I can see that the rock up the road must have beat the one down the road."

So you see, when you give up on the idea of a one true "at rest", then you *have* to give up on the idea of a one true time as well! And even that is not the end of it. If you lose your one true way to see time, then you also lose your one true way to see size *and* your one true way to see mass. You can't talk of *any* of that, if you don't also say what it is you call "at rest". If you don't, then Bert or Dana can pick an "at rest" that isn't the same as what you used, and then what they will get for time and size and mass won't be the same.

What a snag, eh? I hope you can see how that gave some of them the fits, back when old Al told us that one. But even so, that ain't the half of it. I mean, most of us know that if old Al had got hit by a bus at age ten, we'd have got this far on our own in good time. No, it was what came *next* that was the real slap in the face.

[III]

Now, I've said a lot here on how to see (or how not to see) how fast you "move". What I need to tell you now is just what I mean by that word "move". When I say "move", I also mean that you don't slow down or get sped up at any time, *and* that you don't veer to one side at all. When you move, you just keep all that the same as you go. How we say it is, you don't have any "pull". Why do I make a big deal out of that, you ask? Okay, let me tell you.

Cast your mind back to Ari, from way way back when. He's the one who said that if you are at rest, you tend to stay at rest, and if you move, you tend to come to rest. He was off, you know, as he had no way to know that it was the air that has you come to rest. We had to wait a long time for Izzy to come by and say, "No, Ari: if you move, you tend to just go on and on. To come to rest, you need to have a *pull*." The air will give you a pull, a pull that has you come to rest. Then we also have the big pull, the one that says what is down and what is up, the one that has all of us in its grip. Izzy saw that this pull was the same pull that has the moon in its grip, too. I said that a pull can be a veer, yes? That is what the pull on the moon does. The moon has to veer all the time for it to stay with us. Were it not for that pull, it'd just go off in a line -- no veer -- and we'd just sit here and wave bye bye. Same with us and the sun. We veer, each hour, or else we'd get real cold real fast.

But then, see, Izzy had to deal with the way that the pull acts. If a body has more mass, then it also has more pull, yes? That is why the sun is the axis we spin upon, and we are not the axis for the sun. But then why can't it go both ways? You take your ball of lead and your ball of wood and drop them, they land at the same time. But the lead ball has more mass, so it must get more pull. Izzy said, "Well, see, a body has one *more* kind of pull. This pull is such that it will want to stay put all the time. And the more mass it has, the more it will want to stay put. That pull is the 'a body at rest will tend to stay at rest' part of the deal. So you see, that pull and the big pull are in a tug-of-war, and they work out so that any mass will fall just as fast."

I call it a "new kind of pull", but it isn't so new: you feel it all the time. Get in a car and step on the gas -- you feel a pull back into your seat. Let up on the gas a bit, and the pull goes away. Make a left, and you feel a pull to the side. Stop, and you feel a pull out of your seat as you slow down. Or, go to the fair and get on a ride. As you spin, you feel a pull out, away from the ride. You spin: that is to say you veer, and veer and veer and veer, just like the moon. If you had no seat belt, you'd fly off the ride, and you'd fly off in a line. (Well, that is to say, you'd fly off in a line as a bird sees it. To be fair you'd also arc down at the same time. But put that to one side.)

Okay but now, see, old Al's big idea did not work when you look at pull. Go back to when you were lost in the void. You can't say if you move or not, yeah, but you sure can say if you have a *pull* on you or not. If you did, you'd feel it, no? Sure. So then you have no one true "at rest", no one true way to look at time, or mass, or size, but you *do* have one true way to look at a pull? Old Al said, "Erm. I don't buy that." We all said, "Aah, why not? Just give it a rest, Al." You can see why Al did not want to give it a rest, I bet. But this one was not such an easy nut.

[IV]

Izzy once said, Look here: say you have a disk that can spin, and so you put a pail of milk on it and you make it spin. You will see the milk go up the side of the pail, and fly over and out onto the disk. No big deal, eh? The spin will make a pull. But now what if you said that the pail of milk is your "at rest"? Then you have you and the sky and all that in a big huge spin, and the disk with its pail of milk is the only body that is "at rest", yes? How can you say then why the milk goes up? What can make the at-rest milk fly out of the pail like that?

This is why Izzy came to say: Yes, we have no one true "at rest", and when you move, some may say you do move and some may say you don't, and that is okay -- but not so with a pull! A pull is a pull, damn it.

But old Al's mind was set. And he had a big clue that that was not the full tale. I told you that Izzy put a new kind of pull next to the old kind. Well, even he felt that this new pull was a tad bit odd. Not to put it down, mind you -- just that this new kind of pull was so much like the old kind of pull in a lot of ways. You know? Say I put you in a box, and then put that box out in a void. (But this time I don't need to have you in a true void. I just want you to be well away from any pull. You can have a star or two, or as many as you like, as long as you keep them far off. Okay?) Now, say I tied a rope from the box to a ship, and then I got in that ship and sent it up, so that it went fast, and more fast, and more fast ... I just burn up fuel as long as I have any left. As long as I see to it that you get sped up all the time, and at the same rate, you will feel a pull that will feel just like the pull you'd feel if you were back here, at home. If you have a ball of lead and a ball of wood in that box with you, you can drop them and they will both land at the same time. That is a bit odd, no? Puts a bug in your ear, yes? You can bet it put bugs in our ears. But no one had come up with a good way to say why that was so. Not yet.

Old Al, he took that ball and ran with it. He went off for a year, and then ten more. Yep. That long. This was no walk in the park, let me tell you. In fact, some of us said that it was more like a walk off the deep end! For you see, when old Al came back, he said, "This 'new' pull that Izzy gave us, it is just the old pull. Not just *like* it. It *is* it. The two are one and the same. And from this, you will then see that we have no 'one true pull'."

Do you see what he said, here? When you are in that box with the rope on the ship, the pull you feel won't just *act* like the pull back home: it is in fact the same *kind* of pull! So when you say, "Hey! What if I want this box to be my 'at rest', huh? What then? Why does this ball fall down if I'm at rest and all?" -- old Al will say back at you, "Well, you see, you have this big old *void* that goes by, and gets sped up all the time, and *that* has a pull on you and your box." You'd say, "Get out of here! The mass in this void is too far away to give me that big of a pull!" But old Al'd say, "Nope. You don't get it. How much mass you have in your void is moot. It's the fact that it's *all the mass in the void*. All of it but you and your box, that is."

Same with the milk in the pail. If you say that the pail is at rest, then old Al will say that the spin of all else will pull on the milk, and make it jump out over the side.

So here is what we get when we boil it all down. Izzy said that you can't tell if you move or are at rest at any time. You can say that you go and all else is at rest, or you can say that you are at rest and all else goes. It all adds up the same both ways. But old Al then said not only that, but that you can't even tell if you have a pull on you or not. So, at no time, in no way, can you act so that you can't be seen as "at rest". You can go this way or that way or jump up or down or what have you: even so, you can say that you are at rest -- and it will all add up just the same.

This was the big one for old Al. He'd like to jump for joy, it all came out just so. But the rest of us, well, we felt more like it was time to lock Al up, what he said was so wild.

[V]

So some of us said, "Al, you are mad. Look here: you want to make this pull, this pull that we need to keep next to the sun -- you want to make this very real pull into some kind of *fake* pull! I mean, what kind of pull is it that can go away and come back as you pick what to call your 'at rest'? That is no way for a pull to act." And old Al said, "Yeah, you hit the nail on the head. It *is* a fake pull." And we said, "Okay, that is it. You, Al, have lost it." And old Al said, "Feh. Read this and weep." And we read it, or we gave it a try, more like. It was a real mess. Some of us got it, but most of us just went, "Huh?" And some of us said that even if it was true, we'd just as soon stay with the old lie, Al's idea was so hard to make head or tail of.

But Herb -- what? No, Herb isn't his real name, but I like to call him that -- But so then Herb was one of the ones who got it, and he went in with old Al and his new idea, and what they came up with goes like

this.

You know all the ways you can move, here. You have your up-and-down, and you have your east-and-west, and you have your fore-and-back. Well, Herb had said, we want to add one more way here: time. Yeah, time as just one more way to move in. Four ways, all told. And now Herb and old Al said, "Let's take a look at what we can do when we look at here as a four-way here. Like, what if this four-way here can be *bent*? We don't mean that what is *in* a four-way spot gets bent: what if the very *spot* gets bent?" Some of us said, "You two have got bent, is more like it." But they said, "Ha. Get a load of this."

They said, what if mass puts a bend in this four-way here of ours? The more mass you have in one spot, the more bent that spot gets. So now pick out a spot A and a spot B, one on each side of some mass, and each at its own time. What does it look like when a body goes from A to B? You will say: A line. Well, yes and no. It *is* a line, but it's also bent, as it goes past the bent spot. You see, this line will only look like a line if you can see all four ways! If you can't see one of the ways, if for you the way you can't see is what you call *time*, then you will see it as a line with a big old *veer* in it, half way in. Now, take a lot of mass, as much as our sun has, and pick spot A and spot B to be near the mass, and to be the same spot but for the time. Well, when you do that, the line from A to B in the four-way here will be an arc to you and me! An arc that will spin on and on, with that mass as the axis!

"You see?" old Al said. "*You* say that the sun has a pull, but when we spin with the sun as our axis, in the bent-up four-way here we just move in a line! We don't veer off at all! *That* is why I say that your pull is a fake pull. You don't need any pull if you just want to stay on a *line*!"

A few more of us got it, then. But most of us just said, "What are you two *on*? Put down the bong and get *real*! This is way too wild to be true." But they just said, "Just try and see if it isn't true."

So we came up with ways to test old Al's idea, and each time Al hit the gold. His idea had the sun's rays a tiny bit more red than what Izzy said. They were. His idea put Mars a tiny bit off from how Izzy had Mars. It was.

The big one, the one that got told over and over, was the one with the dark-at-day time. You know, when the moon gets in the way of the sun. At that time you can get a real good look at a star when it's up next to the sun. (Next to it in the sky, that is. Not next to it for real. You know what I mean.) They went off and got a good look at a star that was very near the sun, and then they used a book to see just what spot that star was in. You see, the rays from the star pass so near the sun that they get bent, on the way to us. Old Al, his idea said just how much the rays get bent. With Izzy, the rays get bent, too, but only by half as much. So they took a look at the star, and they took a look at the big book, and ... well, I'll bet you can tell me as well as I can tell you just how far off that star was.

A-yup.

And then all of us, we all just sat back and said: "*Whoa*."

And then we all went back to old Al and said to him, "Al, you must have some kind of head on you, to pull an idea like that out of thin air." We said, "Why don't you quit this dumb job you have here and come with us?" We said, "You know what, Al? We *like* you."

[end]

And that is just the way it was. (Well, that is to say, more or less.) Oh dear me, look at the time! Sigh. I do know how to run on, don't I? It must be well past time to turn in. Let me show you out. It was very nice to have you over, and I hope I was of help.

And y'all come back now, hear?

Note: "Herb" actually refers to Hermann Minkowski. (And "Izzy" and "Ari" are, of course, Isaac Newton and Aristotle.)

[Texts](#)

[Brian Raiter](#)

[Muppetlabs](#)