Dialog redaktora PT a Rovelliho RO

A - original English in English

1PT: What inspired you to write a book about time?

1ROVELLI: To work in quantum gravity, one must face questions about the nature of time. General relativity tells us that the amount of time between two events is determined by gravity, and therefore time is affected by the quantum behavior of gravity. There can be quantum superpositions of different temporal states. A clock can be in a quantum superposition of two different times. So I have been thinking about the nature of time and the many problems it raises all through my scientific life. I thought that the moment had arrived to try to connect the dots and write down what I think we do and do not understand about time.

2PT: In the introduction to your book, you argue that "the growth of our knowledge has led to a slow disintegration of our notion of time." What are some of the advances or revelations that challenge the idea that time flows neatly from past to present to future?

2ROVELLI: I cover several in the first part of the book. We have learned that time passes at different rates depending on altitude and on speed. We have learned that the fundamental equations of physics do not distinguish the past from the future. And we have learned that our very strong intuition about the present is valid only in a relatively small bubble around us; there is no objectively defined *present* in the large universe. Those are not speculations. They are established physics.Then there is the speculative research in quantum gravity that further questions the nature of time. In loop quantum gravity, for example, there is no time variable in the fundamental equations of the theory. The theory describes the relative evolution of physical variables rather than their evolution in time.

3PT: If the universe is fundamentally atemporal, what do you think explains the phenomenon that humans experience as time? Is time an illusion?

3ROVELLI: I do not think that the universe is fundamentally atemporal. The main point of the book is that there isn't a single notion of time that is either true or false. What we call *time* is a rich, stratified concept; it has many layers. Some of time's layers apply only at limited scales within limited domains. This does not make them illusions.

For instance, the distinction between up and down is not an illusion, but it has no meaning away from Earth. There is no up and down for astronauts during interplanetary travel. Many properties of time are similar. In particular, there are aspects of our own human experience of time that are very much tied to the specific way our brain works: the fact that we have memories, that we anticipate the future, and so on. It is the human brain, not fundamental physics, that determines what we call the flowing of time and the sense of the speed at which it flows.

4PT: What is your next project?

4ROVELLI: I always have too many projects going on at the same time. I am mostly focused on white holes right now. A white hole, like a black hole, is a solution of the Einstein field

equations but reversed in time. I am studying the possibility that black holes end their lives by becoming white holes.

The time from the formation of the black hole to its evaporation, transformation into a white hole, and final dissipation can be extremely long as observed from the outside but extremely short as measured from inside the hole. It's an intriguing scenario that I developed with Eugenio Bianchi and colleagues in a recent paper. If that scenario is correct, the black holes we see in the sky are stars that are collapsing and then bouncing out, but we see that in extremely slow motion because of gravitational time dilation.

5PT: Can white holes be observed?

5ROVELLI: Yes, perhaps. One hypothesis is that their formation is the cause of fast radio bursts, mysterious super-violent signals captured by radio telescopes. Francesca Vidotto and I recently suggested another possibility that I find intriguing: that small white holes left over by black holes at the end of evaporation could be stable, and they could form an important component of dark matter.

6PT: What are you reading right now?

6ROVELLI: An extraordinary book by Alexander Bogdanov, *Tectology*. Bogdanov was a great Russian intellectual at the beginning of the 20th century. His ideas anticipated aspects of cybernetics, system theory, and contemporary structural realism.

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Dialog redaktora PT a Rovelliho RO

B - original for Czech in English

1PT: Co vás inspirovalo k napsání knihy o čase?
1ROVELLI: Chcete-li pracovat v kvantové gravitaci, musíte čelit otázkám o povaze času. Obecná teorie relativity nám říká, že doba mezi dvěma událostmi je určena gravitací, a proto je čas ovlivněn kvantovým chováním gravitace. Mohou existovat kvantové superpozice různých časových stavů. Hodiny mohou být v kvantové superpozici dvou různých časů. Během celého mého vědeckého života jsem tedy přemýšlel o povaze času a mnoha problémech, které přináší. Myslel jsem, že nadešel okamžik pokusit se spojit tečky a napsat, co si myslím, že děláme a čemu nerozumíme o čase.

2PT: V úvodu své knihy tvrdíte, že „růst našeho poznání vedl k pomalému rozpadu našeho pojetí času". Jaké jsou některé pokroky nebo odhalení, které zpochybňují myšlenku, že čas plynule plyne z minulosti přes přítomnost do budoucnosti?
2ROVELLI: O několika se věnuji v první části knihy. Zjistili jsme, že čas plyne různou rychlostí v závislosti na výšce a rychlosti. Naučili jsme se, že základní fyzikální rovnice nerozlišují minulost od budoucnosti. A naučili jsme se, že naše velmi silná intuice o současnosti platí jen v relativně malé bublině kolem nás; ve velkém vesmíru není žádná objektivně definovaná přítomnost. To nejsou spekulace. Jsou to zavedená fyzika. Pak je tu spekulativní výzkum kvantové gravitace, který dále zpochybňuje povahu času. Například ve smyčkové kvantové gravitaci není v základních rovnicích teorie žádná časová proměnná. Teorie popisuje relativní vývoj fyzikálních proměnných spíše než jejich vývoj v čase.

3PT: Pokud je vesmír v podstatě atemporální, co si myslíte, že vysvětluje jev, který lidé zažívají jako čas? Je čas iluze?
3ROVELLI: Nemyslím si, že vesmír je zásadně atemporální. Hlavním bodem knihy je, že neexistuje jediný pojem času, který by byl pravdivý nebo nepravdivý. To, co nazýváme časem, je bohatý, stratifikovaný koncept; má mnoho vrstev. Některé časové vrstvy platí pouze v omezeném měřítku v rámci omezených domén. To jim nedělá iluze. Například rozdíl mezi nahoru a dolů není iluzí, ale mimo Zemi nemá žádný význam. Astronauti během meziplanetárního cestování nemají možnost nahoru a dolů. Mnoho vlastností času je podobných. Zejména existují aspekty naší vlastní lidské zkušenosti s časem, které jsou velmi svázány se specifickým způsobem fungování našeho mozku: skutečnost, že máme vzpomínky, že předvídáme budoucnost a tak dále. Je to lidský mozek, nikoli základní fyzika, kdo určuje to, co nazýváme plynutím času a smyslem pro rychlost, jakou plyne.

4PT: Jaký je tvůj další projekt?
4ROVELLI: Vždy mi běží příliš mnoho projektů současně. Nejvíce se teď soustředím na bílé díry. Bílá díra, stejně jako černá díra, je řešením Einsteinových rovnic pole, ale obrácených v čase. Studuji možnost, že černé díry ukončí svůj život tím, že se stanou bílými dírami. Doba od vzniku černé díry k jejímu vypaření, přeměně v bílou díru a konečnému rozptýlení může být extrémně dlouhá, jak je pozorováno zvenčí, ale extrémně krátká, jak je měřeno zevnitř díry. Je to zajímavý scénář, který jsem vyvinul s **Eugeniem Bianchi** a kolegy v nedávném článku. Pokud je tento scénář správný, černé díry, které vidíme na obloze, jsou hvězdy, které se hroutí a pak odrážejí, ale vidíme to v extrémně pomalém pohybu kvůli gravitační dilataci času.

5PT: Lze pozorovat bílé díry?
5ROVELLI: Ano, možná. Jednou z hypotéz je, že jejich vznik je příčinou rychlých rádiových vzplanutí, záhadných supernásilných signálů zachycených radioteleskopy. Francesca Vidotto a já jsme nedávno navrhli další možnost, která mě zaujala: že malé bílé díry, které zbyly po černých dírách na konci vypařování, by mohly být stabilní a mohly by tvořit důležitou složku temné hmoty.

6PT: Co právě čtete?
6ROVELLI: Mimořádná kniha Alexandra Bogdanova, Tektologie. Bogdanov byl na počátku 20. století velkým ruským intelektuálem. Jeho myšlenky předjímaly aspekty kybernetiky, systémové teorie a současného strukturálního realismu.

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Now the same and to that + my English comment ◊

1PT: What inspired you to write a book about time?
1ROVELLI: To work in quantum gravity, you have to face questions about the nature of time.
1NAVRATIL: So..., first of all, TIME is the least researched "thing" of all the "things" in the world, it is the least researched physical quantity. ((Professors like Kulhánek only know about her that she runs ..., nothing more)). First: "what is time"? Time is a physical phenomenon of this world, the Universe, which is even more than a physical quantity - see: http://www.hypothesis-of-universe.com/docs/c/c_300.jpg . Time - phenomenon/quantity also has three basic dimensions like space, so we will say: "time" - 3D and "space" - 3D. The

universe would have no meaning without space-time..., which is exactly the opposite of what prof. Kulhánek: without matter there is no space-time, matter is said to produce space-time. Using the phenomenon of **"Time" and Length"**, the Universe builds a basic 3+3 grid-yarn-net → , that is, a 3+3D space-time in which our Universe will "swim". (To this day, no one has investigated whether the Time-quantity also has dimensions, or why it must not have them !!). This basic the state of space-time "stands still" (like the state before the Bang), there is no matter in it, it is inert in everything, infinite, time does not flow here, the length dimensions do not expand here. Time flows until after the Bang, after which the state before the Bang changes to the state of space-time after the Bang. The 3+3D flat state (before the Bang) changes (according to the principle of alternating symmetries with asymmetries) to the state after the Bang, i.e. there **will** be a change in the infinite flat state of space-time "in a finite location" (recently called a singularity) and in this location location to "maximum distortion of dimensions" 3+3D spatiotemporal; we will perceive this locality (in the middle of the infinite flatness before the Bang) as "our Universe" and the first state will be **a foam of dimensions, a state of boiling vacuum = plasma**. Only from this moment-position time begins to pass because the "time dimension" "unfolds", the curvature of all three time dimensions unfolds ! ! !, each different, each exceptionally, just like on Earth in a stop-state "today" (dtto the space expands..., which is said to expand first by "inflation" - rapid "inflating"...; of what? "what is being inflated and where? , it is said that new points=intervals of space in the "spatial grid" were created by the "blowing up. (but no new intervals were created on the time dimensions...?!)

The curved location 3+3D finite (our Universe) "floats" in the non-curved grid-grid 3+3D infinite, then the unfolding of time dimensions begins here and we perceive this as the flow of time. In stop-states from Třesk, the ratio of the unfolded dimensions of length to time is not the same everywhere. This means that the "point" moves in the unfolding space-time ***v < c** , so $\mathbf{v^3 < c^3 = 1^3/1^3}$ * A point from curved space-time moves in a non-curved space-time grid. So it can also be said that <time does not flow to us, but we - the material object - flow to it, we flow = we move through time> - along the time dimension and... and thus we cut off time intervals on the "standing" time dimension... No one has yet proven that the rate of time is still the same from the Big Bang to today, so it is universal for every place in the universe. No one has proven that $\mathbf{t_1 = t_2 = t_3}$ applies on Earth and that $\mathbf{t_1 = t_2 < t_3}$ can also apply on Earth, ...which is commonly shown in STR when time dilates only in the direction of movement of the body away from us. (by the way: the curvature of time dimensions **x/ ($\mathbf{t_1 . t_2}$)** then manifests itself as gravity). *3+3D space-time web (pre-Bang and post-Bang) is flat and infinite. Then, after the Bang, crooked states 3+3D → fields and arbitrary assemblies of matter float and interact in it as "entwined"* ***packages from tangled dimensions of space-time****. In my opinion, the "dimension of time stands still" (flat in that basic grid) and we run "along it", along the time dimension, along the length dimension... (on a photon, time also "stands still", i.e. the photon "flies" at the same speed as expands spacetime, i.e. both time and space "stand" in relation to the photon as it stands in relation to space-time....etc. etc.* Other descriptions are elsewhere. General relativity tells us that the time between two events is determined by gravity, here on Earth. I'm not sure if also in interstellar space or intergalactic space the time-interval between two events is determined by gravity???! In every historical period since the Big Bang, the global gravity has been different - different, and therefore the statement that *time = pace of passage of time is determined by gravity*???., **1ROVELLI** and therefore time is affected by the quantum behavior of gravity. There can be quantum superpositions of different temporal states.
1NAVRATIL:?? what-what "time states" are something independent of matter and gravity and such? Shouldn't we have been talking about the "pace of time"? in different states of

space-time curvature and different mass-field distribution density ?? A clock can be in a quantum superposition of two different times. Not the clock. A clock is not "time", a |||a clock is a mechanism that MUST tick at the same chosen intervals of time throughout the universe.
1ROVELLI: So all my scientific life I have been thinking (me too Mr. Rovelli) about the nature of time, (me too Mr. Rovelli) and the many problems it brings. I thought it was time to try and connect the dots and write what I think we do and don't understand about time.

2PT: In the introduction to your book, you claim that "the growth of our knowledge has led to the slow disintegration of our concept of time." What are the advances or revelations that challenge the idea that time flows neatly from past to present to future?
2NAVRATIL: No revelations that time flows (After the bang) in this sector/quadrant of the Universe with one arrow of time in the direction "there" (other than from the past to the future), there are none! But the passage of time exists in the opposite way, in the anti-world, i.e. in the second quadrant = the anti-world of this Universe ((only in my HDV the vision and "curving" of dimensions (packaging) of time in both directions is demonstrated, in the microworld, once "in direction of the flow of the arrow of time and once the other way around".))
2ROVELLI: I deal with several in the first part of the book. We learned that time passes at different speeds (the word "speed" is inappropriate. Use the "pace" of time) depending on altitude and speed. We found that the basic equations of physics do not distinguish the past from the future. And we've learned that our very strong intuitions about the present only apply in a relatively small bubble around us; there is no objectively defined presence in the vast universe. This is not speculation. It's established physics. Then there is the speculative research into quantum gravity, which further casts doubt on the ?? nature of time. For example, in loop quantum gravity there is no time variable in the basic equations of the theory. The theory describes the relative evolution of physical variables rather than their evolution over time. I can't comment, I don't understand "quantum gravity". (According to my feeling, this is probably about "straightening the nonlinearity of gravity by "quantizing" it...that would be a fraud on PRINCIPLE, of course!)

3PT: If the universe is fundamentally simultaneous, what do you think explains the phenomenon that humans experience as time? Is time an illusion?
3ROVELLI: I don't think the universe is fundamentally contemporary.
3NAVRATIL: The position of the Observer is basically a "stop-state" both in position and in the flow of time...; and essentially in that "unfolding space and unfolding flow of time" one can """relatively""" declare that "we stand still and time flows around us, or even that time stands still (it is a dimension in a standing grid -surprise-networks of 3+3D Euclidean space-time and we flow through it, we move along the "stationary dimension of time and with our shift we carve out intervals on the time dimension - we then perceive this as "our time, our passage of time".).
3ROVELLI : The main point of the book is that there is no single concept of time that is true or false. Of course, this can be said about the whole of physics and not only about time... What we call time is a rich stratified concept, it has many layers. Some of the time layers ?? it only applies on a limited scale within limited domains. Only man has created "layers" in the psyche. That doesn't make them an illusion. For example, the difference between up and down is not an illusion, but it has no meaning outside of Earth. (up or down means "from stronger gravity to weaker gravity - and that's immeasurable in the middle of space.
3NAVRATIL: But it still applies. Similarly, the rate of passage of time in the axis of motion from the direction perpendicular to the motion is immeasurable. The rocket commander as “v” approaches "c" is said to age more slowly in all three directions, but this is not true. It

should age more slowly only in the axis of movement, see STR. Which is nonsense. The rocket commander doesn't age any slower for himself. There is no up and down movement for astronauts during interplanetary travel. (*)
3ROVELLI: Many properties of time are similar. (*) In particular, there are aspects of our own human experience of time that are largely connected to the specific way our brain works O.K. For example, the human brain does not perceive that time runs in three directions differently - at different rates, because the difference is slight, imperceptible. Similar to if a person were in the middle of space and there he would not perceive the difference in the force of gravity in three directions. That is why man on earth considers time, the passage of time to be the same in all directions. : the fact that we have memories, that we predict the future, etc. It is the human brain, not basic physics, that determines what we call the flow of time and the sense-direction of the speed-pace at which it flows.
3NAVRATIL: In every historical period since the big bang, time may have passed at a different rate, no one has ever found that out. We even assume that the pace of the passage of time is the same even today from everywhere, in a stop-state throughout the universe. However, time runs differently in a black hole than in a photon... right?

4PT: What is your next project?
4ROVELLI: There are always too many projects going on at the same time. Right now I'm mostly focusing on white holes.
4NAVRATIL: A white hole, like a black hole, is a solution to Einstein's field equations, but reversed in time. I study the possibility that black holes end their lives by becoming white holes. This is said in fairy tales, and very often. How can a black hole "become" a white hole, but it has to be a hell of a research, Mr. Rovelli..,, with a telescope or on paper?? The time from the formation of a black hole to its evaporation, transformation into a white hole and final dissipation can be extremely long, "time". Time is an interval on the time dimension in the 3+3D system. However, the pace of time is something else. Yes, in a black hole, time can flow at a different rate, but always in the same one direction, because we are in a "world" not an "anti-world". As seen from the outside, but extremely short, measured from the inside of the hole. The author says "as observed". But Mr. Rovelli has to place the observer himself and judge the pace of the passage of time "outside" and "inside" the hole. And Mr. Rovellli judges according to what? According to TR-special.
4ROVELLI: It's an interesting scenario, the model I created with **Eugenio Bianchi** Rovelli created the scenario and the world will deal with it, why ? well, because Rovelli is a celebrity and no one will deal with the HDV model for 40 years, because Navrátil is a phantasmagorical layman,
4ROVELLI: with colleagues in a recent article. If this scenario is correct, if, ….
4NAVRATIL: **if**…the black holes we see in the sky are stars collapsing and then reflecting, "reflecting" means what ? In my opinion, the difference between a black hole and a white hole is the direction of the flow of time and thus the opposite unraveling = time unwrapping, but we see it in extremely slow motion due to gravitational time dilation. An observer from a distance sees-observes a different pace of the passage of time than an observer on the horizon, or below the horizon of a black hole..., this is what the special theory of relativity tells us. But I have my doubts.

5PT: Can white holes be observed?
5ROVELLI: Yes, maybe. One hypothesis is that their formation is the cause of fast radio bursts, mysterious super-violent signals picked up by radio telescopes. According to me, white holes are "from the antiworld quadrant", (similarly to the electron and the positron), this means that they are at the interface of the world and the antiworld due to the opposite flow of

time. If we want to turn a black hole into a white one, we have to reverse the flow of time. **Francesca Vidotto** and I recently proposed another possibility that I find interesting: that the small white holes left behind by the black holes at the end of the evaporation could be stable and form an important component of dark matter.
5NAVRATIL: ☺

6PT: What are you reading now?
6ROVELLI: Alexander Bogdanov's extraordinary book, Tektology. In the early 20th century, Bogdanov was a great Russian intellectual. His ideas anticipated aspects of cybernetics, systems theory, and contemporary structural realism.
6NAVRATIL: BY: ☺

JN, comment in red from 04.06.2021
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Now the same again + my comment translated into English →

1PT: What inspired you to write a book about time?
1**ROVELLI**: To work in quantum gravity, one must face questions about the nature of time. So...above all, TIME is the least explored "thing" of all the "things" in the world, it is the least explored physical quantity. ((Professors such as Prof. Kulhánek only know about it, about time, that |it runs|...nothing more)). First: "what is time"? Time is a physical phenomenon of this world, the Universe, which is even more than a physical quantity - see: http://www.hypothesis-of-universe.com/docs/c/c_300.jpg . Time - a phenomenon/quantity also has three basic dimensions as space, so we will say: "timeart" - 3D and "spaceart" - 3D. The universe would have no meaning without space-time..., which is exactly the opposite of what Prof. Kulhánek: without matter there is no space-time either, matter is said to produce space-time. Using the phenomenon of **"Time" and Length"**, the Big Universe builds a basic 3+3 grid-yarn-net → , that is, a 3+3D space-time in which our Universe will "swim". (To this day, no one has investigated whether the Time-quantity also has dimensions, or why it must not have them !!). This basic the state of space-time "stands still" (like the state before the Bang), there is no matter in it, it is inert in everything, infinite, time does not flow here, the length dimensions do not expand here. Time passes until after the Bang, after which the state before the Bang changes to the status of the number after the Bang. The 3+3D flat state (before the Bang) changes - it changes (according to the principle of alternating symmetries with asymmetries) to the state after the Bang, i.e. there is a change in the infinite flat state of space-time, a change "in the final location" (it is recently called the singularity .). And in this >location< to the "maximum distortion of dimensions" of 3+3D space-time. We will perceive this l o c a l i t y (in the middle of the endless flatness before-bang) as "our Universe". And as the first state there will be **a foam of dimensions, a state of boiling vacuum = plasma**. Only from this moment-position time will begin to pass, because the "time dimension" is "unfolding", the curvature of all three time dimensions is unfolding! ! !, each different, each exceptionally, just like on Earth in a stop-state "today" (dtto the space expands ... which is said to expand first by "inflation" - rapid "blowing up"...; Erm, what?, "what is blowing up and where? It is said that new points=intervals of space in the "spatial grid" were created by this "blowing up. (But no new intervals were created on the time dimensions...?!).
The 3+3D finite curved location (our Universe) "floats" in the 3+3D infinite non-curved net-grid. After that, the unfolding of time dimensions begins here, and we perceive this as the flow of time. In stop-states from Bang (3+3D), the ratio of the expanded dimensions of length

to time is not the same everywhere. This means that the "point" moves $v < c$ in the unfolding spacetime, i.e. $v^3 < c^3 = 1^3/1^3$. A point from curved space-time moves in the non-curvature of the grid, the warp of space-time. So it can also be said that *time does not flow to us, but we - the material object - flow to it, we flow = we move through time - along the time dimension* and... and thus we cut time intervals on the "standing" dimension of time... Nobody he has not yet shown that the rate of time is still the same from the Big Bang to today, that it is therefore universal for every place in the universe. No one has proven that $t_1 = t_2 = t_3$ applies on Earth and that even on Earth it can apply $t_1 = t_2 < t_3$, **(or** $t_1 < t_2 < t_3$**)**…which is commonly shown in STR when time dilates only in the direction of the body's movement away from us. (By the way: the curvature of time dimensions $x/(t_1 . t_2)$ is then manifested as gravitational acceleration).

3+3D space-time web (pre-Bang and post-Bang) is flat and infinite. Then, after the Bang, 3+3D crooked states float and interact in it → fields and arbitrary assemblies of matter as "entwined" ***packages of tangled time-space dimensions****. In my opinion, "the dimension of time stands still" (flat in that basic grid) and we run "along it", along the time dimension, along the length dimension... (on a photon, time also "stands still", i.e. the photon "flies" at the same speed as expands space-time, so both time and space "stand" in relation to the photon as it stands in relation to space-time....etc. etc.* Other descriptions are elsewhere.

1ROVELLI: General relativity tells us that the time between two events is determined by gravity,
1NAVRATI: here on Earth. I am not sure whether also in interstellar space or intergalactic space the time-interval between two events is determined by gravity ???! In every historical period since the Big Bang, global gravity has been different, so that the statement that ***time = the rate of passage of time is determined by gravity****?? ?*
1ROVELLI: and therefore time is affected by the quantum behavior of gravity. There can be quantum superpositions of different temporal states.
1NAVRATIL:? what-what "time states" are something independent of matter and gravity and others?..shouldn't we have been talking about the "pace of the passage of time"? in different states of space-time curvature and different density of mass-field distribution ??
1ROVELLI: A clock can be in a quantum superposition of two different times.
1NAVRATIL: ? A clock is not "time", a clock is a mechanism, not time, which MUST tick off some equally chosen intervals of time. .
1ROVELLI: Thus I have been thinking all my scientific life. **(1NAVRATIL**: i me Mr. Rovelli)
1ROVELLI: about the nature of time **(1NAVRATIL**: me too Mr. Rovelli)
1ROVELLI: and the many problems it brings. I thought it was time to try to connect the dots and write what I think we are doing and not understanding time.

2PT: In the introduction to your book, you claim that "the growth of our knowledge has led to the slow disintegration of our concept of time." What are the advances or revelations that challenge the idea that time flows neatly from past to present to future? No revelations about time flowing in "this sector/quadrant of the Universe" (with one arrow of time "there"), other than past to future, here! But the flow of time exists in the opposite way, i.e. in the second quadrant = the anti-world of this Universe ((Only in my HDV is the vision and "curving" of the dimensions (packaging) of time demonstrated, namely a) once "in the direction of the flow of the arrow of time and b) once in the opposite direction " – in the microworld in the interactions of matter)).

2ROVELLI: I deal with several in the first part of the book. We learned that time passes at different speeds (the word ***"speed"*** is inappropriate. Use the ***"pace"*** of time) depending on altitude and speed. We found that the basic equations of physics do not distinguish the past from the future. And we've learned that our very strong intuitions about the present only apply in a relatively small bubble around us; there is no objectively defined presence in the vast universe. This is not speculation. It's established physics. Then there is speculative research into quantum gravity that further casts doubt on the **??** the nature of time. For example, in loop quantum gravity there is no time variable in the basic equations of the theory. The theory describes the relative evolution of physical variables rather than their evolution over time. Can't comment, I don't understand "quantum gravity". (According to my feeling, this is apparently about "correcting the nonlinearity of gravity by "quantizing" it...; that would be cheating on the PRINCIPLE, of course!)

3PT: If the universe is fundamentally simultaneous, what do you think explains the phenomenon that humans experience as time? Is time an illusion?
3ROVELLI: I don't think the universe is fundamentally contemporary. **The position of the Observer is basically a "stop-state" both in position and in the flow of time...; and essentially in that "unfolding space and unfolding flow of time" one can """relatively""" declare that "we stand still and time flows around us, or even that time stands still (it is a dimension in a standing grid -surprise-networks of 3+3D Euclidean space-time and we flow through it, we move along "the stationary dimension of time and with our shift we cut intervals on the time dimension - we then perceive this as "our time, our passage of time".)** The main point of the book is that there is no single concept of time that is true or false. Of course, this can be said about all of physics and not only about time... What we call time, is a rich stratified concept ??? in the eyes of physicists, not in the "real presentation of the Universe" it has many layers. Some of the temporal layers. **??** Only valid on a limited scale within limited domains. Only man has created "layers" in his psyche. That does not make them an illusion. For example, the difference between up and down is not an illusion, but it has no meaning outside of Earth. (Up or down means "from stronger gravity to weaker gravity - And that's immeasurable in the middle of space. But it's true anyway. Similarly, the immeasurable rate of time is in the axis perpendicular to the axis of motion. The rocket commander at "v" approaches "c " is said to age more slowly in all three directions **but not true**. It should only age more slowly in the axis of motion, see PAGE. The commander on the rocket does not age more slowly for himself at all.). There is no upward motion for astronauts during interplanetary travel and down. (*) Many properties of time are similar. (*) In particular, there are aspects of our own human experience of time that are largely tied to the specific way our brains work. O.K. For example, the human brain does not perceive that time runs in three directions differently - at different paces, because the difference is tiny, imperceptible. Similar to if a person were in the middle of space and there he would not perceive the difference in the force of gravity in three directions. Therefore, man on earth considers time, the passage of time to be the same in all directions. : the fact that we have memories, that we foresee the future, etc. It is the human brain, not basic physics, that determines what we call the passage of time and the sense-direction of speed-pace , which flows. (In every historical period since the big bang, time may pass at a different rate, no one has ever found that out. We even assume that the rate of time passing is the same everywhere today, in a stop-state, throughout the universe. In a black hole, time may pass differently than on a photon… ?)

4PT: What is your next project?

4ROVELLI: There are always too many projects going on at the same time. Right now I'm mostly focusing on white holes. A white hole, like a black hole, is a time-reversed solution to Einstein's field equations. I am studying the possibility of black holes ending their lives by becoming white holes. This is said in fairy tales, and very often. How can a black hole "become" a white hole, well, that must be a hell of a research, Mr. Rovelli.., with a telescope or on paper?? The time from the formation of a black hole to its evaporation, transformation into a white hole and final dissipation can be extremely long, "time" is an interval on the time dimension in the 3+3D system. The pace of time is something else. Yes, in a black hole, time may pass at a different rate, but always in the same one direction, because we are in a "world" not an "anti-world" as observed from the outside, but extremely short as measured from inside the hole. Author says "as observed". But Mr. Rovelli has to place the observer himself and judge the pace of the passage of time "outside" and "inside" the hole. And Mr. Rovellli judges according to what? According to TR-special. It's an interesting scenario, a model I created with **Eugenio Bianchi**. Rovelli created the script and the world will be engaged. Why ? Because Rovelli is a celebrity. Nobody will deal with the HDV model for 40 years, because Navrátil is not a celebrity, he is a phantasmagorical layman. and colleagues in a recent article. If this scenario is correct, ***if, if…*** the black holes we see in the sky are stars collapsing and then reflecting, "reflecting" means what ? In my opinion, the difference between a black hole and a white hole is the direction of the flow of time and thus the opposite unraveling = time unwrapping, but we see it in extremely slow motion due to gravitational time dilation. An observer from a distance sees-observes a different pace of the passage of time than the observer himself on the horizon or below the horizon of a black hole..., this is what the special theory of relativity tells us. But I have my doubts.

5PT: Can white holes be observed?
5ROVELLI: Yes, maybe. One hypothesis is that their formation is caused by fast radio bursts, mysterious super-violent signals picked up by radio telescopes. In my opinion, white holes are "from the anti-world quadrant", (similar to the electron and positron), that is, they are at the interface of the world and the anti-world due to the opposite flow-flow of time. If we want to turn a black hole into a white one, we have to reverse the flow of time. **Francesca Vidotto** and I recently suggested another possibility that I find interesting: that the small white holes that would be left behind by the black holes at the end of the evaporation could be stable and form an important component of dark matter.

6PT: What are you reading now?
6ROVELLI: Alexander Bogdanov's extraordinary book, Tektology. In the early 20th century, Bogdanov was a great Russian intellectual. His ideas anticipated aspects of cybernetics, systems theory, and contemporary structural realism.

JN, comment in red 06/29/2021