

Twisted (by Mario A. Ciampini and Nikolai Kiesel)

*Hi! We are Mario Ciampini and Nikolai Kiesel - researchers at the Faculty of Physics, University of Vienna and the Vienna Center for Quantum Science and Technology.
We are thrilled to welcome you!*

Our story is closely linked to our research on the foundations of quantum physics and its interplay with information theory and thermodynamics.

After all these years, quantum physics still has an air of mystery and it's the mystery that our story wants to convey by exaggerating and even distorting the physics. If you stick with us after the story, we 'll disentangle for you what you may want to remember as fact and what as fiction.

As you read the story, you need to know that it sometimes disintegrates into parallel stories out of which only one survives. You'll notice when. Now enjoy and travel back to the 19th century in a little town in England.

Chapter 1: 1824 Twisted Fate

Leo had done it again. He had taken all his brother's little tin soldiers and broken them. Linus didn't mind too much: he loved every cogwheel in each of his father's creations, so rebuilding them made for a good escape from the daily trouble. Plus, his brother was an idiot.

Yet, his days were spent underground, breathing thick air and piling up stones. With his hands involved in this mindless work, Linus had recently started developing ideas for improving his late father's creations. He wanted to build a tin soldier whose mechanisms were so intricate that it would move smoother, almost like a real human being.

Lost in these thoughts, Linus stumbled upon *it*.

Black, nearly like a hole in the wall yet - how to call it - undefined. Unsharp. Outworldly. Amazed, Linus grabbed *it* and ran out of the mine.

Linus ran and ran to his secret hiding place, put *it* into a dead tree trunk, and immediately fell asleep, exhausted. The punishment for his breakout from the mines came swiftly, harshly, and painfully: the mining corporation wasn't kind to those who abandoned their shift, ever.

So, for months Linus was kept from further inspecting his treasure. When summer came, and with it his only rest half-day from work, Linus finally went out into the forest. He enjoyed the tree leaves and the fresh air; he sang and watched the butterflies.

When he reached the hiding spot in the clearing, he rushed to grab *it*, inspecting *it* closer for the first time. A Box. Lucid, black, cold, its shape somehow undefined. Linus suddenly dropped *it* when he noticed the dead rabbit at his feet, seemingly having chosen the dead tree trunk as its burrow. "Ah! Stupid", Linus thought to himself while grabbing the Box again and continuing his careful inspection.

Struck by a sudden idea, he put one of his tin men on the Box and set it to start walking over it.

What happened later was hard to explain: the tin man became increasingly blurry the more it stayed on the Box, somehow gaining *its* features. Linus observed this optical illusion with increasing curiosity, his excitement rising.

After several hours of trials and tests, Linus got out of his deep concentration noticing the chill breeze of the evening. He needed to get back to the mine for his night shift; however, it would have been such a pity to leave the Box now that he was close to grasping what was happening with *it*.

"When in doubt, flip a coin. You'll know the answer you desire while it's still spinning in the air", always repeated his older brother. Linus got his most valued possession from his pocket, the bronze coin his late father had given him for his tenth birthday. The coin had a picture of a Munchkin cat on one side and a

picture of the same cat dead on the other. Linus threw the coin in the air. "Alive", and I go back to work. "Dead", and I'll call sick and study the Box a bit more.

(I) Alive. Time to go back to that painful nightmare. Well, not before hiding the Box at home, where he would have a better chance to continue searching for its secrets. When Linus finally approached the mines, a roar like a close thunder made him stop in his track.

Looking up, Linus saw an avalanche of stones, falling from the mountain and pouring on the entrance of the mines like a waterfall. His brother was just underneath. Linus' eyes gaping, his heart filled with terror and pain and despair, he starts to run and run and run toward the mine, screaming...

(II) Dead Linus was quite content that the coin had decided for him to lie and the consequent evening of leisure. He put the Box in a bag and ran home, immediately starting to perform all kinds of experiments. His curiosity and inventiveness drove him to understand what was going on with the funny optical effect he saw that day. Yet, he observed something else: when he put one or more of his tin man on top of the Box in particular configurations, the blurriness disappeared suddenly with no apparent reason. He froze while a sudden feeling of dread caught him in the heart...

"NOOOO! Not my brother !!!"

(II) Linus dropped the Box and ran out of the house. He shouted and shouted, trying to wake the rest of the village. "Leo is in danger! Help! Something terrible has happened in the mines! Run and help, PLEASE!". Sleepy reactions from the villagers rapidly became annoyed, then worried, then panicked, as everybody assumed Linus had just come from the mine. In no time, a small army of people was running to the mines finding the whole entry to the mine was stuck with rocks and debris, grey smoke making the air blurred and heavy. Every second counted, here, as the air in the mine would drop rapidly along with the survival probability of those inside. But those were miners deep in their hearts. They knew what to do and how to do it fast. The hundreds of hands worked together like a machine, and soon, almost miraculously, they finally freed the entrance. Linus held his breath, looking at the people leaving the mines, one by one, till... "Leo!" cried Linus. No one was severely injured. And no one knew how help had appeared so fast.

Linus dropped to the floor, unconscious. Waking up, Linus finds himself feverish at home, not remembering how he got there. Leo! Was he alright? Or was it a dream? The Box was still there where he had left it. Absentminded, Linus opened it for the first time.

(I) Linus reaches the mines, the last remains of the avalanche still dropping on the entrance. The whole entry to the mine was stuck with rocks and debris, grey smoke making the air blurred and heavy. Linus removes the stones with all his might, but he is too small, too weak, and there is no one there to help him. Exhausted, Linus passes out. Only the morning shift discovers the disastrous incident. With heavy hearts and no hope, the miners started to remo

His curiosity taking over, Linus looked inside the Box and was quite underwhelmed. Inside, there was nothing. No optical effect outside and nothing inside. That Box remained a mystery. And somehow, he could never shake the feeling that the fact that Leo was safe and sound with him was connected to that strange, blurred black Box.

He continued playing with the Box in ever more complex configurations - a hobby that would keep him obsessed for many years. His tin men, however, caught the attention of a few rich Londoners who inspected the mines. The “Miraculous tin men” became quite a fashion among the city's high society and allowed Linus and Leo to leave their difficult lives behind.

Linus O’Kelvin earned his degree in mechanical engineering the same year as his degree in physics. He had built a solid reputation for producing the finest clockworks and most delicate toys, making him a rich man. Yet, no one understood his most intricate work just outside his villa, and most people thought it art. Silver, gold and copper mechanical constructions combined with nearly infinite complexity and beauty building up to the top black tip, so high in the sky that could never actually be seen - but somehow clearly was.

Chapter 2: 1901 Twisted Mind

Dull! Every single one of his coworkers was entirely and utterly dull. Different shades, but dull still. Everett von Heldenreich congratulated himself for his endurance in putting up with all this. It will be worth it, he thought, while putting a finishing touch to his massive, shiny, oily moustache. Micromanagement was the key - he played his team of 30 researchers like a piano - each individual sound boring as hell but under his hands, a masterpiece. He would need them to make Decoherence Inc. the sole relevant company in the world and his “Destiny Engine” finally a reality.

His journey began only ten years before when his parents had moved to that villa with this intricate artwork in the yard. It had completely captured his attention. He would have liked to know the person who had built it – maybe finally someone with whom to escape the intellectual desert outside his mind. They must have been a genius.

As a child, Everett would try to figure out the inner workings of all the pieces in the huge machinery around the villa, convinced that it was not merely art. His few friends didn’t like to go there. First, for the dead and dry, stony, and live-less landscape and second for the scary “mechanical monster” at its center.

One day, while studying wheels and levers, admiring their intricate complexity, Everett stumbled on a hidden opening in the wall containing the diary of a certain L. O’Kelvin. At last, he could penetrate the thoughts of his outstanding predecessor. In an especially designed holder, there was a fancy coin with a Munchkin cat imprinted, alive on one side, dead on the other. The text on the diary cover struck him: “Open the Black Box to stop the voices”. Had his past friend also experienced the sudden voices and strange intuitions that plagued Everett since coming to the villa?

This event started the systematic investigation of the mystery of the black Box and the mind-blowing mechanical artwork in his yard. The results were mind-blowing: somehow, an instance of a chance-based experiment performed close to the Black Box resulted in all possible outcomes “happening” in parallel stories. The intuitions were a sort of communication between these stories: simply one Everett influencing another Everett. Whatever story was the one to have the Black Box open first was the only one surviving, killing the thread of all the other stories, almost as if they had never been. An appropriately crafted machine would enhance the effect to involve larger and more complex systems. The implications were immense: Everett knew that this treasure and his own genius would make him the most powerful man in the world.

Today, Decoherence Inc. already supported the governments of some carefully selected countries. Not for the money, of course, but to minimize friction in expanding the influence of Everett’s company. Decoherence Inc.’s new employees had to be carefully selected, as well. Everett’s favorite little test for the applicants was designed both to understand their mindset and for his own joy in showing off his undisputed mastery of the world. “Take this coin, and toss it”, Everett would tell an applicant. “I will guess if you get “Dead” or “Alive” as a result. We do it ten times straight, and if I lose even only a single time, you get the job immediately at triple the salary, otherwise... we’ll see”. Usually, after inspecting the coin for tricks, the

applicant would enthusiastically accept the bet, sure to win against so much favourable odds. Then, they would throw the coin in the air:

(I) Dead. “My win”, Everett would say matter-of-factly, “don’t take it badly. You still have a few more tries”. And then he would open the Box...
(II) Alive. “That is really surprising”, Everett would say, grinning. “It’s the first time that happens. My congr...

Some of the applicants flashed with excitement after the principle was explained, and they learned that they would work on how to magnify this effect to ever more complex situations. A few were also puzzled: “Now, that must violate some principle of nature! I can’t put my finger on it, but I’ll figure it out.” The latter group were obviously too easily distracted from the merits of what they had seen and were promptly dismissed.

In his late years, Everett would experience his one and only moment of discomfort in an otherwise boisterous, perfect life when his grandson Abel brought home a friend from school. The girl with piercing, curious blue eyes was a little know-it-all, and Everett couldn’t resist playing the trick with the coin on her. Her response was unexpected. “But - the Second Law...!”, she murmured with an unconscious glance out of the window, her eyes passing over the stony, dead landscape with a hint of shock in her eyes.

Chapter 3: 1950 Twisted End

“I’m not gonna miss that stink!”- Lyra grimaces as she quietly climbs through the nauseous, slime- and vapor-filled tunnels that make up the Heldenburg sewer system. The basement of the world’s most influential conglomerate, Decoherence Inc., is a maze of dark, narrow corridors and windowless rooms. The walls are made of cold, unforgiving steel, and the floors slick with oil and grime. Lyra O’Kelvin infiltrates the power room, which houses the massive steam engines that provide power to the whole building. Underneath the shiny patina of this futuristic corporation, coal was moving the same roaring turbines. Cheap. Reliable. Efficient. And prone to incidents.

Lyra avoids the automaton loading the coal in the gigantic furnace, then approaches a very old-fashioned valve and turns it twice counterclockwise. She doesn’t stop looking at an equally old-fashioned pressure gauge rising toward the red danger area.

“17 minutes and 12 seconds for the fireworks”, Lyra smiles. Lyra leaves the room and slips inside the elevator at the end of a deserted corridor. When the door closes, Lyra reaches into her left pocket for a small, humming device she had spent months developing. She takes a deep breath and looks at it. The green light indicates that no splitting has occurred yet. She sighs with relief while the elevator darts upward toward the sky. “All good. There is still only one me”.

With the whistle of the rising pressure in the boiler room still resonating in her ears, Lyra looks out of the glass elevator down toward the grey roofs of Heldenburg. Outside the city’s perimeter, there is only a black, dead expanse where life has been sucked away so thoroughly that even hope itself is but a memory in the service of that chaos.

When that bitter, arrogant old man showed her the trick with the coin, she immediately understood the connection. However, only years of stubborn study and research into the thermodynamics of “world twisting” (or, as she and her colleagues preferred: “quantum mechanics”) had allowed her to clearly understand how deep the mess was. The Box allowed multiple realities happening simultaneously to interact with each other, which required a steep price. To work, the device generated an *insane* amount of entropy, syphoned to the surrounding environment. Therefore, while Decoherence Inc. thrived, the rest of the world splurged into chaos, with all the beautiful complexity of life slowly washing away into oblivion. That device cannot be allowed to be exploited, not even allowed to exist.

The elevator stops at the last floor with a ding. The door opens to a desert room. The style of the environment is different from the rest of the grey, heavy industrial complex. It seems... old. An intricate mechanism made by copper, gold and silver tubing, clockworks, pulleys and steam is fused with the building and part of the walls. Everything here seems active, every bit working together to rewrite the very true mechanisms of the world.

Lyra's attention rapidly focuses back on the present. A bullet misses her ear by an inch, leaving a ringing sound close to her brain. Another security automaton? No, this time, it feels... different. Lyra rushes forward, dashing behind a desk while another round of bullets flashes toward her. Lyra activates another device in her pocket, then dives to the

(I) Right. The agent guesses the direction and aims at her effortlessly, shooting her in the shoulder... **(II) Left.** The agent guesses the direction and reaches her effortlessly, shooting her in the shoulder...

"It's over, Lyra. An amazing achievement to tap into our machinery, but your trick won't work. Not here, not now". Lyra is confused, unspeakable pain irradiating from the shot, blood trickling to the ground, panic mounting in her chest as she realizes that this will not be a peaceful meeting. Oh well.

"You are too close to the Box to entangle yourself with us".

Lyra O'Kelvin and Abel von Heldenreich are facing each other on opposite sides of this peculiar room, all the clocks in it ticking at different speeds, a cacophony reminding of the wrongness of the place. In the centre of the room is an indefinite Black Box, sitting on a golden pedestal. Lyra looks at her opponent, piercing blue eyes against emerald green. A faint whistle, unperceived by the unaware, reminds Lyra that this is her only shot. The distraction must be 100% perfect. Lyra clicks her device. Abel waves toward the Box, unimpressed. From the outside, the scene becomes indescribable. The machinery in the walls spring alive. Every action becomes blurred, splitting in every possible outcome, counteracting each other and then disappearing. The Box glows ominously and blurs, feeding this breaking of reality.

(I?) Lyra fights with all her might striking directly into Abel's...	(XI?) She blocks another hit to her stomach, counteracts, and jumps away. She tackles again and... finds her knife caressing Abel's throat. She wins. At last. Abel looks at her smil...	(LXXI?) Lyra parries a side blow, twists in her place and grabs Abel's arm, pulling him down to the ground. She jumps on top of him, grabbing him by the collar. "Don't you understand? This place is going to explode in each and every reality. It's inevitable. We need to get out of here!" . Abel looks at her, with the tired, haunted expression of someone that knows too much. "You think I...	(CCIX?) Lyra charges, tackling Abel to the ground. He stumbles, gasping for air. She crawls on top of him, punching his face one, two, three times. He lies motionless on the ground. Facing the Box, she finds th...	(MMCCCLXVII?) Lyra avoids the first shot and crouches backwards. She feigns a stab to the right, then turns her back to a confused Abel. She sees a chance to end all of this. She throws her device to the black Box, with all her strength, aiming right at its center. Abel screams behind her, panicked. She closes her eyes, anticipating her success. Maybe... just maybe... There is no need for her plan to work. Maybe, In this reality she wi...
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“10...9...8...”. It worked, of course. Lyra focuses on the ear-breaking steam whistle coming from somewhere below them, getting even louder. The plan was never to beat him at his game. Abel von Heldenreich is so immersed in contrasting each of Lyra’s potential actions that he never notices the floor trembling.

Lyra rapidly weighs her chances. Why did he have to attack her – no, there was no way left to save him.

With a sudden move, she pushes her rival away, and jumps toward the tall, bright window. The glass shatters with a thundering crash. Lyra feels that split second of weightlessness preceding the fall. She closes her eyes, in the last image the realization, the fear and the regret on Abel’s face.

Was she able to give a future to this world?

Lyra smiles.

“Zero”.