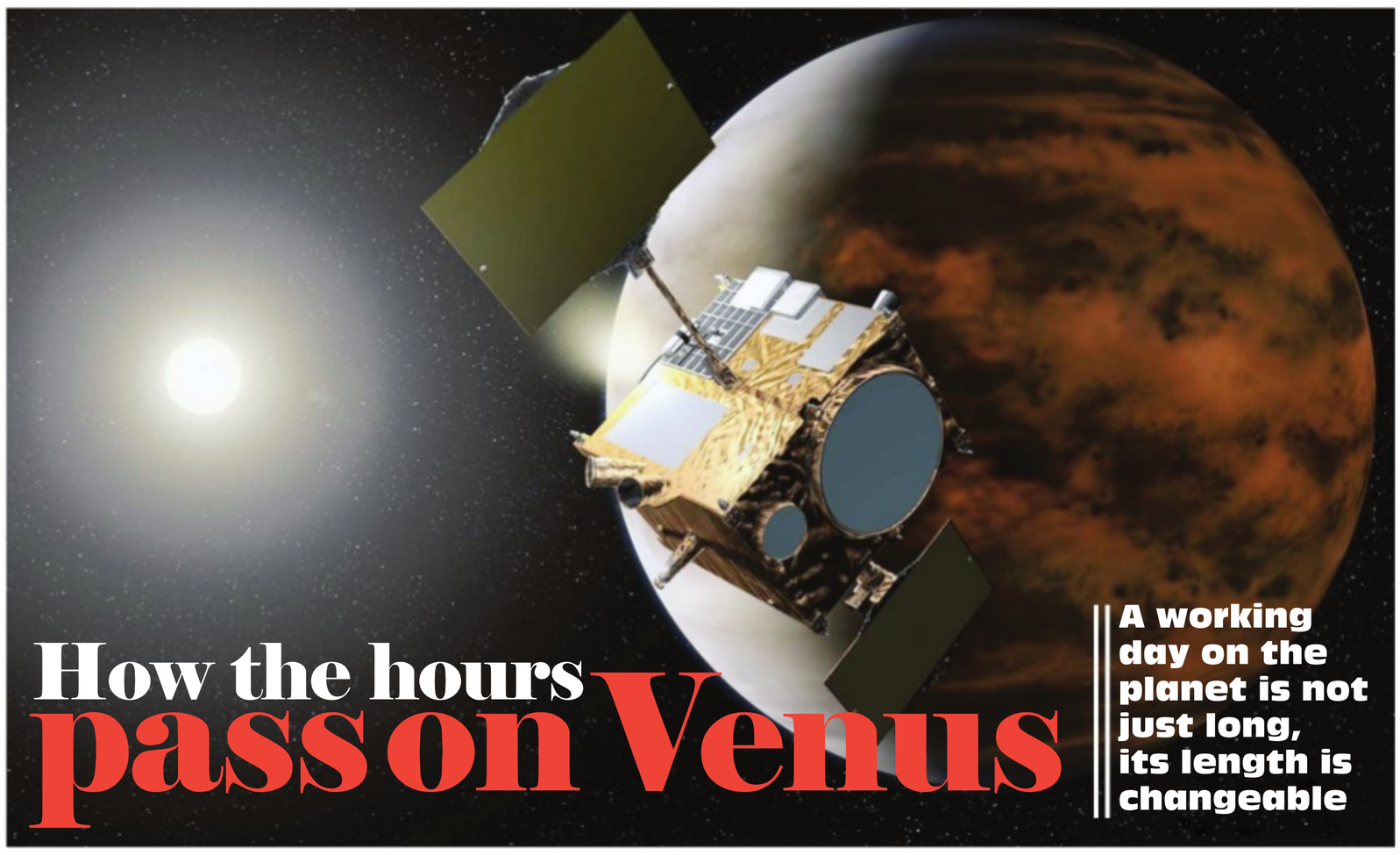

How the hours pass on Venus

A working day on the planet is not just long, its length is changeable

S ANANTHANARAYANAN

The planet Venus rotates slowly on its axis, just once, while the Earth goes round 243 times. This time of rotation, however, has been found to have increased between recent observations. In case of the Earth there is evidence that the speed of rotation varies, generally over millennia. But the length of a day on Venus has been found to have got longer by 6.5 minutes within a span of 16 years.

Thomas Navarro, Gerald Schubert and Sébasien Lebonnois from the University of California at Los Angeles and the Sorbonne in Paris describe in the journal, *Nature Geoscience*, their simulation of the atmosphere of Venus, which may explain how disturbances in the dense atmosphere would affect the planet's rate of rotation.

The simulation allows a variation of as much as two minutes within the time of a solar day. The simulation carried out is to reproduce an unusual feature, a planet-sized pattern, which may be an atmospheric wave that has been found in the upper atmosphere of Venus. This can explain the variation of about seven minutes that has been observed in the length of the day on Venus over the last 40 years, the paper says.

Spinning objects are able to change their speed by altering their internal structure without making any external contact. An object that is moving in a straight line would keep moving till it is stopped or slowed down, generally by braking. But once it has been slowed down, it will not speed up unless it is given a nudge.

That is not the case with a spinning object. If a spinning figure skater, or acrobat were to stretch her arms out, her rate of spin would slow down. And the speed would pick up as soon as she draws her arms in again. This is because the parts of a spinning object that are further from the axis of spin store more of the energy of the spin than parts that are nearer the axis. This is unlike an object that is moving in a straight line, where all parts of the object share the energy of movement only according to their mass.

Objects like stars and planets started out as vast clouds of gas or dust and gradually coalesced under the force of gravity. Any slight, initial net rotation was magnified as parts that were at great distances came nearer the centre. When the star or planet has final shape and profile, there is a final rate of spin, which usually stays constant.

In case of the Earth, although the shape and dimensions are largely stable, there have been changes over the ages. The spin, itself, exerts forces that alter the shape of the object. As the equator spins round faster than the poles, matter is thrown outwards in the form of a bulge at the equator and there's a flattening at the poles.

That leads to slowing of the rate of spin till the bulge stabilises. During the ice ages too, the water content of the oceans gets stored as ice at the poles. The load of ice causes compression and further bulge at the equator, slowing the rotation. When the earth warms again, the ice melts, the pressure relaxes, the bulge reduces and the rotation speeds up.

Ocean currents or winds can also affect the rate of spin of solid mass. As currents and winds come about through an opposite thrust on solid mass, the rate of rotation of the mass would need to change, to keep the total energy of rotation unchanged. At the same time, on Earth, the mass of the ocean and atmosphere is so much less than the remaining parts, that the effect is scarcely perceptible. Mutual tidal effects of the Earth and Moon also bring about a very slow reduction of the speed of rotation. But that effect is extremely feeble, just 2.3 milliseconds a day per century!

As Venus has no moon, there is no tidal effect to worry about. The atmosphere, however, becomes significant. The Venusian atmosphere, which is largely carbon dioxide, and sulphuric acid at high altitudes, is at a pressure that is 92 times the pressure on Earth and the mass of the atmosphere is 93 times the mass of the Earth's atmosphere. We could add 20 per cent to these figures, as the mass of Venus is 80 per cent of the mass of Earth. And further, Venus's atmosphere is highly energetic, blowing feverishly, to go round the planet in four Earth days, while the planet takes 243 days for a rotation. The component of the energy of rotation in the whirling atmosphere of Venus is hence not negligible like it is on Earth.

The definitive measurement of the rotation of Venus was considered as that by Nasa's Magellan mission of 1990-92, which was 243.0185 ± 0.0001 days. The European Space Agency's mission, Venus Express, of 2006, however, found an error of 12.4 miles where some features of the planet had been calculated to be. The implication was that Venus had slowed in its rotation by 6.5 minutes since the last measurement 16 years ago.

Starting late in 2015, the Japanese Venus orbiter, Akatsuki beamed back detailed features of the planet's atmosphere. It had been observed that while the high speed atmospheric wind showed small scale features, there were also large, planet-scale features that seemed to move slower or faster than the main wind. It was thought that these would represent planet-scale waves within the atmosphere.

The orbiter, Akatsuki showed the presence of a bow-shaped structure, 10,000?km across, from the northern hemisphere to the southern hemisphere, at the cloud-top level. "Over several days of observation, the bow-shaped structure remained relatively fixed in position above the highland on the slowly rotating surface, despite the background atmospheric rotation being faster than the planet," the 2017 report of the finding says. Four more large-scale wave features were seen over four Venus days, on the sun-ward side of the planet, in the afternoons, the present paper notes.

Thomas Navarro and his colleagues carried out computer simulations of different conditions that could exist on Venus, to be consistent with known parameters and the present structure. They found what was observed was in keeping with surface features of the planet giving rise to atmospheric waves, where the weight of the atmosphere tries to restore equilibrium that has been disturbed. Such waves, called "gravity waves", arise in the Earth's atmosphere too, when energy is transferred from the lowest layers, where the air cools as one goes higher up, to the higher layer, separated by an intermediate region.

This kind of interaction between the high speed atmosphere and slower moving solid part of the planet could lead to a pull that would affect the rate of rotation, the paper says. The planet would hence show variations in the speed of rotation, like the ballerina or the acrobat. While the reduction, 6.5 minutes over 243 days, is not large, it has come about in a short span of 16 years. The phenomenon reported, however, may be the reason that the rate of rotation of Venus is the slowest in the solar system.

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T Navarrp


G Schubert


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PLUS POINTS

Turning nocturnal

Humans are driving mammals including deer, tigers and bears to hide under the cover of darkness, jeopardising the health of the creatures that are only supposed to be active by day, new research has found.

The presence of people can instill strong feelings of fear in animals and as human activities now cover 75 per cent of the land, we are becoming increasingly harder to avoid. Unable to escape during the day, mammals are forced to emerge during the night.

While this might be comforting to those who would rather avoid predatory cats, it could be interfering with the health and reproduction of creatures that are already vulnerable.

A team led by Kaitlyn Gaynor at the University of California, Berkeley arrived at this conclusion after analysing nearly 80 studies from six continents that monitored the activity of various mammals using GPS trackers and motion-activated cameras.

The scientists used this data to assess the night time antics of the animals during periods of low and high human disturbance. Such disturbances ranged from relatively harmless activities like hiking to overtly destructive ones like hunting, as well as larger scale problems like farming and road construction.

Overall, the researchers concluded that from beavers to lions, there was an increase in nocturnal behaviour when humans were in the vicinity. Their results were published in the journal, *Science*.

The scientists warned that while hunting of animals by human "super predators" is the most obvious way in which we are impacting wild populations, the non-lethal effects of our presence "may have an even stronger influence on fitness and evolutionary trajectories".

In their analysis, the Berkeley team also expressed concern that removing key animals from daytime habitats could have far-reaching effects on entire ecosystems.

If tigers only operate at night, for example, and are less able to hunt their usual prey, the control they exert over those animals will be removed -- leading to communities of species spiralling out of control.

The study is the first to establish this phenomenon as a global trend seen across dozens of mammal species, not just an isolated problem.

The independent

The lost pioneer

Does Albert Einstein's first wife, Mileva Maric, deserve credit for some of his work?

REBECCA BANOVIC

For most, Albert Einstein is synonymous with genius. His face adorns classroom walls across the world and in 1999 he was announced as *Time* magazine's most important person of the 20th century.

However, not many people are aware of Albert's first wife, Mileva Maric and her participation in his scientific productivity. Maric was Albert's wife during his most creative and formative years, yet she remained hidden in the shadows. My parents told me stories about her and I was often left dumbstruck by the thought that a Serbian woman could have actively participated in the history of modern physics.

Debate regarding Maric's role in Einstein's work has persisted for decades. One side contends that she was a collaborator and even co-authored his papers; the other says she was simply an intelligent sounding board.

The catalyst for this passionate debate was the release of old letters, by the family, between Albert and Mileva. These letters were later published in the books *Albert Einstein/Mileva Maric: The Love Letters* and *The Collected Papers of Albert Einstein*.

In many of the letters, Mileva can be observed sharing Albert's scientific and mathematical enthusiasms. At certain points, she is even indicated as a collaborator. Critics argue, however, that the letters provide insubstantial evidence and that their joint work was exaggerated.

Whether Maric participated in Einstein's theories or not, it cannot be denied that she was extraordinary for many reasons. Despite being one of the first female physicists in the world, the importance of her work has not been evaluated. Her story illuminates the plight of intellectual women during the first half of the 20th century.

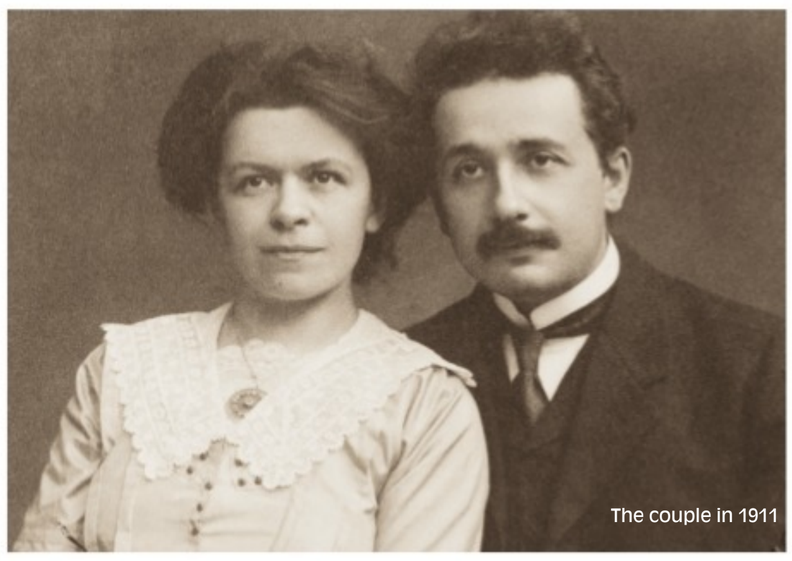
Born in 1875 in Titel, Vojvodina, then part of the Austro-Hungarian Empire, and now Serbia, Maric endured a turbulent path as a girl wishing to study physics as education beyond four years of elementary school was reserved for men only. Seeing Maric's potential, her father Milos sent her across the border to Serbia to the gymnasium in Sabac -- where girls had the same educational rights as boys. Then he took a job in Zagreb (also part of Austro-Hungary) where Mileva encountered yet another hurdle.

Milos petitioned for Mileva to be accepted into the all-male Royal Classical Gymnasium. She was accepted and became one of the first women in the Austro-Hungarian Empire to sit in a high school physics lecture alongside her male peers. At the time, physics did not produce many female names.

Maric deserves recognition not only for her resistance to obstacles and bravely exploring the world of physics, but also for her pioneering role in opening the door for women after her. Eventually, she reached the Swiss Federal Polytechnic in Zurich where she was the only woman in her class.

Maric's very presence at the university marked her as exceptional. There she met Albert Einstein, and they married in 1903.

The letters not only give us a glimpse into Mileva and Albert's personal relationship, but also their intellectual development and shared discipline of physics. In one letter, Albert wrote to Mileva, "How happy and proud will I be when the two of us together will have brought our work on relative motion to a victorious conclusion!" In another letter he said, "I am very curious whether our conserv-


The couple in 1911

ative molecular force will hold good for gases as well."

On many occasions, Einstein continued to write to Maric about "our new studies", "our investigations", "our view", "our theory" and "our paper". But he also heavily relied on her for emotional support. In one letter he told her: "Without you I lack self confidence, pleasure in work ... without you my life is no life."

It is claimed when addressing a group of Croatian intellectuals, Einstein said, "I need my wife as she solves all the mathematical problems for me." It is true that Maric's training in mathematics and physics would have allowed her to research and develop ideas with Einstein.

However, critics remain sceptical in spite of references to "our work" and "our investigation". Some say that the use of pronouns was merely affectionate and that Maric never wrote about physics to Einstein, but rather wrote about mundane subjects.

However, later letters show Einstein did make a distinction between his individual work and what he considered a collaboration with Maric. In one he wrote, "The local Prof Weber is very nice to me and shows interest in my investigations. I gave him our paper. If only we would soon have the good fortune to continue pursuing this lovely path together."

Clearly in this letter Einstein is talking about two different items, his own investigation and his joint collaboration with Maric. The most probable conclusion is that he was working on and referring to several ideas at once. Is it not possible that Einstein had ideas he developed with Maric and those he developed himself? Many of Maric's letters to Einstein have been lost, the reason remaining unknown.

After Maric's death, author Djordje Krstic recalled their son Hans Albert telling him about seeing the couple "work together in the evenings at the same table". Despite the historical context, Maric was a physicist and her talent for the subject makes it conceivable that she and Einstein worked together.

Regarding the most controversial claim, Maric biographer Desanka Trbuhovic-Gjuric also writes about a piece that was written by the Soviet physicist Abraham Joffe. Joffe claims that he saw the original three submission papers of the 1905 theory of relativity paper and said they were signed Einstein-Marity. Marity is the Hungarian variant of Maric. However, Marity was removed from the final publication.

Both Gjuric and Joffe make a provocative claim but is it inconceivable? It is important to appreciate both the background and the context as to why Maric's name may have been omitted from final publication.

In 20th century Europe female scientists faced many institutional obstacles and it was not uncommon for them to be excluded, despite any contribution, from scientific papers. But critics maintain that by Swiss custom the maiden name of the wife is added to the husband's family name. Nevertheless, only Einstein's name appeared in the scientific papers and that would continue to be the case for the rest of his work.

On 31 January 1918, Einstein wrote to Maric offering his Nobel Prize money in exchange for a divorce. However, after he had received his winnings he gave her only half. Consequently, this raised many questions. Why did Einstein use his Nobel Prize money and not regular alimony and child support? Was it half the money for half the work?

After their divorce, they maintained a steady relationship. After all, they had shared interests and two sons. Their youngest son Eduard was diagnosed with schizophrenia and Maric spent the rest of her life caring for him. She died on 4 August 1948 at the age of 72.

In the summer of 2004, Maric's unmarked grave site had finally been identified in Northeim cemetery in Zurich under the number 9,357. I cannot help but feel that this was a poignant reflection on the life of a woman that was excluded from < history.

A slim volume of letters and testimonies cannot provide answers to questions biographers and historians have been posing for decades concerning the intellectual contributions of Mileva Maric. However, their correspondence, I believe, offers a new understanding of the intellectual and emotional resources that made Albert Einstein's path-breaking contributions possible.

Her hidden significance justifiably means her contribution to physics should be researched, investigated and evaluated. For this reason, the evidence that she collaborated, and aided Einstein's scientific development, deserves genuine consideration.

The independent

Elusive 'monster'

Tales of a giant creature lurking beneath the murky waves of Loch Ness have been around for more than 1,500 years — and one academic hopes the marvels of modern science can finally unravel the mystery. Professor Neil Gemmell has travelled from the University of Otago in New Zealand to collect water samples in the Scottish lake, in the hope of finding out more about the creatures that inhabit its depths.

"Over 1,000 people claim that they have seen a monster. Maybe there is something extraordinary out there," he told *AFP*, as he dropped a five-litre probe into the loch. Gemmell said he would be keeping an eye out for "monster DNA", but the project was more aimed at testing environmental DNA techniques to understand the natural world.

The earliest chronicles of a creature are attributed to Saint Columba, who brought Christianity to Scotland in the sixth century. The last reported sighting was on 26 March this year by a US couple standing on the ramparts of the majestic ruin of Urquhart Castle. "They described a large shadow moving under the water which they estimated to be around 30 feet in length," said Dave Bell, skipper of the Nessie Hunter tourist boat.

Theories abound about the true nature of the Loch Ness Monster — from a malevolent, shape-shifting "water horse", to an aquatic survivor of the dinosaur age, right down to logs, fish, wading birds or simply waves, which have been blown out of all proportion.

The straits times/ann