Interview with Astronomer Aneta Wiśniewska

Learn more about our closest star, the Sun, and pursuing a scientific career in this interview with a solar physicist of the Astronomical Institute of Slovak Academy of Sciences, Aneta Wiśniewska. Questions were provided by the public within a call "Ask an astronomer!" on the occasion of International Day of Women and Girls in Science on February 11th, 2025.

Will we be able to obtain more energy and do it more efficiently directly from our Sun in the future?

I believe so! It's very possible that in the future, we'll be able to harness more energy from the Sun more efficiently. Solar energy technology is constantly improving, with advancements in solar panels, solar farms, and even concepts like solar power satellites. As we develop better storage systems and more efficient conversion methods, we could see solar energy becoming a dominant source of power. It's exciting to think about how we might use the Sun as a virtually limitless energy source!

What is the closest distance from which the Sun can be observed by space satellites?

Right now, Parker Solar Probe (PSP) holds the record for the closest approach to the Sun. It gets as close as 7 million kilometers to the Sun.

Will we be able to influence solar prominences and their impact on Earth in the future?

Well, right now, we don't have the technology to directly influence solar prominences. These massive eruptions on the Sun are driven by powerful magnetic forces, and controlling or altering them is far beyond our current capabilities. However, in the future, we could potentially improve our ability to predict solar activity and mitigate its effects. With better space weather forecasting, we might be able to shield our technologies on Earth (like satellites, power grids, and communication systems) from the impacts of solar storms.

What do you anticipate for the further course of the current solar cycle?

The current solar cycle, Solar Cycle 25, is expected to peak around 2025/2026, with increased solar activity like sunspots, solar flares, and coronal mass ejections (CMEs). Moreover, the flare flux in Solar Cycle 24 and Cycle 25 has generally increased compared to Cycle 23, particularly in terms of the frequency of stronger flares. Solar Cycle 24 saw a noticeable rise in flare activity, and Solar Cycle 25 is expected to follow this trend, with even more solar flare occurrences as we approach the peak around 2025. However, the intensity of flares, like X-class flares, hasn’t yet reached the extreme levels observed in past cycles. This increase in flare activity could lead to more noticeable impacts on Earth’s technologies, such as satellite communications and power grids.

Do you also study the far side of the Sun using helioseismology?

Yes, it's possible to study the far side of the Sun using a helioseismic approach. However, my current work focuses more on the waves that could be associated with the most energetic events, like solar flares or eruptive prominences. I investigate the link between oscillatory power, its dominant frequency, and the potential for flare activity. By studying these waves and their connection to solar flares and prominences, we can add another piece to the puzzle, improving our ability to predict space weather more accurately. It’s all about understanding the Sun better to protect our technologies and make more precise forecasts!

What phases will the Sun go through in its lifetime and how long will it take before the Sun "dies"? If, say, 1 billion years from now, people look at a photo of the Sun from that day and compare it to a photo from today, will they see any interesting differences?

We suppose the Sun is about 4,5 billion years old and has about 5 billion more years left before it transforms into a white dwarf, so it’s in half of its lifetime. The Sun is currently in its main sequence phase, steadily fusing hydrogen into helium in its core. In around 5 billion years (Red Giant Phase), the core will run out of hydrogen, it will start fusing helium into heavier elements (carbon & oxygen). In this phase, the Sun will expand massively, swallowing Mercury, Venus, and maybe Earth. 😬 So, I would not be worried about solar observations at that time :) The Sun will be much bigger (up to around 200x its current size!), much, much brighter (around 2000x today’s luminosity), the surface cools down (to around 3000–4000°C), the colour shifts to reddish-orange because cooler stars emit more red light.

After the Sun exhausts helium, its core is mostly carbon and oxygen. Right now, the Sun's core fuses hydrogen at around 15 million degrees Celsius. When it starts fusing helium (red giant phase), the core heats up to around 100 million degrees Celsius. But to fuse carbon into oxygen? It would need at least 600 million degrees Celsius! So it would not be able to fuse carbon or oxygen (too low-mass for that). The outer layers become unstable and puff off into space, forming a glowing shell of gas — this is the planetary nebula stage. The Sun dies as a white dwarf made mostly of carbon & oxygen, never reaching the conditions needed for carbon fusion. White dwarfs fade over time because they have no fusion left.

So in 1 billion years, the Sun will still be a main-sequence star, but it will be:
- brighter (around 10% increase in luminosity)
- slightly larger
- core will be hotter, but surface temperature nearly the same (around 5778 °C)
- still yellowish, maybe slightly whiter due to a tiny increase in effective temperature
- more solar activity — as the Sun ages, it gets more energetic, with more sunspots and solar storms

But overall, it would still look very similar to today's Sun, but warming up Earth dangerously.

When observing through a solar foil, we see white spots on the surface of the Sun in addition to black spots. What are they?

The mentioned white spots are plages and faculae — bright regions associated with strong magnetic fields. Sometimes also strong solar flares can be visible in white light.

Plages are bright patches in the chromosphere, often found near sunspots. They are visible in white light, and so-called H-alpha filters, and are associated with active regions where strong magnetic fields concentrate plasma. The magnetic field compresses and heats the surrounding plasma, increasing density and temperature, which results in more light emission. More hydrogen atoms recombination and excitation in the H-alpha spectral line occur.

Whereas faculae are less intense than plages when observed as bright regions in the photosphere, they are best seen near the solar limb. Solar magnetic fields open up convection cells, allowing hotter plasma from below to shine through. The brightening effect is more visible at the limb because of the way light scatters at different angles.

Do sunspots also occur at the poles of the Sun? Are the poles of the Sun somehow different from the equatorial regions?

Nope! Sunspots almost never appear at the poles. Because the poles of the Sun are weird as hell compared to the equator. The poles host the global large scale magnetic field that flips about every 11 years during the solar cycle (alpha cycle). On the other hand, sunspot magnetic fields are more localised, but stronger than polar magnetic fields.

The equatorial area spins faster (a full circle in around 25 days) than the poles (around 35 days), leading to complex shearing and twisting of magnetic fields. This differential rotation helps generate sunspots at lower latitudes, but not at the poles. Sunspot activity follows the butterfly diagram, where spots migrate toward the equator as the cycle progresses.

Moreover, solar poles have persistent coronal holes, vast dark regions observable in extreme ultraviolet/X-ray images where the Sun's magnetic field is open. These are the main sources of the fast solar wind (around 800 km/s), which blasts out into space. On the other hand, the poles are tricky to study because Earth orbits near the solar equator. Only spacecraft like Ulysses and Solar Orbiter have given us polar views.

How quickly does the structure of sunspots change? Does it happen over hours, days, or months? How long would we have to observe the Sun with the naked eye through, for example, a solar foil to notice any changes? I would also be interested in the same question, but for solar flares.

Sunspots are continuously active and change over time. The structure of a sunspot can evolve in hours to days — they can merge, grow, or even split apart during this time. Major shifts, like a new sunspot appearing or disappearing, could take days to weeks, especially when observed with solar foil.

Solar flares are fast events — they can develop, release energy, and dissipate all within minutes to hours. Flares occur when magnetic fields in the Sun's atmosphere suddenly reconnect, releasing a burst of energy. Therefore, flares can erupt in a matter of minutes! The X-class flares (the biggest ones) are intense, but they usually take minutes to hours to evolve fully. During observation, you'd notice flares erupting within minutes, but it's not like you'll see a flare happening for long periods unless you're lucky with timing. Most of the time, they flare up and fade very quickly. So yeah, if you're watching through solar foil, you might catch a flare in the making, but sunspots would take a little more patience over a longer period! 🔥 😏

My question concerns solar prominences. I'm interested in how they actually form and how they could theoretically affect life on

planet Earth if they are very strong at certain times. Can they disrupt electronics, wireless networks, etc.?

Solar prominences form when plasma is suspended above the Sun's surface by magnetic fields. If they become unstable and erupt, they can release large amounts of energy as coronal mass ejections (CMEs). Strong CMEs can disrupt Earth's electronics, wireless networks, and power grids by disturbing the planet's magnetic field, causing geomagnetic storms.

Did you look at the stars and want to know more about them from a young age?

Yes, it was one of my favourite things to do. My fascination with astronomy began after visiting a Polish planetarium during elementary school.

How did you decide to become an astrophysicist?

I've always loved observing the night sky and reading books about the cosmos, planets, and, funny enough, science-fiction literature about alien civilisations. I chose to study physics because it was both fascinating and relatively easy for me.

During my studies, I realised that astronomy was my true passion, and I wanted to explore it in more depth. In 2010, as a young student, I began working abroad, analysing solar data — and I've been dedicated to it ever since! I'm very loyal to my dreams and still have many to achieve. 😊

Do you perceive/have you perceived any discrimination against women in science, even personally?

No, I never felt discriminated against as a woman. Physicists and astronomers form a very open scientific community, and I've always felt respected by my colleagues — as a woman, maybe even more so! 🙂 It was encouraging to see that a woman can calculate the same things as a man.

What fascinates you most about your work and drives you forward (passion, curiosity...)?

What fascinates me most about my work is observing the Sun with Europe's largest solar telescopes. The experience of being at an altitude of around 2 km above sea level is unforgettable. Moreover, seeing solar features up close — the ones that are much larger than Earth — is incredible. To answer your question, curiosity is always at the heart of science, but you really need to love your job to endure the harsh environmental conditions (low pressure, thin air, and extreme dryness) for long periods.

How do you spend your free time?

Actually, you could call me a "Renaissance person." I have many hobbies, including horse riding, playing guitar, painting, photography, and skiing. 🙂 But most of my time is spent with family and friends. I also enjoy dancing bachata! Haha. 🙂

If you had to choose any other field of study besides astrophysics, what would it be?

Definitely architecture! 🙂 Or maybe a helicopter pilot — I'd love that too!

What advice would you give to young people who would like to pursue either astrophysics or another STEM field (Science, technology, engineering, and mathematics)? List at least 6 tips.

1. Stay curious – Always ask questions and seek to understand the "why" behind things.

2. Learn from failure – Don't be afraid to make mistakes. They're part of the learning process.
3. Focus on problem-solving – Being able to think critically and tackle challenges is key in STEM.
4. Get hands-on experience – Internships, projects, or working with mentors can deepen your knowledge.
5. Stay persistent – STEM fields can be tough, but sticking with it is essential for success.
6. Network and collaborate – Build relationships with peers, professors, and professionals. Teamwork often leads to breakthroughs!

What set of qualities (character traits) is ideal for a successful career in science?

I think for a successful career in science, an ideal set of qualities would include: curiosity, attention to detail, good communication skills, patience, teamwork, persistence, and believing in your own success. Confidence in your abilities keeps you motivated and focused.

Have you ever wanted to fly into space?

Haha, actually, no! 😄 While my curiosity is at its highest level, I'm also mindful of the hazards involved in such trips. I really value my health and well-being... and I definitely wouldn't leave my family behind to achieve personal goals.

Did you enjoy physics in school (elementary/high school)?

Sure, but for me, it was an easy subject – very fascinating. I struggled more with history as a subject in school, haha!

What in the universe fills you with the most awe?

What fills me with the most awe in the universe? Definitely black holes and supernovas. Black holes, with their ability to warp space-time, are mysterious and powerful. The idea that they could connect distant parts of the universe is so mind-blowing.

And supernovas, with their incredible energy and the creation of elements, show the raw power of the universe. Both make me feel like we're just scratching the surface of understanding the cosmos!

What is the representation of women in your profession, specifically in the study of astronomy and research?

Globally, the International Astronomical Union (IAU) reports that only about 16.6% of its members are female, highlighting a significant gender imbalance in the field. In Slovakia, women remain underrepresented in astronomy research.

What motivated you to choose your profession? Does it also fulfill you as a hobby?

I really enjoyed observing the stars and learning about the constellations. The amazing silence in places far from any civilization made me feel like I was in a magical space. It always sparked curiosity in me — are we alone in the Universe? Then I started to investigate the Sun... and I fell in love with it! ☀

How is your work appreciated?

The ability to predict the energetic events that take place on the Sun would be the greatest achievement!