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Fellows at ESO

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"What would happen if gravity was suddenly switched off? I mean something really substantial." A classic question to be asked in the middle of the night. A couple of erratic attempts later ("we would all start floating?" or "the Earth would fly away from the Sun?") the puzzle master reveals the answer: "The Earth would explode! As a result of pressure that normally counteracts the forces of gravity." Aaaaahhhh… our jaws dropped. We were awarded some small pity-points for our failed guesses and told to keep going. Further down deep into the forest, under the moonlight, somewhere in central Poland, on a scavenger hunt for... well, 15 years later I don't quite remember what we were after.

That educational exchange took place at a summer camp organised by Astronomy Club Almukantarat. They really knew how to make learning about science and astronomy cool: camping in tents, classes during the day, stargazing at night. Campfire guitar songs and surprise quest missions. A somewhat different style was that of the Polish Child's Fund, a volunteer-driven organisation that would plant us science-hungry teenagers into research labs and institutes for a week or two so that we could see it first hand. Or maybe even run our own experiment, if we were lucky. Nothing short of extremely lucky and fortunate in any case, to have all such opportunities. By the time university came, attempting to do research for life and living felt like the only natural choice. In comparison, the world outside academia seemed like a vast and somewhat terrifying unknown. Before I knew it, I became absorbed into the Borg.

When studying astronomy, one gets introduced to truly fascinating concepts, some of which may seem close to the line between science and fiction. Take 'common envelope' stars as an example. One star flies into another, much larger, giant star, such that it becomes engulfed by the extended envelope of the giant. Moving through the gaseous medium, the star experiences drag, slows down, and spirals in towards the centre of the giant. It plunges through the fluffy envelope like a gloved hand through a cover of fresh snow; the star's movement scatters and disperses the low-density envelope away into space, such that after a while the giant becomes fully unclothed, its inner dense core revealed. We call it unbinding the envelope. Never observed directly in real time owing to its rapid nature, common-envelope inspiral is surely a rather complex process. A fuel for the imagination of any student of physics who would immediately come up with several reasons (often very creative) explaining why they could not derive the outcome of a common-envelope inspiral on a piece of paper. Lo and behold, a professor comes over to *estimate* the outcome with a few lines of concise equations and a plethora of simplifying assumptions. Isn't that beautiful? Astronomy is often not terribly precise. After all, we are observing stars and galaxies millions of light-years away rather than running a well-controled lab experiment. Some of my fellow students did not like it, preferring the more exact and strict regime of mathematics or theoretical physics. But I was all in for back-of-the-envelope simple calculations or numerical simulations. My master's thesis boiled down to estimating how often in our galaxy a star would fly into its companion star (that it was orbiting in a binary) as a result of a dynamical perturbation induced by a third object flying closely by. The result: well, not too often, as it turns out. But astronomy is a safe space for funky ideas.

After a four-year period as a PhD student at Radboud University in the Netherlands, I eventually found my way to ESO. In my current work, I run numerical simulations to model interactions between stars living in close pairs (binaries) as they transfer gas between each other. I focus on massive stars, at least ten times as massive as the Sun. I try to understand how massive star binaries may lead to the formation of merging pairs of black holes or neutron stars. Since 2015 we can detect such mergers because they emit gravitational-waves. About 100 merger events have been observed so far, but with the increasing sensitivity of detectors this sample will soon skyrocket into millions of mergers detected per year (or one every few seconds). Our numerical work on massive star binaries will be needed to interpret this wealth of data and the ESO telescopes such as the VLT and ELT in the near future will be instrumental in calibrating the models. The code I use solves the same hydrostatic equilibrium equation balancing gravity and pressure in Earth that was needed to solve that midnight puzzle at an Almukantarat summer camp. And I still approximate common-envelope evolution with a few simple equations and a set of crude assumptions. For now, the quest continues.

Louise Dyregaard Nielsen

I love telescopes. I love them to such a degree that I have let my life go wherever the observing conditions are good. I love how humankind built these vast, complicated structures with the sole purpose of understanding the Universe we live in. I love that we can learn so much from such limited information delivered by photons (and in the age of multimessenger astronomy, by electrons and gravitational waves).

Growing up in the Danish countryside, the night sky was dark and easily available. As a young child, I was obsessed with stars, and I probably read through every single astronomy book available at my local library. In 1997 the comet Hale-Bopp was incredibly bright in the northern hemisphere and was visible night after night. I remember going out to spot it with my older brothers as it got brighter and brighter in its orbit around the Sun.

Despite my early fascination with the night sky, I did not know if astronomy was a real career and I had no idea what a scientist was or what they would do for work. There were no academics in my surroundings, and generally I doubted the wisdom of pursuing a career based on a childlike fascination. So after high school, I took a gap year to consider options. I worked in elder care and travelled around Central America where I picked up some Spanish. I spent that year talking to people about what they liked about their lives and jobs, and I found myself always circling back to the idea of becoming an astronomer. I started studying physics at the Niels Bohr Institute (NBI) in Copenhagen, where I met a fantastic group of new friends (all of them so smart) while getting introduced to the world of academia and science. I enjoyed physics, but it was not until I had my first astronomy course during my undergrad that I truly felt motivated to learn.

To be honest, I was not a very good university student and I struggled with time management and balancing studying with work and social events. But I scraped by in my bachelor's degree and started a master's in physics and astronomy feeling somewhat burned out. I decided to study half-time, while working as a high school teacher, teaching maths to 16–18 year olds. At the same time, my university classes were almost entirely astronomy-based, which was great! I also took on a part-time job as a research assistant in a lab at NBI that builds cameras for astronomy use. It was this job, combined with a visit to the Nordic Optical Telescope (NOT) in La Palma, that made me realise I probably enjoyed the methods of observational astronomy more than anything else. In the last year of my master's degree, I got a job as a student astronomer at the NOT, and I worked there while finishing my master's thesis.

From La Palma, I moved to Hawai'i for a few months where I worked at Gemini North Observatory before going back to Europe to take up an internship at the European Space Agency (ESA). It was there I began my first project on exoplanets, simulating spectroscopic observations of atmospheres with JWST/NIRSpec. This position became my stepping stone to starting a PhD in Geneva, Switzerland on measuring the masses of transiting planets.

This was a fantastic time to join the field of (transiting) exoplanets. Harvesting the fruit of years of ground-based surveys such as WASP and Kepler/K2 in space, while anticipating new space missions, TESS and subsequently PLATO, that would give us thousands of transiting planets around stars bright enough to follow up with detailed studies. Simultaneously, the field of radial velocity follow-up was reaching new goals as more instruments came online, namely VLT/ESPRESSO, providing unprecedented precision, and more recently NIRPS at the ESO 3.6-metre, operating in the near-infrared. Today, with more than 5000 exoplanets known, we are starting to get an idea of the general populations of exoplanets, though our detection sensitivities do not yet allow us to detect true equivalents to the planets in our Solar System.

Like many others, I finished my PhD in the depths of COVID-19. During this time I moved to Munich where my partner had got a job. We were determined to defeat the two-body problem experienced by many couples in academia. I started a short postdoc in Oxford but worked remotely as the university was fully working from home, before taking up duty at ESO as a fellow.

Working at ESO is very different from a university, but not unlike my experience at ESA. On a day-to-day level, I enjoy talking to colleagues with different backgrounds and expertise, and truly connecting with what it means to run a world-leading observatory. At ESO, I find that there is more of a 'helicopter perspective' on astronomy as a whole, with a focus on how we can be of service to a large, diverse community. As one of the few people at ESO working on exoplanets, I try to voice the needs and future concerns of my sub-field whenever I can. With ESO's Extremely Large Telescope just around the corner, and in particular the high-resolution spectrograph ANDES, the next steps for exoplanet science have already been taken, and we do not seem to be slowing down any time soon.