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The sky is made of lava: how lava worlds reveal their interiors through their atmospheres

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PUBLICATIONS

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1. **C.P.A. van Buchem**, M. Zilinskas, L.J. Janssen, Y. Miguel, and W. van Westrenen *The effect of H^- continuum on Lava Planet Emission Spectra*, to be submitted
2. **C.P.A. van Buchem**, R. Buddhacharya, M. Zilinskas, Y. Miguel, W. van Westrenen, and S. Zieba *Sensitivity of Dry Lava Planet Atmospheric Emission Spectra to Changes in Lava Compositions*, Monthly Notices of the Royal Astronomical Society, In Rev.
3. **C.P.A. van Buchem**, M. Zilinskas, Y. Miguel, and W. van Westrenen, *LavAtmos 2.0: Incorporating volatile species in vaporisation models*, Astronomy & Astrophysics, Vol 695, A157 (2025)
4. **C.P.A. van Buchem**, Y. Miguel, M. Zilinskas, and W. van Westrenen, *LavAtmos: An open-source chemical equilibrium vaporization code for lava worlds*, Meteoritics & Planetary Science, 58(8):1149-1161, (2023)

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7. M. Zilinskas, **C.P.A. van Buchem**, Y. Miguel, A. Louca, R. Lupu, S. Zieba, and W. van Westrenen *Observability of evaporating lava worlds*, Astronomy & Astrophysics, Vol. 661, A126 (2022)

CURRICULUM VITAE

I was born on a hot summer day (or so I am told) in Paris, on the 5th of July 1995. Although I started out with my parents all to myself, I soon gained not one, not two, but three younger brothers. Each welcome addition to the family brought a move to a house progressively farther from the French capital, into the countryside of Les Yvelines, eventually ending up in the town of Thoiry. These early years are filled with memories of running through the fields with my brothers and our dog, watching TV by the fireplace with our cats on our laps, and going on adventurous bike rides with my friends. It was also in these years that my interest for astronomy first reared its head.

The first thing to trigger my fascination with space was the hand-drawn images from the children's book "L'imagery de l'espace". I then read through everything the local public school library had to offer on the subject, finally convincing my parents to subscribe to a weekly space magazine, the bundled collection of which I still have in my bookcase today. In my 11th summer, my parents decided to take it a step further and show me the true scale of a planet, so we went to live on (what felt like) the other side of the world: Doha, Qatar.

We were enrolled at the American School of Doha, giving me the surreal experience of being in a classroom where I did not understand the language being spoken (mentally preparing me for future university calculus courses). Luckily this only lasted a little while, and we adjusted well to expat life. It was there that I got my first taste of "scientific" experimentation by taking part in the 5th grade science fair with two classmates - and taking home first place. It was also in Qatar that my mind was truly opened to music, discovering that there was more than Sean Paul and French rap. I picked up the guitar and quickly became convinced my goal in life was to become a rock star.

Eventually, we moved back to Europe, settling in Hellerup, Denmark, a town on the outskirts of Copenhagen. Coming from the very limited freedom of compound life in Qatar, being free to roam through Copenhagen was very well timed for my 15 year old self. It was during these years that I went through a lot of personal development (as I guess most teenagers do). I was also becoming more aware of the fact that I had had a very privileged childhood, and thought that I should capitalise on that by doing something in which I felt I could really contribute something to the world. At the time, I was convinced that space travel was the solution to all of humanity's problems. This, coupled with my ever-lingering fascination with space, led me to decide that I wanted to study astronomy. And so, after finishing high school in the summer of 2014, I moved to Leiden.

I only later found out that Leiden is a very good place to study astronomy. My first reason for moving there was the convenience of starting my stay in the Netherlands by moving in with my aunt and uncle for the first half year. The three years of my bachelor's were mainly characterised by the precarious balancing act of spending almost all of my free time at my student society (Quintus) while still doing enough work to pass all my courses. Somehow I

managed and after three years I had my bachelor's diploma in the pocket, although my extracurricular activities might have been reflected in my grade point average. It was these same extracurricular activities though, that led to me being asked to be the head of the full-time board of my student society for a year, which I accepted. This kicked off a very tumultuous year that tested me in many different ways, but also gave me some of the most memorable moments of my life - and of course, led to me meeting Marleen.

The next goal was to get my master's degree. After a few months of readjusting to going back to lectures and re-learning how to use my brain, I realised that if I wanted to continue in astronomy, I had to put a lot more time and effort into my masters than I had during my bachelor's. The extra work paid off and for my second research project I was selected to do a project at ESA/ESTEC. Walking past actual spaceships while on my way to my office was a dream come true (even if my office was located in the break room). Sadly however, the in-office experience was cut short by the pandemic.

Luckily, the interview rounds for a PhD position at Leiden had already taken place when (to quote one of the professors at the time) COVID-19 was still a "far-off Chinese disease", and I was accepted for the PhD position that led to the writing of this thesis. Although it was tough to start these years during the lockdowns, I was lucky enough to have many good friends and family living nearby. Once the restrictions were lifted and conferences started up again, a whole new world opened up for me - finally making me feel like I was truly part of a scientific community. I am very grateful for the large number of places that I was able to visit and the amazing people I was able to meet from all over the world. All in all, my PhD was a very positive experience. However, towards the end I found myself to be increasingly distracted by many of the more acute issues that our society is facing today. For this reason, for the moment being, I have decided to leave the academic world for a job as a scientific software engineer in the space industry - still keeping to my initial ideals, but now more practically oriented.

I am ever grateful for my life thus far and I look forward to seeing what the future holds.

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As with most things in life, what on the surface appears to be the result of a single person's efforts, would never have been possible without the support of the communities surrounding that person. Of course, this project would never have existed in the first place if it weren't for Yamila and Wim.

Yamila, I was very lucky to have you as a supervisor. I don't think I've ever met someone who is as committed to putting people first as you are. First you take care of the people in your team, then you take care of the science. By taking such good care of the social and mental well-being of your students and postdocs you create a very safe and scientifically productive environment. Any time that I felt stuck or demotivated about my work, having a meeting with you always got me out of my rut. Thank you so much for all the support and trust you've given me over these years.

Wim, although the pandemic meant we couldn't see each other as much as originally planned, you were always as supportive as possible from a distance. Always making the time whenever needed to help fill the gaps in my geology knowledge and giving fast, highly detailed feedback on all my writing. Even during times when you had a lot of other things on your mind as well. Thank you.

The wholesome atmosphere in our research group was in a large part also thanks to all my scientific siblings. Mantas, my scientific big brother, you've taught me more than you probably realise, both on a scientific and a personal level. Amy, my scientific twin, it has been a joy to have been able to share the whole PhD journey alongside each other. Of course, we cannot forget our Austrian cousin Sebastian who was always able to show us the way to the nearest karaoke bar and free drinks at whichever conference we were attending. Rojita, as the only master student that I supervised, I don't think I could have asked for a better student. Your view of the world is inspiring and I hope that you never lose your optimism and sense of wonder. Then, of course, there is everyone who strengthened our group later on as well: Emily, Esther, Keren, Leonie, Louis, Solene, and Vanesa. I'm glad to have met you guys and I hope that you pass on the good vibes of our group to whoever joins in the future.

In the 9 years and 6 months that I've either studied or worked at the observatory, I have met a huge number of people who have made my time better. Aaron, Alessia, Andrew, Anniek, Anthony, Aurora, Ben, Billy, Chloe, Colin, Christian, Dag, Dario, Dilovan, Elia, Elina, Frits, Gijs, Hans, Ignas, Ivana, Jeger, Jeroen, Joe, Josh, Joshiwa, Jurjen, Katia, Kevin, Kiki, Kutay, Lucie, Lukas, Luuk, Maite, Mariana, Martijn, Martje, Marta, Matt, Michiel, Naadiyah, Naor, Nico, Osmar, Orin, Piyush, Pranjal, Rico, Richelle, Rob, Roi, Roland, Sam, Saeid, Shun-Sheng, Sid, Silvia, Stefano, Syl, Thijs, Thomas, Timo, Veronica, Victorine, Willeke, William, Yapeng, Yuan, Yuze, Zephyr, Zorry... and I am bound to forget some people but please know that I will never forget the many shared lunch breaks, the bizarre topics discussed during endless coffee breaks, the making and/or destroying of puzzles, taking part in

suicidal eating challenges, racing each other in office chairs, seeing who can climb up all of the Huygens stairs the fastest, the boozy borrels, the many defense parties, board game nights, PhD activities, pandemic zoom hangouts, Sinterklaas, the barbecues, PhSkii, and making music. It's honestly impressive that we had any time left for work at all. The STRW is a truly unique place and even though many people may come and go, I hope that the welcoming atmosphere always remains.

I'm convinced that I would never have made it as far as I did in astronomy without the "Len is een Bierspons" boys. Auke, Couzy, Erik, Jelle, Joey, Jonah, and Len — it was often the fear of disappointing you guys that motivated me to drag myself to classes even on mornings after particularly rowdy nights. I've truly enjoyed eating lunch together basically every day for years, our lengthy study sessions interrupted by a few games of Hearthstone, and eventually also our hiking trips. I'm grateful to have you as a friend group.

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Marleen, thank you for being my personal cheerleader, partner in crime, and best friend. You never cease to impress me. I love you.

“Tout est vrai, et rien n’est vrai!”

"Everything is true, and nothing is true!"

– *L'Étranger*, Albert Camus