Accessible remote sensing of water

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List of publications

Refereed publications

1. *Studying bright variable stars with the Multi-site All-Sky CAmeRA (MASCARA)*
   Olivier Burggraaff; Geert Jan J. Talens; Julien F. P. Spronck; Anna-Léa Lesage; Remko Stuik; Gilles P. P. L. Otten; Vincent Van Eylen; Don Pollacco; Ignas A. G. Snellen
   Astronomy and Astrophysics, 617, A32 (2018)
   doi:10.1051/0004-6361/201833142

2. *Standardized spectral and radiometric calibration of consumer cameras*
   Olivier Burggraaff; Norbert Schmidt; Jaime Zamorano; Klaas Pauly; Sergio Pascual; Carlos Tapia; Evangelos Spyrakos; Frans Snik
   Optics Express, 27(14), 19075–19101 (2019)
   doi:10.1364/OE.27.019075

3. *Biases from incorrect reflectance convolution*
   Olivier Burggraaff
   Optics Express, 28(9), 13801–13816 (2020)
   doi:10.1364/OE.391470

4. *Citizen science with colour blindness: A case study on the Forel-Ule scale*
   Olivier Burggraaff; Sanjana Panchagnula; Frans Snik
   PLOS ONE, 16(4), e0249755 (2021)
   doi:10.1371/journal.pone.0249755

5. *Accuracy and Reproducibility of Above-Water Radiometry With Calibrated Smartphone Cameras Using RAW Data*
   Olivier Burggraaff; Mortimer Werther; Emmanuel S. Boss; Stefan G. H. Simis; Frans Snik
   Frontiers in Remote Sensing, 3, 940 096 (2022)
   doi:10.3389/frsen.2022.940096

Non-refereed publications

1. *A universal smartphone add-on for portable spectroscopy and polarimetry: iSPEX 2*
   Olivier Burggraaff; Armand B. Perduijn; Robert F. van Hek; Norbert Schmidt; Christoph U. Keller; Frans Snik
   Proceedings of the SPIE, 11389, 113892K (2020)
   doi:10.1117/12.2558562

Co-authored publications

1. *Data calibration for the MASCARA and bRing instruments*
   Geert Jan J. Talens; Erik R. Deul; Remko Stuik; Olivier Burggraaff; Anna-Léa Lesage; Julien F. P. Spronck; Samuel N. Mellon; John I. Bailey; Eric E. Mamajek; Matthew A. Kenworthy; Ignas A. G. Snellen
   Astronomy and Astrophysics, 619, A154 (2018)
   doi:10.1051/0004-6361/201834070

2. *Discovery of δ Scuti Pulsations in the Young Hybrid Debris Disk Star HD 156623*
   Samuel N. Mellon; Eric E. Mamajek; Konstanze Zwintz; Trevor J. David; Remko Stuik; Geert Jan J. Talens; Patrick Dorval; Olivier Burggraaff; Matthew A. Kenworthy; John I. Bailey; Blaine B. D. Lomberg; Rudi B. Kuhn; Michael J. Ireland; Steven M. Crawford
   The Astrophysical Journal, 870(1), 36 (2019)
   doi:10.3847/1538-4357/aaf008

3. *Bright Southern Variable Stars in the bRing Survey*
   Samuel N. Mellon; Eric E. Mamajek; Remko Stuik; Konstanze Zwintz; Matthew A. Kenworthy; Geert Jan J. Talens; Olivier Burggraaff; John I. Bailey; Patrick Dorval; Blaine B. D. Lomberg; Rudi B. Kuhn; Michael J. Ireland
   The Astrophysical Journal Supplement Series, 244(1), 15 (2019)
   doi:10.3847/1538-4365/ab3662

Curriculum vitae

I was born in Zoetermeer, the Netherlands, in 1996, and grew up there and in neighbouring Bergschenhoek. I attended Passe Partout primary school from 2000–2006 and from 2006–2012 I attended Erasmus College Zoetermeer, from which I obtained my vwo/gymnasium high school diploma.

I started my Bachelor's degrees in physics and astronomy at Leiden University in 2012. In my second year, I participated in a research project involving observations of the Sagittarius stellar stream using the Isaac Newton Telescope on La Palma, Spain. I graduated cum laude from both degrees in 2015 with a thesis titled *iSPEX: Quantitative Spectroscopy on a Smartphone*, supervised by Frans Snik and Christoph Keller. In that thesis, we attempted to empirically correct the errors caused by JPEG compression, achieving limited success and laying the groundwork for Chapter 3 five years down the line.

I continued my studies in Leiden by pursuing a Master's degree in Research in Astronomy from 2015–2017. This programme included elective computer science courses, studying data mining techniques and neural networks. For my first research project, I worked with Ignas Snellen on the detection and characterisation of bright variable stars using the Multi-site All-Sky CAmeRA (MASCARA). This project eventually led to a publication in Astronomy & Astrophysics, as listed in the previous section. I worked with Anthony Brown for my second research project, investigating the velocities of stars in the solar neighbourhood using the first Gaia data release (DR1). We used the extreme deconvolution (XD) statistical technique to infer the six-dimensional position-velocity distribution of stars from the five-dimensional DR1 data, which did not include radial velocity measurements. Our results hinted towards previously unknown structures in the stellar velocity distribution, which were later confirmed by other groups using DR2. I graduated cum laude in 2017.

I worked as a teaching assistant (TA) on the *Praktische Sterrenkunde* (Practical Astronomy) course from 2015–2020. This course exposed first-year Bachelor's students to all aspects of astronomical work, including data acquisition with a telescope, data analysis in Python, and academic writing. As a TA, I was involved in every aspect of the course, including teaching practicals, grading reports, and building instrumentation. In 2017, I worked with Frans Snik on a LEGO® replica of the Paranal Very Large Telescope (VLT) complex, commissioned by the European Southern Observatory (ESO).

With the astronomy student association L.A.D. 'F. Kaiser', I organised a series of public lectures on astronomy, the Kaiser Spring Lectures, in 2016. We welcomed >300 guests over the course of four lectures. From 2016–2017 I also served as the chair-treasurer for Kaiser.

In 2018, I started my PhD at Leiden University, working in the astronomy and environmental sciences departments under supervision of Frans Snik and Martina Vijver, with Christoph Keller as an additional promotor. My research (Chapters 1–7) was part of the Horizon 2020 consortium MONOCLE. In 2019, I attended the Ocean Optics course at the University of Maine, sponsored by NASA and EUMETSAT. I have attended and presented at several conferences, including SPIE Defense + Commercial Sensing, PittCon, and RSPSoc's Wavelength conference, and co-organised the 2018 Remote Sensing in Ecology workshop in Leiden. I have served as a peer reviewer for the journals Applied Optics, Biomedical Optics Express, Optics Express, and Photogrammetric Engineering & Remote Sensing. Finally, I have given guest lectures on remote sensing and polarimetry in several courses at Leiden University and the University of Siena.

Acknowledgements

At the time of writing, I have spent over a third of my life at Leiden University. I would like to use this section to thank those who worked with or supported me during this period.

First of all, I would like to thank my supervisors/promotors, Christoph Keller, Martina Vijver, and Frans Snik, for their professional and personal support. I appreciate their great enthusiasm and the many opportunities they have provided me.

I am very grateful to everyone at CML and the Observatory who makes the institutes pleasant to be in and work in, including the housekeeping, scientific, and secretarial staff. I would like to thank all members of the Environmental Biology, Remote Sensing, and Astronomical Instrumentation groups for creating a friendly atmosphere. I am particularly grateful to David Doelman for his invaluable advice during the PhD process and to Juriën Huisman and Rafaël Mostert for making my Bachelor's, Master's, and PhD much more enjoyable.

My research was part of the Horizon 2020 consortium MONOCLE and I would like to thank all participants for the pleasant collaborations, field campaigns, and even committee meetings. I am especially thankful to Jess Heard and Stefan Simis for leading the consortium and for always offering a helping hand.

My primary collaborator for smartphone science has been Norbert Schmidt, whom I would like to thank for his enthusiastic work on the SPECTACLE and iSPEX 2 apps, even as I kept suggesting new features. Equally, I would like to thank Armand Perduijn for all the energy poured into designing and producing iSPEX 2 and into teaching me how to think like an engineer – I'll get it one day! I am also grateful to everyone else at DDQ and BLS for their important contributions, in particular Rob van Hek and Joep van der Heiden.

There have been many other pleasant collaborations in the past four years. I would like to thank Hester Volten and Daan Swart of RIVM, Jeroen Rietjens and Martijn Smit of SRON, and Gerard van Harten of JPL for advising and collaborating on various SPEX instruments. I am particularly indebted to my former student Aaron Seymour who single-handedly revived the groundSPEX instrument after many years in an attic (the instrument, not the student). I am grateful to Shungu Garaba, Tristan Harmel, and Paolo Corradi for inviting me into OP^3, to Remko Stuik for designing the groundSPEX goniometer, and to the participants of the ESA measuring campaigns, particularly Wout Bakker and Anton de Fockert of Deltares and Suhyb Salama of ITC. Lastly, I would like to thank Arie van der Meijden of Naturalis for collaborating on the beetle scanner project.

I am very grateful to have been given the opportunity to attend the 2019 Ocean Optics course at the University of Maine, funded by NASA and EUMETSAT. I would like to thank the professors, teaching assistants, classmates and research interns, and the Darling Marine Center staff for providing a highly educational and enjoyable, and utterly gruelling, experience. Most of all, I would like to thank Emmanuel Boss and Mortimer Werther for advising and collaborating on much of my work since then.

I would like to thank the teachers/professors who led me here. At school, these were Dirk Kuilman, Jaap Focke, Meindert Boskma, and Richard van Rooijen. From Leiden, I am particularly grateful to Ignas Snellen and Anthony Brown for supervising my Master's theses. Lastly, I would like to thank Michiel Hogerheijde, Huib Jan van Langevelde, Maarten van 't Zelfde, and Steven Loiselle for providing me with valuable teaching experience.

Additionally, I would like to thank my Leiden friends Coen, Corjan, Daan, Eveline, Teun, and Tim, as well as my online friends Colin, Kyrylo, Steele, Tom, and Vitus for their great

personal and occasionally professional support over the years. I would also like to thank my pal the tortoise, Aku, who lives the life of a madman. Most of all I would like to thank Sanj for all her support, all the new perspectives she has given me, and for the music she has added to my life over these past years.

Finally, I would like to thank my family. My siblings Sebastiaan and Carlijn have always been supportive and have taught me much, especially the art of wordplay. I am a proud uncle to Eléonora and Willem, who I hope will one day read this. I would like to thank my late grandfather Thom, who enthusiastically read every essay I wrote for my Bachelor's courses. My father, Jan Karel, has been instrumental in feeding my insatiable curiosity since I was little, which eventually led to this thesis and for which I am very grateful. Lastly, I would like to thank my mother, Karin, who unfortunately did not get to see me finish my PhD, for all her loving support over the years.

I conclude this thesis with a paraphrase from *Cynegeticus*[29], written almost 2000 years ago by Arrian of Nicomedia:

> For I myself, you know, have raised a hound with eyes as grey as the greyest, and he is both fast and diligent and of good spirit and most gentle. [...] And so I think I should not hesitate to record the name of the hound, because truly I have a most swift, most wise, and most wonderful hound, whose name is Dorus.

[29] Following the translation in *Lives in Interaction: Animal 'Biographies' in Graeco-Roman Literature?*, Thorsten Fögen (2017), doi:10.1515/9783110545623-005.