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## **Predicting the future: Predictive control for astronomical adaptive optics**

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“Don’t adventures ever have an end? I suppose not. Someone else always has to carry on the story”.

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J.R.R. Tolkien,  
*The Fellowship of the Ring*



## List of Publications

### First Author, Peer Reviewed:

- Maaïke van Kooten, Niek Doelman, et al. (2020a). “Brightening of Kepler light curves: from binary star systems to forward scattering dust clouds”. In: *Under review*
- Maaïke van Kooten, Niek Doelman, et al. (2020b). “Robustness of prediction for extreme adaptive optics systems under various observing conditions - An analysis using VLT/SPHERE adaptive optics data”. In: *Astronomy and Astrophysics* 636, A81. DOI: 10.1051/0004-6361/201937076. URL: <https://doi.org/10.1051/0004-6361/201937076>
- Maaïke van Kooten, Niek Doelman, et al. (May 2019). “Impact of time-variant turbulence behavior on prediction for adaptive optics systems”. In: *J. Opt. Soc. Am. A* 36.5, pp. 731–740
- Maaïke van Kooten, Jean Pierre Veran, et al. (2017). “Alternative pyramid wavefront sensors”. In: *Journal of Astronomical Telescopes, Instruments, and Systems* 3.2, p. 029001

### Conference Proceedings

- Maaïke van Kooten, Niek Doelman, et al. (2018). “Implications for contrast as a result of the wind vector and non-stationary turbulence”. In: *Adaptive Optics Systems VI*. vol. 10703. International Society for Optics and Photonics, p. 107032C
- Maaïke van Kooten, Niek Doelman, et al. (2017). “Performance of AO predictive control in the presence of non-stationary turbulence”. In: Instituto de Astrofísica de Canarias
- Maaïke van Kooten, Colin Bradley, et al. (2016). “Fast modulation and dithering on a pyramid wavefront sensor bench”. In: *Adaptive Optics Systems V*. vol. 9909. International Society for Optics and Photonics, 99096G
- Emiel H Por et al. (2018). “High contrast imaging for python (HCIPy): an open-source adaptive optics and coronagraph simulator”. In: *Adaptive Optics Systems VI*. vol. 10703. International Society for Optics and Photonics, p. 1070342
- John Pazder et al. (2014). “The FRD and transmission of the 270-m GRACES optical fiber link and a high numerical aperture fiber for astronomy”. In: *Advances in Optical and Mechanical Technologies for Telescopes and Instrumentation*. Vol. 9151. International Society for Optics and Photonics, p. 915124
- Etsuko Mieda et al. (2016). “Testing the pyramid truth wavefront sensor for NFI-RAOS in the lab”. In: *Adaptive Optics Systems V*. vol. 9909. International Society for Optics and Photonics, 99091J

Olivier Lardière et al. (2017). “Double-Pyramid Wavefront Sensors: Tolerance Relaxation and Cheaper Alternatives using Achromatic Double-Roof Prisms”. In: *Adaptive Optics for Extremely Large Telescopes V (AO4ELT5)*

SY Haffert et al. (2018). “On-sky results of the Leiden EXoplanet Instrument (LEXI)”. in: *Adaptive Optics Systems VI*. vol. 10703. International Society for Optics and Photonics, p. 1070323

## List of Selected Presentations

### 2019

*Performance of different wavefront predictors for SPHERE AO*. AO4ELT6. June 2019. Quebec City, Canada (Poster)

*Instrumentation at Leiden Observatory: from liquid crystals to control*. Herzberg Institute of Astrophysics, National Research Council. April 2019. Victoria, Canada (Oral)

### 2018

*Predictive control for High Contrast Imaging*. NYRIA Workshop. October 2018. Leiden, The Netherlands. (Oral)

*Seeing the future*. Leiden Observatory Science Day. September 2018. Leiden, The Netherlands. (Oral)

*Implications for contrast as a result of the wind vector and non-stationary turbulence*. SPIE Astronomical Telescopes & Instrumentation. June 2018. Austin, United States. (Oral)

*Toward modelling non-stationary turbulence*. March 2018. Wavefront sensing and control for AO Workshop. Durham, England. (Oral)

*Seeing through the atmosphere: How to get the most out of a ground-based telescope*. Open Seminar Series Geoscience & Remote Sensing. May 2018. Delft, The Netherlands. (Oral)

### 2017 & earlier

*Pupil plane wavefront sensor technologies at Leiden Observatory*. Face2Phase Conference. October 2017. Delft, The Netherlands (Oral)

*Performance of AO predictive control in the presence of non-stationary turbulence*. AO4ELT5 Conference. June 2017. Tenerife, Spain (Poster)

*Fast modulation and dithering on a pyramid wavefront sensor bench*. SPIE Astronomical Telescopes & Instrumentation. June 2016. Edinburgh, Scotland. (Poster)

## Curriculum Vitae

Born to Gerrit and Mary van Kooten in Richmond, Canada, on 20 July 1992, I am the 3rd of 4 daughters. Growing up, my father, a professor in land-use and agricultural economics, had a part time appointment at Wageningen University & Research, meaning that my family spent time in Wageningen where I attended peuterspeelzaal and later basisschool (Group 3). At the age of 9, we moved from Richmond to Reno, USA. Here, I have my first memories of enjoying arithmetic and typing classes. Moving back to Canada, (Victoria), my parents enrolled me in French immersion as I was bored in normal classes. For the next 3 years I fully enjoyed science, maths, and learning French. My teachers inspired me to explore many topics outside of the curriculum, which led to me presenting a science project on nuclear fusion and the life-cycle of stars.

I attended Lambrick Park High school, where I took all the mathematics and science courses offered, while spending much of my spare time playing sports including Judo, and field hockey. While I had always enjoyed physics, and had a fascination for stars for as long as I could remember, I was convinced I would enter into a Bachelor program in pure mathematics.

In September 2010, I started my Bachelor's program in Physics and Astronomy at the University of Victoria (UVic) after my mother encouraged me to look at other programs beside mathematics. Supplementary to my classroom work, I completed three work terms at the Herzberg Institute of Astrophysics (HIA). My first position was in the visitor center where I gave telescope tours, prepared education material, and led science camps for kids. I subsequently worked on analysing sub-millimetre data, followed by working in the fiber optics laboratory. As a 4th-year project, I looked for transit events around white-dwarfs with the local 1.8 m telescope. Through these experiences and the people I met at HIA, I knew that astronomy instrumentation was the field for me. I began my Master's of Applied Science degree in UVic's Mechanical Engineering department in 2014, with Colin Bradley as my supervisor. I performed initial work on the wavefront sensing setup to be used by the Thirty Meter Telescope's AO system, investigating different implementations of pyramid wavefront sensors.

In September 2016, I returned to the Netherlands to start my PhD at Leiden Observatory. Working with Niek Doelman and Matthew Kenworthy, my research topic was predictive control for extreme AO systems found in high-contrast imaging instruments. With full control over the direction of my research, I have explored topics including atmospheric turbulence profiling and simulations, as well as linear data-driven prediction, and performed tests on VLT/SPHERE AO data.

I will begin the next stages of my career in astronomy instrumentation as a post-doctoral researcher at the University of California, Santa Cruz, in October 2020. There I will continue exploring AO control and perform on-sky tests at the Keck Telescope.