

HANNES BREYTENBACH

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ABOUT ME

I'm a published researcher in the field of astrophysics with a passion for data science and data visualization. I am currently completing my MSc in astrophysics at University of Cape Town (UCT) and expect to graduate in December 2024.

I'm a proficient full stack `python` developer with 12 years of coding experience and contributions to a number of open-source scientific computing and visualization libraries. I am passionate about open source and have authored and maintain a number of software libraries for applications in astronomy. I have extensive experience in statistical model building and using machine learning to gain valuable insights into data. I have participated in, and later led independent research into developing machine learning models for predicting the onset of seizures in patients suffering from epilepsy using EEG data.

My main hobbies are outdoor adventure sports such as rock-climbing and high-lining, and I have led- and participated in numerous international expeditions to remote mountainous regions on earth.

PERSONAL INFO

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|----------------------------|------------------------------------------------------------------------|
| Full Names: | Johannes Benjamin Breytenbach |
| Current Occupation: | MSc. Student at South African Astronomical Observatory (SAAO) & UCT |
| Work Address: | Room 5-42, RW James Bldg., Dept. of Astronomy, University of Cape Town |
| Date of Birth: | 26 June 1987 |
| Citizenship: | South African |
| Languages: | English, Afrikaans (Native); German (Conversational) |
| Drivers License: | A, B |

ONLINE PRESENCE

 github.com/astromancer

 researchgate.net/profile/Hannes_Breytenbach

 kaggle.com/apodemus

 stackoverflow.com/users/1098683/astromancer

 linkedin.com/in/hannes-breytenbach

 mendeley.com/profiles/hannes-breytenbach2/

 orcid.org/0000-0001-5391-2386

 facebook.com/hannes.breytenbach.3

EDUCATION

2011 – 2024 MSc (Astrophysics) – UCT, SAAO (downgraded from PhD, completed part-time)

- Thesis title: *“A Study of Quasi-Periodic Oscillations in magnetic Cataclysmic Variable Stars”*
- Supervisors: Dr. David Buckley, A. Prof Patrick Woudt
- Modules: Cataclysmic Variable Stars, Stellar Structures, Advanced General Relativity, Hot Topics in Cosmology, High Energy Astrophysics

2010 BSc Honours (Astrophysics and Space Science) – UCT

- Thesis title: *“The Sferic Count Rate from SANA-IV, Antarctica”*
- Supervisors: Dr. Andrew Collier
- Modules: General Astrophysics, Electrodynamics, General Relativity, Computational Astrophysics, Galaxies and Large Scale Structure, Observational Techniques, Radio Astronomy

2006 – 2009 BSc (Physics and Astronomy) – University of Pretoria (UP)

- Project title: *“Rutherford Backscattering Spectroscopy and X-ray Diffraction Spectroscopy of Aluminium 100”*
- Supervisors: Prof. Chris Theron
- Modules: Quantum Mechanics, Solid State Physics, Statistical Mechanics, Differential Calculus, Vector Calculus, Partial Differential Equations, Abstract Algebra, Mathematical Modelling

WORK & TEACHING EXPERIENCE

2021 – 2022 Python Developer / Data Scientist

Float Capital

- Worked on the visualization platform for diagnostics of market system behaviour.
- Researched Agent Based Modelling approach for market prediction.

2022 Tutor

UCT

- Masters course: Cataclysmic Variable stars, Practical component

2009 – 2015 Tutor

UCT, UP

- Tutored various subjects: Biological Physics (1st year), Astronomy (2nd year), Electrodynamics (Hons.)

2007 – 2008 Junior Data Analyst

HartRAO

- Analysed radio data from astronomical masers to search for variability.

SPECIAL SKILLS

Software Development

Scientific Computing

- **2012-2024** Full stack python developer with 12 years of experience, specialising in scientific applications.
Tools: git, vscode, sourcery, pylance, pytest, tox
- **2018-2024** Contributor to matplotlib, astropy, pymultinest
Tools: github, circleCI, AWS pipelines
- **2019-2024** Author and maintainer of several open source packages: [my github](#).
[pyshoc](#): A library for analysing data from the Sutherland High-speed Optical Camera (SHOC) instrument.
[salticam](#): An improved photometry pipeline for SALTICAM ultra-fast imaging camera on SALT.

Cryptocurrency

- **2021-2022** Worked on the visualization code for diagnostics of market system behaviour for the cryptocurrency trading platform Float Capital.
Tools: plotly

Data Science

Machine Learning

- **2018 – 2024** Developed [obstools](#): A library for automated image alignment of overlapping astronomical images etc.
Skills: Image Segmentation, Image Registration, Optimization, Clustering
- **2016** Led a team in [Melbourne University AES/MathWorks/NIH Seizure Prediction Challenge](#): Model ranked top 23% on Kaggle.
Skills: Data Mining, Feature Engineering, Model Selection, Team Management
- **2014** Developed [eeg](#): Algorithms for classification of EEG data for [American Epilepsy Society Seizure Prediction Challenge](#): Model ranked top 15% on Kaggle.
Skills: Time Series Analysis, Digital Signal Processing, Spectral Estimation, Statistical Modelling, Prediction, Classification
Tools: scikit-learn, tensorflow, openCV, xdg-boost

Signal Processing

- **2020 – 2024** Developed [tsa](#): Time series analysis & spectral estimation tools to search for and characterize Quasi-Periodic Oscillations in magnetic Cataclysmic Variable stars.
Tools: scipy, astropy, pandas, sktime

Statistical Modelling

- **2020 – 2022** Developed and tested a generative model for (EM)CCD data for calibrating fast-frame rate video observations of mCVs.
Tools: pymultinest, emcee, lmfit

Cluster Computing

- **2018** Deployed pyshoc on SAAO Mensa cluster.
Tools: multiprocessing, joblib

Astronomy & Astrophysics

Observing

- **2012-2021** Total of 135 nights of observing on SAAO 1.0m, 1.9m, IRSF telescopes, including remote operation.
Tools: Aladin, ds9, js9
- **2017** 7 nights operator training on SALT.

Proposal Writing

- **2014-2015** PI of 2 successful SALT science proposals.
- **2012-2018** Co-I of several observing proposals for SAAO 1.9m, 1.0m telescopes, as well as for the [TNO](#) telescope, National Astronomical Research Institute of Thailand (NARIT).
Tools: \LaTeX , latexmk, PIPT

AWARDS AND ACHIEVEMENTS

| | |
|--------------------|---------------------------------------------------------------------|
| 2013 – 2016 | NRF, Postgraduate Development Programme (PDP) Doctoral Scholarship |
| 2010 – 2012 | South African Square Kilometre Array (SKA) Postgraduate Scholarship |
| 2008 – 2009 | SKA Undergraduate Bursary Award |

LEADERSHIP & INVOLVEMENTS

Academic

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|--------------------|---------------------------------------------------------------------|-----------------------------|
| 2017 – 2018 | Postgraduate Mentor | Astronomy/Physics Dept. UCT |
| • | Advised undergraduate students on postgraduate opportunities | |
| 2014 – 2016 | Postgraduate Student Representative | Astronomy Dept. UCT |
| • | Mediated student issues within Science Faculty | |
| • | Served on Science Postgraduate student council | |
| 2011 | Volunteer | Siyavula Education |
| • | Translated open source High School science textbooks into Afrikaans | |

Public Talks

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|------------------------|------------------------------------------------|-------------------------|
| 2016 January 23 | “The Cataclysmic Variables” | SAAO Open Night |
| 2016 June 20 | “How the universe creates CVs” | Hermanus Astronomy Club |

PROFESSIONAL DEVELOPMENT

Conference Attendance

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|-------------------------|----------------------------------------------------------------------------------------------------------------|------------------------------|
| 2023 Dec. | Magnetism & Accretion 2023 | UCT Graduate Business School |
| • Poster: | “On the discovery of Quasi-Periodic oscillations in the polars J1928-5001 and IGR J14536–5522” | |
| 2017 Nov. | IAU Symposium 339: Southern Horizons in Time-Domain Astronomy | STIAS |
| • Poster: | “Quasi-Periodic Oscillations in magnetic CVs” | |
| 2017 Nov. | .Astronomy9 | SAAO |
| 2017 Sept. | Deep Learning Indaba | WITS |
| 2016 July | South African Institute of Physics (SAIP) Conference | UCT |
| • Talk: | “Quasi-Periodic Oscillations in magnetic CVs” | |
| 2015 Sept. | The Golden Age of Cataclysmic Variables and Related Objects – III | Palermo, Italy |
| • Talk: | “Quasi-Periodic Oscillations in magnetic CVs” | |
| 2015 June | SALT Science Conference 2015 | STIAS |
| • Poster: | “Probing accretion in magnetic CVs through rapid photometry with SALTICAM” | |
| 2014 July | SAIP Conference | UJ |
| • Talk: | “Rapid Variability of magnetic Cataclysmic Variable Stars” | |
| 2013 Sept. | The Golden Age of Cataclysmic Variables and Related Objects – II | Palermo, Italy |
| • Talk: | “Modelling Rapid Variability in Cataclysmic Variable Stars” | |
| 2013 July | SKA Joint Radio Transients Conference | Protea Hotel, Krüger Gate |
| 2013 Feb | StellaNovae | Cape Town |
| • Poster: | “Modelling Quasi-Periodic Variability of Dwarf Novae in Outburs” | |
| 2012 Dec. | SKA Postgraduate Bursary Conference | STIAS |
| • Talk: | “Modelling Quasi-Periodic Variability in Dwarf Novae during outburst” | |
| 2012 Aug. | IAU XXVIII General Assembly | Beijing, China |
| • Poster: | “Modelling Quasi-Periodic Variability in Cataclysmic Variable Stars” | |
| 2011 Dec. | SKA Postgraduate Bursary Conference | STIAS |
| • Poster: | “A study of DNOs and QPOs in Cataclysmic Variable Stars” | |
| 2011 Mar. | Middle-East and African Regional IAU Meeting II (MEARIM-II) | Cape Town |
| 2010 – 2008 Nov. | SKA Postgraduate Bursary Conference | STIAS |

Workshop Attendance

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| 2017 Apr. | Workshop on Magnetic Accretion | SAAO |
| • Talk: | “Observations of Quasi-Periodic Oscillations in magnetic CVs” | |
| 2017 Apr. | SKA Big Data Africa Summer School | Cape Town |
| • Led tutorial session: | “Outlier detection for time series data” | |
| • Led a student team investigating: | “Epileptic seizure prediction from EEG data” | |
| 2016 Nov. | Workshop on Bayesian Analysis in Physics and Astronomy | Stellenbosch |

- Led hack project: “[Bayesian methods for CCD photometry](#)”
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| 2016 May | CDS Tools Workshop | SAAO |
| 2015 Nov. | Workshop on using ALMA for science | UCT |
| 2015 Apr. | GPGPU programming workshop | UCT |
| 2014 Nov. | GADGET Simulations workshop | UCT |
| 2014 Oct. | 2 nd Machine learning JEDI Workshop | Cape Town |
- Developed classification pipeline for [American Epilepsy Society Seizure Prediction Challenge](#)
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|------------------|-----------------------------------------------------------------------|----------------------|
| 2012 Feb. | IAU International School of Young Astronomers (ISYA) | UCT, SAAO |
| 2011 Oct. | Workshop on Space Science and Astrophysics | CHPC, CSIR, Pretoria |
| 2010 Dec. | Workshop on Convection in stars | UJ |
| 2010 Jan. | National Astrophysics and Space Science Program (NASSP) Summer School | UCT & SAAO |

PUBLICATIONS

Peer-reviewed

First-Authored

- [1] *Discovery, observations, and modelling of a new eclipsing polar: MASTER OT J061451.70-272535.5*. By **H. Breytenbach**, D. A. H. Buckley, P. Hakala, J. R. Thorstensen, A. Y. Kniazev, M. Motsoaledi, P. A. Woudt, S. B. Potter, V. Lipunov, E. Gorbovskoy, P. Balanutsa, and N. Tyurina. MNRAS, 484(3):3831–3845, Apr. 2019. URL: <https://doi.org/10.1093/mnras/stz056>.

Co-authored

- [1] *Two Long-period Cataclysmic Variable Stars: ASASSN-14ho and V1062 Cyg*. By L. C. Gasque, C. A. Hening, R. E. Hviding, J. R. Thorstensen, K. Paterson, **H. Breytenbach**, M. Motsoaledi, and P. A. Woudt. AJ, 158(4):156, 156, Oct. 2019.
- [2] *High-speed photometry of the eclipsing polar UZ Fornacis*. By Z. N. Khangale, S. B. Potter, E. J. Kotze, P. A. Woudt, and **H. Breytenbach**. A&A, 621:A31, A31, Jan. 2019. URL: <https://doi.org/10.1051/0004-6361/201834039>.
- [3] *High-speed photometry of faint cataclysmic variables - IX. Targets from multiple transient surveys*. By K. Paterson, P. A. Woudt, B. Warner, **H. Breytenbach**, C. K. Gilligan, M. Motsoaledi, J. R. Thorstensen, and H. L. Worters. MNRAS, 486(2):2422–2434, June 2019.
- [4] *The Astropy Project: Building an Open-science Project and Status of the v2.0 Core Package*. By Astropy Collaboration et al. AJ, 156(3):123, 123, Sept. 2018. URL: <https://doi.org/10.3847/2F1538-3881%2Faabc4f>.
- [5] *Optical Studies of 15 Hard X-Ray Selected Cataclysmic Binaries*. By J. P. Halpern, J. R. Thorstensen, P. Cho, G. Collver, M. Motsoaledi, **H. Breytenbach**, D. A. H. Buckley, and P. A. Woudt. AJ, 155(6):247, 247, June 2018. URL: <https://doi.org/10.3847/2F1538-3881%2Faabfd0>.
- [6] *The Structure of Chariklo’s Rings from Stellar Occultations*. By D. Bérard et al. AJ, 154:144, 144, Oct. 2017. URL: <http://iopscience.iop.org/article/10.3847/1538-3881/aa830d/meta>.
- [7] *Size and Shape of Chariklo from Multi-epoch Stellar Occultations*. By R. Leiva, B. Sicardy, J. I. B. Camargo, J.-L. Ortiz, J. Desmars, D. Bérard, E. Lellouch, E. Meza, P. Kervella, C. Snodgrass, R. Duffard, N. Morales, A. R. Gomes-Júnior, G. Benedetti-Rossi, R. Vieira-Martins, F. Braga-Ribas, M. Assafin, B. E. Morgado, F. Colas, C. De Witt, A. A. Sickafoose, **H. Breytenbach**, J.-L. Dauvergne, P. Schoenau, L. Maquet, K.-L. Bath, H.-J. Bode, A. Cool, B. Lade, S. Kerr, and D. Herald. AJ, 154:159, 159, Oct. 2017. URL: <http://iopscience.iop.org/article/10.3847/1538-3881/aa8956/meta>.

- [8] *A VLT-ULTRACAM study of the fast optical quasi-periodic oscillations in the polar V834 Centauri*. By M. Mouchet, J.-M. Bonnet-Bidaud, L. Van Box Som, E. Falize, D. A. H. Buckley, **H. Breytenbach**, R. P. Ashley, T. R. Marsh, and V. S. Dhillon. *A&A*, 600:A53, A53, Apr. 2017. URL: <https://www.aanda.org/articles/aa/abs/2017/04/aa30166-16/aa30166-16.html>.
- [9] *IGR J19552+0044: A new asynchronous short period polar. Filling the gap between intermediate and ordinary polars*. By G. Tovmassian, D. González-Buitrago, J. Thorstensen, E. Kotze, **H. Breytenbach**, A. Schwöpe, F. Bernardini, S. V. Zharikov, M. S. Hernandez, D. A. H. Buckley, E. de Miguel, F.-J. Hamsch, G. Myers, W. Goff, D. Cejudo, D. Starkey, T. Campbell, J. Ulowetz, W. Stein, P. Nelson, D. E. Reichart, J. B. Haislip, K. M. Ivarsen, A. P. LaCluyze, J. P. Moore, and A. S. Miroshnichenko. *A&A*, 608:A36, A36, Dec. 2017. URL: <https://doi.org/10.1051/0004-6361/201731323>.
- [10] *Peculiarities of the accretion flow in the system HL CMA*. By A. Semena, M. Revnivtsev, D. Buckley, A. Lutovinov, and **H. Breytenbach**. *Astronomy Letters*, 42(6):379–392, 2016. URL: <https://arxiv.org/pdf/1610.00874.pdf>.
- [11] *High-speed photometry of faint cataclysmic variables–VIII. Targets from the Catalina Real-Time Transient Survey*. By D. L. Coppejans, P. A. Woudt, B. Warner, E. Kōrding, S. A. Macfarlane, M. P. Schurch, M. M. Kotze, **H. Breytenbach**, A. A. Gulbis, and R. Coppejans. *MNRAS*, 437(1):510–523, 2014. URL: <https://academic.oup.com/mnras/article/437/1/510/1001483/High-speed-photometry-of-faint-cataclysmic>.
- [12] *On the area of accretion curtains from fast aperiodic time variability of the intermediate polar EX Hya*. By A. N. Semena, M. G. Revnivtsev, D. A. Buckley, M. M. Kotze, I. I. Khabibullin, **H. Breytenbach**, A. A. Gulbis, R. Coppejans, and S. B. Potter. *MNRAS*, 442(2):1123–1132, 2014. URL: <https://academic.oup.com/mnras/article-abstract/442/2/1123/981562/On-the-area-of-accretion-curtains-from-fast>.

Conference Proceedings

- [1] *High time resolution variability, optical photometry and polarimetry studies of magnetic CVs*. By D. Buckley, T. Marsh, J.-M. Bonnet-Bidaud, M. Mouchet, V. Dhillon, H. Breytenbach, P. Irawati, S. Potter, M. Motsoaledi, and P. Woudt. In *42nd COSPAR Scientific Assembly*, volume 42, E1.7-10-18, E1.7-10-18, July 2018.
- [2] *MASTER-SAAO transient detections: new Cataclysmic Variable discoveries*. By D. A. H. Buckley, **H. Breytenbach**, A. Kniazev, M. Kotze, M. Motsoaledi, S. Potter, P. Woudt, V. Lipunov, and E. Gorbovskoy. In *Proceedings of Science*, 2017. URL: https://pos.sissa.it/archive/conferences/255/027/Golden2015_027.pdf.
- [3] *Quasi-periodic oscillations in magnetic Cataclysmic Variables: Results for V834 Cen*. By **H. Breytenbach**, Buckley, D. A. H., Bonnet-Bidaud, J.-M., and Mouchet, M. In *Proceedings of Science*, 2017. URL: https://pos.sissa.it/archive/conferences/255/018/Golden2015_018.pdf.
- [4] *New Observations of Accretion Phenomena in Magnetic Cataclysmic Variables*. By D. Buckley, S. Potter, E. Kotze, M. Kotze, and **H. Breytenbach**. In *EPJ Web of Conferences*, volume 64, page 07005. EDP Sciences, 2014. URL: www.epj-conferences.org/articles/epjconf/pdf/2014/01/epjconf_mag2013_07005.pdf.

Short publications

- [1] *Classification of MASTER OT J061451. 70-272535.5 as an eclipsing Polar*. By D. Buckley, **H. Breytenbach**, A. Kniazev, M. Kotze, M. Motsoaledi, S. Potter, J. Thorstensen, E. Gorbovskoy, V. Lipunov, and P. Woudt. *The Astronomer’s Telegram*, 7169:1, 2015. URL: <http://www.astronomerstelegam.org/?read=7169>.
- [2] *SALT spectroscopy of the flaring blazar J141922. 55-083832.0*. By D. Buckley, **H. Breytenbach**, A. Kniazev, M. Kotze, S. Potter, E. Gorbovskoy, and V. Lipunov. *The Astronomer’s Telegram*, 7167:1, 2015. URL: <http://www.astronomerstelegam.org/?read=7167>.

OUTREACH & VOLUNTEERING

- 2024** Public Stargazing
- Hosted public stargazing event at the Rocklands Highline Festival
- 2023** Public Stargazing
- Hosted public stargazing event at the Namaqua Flower Festival
- 2023-2024** Metal work Clean Green Muizenberg
- Community project to make trash bins for the local park from upcycled oil drums
- 2013 – 2020** Volunteer SAAO
- Volunteer at SAAO Open Night and various public stargazing events
- 2018**
- Hosted public stargazing event at the Festival of Friends, Natures Valley
- 2017-2018** Founding Member & Sport Climbing Coach [DreamHigher](#) NPO
- Coach Rock Climbing to previously disadvantaged young adults
- 2012 – 2015** Mountain Search and Rescue Member Mountain Club of South Africa (MCSA)

SPORTS & CULTURE

- 2022** Project lead South African Highline Record
- Established the longest highline in SA at 460m in Mosselbay
- 2011 – 2015** Committee member UCT Mountain and Ski Club (MSC)
- Fulfilled various portfolio roles including Expeditions, Equipment and Ski
- 2014** Chairperson UCT MSC
- Led a committee of 22 people at the head of a society with 800 members
 - Managed and spent a budget of ~R250 000
 - Coordinated 5-10 weekly events
- 2013** Expedition Leader UCT MSC
- Led Team on MSC expedition to summit Mt Kenya (5 199m)
 - Awarded R 14 000 in sponsorship funding
- 2012** Sports Merit Award UCT
- Led Southern-African team on UIAA Youth expedition to summit the highest mountain in Europe, Mt Elbrus (5 642m)
- 2011** Sports Performance of the Year Award UCT
- Co-organised mountaineering expedition to summit the Himalayan peak, CB13-A (6 264m)
 - Awarded R 30 000 in sponsorship funding
 - [Article in UCT Campus Sport Magazine](#)
- 2010 – present** Waaioek Leader UCT MSC
- Organised and lead numerous international expeditions and multi-day hikes

REFERENCES

Prof. Patrick Woudt

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Prof. Bruce Bassett

Head of Cosmology and Machine Learning group, African Institute for Mathematical Sciences

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Jason Smythe

Co-founder, Float Capital

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