

# Cristóbal Sifón

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## Research Interests

My research focuses on galaxy cluster physics including observable–mass scaling relations for cosmological analyses, brightest cluster galaxies, the mass content of cluster galaxies, and merging clusters. I am also interested in intrinsic galaxy alignments, both as contaminants for cosmic shear and as a physical mechanism in their own right. I use various tools and techniques to study these phenomena, including weak gravitational lensing, spectroscopy, the exploitation of optical surveys in general, and most recently analyses involving hydrodynamical simulations.

**Collaborations:** Atacama Cosmology Telescope (ACT) — Canadian Cluster Comparison Project (CCCP) — Galaxy Cluster Mass Reconstruction Project — Hyper-Suprime Cam survey (HSC) — Kilo-Degree Survey (KiDS) — Large Synoptic Survey Telescope Dark Energy Science Collaboration (LSST-DESC) — Multi-Epoch Nearby Cluster Survey (MENeCS) — Simons Observatory.

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## Employment

[2019 – Present] Profesor Asociado, Pontificia Universidad Católica de Valparaíso (PUCV), Chile  
[2016 – 2019] Postdoctoral Research Associate, Princeton University, USA

## Education

[2012 – 2016] Ph.D. Astrophysics, Universiteit Leiden, The Netherlands  
[2010 – 2012] M.Sc. Astrophysics, P. Universidad Católica de Chile (PUC), Chile  
[2005 – 2010] B.Sc. Astronomy, P. Universidad Católica de Chile, Chile

## Internships

[2011] Science Intern, Gemini South Observatory (6 months)  
[2011] Internship, Rutgers University (2 months)  
[2009] Science Intern, Gemini South Observatory (6 months, *B.Sc. thesis*)

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## Teaching & Mentoring

### Student Research Mentoring

[2018 – Present] Malik Walker, Princeton University: Undergraduate Summer Research Program and Junior Project.  
[2017 – Present] Naomi Robertson, Oxford University (UK): co-advising PhD thesis project.  
[2013 – 2014] Joshua Albert, Universiteit Leiden: co-advised MSc thesis project.

### Teaching Assistant

[Leiden] Stellar dynamics; organizer of MSc thesis defense presentations  
[PUC] Extragalactic astrophysics; Experimental astrophysics; Laboratory of thermodynamics and kinetic theory

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## Grants

[2019] Proyecto FONDECYT Iniciación (PI, 3 years, US\$125,000)

### Successful Observing Proposals (as PI)

I have been the PI of 7 different successful observing proposals in 5 different telescopes:

[**Magellan/FourStar**] (2019A,2019B) 2 nights for near-infrared imaging of galaxy clusters

[**Very Large Array**] (2019A) 4.5 h to study AGN feedback in galaxy clusters

[**Giant Metrewave Radio Telescope**] (2017B,2013B) 44 h to study diffuse radio emission in clusters

[**Gemini South/GMOS**] (2017B) 24 h for optical imaging and spectroscopy of high-redshift galaxy clusters

[**VLT Survey Telescope/OmegaCAM**] (2015A) 6 h for optical imaging of galaxy clusters

**Observing Experience:** I have spent roughly 180 hours observing with optical (Gemini South/GMOS) and near-infrared (La Silla-2.2m) instruments performing both imaging and spectroscopy of galaxy clusters.

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## Community Activity

I have served as a referee for Astronomy & Astrophysics, The Astrophysical Journal, Monthly Notices of the Royal Astronomical Society, and Nature Astronomy.

### Informal courses

[2016] *Making Better Figures*, Universiteit Leiden (<http://bit.ly/2NTznxW>)

### Press articles authored

*Galaxy clusters: Falling into line* (Nature Astronomy News & Views, July 2017)

*Dynamical masses of galaxy clusters discovered with the Sunyaev-Zel'dovich effect* (Gemini Focus Featured Science, July 2013)

### Outreach

[2018 – Present] Assisting with *Public Astronomical Observations in Spanish*, Princeton University.

[2013 – 2014] Assisted with *Public Observations at the Old Observatory*, Leiden Observatory.

[2012] Co-taught an *Astronomy Course for Seniors*, PUC.

[2011] Participated in *Starry Nights*, observation nights for elementary and middle school students in social risk organized by ESO-Santiago.

[2010] Invited talk on board the “FFG14 Almirante Latorre” Chilean Navy ship, Valparaíso, Chile.

[2010] *The Universe*, a series of talks for elementary school students in social risk organized by PUC.

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## Technical skills

I am an experienced python programmer, and I also have some experience with IRAF/PyRAF. I have written pygmos, a Python/PyRAF pipeline to reduce Gemini-GMOS spectra which is available [here](#). I also developed an early analysis pipeline for the FLAMINGOS-II infrared imager and spectrograph installed in the Gemini-South telescope. I am one of three lead developers and maintainers of the galaxy-galaxy lensing pipeline used by the KiDS collaboration (written in python, but which is not public at the moment). Other codes I have written are posted at my [github](#) page.

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## Other Work Experience

**[2007 – 2008]** Ski instructor at Homewood Mountain Ski Resort in Lake Tahoe, CA. Obtained certification as *Level I Ski Instructor* by the Professional Ski Instructors of America (PSIA).

**[2006 – 2007]** Ski lift operator at Sun Valley Resort, Sun Valley, ID.

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## References

- Prof. Henk Hoekstra (*PhD advisor*)  
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# Publication list

I have co-authored 63 scientific articles intended for peer-reviewed publication, including 7 first-author papers. They have been cited more than 2,800 times and have an  $h$ -index of 31, with more than 250 citations on my first-author papers. My publications include three companion reviews on galaxy alignments written for a special issue of Space Science Reviews (B. Joachimi et al. 2015, A. Kiessling et al. 2015, D. Kirk et al. 2015). The full list of publications is summarized below, and can be accessed at [this url](#). I also wrote an invited ‘News & Views’ article for the 4 July 2017 edition of Nature Astronomy, accessible [here](#).

This document is maintained live on [github](#).

## First-Author Papers

7. **C. Sifón**, R. Herbonnet, H. Hoekstra, R. F. J. van der Burg, M. Viola, “**The Galaxy-Subhalo Connection in Low-Redshift Galaxy Clusters from Weak Gravitational Lensing**”, 2018, [MNRAS](#), **478**, 1244 [\[arXiv\]](#)
6. **C. Sifón**, R. F. J. van der Burg, H. Hoekstra, A. Muzzin, R. Herbonnet, “**A First Constraint on the Average Mass of Ultra Diffuse Galaxies from Weak Gravitational Lensing**”, 2018, [MNRAS](#), **473**, 3747 [\[arXiv\]](#)
5. **C. Sifón** et al. (25 co-authors), “**The Atacama Cosmology Telescope: Dynamical Masses for 44 SZ-Selected Galaxy Clusters over 755 Square Degrees**”, 2016, [MNRAS](#), **461**, 248 [\[arXiv\]](#)
4. **C. Sifón** et al. (26 co-authors), “**The Masses of Satellites in GAMA Galaxy Groups from 100 Square Degrees of KiDS Weak Lensing Data**”, 2015, [MNRAS](#), **454**, 3938 [\[arXiv\]](#)
3. **C. Sifón**, H. Hoekstra, M. Cacciato, M. Viola, F. Köhlinger, R. F. J. van der Burg, D. J. Sand, M. L. Graham, “**Constraints on the Alignments of Galaxies in Galaxy Clusters from  $\sim 14,000$  Spectroscopic Members**”, 2015, [A&A](#), **575**, A48 [\[arXiv\]](#)
2. **C. Sifón**, F. Menanteau, J. P. Hughes, M. Carrasco, L. F. Barrientos, “**Strong Lensing Analysis of PLCK G004.5–19.5, a Planck-Discovered Cluster Hosting a Radio Relic at  $z = 0.52$** ”, 2014, [A&A](#), **562**, A43 [\[arXiv\]](#)
1. **C. Sifón** et al. (36 co-authors), “**The Atacama Cosmology Telescope: Dynamical Masses and Scaling Relations for a Sample of Massive Sunyaev-Zel’dovich Effect Selected Galaxy Clusters**”, 2013, [ApJ](#), **772**, 25 [\[arXiv\]](#)

## Major Contributor Papers

11. M. Hilton, M. Hasselfield, **C. Sifón**, et al. (43 co-authors), “**The Atacama Cosmology Telescope: The Two-Season ACTPol Sunyaev-Zel’dovich Effect Selected Cluster Catalog**”, 2018, [ApJS](#), **235**, 20 [\[arXiv\]](#)
10. J. G. Albert, **C. Sifón**, A. Stroe, F. Mernier, H. T. Intema, H. J. A. Röttgering, G. Brunetti, “**Complex Diffuse Emission in the  $z = 0.52$  Cluster PLCK G004.5–19.5**”, 2017, [A&A](#), **607**, A4 [\[arXiv\]](#)
9. R. F. J. van der Burg, H. Hoekstra, A. Muzzin, **C. Sifón**, et al. (17 co-authors), “**The Abundance of Ultra-Diffuse Galaxies from Groups to Clusters: UDGs are Relatively More Common in More Massive Haloes**”, 2017, [A&A](#), **607**, A79 [\[arXiv\]](#)
8. E. van Uitert, M. Cacciato, H. Hoekstra, M. Brouwer, **C. Sifón**, et al. (29 co-authors), “**The Stellar-to-Halo Mass Relation of GAMA Galaxies from 100 Square Degrees of KiDS Weak Lensing Data**”, 2016, [MNRAS](#), **459**, 3251 [\[arXiv\]](#)

7. D. Kirk, M. L. Brown, H. Hoekstra, B. Joachimi, T. D. Kitching, R. Mandelbaum, **C. Sifón**, M. Cacciato, A. Choi, A. Kiessling, A. Leonard, A. Rassat, B. Malte Schäfer, **“Galaxy Alignments: Observations and Impact on Cosmology”**, 2015, [Space Sci. Rev.](#), **193**, 139 [[arXiv](#)]
6. A. Kiessling, M. Cacciato, B. Joachimi, D. Kirk, T. D. Kitching, A. Leonard, R. Mandelbaum, B. Malte Schäfer, **C. Sifón**, M. L. Brown, A. Rassat, **“Galaxy Alignments: Theory, Modelling & Simulations”**, 2015, [Space Sci. Rev.](#), **193**, 67 [[arXiv](#)]
5. B. Joachimi, M. Cacciato, T. D. Kitching, A. Leonard, R. Mandelbaum, B. Malte Schäfer, **C. Sifón**, H. Hoekstra, A. Kiessling, D. Kirk, A. Rassat, **“Galaxy Alignments: an Overview”**, 2015, [Space Sci. Rev.](#), **193**, 1 [[arXiv](#)]
4. R. F. J. van der Burg, H. Hoekstra, A. Muzzin, **C. Sifón**, M. L. Balogh, S. McGee, **“Evidence for the Inside-Out Growth of the Stellar Mass Distribution in Galaxy Clusters since  $z \sim 1$ ”**, 2015, [A&A](#), **577**, 19 [[arXiv](#)]
3. M. Hilton, M. Hasselfield, **C. Sifón**, et al. (26 co-authors), **“The Atacama Cosmology Telescope: The Stellar Content of Galaxy Clusters Selected Using the Sunyaev-Zel’dovich Effect”**, 2013, [MNRAS](#), **435**, 3469 [[arXiv](#)]
2. F. Menanteau, **C. Sifón**, et al. (26 co-authors), **“The Atacama Cosmology Telescope: Physical Properties of Sunyaev-Zel’dovich Effect Clusters on the Celestial Equator”**, 2013, [ApJ](#), **765**, 67 [[arXiv](#)]
1. F. Menanteau, J. P. Hughes, **C. Sifón**, et al. (27 co-authors), **“The Atacama Cosmology Telescope: ACT-CL J0102–4915 “El Gordo,” a Massive Merging Cluster at Redshift 0.87”**, 2012, [ApJ](#), **748**, 7 [[arXiv](#)]

## Contributing Author Papers (All including **C. Sifón**)

45. Q. Xia, et al. (13 co-authors), **“A Gravitational Lensing Detection of Filamentary Structures Connecting Luminous Red Galaxies”**, 2019, [arXiv:1909.05852](#), submitted to A&A
44. Y. Rong et al. (13 co-authors), **“Intrinsic Morphology Evolution of Ultra-diffuse Galaxies”**, 2019, [arXiv:1907.10079](#), submitted to ApJ
43. A. K. Wright et al. (22 co-authors), **“KiDS+VIKING-450: A New Combined Optical & Near-IR Dataset for Cosmology and Astrophysics”**, 2018, [arXiv:1812.06077](#), submitted to A&A
42. H. Hildebrandt et al. (28 co-authors), **“KiDS+VIKING-450: Cosmic Shear Tomography with Optical+infrared Data”**, 2018, [arXiv:1812.06076](#), submitted to A&A
41. J. S. Speagle et al. (12 co-authors), **“Galaxy-Galaxy Lensing in HSC: Validation Tests and the Impact of Heterogeneous Spectroscopic Training Sets”**, 2019, [arXiv:1906.05876](#), accepted for publication in MNRAS
40. S. Huang et al. (12 co-authors), **“Weak Lensing Reveals a Tight Connection Between Dark Matter Halo Mass and the Distribution of Stellar Mass in Massive Galaxies”**, 2018, [arXiv:1811.01139](#), accepted for publication in MNRAS
39. K. R. Hall et al. (25 co-authors), **“Quantifying the Thermal Sunyaev-Zel’dovich Effect and Excess Millimeter Emission in Quasar Environments”**, 2019, [MNRAS](#), **490**, 2315 [[arXiv](#)]
38. C. Hikage et al. (30 co-authors), **“Cosmology from Cosmic Shear Power Spectra with Subaru Hyper Suprime-Cam First-Year Data”**, 2019, [PASJ](#), **71**, 43 [[arXiv](#)]

37. H. Miyatake et al. (58 co-authors), **“Weak-Lensing Mass Calibration of ACTPol Sunyaev-Zel’dovich Clusters with the Hyper Suprime-Cam Survey”**, 2019, [ApJ](#), 875, 63 [[arXiv](#)]
36. K. Knowles et al. (14 co-authors), **“GMRT 610 MHz Observations of Galaxy Clusters in the ACT Equatorial Sample”**, 2019, [MNRAS](#), 486, 1332 [[arXiv](#)]
35. M. Brouwer et al. (18 co-authors), **“Studying Galaxy Troughs and Ridges using Weak Gravitational Lensing with the Kilo-Degree Survey”**, 2018, [MNRAS](#), 481, 5189 [[arXiv](#)]
34. R. Wojtak et al. (17 co-authors), **“Galaxy Cluster Mass Reconstruction Project - IV. Understanding the Effects of Imperfect Membership on Cluster Mass Estimation”**, 2018, [MNRAS](#), 481, 324 [[arXiv](#)]
33. A. Jakobs et al. (20 co-authors), **“Multi-Wavelength Scaling Relations in Galaxy Groups: a Detailed Comparison of GAMA and KiDS Observations to BAHAMAS Simulations”**, 2018, [MNRAS](#), 480, 3338 [[arXiv](#)]
32. A. Dvornik et al. (14 co-authors), **“Unveiling Galaxy Bias via the Halo Model, KiDS and GAMA”**, 2018, [MNRAS](#), 479, 1240 [[arXiv](#)]
31. J. P. Greco et al. (13 co-authors), **“Illuminating Low-Surface-Brightness Galaxies with the Hyper Suprime-Cam Survey”**, 2018, [ApJ](#), 857, 104 [[arXiv](#)]
30. J. F. Wu, P. Aguirre, A. J. Baker, M. J. Devlin, M. Hilton, J. P. Hughes, L. Infante, R. R. Lindner, **C. Sifón**, **“Herschel and ALMA Observations of Massive SZE-selected Clusters”**, 2018, [ApJ](#), 853, 195 [[arXiv](#)]
29. E. Medezinski et al. (16 co-authors), **“Source Selection for Cluster Weak Lensing Measurements in the Hyper Suprime-Cam Survey”**, 2018, [PASJ](#), 70, 30 [[arXiv](#)]
28. E. Medezinski et al. (12 co-authors), **“Planck Sunyaev-Zel’dovich Cluster Mass Calibration using Hyper Suprime-Cam Weak Lensing”**, 2018, [PASJ](#), 70, 28 [[arXiv](#)]
27. R. Mandelbaum et al. (27 co-authors), **“The First-Year Shear Catalog of the Subaru Hyper Suprime-Cam SSP Survey”**, 2018, [PASJ](#), 70, 25 [[arXiv](#)]
26. L. Old et al. (18 co-authors), **“Galaxy Cluster Mass Reconstruction Project: III. The Impact of Dynamical Substructure on Cluster Mass Estimates”**, 2018, [MNRAS](#), 475, 853 [[arXiv](#)]
25. M. Velliscig et al. (17 co-authors), **“Galaxy-Galaxy Lensing in EAGLE: Comparison with Data from 180 Square Degrees of the KiDS and GAMA Surveys”**, 2017, [MNRAS](#), 471, 2856 [[arXiv](#)]
24. A. Dvornik et al. (22 co-authors), **“A KiDS Weak Lensing Analysis of Assembly Bias in GAMA Galaxy Groups”**, 2017, [MNRAS](#), 468, 3251 [[arXiv](#)]
23. M. M. Brouwer et al. (22 co-authors), **“First Test of Verlinde’s Theory of Emergent Gravity Using Weak Gravitational Lensing Measurements”**, 2017, [MNRAS](#), 466, 2547 [[arXiv](#)]
22. M. M. Brouwer et al. (36 co-authors), **“Dependence of GAMA Galaxy Halo Masses on the Cosmic Web Environment from 100 Square Degrees of KiDS Weak Lensing Data”**, 2016, [MNRAS](#), 462, 4451 [[arXiv](#)]
21. N. Battaglia et al. (39 co-authors), **“Weak-Lensing Mass Calibration of the Atacama Cosmology Telescope Equatorial Sunyaev-Zel’dovich Cluster Sample with the Canada-France-Hawaii Telescope Stripe 82 Survey”**, 2016, [JCAP](#), 08, 013 [[arXiv](#)]
20. S. Bellstedt et al. (16 co-authors), **“The Evolution in the Stellar Mass of Brightest Cluster Galaxies over the Past 10 Billion Years”**, 2016, [MNRAS](#), 460, 2862 [[arXiv](#)]



19. K. Knowles et al. (21 co-authors), “**A Giant Radio Halo in a Low-Mass SZ-Selected Galaxy Cluster: ACT-CL J0256.5+0006**”, 2016, [MNRAS](#), **459**, 4240 [[arXiv](#)]
18. D. Crichton et al. (22 co-authors), “**Evidence for the Thermal Sunyaev-Zel’dovich Effect Associated with Quasar Feedback**”, 2016, [MNRAS](#), **458**, 1478 [[arXiv](#)]
17. J. T. A. de Jong et al. (49 co-authors), “**The First and Second Data Releases of the Kilo Degree Survey**”, 2015, [A&A](#), **582**, 62 [[arXiv](#)]
16. K. Kuijken et al. (35 co-authors), “**Gravitational Lensing Analysis of the Kilo Degree Survey**”, 2015, [MNRAS](#), **454**, 3500 [[arXiv](#)]
15. K. Y. Ng, W. A. Dawson, D. Wittman, M. J. Jee, J. P. Hughes, F. Menanteau, **C. Sifón**, “**The Return of the Merging Galaxy Subclusters of El Gordo?**”, 2015, [MNRAS](#), **453**, 1531 [[arXiv](#)]
14. M. Viola et al. (27 co-authors), “**Dark Matter Halo Properties of GAMA Galaxy Groups from 100 Square Degrees of KiDS Weak Lensing Data**”, 2015, [MNRAS](#), **452**, 3529 [[arXiv](#)]
13. R. R. Lindner et al. (25 co-authors), “**The Atacama Cosmology Telescope: the LABOCA/ACT Survey of Clusters at All Redshifts**”, 2015, [ApJ](#), **803**, 79 [[arXiv](#)]
12. B. Kirk et al. (23 co-authors), “**SALT Spectroscopic Observations of Galaxy Clusters Detected by ACT and a Type II Quasar Hosted by a Brightest Cluster Galaxy**”, 2015, [MNRAS](#), **449**, 4010 [[arXiv](#)]
11. L. Old et al. (24 co-authors), “**Galaxy Cluster Mass Reconstruction Project: II. Results for Galaxy-Based Techniques with Improved Models**”, 2015, [MNRAS](#), **449**, 1897 [[arXiv](#)]
10. M. B. Gralla et al. (41 co-authors), “**A Measurement of the Millimeter Emission and the Sunyaev-Zel’dovich Effect Associated with Low-Frequency Radio Sources**”, 2014, [MNRAS](#), **445**, 460 [[arXiv](#)]
9. L. Old et al. (21 co-authors), “**Galaxy Cluster Mass Reconstruction Project: I. Methods and First Results on Galaxy-Based Techniques**”, 2014, [MNRAS](#), **441**, 1513 [[arXiv](#)]
8. M. J. Jee, J. P. Hughes, F. Menanteau, **C. Sifón**, L. F. Barrientos, L. Infante, R. Mandelbaum, K. Y. Ng, “**Weighing “El Gordo” with a Precision Scale: Hubble Space Telescope Weak-Lensing Analysis of the Galaxy Cluster ACT-CL J0102-4915 at  $z = 0.87$** ”, 2014, [ApJ](#), **785**, 20 [[arXiv](#)]
7. M. Hasselfield et al. (44 co-authors), “**The Atacama Cosmology Telescope: Sunyaev-Zel’dovich Selected Galaxy Clusters at 148 GHz from Three Seasons of Data**”, 2013, [JCAP](#), **07**, 008 [[arXiv](#)]
6. E. Calabrese et al. (34 co-authors), “**Cosmological Parameters from Pre-Planck Cosmic Microwave Background Measurements**”, 2013, [Phys. Rev. D](#), **87**, 103012 [[arXiv](#)]
5. N. Sehgal et al. (36 co-authors), “**The Atacama Cosmology Telescope: Relation between Galaxy Cluster Optical Richness and Sunyaev-Zel’dovich Effect**”, 2013, [ApJ](#), **767**, 38 [[arXiv](#)]
4. H. Miyatake et al. (28 co-authors), “**Subaru Weak-Lensing Measurement of a  $z = 0.81$  Cluster Discovered by the Atacama Cosmology Telescope Survey**”, 2013, [MNRAS](#), **429**, 3627 [[arXiv](#)]
3. B. D. Sherwin et al. (31 co-authors), “**The Atacama Cosmology Telescope: Cross-correlation of CMB Lensing and Quasars**”, 2012, [Phys. Rev. D](#), **86**, 083006 [[arXiv](#)]
2. N. Hand et al. (58 co-authors), “**Evidence of Galaxy Cluster Motions with the Kinematic Sunyaev-Zel’dovich Effect**”, 2012, [Phys. Rev. Letters](#), **109**, 041101 [[arXiv](#)]
1. E. D. Reese et al. (44 co-authors), “**The Atacama Cosmology Telescope: High-Resolution Sunyaev-Zel’dovich Array Observations of ACT SZE-selected Clusters from the Equatorial Strip**”, 2012, [ApJ](#), **751**, 12 [[arXiv](#)]