# Rodrigo Carvajal Pizarro

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PhD student in Astrophysics at the Instituto de Astrofísica e Ciencias do Espaço (IA-FCUL) working on Radio Galaxies and on the implementation of Machine Learning tools to study them.

## Education

### Instruction

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| 2019–Present | **PhD. in Astronomy and Astrophysics**, *Faculdade de Ciências, Universidade de Lisboa*, Lisbon, Portugal. |
| | Project: The First Radio Galaxies in the Universe. Supervisors: J. Afonso, I. Matute, H. Messias. |
| 2016–2019 | **MSc. in Astrophysics**, *Pontificia Universidad Católica de Chile*, Santiago, Chile. |
| | Thesis: Stacking UV-selected Lyman-Break Galaxies in the ALMA Frontier Fields[1](Maximum distinction). Supervisor: F. E. Bauer. |
| 2007–2014 | **Licenciado en Ciencias (B.Sc. equivalent)**, *Universidad de Chile*, Santiago, Chile, *Astronomy (Distinction, no thesis required)*. |
| | Courses taken in Physics, Astronomy and Atmospheric Sciences. |

### Prizes and Awards

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| 2019 | **PhD::SPACE Fellowship**, *Instituto de Astrofísica e Ciências do Espaço*, Lisbon, Portugal. |
| | The Doctoral Network in Space Sciences (PhD::SPACE) is a program funded by the Fundação para a Ciência e a Tecnologia (MEC, Portugal) to support PhD Fellowships in Space Sciences, from astronomy and astrophysics to instrumentation. |
| 2017 | **Teaching Assistant Scholarship**, *Pontificia Universidad Católica de Chile*, Santiago, Chile. |
| | This scholarship, awarded by the Pontificia Universidad Católica de Chile, grants students a full exemption from payment of tuition fees and provide a subsistence allowance to students who are beginning their studies. |
| 2007–2010 | **Beca Universidad de Chile**, *Universidad de Chile*, Santiago, Chile. |
| | Beca Universidad de Chile is a benefit that covers tuition and annual fee of any undergraduate program for the official duration of studies. |

## Research Experience

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| January 2019–October 2019 | **Research Assistant**, *Institute of Astrophysics, Pontificia Universidad Católica de Chile (IA-PUC)*, Santiago, Chile. |
| | Image and analyze ALMA data (Bands 3, 4, and 6) from sources located in Abell 2744 as part of the project "Hunting for redshifts of faint DSFGs in A2744" (PI: Bauer) |
| August 2015–March 2019 | **Research Assistant**, *Institute of Astrophysics, Pontificia Universidad Católica de Chile (IA-PUC)*, Santiago, Chile. |
| | Use image enhancement techniques to improve the quality of ALMA observations and study objects with low signal-to-noise ratio but detected with other instruments. Work carried out as part of FONDECYT REGULAR project 1141218 'The Role of SMBHS in Galaxy Evolution' under the supervision of Prof. Franz Bauer and Jorge González, both from the Astrophysics Institute. |
| January 2014–March 2015 | **Research Assistant**, *Joint ALMA Observatory (JAO)*, Santiago, Chile. |
| | Study Mars' atmosphere and produce profiles for temperature, wind speed and other atmospheric variables using data retrieved from ALMA observations. Work carried out under the supervision of Dr. Ruediger Kneissl and Dr. David Rabanus, both from JAO. |

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[1]Thesis text available at https://repositorio.uc.cl/handle/11534/22335

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| August 2013–October 2013 | **Research Assistant**, *Departament of Astronomy (DAS), Universidad de Chile*, Santiago, Chile.<br><br>Study differences from the outer structures of lensing galaxies through the absorbed light of far quasars. Work carried out under the supervision of Prof. Sebastián López as part of FONDECYT project number 1100214. |
| March 2013–May 2013 | **Research Assistant**, *Departament of Astronomy (DAS), Universidad de Chile*, Santiago, Chile.<br><br>Search quasars pairs at small distances over a catalogue of more than 100.000 objects (The SDSS-DR9 Quasar Catalog. Pâris et al. 2012). Work carried out under the supervision of Dr. Isabelle Pâris. |
| March 2012–July 2012 | **Research Assistant**, *Departament of Astronomy (DAS), Universidad de Chile*, Santiago, Chile, Guided Research II.<br><br>Confirm the influence of thermal-broadening Doppler parameter in turbulent broadening in Intergalactic Medium. Adjust Voigt profiles to possible absorption lines for Magnesium and Iron transitions. Work carried out under the supervision of Prof. Sebastián López as part of FONDECYT project number 1100214. |
| May 2012–July 2012 | **Research Assistant**, *Departament of Astronomy (DAS), Universidad de Chile*, Santiago, Chile.<br><br>Measure the correlation for the results of Voigt curve-fitting procedures in metallic species absorption lines. These lines are a product of a far quasar emission. Work was carried out together with Paula Sánchez (DAS/ESO) and under the supervision of Prof. Sebastián López. |
| August 2011–December 2011 | **Research Assistant**, *Departament of Astronomy (DAS), Universidad de Chile*, Santiago, Chile, Guided Research I.<br><br>Determine the influence of thermal-broadening Doppler parameter in turbulent broadening in Intergalactic Medium. Work carried out under the supervision of Prof. Sebastián López. |
| January 2011 | **Research Assistant**, *Departament of Astronomy (DAS), Universidad de Chile*, Santiago, Chile, Basic Tutorial Work.<br><br>Working in project "A study of the Molecular Properties of the Vela Molecular Ridge (Coud C)" searching possible structures (clumps) using data from Mopra Radio Telescope, part of the Australia Telescope National Facility (ANTF). Work carried out under the supervision of Dr. Nadia Lo as part of FONDECYT project number 1100221. |

## Observation Experience

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| February 2013 | **MagE instrument**, *6.5m Magellan-Clay Telescope*, LCO, Chile, One-night observation run under the supervision of Dr. Isabelle Pâris.. |

## Teaching Experience

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| March 2013–July 2013 | **Universidad de Chile**, *Teaching Assistant FI1001. Introduction to Newtonian Physics*, Santiago, Chile, Department of Physics.<br>Professor: Sebastián López |
| March 2013–July 2013 | **Universidad de Chile**, *Teaching Assistant EI2001. Project Workshop*, Santiago, Chile, School of Engineering.<br>Professor: Sebastián López. Practical course intended to teach students how to characterize the CCD at the University Observatory. |
| March 2012–July 2012 | **Universidad de Chile**, *Teaching Assistant AS3004–AS758. Intergalactic Medium*, Santiago, Chile, Department of Astronomy.<br>Professor: Sebastián López |
| 2010–2012 | **Universidad de Chile**, *Teachers Aide MA2001. Multivariable Calculus*, Santiago, Chile, Department of Mathematical Engineering.<br>Professors: Marcelo Leseigneur, Felipe Célèry |

## Student Supervision

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| July 2021 | **Instituto de Astrofísica e Ciências do Espaço**, *Co-supervision of third-year Bachelor and Master students' Summer Internships*, Faculdade de Ciências - Universidade de Lisboa, Lisbon, Portugal. |
| ○ | Together with the main supervisor (Israel Matute) we guided four students on the project "Identifying and characterizing AGN in next-generation radio surveys using machine and deep learning", analysing, mainly with Machine Learning techniques, multi-wavelength catalogues of AGN located in one area of the Southern Sky in order to predict some of their properties. |
| July 2021 | **Instituto de Astrofísica e Ciências do Espaço**, *Co-supervision of third-year Bachelor students' Summer Internships*, Faculdade de Ciências - Universidade de Lisboa, Lisbon, Portugal. |
| ○ | I helped the main supervisor (José Afonso) guiding four students on the project "The 200: exploring the most active supermassive black holes in the first Gyr of the Universe", analysing, in general terms, multi-wavelength catalogues of AGN as a way to understand some of the properties and correlations they might hold. |
| September 2020–February 2021 | **Universidade de Lisboa**, *Co-supervision of third-year Bachelor student*, Faculdade de Ciências, Lisbon, Portugal. |
| ○ | As part of their formation, students of Licenciatura em Física (Bachelor in Physics) must work in a scientific project guided by members of the Faculty of Sciences. I helped the main supervisor (Israel Matute) guiding Iara Tiago on the project "Understanding triggering Radio emission from AGNs (Machine Learning)". |
| July 2020 | **Universidade de Lisboa**, *Co-supervision of third-year Bachelor student*, Faculdade de Ciências, Lisbon, Portugal. |
| ○ | As part of their formation, students of Licenciatura em Física (Bachelor in Physics) might work in a project related to Astrophysics or Science Communication. I helped the main supervisor (José Afonso) guiding Lara Piscarreta on studying radio and X-ray emission of high-redshift AGN. |

## Working Experience

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| October 2013–present | **Tourist guide**, *Observatorio Astronómico Andino (OAA)*, Santiago, Chile. |
| ○ | Guide visitors (tourists) through the observatory. This includes showing them the main characteristics of the night sky and answer their questions referring to Astronomy and Astrophysics. This work might be done in both Spanish and English. |

## Referred Articles

○ Pappalardo, Ciro, Leandro S. M. Cardoso, Jean Michel Gomes, Polychronis Papaderos, José Afonso, Iris Breda, Andrew Humphrey, Tom Scott, Stergios Amarantidis, Israel Matute, **Rodrigo Carvajal**, Silvio Lorenzoni, Patricio Lagos, Ana Paulino-Afonso, and Henrique Miranda. "**Self-consistent population spectral synthesis with FADO. II. Star formation history of galaxies in spectral synthesis methods**". In: *A&A* 651, A99 (July 2021), A99. DOI: 10.1051/0004-6361/202039792. arXiv: 2105.08082 [astro-ph.GA].

○ **Carvajal**, **R.**, F. E. Bauer, R. J. Bouwens, P. A. Oesch, J. González-López, T. Anguita, M. Aravena, R. Demarco, L. Guaita, L. Infante, S. Kim, R. Kneissl, A. M. Koekemoer, H. Messias, E. Treister, E. Villard, A. Zitrin, and P. Troncoso. "**The ALMA Frontier Fields Survey. V. ALMA Stacking of Lyman-Break Galaxies in Abell 2744, Abell 370, Abell S1063, MACSJ0416.1-2403 and MACSJ1149.5+2223**". In: *A&A* 633, A160 (Jan. 2020), A160. DOI: 10.1051/0004-6361/201936260. arXiv: 1912.02916.

○ González-López, J., F. E. Bauer, M. Aravena, N. Laporte, L. Bradley, M. Carrasco, **R. Carvajal**, R. Demarco, L. Infante, R. Kneissl, A. M. Koekemoer, A. M. Muñoz Arancibia, P. Troncoso, E. Villard, and A. Zitrin. "**The ALMA Frontier Fields Survey. III. 1.1 mm emission line identifications in Abell 2744, MACSJ 0416.1-2403, MACSJ 1149.5+2223, Abell 370, and Abell S1063**". In: *A&A* 608, A138 (Dec. 2017), A138. DOI: 10.1051/0004-6361/201730961. arXiv: 1704.03007.

○ González-López, J., F. E. Bauer, C. Romero-Cañizales, R. Kneissl, E. Villard, **R. Carvajal**, S. Kim, N. Laporte, T. Anguita, M. Aravena, R. J. Bouwens, L. Bradley, M. Carrasco, R. Demarco, H. Ford, E. Ibar, L. Infante, H. Messias, A. M. Muñoz Arancibia, N. Nagar, N. Padilla, E. Treister, P. Troncoso, and A. Zitrin. "**The ALMA Frontier Fields Survey. I. 1.1 mm continuum detections in Abell 2744, MACS J0416.1-2403 and MACS J1149.5+2223**". In: *A&A* 597, A41 (Jan. 2017), A41. DOI: 10.1051/0004-6361/201628806. arXiv: 1607.03808.

○ Laporte, N., F. E. Bauer, P. Troncoso-Iribarren, X. Huang, J. González-López, S. Kim, T. Anguita, M. Aravena, L. F. Barrientos, R. Bouwens, L. Bradley, G. Brammer, M. Carrasco, **R. Carvajal**, D. Coe, R. Demarco, R. S. Ellis, H. Ford, H. Francke, E. Ibar, L. Infante, R. Kneissl, A. M. Koekemoer, H. Messias, A. Muñoz Arancibia, N. Nagar, N. Padilla, R. Pelló, M. Postman, D. Quénard, C. Romero-Cañizales, E. Treister, E. Villard, W. Zheng, and A. Zitrin. "**The ALMA Frontier Fields Survey. II. Multiwavelength Photometric analysis of 1.1 mm continuum sources in Abell 2744, MACSJ0416.1-2403 and MACSJ1149.5+2223**". In: *A&A* 604, A132 (Aug. 2017), A132. DOI: 10.1051/0004-6361/201730628. arXiv: 1706.09605.

## Contributed Talks

**October 2021**  **Using a series of Machine Learning Models for the detection of high-redshift Radio Galaxy candidates**, *Debating the potential of Machine Learning in astronomical surveys*, IAP Colloquium, Institute d'Astrophysique de Paris, France.
**R. Carvajal**, J. Afonso, I. Matute, S. Amarantidis, D. Barbosa, P. Cunha, A. Humphrey

**August 2021**  **Using Machine Learning to identify high-redshift Radio Galaxy candidates**, *50th Young European Radio Astronomers Conference*, online event, IRAM.
**R. Carvajal**, J. Afonso, I. Matute, S. Amarantidis, D. Barbosa

**March 2021**  **Exploring new redshift indicators for radio-powerful AGNs**, *RGCW: A new window on the radio emission from galaxies, clusters and cosmic web*, online event, Italy.
**R. Carvajal**, J. Afonso, I. Matute, S. Amarantidis, D. Barbosa

**October 2020**  **Searching for the earliest AGN in the radio sky**, *Internal Workshop of the Intitute of Astrophysics and Space Sciences*, online event, Porto, Portugal.
**R. Carvajal**, J. Afonso, I. Matute, S. Amarantidis

**December 2017**  **Stacking in the ALMA Frontier Fields**, *Distant Galaxies from the Far South*, Bariloche, Argentina.
**R. Carvajal**, F. E. Bauer, J. González-López, R. J. Bouwens, ALMA FF Team

## Posters

**September 2021**  **Detection of high-redshift Radio Galaxies using Machine Learning models**, *Encontro Nacional de Astronomia e Astrofísica*, online event, Portugal.
**R. Carvajal**, J. Afonso, I. Matute, S. Amarantidis, D. Barbosa

**June 2021**  **Using Machine Learning to look for high-redshift Radio Galaxies**, *Encontro Ciência '21: Encontro com a Ciência e Tecnologia em Portugal*, Lisbon, Portugal.
**R. Carvajal**, J. Afonso, I. Matute, S. Amarantidis, D. Barbosa

**March 2021**  **Exploring new redshift indicators for radio-powerful AGNs**, *A precursor view of the SKA Sky*, online event, The SKA Observatory.
**R. Carvajal**, J. Afonso, I. Matute, S. Amarantidis, D. Barbosa

**November 2020**  **Mining the radio sky toward the earliest AGN**, *Encontro Ciência '20: Encontro com a Ciência e Tecnologia em Portugal*, Lisbon, Portugal.
**R. Carvajal**, J. Afonso, I. Matute, S. Amarantidis

**September 2020**  **Mining the radio sky toward the earliest AGN**, *Encontro Nacional de Astronomia e Astrofísica*, online event, Portugal.
**R. Carvajal**, J. Afonso, I. Matute, S. Amarantidis

**March 2015**  **Mapping the winds on Mars. Test study (master project) for planetary atmospheric monitoring with ALMA**, *Ground and space observatories: a joint venture to planetary science*, Santiago, Chile.
**R. Carvajal**, R. Kneissl, D. Rabanus

## Invited Talks or Seminars

**June 2021**  **Developing a ML pipeline to detect high-redshift Radio Galaxy candidates**, *Machine Learning in Astronomy Group - SPARCS*, Sydney, Australia.

**May 2021**  **Explaining Machine Learning Models: SHAP**, *IA - Galaxies Machine Learning Group*, Porto, Portugal.

**July 2020**  **Stacking UV-selected Lyman-Break Galaxies in the ALMA Frontier Fields**, *Instituto de Astrofísica e Ciências do Espaço*, Lisbon, Portugal.

**June 2019**  **Stacking UV-selected Lyman-Break Galaxies in the ALMA Frontier Fields**, *ESO*, Santiago, Chile.

## Attendance to Meetings, Conferences or Workshops

**December 2020**  **Machine Learning in Science & Engineering**, Online event, Columbia University - Data Science Institute.

**December 2020**  **SOCHIAS (Chilean Society of Astronomy) annual meeting**, Pucón, Chile.

**November 2020**  **Exploiting Archives for Radio Astronomy in the SKA-era**, Lisbon, Portugal.

**June 2020**  **European Astronomical Society Annual Meeting**, Leiden, Netherlands.

**March 2019**  **ALMA Community Day (Cycle 7 Proposing Workshop)**, *ALMA Joint Observatory (JAO)*, Santiago, Chile.

○ January 2011 **SOCHIAS (Chilean Society of Astronomy) annual meeting**, Santiago, Chile.

## Technical Skills

### Programming

○ Python. Intermediate Level.      ○ Matlab. Intermediate Level.      ○ Bash scripting. Basic Level.
○ C. Intermediate Level.           ○ LaTeX. Intermediate Level.
○ Java. Intermediate Level.        ○ Mathematica. Basic Level.

### Software Skills

○ Common Astronomy Software Application (CASA) package. Intermediate Level.
○ Tool for operations on catalogues and tables (TOPCAT). Intermediate Level.
○ Gnuplot. Intermediate Level.
○ ESO-MIDAS. Basic Level.
○ Image Reduction and Analysis Facility (IRAF). Basic Level.
○ The Atmospheric Radiative Transfer Simulator (ARTS). Basic Level.
○ SAOImage DS9. Basic Level.
○ EsoRex. Basic Level

### Languages

○ **Spanish.** Native speaker.                    ○ **English.** IELTS Academic 7.5 (Good User)

## Academic Interests

### Academic Interests

○ High-redshift galaxies.    ○ Radio galaxies.        ○ Sub-mm observations.    ○ Planetary atmospheres.

## Relevant Courses

### Physics

○ Classical Mechanics, Statistical Mechanics, Quantum Mechanics, Electrodynamics, Mathematical Methods in Physics, Numerical Methods for Science and Engineering.

### Astronomy – Astrophysics

○ Undergraduate level: Stellar Astrophysics, Galactic Astrophysics, Experimental Astronomy, Astroinformatics, Intergalactic Medium, Introduction to Cosmology. Graduate level: Extragalactic Astrophysics, Stellar Astrophysics, Radiative Processes, Statistics for Astronomy, Stellar Populations

### Atmospheric Sciences

○ Introduction to Meteorology and Oceanography, Applied Meteorology, Atmospheric Fluid Dynamics.

### Mathematics

○ Probability and Statistics, Advanced Calculus, Linear Algebra.

## Certifications

○ Validity: Dec. 2016 - Dec. 2019    **Collaborative Institutional Training Initiative. CITI Program**, *Responsible Conduct of Research. Stage 1 - Basic Course*.

○ Validity: Dec. 2016 - Dec. 2019    **Collaborative Institutional Training Initiative. CITI Program**, *Human Subjects Research. Stage 1 - Basic Course*.

Last update: November, 2021.