

# Carlos Alberto Gomez Gonzalez

Junior research chair in Data Science for Earth, Space and Environmental Sciences

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I am an astronomer and data scientist working at the interface of direct imaging of extrasolar planetary systems and machine learning. Following my interest in open research practices, I develop open-source scientific computing tools featuring advanced image processing and data analysis algorithms for astronomy. I applied, for the first time, deep learning techniques for detecting exoplanets through small-angle high-contrast imaging. I strive to conduct inter-disciplinary research, applying cutting-edge methods and following innovative scientific workflows.

## Personal details

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| <i>Nationality</i>  | Colombian  |
| <i>Address</i>      | IPAG, Institut de Planetologie et d'Astrophysique de Grenoble<br>GIPSA-lab, Grenoble Images Parole Signal Automatique<br>Université Grenoble Alpes |
| <i>E-Mail</i>       | carlos.gomez@univ-grenoble-alpes.fr, carlosgg33@gmail.com  |
| <i>Website</i>      | <a href="https://carlgogo.github.io">https://carlgogo.github.io</a>  |
| <i>Github</i>       | <a href="https://github.com/carlgogo">https://github.com/carlgogo</a>  |
| <i>Speaker deck</i> | <a href="https://speakerdeck.com/carlgogo">https://speakerdeck.com/carlgogo</a>  |

## Academic Qualifications

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| <b>PhD Astrophysics</b>  | 2013-2017 |
| <i>STAR and Montefiore Institutes, Université de Liège, Belgium</i>  |           |
| Supervisors: Jean Surdej, Marc Van Droogenbroeck, Olivier Absil  |           |
| Thesis Title: Advanced data processing for high-contrast imaging – pushing exoplanet direct detection limits with machine learning |           |
| <b>MSc Astrophysics</b>  | 2012-2013 |
| <i>Universidad Autoónoma de Madrid and Universidad Complutense, Spain</i>  |           |
| <b>Specialization in Software Development</b>  | 2011-2012 |
| <i>Universidad del Magdalena, Colombia</i>   |           |
| <b>BSc Astronomy</b>   | 2002-2007 |
| <i>VV Sobolev Astronomical Institute, St. Petersburg State University, Russia</i>  |           |

## Experience

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| <b>Visiting researcher</b>  | 2017-Present |
| <i>GIPSA-lab, Université Grenoble Alpes</i>                                 |              |
| <b>Junior research chair in Data Science</b>                                | 2017-Present |
| <i>Grenoble Alpes Data Institute, Université Grenoble Alpes</i>             |              |
| <b>Data science consultant</b>  | 2017         |
| <i>Science to Data Science, Pivigo</i>                                      |              |
| <b>Technician in Geographic information systems (ARCGIS)</b>                | 2011-2012    |
| <i>IGAC – Agustín Codazzi Geographical Institute, Santa Marta, Colombia</i> |              |
| <b>Scientific assistant at Planetarium of Medellín</b>                      | 2009-2010    |

*Planetarium “Jesus Emilio Ramírez González”, Medellín, Colombia*

**Young Researcher in Astronomy, Teacher of introductory Physics** 2009-2010  
*Technological University ITM, Medellín, Colombia*

**Freelance web developer** 2007-2008  
*Colombia*

**Summer intern, astronomical observations for the Whole Earth Blazar Telescope (WEBT)**  
2005-2006  
*VV Sobolev Astronomical Institute, St. Petersburg State University, Russia*

## Mentoring

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**Co-supervisor of master thesis** 2018-Present  
*Institut de Planétologie et d’Astrophysique de Grenoble, Université Grenoble Alpes*  
Student: Ralf Farkas

**Co-supervisor of master thesis** 2014-2015  
*Institute of Information and Communication Technologies, Catholic University of Louvain*  
Student: Benoit Pairet

## Honors & Awards

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**PyData Amsterdam - diversity scholarship** April 2017  
*Numfocus*

**PhD Scholarship under ARC grant for Concerted Research Action** 2013-2017  
*Université de Liège*

**Scholarship for master studies in Astrophysics** 2012-2013  
*Universidad Autoónoma de Madrid & CSIC International Campus of Excellence*

**Scholarship for studies in Astronomy** 2001-2007  
*ICETEX (Colombia) & Government of the Russian Federation*

## Computing

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### Skills

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- Open-source development (Git/Github).
- Python (advanced, 5 years). Experience with scientific and machine learning libraries: Numpy, Scipy, Jupyter, Scikit-learn, Astropy, AstroML, Scikit-image, Matplotlib, Pandas, pymc3, emcee, NLTK, Spacy, OpenCV, Keras, Tensorflow, Blaze/Dask, H2O, cupy.
- Large experience with bash, L<sup>A</sup>T<sub>E</sub>X.
- Basic knowledge of SQL, C, Fortran, Java, Octave/Matlab, R and HTML.

### Software

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- Author of the open-source “Vortex Image Processing” (**VIP**) Python package for high-contrast imaging of exoplanets/disks (see my Github profile).
- Author of the **SODINN** Python package for detection of exoplanets through high-contrast imaging in a machine learning supervised framework (to be released).
- Contributor to the **PyAstrOFit** package dedicated to planet orbit fitting using MCMC (see my Github profile).
- Contributor to the Keck/NIRC2 pre-processing pipeline containing calibration procedures for high-contrast imaging observations (see my Github profile).

## Data analysis skills

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- Hypothesis testing, Monte Carlo methods (MCMC), data cleansing and feature selection.
- Natural language processing and computer vision.
- Supervised learning (regression and classification). Unsupervised learning (clustering, dimensionality reduction and low-rank modeling). Neural networks (perceptron, MLP, CNN, RNN).

## Outreach & Service

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| 2018 | Mentor for a Software Carpentry workshop at the Université Grenoble Alpes  |
| 2018 | Co-organizer of the Python for science and data analysis in Grenoble group |
| 2018 | Co-organizer of the Data Club at the Université Grenoble Alpes             |
| 2009 | Public outreach at the Planetarium of Medellín, Colombia                   |

## Languages

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| Spanish | Native   |
| English | Advanced reading (C1) and speaking (C1), upper-intermediate writing (B2) |
| Russian | Advanced reading (C1), intermediate speaking (B1) and writing (B1)       |
| French  | Intermediate reading (B1), basic speaking (A2) and writing (A2)          |

## Presentations & Conferences

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### Talks

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- *Exoplanet direct imaging data challenge*, April 2017, Paris-Saclay center for data science, Palaiseau, France.
- *Data science for direct imaging of exoplanets. Machine learning applied to astronomical high-contrast imaging*, April 2017, European Week of Astronomy and Space Science, Liverpool, UK.
- *Data science in astronomical image processing: looking for exoplanets using supervised machine learning*, March 2018, Data Science in the Alps, Grenoble, France.
- *Chasing exoplanets with Python and Machine Learning*, March 2018, PySciDataGre launch event, Grenoble, France.
- *Academic Data Science: conducting research at the interface of different disciplines*, February 2018, Data club seminar, Université Grenoble Alpes, France.
- *High-contrast imaging post-processing methods for exoplanet detection and characterization*, February 2018, Seminar Thoth team, INRIA Grenoble - Rhône-Alpes, France.
- *Supervised detection of exoplanets through high-contrast imaging*, August 2017, Workshop on Image processing for high-contrast imaging, Université de Liège, Belgium.
- *Deep machine learning for astronomical image processing and signal detection*, July 2017, Seminar IPAG, Université Grenoble Alpes, France.
- *Image-processing for high-contrast imaging. Beyond the black-box*, January 2017, Seminar, ETH Zurich, Switzerland.
- *Post-processing for high-contrast imaging*, August 2016, Keck Institute for Space Studies (KISS) workshop on Direct Imaging of exoplanets, Caltech, US.
- *Angular and reference star differential imaging post-processing with VIP*, August 2016, First Vortex international workshop, Caltech, US.

- *Applications of PCA and low-rank plus sparse decompositions in high-contrast Exoplanet imaging*, February 2016, Seminar ICTEAM, Catholic University of Louvain, Belgium.
- *Beyond PCA, Low-rank plus Sparse decomposition of high-contrast ADI image sequences for exoplanet detection*, June 2015, In the Spirit of Lyot conference, Montreal, Canada.
- *Vortex Image Processing package tutorial*, May 2015, Adaptive optics data processing workshop, Laboratoire d'Astrophysique de Marseille (LAM), France.

### Lightning talks

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- VIP & SODINN – *Image/data processing for exoplanets direct imaging*, June 2018, SPHERE upgrades workshop, Grenoble, France.
- VIP & SODINN – *Image/data processing for exoplanets direct imaging*, May 2018, Python in Astronomy, New York, US.
- *Post-processing for high-contrast imaging*, August 2016, Keck Institute for Space Studies (KISS) workshop on direct imaging of exoplanets, Caltech, US.

### Posters

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- VIP – *Vortex Image Processing package*, October 2016, Astroinformatics IAU symposium, Sorrento, Italy.
- VIP – *Vortex Image Processing package*, May 2016, Resolving planet formation in the era of ALMA and extreme adaptive optics, ESO, Chile.
- *Python based pipeline for post-processing in astronomical high-contrast imaging*, July 2014, SciPy Conference 2014, Austin, US.

### Attended conferences & workshops

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- Numediart Deep Learning workshop, May 2017, Mons, Belgium.
- PyData Amsterdam, April 2017, Netherlands.
- PyData Berlin, May 2016, Germany.
- ONERA high-contrast imaging workshop, January 2015, Chatillon, France.
- Sagan Exoplanet Summer Workshop, July 2014, Pasadena, US.
- 5th Subaru International Conference – Exoplanets and disks: Formation and Diversity, December 2013, Hawaii, US.

## Publications

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### Refereed

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- [1] V. Christiaens, S. Casassus, O. Absil, et al. Characterization of low-mass companion HD 142527 B. *ArXiv e-prints*, June 2018.
- [2] **Gomez Gonzalez, C. A.**, O. Absil, and M. van Droogenbroeck. Supervised detection of exoplanets in high-contrast imaging sequences. *A&A*, 613:A71, May 2018.
- [3] M. Reggiani, V. Christiaens, O. Absil, et al. Discovery of a point-like source and a third spiral arm in the transition disk around the Herbig Ae star MWC 758. *ArXiv e-prints*, October 2017.
- [4] G. Ruane, D. Mawet, J. Kastner, et al. Deep Imaging Search for Planets Forming in the TW Hya Protoplanetary Disk with the Keck/NIRC2 Vortex Coronagraph. *Astronomical Journal*, 154:73, August 2017.
- [5] R. Jensen-Clem, D. Mawet, **Gomez Gonzalez, C. A.**, et al. A New Standard for Assessing the Performance of High Contrast Imaging Systems. *ArXiv e-prints*, November 2017.
- [6] **Gomez Gonzalez, C. A.**, O. Wertz, O. Absil, et al. VIP: Vortex Image Processing Package for High-contrast Direct Imaging. *Astronomical Journal*, 154:7, July 2017.
- [7] Z. Wahhaj, J. Milli, G. Kennedy, et al. The SHARDDS survey: First resolved image of the HD 114082 debris disk in the Lower Centaurus Crux with SPHERE. *Astronomy and Astrophysics*, 596:L4, November 2016.
- [8] É. Choquet, J. Milli, Z. Wahhaj, et al. First Scattered-light Images of the Gas-rich Debris Disk around 49 Ceti. *Astrophysical Journal, Letters*, 834:L12, January 2017.
- [9] V. Christiaens, S. Casassus, O. Absil, et al. Characterization of the low-mass companion HD 142527 B. *Under review, submitted to A&A*.
- [10] J. Milli, P. Hiben, V. Christiaens, et al. Discovery of a low-mass companion inside the debris ring surrounding the F5V star HD 206893. *Astronomy and Astrophysics*, 597:L2, January 2017.
- [11] E. Serabyn, E. Huby, K. Matthews, et al. The W. M. Keck Observatory Infrared Vortex Coronagraph and a First Image of HIP 79124 B. *Astronomical Journal*, 153:43, January 2017.
- [12] D. Mawet, É. Choquet, O. Absil, et al. Characterization of the Inner Disk around HD 141569 A from Keck/NIRC2 L-Band Vortex Coronagraphy. *Astronomical Journal*, 153:44, January 2017.
- [13] O. Wertz, O. Absil, **Gómez González, C. A.**, et al. VLT/SPHERE robust astrometry of the HR8799 planets at milliarcsecond-level accuracy. Orbital architecture analysis with PyAstrOFit. *Astronomy and Astrophysics*, 598:A83, February 2017.
- [14] **Gomez Gonzalez, C. A.**, O. Absil, P.-A. Absil, et al. Low-rank plus sparse decomposition for exoplanet detection in direct-imaging ADI sequences. The LLSG algorithm. *Astronomy and Astrophysics*, 589:A54, April 2016.
- [15] F. Cantalloube, D. Mouillet, L. M. Mugnier, et al. Direct exoplanet detection and characterization using the ANDROMEDA method: Performance on VLT/NaCo data. *Astronomy and Astrophysics*, 582:A89, October 2015.
- [16] V. A. Hagen-Thorn, N. V. Efimova, V. M. Larionov, et al. Color variations of the blazar 3C 454.3 in 2004-2006. *Astronomy Reports*, 53:510–518, June 2009.

- [17] C. M. Raiteri, M. Villata, V. M. Larionov, et al. WEBT and XMM-Newton observations of 3C 454.3 during the post-outburst phase. Detection of the little and big blue bumps. *Astronomy and Astrophysics*, 473:819–827, October 2007.

#### Non Refereed

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- [1] O. Absil, D. Mawet, M. Karlsson, et al. Three years of harvest with the vector vortex coronagraph in the thermal infrared, in *Ground-based and Airborne Instrumentation for Astronomy VI*, vol. 9908 of *Proceedings of the International Society for Optical Engineering*, Aug. 2016, p. 99080Q.
- [2] B. Femenía Castellá, E. Serabyn, D. Mawet, et al. Commissioning and first light results of an L'-band vortex coronagraph with the Keck II adaptive optics NIRC2 science instrument, *Adaptive Optics Systems V*, 2016.
- [3] B. Pairet, L. Jacques, **C. A. Gomez Gonzalez**, et al. Low Rank and Group-Average Sparsity Driven Convex Optimization for Direct Exoplanets Imaging, in *Third international Traveling Workshop on Interactions between Sparse models and Technology*, 2016.
- [4] D. Defrère, O. Absil, P. Hinz, et al. L'-band AGPM vector vortex coronagraph's first light on LBTI/LMIRCam, in *Adaptive Optics Systems IV*, vol. 9148 of *Proceedings of the International Society for Optical Engineering*, July 2014, p. 91483X.