Carlos Alberto Gomez Gonzalez

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

I am a data scientist and astrophysicist working at the interface of machine learning and exoplanetary science. My work focuses on the development of advanced pattern recognition techniques for the task of exoplanet direct detection through high-contrast imaging. I pioneered the application of artificial intelligence techniques, such as deep neural networks, to the field of astrophysical high-contrast imaging. 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 strive to conduct interdisciplinary research embracing innovative data-driven scientific workflows.

Personal details

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

Academic Qualifications

PhD: Astrophysics 2013-2017

STAR and Montefiore Institutes, Université de Liège, Belgium

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

MSc: Astrophysics 2012-2013

Universidad Autoónoma de Madrid and Universidad Complutense, Spain

Specialization in Software Development 2011-2012

Universidad del Magdalena, Colombia

BSc: Astronomy, Specialization in Astrophysics 2002-2007

VV Sobolev Astronomical Institute, St. Petersburg State University, Russia

Experience

Research chair in Data Science 2017-Present

Grenoble Alpes Data Institute, Université Grenoble Alpes

Data science consultant 2017

Science to Data Science, Pivigo

Technician in Geographic information systems (ARCGIS) 2011-2012

IGAC – Agustín Codazzi Geographical Institute, Santa Marta, Colombia

Scientific assistant at Planetarium of Medelliín 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, observations for the Whole Earth Blazar Telescope (WEBT) 2005-2006
VV Sobolev Astronomical Institute, St. Petersburg State University, Russia

Mentoring

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

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 skills

- Expertise in open-source development and version control with Git (GitHub, BitBucket, GitLab).
- Advanced Python (more than 5 years). Experience with scientific and machine learning libraries: Numpy, Scipy, Jupyter, Scikit-learn, Astropy, AstroML, Scikit-image, Matplotlib, OpenCV, Pandas, emcee, NLTK, Spacy, Keras, Tensorflow, Pytorch, Blaze/Dask, H2O, Cupy.
- Large experience with bash and LaTeX.
- Basic knowledge of SQL, C, Fortran, Java, Octave/Matlab, R and HTML.

Software

- 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 (private repository, 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

- Hypothesis testing, Monte Carlo methods (MCMC), data cleansing and feature selection.
- Computer vision and natural language processing.
- Deep learning and neural networks. Supervised learning (regression and classification). Unsupervised learning (clustering, dimensionality reduction and low-rank modeling).

Outreach and Service

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

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)

Conferences, workshops and summer schools

Talks

- *A la caza de exoplanetas por imagen directa con Python: De la ciencia de datos, la exoplanetología y otros demonios*, October 2018, PyconES, Málaga, Spain.
- *Supervised detection of exoplanets with deep neural networks*, August 2018, Université de Liège - Colonster castle, Liège, Belgium.
- *Review of mainstream post-processing techniques for high-contrast imaging*, August 2018, Université de Liège - Colonster castle, Liège, Belgium.
- *Exoplanet direct imaging meets data science*, June 2018, NASA ARC Space Science and Astrobiology Division Seminar Series, Silicon Valley, US.
- *Exoplanet direct imaging meets data science*, June 2018, Kavli Institute for Particle Astrophysics and Cosmology, Stanford, US.
- *Exoplanet direct imaging data challenge*, April 2018, Paris-Saclay center for data science, Palaiseau, France.
- *Data science for direct imaging of exoplanets. Machine learning applied to high-contrast imaging*, April 2018, 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

- `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

- `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

- PRAIRIE Artificial Intelligence Summer School, July 2018, Grenoble, France.
- Combining high-resolution spectroscopy and high-contrast imaging for exoplanet characterization, June 2018, Pasadena, US.
- 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

Refereed

[1] W. J. Xuan, D. Mawet, H. Ngo, et al. Characterizing the performance of the NIRC2 vortex coronagraph at W.M. Keck Observatory. *ArXiv e-prints*, August 2018.

[2] V. Christiaens, S. Casassus, O. Absil, et al. Characterization of low-mass companion HD 142527 B. *ArXiv e-prints*, June 2018.

[3] **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.

[4] 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.

[5] 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.

[6] 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.

[7] **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.

[8] 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.

[9] 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.

[10] V. Christiaens, S. Casassus, O. Absil, et al. Characterization of the low-mass companion HD 142527 B. *Under review, submitted to A&A*.

[11] J. Milli, P. Hibon, 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.

[12] 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.

[13] 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.

[14] 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.

[15] **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.

[16] 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.

[17] 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.

[18] 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

[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.*