Alain COULAIS

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Overview

As a research engineer at the Centre national de la recherche scientifique (CNRS) in France, my primary role involves data analysis, including data processing, modeling, algorithms, and software development. I have been involved in multiple international satellite missions in the past, such as ISO (European Space Agency [ESA]), Spitzer (NASA), and Akari (Japan Aerospace Exploration Agency [JAXA]). One significant opportunity for me was working for ten years as a core team member of the High Frequency Instrument (HFI) aboard Planck satellite (ESA/NASA). During that period, working on the time ordered data, I contributed to the development of various models and multiple instrument testings. With the experience gained, I became involved in 2015 in the Mid-Infrared Instrument (MIRI) consortium (ESA), which is an infrared instrument onboard the James Webb Space Telescope (JWST) (NASA/ESA). I have made significant contributions to several high-impact articles, including two in *Nature* and one in *Science*.

Keywords

Data processing, Detectors modeling, IR astronomy, Radio interferomtry, Deconvolution, Inversion, Linux administration, High-Performance Computing (HPC), Software Development, Git, CI, C/C++, IDL/GDL/FL

Education

Ph.D (Physics) 1997
Université Denis Diderot (Paris VII), France *F. Lefeuvre & A. Kerdraon*

M.E. (Computing Science & Electronic, Nuclear Engineering) 1992
Ingénieurs en Science et Technologie (IST), Université Pierre et Marie Curie (Paris VI), France

M.S. (Solid State Physic, Semiconductors, Microwave) 1992
Diplôme d'études approfondies (DEA) Université Pierre et Marie Curie (Paris VI), France

Professional experience

Research Engineer 2015–present
Commissariat à l'Energie Atomique et aux Energies Alternatives (CEA), France *Long-term visitor*

Research Engineer 2001–present
CNRS Laboratoire d'Etudes du Rayonnement et de la Matière en Astrophysique (LERMA), France *Civil servant*

Research Engineer 1998–2000
CNRS Institut d'Astrophysique Spatiale (IAS), France

Research Engineer 1997–1998
CNRS Département de la Matière Interstellaire en Infrarouge et Millimétrique (DEMIRM), France

Graduate Research Assistant 1992–1997
CNRS Département d'Astronomie Solaire et Planétaire (DASOP), France

Intern Student 1991
Thomson General Wireless Telegraphy Company (CSF), France *Frequency selective surface for Rafale radar*

Awards & Distinctions

NASA Honor Award: the Silver Group Achievement Award 2024
as a member of JWST Instrument Commissioning Team

Group Achievement Award in Astronomy, Royal Astronomical Society, UK 2024
as a member of the JWST MIRI development team

Gruber Prize in Cosmology, Yale University, USA 2018
as a member of the Planck Core Team

Group Achievement Award in Astronomy, Royal Astronomical Society, UK 2018
as a member of the PLANCK team

Leadership & professional service

Haut Conseil de l'Évaluation de la Recherche et de l'Enseignement Supérieur 2023–present
HCERES France, Expert member: Evaluation of the performance of french and international labs

Elected member of the LERMA Lab Council 2020–2024
Management of the lab such as recruitment, budget distribution, ...

Elected member of the Scientific Council of Paris Observatory 2010–2018
Technical and scientific grant proposal review, Post-doc selection, ...

Organizer of a workshop on topics related to GDL 2014
at Paris Observatory, Paris, France

co-Lead of the Tau Tiger Team (Planck HFI) 2009–2014
Dedicated team for bolometers' time constant for HFI

Organizer of several sessions at the Tau Tiger Team meetings 2009–2012
Weekly telecons, face-to-face meetings every 2 months

Organizer of conference sessions 2005, 2007, 2010
Free Softwares for science at the Rencontres Mondiales du Logiciel Libre [RMLL]

Invited scientist at the JAXA in Japan 2003
Preparation of the infrared instrument onboard the Akari satellite

Reviewer for several journals 2000–present
A&A, SPIE, Applied Optic

Notable field & laboratory campaigns

MIRI JWST in-flight performance verification phase	2022
Space Telescope Science Institute (STSci), on duty observer	*Baltimore, MD*
Rehearsal for MIRI JWST in-flight operations	2019
STSci, participant	*Baltimore, MD*
Spare MIRI testing campaign	2019
CEA, participant	*France*
Final integration and testing of JWST	2017
NASA Johnson Space Center, on duty observer	*Houston, TX*
Several ground-based testing campaigns for MIRI	2016-2020
NASA Jet Propulsion Laboratory, participant	*Pasadena, CA*
JWST all instruments testing	2015
NASA Goddard Space Flight Center, participant	*Washington DC*
Planck-HFI in-flight remote monitoring	2009-2010
IAS, on duty observer	*France*
In-flight performance verification phase of Planck-HFI satellite	2009
IAS, participant	*France*
Characterization of the Proto-Flight Model (PFM) of Planck-HFI	2007
IAS, participant	*France*
Characterization of cryo qualification model (CQM) of Planck-HFI	2006
IAS, PI of the TAU ELS campaign	*France*
Radio-interferometer	2003
Institut de Radioastronomie Millimétrique (IRAM), scientific observer	*France*
30m single dish antenna	2002
IRAM, scientific observer	*France*
Nançay Radio Héliographe	1993–1996
DASOP, on duty observer	*France*

Selected Publications

As a lead author of approx. 20 articles and as a co-author of more than 100 articles in peer-reviewed journals ranked A, I have selected the most important ones for inclusion. Approx. 70 of these articles are from my membership in the Planck-HFI team, to which I have made significant contributions. (Internal technical reports are not included here.)

- H-index: 86; 49,731 citations (*from Astronomical Data System*)
- H-index: 56; 26,278 citations (*from Scopus*)

ORCID: https://orcid.org/0000-0001-6492-7719

- Franson, C. et al. (2024) *Emission lines due to ionizing radiation from a compact object in the remnant of Supernova 1987A*, accepted in **Science**
- Dyrek, A. et al. (2024) *SO_2, silicate clouds, but no CH_4 detected in a warm Neptune*, **Nature** 625, 51–54 https://doi.org/10.1038/s41586-023-06849-0
- Barrado, D. et al. (2024) *$^{15}NH_3$ in the atmosphere of a cool brown dwarf*, **Nature**, Volume 624, Issue 7991, p.263-266 https://doi.org/10.1038/s41586-023-06813-y
- Bouwman, J. et al. (2023) *Spectroscopic time series performance of the Mid-Infrared Instrument on the JWST* PASP 135 038002 https://doi.org/10.1088/1538-3873/acbc49
- Park, J. et al. (2022) *GNU Data Language 1.0: a free/libre and open-source drop-in replacement for IDL/PV-WAVE. Journal of Open Source Software*, 7(80), 4633, https://doi.org/10.21105/joss.04633
- Bouchet, et al. (2022) *Characterization of the MIRIm double prism assembly at short wavelengths: implications for transit observations of exoplanets*, Proceedings of the SPIE, Volume 12180, id. 121800Z https://doi.org/10.1117/12.2629778
- Klaassen, P. D. et al. (2022) *MIRISIM: a simulator for the Mid-Infrared Instrument on JWST*, MNRAS, Volume 500, Issue 3 https://doi.org/10.1093/mnras/staa3416
- Planck Collaboration (2016) *Planck 2015 results. XIII. Cosmological parameters*, A&A, vol. 594 https://doi.org/10.1051/0004-6361/201525830 (`cited: 11701`)
- Planck Collaboration (2016) *Planck 2015 results. XX. Constraints on inflation*, A&A, vol. 594. https://doi.org/10.1051/0004-6361/201525898 (`cited: 2343`)
- BICEP2/Keck Collaboration (2015) *Joint Analysis of BICEP2/Keck Array and Planck Data*, Physical Review Letters, vol. 114, no. 10 https://doi.org/10.1103/PhysRevLett.114.101301 (`cited: 904`)
- Catalano, A. et al. (2014) *Analytical approach to optimizing alternating current biasing of bolometers.* Applied Optics 49, 5938. https://doi.org/10.1364/AO.49.005938
- Coulais, A. et al. (2014) *Scaling GDL for Multi-cores to Process Planck HFI Beams Monte Carlo on HPC*, ADASS XXIII 485, 331. https://articles.adsabs.harvard.edu/pdf/2014ASPC..485..331C
- Planck Collaboration (2014) *Planck 2013 results. XVI. Cosmological parameters*, A&A, vol. 571. https://doi.org/10.1051/0004-6361/201321591 (`cited: 7759`)
- Planck HFI Core Team (2011) *Planck early results. IV. First assessment of the High Frequency Instrument in-flight performance*, A&A, vol. 536. https://doi.org/10.1051/0004-6361/201116487
- Lamarre, J.-M. et al. (2010) *Planck pre-launch status: The HFI instrument, from specification to actual performance*, A&A, vol. 520. https://doi.org/10.1051/0004-6361/200912975
- Pajot, F. et al. (2010) *Planck pre-launch status: HFI ground calibration*, A&A, vol. 520. https://doi.org/10.1051/0004-6361/200913203
- Kaneda, H. et al. (2009) *Application of Photoconductor Physical Transient Model to Fourier Transform Spectrometer Data of AKARI/Far-Infrared Surveyor (FIS)*, Publications of the Astronomical Society of the Pacific 121, 549. https://doi.org/10.1086/599818
- Giovannelli, J.-F. & Coulais, A. (2005) *Positive deconvolution for superimposed extended source and point sources* A&A, vol. 439 https://doi.org/10.1051/0004-6361:20047011
- Coulais, A. & Abergel, A. (2000) *Transient correction of the LW-ISOCAM data for low contrasted illumination.* A&A Sup. Series 141, https://doi.org/10.1051/aas:2000130

Projects

MIRI JWST | *an ESA instrument onboard NASA infrared space mission* 2015 – Present

- Contributed to the development of the pre-launch simulators, particularly in coronagraphic mode & exoplanet observation simulations, with some of them implemented on HPC platforms
- Member of the Exo-Planets & sn1987A science groups
- Contributed to the Level 2 pipeline, enhancing ramp processing & mosaicing capabilities

Planck-HFI | *an ESA and NASA space mission* 2005–2015

- Member of the core-team group (1 & 2)
- PI of the TAU ELS campaign during ground-based testing
- co-Lead of the Tau Tiger Team working group (2008–2012)
- Member of the beam working group (2012–2014)
- Developed models for the bolometers & electronics
- Discovered two majors technical issues: the TAU ELS (excess response at low frequency) & the pointing problem
- Contributed to delivering the final parameters for curing time-ordered data

Multiband Imaging Photometer for Spitzer (MIPS) | *a NASA Infrared space mission* 2001-2002

- Collaborated with the University of Arizona in Tucson, AZ
- Developed a model of the detector (first model for Ge:Ga IR detectors)

AKARI (Astro-F) | *a JAXA Infrared space mission* 2001-2002

- Collaborated with JAXA & the University of Tokyo in Japan
- Developed a model of the detector, providing a inversion code for the Fourier Transform spectrometer (FTS)
- This inversion code serves as the foundation for scientific work conducted using this FTS

Atacama Large Millimeter Array (ALMA) | *Europe/USA large radio-interferometer* 1998, 2000–2004

- Member of the heuristic pipeline working group
- Contributed to several internal software-related audits (i.e., performance, scalability, usability)
- Developed a fast gridding algorithm that has been incorporated into the official code

Infrared Space Observatory (ISO) | *a ESA Infrared space mission* 1998–2001

- Developed a model of the ISO-CAM detector & a transient correction method
- Lead of the transient correction team for all four instruments
- Developed results that have been used as scientifically validated data for all four instruments

Selected oral presentations

ARIEL workshop, *Paris, France, Feb. 2022*

- L168-9b par le LRS de MIRI sur le JWST

Société Française d'Astronomie et d'Astrophysique (SF2A), *Nice, France, Jun. 2012*

- Status of the Planck-HFI mission and data processing

Several technical talks at the Planck-HFI core team meetings & the Tau Tiger Team meetings (2006–2015)

Astronomical Data Analysis Software and Systems (ADASS) conference XXI, *Paris, France, Nov. 2011*

- Space Missions: Long Term Preservation of IDL-based Software using GDL

ADASS XIX, *Sapporo, Japan, Oct. 2009*

- Status of GDL - GNU Data Language

AstroF workshop, Tokyo Univ., *Japan, Jul. 2002*

- Invited seminar - infrared photo-detectors : the experience gained from ISO

Several technical talks within the internal ISO transient team group (1998–2001)

Technical skills & software development

Operating systems

- UNIX & Linux (most flavors, sys. admin since 25 years), *BSD
- OSX (Brew & Xcode, CLI, admin.)

Programming languages

- Expert in IDL/GDL/FL
- One of the maintainers of GDL, one of the main contributors, since 2006
- Advanced in C/C++ & bash
- Intermediate in Python (Conda, matplotlib ...), R, MATLAB

Tools

- CMake, Valgrind, cppcheck, Codecov (gcov, lcov)

Utilization of libraries

- FFTw, PLplot, HDF5, Eigen3 (MKL concurrent), BLAS/LAPACK, dSFMT, ...
- OpenMP, MPI

Techniques

- Regression testing & continuous integration (Travis CI)
- Bench-markings
- Slurm, PBS (I had time on NERSC ...)

Codes

- Most of my currents dev. (MIRI) are hosted in private GitLab or SVN depot.
- I never officially published my lib. but it is used in Planck & MIRI & Nika 2 communities !

Teaching & mentoring students

- 2001–present, Teaching a basic course in radio interferometry at the master's level, covering topics such as Fourier transform, UV plane, and deconvolution
- 2014–2017, Mentoring undergraduate students during Massive Open Online Courses (MOOCs) in astronomy
- 2000–present, co-Mentoring or significant technical contributions: 6 Ph.D students (FB, FL, AC, MML, YC, AD)
- 1998–present, Mentoring intern students: 8 from high schools, 15 from undergraduate schools, 20 from graduate schools

Languages

French (native), English (fluent), Japanese (intermediate), German (intermediate)