



Jean-Luc Starck

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ABOUT ME

Jean-Luc Starck is Director of Research and Head of the [CosmoStat laboratory](#) at the [Institute of Research into the Fundamental Laws of the Universe, Département d'Astrophysique](#), CEA-Saclay, France. Jean-Luc Starck has a Ph.D. from Nice Observatory and an Habilitation from University Paris XI. He was a visitor at the European Southern Observatory in 1993, at UCLA in 2004, and at Stanford's Department of Statistics in 2000 and 2005. Since 1994, he is a tenured researcher at CEA. In 2010, he established the [CosmoStat laboratory](#), whilst being strongly involved in the [Euclid ESA space mission](#). He received the [EADS prize of the French Academy of Science](#) in 2011, the International Astrostatistics Association (IAA) Fellow Prize in 2016, and the [2018 Gruber Prize in Cosmology](#) (as member of the ESA Planck team). Dr. Starck leads CosmoStat, an **interdisciplinary research** group at the interface between **cosmology** and [statistical methods](#) with a focus on **industry-academia partnership**. He has organized 24 [conferences](#), and was keynote, invited or seminar speaker over fifty times in the last five years. Over the last 10 years, he has been involved as PI or Co-I in the management of 8 million euros of [grants from national, European and international sources](#), including a [senior ERC](#). He has published over [250 refereed papers](#) in astrophysics, cosmology, signal processing and applied mathematics, and he is the author of [three books](#).

WORK EXPERIENCE

Head of CosmoStat laboratory

Commissariat à l'énergie atomique et aux énergies alternatives [01/01/2010 – Current]

City: CEA Saclay

Country: France

Big Collaboration Management:

In 2011, I took the leadership of the biggest Organization Unit (OU) of the [Euclid space mission](#), named Level 3 unit (OU-LE3). This unit is part of the Euclid group segment and it is composed of 250 researchers and engineers from Europe and the US. It is dedicated to designing the algorithms that will be used to deliver ESA Euclid products such as power spectra, cluster catalogs, or mass maps. **Leading such a broad international structure has been an enriching challenge. It has provided hands-on experience on how to manage a large group of scientists, including senior scientists and senior managers, in a cross-disciplinary, international and multi-cultural setting with high political visibility.** Obviously, this experience was at a higher level than the management of the CosmoStat laboratory.

The CosmoStat laboratory:

I have founded, and organized the hiring of all the permanent researchers, of CosmoStat as an interdisciplinary research group at CEA Saclay since 2010. CosmoStat is part of both the Astrophysics Division (DAp-Département d'Astrophysique) and the Electrical Engineering Division (DEDIP-Département d'Electronique Détecteurs et d'Informatique pour la physique) at the Institute of Research into the Fundamental Laws of the Universe (IRFU). The establishment of CosmoStat was facilitated by the acquisition of my Advanced ERC Grant, and the access to a rich pool of excellent Ph.D. candidates and Postdoctoral researchers for creating a dynamic and highly competitive laboratory. CosmoStat is also part of AIM (Astrophysics, Instrumentation and Modelling), a mixed research unit of CEA, CNRS, and Université Paris-Diderot (Paris 7), and the newly created Université Paris-Saclay. Its scientific focus is on computational cosmology and associated applications. The motivation behind its foundation was to bring together engineers and astrophysicists, in order to develop and apply novel methods from statistics, machine learning, signal processing, and compressed sensing to large datasets in cosmology and other fields. The [main CosmoStat research areas](#) are the following:

- Statistics, Machine Learning & Signal Processing.
- Cosmology: Analyze and interpret data.
- Education: Members of CosmoStat are involved in teaching and education.
- Dissemination of our ideas and tools in and outside the astronomical field.

The laboratory has achieved notable international recognition due to the quality of our research and our commitment to reproducible research.

European Projects:

I have been PI or Co-I of many European projects. The two biggest ones are the EU ERC Advanced Grant (2009-2014) and the EU H2020-FETOPEN DEDALE project (2015-2018). Over the last 15 years, I have been awarded 8MEuros of grants and funds from national, European, international and industry sources, including 5MEuros of European funding for R&D collaborations with industry.

Since 2013, I am Directeur de Recherche equivalent 'Classe Exceptionnelle' at CEA.

Researcher

French Alternative Energies and Atomic Energy Commission (CEA) [20/06/1994 – 31/12/2009]

City: Gif-sur-Yvette

Country: France

Staff position in the Astrophysics department, involved in several space missions (ISO, XMM, Planck, Fermi).

Visiting Scientist

Stanford University [02/01/2005 – 31/08/2005]

City: Palo Alto

Country: United States

Collaboration with colleagues at Stanford in both astrophysics and statistics departments.

Visiting Scientist

UCLA [30/08/2004 – 31/12/2004]

City: Los Angeles

Country: United States

Organizer of a long educational program at IPAM.

Visiting Scientist

Stanford University [15/12/1999 – 31/12/2000]

City: Palo Alto

Country: United States

Visiting researcher in the Statistics department.

Postdoctoral researcher

European Southern Observatory (ESO) [02/01/1993 – 31/08/1993]

City: Garching

Country: Germany

Research on Hubble Space telescope images deconvolution.

EDUCATION AND TRAINING

Habilitation à diriger des recherches,

Paris XI University [29/11/1999 – 29/11/1999]

Address: 15 rue George Clemenceau , 91405 Orsay (France)

PhD

Nice Observatory [01/11/1989 – 12/12/1992]

Address: Boulevard de l'Observatoire,, 06304 Nice (France)

<https://www.oca.eu/en/home-oca-en>

CONFERENCES AND SEMINARS

Conferences & Summer schools

- Chair of 24 international conferences and 3 summer schools (full list can be found [here](#)).
- Over the last 10 years, I am invited as a [keynote or invited speaker](#) 10 times per year on average.

<http://jstarck.cosmostat.org/conference/>

HONOURS AND AWARDS

Selected National and International Prizes and Awards

- 2022: European Astronomical Society Tycho Brahe Medal.
- 2021: Member of the [Academia Europaea](#) (2021).
- 2018: Recipient of the [2018 Gruber Prize in Cosmology](#) (as member of the ESA Planck team).
- 2016: [International Astrostatistics Association](#) (IAA) Fellow Prize.
- 2011: [EADS Prize](#) of the French Académie des Sciences.
- 2008: [Advanced ERC grant](#) (2.4MEuros).

PUBLICATIONS

Selected Academic Achievements

- [Publications](#): Over 250 peer-reviewed publications and 18 book chapters in both statistical and image processing journals, as well as astrophysics and cosmology journals.
- Citations ([Google Scholar](#)) in March 2022: 89500, h-index: 123, [most cited first author paper](#): 3200.
- Books/Monographs: I have published 3 books on data processing and astrostatistics (further details are available online [here](#)). All have been re-edited, last one in 2016.

<http://jstarck.cosmostat.org/publications/publi/>

INTERDISCIPLINARY RESEARCH

Interdisciplinary Research

[Current]

My research focuses on [many different subjects](#) related to both [data processing](#) (e.g. image restoration, deconvolution, blind source separation) and [astrophysics](#) (e.g. weak lensing, cosmic microwave background, large-scale structures). My main scientific results over the past ten years are the following:

- The first reconstruction of [dark matter maps from weak lensing observational data using deep learning](#). We trained a convolutional neural network (CNN) with a Unet-based architecture on over 3.6×10^5 simulated data realizations with non-Gaussian noise and cosmological parameters varying over a broad prior distribution. Our DeepMass method was proven substantially more accurate than existing mass-mapping methods. With a validation set of 8000 simulated DES SV data realizations, compared to Wiener filtering with a fixed power spectrum, the DeepMass method improved the mean squared error (MSE) by 11%. With N-body simulated MICE mock data, we showed that Wiener filtering with the optimal known power spectrum still gives a worse MSE than our generalized method with no input cosmological parameters; we demonstrated that the improvement is driven by the non-linear structures in the convergence. With higher galaxy density in future weak lensing data unveiling more non-linear scales, it is likely that deep learning will be a leading approach for mass mapping with Euclid and LSST ([Jeffrey et al., 2020](#)).
- The most accurate [Cosmic Microwave Background \(CMB\) map](#): Thanks to our new blind source separation method (GMCA), a truly full-sky estimate of the CMB map has been delivered to the astrophysical community ([Bobin et al., 2016](#)). This is the first time that the CMB could be recovered even at the Galactic Center. We have also shown that some specific studies, such as the kinetic Sunyaev-Zeldovich, are feasible only by using our map.
- The [3D tomographic weak lensing](#) is one of the most important tools for modern cosmology: Underlying the link between weak lensing and the compressed sensing theory, we have proposed a new approach to reconstruct the dark matter distribution in three dimensions using photometric redshift information. We have shown that we can estimate with a very good accuracy the mass and redshift of dark matter haloes, which is crucial for unveiling the nature of the Dark Universe ([Peel et al., 2017](#); [Leonard et al., 2014](#)).
- [Radio-Interferometry Image Reconstruction](#): We have developed an original application of sparse recovery in radio interferometric data, which enables an increase of angular resolution by a factor of two compared to the previous state of the art (Girard et al., 2017; Garsden et al., 2015). Our technique has been fully tested and validated on real data and is currently being considered for a full implementation on the Square Kilometer Array (<https://www.skatelescope.org>).

These breakthroughs were all obtained using very modern mathematical tools, deep learning, proximal theory, compressed sensing and sparse representations.

<http://jstarck.cosmostat.org/research/>

Knowledge & Technology Transfer (KTT) and Relations with Industry

CEA is focused on KTT towards industry and society, and I have been involved in KTT activities at different levels over the last 25 years:

- **Industry:** I have received 5MEuros of EU funding for R&D collaborations with industry. I have been collaborating on R&D projects with [SAFRAN](#) since 2007, by supervising two Ph.D. students and through two European projects. I was closely collaborating with two other companies ([Imec](#) and [Planetek](#)) on the H2020-COMPET-06-2014 [PHySIS](#) project.
- **CEA Direction de la Recherche Technologique (DRT):** The DRT does collaborative work with industry in addition to research. I supervised a DRT-funded Ph.D. student working on mass spectroscopy and blind source separation. This work has a wide range of applications, from material sciences to isotope tracing and dating.
- **CEA Life Science and Matter Science:** In January 2016, the two fundamental research divisions (DSM-Science of Matter, and DSC-Life Sciences) merged, creating a new division of Fundamental Research (DRF). The goal was to cross-fertilize between both fields, and a CEA internal call for projects was made. Our [COSMIC project](#) was one of few accepted. Its goal is to transfer techniques we developed for radio-interferometry to Magnetic Resonance Imaging (MRI). Our techniques will be applied to NEUROSPIN data, a leading centre of neuro-imagery.
- Collaborations in **Agriculture, Finance, Image and Video Processing, Statistics**, etc.: I collaborated with experts from a wide variety of fields, e.g. economic and financial measures used in agriculture (Morehart et al., 1999), financial data streams (Zheng et al., 1999), financial forecasting (Renaud et al., 2005), electricity forecasting (Benaouda, 2006), video processing (Tzagkarakis et al., 2012), laser range imaging (Tsagkatakis, 2015), optimization theory (Donoho et al., 2012), and clustering (Murtagh et al., 2000).
- **CEA Astrophysics department:** Knowledge transfer can occur even between two subfields that seem similar from outside. The methods developed for and applied on cosmological data by my group have many applications in astrophysics. Transferring code and knowledge to my immediate colleagues has always been an important part of my activities.
- **Reproducible research:** Reproducibility is at the heart of scientific methodology. With algorithms to extract information from data becoming ever more complex, it can be challenging to reproduce others' results and reproducible research is crucial for scientific advance. The concept of reproducible research consists of providing not only the data associated with a given paper, but also the codes used to analyze the data and the scripts that were used to process the data and even create the figures. Reproducible research is an important part of the non-commercial branch of KTT. In this spirit, my group made more than 30 packages freely available on the web (see <http://jstarck.cosmostat.org/software>). I encourage all my students and postdocs to follow this principle.

Scholarly Activities & Services to the Community

- 2014 - 2022: Vice-President of the [International Astrostatistics Association](#).
- 2013 - present: [Square Kilometer Array](#) (SKA): member of the Cosmology Scientific Working Group.
- 2011 - 2021: Associate editor of the [SIAM Journal on Imaging Sciences](#) (SIIMS).
- 2002 - present: National and International Project Reviewer on various pannels (French ANR, European Science Foundations (ERC, FET, etc.), US National Science Foundation, Austrian SF, Belgium SF, Netherlands SF, etc.).
- Jury member for Thesis/Habilitation committees.
- 2001 - present: [Chair of 24 international conferences](#).
- 1992 - present: Journal Reviewer: *Astrophysical Journal*, *Astronomy and Astrophysics*, *IEEE Image Processing*, etc.
- Outreach is important to get the general public excited about science and so I communicate about my most recent research through press releases, interviews with journalists and videos, a selection of which can be found [here](#).

TEACHING

Teaching

[Current]

I strongly believe that teaching is an integral part of research, and as such I have volunteered at selected teaching assignments in the Paris region and internationally since 1998.

- 2004 - present: I have supervised [36 PhD students and postdocs](#) (8 of them are currently in my group) of 17 different nationalities. Of the 26 who have continued beyond CosmoStat, 17 continue to work in academia (15 with permanent academic positions) and 9 work in industry (all with permanent positions), some are still involved in research with my group via academia-industry partnerships.
- 2004 - present: Schools and long-term educational programs: I have organized a [long educational program](#) at UCLA in 2004, and [several tutorial sessions and summer schools](#) (the last one in 2018 as part of the COSMO '21 international conference) for graduate, post-graduate and postdoctoral researchers.
- Funding: I have been successful in obtaining funding from international organizations (European Space Agency, European Southern Observatory), national entities (e.g. CNRS), and from private companies (e.g. Thales). The GOLD event funding had a total cost of 170KEuros, covering the housing and food for all students coming from all around the world.
- 1998 - present: To support teaching, I have published [three books](#) in the field of signal processing, and astrophysical and cosmological data analysis geared towards advanced undergraduates, graduates and researchers.
- 1998 - present: Teaching at graduate and postgraduate level internationally since 1998 (ENS Cachan, Paris VI, Paris XI, international summer schools, etc.).

ORGANISATIONAL SKILLS

Diversity and Inclusion

Philosophy: I am dedicated to furthering inclusion and gender equity in research, teaching and academia. I truly believe this is essential to ensure meritocracy, and thus quality, which is of utmost importance in research. Whether in my group or in conferences I organize, I aim for gender balance and representation from a wide variety of backgrounds. I am always interested in new ideas on how to achieve this, and implement them in the hiring strategy, as well as in the organization of seminars and conferences.

Quantifiable results: 33% (1/3) of current permanent staff at CosmoStat laboratory are women. Since its creation, 30% of all members have been women (Masters, PhDs, Postdocs and permanent staff). The Head of DAp/CEA has identified CosmoStat as the laboratory with the highest proportion of women arriving and staying. CosmoStat has hosted over 100 members from 18 different countries, and 5 different continents (Europe, America, Asia, Oceania, Africa).

LANGUAGE SKILLS

Mother tongue(s): **French**

Other language(s):

English

LISTENING C2 READING C2 WRITING C2

SPOKEN PRODUCTION C2 SPOKEN INTERACTION C2