ACTIVITY REPORT

Usual name: Barthelemy First name: Mathieu

Position: Teacher Grade: 1st Discipline/section: 34

Astronomy and Astrophysics

Date of birth: 4 March 1972
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DISTINCTION

➔ **Knight of the Order of Academic Palms (Promotion of 14 July 2017)**

LATEST DIPLOMAS

Date	Qualification
July 1996	Certificate in Physics, specialising in Physics
December 2003	Doctorate – Modelling of radiative transfer in the atmospheres of Jupiter and Saturn. Supervised by J. Lilensten.
June	**HDR – Planetary thermospheric and ionospheric emissions**

PROFESSIONAL EXPERIENCE

- 1996-1997: Trainee associate professor, Lycée du Parc (Lyon)
- 1997-1998: National Service; contingent scientist. ONERA-CERT/ DMAE (Toulouse)
- 1998-1999: Teacher at Lycée Jean Vilar in Meaux
- 1999-2004: Lecturer at IUT 1 in Grenoble (Thesis in parallel from 2000 to 2003 at LPG).
- 2004-2019: Senior Lecturer at UFR PhITEM/IPAG
- **2019-……: University professor at UFR PhITEM/IPAG**
  - ***2015-2021: Director of CSUG***
  - ***2021-2025: Scientific Director of the Maison pour la science Alpes Dauphiné (MPLS-AD)***
  - ***2021-...: Deputy Director of CSUG***

EDUCATION

- Lecturer in general physics (mechanics, electromagnetism, optics, etc.) at Bachelor's and Master's level.
- Head of the L1 PHY 202 course (> 120 students) from 2021 to 2023.
- Preparation for competitive examinations (Agrégation and Capes) in Physics and Chemistry (2004-2011)

- Lecturer in planetology (M1 and M2: space plasma courses, M2 A2P: atmospheric physics courses, 2004-...
- Teaching heat transfer in M1 Physics. Overhaul of teaching methods. 2025-…
- Head of M2 A2P, Plasma Astrophysics, Planets (2011-2015).
- Main organiser and teaching coordinator for the Polarisation summer school (COST MP 1104, Aussois, June 2014)
- Training and supervision of internships at CSUG (2015-…)
- Continuing education in Space Engineering (CSUG): Orbitography and mission definition (2022-...)
- Lecturer in the "Anthropocene and planetary boundaries" training courses (UGA design factory): 2025-...
- Inaugural conference of the School of Mediation (Territoires de Sciences, Grenoble, 2024): *What makes science?*
- ERCA speaker 2016-2024
- MPLS courses: Critical Thinking 2023–..., Environmental Sensors (2025–...), Newspace (2021–...).
- Chair of the MT180 competition pre-selection jury in Grenoble (2021).
- Participation in the 100 Parrains 100 classes programme (x3)
- Regular activities in schools and colleges (up to 10 per year)
- More than 7 public conferences per year (average 21-24)

Supervision:

- **5 theses supervised:** 5 theses defended, including 3 co-supervised (2 at 80%, 1 at 40%). 2 CIFRE theses.
- **46 interns**: 15 interns in Bachelor's 2, 3 or DUT, 16 interns in Master's 1, 15 interns in Master's 2 or PFE
- **16 thesis juries** (including abroad)
- **1 HDR panel**

ADMINISTRATIVE

- Head of the OSUG communications unit from 2006 to 2009.
- Grenoble representative on the steering committee of the R2A2 network (2004-2007).
- Vice Chair and initiator of the COST MP1104 group: "Polarisation as a tool to study the solar system and beyond. 23 countries. (2011-2015). ~150 k/year.
- Member of the OSUG research commission (2011-2018)
- Elected alternate member of the UJF CTP (2010-2011)
- Elected to the UJF CS (2012-2015)
- Elected to the PAGE Council (2015-2020)
- Member of the CSUT scientific council (2016-2019)
- Member of the Scientific Council of the Paris Nanosat Federation (2023-...).
- Member of the Scientific Council of the ATST (Action thématique Soleil Terre, part of the national Astronomy and Astrophysics programme, formerly PNST, CNRS INSU): 2025-...

- Member of the OFRAME[1] (French Office for Applied Research in Space Meteorology) Executive Committee: 2023-...
- Member of the board of the UGA doctoral school of physics (2021-...)

RESEARCH TOPICS

Studies of polar auroras on Earth and other planets for space meteorology

Keywords

- Space meteorology
- Ionosphere/Planetary thermospheres
- Aeronomy, polar auroras
- Emission mechanisms
- Radiative transfer
- Polarisation of emissions
- Nanosatellites, cubesats
- Instrumentation and models

RESEARCH SUMMARY: MAIN RESULTS AND DEVELOPMENTS

II.1.a) Earth instrumentation

- **PI of 6 instruments, including**
  - **3 space instruments: AMICal Sat (mission completed), ATISE Wind (TRL 2), SATIS (phase 0);**
  - **3 ground instruments: 1stCru (mission completed), Tomoaurora (partially operational, 2025), ASA (operational 2025).**
- **Co-investigator for 3 other ground-based instruments:**
  - **ASIS (operational permanent installation since 2023),**
  - **PLI (operational permanent installation since 2024),**
  - **PLIP (operational in occasional campaign mode)**
- **Scientific advisor for another space instrument, ESA-WFAI (UV: AUI and Visible: AOSI), Phase B1.**
- **French PI of the ASA (All Sky Antarctica) project in collaboration with NIPR for coverage of the entire southern oval (2024-...).**
- Member of the ARCTICS group (ISSI) for the use of amateur images for auroral physics (Grandin et al. 2024)
- PI of the SWING project (CSUG-AXA RF/AXA XL contract) for a period of 2 years and 6 months

Some recent notable results

- Measurement of the polarisation of the red line (Press release, Lilensten et al. 2008) and the 427 nm band of N2+ (Barthelemy et al. 2019)
- Reconstruction of particle fluxes at the top of the atmosphere using tomographic imaging (Robert et al. 2023)

[1] The national Sun-Earth programme, now Sun-Earth Thematic Action, is the structuring body of our scientific community. OFRAME also represents the applied part of these themes. It is the body that prepares requests in advance for the ministerial conference for the "space weather" part of ESA's S2P programme (budget around €10 million).

- Production of synthetic spectra of polar auroras (Barthelemy et al. 2025, Submitted to JSWSC, minor revisions)

II.1.b) Planets

- **1st detection from Earth's environment of Uranus' polar auroras, determination of the precipitated flux (Lamy et al. 2012, Barthelemy et al. 2014)**
- Calculation of the contrast between the star and exoplanets in the far UV (Menager et al. 2013).
- **Improvement of the determination of Uranus' rotation period (Nature Astronomy, Lamy et al. 2025)**

II.1.c) Simulations

- Atmospheric radiative transfer code (overlapping lines).
- Development of a code for simulating H_2 emissions (Ex-nihilo)
- Inversion of the Transsolo code (Robert et al. 2023)
- ML code for predicting low-energy electron fluxes (in progress, ex nihilo, thesis by S. Bouriat, 2023)
- Synthetic spectra of polar auroras (Barthelemy et al. 2025)
- Code for reconstructing particle energies from RGB images (in progress)

II.2) OTHER RESEARCH PROJECTS

- QlevEr Sat: Co-I of an Earth observation satellite with on-board AI (2019-2023)
- NanoBob: QKD satellite project with uplink
- Cybelle: Project in collaboration with the social sciences and humanities to study the circulation of astrophysics images in society
- Ciel: Project in collaboration with the social sciences and humanities to study IP regimes in the space sector.

SCIENTIFIC PRODUCTION

- **68 publications, 2 submitted (one publication accepted in Nature Astronomy in 2025)**
- 22 publications on teaching and scientific mediation (Cahiers pédagogiques, The Conversation, Echosciences, etc., 21 in French, 1 in English).
- More than 100 presentations at international meetings (>50% oral).
- 24 guest seminars at laboratories.

RECENT ADDITIONAL TRAINING

- IDM-CIC: CNES. 2 days (2015). Training courses designed to teach the use of concurrent engineering tools for the initial assembly of space missions.
- Management. 60 hours. Agency for the Development of Organisations and Individuals (now Co EFFY), 2018.
- Media training workshop organised by the UGA Foundation. 2023, 1 day.
- Anthropocene and planetary boundaries workshops (UGA design factory, 2 days), 2024,
- Workshop: "Questioning your position as a manager" (UGA Design Factory, 1 day), 2024,
- Workshop on "The meaning of my research" (UGA Design Factory, 1 day), 2025.

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EDUCATIONAL INVESTMENT

My current teaching is strongly focused on active learning methods[2]. The overall aim is to develop new teaching methods at university to improve student success, motivation and autonomy. In addition, I am very attentive to transitions and spatial aspects, and I have tried to introduce elements related to these concepts into all of my teaching.

In June 2021, I took over as director of the Maison pour la Science Alpes Dauphiné. This structure is dedicated to the scientific training of primary and secondary school teachers and is jointly run by the Grenoble INP rectorate and the UGA. It conducts around 60 training sessions per year in all areas corresponding to scientific subjects (i.e. mathematics, technology, life and earth sciences, physical and chemical sciences). Each training course is delivered by a pair of educational trainers and researchers. The programme is run under the auspices of the La main à la pâte foundation, created by Georges Charpak, and the academies of science and technology. The MPLS-AD also manages training programmes such as "Scientific Partners for the Classroom", which enables students from L2 to PhD level to offer science lessons in primary school classrooms after completing a training course. In order to keep in touch with the field and develop other types of active teaching methods, I have chosen to fulfil part of my teaching obligations in these training courses by taking responsibility for certain subjects (Climate, NewSpace, Space Meteorology and Space Environments, Critical Thinking-Scientific Thinking). Managing this structure represents an annual workload of around 600 hours for 1,200 person-days of training (figures for 2023 and 2024). We manage around 20 educational trainers and 50 scientific trainers every year.

From 2015 to 2025, my teaching activity has also been heavily focused on the CSUG and space activities. We have implemented a "learning by doing" approach based on projects or internships with the aim of training students of all levels in space projects. In terms of teaching, the CSUG can be seen as a practical school that allows students to implement and apply the knowledge they have acquired during their studies to concrete projects. It enables students to acquire a "system" vision and learn to work in a project environment in collaboration with industry. Students involved in the CSUG in the form of projects spend between 50 and 100 hours on a specific topic related to a space mission or instrument development project. Students ranging from IUT to M2, including engineering schools, are involved in these projects. This represents approximately 80 students per year for a total of 6,000 hours per year. Students have produced components that flew from 2020 to 2025 in the AMICal Sat satellite. Although its operations were hampered by the breakdown in scientific relations with Russia, we were able to confirm that this satellite functioned from its launch until its re-entry into the atmosphere on 10 January 2025. This demonstrates the quality of what has been achieved with the students.

We also take on students for internships, again from IUT or L1 to M2 or PFE. These internships enable 20 students per year to gain solid experience in the space sector.

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[2] Flipped classrooms, learning by doing, supervised investigations, etc.

and last from 2 to 6 months. Interns participate very actively in the development of space projects and represent a total of approximately 10,000 hours per year.
While students in the STEM fields represent the vast majority of students, every year we have students from the humanities and social sciences working on topics related to the space sector (economics, law, communication, etc.). For example, a student from the IEP in Grenoble who did an internship at the CSUG in 2019 is now working on a thesis on the economic exploitation of space data at the CNES and Toulouse Business School.
The CSUG alumni network after five years includes former students working for our industrial partners, space agencies, major industrial groups in the sector, as well as start-ups and young companies. Beyond the space sector, some students have moved on to other highly standardised sectors such as nuclear power and health.
Also as part of the CSUG, I have twice participated in the UGA Citizen Campus programme, which aims to raise students' awareness of the societal challenges of the sciences they study in their courses. It is an interdisciplinary and inter-level programme bringing together students from first year to PhD level. I led four-hour sessions on issues in the space sector based on the question: "Should access to space be democratised?"
The CSUG is included in the AMI CMA COMETES, which has been accepted and will start in March 2025. This AMI CMA includes several university space centres in the south of France. The total grant is over €20 million, with Grenoble's share amounting to around €2.5 million. This success demonstrates the strength of what I have built with my colleagues since 2014. The aim of this programme is to develop training courses for careers in the space industry and will enable us to scale up both quantitatively and qualitatively while maintaining the originality of the training courses offered at the CSUG and the CSUG's focus on payloads and subsystems, in line with the strengths of the Grenoble site.

Before I took over as director in 2018, we at MPLS-AD set up and ran a 16-hour (two-day) "Newspace" training course for primary and secondary school teachers. This training course will be updated, expanded and included in this CMA AMI.

The CSUG has also set up a certified continuing education programme, which began in January 2022 and will start its fourthsession in 2025. It represents a total of 110 hours. I teach courses on orbitography, mission design and "state space policies". I also supervise some of the projects, which account for half of the training programme's hours.

Although I stepped down as director of the CSUG in June 2021, I remain heavily involved in its educational and scientific activities and am still its deputy director in 2025.

In addition to the CSUG, from 2021 to 2025, I also taught M1 courses (RF: Astrophysics course, Solar System Plasmas section, RI: Heat Transfer course) and bachelor's degree courses (PHY202, Optics; lectures, tutorials and practicals, acting course coordinator in 2022). The optics module is taught using problem-based learning. In January 2025, I resumed teaching the Heat Transfer course for the M1 Research and Innovation programme. I chose to set up a teaching experiment as part of this course in order to include a transition focus and active teaching methods. This experiment is being carried out in collaboration with the Design Factory at Grenoble INP/UGA. Although we do not yet have any feedback, the current course is going very well and the students are very engaged.
Finally, starting in 2024, I trained in the Anthropocene and planetary boundaries so that I can continue to train students and trainers on these issues at the Design Factory. I will give my first lectures in February 2025.

Beyond training in the strict sense, I am involved in numerous activities to promote scientific and technical culture. My activities at the Maison pour la Science mean that I am in contact with primary and secondary schools and that I give regular talks at these establishments on the polar aurora and space meteorology, as well as on critical thinking issues surrounding global warming. In 2022-2023, for example, I ran a programme with the Morte school (Isère) on polar auroras, which led me to give three presentations during the year to both primary and nursery school pupils. In 2023, I also led a day-long workshop on critical thinking and global warming at the Anonay secondary school in Ardèche.
I also give talks in various settings for the general public, such as at the Université du Temps Libre (UTL) in Essonne, at the Montagnes et Sciences festival (2018: two talks in Grenoble and Clermont-Ferrand; 2023: four talks in Grenoble, Bourg d'Oisans, Tignes and Valence) and even in a village bar in Trièves. I also gave the inaugural lecture at the mediation school held at La Casemate (CCSTI de l'Isère) in June 2024. I regularly lead workshops on the Planeterrella experience (polar aurora simulator) installed at the OSUG. I was also the main organiser of the coordination meeting on educational partnerships held in Grenoble in May 2023 (approximately 100 people). In the same context, the MPLS has been organising annual partner meetings for the past three years, providing opportunities for reflection on scientific and technical culture. The 2023 session focused on participatory science, while the 2024 session focused on education for transition. We are planning a 2025 session on critical thinking.

The creation, implementation and management of the CSUG earned me the title of Chevalier de l'Ordre des Palmes Académiques in 2017.

The official European definition of *space weather* is as follows:

"Space weather is the physical and phenomenological state of natural space environments. The associated discipline aims, through observation, monitoring, analysis and modelling, at understanding and predicting the state of the sun, the interplanetary and planetary environments, and the solar and non-solar driven perturbations that affect them; and also at forecasting and nowcasting the possible impacts on biological and technological systems. (From Lilensten et al 2008, COST 724 publication)"

As this definition indicates, space weather involves studying the impacts that variations in solar activity can have on Earth and other planets. These variations can affect large electrical grids (widespread power outage in Quebec in 1989), GNSS systems by shifting positions by several hundred metres, satellites, radio communications, etc.

Space weather includes phenomenological aspects of understanding the mechanisms at work throughout the chain from the Sun to the planets, including Earth, via the solar wind, the magnetosphere and the atmosphere. It also includes aspects of forecasting at different time scales ranging from minutes (nowcasting) to months or even years (forecasting).

In space weather, it is generally considered that the last major event took place in 1859 (the Carrington Event), at a time when technological systems were very underdeveloped. The consequences were limited. This would probably no longer be the case today, and an event of this magnitude could cause major damage to current technological systems. On a global scale, it is generally estimated that a major space weather crisis, which occurs approximately 1/200 to 1/300 times per year, could cost more than €2 trillion([3]. It appears that an event as powerful as the one in 1859 could have hit the Earth in 2012, but most of the energetic particles from the coronal mass ejection (CME) passed by our planet.

In 2025, it remains extremely difficult to predict these exceptional events and fully understand their implications. Phenomena with higher occurrences can cause malfunctions in certain technological systems on a smaller scale. While it is important to be able to predict exceptional events, it is also important to accurately characterise periods of more "normal" activity, as these can have significant consequences.

Thus, in 2024, a few months before the solar maximum of cycle 25, two significant events were recorded, one in May and another in October, with the May event being stronger than that of 2003 but with very different characteristics in terms of both its physical parameters and its consequences. While in 2003 several satellites were lost in addition to local power failures (Sweden), the May 2024 event caused temporary disruptions but did not appear to cause permanent damage to systems thanks to alerts from various international services (NOAA, MET, ESA, etc.). However, the 2024 event gave rise to polar auroras at very low latitudes (Mexico, India, see Grandin et al. 2024, Robert and Barthelemy, The Conversation, 2024).

Another example is a very typical geomagnetic storm, of the kind that occurs several times a month, which had significant consequences in 2022 when Space X lost around 40 Starlink satellites due to increased atmospheric density. Finally, in 2015, a solar radio burst disrupted communications in Scandinavia in the frequency ranges used by civil aviation, seriously disrupting air traffic for several hours.

[3] http://www.agcs.allianz.com/assets/PDFs/GRD/GRD%20individual%20articles/GRD-2009-01-SpaceWeather.pdf

Even more commonly, low-energy suprathermal electrons (20eV-50keV) from the magnetosphere can heavily charge satellites, causing parasitic currents within their structure. These currents can damage certain satellite components or generate unexpected mechanical torques that cause the satellite to spin, disrupting its attitude control systems. In addition to its fundamental aspects, this science therefore also involves risk prevention issues.

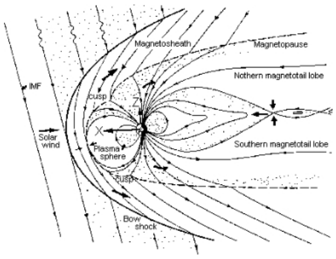

Figure 2 a: Diagram describing the structure of the Earth's magnetosphere. Solar wind particles undergo complex trajectories in the magnetosphere, which accelerate them. They precipitate into the upper atmosphere along magnetic field lines, generally on the night side (Taken from Bothmer 1993). The particles of particular interest to us are those originating from reconnection zones at the rear of the magnetosphere and precipitating into the atmosphere.

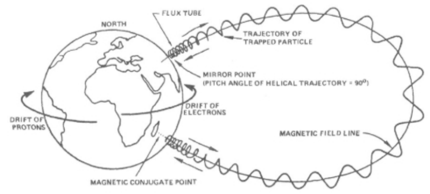

Figure 2b: Precipitation of particles into the Earth's atmosphere (Spjeldvik et al. 1985).

Space weather consists of a chain of phenomena originating from the Sun and reaching the Earth. It is therefore a systemic science based on a very wide range of objects and processes. This involves studying the Sun and its activity, the solar wind, magnetospheric processes and atmospheric processes, often at high altitudes (z>80km in the case of Earth) linked to solar activity (Figures 2a and 2b). My work clearly falls within this last link in the chain and consists of understanding the response of the upper atmosphere to the Sun's energy inputs and their consequences. More specifically, my work focuses on the study of low-energy particles (20 eV-50keV) that cause light emissions at high latitudes. These regions centred around the magnetic poles are called auroral ovals.

This is a young science that lags significantly behind classical meteorology, particularly due to the lack of measurement points for the phenomena at work. Whether on Earth or on other planets, the study of the upper atmosphere for space meteorology faces a major problem of a lack of observable quantities. While this is to be expected in the case of planets, particularly exoplanets, one might think that there would be sufficient measurements available on Earth to characterise the Earth's response to variations in solar activity. This difficulty is particularly acute for particles in the energy range that create polar auroras. This problem is due to a peculiarity of the atmospheric region between 80 and 300 km altitude, where much of the energy from solar wind particles is deposited. While this zone is too high for stratospheric balloons (maximum altitude 50 km), it is also too low for satellites, which are currently unable to remain in orbit for long periods at altitudes below 300 km. Some colleagues humorously refer to these layers of the atmosphere as the "ignorosphere". It is therefore essential to use remote sensing to understand the phenomenology of these atmospheric regions. The study of auroras is therefore a privileged means of studying these regions.

Furthermore, these energy ranges have long been considered less critical than higher-energy particles, whose direct effects can appear more significant. However, as they are more numerous, they play a major role in the short and long term, particularly for satellites, GNSS systems

GNSS systems, submarine cables and electrical networks. **They are once again becoming a subject of great interest, particularly for the ESA (D3S Mission). However, the global community working on this subject remains fairly small. It is even smaller in France, with fewer than 10 people working on the luminous emissions of the Earth's ionosphere (Toulouse, Paris, Grenoble).**

In the case of the Earth, two main types of observation methods are currently available. Active observations, very often from radars, and passive observations of light emissions from these regions of the atmosphere. My work focuses on these optical observations from both space and the ground.

However, auroral zones are highly variable on large and medium scales. The extent of the oval in particular is highly variable and depends heavily on solar activity. On smaller scales, the
"zoology" of these emissions is very diverse, linked to magnetospheric phenomena coupled with the dynamics of the ionosphere at high latitudes.

From a more formal point of view, the physics of polar auroras is described by the transport of particles along field lines and by the vertical and horizontal currents that develop at these altitudes. In one dimension, this transport is resolved using the non-conservative Boltzmann equation (kinetic modelling). For 40 years, a code called Transsolo has been developed to solve this equation along each field line.

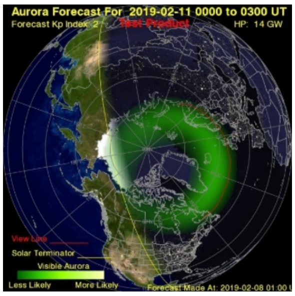

Figure 3: Forecast of the auroral oval for 11 February 2019 from NOAA (Taken from swpc.noaa.gov)

The Grenoble group, which was heavily involved in kinetic modelling and radar observations in the 1990s, took a turn towards the observation of light emissions in both modelling and instrumentation when I arrived in 2004, with a view to finding additional observable quantities. Our activity is divided into three main areas:

1. The study and measurement of the spectroscopy and polarisation of thermospheric emissions.
2. Instrumentation and spectroscopic, photometric and tomographic measurements of auroral emissions from the ground and space.
3. The interpretation of these measurements via numerical simulations up to observable quantities.

These three areas are linked by the desire to reconstruct energy inputs into the atmosphere, their deposits and their dynamic effects on these altitude layers. On a personal level, my work, which began with planetary cases, is now strongly focused on the Earth (almost exclusively since 2014)[5].

Since 2020, the new avenue of using machine learning has been explored as part of a thesis (Simon Bouriat) in partnership with the Gipsa Lab and the MIAI institute (Jocelyn Chanussot) under a CIFRE contract with SpaceAble. The aim is to predict low-energy electron fluxes at the entrance to the atmosphere using solar data (Lasco, etc.), simulations (Cactus), data at L1 and in the magnetosphere. This work is based on both DNN (Deep Neural Network) simulations

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[4] *A 589 nm ionospheric LIDAR was deployed in Andoya, Norway, in early 2019. It will usher in the era of active optical observations of the lower ionosphere (M. G. Johnsen, personal communication, Feb 2020).*

[5] *In 2021, two PhD students from the LAB in Bordeaux and their supervisors asked me for the kinetic and light emission codes developed for Jupiter with a view to adapting them for all the giant planets and Triton. A collaboration has been set up since then. The measurements of Uranus in 2012 and thereafter continue to yield results to which I am contributing.*

Network) and physical models. **However, continuing this research in Grenoble requires human resources that I do not currently have at my disposal. It will most likely be passed on to other teams around the world in the coming months through collaborations that are currently being established.**

My work therefore lies at the intersection of simulation, observation and instrumentation. As PI (Principal Investigator) for several instruments, including three space-based ones (AMICal Sat, ATISE Wind, SATIS),
and advisor scientist for another (ESA-WFAI), I have participated in regular field campaigns to observe polar auroras in the Arctic and, more recently, in Antarctica. During my career, I have also developed simulations concerning emissions linked to particle transport in the upper atmosphere (Transsolo kinetic code emissions module), radiative transfer and, now, machine learning. Since 2020, as part of Elisa Robert's thesis, we have also initiated procedures to invert these simulations in order to reconstruct energy inputs into the atmosphere (Robert et al. 2023).

Developed over 27 months and launched in September 2020, AMICal Sat began to produce its first results in October of the same year. Flow processing and inversion routines have since been under development and are yielding promising results for both space and ground-based instruments (Barthelemy et al. 2022, Robert et al. 2023). One of the unique features of AMICal Sat is that it is equipped with a dispersed RGB detector, which makes it more sensitive and allows it to reconstruct the intensity of more auroral lines. With its wide field of view (40°), this instrument allows us to map a significant portion of the auroral zones, since the diagonal on the ground is approximately 250 km when pointing at the nadir. Each pixel represents 240 m, but the dispersed RGB matrix means that we cannot expect a resolution better than 1 km or even 5 km for spectral information. The cessation of operations in 2022 (Russia-Ukraine war), in addition to the failure of the orientation system, prevented us from going as far as planned.

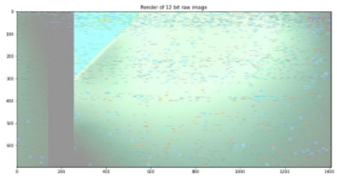

Fig 4: Recoloured image of an aurora taken by AMICal Sat. A preliminary reconstruction of particle fluxes was performed on 17x17 pixels at the bottom right of the image (central pixel: 1216, 644). Barthelemy et al. 2022JMASS.

Beyond its scientific and technical results, the mission initiated the reconstruction of the energies of particles precipitating into the atmosphere from scattered RGB or RGB images. This demonstrated the importance of having synthetic spectra of polar auroras as a function of precipitation conditions. **With the help of Elisa Robert at CSUG and Hervé Lamy at BIRA for verification, I then calculated almost all of the spectral lines in the visible (380–900 nm) and far UV (120–200 nm) ranges. This led to the production of synthetic auroral spectra, which represented a major obstacle to auroral simulation (Barthelemy et al. 2025, submitted to JSWSC). This study has many implications, as it requires a review of a large number of auroral measurements made using filters. An article on the UV part is in preparation, as is another on the issue of the 427 nm band (N2+), which is in fact polluted by two other lines. Others will follow in the next few years.**

Resolving both the spectral and field of view issues, the WFAI instrument will enable spatial and spectral information to be obtained simultaneously from a higher orbit (ESA Aurora-D mission, 6,500 km) or elliptical orbit (ESA Aurora C missions, 6 satellites, 400-4,000 km). It will consist of two sub-instruments: an FUV (130-170 nm) section in the form of several wide-field photometers (60°x60°) called AUI, and a hyperspectral visible section (AOSI). This instrument will be able to cover the entire night side of the oval in a single exposure with a resolution of 30km/pixel on the ground, while the UV part will cover both the day side and the night side. These two instruments are in phase B1 and are expected to fly in 2029.

In recent years, particularly since 2022, we have also developed a series of ground-based instruments in collaboration with BIRA-IASB in Belgium and NIPR.

In collaboration with BIRA, a spectrometer called ASIS (Auroral Spectrometer in Skibotn) was installed in 2023 in Skibotn, Norway. Since October 2023, it has been providing a spectrum every 30 seconds during the auroral season (October-March). This spectrometer is installed with a line of sight along the magnetic field and has a field of view of 4.5°. More recently, in 2024-2025, we installed a series of imagers with the same institute, comprising six filters at different wavelengths (427, 557, 630, 656, 672 and 400-800 nm) to obtain wide-field images of the auroras. This instrument is included in the Scandinavian aurora observation networks, notably ALIS-4D, as well as the British (ASK) and Japanese instruments. The data from these instruments will soon be available online in accordance with data recommendations. The BIRA-IASB is responsible for this aspect. A new ASIS-Red spectrometer will be installed alongside ASIS from October 2025. It is currently being tested at IPAG and CSUG.

Finally, during the southern summer of 2024-2025, we installed full-sky cameras at the Dumont D'Urville and Concordia Antarctic stations in the 391 and 630 nm bands. These cameras are part of a large network currently under construction led by the Japanese NIPR (National Institute of Polar Research), in particular Ryuho Kataoka. These instruments will enable us to double our aurora observation time, as well as study north-south differences around the equinoxes. I am also a partner in a request to install a spectrometer and imager at the Belgian Princess Elisabeth station in Antarctica (PI Hervé Lamy. Submitted on 10/02/2025).

On the machine learning side, consolidated results from Simon Bouriat's thesis were obtained in the first half of 2022. Data conditioning has been completed (S Bouriat et al. 2023) and the first neural networks have been set up. The initial results are currently being analysed and are very encouraging (Fig. 5). The rest of the thesis will be devoted to refining the neural networks used, refining the learning processes and, above all, segmenting the forecasts geographically. A first operational version of the code was implemented before the thesis defence in autumn 2023. **The quality of the forecasts already obtained is better than any obtained by physical methods. They are comparable in quality to the OVATION code, better in normal conditions and less good in severe conditions (Bouriat, thesis 12/2023). This represents a major advance for space meteorology.**

As mentioned above, we do not currently have the human resources to continue developing this topic and will soon be passing it on through collaborations.

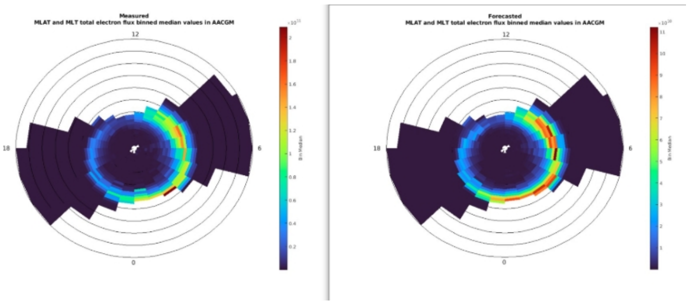

Figure 5: ML code forecast for the auroral oval obtained in early February 2022. The correspondence with the measurements is very good but could be further improved, particularly during very active periods, which are the only times when the OVATION statistical code is better than these simulations (Thesis by Simon Bouriat, Defence 12/23).

To conclude on auroral aspects, it is essential to mention my involvement in the ARCTICS group, an ISSI (International Space Science Institute) group whose work began in 2023 and whose objective is to exploit data produced by amateurs (mainly photos) for the science of polar auroras. This international group of around fifteen researchers and a few very active amateurs in the community has already made numerous advances. A handbook for both amateurs and professionals has recently been published. This work is particularly original work, it aims to be a reference document for interactions between these two communities and to provide a state-of-the-art overview of the possibilities offered by these amateur photos (Herlingshaw et al. 2024, Zenodo, https://doi.org/10.5281/zenodo.13931939).

Finally, the operational aspects of space weather are particularly important and relate to the prevention of risks to technological infrastructure, which can reach costs exceeding $2 trillion in the event of a major event such as that of 1859. It is therefore essential to take these risks into account and quantify them. In this context, we have set up a collaboration with AXA XL via the AXA RF research fund with a view to quantifying these impacts, particularly for ground infrastructure, and proposing occurrence/severity diagrams for the various associated risks (SWING Project). This project started in 2024 and will continue until spring 2026. This project was set up via the UGA foundation and includes G2ELAB. The operational part of this project is coordinated by Elisa Robert, who is working on her thesis with me until 2023. I am the scientific lead for this project.

Since the start of the SWING project, we have been able to

Produce risk occurrence diagrams for different phases of the solar cycle using Hp30 indices and the derivative of the Earth's magnetic field as measured by ground-based magnetometers (dB/dt).

Produce preliminary calculations of the propagation of induced currents in conductors. In this regard, it appears that a study at different frequencies is critical, particularly between 0.5 and 5 Hz, frequencies at which the impacts seem to be most critical. The G2ELAB team in charge of this aspect noted that these induced currents are currently very often poorly taken into account and that developments are needed to ensure a "realistic" assessment of the impacts and better forecasting.

All of my activities in the field of space meteorology are carried out between IPAG and CSUG.

Research projects from 2025 onwards

The development strategy for my research activity over the next five years will be fairly similar to the current strategy, with a very strong focus on large-scale determination of the particle flows that create polar auroras and their consequences, as well as on the dynamics of the auroral ionosphere, which is essential to understanding the system.

We will focus on the ground and in space:

On the instrumental aspects, by developing new instruments such as ATISE Wind, which measures ionospheric winds (CNES R&D currently under evaluation), maintaining existing instruments and implementing data processing codes that are as automated as possible. The inversion of data from the WFAI instrument aboard Aurora D (2029) and C (2033) will represent a significant part of my future activity.

On the simulation side, we plan to couple current auroral emission simulations with the IPIM code developed in Toulouse (IRAP), which allows us to take into account a wider range of phenomena, in particular horizontal transport phenomena that are not currently considered in current simulations. An industrial partner will be involved in making this coupling operational for space weather.

We will also launch a research programme with ONERA and the University of Strasbourg to cross-reference data from neutron detectors, magnetometers and visible camera noise. This will result in a thesis that we hope to start in October 2025.

We will, of course, continue to develop the SWING project and consider the next steps to be taken following these developments.

Finally, recent measurements and images taken by amateurs have made it possible to better characterise the continuum that is sometimes observed in polar auroras (Herlingshaw et al. 2024, page 28). This continuum is not yet understood and the processes that create it are still poorly constrained. To this end, we are collaborating within the ARCTICS group, and more specifically with Noora Partamies (UNIS, Norway), to try to better understand the conditions that create this strange continuum. An article on this subject has been submitted.

International collaborations

Being very small, the Grenoble group is heavily involved in collaborations. **The French ionosphere community is generally extremely small. This has given me the opportunity to carry out all my projects with a view to achieving the most international cooperation possible.** Given the specific nature of the subject, very strong links have been established with northern countries, particularly Norway and Finland. Links had also been established with Russia. These were severed in 2022.

Elsewhere in Europe, Belgium has taken a very strong position in the field of space meteorology by creating the STCE. We have developed a very strong collaboration with them in both modelling and instrumentation, particularly with the IASB. Our ground instruments in the Arctic (Norway) are entirely developed within the framework of this collaboration.

The All Sky Antarctica programme (#IEPV 1286) is built around collaboration with the NIPR in Japan (R. Kataoka). It involves installing cameras across the Antarctic continent to better monitor these phenomena. I am responsible for the French part of this programme.

Maxime Grandin (FMI, Finland) recently obtained ERC funding, in which I am collaborating on the assembly of instruments, particularly for proton auroras, and on simulations related to these auroras.

In addition, we carry out all our field campaigns in Norway in collaboration with the University of Tromsø in Norway (for over 15 years). Also in Norway, we are building a collaboration with UNIS on the issue of the continuum.

Finally, the ARCTICS group is a highly international collaboration involving colleagues from the following countries: Canada, the USA, New Zealand, the UK, Norway and Finland.

DESCRIPTION OF 5 PUBLICATIONS

BARTHELEMY ET AL. JSWSC, 2025. SUBMITTED. MINOR REVISIONS.

Publication detailing the procedure for calculating synthetic spectra of polar auroras based on precipitation conditions. This publication is key in several respects. It will enable precipitation to be reversed in many conditions, particularly in RGB in conjunction with the ARCTICS group. Many measurements using filters will need to be reinterpreted in light of these calculations.

BARTHELEMY ET AL. IEEE, JMASS, 2022

Article describing the AMICal Sat satellite and its preliminary results. This article represents the culmination of work launched at CSUG for the construction of this satellite, extending to the scientific exploitation of the data. It combines technical aspects and preliminary scientific results. The satellite's operations had to be halted in February 2022 due to the end of collaboration with Russia. It re-entered the atmosphere on 10 January 2025, sending its last telemetry 10 hours earlier, demonstrating the quality of what had been produced.

HERLINGSHAW ET AL. AURORA HANDBOOK FOR CITIZEN SCIENCE 2024

This publication is very special in that it is a collective work by the ARCTICS group aimed at amateurs with a view to improving relations between amateurs and professionals.

The overall objective is to be able to extract scientific information from photographs taken by amateurs. This publication is referenced under Zenodo.

ROBERT ET AL. 2023

This article presents mesoscale electron precipitation maps (~200 km side) derived from tomographic measurements by the ALIS network in Scandinavia. In addition to reconstructing average energies and total precipitated fluxes, a link with acceleration processes in the magnetosphere has been identified.

LAMY ET AL. 2012, GRL**[6]

This article reports on observations made in collaboration with Laurent Lamy (LESIA) using the Hubble telescope, which enabled the first detection of a polar aurora on Uranus from Earth. It is important to note that several publications have resulted from this initial work, including a recent article in Nature Astronomy (Lamy et al; 2025). One of these articles (Barthelemy et al. 2014) describes the reconstruction of the particle flows creating these auroras.

COLLECTIVE RESPONSIBILITIES

I have consistently taken on collective responsibilities since becoming a senior lecturer. Whether in elected positions on councils or scientific roles in bodies such as scientific councils of various organisations, my commitment to these tasks has been constant throughout my career.

In 2006, I took on responsibility for communications at the Grenoble Observatory for the Sciences of the Universe (OSUG).

In 2010, noting the dispersion of the community studying polarisation in astrophysics, Hervé Lamy (BIRA-IASB) and I set up a COST group on this theme, of which I was then Vice-Chair from 2011 to 2015. We managed around €150k/year as part of this programme.

In 2014, I set up the CSUG with colleagues and took over its management when it was inaugurated in 2015. It then became an SFR. I managed it until 2021 after launching the first AMICal Sat satellite. The CSUG's annual budget, excluding specific projects, is around €150k/year. During my term of office, we obtained H2020-type funding, ESA funding and sponsorship totalling more than €1.5 million. We brought together up to 15 people during this term of office.

In 2021, I took over as scientific director of the Maison pour la Science in May. This small but highly efficient team (4 to 5 people) is jointly supervised by the UGA, the rectorate and Grenoble INP, with a non-HR budget of around €40,000 per year. It provides more than 1,200 person-days of training per year and requires the coordination of several dozen contributors (around 20 educational trainers from the local education authority and more than 50 scientific contributors or engineers).

Particularly sensitive to the development of doctoral students, and after having been responsible for the Master 2 Astrophysics, Plasma, Planet programme from 2011 to 2014, I joined the office of the doctoral school of physics in 2021.

[6] Articles marked ** have been the subject of press releases.

Finally, I have recently become heavily involved in the French community for Sun-Earth relations and space meteorology by joining the scientific council of the ATST and the board of the OFRAME.

The list of my scientific and purely administrative responsibilities is given below:

- ***2015-2021: Director of the CSUG***
- ***2021-2025: Scientific Director of the Maison pour la science Alpes Dauphiné (MPLS-AD)***
- ***2021-...: Deputy Director of CSUG***
-
- Head of the OSUG communications unit from 2006 to 2009.
- Representative for Grenoble on the steering committee of the R2A2 network (2004-2007).
- Vice Chair and initiator of the COST MP1104 group: "Polarisation as a tool to study the solar system and beyond. 23 countries. (2011-2015). ~150 k/year.
- Member of the OSUG research commission (2011-2018)
- Elected alternate member of the UJF CTP (2010-2011)
- Elected to the UJF CS (2012-2015)
- Elected to the PAGE Council (2015-2020)
- Member of the CSUT scientific council (2016-2019)
- Member of the Scientific Council of the Paris Nanosat Federation (2023-...).
- Member of the Scientific Council of the ATST (Sun-Earth Thematic Action within the National Astronomy and Astrophysics Programme, formerly PNST, CNRS INSU): 2025-...
- Member of the OFRAME (French Office for Applied Research in Space Meteorology) Executive Committee: 2023-...
- Member of the board of the UGA Doctoral School of Physics (2021-present)

1. TEACHING TABLE

Year	Level	Qualification	Title	Type of programme (1)	Nature (2)	Enrolment	Annual number of hours
2021-2022	M1	1st year Master's degree	Space technology	FI	Tutorial	12	1 p.m.
2021-2022	FC	Non-degree	MPLS training courses	FC		25 on average per training course	51 hours
2021-2022	Hourly relief		MPLS management				48
2021-2022	M1	RF and IR Physics	Master's project	FI	Practical Project	12	36 hours
2021-2022	M1	Physics RF	Astrophysics	FI	CM/TD	35	12
2021-2022	L1	Bachelor's Degree in Engineering Sciences	PHY 202 Geometric Optics + teaching responsibilities EU	FI	Lectures/Tutorials/Practicals	~120	4.5 hours lectures + 6 hours + 16 hours TD + 12 hours TP
2022-2023	L1	Bachelor's Degree in Engineering Sciences Engineering	PHY 202 Geometric Optics + resp pedagogical EU	FI	CM	~120	4.5 hours of lectures + 6 hours of tutorials
2022-2023	FC	Non-degree	MPLS training courses	FC		25 on average per training course	22.5 hours
2022-2023	M1	RF and IR Physics	Master's project	FI	Practical Project	12	36 hours
2022-2023	M1	Physics RF	Astrophysics	FI	CM/TD	35	12
2022-2023	Hourly allowance		MPLS management and organisation of the education symposium				96
2023-2024	M2	M2 TMA	Atmospheric boundary layer turbulence atmospheric	FI	CM	10	1.5 hours
2023-2024	FC	Non-degree	MPLS training courses	FC		25 on average per training course	17
2023-2024	Hourly rate		MPLS management				72
2024-2025	M1	RF and IR Physics	Master's project	FI	Practical project	8	24
2023-2024	FC	DU	Space Engineering	FC	CM	6	8
2023-2024	M1	RF Physics	Extreme GS	FI	TP-Project	10	50 hours
2023-2024	FI	M1	Astrophysics	FI	CM/TD	35	12
2024-2025	M2	M2 TMA	Turbulence in atmospheric boundary layer	FI	CM	10	1.5h
2024-2025	FC	Non-degree	MPLS training courses	FC		25 on average per training course	~50 hours To be confirmed

2024-2025	FI	Training of trainers	Anthropocene and planetary boundaries	FC and FI	CM/TD	Variable	~8 p.m. to be confirmed
2024-2025	FC	DU	Space engineering	FC	CM	6	8
2024-2025	M1	Physics RI	Heat Transfer	FI	Lectures/Tutorials	14	28.5 hours
2024-2025	M1	RF Physics	Astrophysics	FI	CM/TD	35	12 hours
2024-2025	M1	Physics RF and RI	Master's project	FI	Practical project	8	24
2024-2025	Hourly discharge		MPLS management				48

(1) initial/continuing education, professional, face-to-face/distance learning
(2) lectures, practical work, tutorials, supervision of final projects and internships

2020-2021

- L1 Opt Phy 202. APP: 36 hours
- L2 Thermal tutorials/practical work: 20 hours
- M2 A2P (astro) Planetology Lectures: 10 hours
- Supervision of CSUG students: AMICal Sat, ATISE (~120 students). Co-supervision of ThingSat students
- MPLS training: 16 hours
- Citizen campus: 4 hours

2019-20

- **1 semester CNRS delegation**
- M2 A2P (astro) Planetology Course: 10 hours
- Supervision of CSUG students: AMICal Sat, ATISE (~120 students). Co-supervision of ThingSat students
- MPLS training: 16 hours
- Citizen campus: 4 hours
- ERCA intervention: 2 hours plus project monitoring

2018-2019

- **2 semesters of CRCT**
- M2 A2P (astro) Planetology Course: 10 hours
- Supervision of CSUG students: AMICal Sat, ATISE (~120 students). Co-supervision of ThingSat students
- Citizen Campus: 4 hours
- ERCA intervention: 2 hours plus project monitoring

2017-2018

- CSUG management time off: 96 hours
- Supervision of CSUG students: AMICal Sat and ATISE (~120 students)
- L3 Physics Chemistry. Tutorials 15 hours
- M2 A2P (astro) Planetology Lectures: 10 hours
- ERCA intervention: 2 hours plus project supervision

2016-2017

- CSUG management time allowance: 96 hours
- Supervision of CSUG students: NanoBob, AMICal Sat and ATISE (~120 students)
- L3 Physics Chemistry. Lectures 15 hours, tutorials 15 hours
- M2 A2P (astro) Planetology Lectures: 10 hours

2015-2016

- L3 Physics Chemistry. Lectures 15 hours, tutorials 15 hours
- M1 Physics Space Physics Lectures: 30 hours
- M2 A2P (astro) Planetology Lectures: 12 hours
- CSUG management time off: 96 hours
- Supervision of students for phase 0 of ATISE

2014-2015

- L3 Physics Chemistry. Lectures 15 hours, tutorials 15 hours
- M1 Physics Space Physics Lectures: 30 hours
- M2 A2P (astro) Planetology Lectures: 12 hours
- Time off CSUG assembly: 96 hours

2013-2014

- 57 hours postponed due to closure of the FORMESPC Master's programme 1st semester
- M1 STE Fluid Mechanics Course: 30 hours
- M1 STE Numerical Analysis Course-Practical: 24 hours
- M2 A2P (astro) Planetology Lectures: 18 hours
- L3 Physics Chemistry. Lectures 15 hours, tutorials 15 hours
- M1 Physics. Practical work on dynamic systems and non-linear phenomena: 30 hours

2nd semester

- M1 Astrophysics Lecture: 15 hours

2012-2013

1st semester

- M1 STE Fluid Mechanics Lectures: 30 hours M1 STE Numerical Analysis Lectures-Practicals: 24 hours
  M2 A2P (astro) Planetology Course: 18 hours
- L3 Physics Chemistry. Lectures 15 hours, tutorials 15 hours
- M1 FORMESPC Mechanics Lectures-Tutorials: 50 hours
- M1 FORMESPC Mechanics Practical work: 12 hours

2nd semester

- M1 Physics Astro Lectures: 15 hours

2011-2012

Postponed ~40 hours due to closure of the agrégation preparation course 1st semester

- M1 STE Fluid Mechanics Lectures: 30 hours
- M1 STE Numerical Analysis Course-Practical: 24 hours
- M2 A2P (astro) Planetology Lectures: 18 hours
- M1 FORMESPC Mechanics Lectures-Tutorials: 25 hours
- M1 FORMESPC Mechanics Practical work: 12 hours

2nd semester

- M1 Astrophysics Lecture: 15 hours
- IUT Physical Measurements Mechanics Tutorials: 24 hours

2010

- L3 Physics Chemistry: Electromagnetism Wave Practical: 12.5 hours
- M1 FORMESPC Mechanics Course-Tutorial: 25 hours
- M1 FORMESPC Mechanics Practical: 12 hours
- Preparation for competitive examination mock exams: 16 hours
- Preparation for aggregation exams Free labs: 24 hours
- Preparation for aggregation practical work: 4 hours
- Aggregation preparation lessons: 2.5 hours
- Doctoral course TUE radiative transfer: 12 hours
- M1 Astrophysics Physics Course: 15 hours
- M2 AMD Planetology: 6 hours

2009-2010

- Preparation for teaching certification exam, written portion: 8 hours
- Preparation for teaching certification practical work 8 hours
- Preparation for teaching certification Open labs 36 hours
- Preparation for teaching certification exam: timed lesson 4.5 hours
- Preparation for teaching certification exam Physics lesson 5 hours
- M2 Planetology 8 hours
- Internal teaching qualification 18 hours
- CAPES written exam preparation 7 hours
- CAPES practical preparation 12 hours
- CAPES preparation: Assemblies 10 hours
- L3 Physics Chemistry Tutorial 18 hours
- L3 Physics Chemistry Practical 35 hours
- Trans Planétologie course unit 5 hours

2008-2009

- Planetology M1-M2 Lecture 8 hours

- Internal aggregation course-tutorial 27 hours
- Electromagnetism L3PC Tutorial 15 hours
- Electromagnetism L3PC Practical 32 hours
- Aggregation preparation Open lab 57 hours
- Aggregation preparation lesson 5.5 hours
- Aggregation preparation, written 8 hours
- Capes Preparation Practical Electricity 28 hours
- Capes preparation written 4 hours
- Capes Labo libre preparation + time-limited assembly: 15.5 hours

2007-2008

- Planetology M1-M2 Course 8 hours
- Electromagnetism L3PC Tutorial 15 hours
- Electromagnetism L3PC Practical 32 hours
- Preparation for Agrégation Open laboratory 57 hours
- Agrégation preparation lesson 5.5 hours
- Agrégation preparation, written 8 hours
- Capes Preparation Practical Electricity 28 hours
- Capes preparation written 4 hours
- Capes Labo libre preparation + time-limited assembly: 15.5 hours
- IUT practical thermo 28 hours

2006-2007

- IUT1 Practical Physical Measurements Thermodynamics 56 hours
- OSUG TUE555 lectures and tutorials 12 hours
- Agreg.ue Practical Work Free Laboratory 36 hours
- Agreg.ue EEE Practical 8 hours
- Capes.ue Lectures-Tutorials Preparation for written exam. Mock exam 3 hours
- Capes.ue Tutorial Time-limited editing 8 hours
- Capes.ue Lectures and tutorials: Additional information 2 hours
- Capes.ue Practical work EEE 28 hours
- Capes.ue OPTICS practicals 24 hours
- PHY416i.ue 8 Astrophysics lectures 8 hours

2005-2006

- Radiative Transfer Doctoral Course 10 hours
- IUT1 Practical Physical Measurements Thermodynamics 44 hours
- OSUG Course-Tutorial TUE555 10 hours
- OSUG Visits and General Public 9.5 hours
- CESIRE Head of the ATIDE Platform 18 hours
- Agreg.ue Practical Work Open Lab 30 hours
- Agreg.ue Practical Work EEE 8 hours
- Capes.ue Lectures-Tutorials Preparation for written exam. Mock exam 5 hours
- Capes.ue Tutorial Time-Limited Editing 6.25 hours

- Capes.ue Lecture-Tutorial Supplements 2.5 hours
- Capes.ue Practical work EEE 24 hours
- Capes.ue OPT practical work 24 hours
- PHY416i.ue Astrophysics lectures 18 hours
- INF508p.ue Info Practical 24 hours
- PHY507p.ue Signal Processing Practical 24 hours

2004-2005

- IUT1 Physical Measurements Tutorial Maths Tutorial 48 hours
- IUT1 TM Physical Measurements Thermodynamics 24 hours
- OSUG Course-Tutorial TUE555 8 hours
- CESIRE Responsibility ATIDE Platform
- Capes.ue EEE practicals 24 hours
- Capes.ue OPT Practical 24 hours
- INF508p.ue Info Practical 24 hours
- PHY507p.ue TP Signal Processing 24 hours

SUMMARY OF TEACHING ACTIVITIES PRIOR TO MY APPOINTMENT AS SENIOR LECTURER (1996-2004)

1996-1997 IUFM internship Lycée du Parc in Lyon	• Responsibility for a Year 10 class. (6 hours/week) • Supervision of three groups of Year 11 students in the Physics Olympiad competition - *Modelling of airflow around aeroplane wings* ***(group ranked 1st in the national competition).*** - Demonstration of radiation pressure using double exposure holography. - *Measurement of the air index using a Michelson interferometer.* • Professional thesis: - *Measurement: what status does it have in secondary schools?* Supervised by Jean Gréa (LIRDHIST/University of Lyon 1).

1997 Scientist with ONERA/CERT/DMAE	• Set up a 50-hour course on radiative transfer for the DMAE aerothermics team. • Radiative transfer course for third-year SUPAERO students (approximately 10 hours).
1998 Teacher at Lycée Jean Vilar in Meaux (77)	• 2 Year 10 classes • 1 sixth form class specialising in physics. • Physics Olympiad (1 group) *- Creation of a filament disappearance pyrometer.*

1999-2000 IUT Physical Measurements Grenoble. Administrative responsibilities	• Electronics tutorial (1st year) • Mathematics tutorial (1st year) • Optics, thermodynamics, mechanics practicals (1st year) Total of around **500** hours • Supervision of trainees in initial training (3) and continuing education (1)
2000-2001 IUT Physical Measurements Grenoble.	• Mathematics tutorials (1st year) • Statistics tutorials

Administrative responsibilities	• Thermal/thermodynamics tutorials (1st year) • Optics, thermodynamics, mechanics practicals (1st year) Total of around **500** hours • Supervision of trainees in initial training (3) and continuing education (1) • Responsibility for practical work in optics, thermodynamics and mechanics (1st year). • Implementation of tutored projects. • Participation in consultation meetings for mathematics teachers in physical measurements
2001-2002 IUT Physical Measurements Grenoble. Administrative responsibilities	• Mathematics tutorials (1st year) • Statistics tutorials • Thermal/thermodynamics tutorials (1st year) • Optics, thermodynamics, mechanics practicals (1st year) Total of approximately **450** hours • Supervision of trainees in initial training (3) and continuing education (1)

Champollion Secondary School INPG	• Responsibility for practical work in optics, thermodynamics and mechanics (1st year). • Responsibility for tutored projects. • Elected to the departmental council • MPSI exams with Ms F. Papillon. (100 hours) • Marking of 220 INP joint entrance exam papers. Physics test 2, organised by Mr Brulard.
2002-2003 IUT Physical Measurements Grenoble. Administrative responsibilities	• Statistics and probability classes. • Mathematics tutorials (1st year) • Statistics tutorials • Thermal/thermodynamics tutorials (1st year) • Optics, thermodynamics and mechanics practicals (1st year) Total of approximately **430** hours**.** • Supervision of trainees in initial training (3) and continuing education (1)

	• Responsibility for practical work in optics, thermodynamics and mechanics (1st year).
2003-2004 IUT Physical Measurements Grenoble. Administrative responsibilities	• **Courses** in metrology, statistics and probability. • Mathematics **lectures** and tutorials (first semester repeaters group) • Statistics tutorials. • Thermal tutorials (1st year). • Practical work in optics, thermodynamics and mechanics (1st year) Total of approximately **192** hours • Supervision of trainees in initial training (1 or 2) and continuing education (1) • Responsibility for practical work in optics, thermodynamics and mechanics (1st year).

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1. **Listed publications (these should not be attached)**

RANKED LIST OF PUBLICATIONS (THESE SHOULD NOT BE ATTACHED)

→ Book: Le système solaire revisité (The Solar System Revisited). Published by Eyrolles. Edited by Jean Lilensten. 10/2006

1. **Barthélemy, M**.; Parkinson, C.; Lilensten, J.; Prangé, R.; **Modelling the Lyman β dayglow in the Jovian atmosphere**. Astronomy and Astrophysics, v.423, p.391-395 (2004).

2. **Barthélémy M**., Lilensten J., Parkinson C., **H_2 vibrational temperatures in the upper atmosphere of Jupiter**, *Astronomy and Astrophysics*, 437 1 329-331 (2005)

3. Lilensten J., Delorme P., Samouillan S., Engel E., **Barthélémy M**., **Influence of the thermosphere on electromagnetic waves propagation: Application to GPS signal**, *Radio Science*, 40 2 RS2005 (2005)

4. Lilensten J., Cander L. R., Rietveld M.T., Cannon P.S., **Barthélémy M.**, **Comparison of EISCAT and ionosonde electron densities: application to a ground-based ionospheric segment of a space weather programme**, *Annales Geophysicae*, 23 1 183-189 (2005)

5. Blanc, M., D. Moura, Y. Alibert, N. Andre, S. K. Atreya, I. Baraffe, **M. Barthelemy**, A. Barucci, R. Beebe, W. Benz, B. Bezard, D. Bockelee-Morvan, S. J. Bolton, R. H. Brown, G. Festou, E. Flamini, M. Fluchignoni, M. Galand, D. Gautier, T. Gombosi, E. Gruen, T. Guillot, R. Kallenbach, S. Kempf, T. Krimigis, N. Krupp, W. Kurth, P. Lamy, Y. Langevin, J.-P. Lebreton, A. Leger, P. Louarn, J. Lunine, D. Matson, A. Morbidelli, T. Owen, R. Prange, F. Raulin, C. Sotin, R. Srama, D. F. Strobel, N. Thomas, H. Waite, O. Witasse, P. Zarka, and J. Zarnecki, **Tracing the Origins of the Solar System**, in *39th ESLAB Symposium on Trends in Space Science and Cosmic Vision 2020; SP-588*, F. Favata, J. Sanz-Forcada, A. Gimenez, B. Battrick, and D. Danesy, editors, ESA, Noordwijk, pp 213-224, 2005.

6. Lilensten J., Simon C., **Barthélémy M**., Moen J., Thissen R., Lorentzen D.A., **Considering the polarisation of the oxygen thermospheric red line for space weather studies**, *Space Weather: The International Journal of Research and Applications*, 4 11 S11002 (2006)

7. **Barthélémy M.**, Lilensten J., Parkinson C., **A method to detect H_2 in the atmosphere of transiting extrasolar planets using the EUV spectrum**, *Astronomy and Astrophysics*, 474 1 301-306 (2007)

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5 **Mathieu Barthelemy** and Anne Vialatte. Grenoble - Tromsø: or how to move a lot of equipment to Norway. **Series of 6 articles** with Anne Vialatte. Echosciences Grenoble, March 2016

6 **Mathieu Barthelemy** and Anne Vialatte. 10 minutes of clear sky and... a small aurora, **Series of 3 articles**. Echosciences Grenoble, October 2016

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8 **M. Barthelemy**. Space and auroras; Echosciences Grenoble, March 2017.

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10 **M. Barthelemy**, Northern Lights: what they teach us about space climate and weather. The Conversation, 10 January 2021.

11 **M. Barthelemy**, When will we see the Northern Lights again in France? The Conversation, March 2023

12 Robert E, **Barthelemy M**; Transport, communications, etc.: how do solar storms interfere with human activities? July 2024. (English version: How solar storms play havoc with our lives)

13 **Herlingshaw, K., Lach, D., Dayton-Oxland, R., Bruus, E., Karvinen, E., Ledvina, V., Partamies, N., Grandin, M., Spijkers, M., Nishimura, Y., Knudsen, D., Ladbrook, L., Martinis, C., Gallardo-Lacourt, B., Dyer, A., Mielke, L., Ratzlaff, C., Evans, L., Helin, M., Kuzub, J., Barthelemy, M., Thomas, N., Glad, M., Donovan, E., Syrjäsuo, M., Cordon, S., Andersen, J., and Legg, C. (2024).** ***ARCTICS Aurora Field Guide and Handbook for Citizen Science.*** **Zenodo, https://doi.org/10.5281/zenodo.13931939.**

14 **M. Barthelemy**. Observing the southern lights: not so simple... Echosciences Grenoble, 01/2025

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2. **List of thesis supervision and co-supervision**

1) Hélène Ménager, 09/2009-07/2011. 80% supervision. Hélène Ménager is now a lecturer at the IUT Chemistry Department in Grenoble.
   a. Menager, H, Barthelemy, M, Lilensten, H Lyman alpha line in Jovian aurorae: electron transport and radiative transfer coupled modelling. J. Astronomy and Astrophysics, Volume 509. 2010
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2) David Bernard, 09/2011-06/2014. 40% supervision. David Bernard is now a lecturer at the Limoges University Institute of Technology in physical measurements.
   a. Bernard, D.; Lilensten, J.; Barthélemy, M.; Gronoff, G. Can hydrogen coronae be inferred around a CO2-dominated exoplanetary atmosphere? Icarus, Volume 239, pp. 23-31. 09/2014
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3) Anne Vialatte, 09/2014-10/2017. Full-time supervision. Anne Vialatte now works in the private sector in IT development.
   a. Mathieu Barthelemy, Hervé Lamy, Anne Vialatte, Magnar Gullikstad Johnsen, Gael Cessateur and Naima Zaourar. Measurement of the polarisation in the auroral N2+ 427 nm band. J J. Space Weather Space Clim. 2019, 9, A26.
   b. Mathieu Barthelemy, Vladimir Kalegaev, Anne Vialatte, Etienne Le Coarer, Erik Kerstel, Alexander Basaev, Guillaume Bourdarot, Melanie Prugniaux, Thierry Sequies, Etienne Rolland, Emmanuelle Aubert, Vincent Grennerat, Hacheme Ayasso, Arnau Busom Vidal, Fabien Apper, Mikhail Stepanov, Benedicte Escudier, Laurence Croize, Frederic Romand, Sebastien Payan and Mikhail Panasyuk; AMICal Sat and ATISE: two space missions for auroral monitoring. J. Space Weather Space Clim. 2018, 8, A44
   c. Frédéric Romand, Anne Vialatte, Laurence Croizé, Sébastien Payan, Mathieu Barthélemy, CO2 Thermal Infrared Signature Following a Sprite Event in the Mesosphere. Journal of Geophysical Research: Space Physics Volume 123, Issue 9
   d. Vialatte A, Barthelemy M, Lilensten J et al. Impact of the solar EUV flux on Nitric Monoxide in the upper atmosphere. The Open Atmospheric Science Journal. vol. 11, issue 1, pp. 88-104; Apr 2017.

4) Elisa Robert, 03/2020-03/2023. Full-time supervision. Elisa is currently a postdoctoral researcher under the contract with AXA XL and AXA RF mentioned above (SWING). Postdoctoral research position lasting 2 years and 4 months.

   a. Elisa Robert, Mathieu Barthelemy, Gael Cessateur, Angélique Woelfflé, Hervé Lamy, Simon Bouriat, Magnar Gullikstad Johnsen, Urban Brandstrom, Lionel Biree. Reconstruction of precipitated electron fluxes using auroral data. J. Space Weather Space Clim. 2023, 13, 30
   b. E. Robert, M. Barthelemy and T. Sequies, "The Satellites for Auroral Tomography in Space (SATIS) Project: Tomographic Reconstruction of the Auroral Emissions. IEEE Journal on Miniaturisation for Air and Space Systems, vol. 5, no. 4, pp. 237-245, Dec. 2024, doi: 10.1109/JMASS.2024.3449071.
   c. Mathieu Barthelemy, Elisa Robert, Vladimir Kalegaev, Vincent Grennerat, Thierry Sequies, Guillaume Bourdarot, Etienne Le Coarer, Jean-Jacques Correia, Patrick Rabou. AMICal Sat: A sparse RGB imager on board a 2U cubesat to study the aurora. IEEE-JMASS. July 2022.

5) Simon Bouriat, 10/2020-12/2023. Supervision at 50% then 80% during the last 2 years. Simon Bouriat is currently a post-doctoral researcher at ISAE SUPAERO.

   a. S Bouriat, P Vandame, M Barthelemy, J Chanussot. Towards an AI-based understanding of the solar wind: A critical data analysis of ACE data. Frontiers in Astronomy and Space Sciences 9, 980759. 2022.
   b. S Bouriat, P Vandame, M Barthelemy, J Chanussot. Electron Aurora and polar rain dependencies on Solar Wind Drivers. JGR. 08 2023
   c. Elisa Robert, Mathieu Barthelemy, Gael Cessateur, Angélique Woelffl√©, Hervé Lamy, Simon Bouriat, Magnar Gullikstad Johnsen, Urban Brändström, Lionel Biree. Reconstruction of precipitated electron fluxes using auroral data. J. Space Weather Space Clim. 2023, 13, 30

6) ATISE Wind: an instrument for measuring thermospheric and ionospheric winds. 100% supervision. Start date: October 2025.

Another topic proposed for 2025:

1) Definition and integration of magnetic indicators in the dynamic modelling of atmospheric cosmic rays for the characterisation of the natural atmospheric radiation environment and its effects. 20% co-supervision, in collaboration with ONERA and the University of Strasbourg.