# Pablo J. Bilbao

4th year plasma physics PhD student

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## Education

**Plasma Physics PhD student: 4th year** — *Lisboa, PT*

GoLP/IPFN, Instituto Superior Tecnico — *September 2020 – December 2024*

- Supervisor: Prof. Luís. O. Silva. Thesis title: "Kinetic Instabilities in Extreme Plasma Physics: Laboratory and Astrophysical Dynamics".

**MPhys Particle Physics with Cosmology** — *Lancaster, UK*

Lancaster University — *September 2016 – June 2020*

- Grade: First degree Hons.
- Supervisor: Dr. Elisabetta Boella. Master thesis: "Towards a better understanding of Target Normal Sheath Acceleration experiments at the Laser Light Ion beam-line (L3IA) aided by an exhaustive Parameter Scan".

## Publications

- **P. J. Bilbao**, et. al. "Ring momentum distributions as a general feature of Vlasov dynamics in the synchrotron dominated regime" Physics of Plasmas, Special issue: Papers from the 65th Annual Meeting of the APS Division of Plasma Physics (under peer-review 2024)
- C. D. Arrowsmith, P. Simon, **P. J. Bilbao**, et. al. "Laboratory realization of relativistic pair-plasma beams" (under peer-review 2024) *arXiv:2312.05244*
- **P. J. Bilbao** & L. O. Silva, "Radiation reaction cooling as a source of anisotropic momentum distributions with inverted populations." Physical Review Letters 130.16 (2023): 165101. 10.1103/PhysRevLett.130.165101
- C. Badiali, **P. J. Bilbao**, *et al.*, "Machine-learning-based models in particle-in-cell codes for advanced physics extensions." Journal of Plasma Physics 88.6 (2022): 895880602. 10.1017/S0022377822001180
- L.Gizzi, E. Boella, L. Labate, F. Baffigi, **P. J. Bilbao**, et. al. "Enhanced laser-driven proton acceleration via improved fast electron heating in a controlled pre-plasma" Scientific reports 11.1 (2021): 13728. 10.1038/s41598-021-93011-3.

Planned

- **P. J. Bilbao**, T. Silva & L. O. Silva, "Radiation reaction induced radio maser emission for astrophysical plasmas" (in prep. 2024).
- C. D. Arrowsmith, **P. J. Bilbao**, et. al. "Evidence of suppressed beam-plasma instability in a laboratory analogue of blazar pair jets". (in prep. 2024).
- T. Silva, **P. J. Bilbao** & L. O. Silva, "The electron cyclotron maser instability in laser-ionized plasmas" (in prep. 2024).
- **P. J. Bilbao**, et. al., "Radiatively cooled ion-channel laser emission as a laboratory analogue of astrophysical synchrotron cooled coherent maser bursts" (in prep. 2024)
- **P. J. Bilbao**, M. Lyutikov & L. O. Silva, "Numerical study of FEL-like processes in pulsar and magnetars magnetospheres" (in prep.).
- **P. J. Bilbao**, T. Grismayer & L. O. Silva "A self-consistent study of the surfatron in the relativistic regime driven by photon bursts undergoing Compton scattering" (in prep.).

## Presentations & Conferences

Oral presentations

- **Invited:** European Physics Society Plasma Physics conference, July 2024 (Salamanca, Spain), "Coherent electron cyclotron maser emission triggered by radiation reaction".
- **Invited:** High Energy Density Laboratory Astrophysics (HEDLA), May 2024 (Tallahassee, FL), "Laboratory analogues of astrophysical coherent maser processes".
- **Invited:** Fifth Purdue Workshop on Relativistic Plasma Astrophysics, May 2024 (Purdue, IN), "Radio Masers in the Synchrotron Dominated Regime".
- **Invited:** 65th Annual Meeting of the American Physics Society Division of Plasma Physics, November 2023 (Denver, CO), "Kinetically unstable distributions as a result of radiative damping in strong electromagnetic fields".
- Oxford University Plasma Theory Group, August 2023 (Oxford, UK) "Nonlinear cooling and kinetic instabilities in strong field plasma physics"
- European Physics Society Plasma Physics conference, June 2023 (Bordeaux, France), "Coherent radiation via synchrotron cooled electron cyclotron maser emission".

- New Perspectives in Numerical Methods for High-Energy Multi-Scale Astrophysics at the Princeton Center for Theoretical Science, April 2023 (Princeton, NJ), "A general approach for the acceleration of particle-in-cell simulations with Machine Learning-based models".
- 64th Annual Meeting of the American Physics Society Division of Plasma Physics, November 2022 (Spokane, WA). "Radiation reaction cooling as a progenitor of kinetic instabilities and coherent radiation" & "Coherent radiation from kinetic instabilities in radiation reaction dominated domain".
- **Invited:** LPHYS'22, June 2022 (Online), "The Impact of Radiation Reaction on the Topology of the Momentum Space".
- European Physics Society Plasma Physics conference, June 2022 (online), "Generating inverted Landau level populations through radiation reaction cooling".

Poster presentations

- "Coherent radiation from synchrotron cooled electron cyclotron maser instability" at doctoral training school Les Houches 2023 – Plasmas under Extreme Conditions: from Astrophysics to the Laboratory.
- "Synchrotron cooling as a progenitor of kinetic instabilities and coherent radiation" at HEDLA (Lisbon 2022).
- "Improving the current understanding of TNSA experiments at the Laser Light Ion beam-Line via high-fidelity Particle-In-Cell simulations" at the 62nd Annual Meeting of the APS Division of Plasma Physics (online 2020).
- "On modelling laser-driven ion acceleration at the LaserLight Ion beam-Line" at the 47th Annual EPS (European Physics Society) Plasma Conference, Spain (2021).

## Supervision & Teaching

- Co-supervisor of Francisco Assunçao Masters Thesis, "Particle drifts in the radiatively cooled regime and its applications to astrophysical plasmas" (IST Lisbon, 2023-2024)
- Co-supervisor of 2 Bachelor student internships, "CERN Fireball" & "Particle Drifts and Radiation Reaction" (Fall term 2023)
- Teaching assistant: Prof. Luís O. Silva's "Discoveries of modern Physics" course for 100 2nd year Physics undergraduate students (Fall terms 2022 & 2023).

## Awards & Grants

- Co-PI (and main author) with L. O. Silva (PI) of the supercomputing grant EHPC-REG-2021R0038, where we were awarded 33 million CPU hours in LUMI.
- Awarded second place for best video at the 62nd Annual Meeting of the American Physics Society Division of Plasma Physics 2020 Visual Science Communication competition.
- Awarded second place for best video at the 63rd Annual Meeting of the American Physics Society Division of Plasma Physics 2021 Visual Science Communication competition.

## Technical Skills

- **C/C++ & Fortran:** Implementation of vectorised Neural Networks with Basic Linear Algebra Subprograms within a large scale scientific Particle-in-Cell code (OSIRIS).
- **HPC**: work has been deployed in pre-Exascale clusters such as LUMI through the Euro HPC joint undertaking.
- **Python: Machine Learning** applications – Training neural networks to obtain heuristic physical models for Physics simulations.
- Misc: **Rust**, LaTeX, **Java** and **Linux**; Smooth-Particle-Hydrodynamics