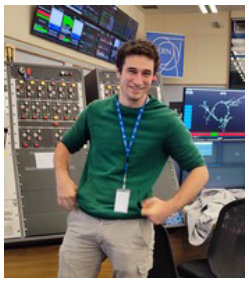
UCLA

Plasma Physics Seminar

Physics & Astronomy Building (PAB) Room 4-330
Via Zoom: https://ucla.zoom.us/j/92785449357?pwd=SVBTSko3bTdEUW03dzQwNks1Q2lKZz09
Friday, May 10, 2024 at 12:30PM
Lunch will be served at 12:00PM

Radiatively Cooled kinetic Plasma Physics in Astrophysics and The Laboratory

Pablo Bilbao (Instituto Superior Tecnico, University of Lisbon)



Abstract: Upcoming experiments using intense lasers, high energy particle beams and high density plasmas, along with plasmas found in extreme astrophysical environments, provide environments where relativistic charged particles radiate photons with energy comparable to their kinetic energy. The recoil that these particles experience (radiation reaction) will drastically change the single particle dynamics and the collective properties of plasmas. This results in "bunching" in momentum space, effectively, driving the plasma away from kinetic equilibrium and triggering the onset of kinetic instabilities. Notably, we analytically demonstrate that for the case of strongly magnetised plasmas, synchrotron cooling leads to ring momentum distributions. In turn, the resulting momentum distribution efficiently drives the electron cyclotron maser instability, leading to coherent radiation emission. This mechanism and subsequent maser emission are relevant under astrophysical conditions and could be key to understand coherent radiation emission (such as FRBs) around compact objects, where strong magnetic fields and non-thermal electrons are present. Additionally, we investigate other electromagnetic field configurations, such as beams undergoing betatron oscillations in an ion-channel. We find that laboratory betatron cooling leads to ring-beam distributions, making it analogous to astrophysical synchrotron cooling. This opens an exciting avenue for studying radiatively cooled plasmas in a realisable beam plasma experimental platform. Our theoretical findings are corroborated with Particle-in-cell simulations with OSIRIS.

Bio: Pablo obtained his Master's degree in Physics with a specialization in Particle Physics and Cosmology from Lancaster University, UK (2016). There, his thesis under Dr. Elisabetta Boella investigated laser-solid particle acceleration using Particle-in-Cell modelling. He is currently a PhD student at GoLP (IST) in Lisbon under Prof. Luís O. Silva, focusing on kinetic plasma instabilities under extreme conditions, particularly those relevant to astrophysical compact objects. Additionally, his work on extreme plasmas included participation in the first-ever laboratory experiment simulating a pair-beam blazar jet interacting with the interstellar medium, conducted at CERN's HiRadMat facility in collaboration with the University of Oxford, where he also held a visiting student position.