Programma *Professori di Chiara Fama 2026*
del Dipartimento di Fisica e Astronomia

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Sensing the Atmosphere: From Fundamental Laser Spectroscopy to Global Climate Monitoring

Overview

Laser spectroscopy offers the possibility to sense trace molecules as well as to follow chemical reactions, turning light into a precise probe of our atmosphere. This three-session lecture series explores the synergy between fundamental light-matter interaction and cutting-edge optical engineering. We will trace the journey of a photon from the laboratory bench to the stratosphere, demonstrating how precision spectroscopy has become an indispensable tool for atmospheric monitoring and chemical analysis of our atmosphere.

This series is designed for a broad audience—from ***advanced undergraduates*** looking for a conceptual roadmap to ***doctoral students and postdocs*** seeking a glimpse into current research challenges in environmental monitoring.

1: The Toolbox of Precision – 14 May 2026, 14.30-16 – Aula Querzoli, LENS

Laser Spectroscopy, from basic concepts to advanced techniques. Moving beyond basic absorption, we will dive into advanced spectroscopic measurement techniques required for high-sensitivity sensing:

- ***Wavelength Modulation Spectroscopy (WMS)***: Extracting signals from noise in turbulent environments.
- ***Cavity Enhanced Absorption Spectroscopy (CEAS)***: Leveraging optical "kilometers" within centimeter-scale cells.
- ***Laser Heterodyne Radiometry (LHR)***: The art of using the sun as a light source for vertical atmospheric profiling.

2: Extreme Frontiers: From Oceans to the Stratosphere – 18 May 2026, 11:00-12.30 Aula Querzoli, LENS

This session focuses on multi-scale ***integrated carbon observation***, from ocean–atmosphere carbon exchange at the ocean surface to vertical profiling of greenhouse gases up to the lower stratosphere.

- ***Surface to Air***: Deploying WMS for real-time flux measurements at the ocean-atmosphere interface.
- ***The Vertical Column***: Using LHR to resolve vertical concentration profiles of greenhouse gases in the atmospheric column through the troposphere and into the lower stratosphere.

3: Simulating the Atmosphere: Chemical Kinetics in the Lab – 21 May 2026, 14.30-16 Aula Querzoli, LENS

The final session brings us to the controlled environment of ***Atmospheric Simulation Chambers***. We will use the extreme sensitivity of cavity-enhanced techniques to "watch" chemical reactions happen in real-time to investigate chemical kinetics and reaction mechanisms in a simulated atmosphere under controlled conditions.

- ***Radical Tracking***: Quantifying short-lived intermediates that drive atmospheric oxidation.
- ***Kinetic Modeling***: How spectroscopic data serves as the ground truth for global climate models.

Key Highlights

- Bridging the gap between ***quantum mechanics*** and ***environmental policy***
- Technical deep-dives into advanced spectroscopic techniques: ***WMS***, ***CEAS***, and ***LHR***
- Real-world case studies from ***Arctic campaigns*** to ***simulation chambers***