Femtosecond laser filamentation in the atmosphere for remote laser applications

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Abstract

Laser filamentation is a nonlinear phenomenon that occurs when ultrashort laser pulses with a peak power exceeding a few gigawatts propagate in air. This results in the self-contraction of the beam, maintaining a very high intensity in a thin channel over many Rayleigh lengths, and leaving a plasma channel in its wake. This spectacular effect can be obtained remotely (kilometer range) allowing for the future development of remote applications requiring high laser intensity. Over the past decade, femtosecond filaments have proven to be a powerful tool for controlling electric discharges in atmospheric air, generating acoustic waves and creating optical waveguides through hydrodynamic effects, and radiating UV lasing from excited nitrogen or broadband terahertz radiation.

In this talk I will discuss recent results obtained at LOA based on filament formation such as the guiding of lightning with lasers, as part of the Laser Lightning Rod project, and steering THz radiation using the flying focus technique.

Fig. 1. Photography of the LLR experiment on Mont Saentis in July 2021.

Short bio

Aurélien Houard is a research scientist at École Polytechnique in Palaiseau, France. After earning his Master's degree in plasma physics from the University Paris Saclay, he received his Ph.D. from École Polytechnique in 2008. There, he studied the generation of terahertz radiation from laser filamentation in air. He was hired as a research scientist at the Laboratory of Applied Optics (LOA) in 2009 and has led the Filamentation group since 2010. He has collaborated with various research institutes, including the University of Geneva, Shanghai University of Science and Technology, Lund University, DRDC Canada, Trumpf Scientific Lasers, EPFL, ONERA, and Stanford University. His group is specialized in studying the nonlinear propagation of intense femtosecond laser pulses in transparent media and filamentation phenomena. In 2016, he launched the "Laser Lightning rod" project with Prof. J.-P. Wolf of the University of Geneva and Trumpf Scientific Lasers. This project led to the first demonstration of laser-guided lightning spanning over 50 meters.