Propagation of ultrashort laser pulses in adverse conditions and applications to lightning control

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The propagation of ultrashort laser pulses in the atmosphere results in self-guided filaments, which can propagate over tens of meters and be generated at kilometer-range distance, which have been suggested, among other applications, to be good candidate for lightning control. However, the control of high voltage discharges by laser filaments encounters several limitations, including the need to propagate the pulses through perturbed atmospheres, and the limitation of the plasma lifetime within the filaments, which may limit their usable length for guiding lightning discharges.

We will discuss the generation and propagation of filaments in adverse conditions, such as rain, fog, pressure gradients or a turbulent atmosphere. In spite of their origin in a delicate balance between Kerr self-focusing and defocusing on the generated plasma, the filaments are surprisingly robust and can propagate without perturbation in such media. Consequently, the control of high-voltage discharges in the laboratory on the meter-scale is little affected by a synthetic rain. We also demonstrated that the use of a second laser pulse enhances the plasma density and improves the triggering efficiency of the filaments at low voltages, suggesting that such schemes may enhance the effect over long distances.