ULTRAFAST LASERS

Soliton-like laser pulses punch through fog

Intense ultrafast pulsed laser beams have successfully been sent through a laboratory fog that approximates cloudy atmospheric conditions by Jean-Pierre Wolf and others at the Université Claude Bernard Lyon (Villeurbanne, France).[1] Because water tends to absorb and scatter light, water droplets in the atmosphere plague open-air laser applications, including free-space laser communications, remote pollution monitoring, and rangefinding. The pulses produced by the group's laser, however, create nonlinear effects in the artificial cloud, allowing the light to propagate without losing much energy or being diverted (see figure).

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An ultrafast laser creates light filaments in the open air that propagate much as solitons propagate in fiber; in both cases, conflicting nonlinear processes create a pulse that neither diverges nor collapses.

The researchers used a chirped-pulse-amplified (CPA) Ti:sapphire laser emitting 810-nm 120-fs pulses at powers of 10^{14} W/cm^2 to create light filaments—streaks of light about 150 μm wide and 10 m long—in the laboratory (higher-power lasers can produce longer filaments). The filaments are caused by a balance between two nonlinear effects that creates quasi-soliton pulses. The Kerr effect modifies the index of refraction of the air and water and focuses the light, while the intense light also ionizes the air molecules, creating a plasma that defocuses the light.