PROPAGATION

# Shock Waves in Disordered Media

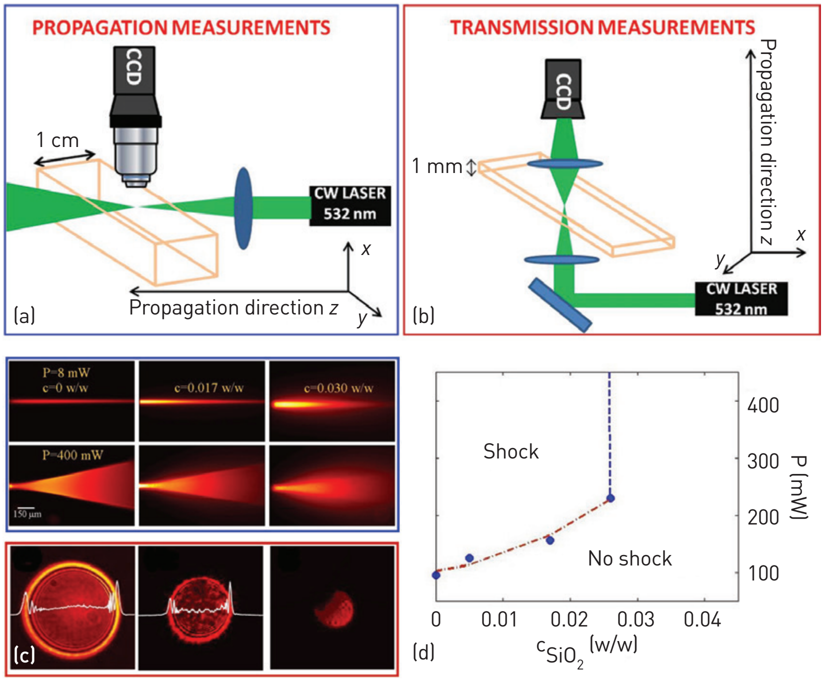
Dispersive shock waves (DSWs) are observed in nonlinear optics in systems described by universal models, such as the nonlinear Schrödinger equation, when the hydrodynamical approximation holds true. DSWs are characterized by the appearance of fast oscillations, so-called undular bores, through which the optical system regularizes the emergence of discontinuity in some quantity involved in the propagation of the optical field.

Given the coherent nature of such a regularizing mechanism, the introduction of a certain amount of disorder competes with nonlinearity and hampers the shock formation. This makes DSWs an appealing framework to study the interplay between randomness and nonlinear waves.

We investigated the effect of disorder on the formation of optical DSWs when a Gaussian laser beam propagates in a thermal Kerr-like defocusing medium in the presence of controllable disorder obtained by a colloidal dispersion of silica ($SiO_2$) particles.[1] During our experiments, we found evidence for the existence of a phase diagram in terms of nonlinearity and amount of randomness.

For our study, we used two configurations of the experimental setup allowing the visualization of the beam along its propagation direction and of its wave-vector spectrum at the exit face of the sample holder. We observed that the shock formation is enhanced by increasing the nonlinearity, while random light scatterers hamper and eventually inhibit the wave breaking phenomenon.

The competition was quantified, resulting in the first calculation of a shock/no-shock diagram in terms of nonlinearity strength and disorder degree.[2,3] OPN




(a) Configurations for the direct visualization of the top fluorescent emission along the propagation direction of the laser beam and (b) of the transmitted beam at the exit face of a 1-mm thick sample cell. (c) Images in the blue box were collected through the propagation measurements apparatus by varying the laser power, P, and $SiO_2$ concentrations; images in the red box were obtained through the transmission measurements apparatus. They represent the far-field measurement of the transmitted beam at exit face in the same conditions of the high-power images above.[4] (d) Disorder-power phase diagram with shock and non-shock regimes as obtained by analyzing the images in panel (c).

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