Geophysical Research Abstracts
Vol. 12, EGU2010-5333, 2010
EGU General Assembly 2010

Optical Rogue Waves: Theory and Experiments

M. TAKI, A. MUSSOT, A. KUDLINSKI, E. LOUVERGNEAUX, and M. KOLOBOV
PhLAM, Université de Lille1, Villeneuve d'ascq, France (taki@phlam.univ-lille1.fr)

In the ocean, giant waves (also called killer waves, freak or rogue waves) are extremely rare and strong events. They are not well understood yet and the conditions which favour their emergence are unclear. Very recently, it was shown that the governing equations [1] as well as the statistical properties of an optical pulse propagating inside an optical fibre [2] mimic very well these gigantic surface waves in the ocean. Here we generate both experimentally and numerically optical rogue waves in a photonic crystal fiber (microstructured fiber) with continuous wave (CW) pumps. This is relevant for establishing an analogy with rogue waves in an open ocean. After recalling fundamental rogue waves [3] known as Akhmediev breathers that are solutions of pure nonlinear Schrödinger (NLS) equation, we analytically demonstrate that a generalized NLS equation, which governs the propagation of light in the fiber, exhibits convective modulationnal instability [4]. The latter provides one of the main explanations of the optical rogue wave extreme sensitivity to noisy initial conditions at the linear stage of their formation [5]. In the highly nonlinear regime, we provide the evidence that optical rogue waves result from soliton collisions leading to the rapid appearance/disappearance of a powerful optical pulse [6].

REFERENCES

[1] C. Kharif, E. Pelinovsky, and A. Slunyaev, "Rogue Waves in the ocean", Springer Berlin Heidelberg, 2009
[2] D. R. Solli, C. Ropers, P. Koonath, and B. Jalali, "Optical rogue waves" Nature 450, 1054-1058, (2008).
[3] N. Akhmediev, A. Ankiewicz, and M. Taki, "Waves that appear from nowhere and disappear without a trace", Phys. Lett. A 373, 675 (2009).
[4] A. Mussot, E. Louvergneaux, N. Akhmediev, F. Reynaud, Delage, and M. Taki, "Optical fiber systems are convectively unstable", Phys. Rev. Lett. 101, 113904 (2008).
[5] M. Taki, A. Mussot, A. Kudlinski, E. Louvergneaux, M. Kolobov, M. Douay, "Third-order dispersion for generating optical rogue solitons", Phys. Lett. A 374, 691-695 (2010).
[6] A. Mussot, A. Kudlinski, M. Kolobov, E. Louvergneaux, M. Douay and M. Taki, "Observation of extreme temporal events in CW-pumped supercontinuum", Opt. Express 17 (19), 17010 (2009).