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NLSE-based model of a random distributed feedback fiber laser

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Paper Abstract

In this work we propose a NLSE-based model of power and spectral properties of the random distributed feedback (DFB) fiber laser. The model is based on coupled set of non-linear Schrödinger equations for pump and Stokes waves with the distributed feedback due to Rayleigh scattering. The model considers random backscattering via its average strength, i.e. we assume that the feedback is incoherent. In addition, this allows us to speed up simulations sufficiently (up to several orders of magnitude). We found that the model of the incoherent feedback predicts the smooth and narrow (comparing with the gain spectral profile) generation spectrum in the random DFB fiber laser. The model allows one to optimize the random laser generation spectrum width varying the dispersion and nonlinearity values: we found, that the high dispersion and low nonlinearity results in narrower spectrum that could be interpreted as four-wave mixing between different spectral components in the quasi-mode-less spectrum of the random laser under study could play an important role in the spectrum formation. Note that the physical mechanism of the random DFB fiber laser formation and broadening is not identified yet. We investigate temporal and statistical properties of the random DFB fiber laser dynamics. Interestingly, we found that the intensity statistics is not Gaussian. The intensity auto-correlation function also reveals that correlations do exist. The possibility to optimize the system parameters to enhance the observed intrinsic spectral correlations to further potentially achieved pulsed (mode-locked) operation of the mode-less random distributed feedback fiber laser is discussed.

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