Random Lasers as platforms to study Universal Photonic Phase-Transitions

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Random Lasers (RLs) are light sources that operate due to the multiple scattering of light in disordered gain media that provide the feedback for laser action. No optical cavity of conventional mirrors contributes to the optical feedback. In this talk I will review advances in the RLs research with examples of systems operating in pulsed and continuous-wave regimes. The mechanisms governing the behavior of RLs based on colloidal-suspensions of dielectric nanoparticles and luminescent dyes, powders consisting of nanocrystals doped with rare-earth ions, and random fiber lasers, will be discussed. The contribution of wave-mixing will be exemplified by the multi-wavelength emission and tunable UV-blue RL generation from neodymium-doped nanocrystals. Wave-mixing among lasing modes also influence the RLs intensity fluctuations. The observation of Lévy distribution of intensity fluctuations and the Replica-Symmetry-Breaking transition from the photonic paramagnetic phase to the photonic spin-glass phase are interesting examples of the RLs complex behavior that will be also discussed.