Nonequilibrium self-polarisation and light thermalisation in single mode optical fibers

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In analogy to dilute classical gasses where thermalisation occurs irreversibly due to collisions between particles, optical waves can exhibit a phenomenon of thermalisation thanks to non-linear interactions. These classical waves thus evolve toward the equilibrium distribution of Rayleigh-Jeans, as recently shown in numerical and experimental studies considering multimode optical fibres.

Thanks to numerical simulations, we predict that wave thermalisation also occurs in a single mode fiber, when temporal effects (non-monochromatic wave) are involved. In this specific case, thermalisation induces a self-polarisation effect of the incident unpolarised light along the propagation inside the fiber. By following a wave turbulence approach, we derive a kinetic equation whose numerical simulations are found in good agreement with the Non-Linear Schrödinger Equation (NLSE) simulations for the considered system. This wave turbulence description clearly shows that maximisation of entropy (or "disorder") is reached when light is highly polarised. The experiment aimed at observing the phenomenon is in progress. Aside from fundamental aspects, this study also provides results eventually useful in order to get polarised light from an incoherent unpolarised beam without loss of energy.