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Investigation of distribution mechanism of noise fluxes between three oscillating modes of a free-running class-A laser

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In this paper, the noise aspects of a class-A laser from the single mode state with one cavity damping rate γ_C are extended to the more general case of three-mode state with the three equal cavity damping rates $\gamma_L = \gamma_C = \gamma_R$. The cavity Langevin force Γ_α is thus divided into three parts $\Gamma_{\alpha L}$, $\Gamma_{\alpha C}$ and $\Gamma_{\alpha R}$ associated with the simultaneous oscillations of cavity left, central, and right modes, respectively. In this way, the phase and amplitude fluctuations of cavity electric field components are analytically calculated by solving the three-mode Maxwell-Bloch equations of motion in the presence of three fluctuating cavity Langevin forces $\Gamma_{\alpha L}$, $\Gamma_{\alpha C}$ and $\Gamma_{\alpha R}$. The correlation functions of three latter cavity Langevin forces are then used to calculate the noise fluxes that are simultaneously superimposed on the mean energy fluxes of oscillating modes in the form of stimulated emission radiation. The most advantage of our calculations is to determine the exact share of each oscillating mode in the total noise flux spectra of laser, spontaneous emission, and pumping of a three-mode class-A laser. The results indicate that the cavity Langevin force of each of three oscillating modes makes a direct contribution in producing the noise fluxes of other two oscillating modes. Our model is finally confirmed by demonstrating a balance relation between the input pumping noise flux and the output noise fluxes of laser and spontaneous emission of three oscillating modes.

Biography

Jafar Jahanpanah received the BSc degree in Applied Physics from Amir Kabir University, Tehran, Iran, in 1989, and the MSc degree in Optics Communication and the PhD degree in Laser Theory from Essex University, UK, in 1992 and 1995, respectively. He began his PhD research with Prof. R. Loudon with a focus on the gain, stability, and injection-locking topics in a single-mode laser amplifier. His current research interests include laser noise and also the gain, stability, and mode-locking phenomena in the multi-mode lasers. He has published many articles in journals of PRA, OSA, applied physics, optics communications, and IOP.

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