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Stationary Intensity Distribution of Single-Mode Laser Driven byAdditive and Multiplicative Colored Noises with ColoredCross-Correlation

LIANG Gui-Yun,[1,3] CAO Li,[1,2] WANG Jun,[1,3] and WuDa-Jin[2,3]

[1] State Key Laboratory of Laser Technology, Huazhong University of Science and Technology, Wuhan 430074, China

[2] CCAST (World Laboratory), P.O. Box 8730, Beijing 100080, China

[3] Department of Physics, Huazhong University of Science and Technology, Wuhan 430074, China

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Abstract: Applying the approximate Fokker-Planck equation we derived, we obtain the analytic expression of the stationary laser intensity distribution $P_{st}(I)$ by studying the single-mode laser cubic model subject to colored cross-correlation additive and multiplicative noise, each of which is colored. Based on it, we discuss the effects on the stationary laser intensity distribution $P_{st}(I)$ by cross-correlation between noises and "color" of noises (non-Markovian effect) when the laser system is above the threshold. In detail, we analyze two cases: One is that the three correlation-times (i.e. the self-correlation and cross-correlation times of the additive and multiplicative noise) are chosen to be the same value ($\tau_1=\tau_2=\tau_3=\tau$). For this case, the effect of noise cross-correlation is investigated emphatically, and we detect that only when $\lambda\neq 0$ can the noise-induced transition occur in the $P_{st}(I)$ curve, and only when $\tau\neq 0$ and $\lambda\neq 0$, can the "reentrant noise-induced transition" occur. The other case is that the three correlation times are not the same value, $\tau_1\neq\tau_2\neq\tau_3$. For this case, we find that the noise-induced transition occurring in the $P_{st}(I)$ curve is entirely different when the values of τ_1, τ_2, and τ_3 are changed respectively. In particular, when τ_2 (self-correlation time of additive noise) is changing, the ratio of the two maximums of the $P_{st}(I)$ curve R exhibits an interesting phenomenon, "reentrant noise-induced transition", which demonstrates the effect of noise "color" (non-Markovian effect).

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Key words: single-mode laser, colored cross-correlation, noise-induced transition

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