

this classical entanglement can yield a higher value. Note that we have chosen the initial condition $(x, p_x, y, p_y) = (0.25, 0.1, 0.0, 0.1)$ because it lies entirely inside the domain for the chosen parameter range of λ . The wavelength (analog of \hbar) given in Eq. 1 is selected as $\lambda_w = 0.01$. The value of λ_w is set small enough in order for the wavepacket to be contained entirely inside the defined two-dimensional cross-sectional domain. We have also used the equally position squeezed $\zeta_1 = \zeta_2 = \zeta$ wavepacket at a relatively small value of $\zeta = -0.25$ due to the numerical considerations. From Figs. 3(a) and 3(b) we can clearly see that as the core boundary deformation λ increases, the production of classical entanglement is found to increase for both the case of initial coherent state and initial squeezed coherent state. This is again observed in Figs. 4(a), 4(b) and 4(c) according to the corresponding von Neumann entropy of entanglement. It is well known that when the deformation parameter approaches $\lambda = 0.5$, the dynamical behavior of the classical system is highly chaotic (see Figs. 4(d), 4(e) and 4(f)) with the higher classical entanglement maxima observed in the corresponding optical system. Thus, our results clearly indicate the effect of the geometrical deformation on entanglement dynamics of initial squeezed coherent states in a chaotic optical fiber. It is to be noted that a judicious choice of a chaotic core cross-section would lead to the generation of highly entangled transverse modes. These results are also in accordance with our previous studies [4, 60].

Taking into account the recent experimental progress to quantify the classical entanglement [28], we do believe that an experiment can be performed as follows. After passing light beams through a chaotic optical fiber, the transverse field modes of light will get classically entangled. Changing the geometry of the fiber cross-section can affect the transverse mode intensity profile. The intensity measurement of the transverse electric field can be recorded on a CCD camera and this information can be used to measure the effect of geometry on the classical entanglement.

5. Conclusions

We have explored the dependence of the classical entanglement with the boundary deformation. We have seen that as the boundary gets deformed into a chaotic billiard, the entanglement in the eigenmode increases. This demonstrates that the classical entanglement has a dependence on the boundary geometry and the associated chaotic dynamics. We have also analyzed the propagation of a coherent state and a squeezed coherent state in a chaotic Robnik optical fiber. We have found that an initial squeezing can indeed enhance classical entanglement in chaotic optical fibers. More importantly, our results have specifically shown the cross-sectional geometry dependence of the classical entanglement.

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