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# A two-dimensional discrete-time laser model: Exploring bifurcations and chaotic behavior

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We investigate the local dynamics, bifurcations, and chaos in a two-dimensional discrete-time laser model. The study reveals that the model has a boundary fixed point and a unique positive fixed point under specific parametric conditions. Using linear stability theory, we explore the local dynamics and various topological classifications of these fixed points. The existence of prime-period and periodic points in the model is also examined. It is found that a flip bifurcation occurs at the boundary fixed point, and another flip bifurcation occurs when parameters vary within a small neighborhood of the unique positive fixed point. Furthermore, the model undergoes a Neimark-Sacker bifurcation near the unique positive fixed point, leading to the emergence of a stable invariant curve. Numerical simulations are conducted to validate the theoretical results and demonstrate the complex dynamics of periods 2, 3, 4, 5, 8, and 9. Additionally, Maximum Lyapunov exponents and fractal dimensions are computed to confirm the chaotic behavior of the laser model. Finally, a feedback control method is applied to stabilize the chaos observed in the model.

## Biography

Abdul Qadeer Khan got the Ph.D. degree at the age of 32 years from Department of Mathematics, University of Azad Jammu and Kashmir, Muzaffarabad, Pakistan. During his PhD studies, he worked in the School of Mathematical Sciences, Shanghai Jiao Tong University, Shanghai, P. R. China under HEC “International Research Support Initiative Programme (IRSIP)”. Currently he is working as an Assistant Professor in the Department of Mathematics, University of Azad Jammu and Kashmir, Muzaffarabad, Pakistan. His current research interests include stability, bifurcations and control in some discrete-time mathematical models from physics, chemistry, biology, ecology etc. With in domain of research, Dr. Khan has published 82 research papers in well known reputed Journals, and moreover so for Dr. Khan has win 3 research projects from international funding agency. Dr. Khan has pupervised 25 MS students and 2 PhD students. Currently 8 Ms Students and 3 PhD students are under his supervision.