Reply to "Comment on 'Flow-induced arrest of spatiotemporal chaos and transition to a stationary pattern in the Gray-Scott model'"

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We reply to the Comment of Berenstein *et al.* [preceding paper, Phys. Rev. E **94**, 046201 (2016)] on our article [D. Das, Phys. Rev. E **92**, 052914 (2015)] about the effect of streamlined flow on the dynamics of the Gray-Scott model characterized by wave-induced spatiotemporal chaos.

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In our recent publication [1] we studied the effect of streamlined flow on the Gray-Scott model characterized by wave-induced spatiotemporal chaos in one dimension [2]. Our choice of the Gray-Scott model was based on the fact that it has long served as a paradigm to model the kinetics of cubic autocatalytic reactions. The authors of [3] review our results and (i) remark that we have used a single point in the space of kinetic parameters to study the effect of flow on the Gray-Scott model, which resulted in missing a variety of other dynamical scenarios, which they point out [4,5], and (ii) project us as claiming that the transition from spatiotemporal chaos to stationary spatial structures with an increase in flow strength has a unique path wherein the system changes from absolute to convective instability and eventually to stable stationary patterns.

The rationale behind the use of the single point in the parameter space is the fact that it sufficed to adequately represent the dynamical state (wave-induced spatiotemporal chaos) that we primarily intended to explore by subjecting the system to streamlined flow. While we admit that we overlooked their work on Oregonator [4], the system that we studied is far more general than the Oregonator model that they studied. Several features distinguish their study from ours. First, the genesis of the spatiotemporal chaos is different (which they acknowledge). While the spatiotemporal chaos they studied is classified under defect-mediated turbulence, we, on the other hand, explored the case of wave-induced chaos wherein the Dirichlet boundary (constant values at the boundary) precludes the system from reaching the sole attractor in the phase space (the stable node). The Dirichlet boundary serves the role of wave emitter analogous to the one played by spirals in a two-dimensional system leading to spiral breakup and eventually to spatiotemporal chaos. It is noteworthy and pertinent to mention that both the choice of kinetic parameter (μ and ϕ) and the values of the boundary satisfying the Dirichlet condition are crucial in deciding whether the system will evolve into a state of wave-induced spatiotemporal chaos or not. Second, the Oregonator model is the mathematical representation of a specific oscillatory reaction, viz., the Belousov-Zhabotinskii reaction (based on the Field-Korös-Noyes mechanism), whereas the Gray-Scott model has long served as a minimal model that allows the existence of multistability, hysteresis, and oscillatory behavior [6].

We never claimed in our publication that the change in the dynamical behavior of the Gray-Scott model with change in flow strength is the only route to eventual attainment of the stable stationary patterned state, i.e., the system must change instability from absolute to convective en route to stationary stable structures as has been presented by the authors of [3]. The authors of [3] mistakenly generalized our observance to every set of kinetic parameter and boundary values. However, it should be noted that the parameter regime we studied clearly distinguishes the different instabilities that occur along with the order of their occurrence that are validated by the numerical simulations in one space dimension. Therefore, from the foregoing discussion it is clear that studying even a small region of the parameter space can help explore a plethora of different dynamical situations that result from the interplay between the specificities of the nonlinearity of the system, the kinetic parameters, the boundary conditions, and the system size. Consequently, we think that although extensive research on reaction-advection-diffusion systems has already been carried out, it is rather far from being exhaustive and many more intricate phenomena hidden in the Gray-Scott model will be revealed in the near future.

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