Abstract Submitted
for the DFD20 Meeting of
The American Physical Society

Symmetry-breaking-induced rare fluctuations in a time-delay dynamic system YIN WANG, WEI XU, Hong Kong University of Science and Technology, PIK-YIN LAI, National Central University, PENGER TONG, Hong Kong University of Science and Technology — Inspired by the experimental and numerical findings, we study the dynamic instabilities of two coupled nonlinear time-delay differential equations that was used to describe the coherent oscillations between the top and bottom boundary layers (BLs) in turbulent Rayleigh-Bnard convection. By introducing two sensitivity parameters for the instabilities of the top and bottom BLs, we find three different types of solutions, namely, in-phase oscillations, period doubling and chaos. The chaos solution contains rare but large amplitude fluctuations. The statistical properties of these fluctuations are consistent with those observed in the experiment for the massive eruption of thermal plumes, which causes random reversals of the large-scale circulation in turbulent Rayleigh-Bnard convection. Our study thus provides new insights into the origin of rare massive eruptions and sudden changes in large-scale flow pattern that are often observed in closed thermal convection systems of geophysical and astrophysical scale.

Yin Wang
Princeton Plasma Physics Laboratory

Date submitted: 21 Jul 2020 Electronic form version 1.4