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Physics of Financial Markets: Can we Understand the Unpredictable Phenomenon of Flash Crashes[1]

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Dangerous vulnerability is hiding in complex systems. Indeed, disasters ranging from abrupt financial "flash crashes" and large-scale power outages to sudden death among the elderly dramatically exemplify this fact. While we can understand the cause of most events in complex systems, sudden unexpected "black swans" whether in economics or in the "physicists world" cry out for insight. To design more resilient systems we will describe recent results seeking understanding of these black swans. In many real-world phenomena, such as brain seizures in neuroscience or sudden market crashes in finance, after an inactive period of time a significant part of the damaged network is capable of spontaneously becoming active again. The process often occurs repeatedly. To model this marked network recovery, we examine the effect of local node recoveries and stochastic contiguous spreading, and find that they can lead to the spontaneous emergence of macroscopic "phase-flipping" phenomena. The fraction of active nodes switches back and forth between the two network collective modes characterized by high network activity and low network activity. Furthermore, the system exhibits a strong hysteresis behavior analogous to phase transitions near a critical point [A. Majdandzic, B. Podobnik, S. V. Buldyrev, D. Y. Kenett, S. Havlin, and H. E. Stanley, "Spontaneous Recovery in Dynamic Networks," Nature Physics **10**, 34 (2014)].

[1]This work was carried out in collaboration with a number of colleagues, chief among whom are A. Majdanzic, B. Podobnik, S. V. Buldyrev, D. Y. Kenett, and S. Havlin.