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Complex-periodic cardiac spiral waves mediated by static and dynamic defects[1]

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Spiral wave activities arising on cardiac tissues have been the subject of numerous studies in the field of nonlinear dynamics as well as medical sciences for the reason that they are associated with cardiac arrhythmia and their dynamical properties are scientifically very intriguing. One of the important issues regarding these waves is to understand the role of system inhomogeneities. For example, localized inhomogeneities (in cell density or electrical conductivity) like infarcts can often initiate re-entrant spiral waves that become self-sustained once formed. Some localized inhomogeneities can also act as a pinning site anchoring spiral waves. In this lecture, I will discuss that besides the aforementioned two simple cases they can have a far more complex role of generating multiply periodic (period-2, -3, and -4) or chaotic waves. Our experimental observations suggesting this new possibility were obtained through dissociated cardiac cell cultures of rat ventricles. The wave activities were visualized by a non-invasive, non-interferometric phase-contrast macroscope that was developed recently by us. Similar situations could be also reproduced in a model simulation.

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