

Invited: SPCS-I-04

## Chaos, Complexity and Computation: Patterns in oscillatory media

**R Janaki, Shakti N Menon and Sitabhra Sinha**

**The Institute of Mathematical Sciences, Chennai 600113, India**

Ever since the pioneering work of Alan Turing, it has been known that diffusively coupled relaxation oscillators can exhibit a remarkable variety of spatial patterns. Indeed, there have since been numerous attempts to describe spatial patterns in a variety of natural phenomena through the framework of reaction-diffusion mechanisms. However, it has recently been shown by us that when such oscillators are coupled through the inactivation (or inhibitory) component alone, they are capable of producing complex spatio-temporal patterns, e.g., anti-phase synchronization, spatially patterned oscillatory death, chimera and propagating defects [1]. Several of these have been confirmed subsequently in experimental studies [2]. Here we report our further investigations which have uncovered the fundamental repertoire of patterns that occur in regular networks of oscillators coupled via the inactivation variable. We observe the emergence of a large variety of patterns in both a 1-D array, as well as, a 2D lattice, in which patterns such as spiral waves, disordered states and line dislocations are observed. The latter is of particular interest as its emergence can be interpreted as an instance of coarsening dynamics. Furthermore, we observe that the system exhibits a hysteresis-like behavior in the transition between oscillating and non-oscillating synchronization patterns. We also show that potentially one can design schemes for implementing arbitrarily complicated computation using reaction-diffusion processes, thereby bridging pattern formation with universal computability [3].

### References:

1. R Singh and S Sinha, *Phys.Rev. E*, **87**, 012907 (2013).
2. L V Gambuzza, A Buscarino, S Chessari, L Fortuna, R Meucci and M Frasca, *Phys. Rev. E*, **90**, 032905 (2014).
3. S N Menon and S Sinha, *Proc. IEEE SPCOM 2014* (arXiv1405.2789)