## Invasion Waves in the biochemical warfare between living organisms

Sylvestre Aureliano Carvalho and Marcelo Lobato Martins\* Departamento de Física, Universidade Federal de Viçosa \*Institute of Science and technology for Complex Systems

Microorganisms and plants very commonly synthesize and secrete toxic secondary chemical compounds (allelochemicals) that inhibit or kill sensitive strains or individuals from their own or other species. The race of plants and microbes for adapt to the allelochemicals synthesized by their neighbors may drive species coexistence and community composition. In this work we propose and study, using analytical and numerical methods, a model that describes two species interacting through allelopathic suppression and competing for resources. Employing linear stability analysis, the conditions for coexistence or extinction of species in spatially homogeneous systems were determined. We found that the borders between the regimes of bistability (two strong competitors), coexistence (two weak competitors), and the extinction of the weaker by the stronger competitor, are altered by allelopathic interactions. These changes are primarily determined by the two model parameters that control the species functional responses to the secreted allelochemicals. In addition, travelling wave solutions for one species invasion were obtained considering the spatially explicit nature of the model. Our findings indicate that the minimum speed of the invasion wavefronts depend primarily on the competition coefficients and, again, on the parameters characterizing the species' functional responses to their allelochemicals. As a general rule, species provided with the most effective chemical weapons dominate the population dynamics. Finally, we obtained a quite interesting finding: the model exhibit tristability at the coexistence region due to the combination of allelopathy and patchy population distributions in space. So, our model provides a distinct mechanism, independent of social behaviors, that produces such unexpected tristability impossible in classical competition models involving one-to-one individual interactions.