Diversity-induced resonance in a model for opinion formation

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Resonance in forced dynamical systems is a topic of widespread interest with many applications. A resonance usually appears as the effect of a matching between some parameters of the internal dynamics and the external forcing. It was shown in the early 80's that in a non-linear system a resonance can also appear as a function of the intensity of the fluctuations, of either internal or external origin. The basic mechanism leading to this *stochastic resonance* is rather generic and requires only a bistable system, a sub-threshold periodic forcing and a fluctuating term in the dynamics. The surprising result that fluctuations can enhance the response of a dynamical system to external forcing has become a new accepted paradigm and there have been many extensions and applications[1,2].

While most of the work in this field has focused on low-dimensional systems, more recent work analyses the role of fluctuations in the response of an *extended* system. A usual modelling is that of many identical units placed on the sites of a lattice, such that their response to the forcing is modified by the interactions amongst the units. A typical assumption in this case is that all the units are identical in the sense that they all possess the same values for some constituent parameters. For most applications, mostly in the biological or social sciences, the assumption of identical units is not a reasonable one since some sort of diversity or variability will always be present. We have shown in a recent work a new type of resonance with the external forcing as a function of the degree of diversity of the system[3,4]. This has been proven in bistable and excitable systems in which the diversity is modeled by *quenched noise*, i.e. by a parameter that adopts a different value for each of the units.

Although surprising at first, the fact that the right amount of diversity can enhance the response to an external forcing is not against our intuition. Think, for example, of a society which is very homogeneous in that all the members of the population work on a particular economical field. If the economy tilts and that particular field becomes of less importance, it will have a big negative impact in the overall wealth of the population since they will not be able to follow the change. However, if there is some degree of heterogeneity and fractions of the populations work on different fields, there will be always a section that can adapt easily to the changing economy. The final ingredient that allows the whole society to follow the change is some degree of interaction by which the benefited agents can pull the others.

In this communication, we present a rather different example of diversity-induced resonance in a simple opinion formation model. The model incorporates two basic ingredients for the evolution of the opinion held by an individual: social pressure and the effect of advertising. The heterogeneity in the model appears in that every individual has an intrinsic preference for a particular option. We also consider that the network of interactions has a non-uniform distribution of links. In both cases, as shown in the figure, there is a resonance effect (optimal synchronisation of the average opinion with respect to the external signal) as a function of parameters measuring the diversity in the distribution of the preferred opinions or the rewiring probability of links.

By giving an example which is very far away from the typical dynamical system applications, we want to emphasize the generality of the mechanism leading to the diversity-induced resonance. Furthermore, we believe that the example has interest on its own in the field of social sciences, since it shows that an external forcing (imitating the effect of advertising) has a larger impact on a hetereogenous society than on a completely homogenous one. This effect might be relevant when explaining the changes in opinion (e.g. in poll's results) motivated by an apparently small change in the external environment.

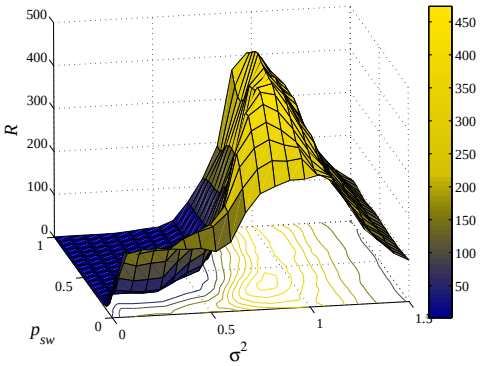

Figura 1. Measure of the collective opinion synchronization with the external signal as a function of the diversity σ in the preferences or the rewiring probability p_{sw} of the network.

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