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COMMENTARIES

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Sloppy organisms

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Commentary on

Transtrum M.K. et al., 2015, Perspective: Sloppiness and emergent theories in physics, biology and beyond, *The Journal of Chemical Physics*. Vol. 143: 01091.

This paper by the James Sethna group at Cornell appeared on *The Journal of Chemical Physics* one year ago. We can imagine the typical reader of *Organisms* as a biologist that, even if curious of theoretical issues, has a very low probability to step into a paper appearing on a chemical physics journal and (only apparently) very difficult to read given the large use of mathematical formalism. In this case, the reader should miss a very important piece of science, exactly located in the very center of ORGANISMS mission.

The authors here give a very brilliant (and fundamentally simple) explanation of why all the efforts to get a more faithful reconstruction of a complex system based on the multiplication of microscopic details are bound to failure. The examples described in the text come from many fields of science but for the *Organisms* reader I think the image reported below could be the most attractive (Fig.1).

Even at this very basic level of organization, is possible to collapse tiny details into collective parameters without losing information (on the contrary the right model is much more robust than the left one due to the fact the less are the parameters to estimate, the lower the effect of error variance). Organisms, as seen by a modeler's eye, are fantastic devices to simplify the plethora of irrelevant details into few robust and effective degrees of freedom. Quoting the authors, we must think that

> "[…] *while three-dimensional liquids have enormous microscopic diversity, in a certain regime (lengths and times large compared to molecules and their vibration periods), their behavior is determined entirely by their viscosity and density. Although two different liquids can be microscopically completely different, their effective behavior is determined only by the projection of their microscopic details onto these two control parameters.*

By no doubt, the quest for the biological analogs of 'viscosity' and 'density' is a crucial part of the goal of this Journal.

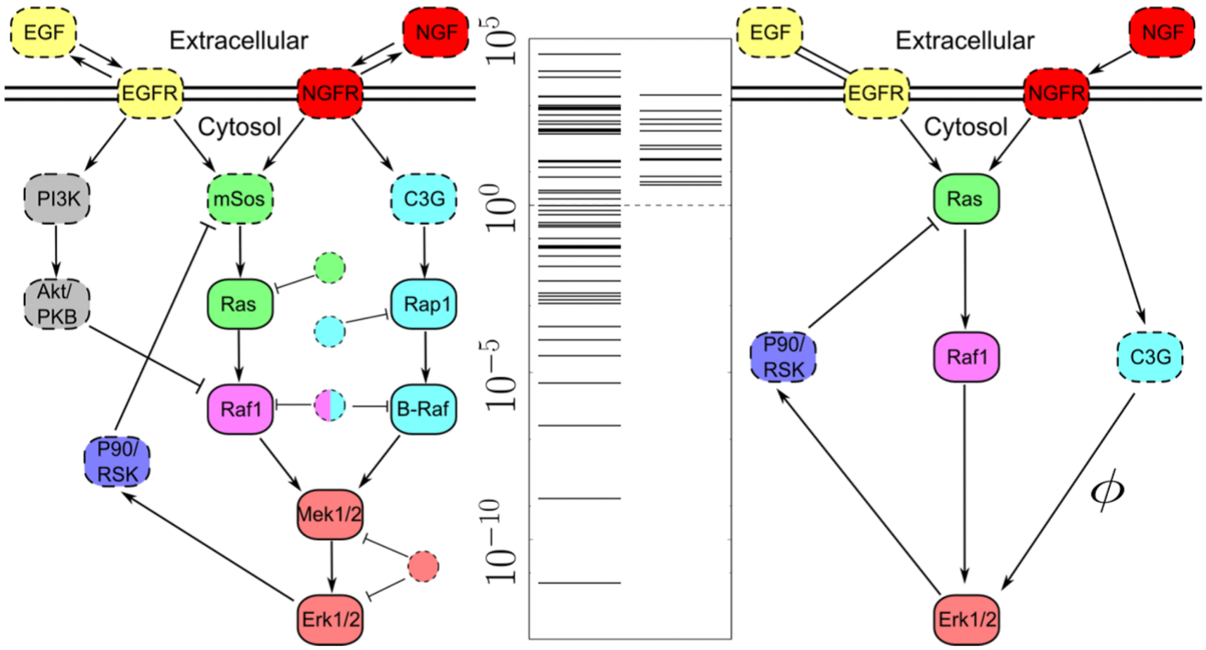

Fig.1. The figure reports two models of the Epidermal Growth Factor (EGFR) activity. The model on the left builds upon a much more detailed knowledge with respect to the model on the right. Notwithstanding this difference, the two models have an identical predictive ability. The reason for that lies in the bar graph in the middle reporting the eigenvalues (we can roughly identify as proportional to the relevance of the contribution of each element to the model performance). The two patterns relative to the complex and simplified models indicate that the simplified model has removed the irrelevant parameters identified as eigenvalues less than 1 (dotted line) while retaining the complex model predictive power (linked to the major eigenvalues).