



DISCUSSANT RESPONSE

by

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to **Itamar Procaccia's**

CHAOS AS A LIMITATION ON PREDICTABILITY, NOT ON SCIENCE

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Comment on Paper

Chaos as a Limitation on Predictability, Not on Science

by Itamar Procaccia

The author has demonstrated in a simple and direct way that there are problems which one cannot hope to understand in complete detail by solving the basic equations even though we may be certain that the variables involved describe the underlying behavior. This is precisely the situation that led Boltzmann to his formulation of statistical mechanics for complex systems and provided a basis for understanding the laws of thermodynamics, which previously had rested on an empirical base. In other words, new, valuable understanding of the behavior of complex systems was gained at a higher level through a statistical approach. This understanding was both reinforced and broadened with the introduction of quantum mechanics.

It follows that the limitations at one level of complexity may provide profound new insight at another if the proper approach can be found. We cannot hope to predict earthquakes by solving the equations of motion for each particle in the earth but have hopes that other approaches will be useful, whether empirical or theoretical. The problem of predicting the climate in the next century is probably more complex since it depends on factors external to as well as in the

interior, and on the surface of the earth. Nevertheless one may still ask if practically useful rules can be found.

The problem of comprehending the holistic properties of living systems is complex at an even higher level. One may ask, however, if there are clues to achieving understanding beyond those provided by the biologist working at the purely empirical observational level.

Frederick Seitz - June 1991