A CONVERSATION WITH LEO P. KADANOFF

BY E. ALTSHULER

Well known physicist Leo P. Kadanoff (James Frank Institute, University of Chicago) had an active participation at March*COM*eeting'12: he gave the opening lecture, and also headed the Committee for the selection of the Best Poster. In the short conversation below, we find his opinions on different aspects of contemporary Physics, from "grand unification efforts", to Physics in Cuba.

E. A. Some claim that we are near to reach the "Theory of everything" in Physics -based on the unification of all forces. The recent (possible) discovery of the Higgs boson seems like an important new piece in the jigsaw. After completing it, our job might be just to understand the details of "non-essential" phenomena -so to speak. Do you think we will actually reach a "Theory of everything"? Should the "leftover phenomena" be regarded as less essential to Physics?

L. K. *In the usual discussions, the "theory of everything" means a theory narrowly aimed at unifying our understanding of gravity and the quantum theory of particles and fields. Such an increased understanding will affect only few small parts of science, especially particle physics and cosmology, and perhaps some additional parts of astronomy. Such a discovery would leave most scientific investigations unaltered in intellectual interest, impact, and value. We do not know if this kind of unification is possible and if it would in any way change our view of the world.*

E. A. One may think that the aim of Physics is to provide quantitative descriptions of natural phenomena -regardless their nature. Under that wide-scoped definition, to what extent Chemistry and Biology are being "engulfed" by Physics these days?

L. K. *I work in an institute that contains both physicists and chemists. They have very different views of the natural world, and aim at very different outcomes. Typically, the chemist is impressed by the richness and variety of nature. His or her work is aimed at discovering differences between the behaviors of different things (usually molecules) and understanding these differences. Physicists emphasize the unity of nature. They (we) typically look for similarities among different things, and try to explain how these similarities arise.*

I see biology as being in an unsettled state. Some Governments and big businesses have heavily supported molecular biology in the hope and expectation that it would have an immense and profitable impact upon human disease. However, the impact has been smaller than expected. Many important processes occur not at a molecular scale, but at a considerably larger scale. Neglected subjects like organism biology and environmental biology have begun to move to the fore. All of these subjects can make occasional use of the kinds of unifying perspectives that can be supplied by the methods of physics. Often they need math knowledge. Very often all of biology needs sophisticated instrumentation and sophisticated understanding of how the instrumentation works. These things can come into biology through the work of physicists. However, biology must come to its own view of nature, distinct from that of physics or chemistry, and beyond that of legislators and drug companies. This is happening slowly.

E. A. As in many human endeavors, attractive labels are used to identify some areas of research as extremely new and "hot" -sometimes the label is well justified, sometimes not so well justified, I'd say. What do you think about the use of "Complexity" as a "trademark" in Science? What about the use of the prefix "nano"…?

L. K. *Words can be traps.*

To say that one works on "complexity" might mean that one is working on the generation of general laws which might apply quite broadly to many complex systems. That can be dangerous because such laws might not exist, or because useful laws might be hard to find. It might be better to say that one works on geothermal turbulence, or the structure of clays, or the walls of biological cells. In each of these areas, there are important discoveries to be made and specific phenomena to be explained.

"Nano" is another trap. There are many interesting things in chemistry, biology, and physics that occur on the scale of nanometers. Very few things are interesting mainly because they occur at nanoscales. A scientist can only go a small way toward justifying his/her work by saying it is "nano". The next step is the important one. Why is it interesting? For illuminating some natural behavior? For constructing some practical device? Why? "Nano" is hardly enough.

E. A. I feel that research in "Complexity" has been liberating for some experimental physicists -like me- due to the fact that, thanks to computers, one can find new Physics in simple, inexpensive experiments. In your opinion, to what extent the field of "Complexity" should be used as a "lifesaver"

for experimental Physics in developing countries?

L. K. *Computers are liberating, but they are also dangerous.*

My grandchildren tend to use computers as a replacement for contact with the world. It is particularly important for the Latin world that there be a clear and always-present contact between things that happen in the world and things that are seen in our lab computers. The experimentalist who uses a computer to control and experiment is not too exposed to this danger. The simulator who tries to represent something in nature by a computer program is however very exposed to the danger that he/she might lose contact with the real world of experiment.

E. A. After having participated in a couple of scientific Physics events in Havana during the last two of weeks, what's your impression about Physics in Cuba?

L. K. *I was very impressed by the high quality of physics research in Cuba. There are so many people with good ideas!*

E. A. Cuban physicists tend to publish their finest scientific results in well known, high-impact scientific journals, instead of doing it in the Revista Cubana de Física (RCF) -a natural consequence of the highly competitive nature of science nowadays. What strategy would you suggest to increase the scientific level of the papers published in the RCF?

L. K. *Your scholars would like to be known in the rest of the world. This is natural. Publications in high impact journals are a good way to receiving a bit of recognition from abroad.*

However, recognition from the home country is also a good thing. I would suggest that RCF makes a big fuss about the one or two or five best papers published in a given year.

This fuss might take the form of a few pesos, plus a big certificate, plus a chance to present at a local physical society meeting.

Leo Kadanoff, as president of the selection committee for the Best Poster of March*COM*eeting'12, congratulates A. Hernández for the First Prize, with the poster entitled "A rheological model based on nonlocal relations between shear stress and velocity gradients for complex fluids". The work was made in collaboration with Prof. O. Sotolongo ("Henri Poincarè" Group of Complex Systems, Physics Faculty, University of Havana). In the picture, with a white shirt, organizer J. O. Fossum (Physics Department, Norwegian University of Science and Technology), reads the award act. The scene took place at "Ambos Mundos" hotel, Havana, on March 7, 2012. (Photo: O. Ramos)