



News & Views

Is philosophy of any use for scientists?

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This is a question which would certainly divide physicists in particular and scientists in general. Being aware of that, here I would like to take the successful career path of an excellent physicist as a positive example, supplemented by my own humble and negligible experience. I do hope that a bit of such discussion would be useful in the current rash state of scientific research in China.

Anthony J Leggett is currently a physics professor at both University of Illinois at Urbana-Champaign, Illinois, USA and Shanghai Jiao Tong University, Shanghai, China. He was awarded the Nobel Prize in physics in 2003 for his theoretical work on superfluidity (https://www.nobelprize.org/nobel_prizes/physics/laureates/2003/). He has always been asking probing questions, very much to do with his training in philosophy in his undergraduate years at Oxford University, UK—before his curiosity was aroused, and his ambition was initially not in physics/science, that is, he did not learn physics until completing an arts degree. Evidently his success so far owns a lot to such an experience—he says, two mental tools learnt in his philosophical training have been enormously helpful: how to state a problem clearly and how to know the validity of an assertion. In addition to his achievement in superfluidity, his work on macroscopic quantum phenomena has a tremendous influence in related fields [1–3]. Though already a world class expert on quantum physics, same as Einstein, Schrodinger and others, he has been deeply concerned with the foundation of quantum mechanics and has been pushing the boundary of our understanding. As he usually remarks, quantum mechanics is more than a theory; any amount of effort to make it clear should always be needed.

Leggett has also been trying to make his sober thoughts accessible to wider audience. His unassuming name Tony has been equally known among students, colleagues, and casual acquaintances. His popular science book, *The Problems of Physics* [4], was published one year ahead of Hawking's *A Brief History of Time* [5], in which many problems discussed still remain open. Curious readers may easily find the opposite philosophical tendencies implied in those two great popular science books: the positive attitude was taken in *The Problems of Physics* and a negative one assumed in *A Brief History of Time*. The latter is a clear show of great confidence of some physicists armed with the tremendous success of physics. As a physicist, I am certainly pleased with such an assuring view. Nevertheless, as a serious cutting-edge researcher, perhaps

the sober attitude in the former may be better to lead us to new discoveries, and, to paradigm shifts.

Needless to say, Tony finds great happiness in interacting with budding scientists and all kinds of students. For example, last a few years he has been teaching a class on superconductivity and superfluidity to both undergraduate and graduate students annually in Shanghai, China. Not surprisingly, professors have been found in this class, too. He also found time to interact with primary, middle and high school students worldwide: in China alone ranging from Pingliang Second High School in the “wild” west of Gansu to Suzhou North America High School in the “sophisticated” east of Jiangsu, encouraging and nurturing curiosity in young and developing minds. His typical words are, no question is stupid. I still vividly remember the scene at my Seattle home that my daughter, in primary school, explained to him that how black hole would be formed.

With his enormous expertise and 60 year experience, in this January Tony gave an insightful, challenging and forward looking lecture on the future of condensed matter physics in Shanghai Jiao Tong University. We were very much impressed by his critical and constructive thinking. In my view his rugged seashore metaphor and the classification of open physics problems into three types, for example, will surely continue to inspire all of us during research. They remind us that unfathomed deep waters are out there; that for some problems we have no idea of “Hamiltonian” or “Lagrangian”, the starting point of typical physical approaches. Despite of his busy schedule, Tony kindly responded to the request of writing down his lecture, the essay in same issue [6], which will certainly benefit us greatly. I also sincerely appreciate the invitation from *Science Bulletin* to publish his lecture: a favor for our scientific community has been done.

As a student of his, I would certainly agree with Tony that a proper philosophical training is of great help. His probing style derived from such attitude, however, was both a blessing and a despair to myself: most of my results, outcome of hard work of sometimes even months, would not be able to survive his questions during first few minutes, which would end the discussion until next time when I would believe being able to address his questions. For those results that eventually passed his interrogation, he is typically not willing to co-author the papers even for research that he would have initiated, in order to leave students/postdocs more credit. For example, one of my best works during student period was on the dissipative level-crossing problem, prototypes in many fields ranging from biology,

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chemistry, condensed matter physics to astrophysics. It was published without Tony as a coauthor [7]. This had a drawback though—the problem is still very relevant in many fields, but, authors of many related recent papers have not been aware of us—a poor student and a poor postdoc. The benefit is also evident, the blessing side, at least to me: Going through such intellectual gymnastics provides a solid base for being confident in my own work, not swung by superficial external views as well as by occasionally deep and inside critiques. I would like to bring out two such examples from Shanghai Center for Quantitative Life Sciences as illustration, one on a new and powerful formulation of nonequilibrium processes and one on the mechanism of cancer, discussed in two essays [8,9].

Finally, taking this opportunity we all congratulate Tony for his eightieth birthday, and, wish him more productive years.

Conflict of interest

The author declares that he has no conflict of interest.

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Ping Ao Changjiang Professor in Shanghai University, graduated from Peking University in 1983, China. He entered into the graduate school of University of Illinois at Urbana-Champaign, Illinois, USA, via the CUSPEA program initiated by TD Lee. He obtained his Ph.D. degree in physics by studying macroscopic quantum phenomena, supervised by AJ Leggett. He did his post-doctoral research on dynamics of topological defects, supervised by DJ Thouless. Currently his research interest ranges from biology, engineering, medicine, and physics.