

## Macroscopic Quantum Mechanics and “System of Systems” Design Approach

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### TALK OUTLINE

“System of Systems Engineering” (SoSE) studies the design of an assembly of fully functional systems expected to work as a single super-system. In this field, the entire approach has been classical in the following senses. The physics that governs the behavior of the individual “sub” systems is classical mechanics; and the super-system’s dynamics is treated solely in terms of the interactions among these classical “sub” systems.

What if it could be shown that an alternative, non-classical physics governs the dynamics and behavior of the systems *at the macroscopic level*, with correspondingly new testable observations? Such a possibility, so far not entertained, will have immediate relevance to SoSE design approach. The design of the super-system can then be approached differently, taking into account this alternative non-classical macroscopic dynamics governing the interaction of the “sub” systems as well.

Indeed, we already have the possibility for such a non-classical theory in the form of quantum mechanics. The Schrödinger equation, which is at the heart of quantum theory, is applicable in principle to *both* microscopic and macroscopic regimes. Thus, it would seem that we already have in hand a non-classical theory of macroscopic dynamics, if only we can apply the Schrödinger equation to the macroscopic realm. However, this possibility has been largely ignored in the literature because the current statistical interpretation of quantum mechanics presumes the classicality of the *observed* macroscopic world to start with. But the Schrödinger equation does not support this presumption. The state of superposition never collapses under Schrödinger evolution. The Born’s rule, contrived to link the wave function to the macroscopic world treated classically at the point of observation, has led to the development of microscopic quantum mechanics and its prodigious pragmatic success. However, its essentially quasi-classical approach has also given rise to numerous conundrums and paradoxes, especially in linking the quantum microscopic world and the classical macroscopic world within a single overarching conceptual framework. The difficulty in making this link, which is referred to as the “measurement problem”, has remained intractable, and the problem remains unresolved even after a century of interpretive efforts.

In an effort to avoid all the paradoxes of microscopic quantum mechanics, and to get at the quantum ontology at the macroscopic level, I have recently argued that the deterministic Schrödinger equation can be directly applied to the macroscopic realm, *independent of current microscopic quantum mechanics*. (Gomatam, 2009) I have termed this new approach “macroscopic quantum mechanics” or MQM. MQM would describe the observable behavior of a

macroscopic object in terms of properties that it has *solely* by virtue of its *physical relation to other macroscopic objects*. In this sense, MQM would be new, and complementary to Newtonian mechanics, which solely deals with properties that a macroscopic object possesses independently of the rest of the world (its so-called primary properties). MQM would thus allow us to scientifically examine the idea that a complex system can be seen in two different ways: as a collection of classical sub-systems interacting in terms of classical, primary properties, as is presently done; or as a collection of *quantum* sub-systems interacting in terms of quantum, relational properties. This alternative quantum viewpoint at the macroscopic level, if successfully developed, should lead it seems by its very nature, to new principles governing the behavior of the super system that can reflect in our design approaches, and also yield new, testable predictions not available within the present classical praxis of SoSE.

To sum up, the focus of the new approach is to open a way to treat the dynamical interactions of *macroscopic* sub-systems on a quantum footing using MQM. Needless to add, MQM would have repercussions not just on SoSE, but on all other fields of science and engineering.

MQM is still a new idea, and at present can best be described as a research program in its earliest stages. In my talk, I shall discuss MQM in some detail, and try to mention its possible implications to SoSE without claiming to provide specific future applications.

## Reference

Gomatam, R. (2009) Quantum Theory, the Chinese Room Argument and the Symbol Grounding Problem In P. Bruza et al. (2009) (eds.) Quantum Interaction-2009, *Lecture Notes in Artificial Intelligence*, vol. 5494, pp. 174-183, Springer-Verlag: Berlin, Heidelberg

Talk time: 1 hr (45+15)

## A Brief Bio:

Prof. Gomatam is the director of Bhaktivedanta Institute at Berkeley/Mumbai ( [www.bvinst.edu](http://www.bvinst.edu) ), and of the newly formed Institute for Semantic Information Sciences & Technology in Berkeley. He received his masters in electronics engineering in the early 70s from BITS, Pilani, India. After working in India for a few years with a major international airline on their software development projects, he moved to USA and worked for a number of Fortune-500 companies including General Motors, Ford, Chrysler, Burroughs and IBM as a freelance software specialist in the areas of operating system design, data communications and very-large database design. In the mid-80s, he turned to academics, taking a Ph.D. in the foundations of quantum mechanics. He now carries out full-time research and graduate level teaching. His main area of research interest is foundations of quantum mechanics, where he is aiming to develop a new application of the Schrödinger equation directly at the macroscopic level. He has related interests in objective semantic information processing and philosophy of language. His publications are available at <http://bvinst.edu/faculty/~gomatam.htm>