Newton's Hypotheses Non Fingo

Approaches for attempting to implement this task within theories of quantum measurement are discussed in detail in the section *The Rise of the Measurement Problem*. Bohr's requirement can be seen to actually be in accord with Newton's 17th century approach for communicating the facts of a world that happens not have a finite quantum of action. Newton does not make hypotheses about the material substance around us but instead focuses from the very start on the *facts*, the interactions that we experience, just as Bohr had focused on the experimental arrangements. The prime example is Newton's theory of gravitation in which a universal attractive force between masses would exert its influence instantly and extend over arbitrary distances of empty space. This violated the standard mechanical philosophy at that time, as dictated by Descartes and Boyle, in which explanation must be built up from hypothesized properties and motions of the materials filling space. In the second edition of the *Principia* of 1713, Newton introduced the General Scholium with its dictum *Hypotheses non fingo*, saying he would *not feign hypotheses* in place of sound explanation. It is enough that this force really exists and that it serves abundantly to account for the major phenomena of the heavens and our earth. Descartes viewed forces acting at a distance as something occult which cannot exist [340, p. 221]. However, Descartes' scenarios of vortices comprising materials filling space could not explain gravitation. Descartes' only secure *fact* was that he exists, the *Cogito*, the proposition that *if I think I am* as this requires an I that is thinking. From this, he proceeds to infer the reality of material substances of the world and their properties [304, p. 203].

Newton could be said to have a *top-down* approach whereas Descartes' approach is *bottom-up* [554, p. 367]. In private, Newton did make attempts to "explain gravity" [407, p. 40], but couldn't find a suitable explanation. He was satisfied in his place and time not to feign hypotheses. It would take almost 400 years of further development in mathematics and physics to explain gravity within Einstein's theory and gravitational interactions moving at the speed of light in order to justify why Newton's action at a distance can be an excellent approximation. In a 1672 letter to the Jesuit Father Ignace Gaston Pardies, Newton expands on his approach in more detail [554, p. 369]:

> *See the print edition of The Quantum Measurement Problem for quotation.*

These requirements were later codified in the 1726 edition of the *Principia*, Vol. 2 as "Rules of Reasoning in Natural Philosophy," which might be regarded as guidelines for deductive reasoning in the physical sciences [308, pp. 202-205]:

Rule I. We are to admit no more causes of natural things than such as are both true and sufficient to explain their appearances.

Rule II. Therefore, to the same natural effects we must, as far as possible, assign the same causes.

Rule III. The qualities of bodies, which admit neither intension nor remission or degrees, and which are found to belong to all bodies within the reach of our experiments, are to be esteemed the universal qualities of all bodies whatsoever.

Rule IV. In experimental philosophy, we are to look upon propositions collected by general induction from phenomena as accurately or very nearly true, notwithstanding any contrary hypotheses that may be imagined, till such time as other phenomena occur, by which they may either be made more accurate, or liable to exceptions.