A NOTE ON INTERACTION, COGNITION, AND EPISTEMIC LIMITS IN PHYSICAL THEORIES

** *This note builds on an assumption articulated in Note 1—that human perception and cognition may provide incomplete or indirect access to reality.*

Scientific knowledge is obtained through observation, measurement, and inference, all of which are mediated by human cognition and by physical instruments designed and interpreted by humans. Scientific theories therefore do not access reality directly; they describe regularities that are accessible through specific modes of interaction. This mediation is not a weakness of science, but a structural condition under which scientific knowledge is possible.

All physical measurements require interaction between the system under study and a measuring apparatus. Information enters scientific description only insofar as such interactions occur and produce observable effects. Consequently, the domain of empirical science is restricted to aspects of reality that couple—directly or indirectly—to matter, fields, or spacetime structures that our instruments and cognition can register. Where no interaction exists, no information can be transmitted, and no empirical distinction can be made.

From an epistemic standpoint, any hypothetical aspect of reality that does not interact with observable systems is indistinguishable from non-existence. This statement does not assert that such aspects do or do not exist; rather, it defines a boundary on what can be meaningfully known or modeled within an empirical scientific framework. Questions that lie entirely outside the space of interaction and information exchange are therefore not decidable by science.

To illustrate this boundary, consider a purely hypothetical example: suppose there existed a form of energy or field that does not couple to known particles, forces, or spacetime degrees of freedom in any detectable way. Such an entity would produce no measurable signal and no observable effect on matter. Even if postulated to exist, it would carry no information accessible to observation and would be epistemically indistinguishable from non-existence. This example is illustrative only and does not propose new physics.

This observation has implications for how scientific theories are interpreted. Empirical success—predictive accuracy, internal consistency, and technological utility—does not imply ontological completeness. Historically, highly successful theories such as classical mechanics and thermodynamics were later understood as effective descriptions rather than final accounts of reality's structure.

Quantum mechanics, despite its extraordinary predictive power, does not escape this general condition. Its formalism provides a precise framework for predicting measurement outcomes, yet its interpretation remains underdetermined by experiment alone. This suggests that scientific theories are best understood as effective interfaces between interaction and prediction, rather than direct representations of reality as it is.

This note does not propose new physical principles, hidden entities, or revisions to established theories. Its purpose is solely to mark an epistemic boundary: scientific theories describe reality insofar as it is accessible through interaction, measurement, and cognition. Beyond that boundary, statements about existence or structure lose empirical content. Recognizing this limit clarifies the scope of scientific knowledge and helps avoid category errors, without weakening the empirical power or progress of science.