Realistic Lagrangian-Only Quantum Theory

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Paper: "Lagrangian-Only Quantum Theory", arxiv.org/pdf/1301.7012
(The technical calculations in sections III and V will be deemphasized.)

Extended Abstract for this presentation:

Despite the importance of the path integral, there have been relatively few attempts to look to the Lagrangian for a more realistic framework that might underlie quantum theory (in the same way that statistical mechanics underlies thermodynamics). This presentation is a proof-of-principle that such a framework plausibly exists, and takes the form of a spacetime-field ontology.

If the primary lesson from the "sum over all paths" of the path integral is taken to be that **there are no dynamical laws**, one cannot solve physical problems using the "Newtonian Schema" (initial state + dynamics = outcome). But there is another path forward, aligned with the use of the Lagrangian in classical physics, where the actual history of a system is constrained on its spacetime boundary and solved "all at once". (For more on the distinctions between the "Newtonian" and "Lagrangian" Schemas, and the promising features of the latter, see the essay at arXiv:1211.7081.)

Even without dynamics, one can still calculate probabilities in the Lagrangian schema. For example, in statistical mechanics, the relative probability of 3D macrostates can be found by constraining the possible microstates with available knowledge, and then assuming all remaining microstates have an equal *a priori* probability. Extending this dynamic-free analysis to "4D states", or histories in a block universe, leads to the natural assumption that all "microhistories" should be assigned an equal *a priori* probability, but only one microhistory need be real. There are many interesting features that result from this unexplored assumption, including the natural emergence of joint probabilities (vs. conditional probabilities) and the role of the future in constraining the likelihood of past events.

Given this foundation, the other key idea is to only consider field histories for which the Lagrangian density is always zero. Such constrained microhistories can cluster around solutions to classical dynamic equations, but are not restricted to them. With this change, it appears possible to replace the complex amplitudes in the path integral with classical probabilities. In the case of a toy Lagrangian that corresponds to an arbitrary spin state, these principles allow one to derive both the Born rule and its limits of applicability. The natural utilization of the so-called "retrocausal loophole" also results in the first explicit, spacetime-continuous, hidden-variable description of a Bell-inequality-violating system. These results should therefore be of considerable interest to not only quantum foundations, but also efforts to make quantum field theory more compatible with general relativity.