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Equations Without Equations: Towards Formalizing Physicists' Reasoning VLADIK KREINOVICH, ROBERTO ARAIZA, University of Texas at El Paso — Not all mathematical solutions to physical equations are physically meaningful: e.g., if we reverse all the molecular velocities in a breaking cup, we get pieces self-assembling into a cup. The resulting initial conditions are "degenerate": once we modify them, self-assembly stops. So, in a physical solution, the initial conditions must be "non- degenerate". A challenge in formalizing this idea is that it depends on the representation. Example 1: we can use the Schrödinger equation $i\hbar\frac{\partial\Psi}{\partial t} = -\frac{\hbar^2}{2m}\Delta\Psi + V(\vec{r})\Psi$ (1) to represent $V(\vec{r})$ as $F(\Psi,\ldots)$. The new equation $dF/dt = 0$ is equivalent to (1) but now $V(\vec{r})$ is in the initial conditions. Example 2: for a scalar field φ, we describe a new "equation" which is satisfied iff ϕ satisfies the Euler-Lagrange equations for some Lagrangian $L(\varphi, \varphi_{,i}\varphi^{,i})$. So, similarly to Wheeler's cosmological "mass without mass," we have "equations without equations."

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