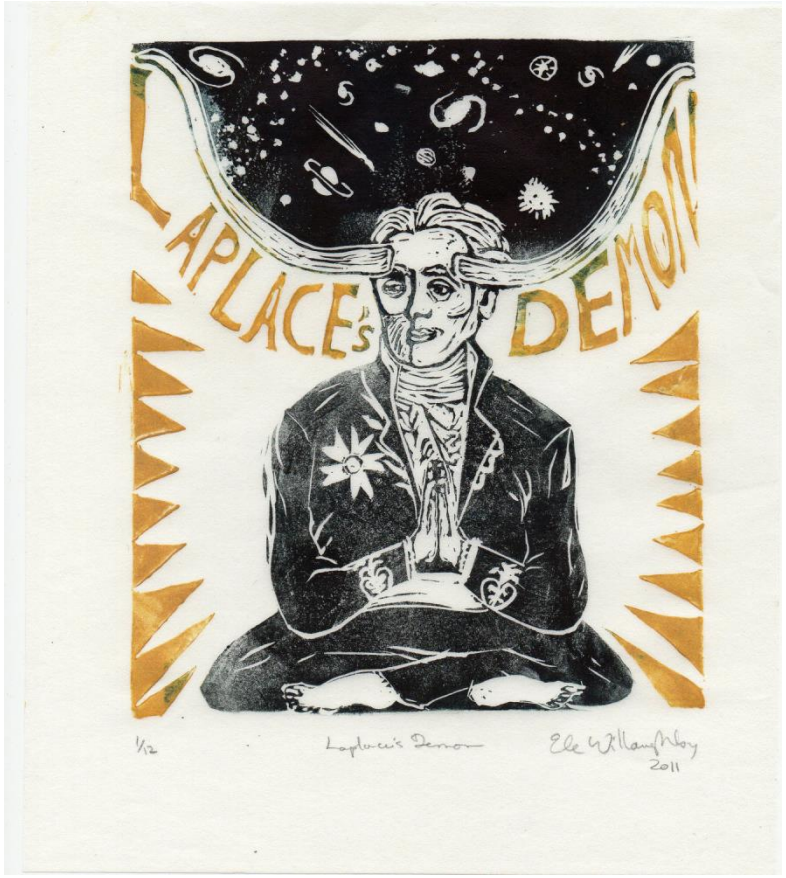
The Ghost of Laplace's Demon

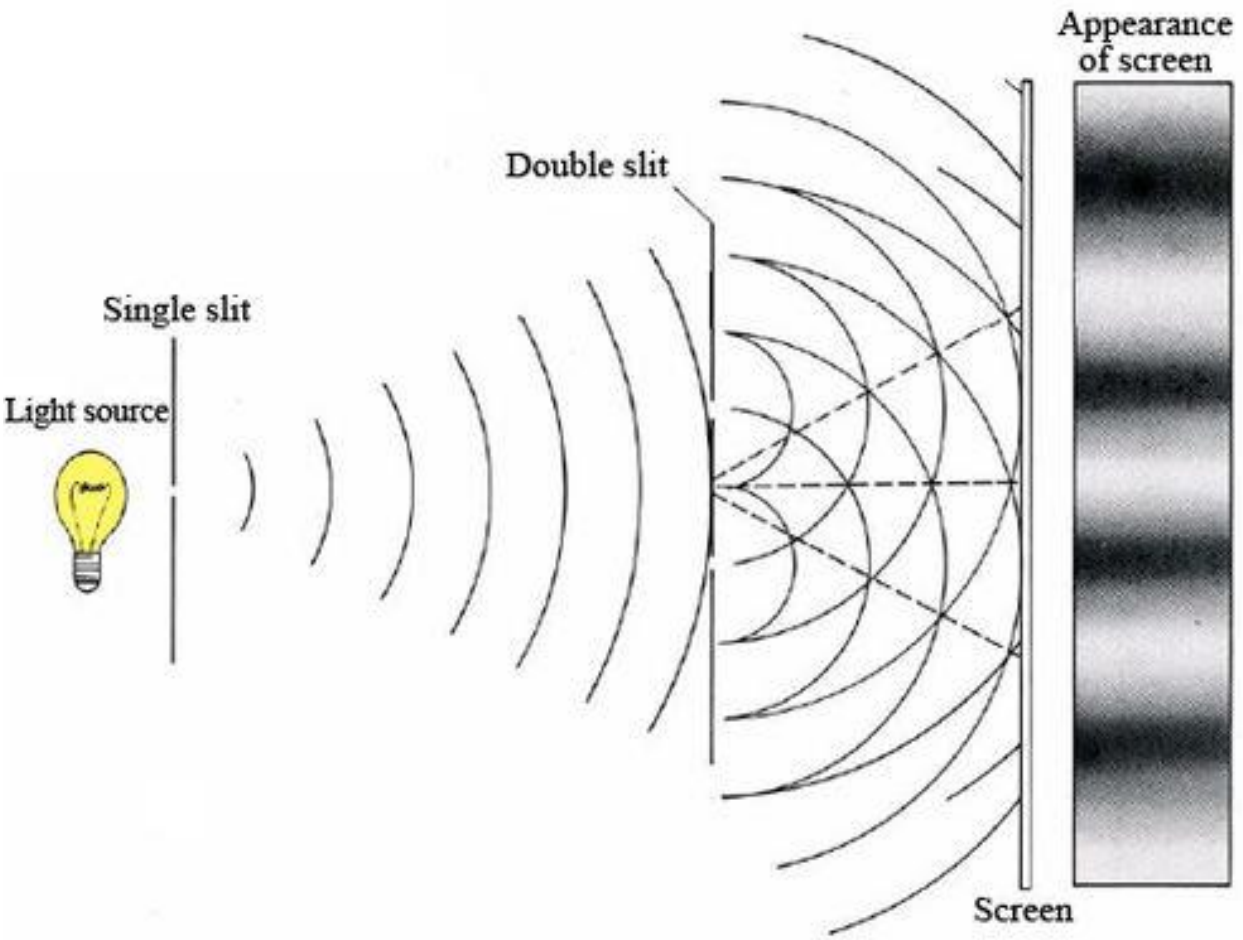
Casual Determinism's Survival in an Alternative Interpretation of Quantum Mechanics

Laplace's Demon and Causal Determinism

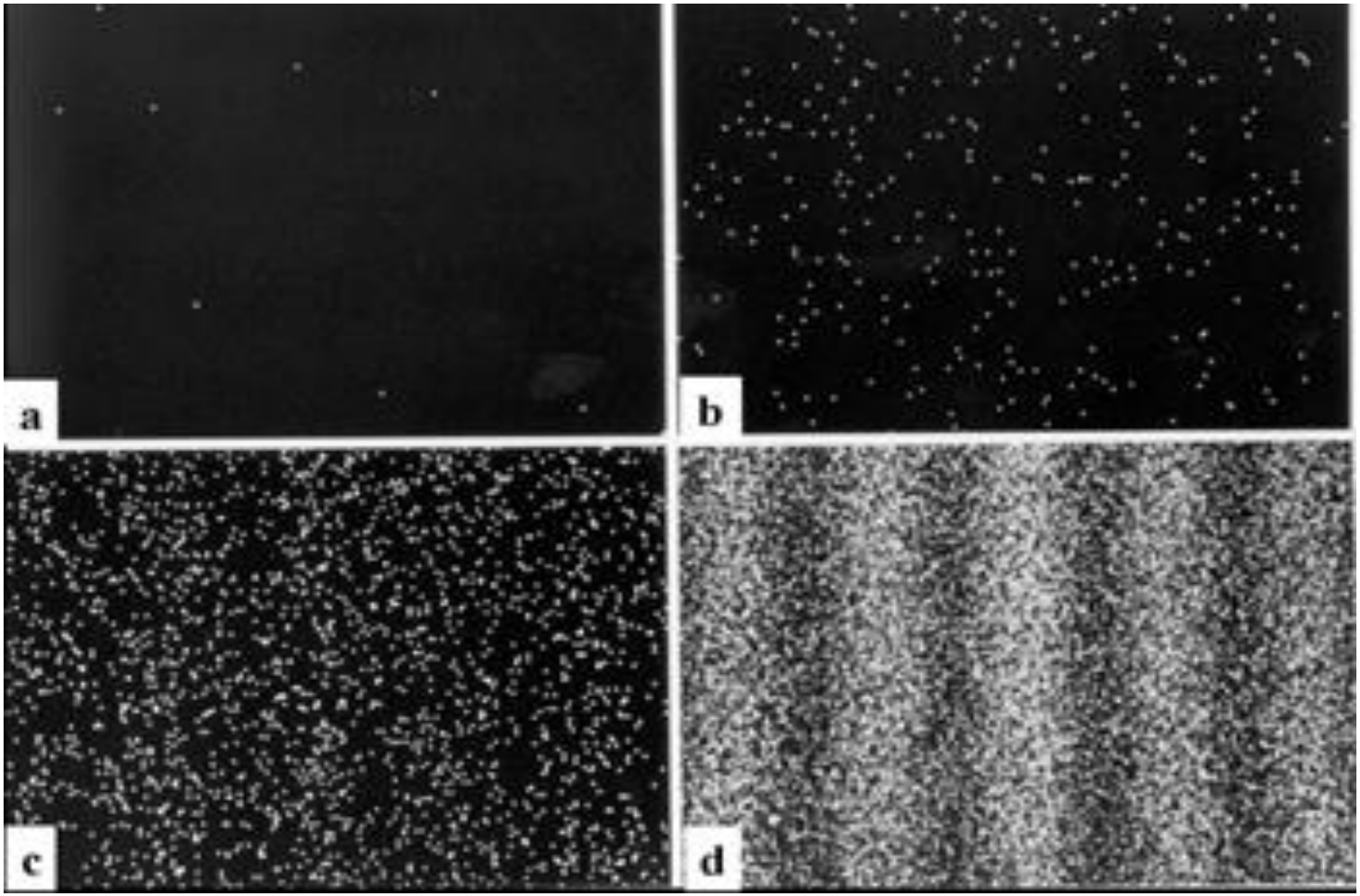
- *"We may regard the present state of the universe as the effect of its past and the cause of its future. An intellect which at certain moment would know all forces that set nature in motion and all positions of all items of which nature is composed, if this intellect were also vast enough to submit these data to analysis would embrace in a single formula the movements of the greatest bodies of the universe and those of the tiniest atom; for such an intellect nothing would be uncertain and the future just like the past would be present before its eyes* (Laplace, 1816)*."*



Young's Double Slit



De Broglie's Electron



The ‘orthodox’ interpretation of QM: Copenhagen

“A philosophical extravaganza dictated by despair” Schrödinger

Nature is fundamentally probabilistic.

Probability of event given by absolute square of (Born rule).

`Measurement' has special status and randomly picks out exactly one of the many possibilities allowed for by the state's wave function through nonlocal `collapse process'.

The ‘orthodox’ interpretation of QM: Copenhagen (cont.)

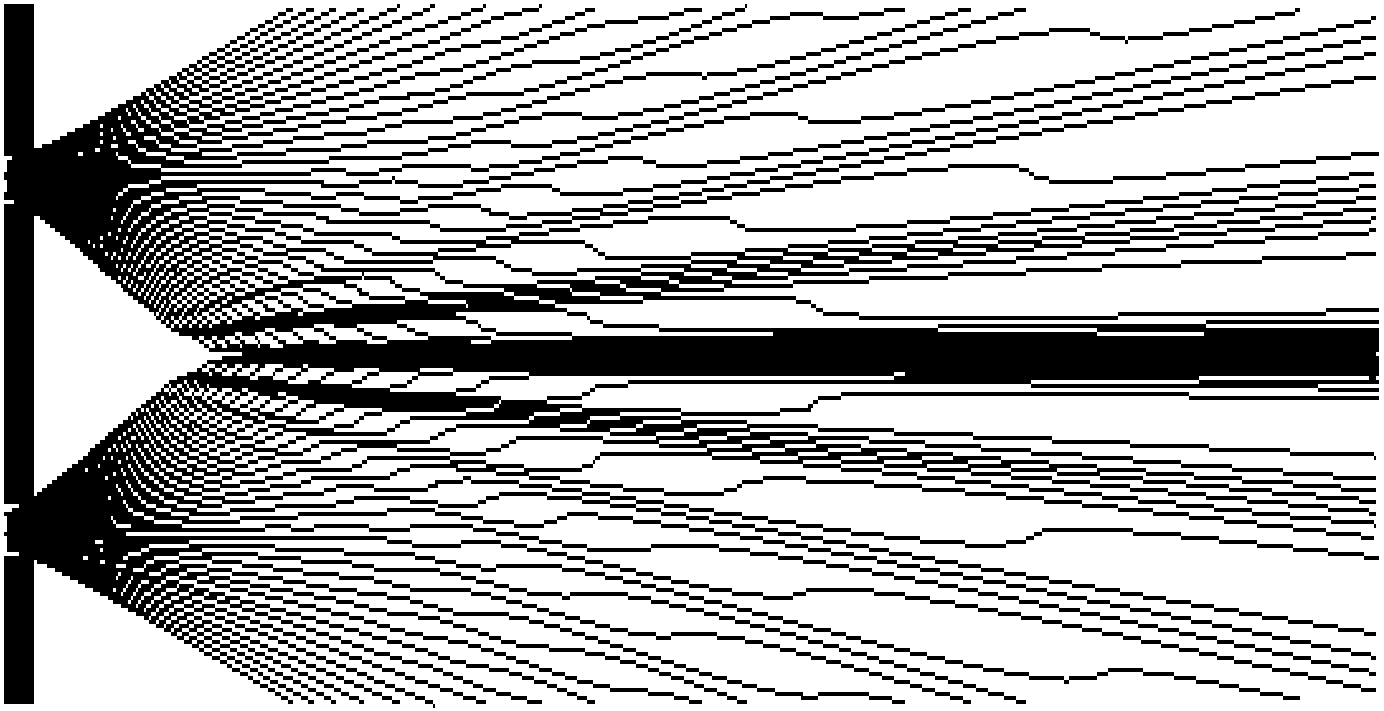
Complementarity principle: An experiment can show the particle-like properties of matter, or wave-like properties, but not both at the same time.

An alternative: Pilot Wave

(Bohmian mechanics, de Broglie-Bohm, casual interpretation….)

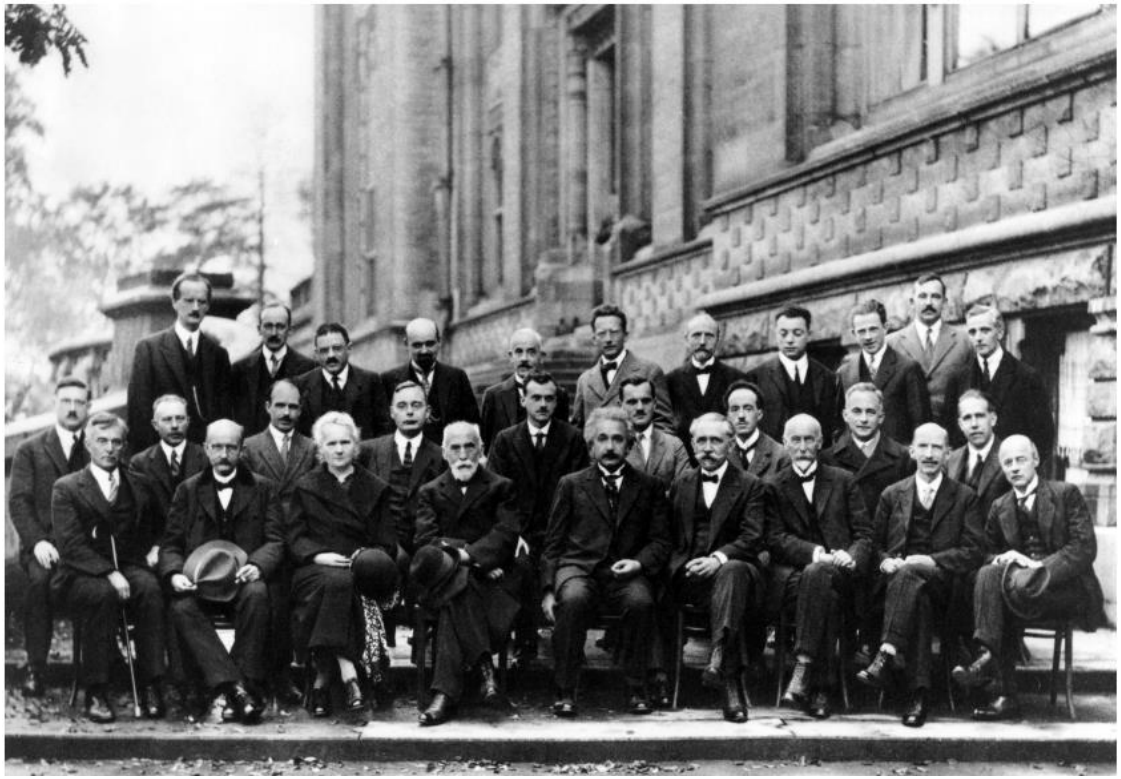
- QM does not have to be ‘weird’
- Classical statistical mechanics dictated by a non-classical, but familiar, dynamics via a ‘Quantum’ Potential. (An extra force to push particles in non-classical ways)
- Particles have definite trajectories guided (piloted) by waves.
- Predictively identical to CI

Wave ‘channels’ & ‘hidden’ variables



Why don’t we explore this more?

Historical context, Solvay 1927



Occam's razor

$$Q = -\frac{\hbar^2}{2m}\frac{\nabla^2 R}{R}$$

Among competing hypotheses, the one that makes the fewest assumptions should be selected.