On Wave Function Monism in Spontaneous Collapse Theories

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Introduction

- orthodox quantum mechanics =(def) only Schroedinger wave function
- Is OQM complete?= Is wave function monism possible?
- Schroedinger→NO: the measurement problem
- Bell's alternatives
  - Either the wave function is not everything or it evolves differently
    - BM
    - GRW

Introduction

- GRW and orthodox quantum mechanics
  - wave function monism (even if in GRW different evolution equation)
  - So, monism without the measurement problem?
- Questions:
- 1- Is strict (bare) monistic GRW possible?
  - No: but we can "dress it up"
- 2- Is "dressed-up" monism reasonable/desirable?
  - No

Monistic GRW

- David Albert's view
- The wf is a real physical field
- Physical space = configuration space (dimension M=3N)
- Motivation:
  - Very natural (analogy with CM and CED)
- Problems:
  - 1-account of the false belief that we live in a 3-d space
  - 2-account of macro properties

The Impossibility of Strict Monism: 3d space

- Recovery of 3-d space
  - $\Psi(q)=\Psi(q_1,...,q_N)$, q_i in R^3 ?
- Not enough resources:
  - already assume that the configuration can be divided as such= there are 3d particles!
- gap:
  - a map (from configuration to 3d space) is needed

The Impossibility of Strict Monism: Macro Properties

- Observables as physical properties
  - the eigenstate--eigenvalue rule (EER): an observable has a well-defined value of a system S iff S' quantum state is an eigenstate of that observable
- monistic GRW:
  - infinite tails
  - no definite properties
- gap:
  - a map (from configuration to 3d space) is needed → Albert and Loewer's proposal (see later)

Rule One: the Hamiltonian

- Albert proposal for Rule 1 (3d problem):
  - $H = \nabla^2_q + V(q)$, q in R^M
  - empirical fact: $V(q) = \Sigma_{i<j} V(|q_i - q_j|)$, $q = (q_1, \ldots, q_N)$, q_i in R^3
  - this ensures us of the appearances of the world as 3 dimensional

Rule Two: Supervenience

- Albert and Loewer proposal for Rule 2 (macro properties)
- New rule:
  - particle x is in region R' iff the proportion of the total square amplitude of x's wave function which is associated with points in R is greater than or equal to 1-p
- it maps macro talk to micro talk

Practical Rules

- Both rules are not additional ontologies
- Rather, they are just practical rules

The Alternatives:Local Beables and Primitive Ontology

- John Stuart Bell:
  - Necessity of supplementing the wf description with something else, also in GRW
- local beables as an ontological rule
- primitive ontology = local beable in 3d space
- monistic GRW = GRW0
  - no primitive ontology

GRWf

- Bell:
- ``flashes''= space-time events corresponding to localization events of the wave function
- GRWf
- $F_{[0,t]} = \{(x_1,t_1),(x_2,t_2), \ldots (x_i,t_i),..\}$

GRWm

- Ghirardi:
- mass density $M^\Psi = M^\Psi(x,t)$ in 3d space
- GRWm

The General Structure of Fundamental Physical Theories

- Fundamental ingredients of a mechanical explanation:
  - space-time
  - trajectories of the primitive ontology in it
- examples:
  - Newtonian mechanics
  - Bohm's theory
  - GRWf and GRWm
- Common structure: (X,f)

The Two Approaches Compared

- What is Wrong with GRWf and GRWm?
  - 1-The Status of the Wave Function is mysterious
    - wave function as a law
    - Objections:
    - 1-time evolution
      - reply: quantum cosmology
    - 2-degrees of reality
      - replies:
        - nominalism
        - not strong enough
        - non existence of the wave function

The Two Approaches Compared

- What is Wrong with GRWf and GRWm?
  - 2-Artificiality
    - Begging the question: which is describing realty?
  - 3-Redundancy
    - Begging the question: what is necessary to explain?
  - 4-Complexity
    - Misleading: theories with PO just postulates the existence of PO in s-t
    - Against Occam's razor: not true that the simplest always explains better

The Two Approaches Compared

- What is Wrong with GRW0?
  - 1-Methodology: Radicality
    - GRW0 is even more radical than the brain-in-a-vat scenario:
      - Why believe it if less radical alternatives are available?
  - 2-Are the rules successful?
    - Monton, 2002
  - 3- Are the rules plausible?
    - 1-The Hamiltonian Rule:
    - Hamiltonian --> 3d or 3d --> Hamiltonian?

The Two Approaches Compared

- 2-The Supervenience Rule
  - GRWf and GRWm:
    - clear ``mechanism of explanation''
  - GRW0:
    - addition of rules because "they work''

The Two Approaches Compared

- 4-The Mind-Body Problem
  - GRWf and GRWm:
    - The mind-body problem can be left out
  - GRW0:
    - !!!!!

Why not Both?

- The "mixed" view???
  - monism is appealing because for its ontological simplicity
  - primitive ontology is appealing because of its explanatory simplicity
- the mixed view complicates both!