

## On Wave Function Monism in Spontaneous Collapse Theories

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## Introduction

- orthodox quantum mechanics = only Schrodinger wave function
- wave function monism ?
- NO: the measurement problem.
- Bell's alternatives
  - either the wave function is complete or it evolves differently
    - BM
    - GRW

## Introduction

- GRW and orthodox quantum mechanics
  - wave function monism?
  - in GRW: different evolution equation...
- Questions:
  - 1- Is monistic GRW possible?
    - no
  - 2- Is it reasonable/desirable?
    - no

## Monistic GRW

- David Albert's view
- physical space = configuration space dimension  $M=3N$ .
- problems:
  - account of the false belief that we live in a 3-d space
  - account of macro properties

## The Impossibility of Strict Monism: 3d space

- $\Psi(q)$ ,  $q$  in  $R^M$
- $\Psi(q) = \Psi(q_1, \dots, q_N)$ ,  $q_i$  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
- monistic GRW:
  - infinite tails
  - no definite properties
- gap:
  - a map (from configuration to 3d space) is needed

## Rule One: the Hamiltonian

- $H = \nabla_q^2 + V(q)$ ,  $q$  in  $\mathbb{R}^M$
- empirical fact:  $V(q) = \sum_{i < j} V(|q_i - q_j|)$ ,  
 $q = (q_1, \dots, q_N)$ ,  $q_i$  in  $\mathbb{R}^3$ 
  - this ensures us of the appearances of the world as 3 dimensional

## Rule Two: Supervenience

- 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 with 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 and local beables 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
- $F_{[0,t]} = \{(x_1, t_1), (x_2, t_2), \dots, (x_i, t_i), \dots\}$

## GRWm

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

## The General Structure of Fundamental Physical Theories

- 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
    - 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
  - 3-Simplicity
    - misleading
    - against Occam's razor
  - 4-Redundancy
    - begging the question

## The Two Approaches Compared

- What is Wrong with GRW0?
  - 1- Radicality
    - GRW0 is even more radical than the brain-in-a-vat scenario ...
  - 2-The Hamiltonian Rule
    - Hamiltonian --> 3d
    - or
    - 3d --> Hamiltonian???

## The Two Approaches Compared

- 3-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?

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- 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!