

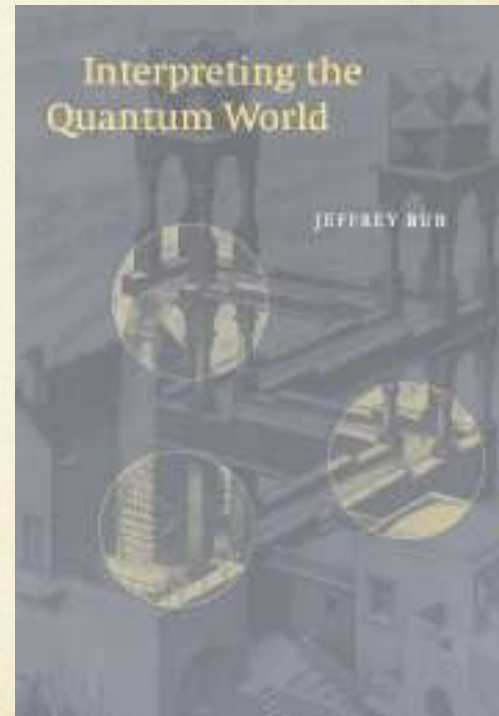
Orthodoxies on the Interpretation of
Quantum Theory: The Case of the
Consistent History Approach

Olival Freire Jr.
Universidade Federal da Bahia, Brazil

Talk's outline:

- Introduction – on different meanings of quantum orthodoxy
- Consistent history approach – a brief presentation
- Has there been the birth of a new orthodoxy?
- The reception of the consistent history approach
- A short conclusion

Jeffrey Bub - *Interpreting the quantum world*,
Cambridge University Press, 1997.



- For most physicists, the measurement problem of quantum mechanics would hardly rate as even a 'small cloud' on the horizon. The standard view is that Bohr had it more or less right, and that anyone willing to waste a little time on the subject could easily straighten out the sort of muddle philosophers might get themselves into. There seems to be a growing consensus that a modern, definitive version of the Copenhagen interpretation has emerged, in terms of which the Bohr-Einstein debate can be seen as a rather old-fashioned way of dealing with issues that are now much more clearly understood.

Jeffrey Bub (1997, 212)

Indeed, Bub introduced the concept of orthodoxy in four different ways:

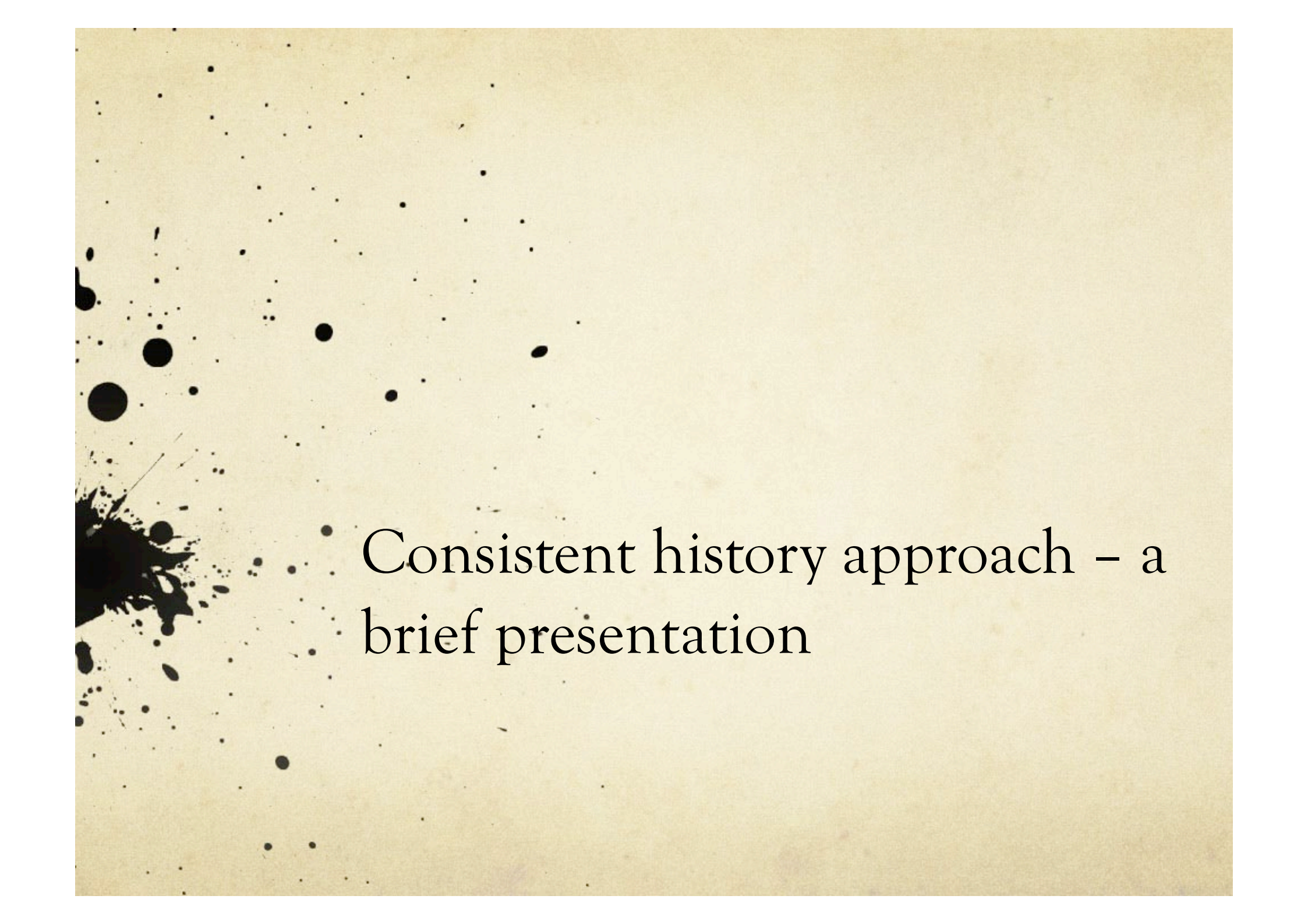
- “For most physicists, the measurement problem of quantum mechanics would hardly rate as even a ‘small cloud’ on the horizon.” #1
- “the orthodox (Dirac-von Neumann) interpretation principle (the ‘eigenvalue-eigenstate link).” #2
- Bohr’s ‘Copenhagen Interpretation.’ #3
- New orthodoxy as the mix of several strands: environment-induced decoherence, elements of Everett’s ‘relative state’ formulation, and the notion of ‘consistent histories.’ Omnès as its spokesman. #4

Thus, the issue of historical and practical interest seems to be:

- Is the “new orthodoxy”, meaning #4 (the consistent history approach), resuscitating orthodoxy meaning #1?
- If this be the case, such a symbiosis may have been harmful to the development of the research on the foundations of quantum mechanics.

Resuming:

- New orthodoxy as the mix of several strands: environment-induced decoherence, elements of Everett's 'relative state' formulation, and the notion of 'consistent histories.' Omnès as its spokesman. #4
- For most physicists, the measurement problem of quantum mechanics would hardly rate as even a 'small cloud' on the horizon. The standard view is that Bohr had it more or less right, and that anyone willing to waste a little time on the subject could easily straighten out the sort of muddle philosophers might get themselves into [...] #1



Consistent history approach – a
brief presentation

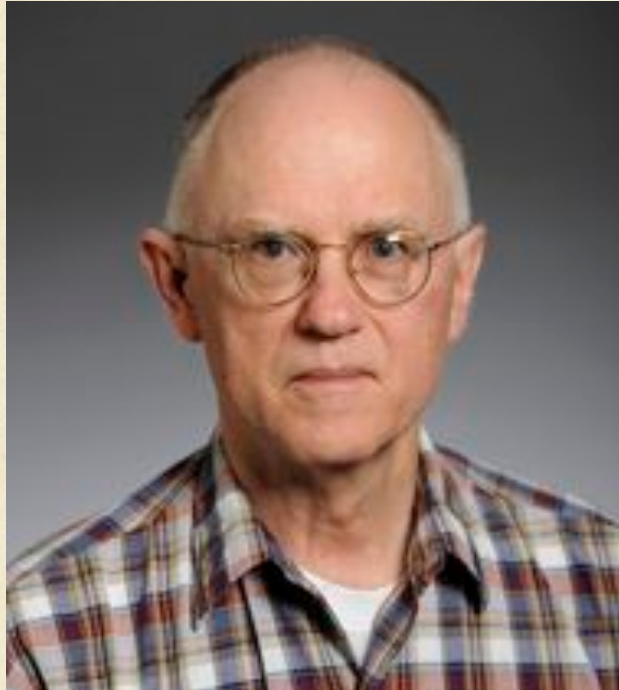
Robert Griffiths



Consistent Histories and
the Interpretation of
Quantum Mechanics,
*Journal of Statistical
Physics*, 1984

- ✓ Mathematical criteria to use classical rules of probability to produce conditional probabilities with quantum systems
- ✓ Sequences satisfying such criteria are consistent histories
- ✓ Thus, we have a new regulatory principle to be adopted in quantum theory
- ✓ Main advantage: to be applied to closed quantum systems between successive measurements
- ✓ Thus, measurement is no more a central process for quantum theory
- ✓ Thus, the new approach solved conceptual difficulties related to conscious observers (von Neumann, Wigner) and classical apparatus (Bohr)

Robert Griffiths



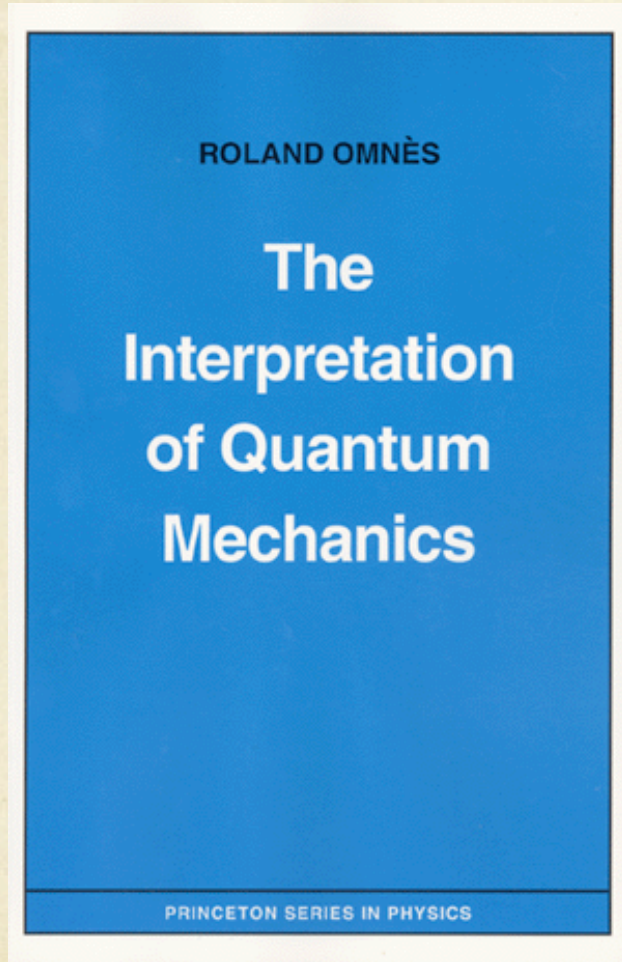
Consistent Histories and
the Interpretation of
Quantum Mechanics,
*Journal of Statistical
Physics*, 1984

✓ He saw his contribution “as an extension and (we hope) clarification of what is, by now, a ‘standard’ approach to quantum probabilities” and a part of “an extended controversy which is far from being resolved.”

✓ He discussed ideas of Kurt Gottfried, Marcelo Cini, Peter Moldauer, and Hugh Everett in addition to the “orthodox views” by von Neumann and Wigner.

✓ No special influence from Everett’s interpretation

Roland Omnès



Mathematical techniques similar to those used by Griffiths.

Conceptual foundations are different. Omnès looked for a “revision of the logical foundation of quantum mechanics.”

He developed the logical and theoretical machinery that allowed him “to construct consistent Boolean logics describing the history of a system, following essentially Griffiths’ proposal.”

Discussions with Bell, Vigier, and d’Espagnat. But, work unrelated to controversy on the foundations of quantum theory. Never cited Everett.

Work is a “significant progress ... towards a consistent and complete reformulation of the Copenhagen interpretation.”

Murray Gell-Mann & James Hartle

Quantum mechanics in the light of quantum cosmology, 1989



Quantization of gravitation led them to foundations of quantum mechanics

Hartle-Hacking wave function of the universe, a solution of the Wheeler-DeWitt equation for quantizing gravitation.

Murray Gell-Mann & James Hartle

Quantum mechanics in the light of quantum cosmology, 1989

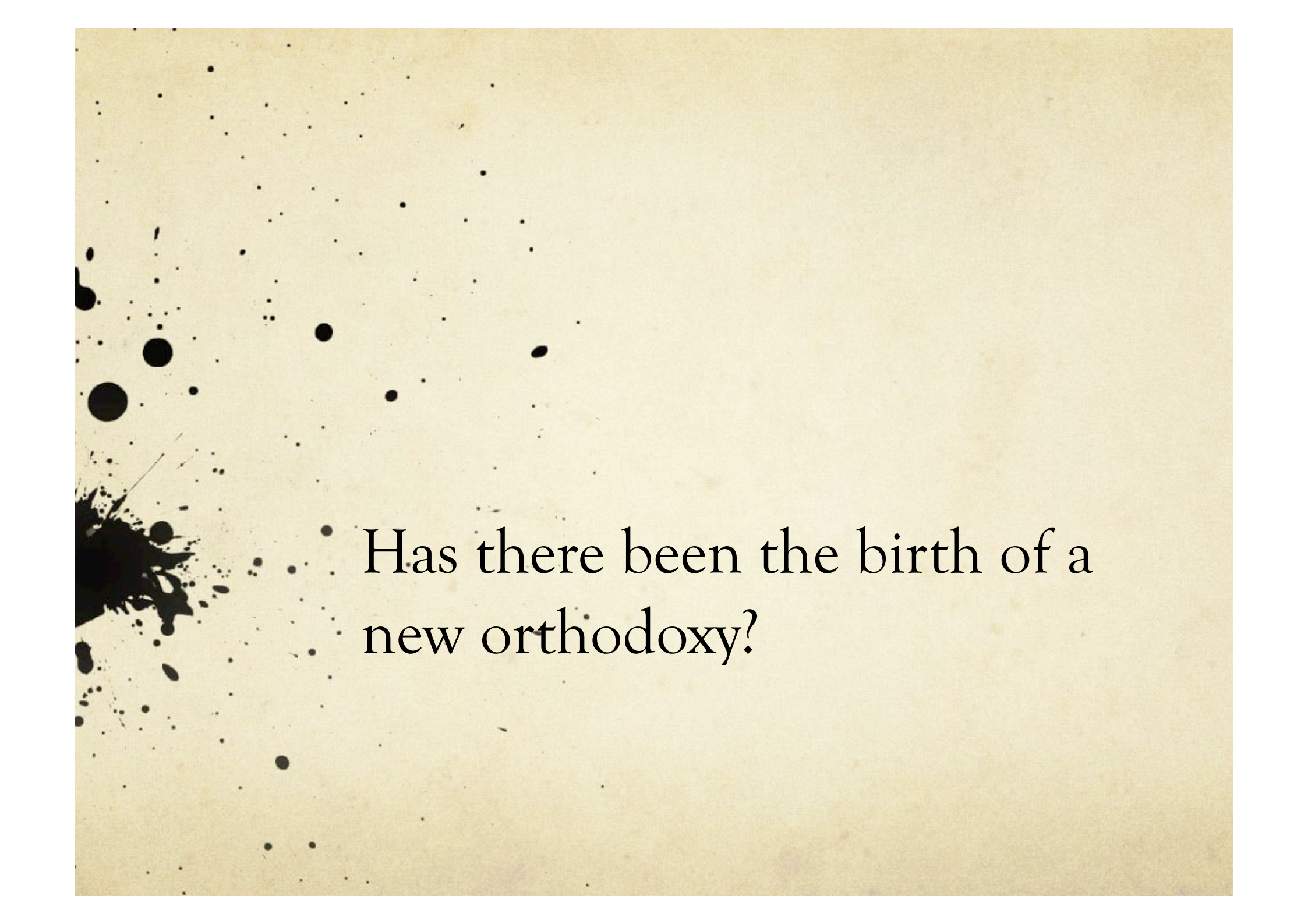
The main merit of their contribution was to associate the attribution of classical probabilities in quantum systems with decoherence.

The connection was that “decoherence requires a sufficiently coarse-grained description of alternative histories of the universe.”

Standard interpretations are inadequate for cosmology because “measurements and observers cannot be fundamental notions in a theory that seeks to discuss the early universe when neither existed.”

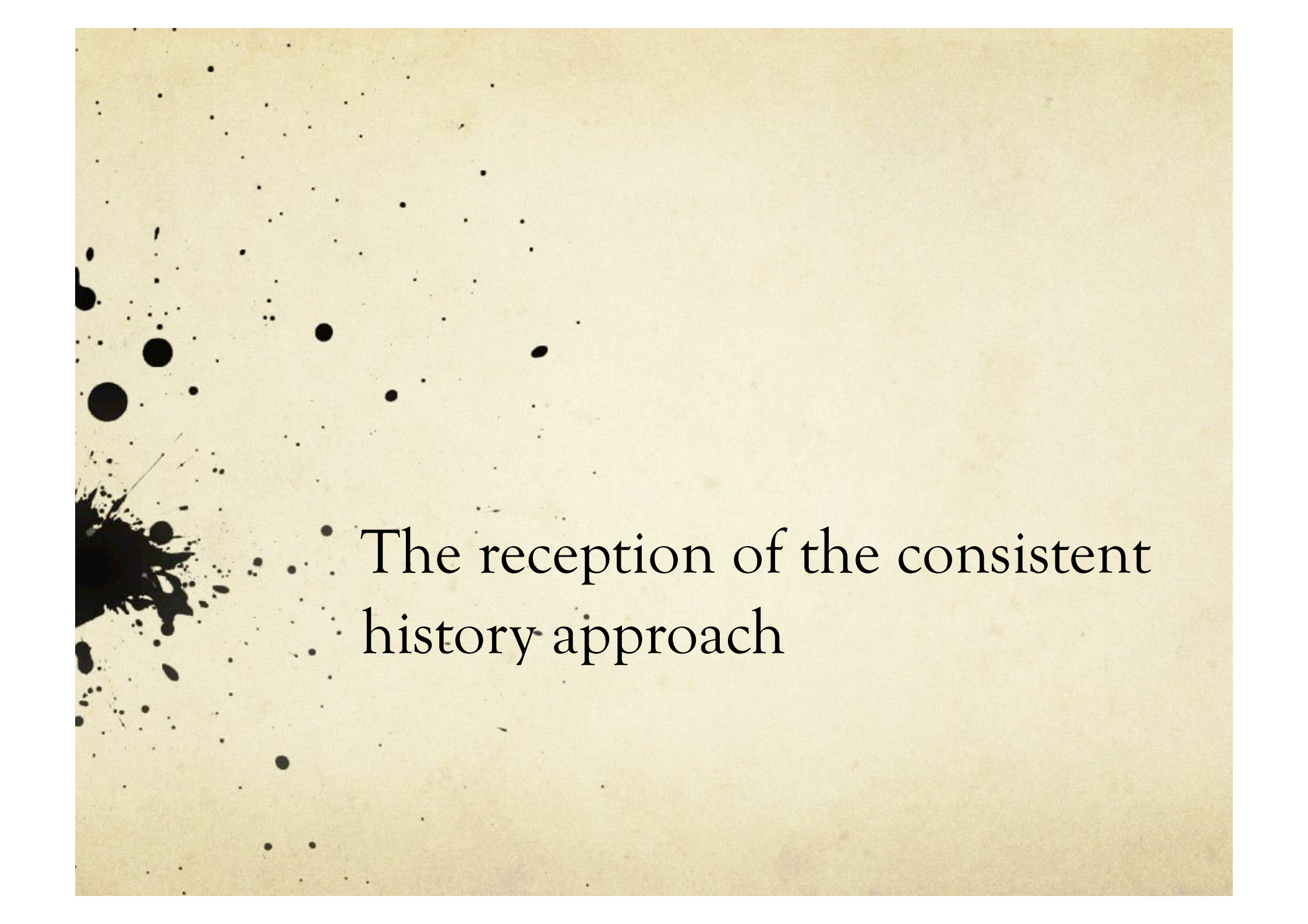
Everett was the first to suggest “how to generalize the Copenhagen framework so as to apply quantum mechanics to cosmology.”

Their work is a “post-Everett” stage in quantum mechanics



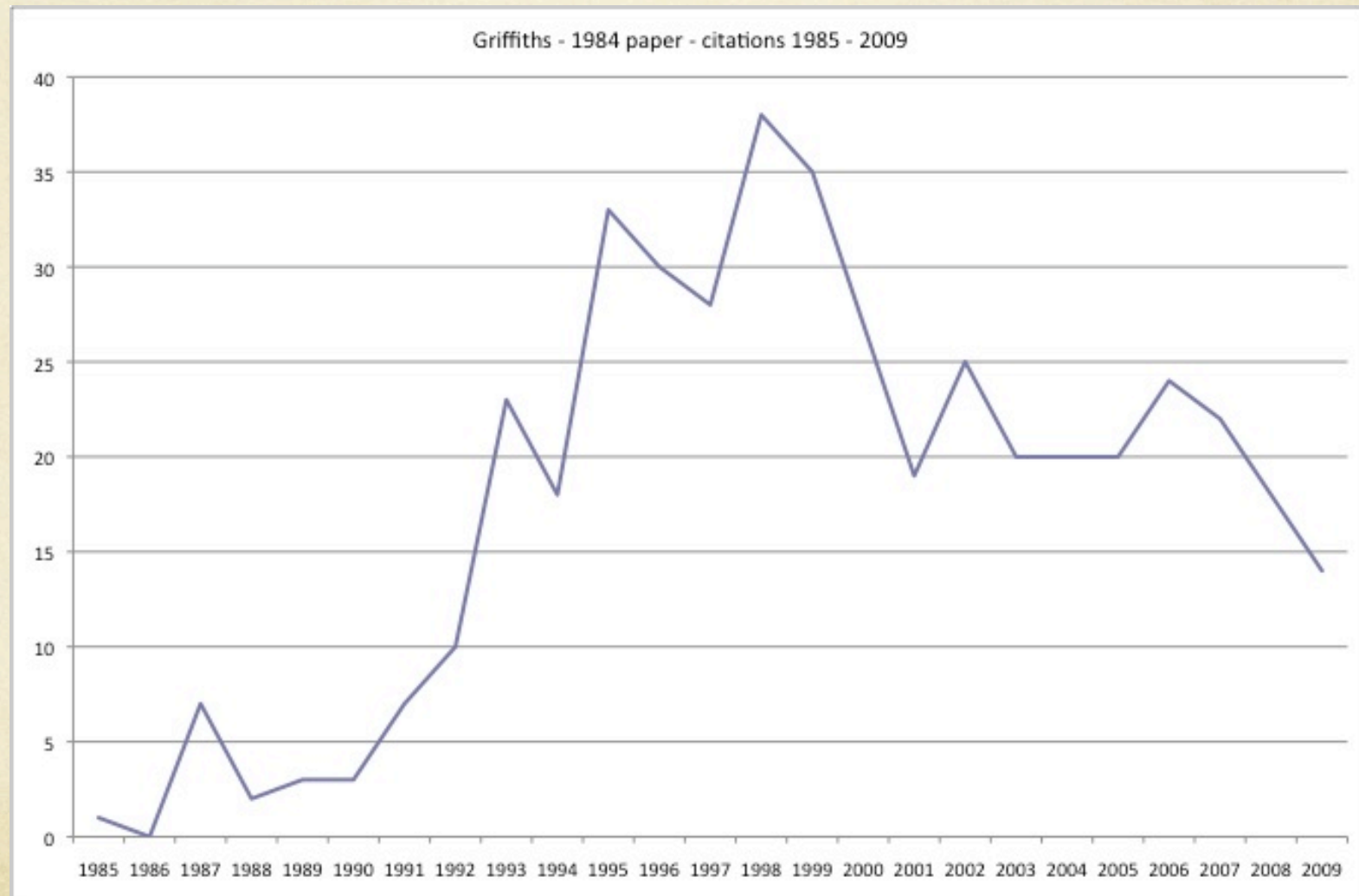
Has there been the birth of a
new orthodoxy?

- The rhetoric used by some of the consistent historians may have raised concerns about the claim of a new definitive solution to the problems in the foundations of quantum theory.
- “when these three ideas [decoherence, transition quantum classical, consistent histories] are put together, they provide a genuine theory of interpretation in which everything is derived directly from the basic principles alone and the rules of measurement theory become so many theorems (emphasis are mine).” Omnès (1999).



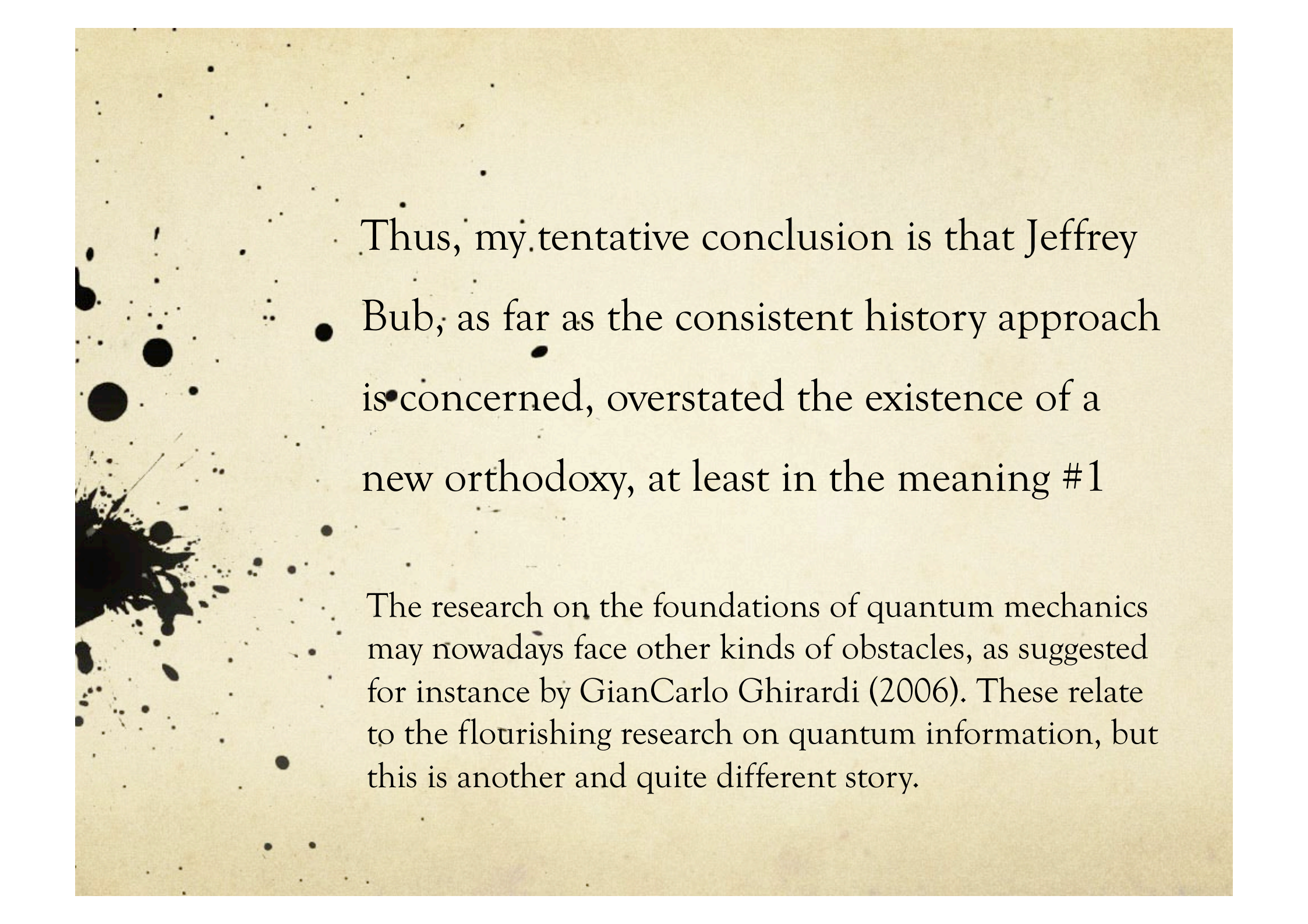
The reception of the consistent
history approach

Playing with scientometrics ...



Physicists who cited Griffith's paper more than ten times

- J. J. Halliwell - 29
- C. Anastopoulos - 22
 - R. Omnès - 21
- R. B. Griffiths - 18
 - B. L. Hu - 15
- J. B. Hartle - 13



Thus, my tentative conclusion is that Jeffrey Bub, as far as the consistent history approach is concerned, overstated the existence of a new orthodoxy, at least in the meaning #1

The research on the foundations of quantum mechanics may nowadays face other kinds of obstacles, as suggested for instance by GianCarlo Ghirardi (2006). These relate to the flourishing research on quantum information, but this is another and quite different story.