

Experimental Test of qRule Theory

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Three qRules governing the collapse of a wave function are given in another paper. In most situations the predictions of this theory are identical with the predictions of other foundation theories. However, there is at least one experiment in which the qRules predict results that are characteristically different from other theories. These results are shown to be a function of molecular collisions in an experiment proposed by Collett and Pearle. Wave reductions in other collapse theories are distinctly not a function of collisions.

Introduction

The most highly developed theory of quantum mechanical state reduction (i.e., wave collapse) is the GRW/CSL theory of Ghirardi et al. [1] and Pearle [2]. According to that theory, elementary particles occasionally (although rarely) undergo a spontaneous collapse that spreads to the macroscopic level through correlations. The rate of collapse is governed by a small hypothetical constant λ that has not as yet been observed.

In 2003 Collett and Pearle proposed an experiment intended to establish an empirical basis of that theory [3]. A micro-disk of aluminum or gold is suspended in a Paul trap at 4.2° K and very low pressure ($5 \cdot 10^{-17}$ Torr), and the disk's angular diffusion rate is observed. The disk with a radius of 200 nm and a thickness of 50 nm is held vertically with its normal lying along the horizontal, while laser photons are directed horizontally toward it. The angular deflection of the photons is therefore a measure of the disk's angular diffusion. The claimed spontaneous reduction of the angular state can then be

observed, and so the reduction rate λ can be measured. The measurement must take place between collisions with atmospheric molecules.

If this experiment produces the expected results we would have to conclude that the qRule theory proposed by the author is incorrect, for the qRules posit no constant λ and they do not provide for the introduction of energy in connection with a stochastic choice [4]. However, if the experiment does not confirm the diffusion predicted by GRW/CSL, then other alternatives such as the present proposal will remain on the table.

Collision Reduction with Sphere

It is theoretically simpler to consider the collapse mechanism with a small sphere as in Ref. 4. A small sphere of radius $r_0 \approx 10^{-5}$ cm is solid aluminum or gold. Imagine that it has expanded to five times that radius as a result of the uncertainty of its momentum. This is shown in Fig. 1a where a number of small dashed spheres representing the minimum volume sphere are circumscribed by a large dashed sphere representing its uncertainty of position. An incoming molecule shown as a black dot in Fig. 1b penetrates the extended radius, engaging the sphere at various points in *faux* collisions (defined in Appendix I of Ref. 4). These collisions occur in a ready component of the qRule equation prior to a stochastic hit, so they have no empirical reality even though their wave function goes into the Schrödinger equation. Only two faux collisions are shown in Fig. 1b (dashed lines), although there is a continuum of collisions like this prior to the stochastic hit. The third collision pictured in Fig. 1b (solid lines) is assumed to occur at

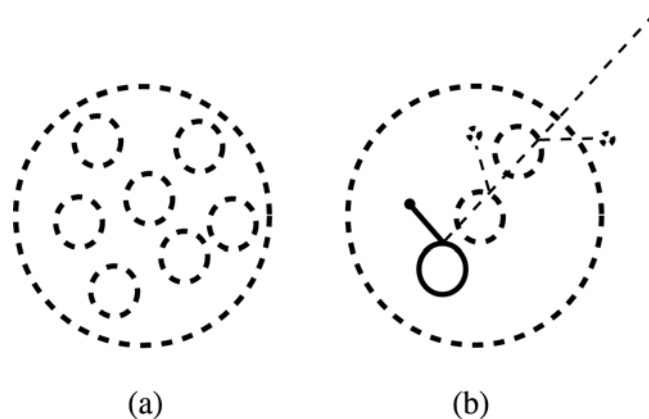


Figure 1: Uncertainty of position of sphere

the time of a stochastic hit, so it is a *realized* collision. Each of these collisions is non-periodic.

If the collisions in Fig. 1b are also continuous like Compton scatterings there will be no collapse of the wave. For a collapse to occur there must also be an orthogonal quantum jump. A change in the rotational level of the disk will generally provide the required jump. A diatomic molecule at 4.2°K may also provide rotational levels for this purpose. Either way, it is overwhelmingly likely that the interaction gap will be orthogonal. This together with non-periodicity satisfies the conditions for a state reduction.

This collapse is analogous to that of an atom with the smallest initial width Δx_0 consistent with Δp_0 that expands because of Δp_0 , and collapses under the right qRule conditions to the smallest width Δx consistent with the value of Δp at that time. See the example given in Ref. 4 in connection with Fig. 3 of that paper.

Experimental Set-up

The proposed experiment involves a disk rather than a sphere. The reduction principle is the same in both, but a disk has a measurable angular displacement and diffusion rate. According to the qRule theory, state reductions of the disk will occur only in connection with molecular collisions with the disk, so an observation of collapse must span the time of a collision in order to confirm the predictions of the theory. The assumption is that after a time the angular uncertainty will be much larger than the original $\Delta\phi_0$ because of the original ΔL_0 , and that a collapse will reduce the angle to the smallest value $\Delta\phi$ consistent with ΔL at that time (which might differ from the initial ΔL_0 because of collision dynamics). It will be difficult to measure the state reduction following a collision because of the disruptive influence of the collision. Assuming that this difficulty can be overcome, a collision reduction will provide a unique test of the proposed qRule theory inasmuch as no other foundation theory shows that kind of dependence.

References

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