Why Johnny Can't Q.M.

Robert I. Price

Emeritus Associate Professor of Physics
Department of Physics and Physical Science
University of Nebraska at Kearney

Developing an Interpretation-Free Quantum Mechanics

We live our lives in a "Facial Recognition" mode, *exempli gratia*, *Pareidolia* represents a feature not a defect of our suite of perceptions. As a result we are prone to (sometime fortuitous) mistakes and misinterpretations. This feature also allows us to construct "Toy Models" that guide us to understanding the unknowables of our existence. A double-edged sword, to be sure, our classically forged cognition needs to be retrained to deal with the enigma known as Quantum Mechanics.

Both the ***Game of Eleusis*** invented by Robert Abbott in 1956, and the ***Game of Life*** invented by John Horton Conway in 1970 parallel the inspiration of many Toy Models for comprehending aspects of how scientists understand ***Reality***, *id est*, the way the world really works. Many authors use simplified constructs to illustrate a "bottom - up" explanation of how science works. My intent is to articulate the "top - down" route: "Doing" particle physics to elucidate perceived relationships (observations) that lead us to theories (explanations) in our quest to understand (know about) ***Reality***. For this work I will use the ***Game of Life*** to explore how we might approach an understanding of Quantum Mechanics and now it determines the processes of Elementary Particle Physics and by extension all that we know and can ever know. As such, it is not intended to represent all aspects, or even the core concepts of this rather esoteric subject. The intent is to articulate the point of view that "Theory" is fundamental to the process of "doing" particle physics and elucidate its relationship with observation and our attempt to understand "Reality".

---

1 Observations (and refinements of same)

Running the ***Game Of Life*** program often results in distinctive (?-mark shaped) patterns of cells (designated by the name "Glider") being produced. This five cell pattern seems to be created (sporadically) within virtually every active region (particularly in the case of randomly generated examples) of this brand of cellular automata simulations.

Cursory observations lead to the realization that the glider's direction of travel is determined by its orientation. Rotate the pattern by $\pm 90^\circ$ or 180° and the direction of travel will be rotated by that same amount.

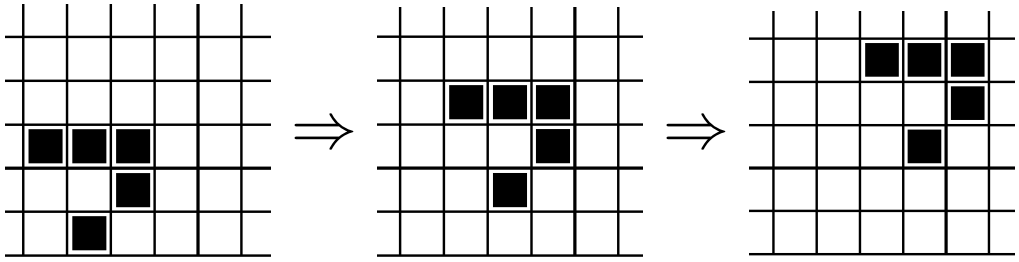

Figure 1: A Glider Moves Up and to the Right

The most basic observation is that the structure appears to move one cell horizontally as it moves one cell vertically.

1.1 Time-Space Analogy

I prefer a Time-Space presentation where the vertical axis represents time and the horizontal axis represents a displacement along a single direction. With this frame of reference I think of this as describing a simplified version of particle dynamics.

This perspective highlights the Time $\leftrightarrow$ Space exchange symmetry of QM and allows for the annihilation of Glider – Anti-Gilder pairs.

1.2 2D-Space Analogy

Perhaps a more accessible mode of presentation is to think of the glider as moving about on a horizontal flat surface. And the results of running scenarios suggest (and test) various theories.

We are "wired" to explain our experience in terms of knowns, and causes generating effects.

2 Theories ("explaining" observations)

Careful observations (frame-by-frame) reveal that a glider's form changes as it moves. This "slow-mo" perception might suggest various ways you might describe how a glider executes a "step" while retaining its identity as it moves about in this landscape.

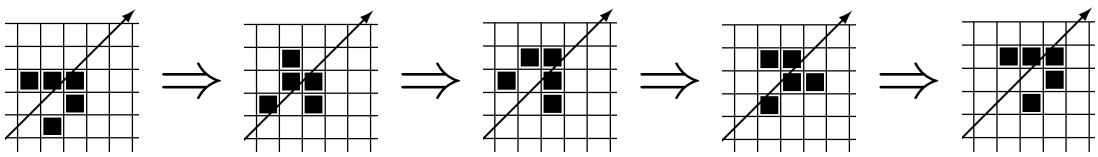

Figure 2: Notice the glider's "Internal Structure"

The words you use constitute your theory of the Quantum Mechanics of Glider Motion.

It is vital that you understand that your theory is "only a theory", in that it, like all science at this level, represents an effort to "understand" that which is inherently not understandable.

3 Reality (that which is inaccessible to us)

The ***Game Of Life*** like the ***Game of Eleusis*** may be executed using a variety of rules that produce indistinguishable activity. That is, a variety of possible underlying realities may be responsible for the emergent processes we theorize to explain our observations. Put as implemented $\cdots$

The ***Game Of Life*** is a cellular automata environment that uses a small set of rules to transform geometric patterns ("objects") to make it seem that they move and interact as if they were alive. Some geometric patterns transform to generate, annihilate, or alter the characteristics of other geometric patterns.

Regardless of how we might choose to "explain" processes, the reality of the ***Game Of Life*** is defined by four simple rules. Each cell adjoins eight neighboring cells and for each cell $\cdots$

Any:

1. live cell with fewer than two live neighbors dies.
2. live cell with two or three live neighbors lives.
3. live cell with more than three live neighbors dies.
4. dead cell with exactly three live neighbors becomes a live cell.

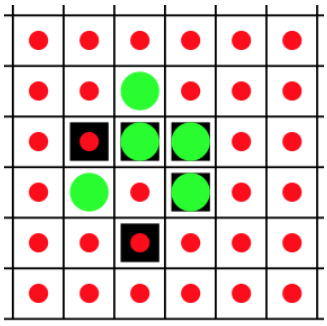

Figure 3: $\cdots$ Behind The Curtain

4 Concluding Remarks

Serendipity too often is given credit for uncovering the greatest of scientific insights and discoveries. Every competent physicist knows the value of creative, "unstructured" thought needed to generate scientific insights or to prepare for discovering new unexplored "territory". Henry David Thoreau said it best, "I took a walk in the woods and came out taller than the trees." Taking a walk in the woods is a normal part of the creative process and serendipity is just another term for having a well prepared mind for the task.

In the ***Game of Life*** analogy I have stressed the fact that the rules are constructed and we can, at best, only infer that the true rules must be consistent with what we have, so far, observed.

So while the above may not be satisfying, consider:

We observe and theorize laws of nature and use these laws to predict and "explain" all manner of phenomenon. At no time have we ever uncovered any "proof" the rules are really as they appear. We must deal with the knowledge that we might never know the actual rules $\cdots$ ever $\cdots$