THE UNREASONABLE PERSISTENCE OF QUESTIONABLE PHYSICAL DOCTRINE

Evert Jan Post
7933 Breen Ave, Westchester, CA 90045-3357

abstract: The developments of theoretical physics in this century can be subdivided in four major separate time intervals, each taking roughly twenty five years to come to fruition or the lack thereof. The first two quartiles maintain close relations to already existing theory, whereas the last two quartiles are becoming more divorced from existing concepts of understanding. Unlike the highlights of experimental discoveries, theory in those same years reveals a strange recurrence of doctrines that have proven ineffective.

Criteria for Subdividing Eras of Development

In any realm of human endeavor it is natural to look for patterns how certain key ideas initiate waves of developments until the harvest of results begins to simmer down. By that time a new idea comes into public focus diverting attention away from diminishing returns of previous ideas. A new wave of development is about to begin.

Events of this kind have happened a few times this century. They are spaced in intervals corresponding roughly to periods in which leading persons have held office in positions of consequence. Even if the here cited periods don't justify sweeping conclusion, in the sense of "and so ad infinitum," it remains instructive to list those happenings.

So, let us look at the effectiveness of subsequent waves of development. Closer scrutiny reveals a strongly modulated effectiveness. Some results are quantitative and precise, others are qualitative, concerned with methods of classifying an abundance of experimental observations. Finally there are those efforts on the verge of establishing a contact with physical reality, but not making the grade.

The twentieth century has seen two major developments, which traditionally fall under the headings quantum theory and relativity. Since relativity is more remote from everyday physics, let us examine here quanta, because they provide more to compare.

A Short History of Quanta Observation

The earliest quantum discovery really goes back to the verification of the existence of a universal unit of electric charge. Faraday's law of electrolytic deposits gave a first indication of the existence of nature's first quantum as associated with electric charge. Only as late as 1909 has a direct verification been made by Millikan with his famous oil-drop experiment.

The emergence of a quantum of electric charge did not really initiate a new era of physics, because the world of chemistry had conditioned us already to accept a discreteness of matter. So it did not come so totally unexpected that charge as a matter associated thing could be a really uniquely discrete thing.

The next quantum calling on public recognition was much more abstract. Planck discovered that a physically realistic law of heat radiation demanded an energy subdivision in small quanta ¡ø. The small constant ¡ has the dimension of action with ø the associated angular frequency of radiation. Unlike the quantum of electricity ±e, the new quantum of action ±¡ would cause a major revolution.

The law of conservation of electric charge seems closely related to the discreteness of charge. It is easier visualized as a global integral law than as a local differential law. In the latter case the discreteness of charge clashes with the exigencies of calculus. Yet unless one directly deals with the discreteness, it is customary to honor also the differential law of conservation. Since it appears that all known charge creating processes create opposite polarities in equal amounts, the phenomenon of charge creation is not seen as a violation of the law of net charge conservation.

Unlike charge conservation, there is no such thing as an accepted law of action conservation. The action integrals are either one-dimensional for particles or four-dimensional for fields, both are required to retain stationary values. Yet the latter condition is not normally construed as an expression of action conservation. There is no such thing as a differential statement of action continuity or conservation if you will. Depending on levels of admissible mathematical sophistication it is either accepted as not existing or it is proven not to exist. This reveals action to be an intrinsically global concept. Similar as in the case of charge creation, action seems created in equal amounts of opposite "polarity", as indicated by a notation ±¡ or ±h.

As late as the Sixties did experimenters[1] discover the existence of magnetic flux quanta of magnitude h/2e. The possibility of such quanta had been suggested in the Thirties by Fritz London.[2] The flux quantum is an example of a quantity that can be said to obey local and global conservation: *i.e.*, Faraday-Maxwell's induction law. Soon an electric equivalent of the magnetic flux was identified; it manifests itself explicitly in the Josephson ac effect as a time integral of an electric potential over one period.(refs. 10&13)

In the Eighties it was experimentally discovered that the Hall impedance[3] could be quantized in rational fractions of h/e^2. No theoretical predictions had been made to this effect. In fact, presently its theory is not at all a closed chapter of physics.

Yet, notwithstanding theory lagging behind the reality of experiment, there is agreement that the very simple formulas describing Josephson ac and quantum Hall effects are expressing extremely fundamental quantum features. Their combined measurements lead to values for e and h reproducible to nine decimal places. Earlier e and h data extracted from more complicated spectral calculations and subsequent observations can't really compete with that precision.

A Short History of Quantum Tools

Since the best measured data about quanta come from relations that are only marginally backed by what is currently regarded as official Quantum Mechanics and its offshoot Quantum Electro-Dynamics QED, a brief history and description of the tools is in order.

First Quartile Planck and Bohr-Sommerfeld

The first twenty five years of quantum theory culminated in a technique of quantizing the phase integrals of analytical mechanics. This method left standard analytical mechanics completely intact, except that the integration constants were found to be restricted to multiples of h. In a little known paper Einstein[4] pointed out how the quantized phase integrals determined topological characteristics of the orbital manifold created by those solutions. These quantized phase integrals became known as the Bohr-Sommerfeld conditions. They summarized in a very attractive and elegant manner the earlier more ad hoc quantization recipes used by Planck, Einstein and Bohr. Sommerfeld's famous calculation of the fine structure of the hydrogen atom may well be regarded as a high point of its achievements.

Second Quartile QM and QED

The Bohr-Sommerfeld process produced results in near-perfect agreement with observation. Even the Stark effect could be so described by using the familiar methods of perturbation theory. For the Zeeman effect these methods turned out to be partially successful. The so-called anomalous Zeeman effect sadly escaped the Sommerfeld method. New insights were needed to incorporate those anomalies.

An initially step by step process exploded into what was going to be the next twenty five years of developments. The initial phase seemed completed in less than five years. First Compton and Kronig and then later Uhlenbeck-Goudsmit explicitly postulated the existence of an electron spin and magnetic moment as a possible key to the Zeeman anomalies. Yet, at this point, theorists, now dissatisfied with Sommerfeld's semi-classical procedure, came up with very drastic changes in the theoretical machinery that was to be applied to atomic systems.

Parallel efforts by Heisenberg, Schroedinger and Dirac led to what is now known as the wave equation approach. The Dirac version, which was designed to cope with the premises of special relativity, produced what was seen as a natural evidence for the existence of electron spin and magnetic moment.

These were probably some of the most amazing years of theoretical development in the history of physics. The Dirac equation not only reproduced the Sommerfeld fine structure for zero external magnetic field, it also gave the Zeeman anomaly in the presence of a magnetic field.* The most unusual success of this sequence of developments may have been responsible for an in part undue emphasis in relating these new tools (or 'recipes' as some would say) to fundamental theory. Sommerfeld, who had been a champion of the phase integral method, soon became also a champion of the "wave" method.

---

*While the Dirac equations yield electron spin and moment, the energy interaction term of the magnetic moment drops out if the external field is absent. This fact can be appreciated as an, at least, formal account of why Sommerfeld and Dirac processes give the same fine structure. Yet, Pauli showed, the fine structure as due to an interaction of spin moment and an orbitally generated magnetic field. Sommerfeld and Dirac both mysteriously account for the fine structure, yet without an explicit electron moment! The Pauli method permits an explicit account of the moment anomaly and yields the more precise answers for the fine structure. (see ref.13)

The remaining years of this quartile were spent on further scrutiny of new microwave measurements of small Hydrogen level shifts. They showed that the Dirac equations could not be a last word for obtaining exact data about the hydrogen spectrum and the electron's magnetic moment. A Thirties' offshoot of quantum mechanics, earlier referred to as QED, which had been suffering of unexplained infinities, was finally beginning to show promise. People learned to deal with the infinities and obtained meaningful finite answers. At the end of this second quartile, calculations of the Lamb shift of hydrogen and the electron's anomalous moment rewarded these heroic efforts with success in the early Fifties.

In the course of time these complicated higher order corrections of the hydrogen spectrum were then used in conjunction with very accurate spectral observations in the hope of so obtaining more accurate data for h and e. The at first promising expectations were not fulfilled. By the Eighties the more precise and accurate data came from Josephson- and quantum Hall effects. All of this indicated that the simple expressions obeyed by these macroscopic effects (even if not well justified by standard theory) might be closer to fundamentals of quantization than the far more complicated formula describing spectral behavior.

Third Quartile Particle Classification and QCD

In the meantime accelerator experiments had been yielding a treasure house of data about a great variety of elementary particles. This wealth of information called for ordering. The group methods of the *eight fold way* have been helpful in this endeavor.

While the methods of the first two quartiles centered around very pronounced quantitative ambitions that were in many ways realized, the third quartile is much more qualitative in nature. The methods of this era have been named Quantum Chromo Dynamics (QCD).

Not all the basic items and concepts proposed in the Chromodynamic context have been physically identified. This holds for most of the quarks. Opinions are still marginal and somewhat divided as to whether or not those that have been said to be identified have been really identified. The for ever evasive magnetic monopoles are still being mentioned as having a conceivable role in this realm. Very extensive efforts to experimentally identify these monopoles have been unsuccessful,[5] now two decades later they still are.

QCD attempts to order a multitude of particles observed in the world's accelerators. It does so by creating more particles many of which are not observed. This philosophy of interpreting existing particles in terms of hypothetical components makes the impression of yielding diminishing returns. All particle pictures considered in QCD have remained the topological equivalents of simply connected "colored" spheres, one might consider more fancy structures that conceivably could link and intertwine with one another with the purpose of creating new observed entities. It is not yet clear whether the next phase of physical research, called String theory, has anything to do with such objectives. Here topology in higher dimensional realms is making an appearance. It is not clear at this moment whether these higher dimensionally intertwined structures will descend into the realm where ordinary mortals are trying to see what is head or tail.

Fourth Quartile Strings

From QCD onwards, sometime in the Seventies, physics may have entered the fourth quartile of this century. It has gone in the direction of greater abstractness rather than seeking contact with that part of experimental reality that has been yielding the more impressive quantitative results. Yet, time has told us many times to consider that what is to be regarded as substantive often remains in the eye of the beholder, at least for the time being.

The theory or theories of Strings are examples. Although there is a hope of ultimately establishing a contact with the reality of nature, so far that contact has not been forthcoming. At least that is what a recent review article reports.[6] When its author Polchinsky raises the question when String theory will be able to make sharp predictions, the answer given is: not for a while; which is sort of disturbing for a theoretical discipline that claims in 1996 to have been around for more than twenty five years.

It is said that first the vacuum has to be better understood. Perhaps earlier investigators have filled the vacuum with too many things that have not been proven to exist. Reading further in ref.6 one finds that amazingly String theory still continues holding out hope for the existence of magnetic monopoles.

It is strange indeed if a highly mathematical theory invoking sophisticated notions relating to

topology in higher dimensions fails in applying those very same principles to every day realistic physical experiences in space and time. Unlike magnetic monopole quanta, magnetic flux quanta, by contrast, have been well established physical entities since the early Sixties.[1]

The **closed** differential 1-form whose residues are observable flux quanta has an exterior derivative that defines an **exact** differential 2-form defined by the electric field **E** and magnetic induction **B**. The latter being exact cannot have nonzero residues *i.e.,* no magnetic monopoles! For decades QCD and String people have now been preaching a gospel honoring a motto that says: "Have your cake and eat it too!" [**]

In the past, objections to such pocedures have been made over and again without eliciting even a response. This situation testifies to a deliberate absence of open communication. In fact, this lack of open exchange spills accross the disciplinary boundaries. Physicists have managed to find mathematical counsel backing their contradictory position.

If String theory ventures into more sophisticated topological structures, the point is well taken. Perhaps one of these days those higher dimensional structures will descend in the realm of space and time where ordinary mortals live. By that time it may come to pass that the nether regions of (Super) String theory have learned to comply with the realities of life such as revealed to ordinary mortals.

Physics' Confrontation with Philosophy

A long time ago some Greek philosophers served poor counsel to experimental inquirers of their time. Modern physics still has not forgotten and has never forgiven this sample of unintended misguidance. Ask any contemporary physicists about philosophy and physics and the chances are many let it be known that they cannot afford to indulge in such activities.

[**] The issue of monopoles versus magnetic flux quantization invites a use of basic principles of differential topology. Since flux quantization is a confirmed fact of nature, the alternative of magnetic monopoles is excluded. If, conversely, monopoles were to exist, they would have to be residues of a 2-form, which could not be exact and not derivable from a 1-form governing flux residues. Hence a theory of flux residues would fall flat, which contradicts existing experiences. **In avoiding this alternative one cannot make a 2--form one time closed and another time exact, that contradicts the global definitions of the very uniquely distinguished concepts of closed and exact.**

All the while philosophy has had ample time to mend its erring ways. As in physics they have been making subdivisions. The ones that come to mind as cogent to the present situation in physics deal with the theory of knowledge. Modern philosophy makes a distinction between *ontology* and *epistemology*. The adjectives pertaining to the activities denoted by these nouns are *ontic* and *epistemic*. Zerin[7] has given a for the present purpose delightfully succinct definitions of these two aspects of knowing:

Ontology and ontic refer to what we know, epistemology and epistemic refer to how we know what we know.

It seems knowledge theorists have been studying contemporary physicist behavior by coming up with a picture made to measure for the developments here depicted. Philosophers are not only showing they have been mending their ways over the last two millennia, their perception almost reveals a sentiment of gentle but sweet revenge for centuries of disdain.

Looking at QCD and Strings, one senses a work atmosphere of ontic isolation, even ontic despair if you will. There is a hunkering for finding out where it will go. However, finding out where it will go, it helps to know first where it came from. Physics is now paying for a past in which it was not interested where things came from. It testifies to ontics going it alone and losing contact with epistemics. It can hardly be denied, modern research has an overly strong ontic orientation ruled by the **brutal motto**: **Results, never mind where they come from.**

The truth of the matter is ontic and epistemic elements need one another in order to go hand in hand. Physics became spoiled by brilliant ontic recipes. In the long run, **the ontic isolation of the Schroedinger-Dirac methodology failed to make epistemic contact.**[#] Instead of counting such blessings produced by lucky recipes, physics pursued a path of more ontic adventure greedily groping for new revealing recipes. Probability gives small odds for such jackpot surprises to come about.

Even if serendipity has had and will always have a role in science, it is not an item to be made into a trusted element of every day life, unless, of course, lotteries, stock markets and other forms of gambling addiction are going to take over the world.

[#] The Copenhagen view blocks this epistemic contact.

Gambling might be called the epitome of an exclusively ontic life style. Yet even here an epistemic element emerged, because gamblers stimulated the first ideas for a mathematical theory of probability. The ensuing insights should have cured their addiction.

An essay writer[8] on science has recently interviewed a number of physicists. The results show a certain measure of emotional unbalance about the subject matter. Perhaps the interviewees let go of some spur-of-the-moment sentiments, yet somehow reflecting current attitudes. Here are some signs of a physics entrapped in self-adulation; a pass-time that easily creates vulnerability.

Conclusion

The conceptual framework of contemporary physical theory that comes across from the preceding sections is a strange mixture of justifiable pride but also arrogance. Disciplines, groping for ontic escapes, reveal their desperate need for epistemic order with idle references to theories of everything. Past unparalleled ontic successes of quantum mechanics are still blinding realist views of the present. Physics has been driven to duplicate these earlier successes, similarly as gamblers keep returning to their lucky number.

Physics needs to assess whether what it has learned over the past half century from high energy physics measures up against the achievements in general physics. Among the latter may be listed:

1. The Mössbauer effect[9]
2. The discovery of flux quanta[1]
3. The Josephson effects[10]
4. The Quantum Hall effect[3]
5. Gyromagnetic measurements on single electrons and muons in Penningtraps.[11]
6. The single photon and electron incidences build- up of interference patterns.[12]

Four of these six high lights in the realm of general physics have earned Nobel Awards. The existence of flux quanta was predicted in the Thirties. Their existence at half the predicted value was simultaneously confirmed by German and US teams of researchers.

For high energy physics, knowledge of electrons, muons, neutrinos, pions and protons has been greatly enhanced. They were made more precise during this time. Yet, much of that knowledge (less precise) was available half a century ago. High lights of high energy physics have been identifications of particles generated by the ever more powerful accelerators. These are checks on existing classification schemes

Note that three of the five major events in general physics had been somewhat anticipated The others were the result of serendipity and their delineation in terms of standard theory is still causing problems. Yet the very simple relations adopted for Josephson and Quantum Hall effect have given far better fundamental data of h and e than the spectral observations leading to h and e via combinations of Dirac-theory and QED.

These are facts of life that send a message about the tenability of the contemporary paradigms of physical theory. I hereby respectfully submit that the following doctrines of modern physics are defective and due for a serious reevaluation:

I Copenhagen's single system thesis assigns a zero-point energy to individual harmonic oscillators, which in turn leads to QED infinities. Planck knew how to avoid that!

II The wave-particle duality compares things that are fundamentally incomparable. Orthonormal decompositions indicate that the mathematical artifact, called wave, always retains an intrinsic plurality connotation, which is not comparable to a singular item. There is at best a many particle-wave duality!

III Magnetic monopoles are incompatible with flux quantization. Since flux quanta have been observed, magnetic monopoles fly in the face of physical reality.

IV The public deserves to know: how many quarks and gluons have been suggested and how many have now been truly observed?

V To the extend that it can be understood as a physical theory, (Super) String theory will have to consider a basic inadequacy now that it came up with a spacetime topology admitting magnetic monopoles.

The science essay writer Horgan[8] has recently interviewed a number of leading physicists. Even if an analysis in depth of technical matters is bound to be limited in an essay context, the depth of profiling of the characters of the personalities involved more than makes up for shortcomings in physical substance. Several of these leaders display measures of unbalance with respect to their beloved subject matter. Perhaps interviewees let go of spur-of-the-moment sentiments, which somehow reflect current attitudes. Here are signs of a physics entrapped in self-adulation; a pass-time that easily creates vulnerability.

One would think, anything making attempts at pinpointing predicaments, such as created by the items I, II, III, IV,V listed in this conclusion, better be prepared to weather the impact of a confrontation with an establishment defending its turf with a vengeance.

Yet, none of this happened. All these points have been listed earlier in the literature as isolated items. By virtue of this fact they have passed some preliminary stages of review. For the purpose of an enhanced impact, it was thought to have them collected in a 1995 monograph.[13] In the two years that have gone by since, no acknowledgment has been forthcoming that any of these five points constitute a valid argument to reconsider existing doctrine.

Has our physics establishment, and the principles it stands for, become so perfect and self-contained that it is a foregone conclusion that any confrontation is expected to be decided in favor of existing establishment views? Horgan's profiles and the title of his essay[8] provide a haunting testimony of intellectual inbreeding, which is getting too close to reality for comfort.

References

1 W M Fairbank and B S Deaver, Phys. Rev. Lett.**7**, 43(1961); R Doll and M Naebauer, Phys. Rev. Lett.**7,** 51(1961)
2 F London, *Superfluids I* (New York, 1950)p152
3 K von Klitzing, G Dorda and M Pepper, Phys. Rev. Lett.**45**,494(1960)
4 A Einstein, Verh. Dtsch. Phys. Ges.**19**, 82(1917)
5 E J Post , Phys. Rev.**D9**,3379(1974)
6 J Polchinski, Rev. Mod. Phys.**68**,1254(1996)
7 E Zerin, Transactional Analysis J.**25**,150(1995)
8 J Horgan, *The End of Science* (Addison-Wesley, Reading, 1996)
9 R L Mössbauer, Z. Physik **151**, 124 (1958)
10 B D Josephson, Physics Letters **1**,251 (1962)
11 H Dehmelt et al, Phys. Rev., **D 34**,722(1986); Phys. Rev. Lett., **59**, 2(1987)
12 A Tonomura, J Endo, T Matsuda, and T Kawasaki, Am. J. of Phys.**57**, 117 (1989)
13 E J Post, *Quantum Reprogramming* (Kluwer, Dordrecht, Boston 1995) BSPS 181.