Scientific
Research
Publishing

The Energy Conservation Paradox of Quantum Physics

V. E. Shapiro

Shapiro Physics, Vancouver, Canada
Email: vshapiro@triumf.ca

Abstract

This work asserts that quantum theory runs into a fundamental conflict with the principles of energy conservation inferred from the statistical evolution of interacting systems. The gist is the energy of systems by the principles of Lagrangian mechanics leaves out of account their energy associated with the phase flows of non-invariant phase volume. The quantum theory takes this fact into account, but does that improperly. We show it by presenting insoluble inconsistencies and a case study.

1. Introduction

The conservation of energy/matter via transformations is in the heart of physics, its unifying guideline. It relies on the fact that the established consistent pattern formation of the world around us is basically relaxation to recurrent states of rest and motion stable against ambient chaos. But with these attributes the notion of energy assumed in line with the principles of analytical formalism going back to Euler and Lagrange leaves out of account a complementary energy, we called it vortex energy, that makes an essential part of the whole of systems energy. It exhibits in systems phase space by flows with broken phase volume invariance (Liouville theorem), indecomposable into invariant-volume flows. The notion of vortex energy was introduced into energy perception in [1] [2].

An evident example of conserved vortex energy is the energy of rigid bodies rolling without sliding on a plane. This and overwhelmingly diverse mechanics of phenomena inherit constraints on the motion not reducible to independent variations of generalized coordinates of the systems. Such constraints called nonholonomic by Hertz [3]-[5] are not integrable. They violate the variation principle of stationary action and the associated energy decomposition formalism; in terms of kinetic rates they emerge as the limit opposite to detailed

balance-utmost strong friction causing the nonholonomy of zero-time relaxation. The same no less applies to the world of systems evolution with diffusion and relaxation of finite rates beyond detailed balance.

The vortex form of energy accounts for these factors. The process of breaking trends of phase volume invariance can be viewed as due to the nonlinear cumulative effect of ambient chaos. Given that quantum physics is postulated as inherent in trends beyond that of systems governed by a classical Hamiltonian, it is imperative for this physics to be within that of vortex energy realm [2]. Our conclusion refutes the beliefs banning the classical routes to the realms called quantum, unveils their vortex nature related to irreversible processes. But what is more, and will be questioned below, is the steadfast adherence of quantum theory to the principles of energy conservation.

2. Problem Setting

The quantum theory assumes existing an ideal where the evolution of systems is described by a wave function $\psi(z,t)$ obeying Schroedinger equation

$$ih\partial\psi/\partial t = \hat{H}\psi, \tag{1}$$

its Cauchy problem with suitable boundary conditions and governed by a quantum Hamiltonian $\hat{H}$, a Hermitian operator having noncommuting terms bound to Planck's constant h; $i^2 = -1$, and the absolute value $|\psi|^2$ is taken for the density of statistical distribution of systems states z at instant t. With the observable values of $\hat{H}$ defined in this quantum ideal in Dirac's notation as the averages

$$\langle\hat{H}\rangle = \langle\psi|\hat{H}(\hat{z})|\psi\rangle, \tag{2}$$

and with all other observable system's properties defined like in (2) where the explicitly written $\hat{H}$ is replaced by Hermitian operators associated with observables, the eigen spectrum of $\hat{H}$ governing the evolution of ψ is assigned the observable measure of energy.

While the evolution governed by a classic Hamiltonian, or a function of it within the concept of generalized thermodynamic potential [6] and the wider concept in [1] [2], is reversible and preserves phase volume invariance, it is clear that the distribution $|\psi|^2$ may not preserve these features when $\psi(z,t)$ is continuously diverged by noncommuting operations. But where is a niche for all this quantum ideal in the vortex energy realm?

We shall go into that of given by the statistical distribution function, $\rho(z,t)$, smooth in the same phase space as $|\psi|^2$ and obeying a general continuity equation

$$\partial\rho/\partial t = -div(\hat{v}\rho) = [H,\rho] + I, \tag{3}$$

its Cauchy problem under the same natural boundary conditions. Similarly to the evolution of $|\psi|^2$, the terms in (3) and the solution to it are assumed existing, preserve $\rho \geq 0$ and normalization $\int\rho d\Gamma = 1$ over the same phase space Γ of system variables $z = \{x_i, p_i\}$, a set of n pairs of generalized coordinates x and momenta p. The term $\hat{v}\rho$ in (3) is the flux density of phase fluid, a $2n$-vector functional of ρ non-anticipating and nonlocal in z with $\hat{v}$ an integro-differential operator of phase fluid velocity. $H = H(z,t)$ with $[,]$ a Poisson bracket

$$[a,b] = \sum[(\partial a/\partial x_i)(\partial b/\partial y_i) - (\partial a/\partial y_i)(\partial b/\partial x_i)] \tag{4}$$

(summing is over all i's of n) is a Hamiltonian governing an arbitrary chosen ideal of phase fluid flow in Γ, ideal in the sense that $\hat{v}$ reduces then to a vortex-free field of instant velocities $v(z,t) = [z,H]$, for then $div[z,H] \equiv 0$. The functional $I = I[\rho]$ embodies the constraints beyond this ideal, including terms of irreversible drift and diffusion. Continuous systems and relativism can be treated with n taken unlimited and t the time of a single observer.

3. The Domain of Vortex Energy

Since the Poisson bracket expressions $[a,b]$ and phase volumes are invariant under canonical transformations,

so the terms $\partial\rho/\partial t$ and I of (3) are. But the evolution of ρ by Equation (3) and these terms are in effect invariant only in the case of the ideal where I comes down to a Poisson bracket $[H',\rho]$ with H' a function of z, t, thus making the sum $\mathrm{H} = H + H'$ a generalized potential (a dressed Hamiltonian) governing the system. Obviously it is not the patches beyond this ideal that are rare in reality, it is the patches of ideal. Beyond this ideal, the terms $[H',\rho]$, I and $\partial\rho/\partial t$ are hardly invariant and cause persistent flows already in the very stationary conditions of energy conservation, where Equation (2) is autonomous (see [2]). Such autonomy offers a clearer view of the vortex energy realm versus the quantum postulates by (1), (2). Below we shall concentrate on this case.

The realm of the classical ideal in point is then the domain of stationary vortex-free phase fluid flows of density $\rho(z) = \rho(\mathrm{H}(z))$ with $\partial\rho/\partial\mathrm{H} \leq 0$ and H bound from below for stability. This necessitates rigid constraints on I: the irreversible drift and diffusion must then be in detailed balance-tend to zero in self-compensation for each of all n degrees of system freedom. As diffusion means sources, the irreversible drift is to be sinks, dissipation, cause relaxation to the state of ideal. In conditions of energy conservation beyond detailed balance, the irreversible drift and diffusion inevitably cause persistent (not entrained in stationary chaos on the average) phase fluid flows.

An exotic example of such imbalance is the systems with non-holonomic constraints that do no work on each of n degrees of systems freedom; it can be viewed as a limit of zeroth diffusion and utmost strong friction, *i.e.*, zero-time relaxation causing the non-holonomy. Both this limit and a general imbalance between the irreversible drift and diffusion of finite rates, which do work on the system, but in a way of zeroth total work on the system, are within the realm of vortex energy. This encompasses all conditions of conserved vortex energy realm with its persistent flows of phase fluid within autonomic Equation (3).

Let us now juxtapose the outlined realm of vortex energy with that of density distribution $|\psi|^2$ for the quantum-ideal problem statement.

4. Fundamental Contradictions

The quantum theory is indissolubly related to the uncertainty principle, hence, its domain is to be beyond the purely dynamical non-holonomic systems of zeroth diffusion. The quantum phenomena to be observed as recurrent against ambient chaos suppose conditions of relaxation, stability and ergodicity, and all that, if this were the case, would be only in the vortex energy realm beyond the ideal nonholonomy. But there is no niche for the systems having discrete energy spectrum of states in the vortex energy realm of diffusion and relaxation of finite rates: finite rates inevitably cause spectra of finite line-widths.

So, the inherent hallmarks that together constitute the notion of quantum ideal have no niche in whatever autonomic conditions in question. It means that the quantum ideal construction fails as a rigorously defined bridge to energy conservation observations, appears without footing beyond the classic ideal. These things are verities when treating the states of quantum systems as a mixture of pure states each given a statistical weight in the sense used in classics, *i.e.*, resorting to a semi-classical approach to the irreversible kinetics and the concept of entropy.

Along with the incompatibility set-forth above, the following basic inconsistency takes place. Its crucial point is the density distribution $|\psi|^2$ of the quantum ideal, its pure states, is independent of t in autonomic conditions. The solutions to autonomic (3) in detailed balance are also independent of t as then $\rho = \rho(\mathrm{H}(z))$, and it is assumed so in the semi-classics modeling in question. However, the conditions of energy conservation of autonomic Equation (3) beyond detailed balance is another story and makes a difference.

Thereat, it is not just that $\partial\rho/\partial t \neq 0$ in (3) links to imbalance, it is the variations (correlations) between densities of phase fluid at different t's is a matter of principle, signifies persistent flows of fluid as observable in the (z,t) space of systems in the stationary realm of vortex energy. So, while t-dependent phenomena in stationary outer conditions are usually referred to non-equilibria, this is not the case of vortex energy realm, where it is just the equilibrium states of motion with conserved energy [2]. The persistent flows in point can be fast and stable depending on conditions of self-sustained imbalance. It is largely admitted of a test.

The same should be expected from the quantum phenomena, including its ideal by (1) and (2) for $\hat{H}$ independent of t. However, since $\psi(z,t)$ reduces then to a sum

$$\psi(z,t) = \sum e^{-i\lambda_k t}\psi_k(z) \tag{5}$$

over the basis of orthogonal eigen-functions $\{\psi_k(z)\}$ of $\hat{H}$ with reals $\{\lambda_k\}$ its eigen values, it yields vanishing temporal variations of $|\psi|^2$ in pure states. The null variance means that the energy of a pure state cannot be associated with circulating vortex energy conserved in the system, never represents its energy level. This is the point.

It cannot be otherwise, since the vortex energy as a function (generally a functional) dual to that of given by a function of states inherent in flows of invariant phase volume is integral, indecomposable into flows of invariant volume. To identify persistent currents with a pure quantum state, a ground state or some other state, is not viable in this sense. It pertains to the symmetry in space-time and balance theorems of quantum theory going back to Heitler, Coester, Watanabe [7]-[9]. Treating the pure states of quantum systems as statistically independent, of random phases and this or that statistics of quantum energy spectrum levels treated as energy levels, appears a theory also lacking steadfast adherence to the vortex energy realm of energy conservation.

5. Case Study

A telling example is the much-used Manley-Rowe power-frequency relations of nonlinear wave-mixing. Proved first ad hoc for classical resonant systems of nonlinear capacitors and inductors [10], these relations are accepted since then widely, see review [11], as intrinsic also in the quantum energy transfer and stemming from its theory, e.g. [12] [13]. For a three-level quantum scheme the relations mean

$$N_{12} + N_{13} = 0 \text{ and } N_{21} + N_{23} = 0 \tag{6}$$

where $N_{ij} = -N_{ji}$ is the number of quanta per second going from level i to level j, the energy in each quantum is hf with f the frequency of the transition, so $N_{12}hf_{12}$ is construed as the power in frequency f_{12}. The general multi-level relations are commonly reasoned analogously-as equivalent of two principles, that of energy conservation and that of detailed balance.

However, the two principles are in contradiction, not in the least compatible beyond the classic limit, since detailed balance is referred there to balance between quantum energy levels, hence, beyond the realm of energy conception where each level is a measurable energy state. The mistaken view is detrimental to search for new methods of wave mixing.

It has a direct bearing also on the popular concept of quasi-energy for the systems in high frequency fields. The averaged impact of hf fields reduces then to that of an effective potential. Treated classically the concept completely abstracts away of the vortex energy, which appears in the long run particularly incorrect for the phenomena of laser cooling and trapping in optics and other hf fields, see [1] [2]. Treated by quantum theory or semi-classically, it does not clear up the trouble while adds new ones.

A telling example is also the concept of quantum computers, since its quantum principle is untenable, in complete dependence of the quantum ideal in question. There, as well as in many other things, forming conclusions based on quantum principles needs correction. It includes the entropy concepts for reasoning of stability of systems in vortex energy realm; the unfit of classical entropy concepts there was noted in [2].

6. Resume

The contradictions unveiled raise fundamental questions about the whole point of energy and matter—its integral, cumulative bond with the ambient chaos. We addressed here one of its basic aspects, the quantum energy transfer, and have shown that its theory appears in an insoluble conflict with the energy conservation principles which the phenomena called quantum really display. Really they display the energy duality with respect to phase volume invariance, while quantum postulates depart from its principles.

The alternative, keep putting the quantum postulates as a guiding idea above all, appears fraught with depriving the physics based on energy of tangible ground based on work done by the systems. Proving the contradictions, the term vortex energy was invoked for classification, but with its principles we have provided the stuff for rethinking the conventional practice.

References

[1]   Shapiro, V.E. (2008) *Physics Letters A*, **372**, 6087-6093. http://dx.doi.org/10.1016/j.physleta.2008.08.016

[2] Shapiro, V.E. (2014) Energy Theory: The Vortex Nature of Quantum Physics. Kirensky Institute of Physics, Russian Akad. of Sciences, Krasnoyarsk.

[3] Hertz, H.R. (1899) The Principles of Mechanics Presented in a New Form. English Transl, Macmillan, London.

[4] Appell, P. (1893-1896) Traité de Mécanique Rationnelle. 4 Vols, 3rd Edition, Gauthier-Villars, Paris.

[5] Neimark, Yu.I. and Fufaev, N.A. (1967) Dinamika Negolonomnih Systems. Nauka, Moscow.

[6] Graham, R. and Haken, H. (1971) *Zeitschrift für Physik*, **243**, 289-302. http://dx.doi.org/10.1007/BF01394858

[7] Heitler, W. (1957) Quantum Theory of Radiation. 3rd Edition, Oxford University Press, London.

[8] Coester, F. (1951) *Physical Review*, **84**, 1259. http://dx.doi.org/10.1103/PhysRev.84.1259

[9] Watanabe, S. (1955) *Reviews of Modern Physics*, **27**, 26-39.

[10] Manley, J.M. and Rowe, H.E. (1956) *Proceedings of the Institute of Radio Engineers*, **44**, 904-913.

[11] Dodin, I.Y., Zhmoginov, A.I. and Fisch, N.J. (2008) *Physics Letters A*, **372**, 6094-6096. http://dx.doi.org/10.1016/j.physleta.2008.08.011

[12] Weiss, M.T. (1957) *Proceedings of the Institute of Radio Engineers*, **45**, 1012-1013.

[13] Schulz-Dubois, E.O. and Seidel, H. (1966) *Electronics Letters*, **2**, 24-25. http://dx.doi.org/10.1049/el:19660019