THE LAW OF POWER DEMANDS EXOTIC PARTICLES

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AMSTRACT

The examination of the mechanisms that could possibly underlie the perpetual steady energy currents - termed here the 'Halley-Power-Flows'- associated with the internal actions in inertial equilibrium systems shows that the Law of Power demands the existence of exotic particles.

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HALLEY'S PERPLEXITY

Pondering upon Newton's suggestion that since 'activity' – the term used in *Principia* for energy – is conserved it could have the attributes of substance, the astronomer Edmond Halley has an epiphanic revelation, in the author's science play *The Catherine Conspiracy: orThe Honest Relativity*, that at times the power of thousands of horses could be coursing through him as he rides at ease in his coach.

Halley's perplexity arises from his practice of pressing hard his feet against the footrest and reclining against the back of the seat while riding in his coach. As the coach moves his feet must do work upon the coach and continuously impart energy in accordance with the Law of Power : $dW/dt = \mathbf{v}.\mathbf{F}$. The back of the seat would similarly be doing work and imparting energy to Halley at the same rate. Thus a current of energy must flow through his body as the coach moves.

This current of energy can be of enormous proportions, for the motion has to be reckoned with respect to the Absolute Space. Even if Halley were exerting a moderate force of 10 Kg weight still when the coach is aligned along the motion of the Earth in its orbit, with the Sun being at rest, the velocity would be about 30 Km/sec and the power coursing through Halley's body would equal that of about 4000 horses. And, since the velocity of the Solar system is seen to be about 300 Km/sec from the cosmic background radiation anisotropy the flow of power would equal that of 40,000 horses – or 30 MW , when the coach is aligned along the direction of this motion.

Halley's perplexity certainly demands a resolution.

THE HALLEY-POWER-FLOWS

The Law of Power : $dW/dt = \mathbf{v}.\mathbf{F}$ is formally unexceptionable, but has an apparently bizarre consequence, requiring perpetual energy flows associated with the internal forces in an inertial equilibrium system - as revealed to Halley and termed the 'Halley-power-flows' here - even when the force is not transparently overcoming any resistance and nor is the state of uniform motion of the body upon which it acts is being changed by the action of the force.

This blatantly counterintuitive implication of the Law of Power is indeed difficult to accept without having some sensible mechanisms underlying the Halley-power-flows, and generating and maintaining the perpetual energy circulations.

We could eliminate this anomalous situation by reformulating the law of power as, $dW/dt = \mathbf{v}.d\mathbf{p}/dt$, so that no perpetual steady current of energy is associated with an internal force in an inertial equilibrium system.

However, in the Lorentz theory the rotational equilibrium of a rod, carrying equal and opposite charges at its two ends, and moving along a line inclined to its axis demands the existence of a Halley-power-flow, with energy possessing dynamical attributes, as has been discussed in the authors paper 'Work and Making Relativity Work', (NPA, 2007). It is also the dynamical effect of a Halley-power-flow that ensures rotational stability, and secures 'relativity' in the explanation of the 'Trouton and Noble experiment'.

The other alternative is to deny physicality to energy, as was the position in the Newtonian mechanics, but this militates against a large body of physical experience.

Nevertheless, even if the Law of Power were necessary in the present form, yet, for the understanding and credibility of the law, it is necessary to have some sensible mechanisms underlying it, the mechanisms that give rise to perpetual steady energy currents in inertial equilibrium systems.

We consider here the possible mechanisms that could make the Law of Power work. It is seen that the Law to be workable demands the existence of 'exotic' particles.

A KINETIC MECHANISM

First we consider an idealized simple situation where the Law of Power emerges naturally from the elementary mechanics.

The physical mechanism underlying the Halley-power-flows must conceivably be a kinetic one. A kinetic mechanism can indeed be conceived, and in a simple idealized situation it does provide a complete and consistent account of the Law of Power.

Suppose AB is a hollow circular metal cylinder, length L, closed at both the ends with metal disc-stoppers, and filled with a gas.

Suppose the molecules of the gas have rest-mass m , and that they execute to-and-fro motions between the two stoppers with velocities v parallel to the axis of the cylinder, without any collisions. Suppose the number of molecules that rebound at a stopper in a unit time is N. Using Roemerian units, with the velocity of light being unity, and using $\gamma(v) = 1/\sqrt{1-v^2}$, the momentum and the energy of a molecule are $\gamma(v).m.v$ and $\gamma(v).m$ respectively. Since the to-and-fro travel time for the molecules is $2.L/v$, the total number of molecules N_0 will be given by, $N_0 = 2.N.L/v$. At any instant half of them will be traveling in one direction, and the other half in the other. The total energy of the gas at any instant will be $\gamma(v).N.m$, and remains constant.

When a molecule rebounds elastically at a stopper its momentum changes by an amount $2.\gamma(v).m.v$, while there is no change in its energy. Since N molecules rebound per unit of time, the force exerted on the lid is given by, $F = 2.\gamma(v).m.v.N$, which would be the product of the pressure and the cross-sectional area of the cylinder.

The force exerted on the lid is in the outward direction, corresponding to a positive pressure, and the lid would be exerting an equal force in the inward and the opposite direction.

Now let the cylinder be set into a uniform rectilinear motion in the direction from A to B .

In this inertial state of motion the velocities of the molecules would no longer be equal in both the directions. They would be determined by the law of composition of velocities, and their energies and the momenta would also get velocity-modified accordingly. We shall denote by subscript (+) the dynamical attributes for the molecules traveling in the direction of the motion of the system, and by the subscript (-) those for the molecules moving in the opposite direction.

We have, $v_+ = (v+u)/(1+v.u)$ and $v_- = (v-u)/(1-v.u)$

With this, we also have, $\gamma(v_+) = \gamma(u).\gamma(v).(1+v.u)$ and $\gamma(v_-) = \gamma(u).\gamma(v).(1-v.u)$

Using these values, we have, $p_+ = m.\gamma(u).\gamma(v).(v+u)$ and $p_- = m.\gamma(u).\gamma(v).(v-u)$

Also, $E_+ = m.\gamma(u).\gamma(v).(1+v.u)$ and $E_- = m.\gamma(u).\gamma(v).(1-v.u)$

Taking into account the velocity-contraction of the length of the cylinder and its motion with velocity u , the time of to-and-fro travel increases to $\gamma(u).2.L/v$. This is the ballistic analogue of the 'Langevin clock', and a manifestation of the clock-retardation effect of motion.

The number of molecules rebounding per unit of time at an end lid is now $N/\gamma(u)$, and the change of momentum at a rebound is $(p_+ + p_-)$ i.e. $2.m.\gamma(u).\gamma(v).v$

Therefore, the inward force F* exerted by the lid is given by, $F* = 2.m.N.\gamma(v).v$

Similarly at each rebound at the trailing end A the energy of the molecule changes from E- to E+ , that is to say, an energy $2.m.\gamma(u).\gamma(v).v.u$ is added.

Therefore, the energy imparted to the gas by the lid per unit of time is given by,
$dW/dt = 2.m.N.\gamma(v).v.u = u.F*$

This is just the Law of Power.

Similarly, at each rebound at the leading end B the molecule would be loosing an equal amount of energy, which means that the lid at that end would be doing 'negative' work, which is as it should be for the inward force exerted by the lid at that end is in the direction opposite to the motion of the system. This 'negative' work, or the withdrawal of energy at the leading end B can be readily seen to be in accordance with the Law of Power.

The energy imparted at the end A, the source, will be traveling, along with the molecules carrying it, with the velocity $(u+v)/(1+u.v)$, and reaching the receding front end B, the sink, in time $\sqrt{1-u^2}.L/[(u+v)/(1+u.v)-u] = (L/v).\gamma(u).(1+u.v)$

This is the Halley-power-flow.

The energy of the gas is, $(1/2).N_0.(E_+ + E_-) = N_0.m\gamma(u).\gamma(v)$

The momentum of the gas is, $(1/2).N_0.(p_+ - p_-) = N_0.m.\gamma(u).\gamma(v).u$

This shows that the centre-of-mass motion is inertial with velocity u , as it should be.

The whole scheme is thus complete, self-consistent, validates the Law of Power, and exhibits explicitly the kinetic mechanism that underlies the Halley-power-flows.

This kinetic mechanism is so natural, straightforward, and requiring no other additional actions or processes that it is difficult to conceive that the Halley-power-flows could have any other basis.

All the above workings remain *mutatis mutandis* valid in the Newtonian mechanics, and the workings are in fact much simpler. But, since the energy is not a physical and dynamical entity in Newtonian mechanics, they are not of vital significance.

GENERAL FLUIDS

The situation considered thus far has been an idealized one, with the molecules executing to-and-fro motions independently without collisions.

However, it can be readily seen that if we suppose that the molecules undergo collisions, and the two colliding molecules exchange velocities, all the above deductions would remain valid.

Further, even if we suppose the gas molecules to have more random motions, it can be inferred from the kinetic theory of gases that the mechanism would still provide a justification of the Law of power, and provide a consistent explanation of the power flows.

The mechanism will similarly work with perfect fluids also.

It will also work with the confined mass of radiation. It may be noted that that the changes of energy and momenta at the rebounds with the two end lids correspond exactly to the changes of frequency and wave-length of the photons during the reflections at approaching and receding mirrors.

The situation is, however, more complex in the case of solids.

FLOW THROUGH A COMPRESSED SOLID.

Consider a solid metal bar AB held between the parallel plates of a press mounted on a horizontal platform at rest, and be subjected to compression by the two plates. Now, let the platform be set into a uniform motion with uniform velocity u in the direction from A to B. The force, say F, exerted by the plate at the end A will be doing positive work at the rate u.F per unit time, and imparting energy at the end A to the rod. The plate at the end B will be exerting equal and opposite force, doing negative work, and withdrawing energy at the rate u.F. Accordingly, there will be set up a steady current of energy flowing from A to B in the rod.

We may expect a similar mechanism to underlie this power-flow, following Newton's maxim: "The Nature is always consonant and conformable to herself."

However, the atoms constituting the bar are not freely mobile and are fixed at the nodes of the lattice and only execute small motions around those points. Therefore, the atoms of the solid cannot serve as the carriers of the energy flow.

Three other possibilities can nevertheless be conceived.

First, the solid contains mobile electrons, and they could possibly serve as the carriers.

Second, the vibrations of the lattice atoms generate phonons, which are akin to the radiation quanta, as studied in solid state quantum physics. These phonons could act as the carriers.

Third, the energy added as a result of the work done by the compressive forces could give rise to transient particles other than the phonons considered above, as the solid state physics studies are essentially confined to stress-free bodies. These new particles, that we may designate by a non-committal appellation 'ferryons', because for our present

purposes we are not concerned with their exact nature or properties, and require them only to ferry energy and momentum from one place to another as carriers.

This third possibility has a merit in that the mechanism is independent of the atoms of the body and need not disturb them. Thus the sensorium constituted by atoms would not be affected by the energy flow, and explain the fact that Halley does not become aware of the power of thousands of horses coursing through him.

Many detailed considerations would be necessary, and they will depend upon the physics of the solid body, but a kinetic mechanism on the lines discussed need not be impossible, and must, in fact, be conceived to operate.

Some further considerations, however, arise with the solid bodies in tension.

SOLIDS IN TENSION

Suppose the metal bar AB considered above is fitted with crossbars at the two ends A and B extending beyond the bar on both the sides, and that the bar is stretched by means of two screw-jacks placed between the extending crossbars on the two sides.

Let the assembly be set into a uniform rectilinear motion in the direction from A to B,

Here the force, say F, acting at the end A will be in the direction opposite to the motion, and will be doing negative work, while the equal force acting at B will be in the direction of motion and will be doing positive work upon the rod. Thus the Law of Power requires a flow of energy from the end B to the end A through the rod.

We could expect that the Halley-power-flow through the rod is generated and maintained by the kinetic mechanism, as the scheme is workable in all the other situations considered hitherto. However, there is a difficulty.

At the reversal of motion at the end A, where the motion opposite to the system-velocity is changed to motion in the direction of the system velocity, the 'ferryon' must suffer a change of momentum in the direction opposite to the direction of motion. This is clearly possible only if the rest-mass of the 'ferryon' is negative.

Thus the kinetic mechanism requires negative-mass particles for the Halley-flow through a solid body in tension.

No negative mass is known hitherto, but it is not *per se* inadmissible, since it is not a logical impossibility. Hermann Bondi showed that the concept is not necessarily inconsistent. Negative mass is in some places invoked in the context of black-hole radiation, string theories, ultra-low temperature physics, negative aether pressure for explaining Cassimir effect, etc. Our present discussion shows that such particles could be necessary even in common ordinary situations. It may be observed that in a certain sense tension in a solid does correspond to 'negative pressure'.

Nevertheless, before admitting such unknown particles we must explore possible alternatives.

COMPOSITE SYSTEMS

Alternatively we may consider the following scheme to avoid negative-mass particles.

While the bar AB is in tension the two screw-jacks are in compression, and an equal Halley-flow must occur through the two screw-jacks in the opposite direction. Therefore, we may suppose that the flow in the direction of motion through the screw-jacks is not generated by a confined 'ferryon' gas through the kinetic mechanism, but that a current of positive-energy 'ferryons', generated in response to the elastic stresses, flows through

the screw-jacks in the direction of the system-velocity, through the handles, and back through the bar in the direction opposite to the system-velocity, as is required. Thus in effect a steady energy circulation along a closed path is generated and maintained.

This proposal is certainly admissible, fully in order, and has the merit of avoiding introduction of the negative-mass particles.

Nevertheless the proposal is not free of difficulties. The rates at which energy and momentum are transferred are F.u and F respectively. Therefore (momentum/energy) ratio for the ferryon-current must be 1/u , which is greater than unity, since in the Roemerian system of units that we are using u is less than one.

Now such a current cannot be composed of subluminal particles.

Therefore, here the 'ferryons' must be supraluminal particles.

The theories of supraluminal 'tachyons' have been extensively studied. Whatever difficulties they may or may not have with relativity they are not logically impossible and cannot be denied admission. The above discussion indicates that the presence of supraluminal particles in inertial equilibrium systems is necessary for the operation of the Law of Power.

Further, there are situations where such a scheme would need some modifications.

MIXED COMPOSITE SYSTEMS

An inertial system could be composed of a solid part and another perfect fluid part. The system composed of the gas under pressure in a metal cylinder closed by metal lids at the two ends discussed earlier is of this nature.

Here the elementary dynamics of the gas molecules is itself sufficient for the working of the Law of Power, and no additional mechanism is either needed or admissible.

Therefore, in this case we cannot have a closed steady current, and must suppose that the 'ferryon' current is generated at the leading end stopper at B, flows back through the walls of the metal cylinder, which are in tension, and gets annihilated at the trailing end stopper at A

Thus, there must be a steady current of supraluminal 'ferryons' along an open path, along with continuous creation and annihilation processes at the two ends of the path.

EPILOGUE

The analyses and discussions so far have necessarily been broad and sketchy. In a general system the situation could be extremely complicated with internal stresses varying continuously. The elastomechanics of moving bodies at sufficiently deep level has not received much attention, and can provide a vast luxuriant field for theoretical and experimental explorations.

However, further detailed studies would not affect in essence the conclusions arrived at here from the basic considerations.

Therefore, it could be concluded that to be workable in the inertial equilibrium systems the Law of Power demands the existence and active involvement of 'exotic' particles.

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