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THE AXIOMATIC DRAMA OF CLASSICAL PHYSICS

SALUTATION: (Lecture opening)

Two dramas should be enacted tonight: that of axiomatic polarity in the physics of matter and motion, and that of your trying to penetrate the thoughts of Charles Bell.

America has hatched a funny notion of education: that as long as you are sorting over and expressing your own views, you are active; but as soon as a teacher opens up to tell you something, you become passive and your interest must flag.

On the contrary, there is no fiercer activity than the pursuit of what escapes you in the thought of another, of what used to be called a master.

As in physics, the sign of your acceleration must be a proportionate counterforce, which we will feel between us as salutary strain. How else would I know there was a fish on the line? Shall we not be fishers of men?

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PREVIEW:

Our drama is of axiomatic polarity in the physics of matter in motion. It pursues the question: "What is conserved through dynamic exchanges?" Although history blurs beginnings and endings, we begin with Leonardo on "Force...is a spiritual power...an active, incorporeal life..." The middle of our action swells through Galileo, Huyghens and Newton to Leibnitz' grasp of what we call The First Law of Thermodynamics, that Live Force (our energy) can be neither created nor destroyed. When, by axiomatic necessity, this pooling of active stuff as substratum of the universe, brings it to rest (Aristotle: "Surely the substratum cannot cause itself to move"), our drama ends with Carnot's Second Law -- specter of an energy which, like old Tithonus, cannot die, but always withers away: "consumed with that which it was nourished by." Thus no sooner is Leonardo's mystery of force summed under the logic of substance, than its clamming up is implied.

But since even this outline has invoked Aristotle, with what we have called "axiomatic necessity", the foreground drama must have a deeper underlay, a kind of metaphysical fate or Anangke.

Mostly we think of physics as empirical, not axiomatic. If we hang five steel balls, each from two threads so they swing in a single line, and with each touching the next, we can explore their motions (however the construction was made by someone who knew what he wanted to prove). When I pull the first ball out and drop it, some quantity of motion seems communicated through the chain, so that the last, on the other side, pops out with almost what the first brought in; and so it goes, push-me, pull-you -- but not quite: chaos creeps in; the pulse works less and less.

But that is already the history we outlined as enacted through the speculation of three centuries. Is physics so simple-minded? Almost, but not quite. Leibnitz' presentiment was that what is lost outwardly may be preserved (as heat) in the motions of the minute parts. Curious this insight should become the axiomatic noose on which (in Carnot) deathless energy settles toward its heat death.

As if whoever embarked in ignorance on an axiomatic field -- those Renaissance explorers, in the tipsy certainly of causal logic and algebraic consistency, formulating the vital ambience of the world -- must enact, swept on the cross-currents naively denied, the paradox and reversal of the a priori.

So conservation leads to decay, absolute motion to Relativity; causality hatches quantum indeterminacy; last,

mathematics, cornerstone of the whole, proves in Goedel its unprovability. From this larger cycle, we draw the sportive interlude of classical physics.

How subtly, in that action, the Tao and Yin-Yang complementarities, commonplace in the new physics, have enlivened the enterprise from the start.

FROM QUESTION TO METHOD:

What does it mean that Kant was able to draw from reason itself antinomies of "yes" and "no" to those four crucial questions of metaphysics? -- proving at once:

1) That the world has, and has not, a beginning in time and a limit in space;

2) That the composite must, and cannot be, made of simple parts;

3) That within the laws of nature there both is and is not a causality of freedom;

4) That an absolutely necessary being (God) exists and does not exist.

In Kant's enlightened comedy, that crisis of Pure Reason finds a solution in the Moral Will. As if the outcrop of contradiction were a salutary warning that speculation has climbed too high and must descend to empirical pastures, handing the metaphysical banner to Practical Reason: "Excelsior!"

But what if the moral imperative should abnegate (in Fear and Trembling) reason's categorical ground? What if the empirical should still gape with "yes-and-no"? Is the first antinomy clearly separable from ours of steady-state against the Big Bang? Or the second from our Bevatron search for Quarks? The third from the present convergence of biochemistry, neurology, cybernetics and fractals? Does not the horn of dilemma bare itself in every seed-plot and fish-pool of knowledge -- as in science, that of deterministic cause; in arithmetic, of the unit base of integers, in geometry, the dimensionless point of Euclid's First Definition (not to speak of the Parallel Postulate). Through all Kant's a priori, cricket voids are chirping: "both impossible and necessary", and "as sure as unthinkable".

Paradox has never been contained in the comfortable category of warning. When Pascal took it head-on, he sensed reason's overthrow. But did he panic too soon, forgetting his own deepest insight: "since the opposite principles are also true"? Instead of reeling to the creed-wager, he might have run into the street crying the Eureka of Paradox: "The leap which is our calling." So stripped for action, would he not have seen the Probability of an Odyssean METHOD, such a calculus of symbolic fields as Leibnitz would glimpse in his youth and almost articulate in the Monadology -- though

hampered by the Axiom of Separation which would "pre-fore-or-destinate" his Harmony?

AXIOMS AND FIELDS:

What is clearest (and least clarified) about axioms, those inner necessities of thought, Aristotle's famous first principles, common to all, which do not require or admit of proof (though Kant seems to be proving them), is that they tend to come in polar pairs, forcing us to the question: are such certainties Categorical, Hypothetical (if such-and-such, then so-and-so), or Disjunctive (less Kant's either-or, than a complementary yes-no)? It would be strange to say "all in one"; since the categorical excludes <u>if</u> and <u>no</u>, and how have first principles proclaimed themselves but categorically?

At a liberal arts college there was a soulful tutor who got so wrapped up in Plotinus --

> From such a unity as we have declared the One to be, how does anything at all come into substantial existence, any multiplicity, dyad, or number? (and) Why should the One overflow?

he used to meet his math class with a look beyond infinity. "Now let us contemplate the One" he would say, and drop his face into his hands. For ten or fifteen minutes, silence would reign. Before long the students went to the Dean. Even at a Platonic academe, they wanted a stir of becoming. Special as that tutor was, he had to move on; which showed

how essential it is for the One (however incomprehensibly) to overflow.

Suppose we drop our heads into our hands and contemplate the oldest and deepest assurance mind gives us -- what we may call the "Eleatic Axiom" -- of the ultimate rational identity of substance, prototype for Plotinus, for causality, for mathematical equation: <u>that Being is what it is</u>. Parmenides of Elea:

> It is necessary both to say and to think that Being is; for...it is impossible that non-being is...And...Being is without beginning and indestructible; it is universal, existing alone, immovable and without end...From what did it grow, and how?...If it came into existence, it is not Being...So its generation is extinguished, and its destruction is proved incredible...Further it is unchanged...for if it lacked anything it would lack everything...
>
> Nor is there nor will there by anything apart from Being...Wherefore all these things which mortals determined in the belief that they were true will be but a name: that things arise and perish, that they are and are not, that they change their position and vary in colour...

If this is an axiom of mind (and there is no more venerable one), its eternizing truth evacuates the actual. When the One is drunk neat (Substance identified with the cosmos itself), its logic is at peak, its practicality almost nil. Aristotle: "Though these opinions seem to follow in a dialectical discussion, yet to believe them seems next door to madness when one considers the facts." That Eleatic axiom takes no account of particularity or change, of incarnate becoming. In absolute verity and total

distortion, it must cast, like a shadow, some existential contrary -- why not the most obvious and neglected rule of philosophy? "If a thing is, it is possible." How far from the Eleatic "by the logic of Being, change cannot be" is this chessboard advance of the merely factual pawn: "Since change exists it can be." (Sartre of the Existentialists: "They think that existence precedes essence".)

Simple as Aristotle's other conclusion in the Posterior Analytics, when confronted with the Meno paradox of learning (to seek for what you have no notion of), he traces First Principles up an organic stair from animal Perception through Memory to the universals of Science -- soaring to his greatest (perhaps his only) simile:

> It is like a rout in battle stopped by first one man making a stand and then another, until the original formation has been restored.

That wonderful bow to Plato's Recollection ("the original formation") suspends the organic climb over a priori paradox. To which Aristotle's answer is acceptance of the field (as if he had said "if a thing is, it is possible"): "The soul", he writes, "is so constituted as to be capable of this process."

IDEAS AND CAUSALITY

How could reason after Parmenides (or even in Parmenides himself) do anything but slack off from the Eleatic absolute? Yet -- as reason -- it has still to

reconstitute substantial identity over factual denial. The Doctrine of Ideas is one such recovery. For Socrates and Plato the dilemma of Particularity is unavoidable: that Being, contrary to its charter, appears subdivided all over the place. Subsume it, then, under the intelligible species of eternity by giving each configuration, from table and man to beauty and good, its immortal Idea. Though for that recovery of the lost One under the alienation of many, the original question continually revives: how can the primary and changeless have any connection with the fleeting and relative? As Socrates confessed when asked in the Parmenides whether dirt and dung have Forms: "Sometimes I think there is nothing without an idea...and then I think I may fall into a bottomless pit of nonsense and perish."

Suppose now the focus should shift from the spatial adversary of Being, Particularity, to the temporal adversary, to that Flux which Socrates himself rapturously parodies in the Theaetetus:

> in the language of nature all things are being created and destroyed, coming into being and passing into new forms; nor can any name fix or detain them..O Theaetetus, are not these speculations sweet as honey?

Must not Eleatic Being, fished up from the river of change, take the form of Causality, the axiom of sufficient reason:

that what was, bears the causal identity of what is and will be?

Such is Descartes' proof of God:

> since I am a thinking thing, and possess in myself an idea of God, whatever...be the cause of my existence, it must of necessity be admitted that it is likewise a thinking being, and that it possesses in itself the idea and all the perfections I attribute to Deity...since what is cannot be produced by what is not.

It is rabbits out of a hat -- that if you pull them out, there must have been rabbits in there. So God can be proved a rabbit, or an eternal rabbit-thinking fool. Though for all the causal axiom, Darwin pulls rabbits out of some hat or other, where no rabbits were before. It seems evolution can't have worked by the logic of equation. So the causal axiom also requires its existential contrary -- operation bootstraps, a conditioned coming-to-be of what was not -- complement of categorical causality: The Axiom of Emergence: -- For time to be real (Kierkegaard's moment... decisive), the future cannot be contained in predictive causality.

SUBSTANCE AND COMPLEMENTARITY:

It was in fact just before Parmenides, that Heraclitus had celebrated the counterpole of Eleatic Being -- Flux:

> The way up and the way down is the same. Fire lives in the death of air and air lives in the death of fire; water lives in the death of earth, earth in that of water...We do not step twice in the same rivers, for other waters are always flowing on: we are and we are not.

Yet Heraclitus was not just a Flux man (his arrow of change: fire-to-air-to-water-to-earth -- rounds, either way, to a wheel of fire):

> Not on my authority, but on that of the truth (logos), it is wise for you to accept that all things are <u>one</u>.

He had hymned the sacred opposition of One and many, Being and becoming:

> From what draws apart results the most beautiful harmony...as in the bow and the lyre. All things take place by strife...Changing (the all) finds rest. (<u>Metaballon anapauetai</u>.)

The complementarity was not just of Parmenides against Heraclitus, or even of thought against world; since changeless One and transforming many are at once limits of the phenomenal and yoked cognitions of mind.

If the Categorical, however, precipitates its polar pair, it must be logically Disjunctive. Consider "The whole is equal to the sum of its parts."

Who can deny it? But grind some old college table to sawdust. In what sense will the unarguable truth prove true? Or try a costlier experiment. Take a pair of

freshmen (not to discriminate, boy and girl) and dissolve them in acid. When the police come, tell them "The whole is equal to the sum of its parts." If the watchdogs are clever, they will say: "Your axiom is disjunctive. It is true; but in those words of Pascal:

> les conclusions sont fausses, parce que les principes opposes sont vrays aussy.

"No whole," they will say, "in so far as it is whole, can be simply a sum of parts." So they take you off, gloating as Dante's devil did over Montefeltro: "Maybe you didn't know I was a logician?" -- "Forse tu non pensavi ch'io loico fossi!"

Does every axiom cast the shadow of its own antinomy?

Here, like Aristotle, we must trace axiomatic assurance back through nature and animal perception into the latency of a vanishing intuition. At that point it will appear that what seemed Categorical and then Disjunctive, must also be Hypothetical.

Since all a priori assurances spring from an archetypal root -- the intuition of a medium of linear covariance, ofa causal jell we may call Substance. It undergirds thought, perception, motion, even space-time, with the form of a homogeneously ordered and reliably continued symmetry -- as if, swimming our incarnate breaststroke, we could depend on a fluid congruence, responsive alike to thrust and counterthrust -- no space-pockets, no discontinuities, but

such measurable substantiality as inertial devices use to keep spaceships on course.

WOLF AXIOMS: AN INTERLUDE

To exhibit how deep that ground of intuitive knowledge, I have set down the axioms of covariance as seen by wolf or coyote: --

"Is" means "is", at least for a while.

If the signs are rabbit, it won't turn to bear.

You know what you know all round. It may hide, it can't disappear.

A half eaten rabbit is not a rabbit by half.

A push of the right sends you left; of the left symmetrically.

Plot your course; no sinkholes in space.

Rocks don't move themselves; when things move, hunt for why.

If wind moves itself, bay the wind.

One and one are one and one -- better but harder to catch.

You know straight from crooked, if you don't know why.

If you roll over, you're upside down.

If you jump you fall.

If you run forward, you keep going.

If you hit something there's a jolt -- the bigger the bigger, the faster the bigger still.

Pant for heat, drink for thirst.

Dead wolf, cold wolf; no hot turd.

Wolf on wolf makes little wolves.

Did big wolf begin it? Bay the unknowables: fire, wind, sun, moon, sky.

Though I never heard wolf, coyote, or dog announce these truths, I am sure they couldn't operate without such awareness. What is it but of Substance: a consistently ordered and reliably continued linear symmetry -- yet of something also beyond that, something mysterious to be bayed?

I assume amoeba hunting paramecium has like assurances. Evolution must have actualized these frames of sensibility, which Emanuel Kant reflected back on the world. Maxwell seems shrewder. "The only laws of matter," he writes, "are those which our minds must fabricate" (that's Kant); "and the only laws of mind are fabricated for it by matter" (that's a bolder Darwin).

THE GENERATION OF AXIOMS

All axiomatic absolutes, all trusted first principles, arise when the intuition of some such pre-cognitive ground is applied at different levels of impacted and abstracted experience. Thus the categorical becomes hypothetical, its truth bearing a conditionality mostly ignored: -- <u>If this, then that</u>: if the covariance of substance be posited of

such and such realm, such and such common notions and deductive proofs must follow. Nothing, however, is assured about the fitness of the intuition or of its generated postulates to any actual field. How should so conditioned a certainty not promote dialectical polyvalences?

A) Of Quantity

Of the great scientific extensions, let the first (and least empirical) be to quantity itself. All the premises of magnitude and number, equals to equals, ratio, the commutative, associative and distributive laws of arithmetic, crop out inevitably; though of course their relevance to a world of organized material stands under probability and contradiction -- Einstein's "As far as the propositions of mathematics refer to reality, they are not certain, and insofar as they are certain they do not refer to reality."

We have already toyed with the irreversible reduction of whole students to the pseudo-identity of molecular parts. And what could show better than the physics we are to dramatize, the eviction of perception and response from a universe stripped to the determinants of equational cause?

B) Of Geometry

The second application takes in dimensionality, also deeply bedded in experience. But what experience of curved images on a curved retina, where spherical perspective turns receding train rails to a lens-shape meeting on the horizon

before and behind -- what experience ever showed anybody a straight line? Here too there is an unexpressed condition: If space conform to the linear homogeneity of what we have called Substance, Euclidean Geometry, its definitions, postulates and propositions ensue, mere spellings out of unbiased dimensionality.

This is not to deny that paradoxes (as between points and line) will lurk under Euclidean clarity -- as in Aeschylus the Chthonic Furies are enshrined under Athena's Acropolis. Nor is it guaranteed that such a geometry will hold at high velocities, or in the force-fields of nuclei, dwarf stars, Black Holes -- will hold, indeed, anywhere absolutely. Yet those very anomalies must be assimilated to reason by applying again, under transformation, the consistencies of covariance. Thus Kepler would bring circular eccentricities into the concord of the ellipse.

What can be claimed is this: that if we apply the intuition of homogeneous symmetry to a dimensionality conceived as linear, we will come up with Euclidean Geometry. If the homogeneity is conceived as of uniform negative curvature, the issue will be the geometry of Lobachevsky; if spherically or elliptically positive, that of Riemann; if as involved with time in hyperbolic curvature, it will be that of Einstein out of Minkowsky. In each case the formulabilities of covariance are reinvoked under the perturbation of deeper denial.

C) Of Logic

The third classical application is to the language of concept. Its hypothesis is this: if expressed thought is a predicational ordering of isolable and equationally reliable units (which nothing expressed in words has ever been; but if expression should be that predicational ordering of integral concepts around which you can draw circles and pretend "this does not merge with that"; so that virtue's being knowledge precludes its being habit) -- then Aristotelian logic, with its laws of non-contradiction and the excluded middle, necessarily results (since if the terms are reliable, is precludes is not and yes does not shade into no).

To which , memory opposes a Mississippi high school teacher, Miss Hawkins (called Hawkeye) who to every searching question would answer: "Well, yes, and then again, no." In the end she was wiser. Let Descartes exhibit the risk of logical inference: (from the Method)

> In the act of thinking all was false, it came to me as necessary that I, who did the thinking, must be real. Thus observing that the truth: I think, therefore I am, was so certain that no extravagance of the skeptics could ever shake it, I took it boldly for the first principle of the philosophy I was in search of...I thence concluded that I was a substance whose whole essence or nature consists only in thinking, and which, that it may exist, has need of no place, nor is dependent on any material thing...

(which Pascal postscripts: "Shall I doubt that I doubt?")

Descartes' certainty (of a similar proof) is stressed in the Meditations:

> I consider the demonstrations of which I here make use to be equal or even superior to the geometrical in certitude and evidence.

Let us call them equal, since their certitude rest on the same conditionality: "If the properties of Substance apply, this follows." But the if here seems iffier -- stretched from the old ratios of embodied act to the quickenings of symbolic thought: if mind, world, God are formulable, without paradox, in the equational logic of words, then Cartesian doubt, equated with Thought, may draw from the Eleatic axiom self as eternal thinking substance, world as formulable and extended substance, both secured by God as infinite substance and eternal rational cause -- all with the unanswerability of Euclid, so long as the operations are not held to the sliding ambiguities of any actual self, doubt, or world. But how can the axiom of substance be applied to a consciousness born in time and subject to the fluctuation of doubt? That "I" is too amorphous not to be put in quotation marks. So too the word "think", of which the immediate evidence was doubt. You'd as soon say: "I nightmare, therefore I am" -- and prove by the axiom of sufficient cause that God is a damned nightmarer. And what of the copular of Being, "I am"? Its eternity crowns dim adumbration. It also has to go into quotation marks. Is Descartes' "geometric certitude" a shrewd hunch of some

conscious activity? The truth is more radical, both better and worse than that. What Descartes has exhibited is the indisputable pole of Eleatic "I am", between which and the equally indisputable contrary of sceptic nothingness, thought and experience hang. It is Hamlet's "paragon of animals...quintessence of dust", Pascal's "gloire et rebut" -- "pride and garbage of the universe."

D) Of Physics

After number, geometry and logic, the fourth extension of Eleatic reason is to matter in motion. When the motions, actual and potential, of gravitating bodies are treated as a quantity which, by the axiom of substance, is continuously preserved, modern physics results. Poincaré objects that the conservation of motion can hardly be a priori if the Greeks failed to see it; and surely Aristotle chose conservation of place, by which mass tries to stand still. But place is not a quantity; and here, as before, the axiom of substance, conquering a new realm, has let the a priori evolve in time.

It has been common to call the new science empirical -- Leonardo's "experience, true mistress", Galileo's "brute fact" after what Whitehead calls the "unbridled rationalism" of the Medieval. But Leonardo continues: "Experience always proceeds from accurately determined first principles...Understand the cause and you will have no need of the experiment." From Galileo and Descartes to Newton

and Leibnitz, everybody's first principle is the same. It is in the inborn axiom of Being, applied now to some assumed "quantity of motion". Descartes: "That God is the first cause of motion, and that He always conserves an equal quantity of it in the universe." The advance of the century was chiefly in mathematizing the variants (velocity and acceleration, momentum, force, energy) of that ubiquitous Motion. And what made those seekers into nature vulnerable to the backlash of the a priori, was not that they looked too much at matter and too little's at thought's necessity; but that they narrowed thought too much -- taking the one-way quantifications of Substance for unambiguous truth.

That the closed-system logic they employed could only formulate the inert, did not prove the cosmos inert. When they found at last that energy itself must subside to a stagnant pool, what had the computer done but to grind out the problem it had been fed; while the programmers took its printout for the starry universe?

FROM LEONARDO TO LA PLACE:

Leonardo had praised the ambiguity of force, animistic mover of inert mass:

> Force I define as an incorporeal agency, an invisible power, which...constrains all created things to change of form and position... It is born in violence and dies in liberty; and the

> greater it is the more quickly it is consumed... It desires to conquer and slay the cause of opposition, and in conquering destroys itself... Without force nothing moves.

In this live enigma, the First and Second laws of Thermodynamics are precursively fused.

With what clarity of "divide and conquer" Newton's three laws have rationalized Leonardo's mystery.

> Law I: Every body continues in its state of rest, or of uniform motion in a straight line, unless it is compelled to change that state by force impressed upon it.
> Law II: The change of motion is proportional to the motive force impressed; and is made in the direction of the right line in which that force is impressed.
> Law III: To every action there is always opposed an equal reaction: or, the mutual actions of two bodies upon each other are always equal, and directed to contrary parts --

Yet nature will creep where it cannot go. Laired under these three laws are the denial of causality and the paradox of inertia: -- first, of causality: that motive <u>force</u> cannot come into being but as validated by the inertial counterforce of acceleration, its assumed result; so cause withdraws from physics into the consciousness which has willed "I'm going to move that rock"; second of inertia: that <u>mass resists acceleration only by accelerating</u> (as: "I resist sin by sinning").

Meanwhile even Leonardo, in that pre-dawn of rational consistency, had not only hymned the riddle of force, but had set the traps of material cause. When he wrote:

> a spirit cannot have either sound or form or force...where there are neither nerves nor bones there cannot be any force exerted in any movement made by imaginary spirits --

how could he not know he had turned the universe to Leibnitz' Mill, into which, entering, we

> would find only pieces working one on the other, but never anything to explain Perception?

Had not the whole issue been debated by classical atomists: Epicurus, finding in the determinism of Democritus no loophole for what we experience as volition, and so, to give a ground for the choice on which philosophy itself was reared, introducing atomic swerve, each atom, as Lucretius would take it up, making its clinamen "at no fixed places and at no fixed time" -- a margin which quantum indeterminacy would unwittingly restore. But it was exactly such metaphysical speculation those new men of science wanted to avoid: Newton, in the Principia, Preface --

> I wish we could derive the rest of the phenomena of Nature by the same kind of reasoning from mechanical principles --

fathering, for all its author's theological scruples, the determinism of La Place:

> to comprehend in one formula the movements of the largest bodies...as of the minutest atom...nothing uncertain,...past, present, or future --

against which Blake was already in rebellion: "Without contraries is no progression..." and: "The same dull round even of a universe would soon become a mill with complicated wheels."

THE DIPOLE OF ACTION:

The truth is, those Promethean conquerors of nature -- even as they trusted the one-way application of Eleatic Substance to matter and motion -- had turned by choice or necessity from the axiomatic antinomies their genius could so easily have formulated: those extensions of the Greek One-many, that nothing can be conceived but as one, nothing but as composed and modified in space and time; nothing but as substance, nothing but as accident; nothing but as absolute, nothing but as relative; or (the root of quantum ambivalence) nothing but as particle, nothing but as field (so that even impact, magnified, becomes also action at a distance).

It had been clear to the Renaissance speculators that some power had to be invoked to stir up matter, long conceived as inert. What was not clear was that mind was grappling with a metaphysical dipole which physics could not escape, the opposed axioms of cause, springing from the <u>One</u> as motionless, and the activating <u>other</u> as disparate, unable to contact the <u>One</u>. That is the reversing field in which

Dynamics would be whirled. As I phrased it almost 50 years ago (though no one has paid much mind):

> A) The one cannot stir itself (so in Parmenides, Being comes to rest).
>
> B) If the dual is invoked for action (Heraclitus "all things take place by strife"), then contraries cannot interact, insofar as they are contraries. (It is Leonardo's axiom of separation, that no spirit can operate on matter).

If we try to bridge the dipole (as nature does such complements: my mind voicing these words, my will stirring this hand), then the I that both thinks and moves, knows by the logic it also contains that such a self-opposed and self-activating unity lives in the mystery of paradox. The fact that experience everywhere attests such powers, does not make them less recalcitrant to quantitative method.

For the first dictum of the di-pole, we have already cited Parmenides, with Aristotle's "the substratum cannot cause itself to move". It was the second which led Plato and the whole late classical world to deny the commerce of God with man: (Symposium)

> For God mingles not with man; but through Love all the intercourse and converse of God with man...is carried on...

(as if a middle term could solve such an antinomy). And though the God-man double was joined in Christian faith, it would cleave again with the revival of Classical reason. Leonardo's powerless spirits point to the Cartesian separation of extended matter and non-extended mind, which

Descartes' caprice of the pineal gland could hardly fuse. In Leibnitz the logical denial of a communion obviously experienced --

> For it is not possible to conceive how one (soul) can have an influence on the other (body) --

necessitates the God-ordained harmony of mechanist mill and windowless monads. The same impossibility led Berkely to a monism in which esse is percipe -- all externals thinned to ideas in the mind of God.

Of course this solution, by the first law of the dipole, must produce an actionless universe. The inference could have been dodged by calling God a transrational mystery, both one and many, at peace and at war with himself, but that is just what Berkeley's 18th century reason will not admit. "Impossible," he writes, "even for an infinite mind to reconcile contradictions" -- oblivious that his rational and Eleatic One, like energy later, can only fall into the mill and determinism of Blake's "dull round".

As for the resolution of the di-pole, if physicist, astronomer, biologist (unwittingly) should make energy that tensile one, both substratum and elan vital, it will turn out indistinguishable from spirit, the purposive paradox crowning a phenomenal field. Leibnitz and Pascal went further than anyone of the time (almost than anyone since) in suspending complementarity, -- Pascal driven to vertigo,

Leibnitz on the verge of Method. As voiced near the beginning of the Monadology:

> The passing state, which involves and represents a multitude in unity or in the simple substance, is nothing else than what is called perception;

and toward the close:

> According to this system bodies act as if (to suppose the impossible) there were no souls, and souls act as if there were no bodies, and yet both body and soul act as if each were influencing the other.

Though this vital mystery seems to defy the claimed first law of Leibnitz' logic: "that whatever implies a contradiction is false." Since what else but radiant contradictions are his multitude in the unity, transience in the eternal, trivalence of physics, spirit and biology?

How prophetic the 17th century might have been if, instead of mouthing classical logic, it had applied the polar suspensions of physics to metaphysics as well. All those scientists were skillful at balancing opposite trends (as inertia and gravity) where exact solution required it. They knew that without force and counterforce no real action, elastic limit or material boundary can exist. What follows? If an object so bounded were a single substance, it would be transrational, a counter-tensile one (Lucretius' atoms axiomatically mystical); so every raindrop, sun, galaxy, is to be conceived under the dialectic of one-many (in which nature happily concurs): the sun as one matter is drawn in; as particles accelerated by that fall together, it

thrusts out. But now every formed thing, down to the particles called primary, must be dissolved in its turn, or become (like the damped-wave model of the electron) some quantum mystery, subsuming paradox and therefore indeterminate. In the 17th century only Pascal --

> In this abridged atom...an infinity of universes...without end and without cessation --

and Leibnitz --

> organic bodies are still machines in their smallest parts, ad infinitum --

intuited that bottomless universe -- Leibnitz delighted, Pascal clutching for the handrail. If Leibnitz, skilled in infinites and infinitesimals, had pursued Pascal's contraries all the way, would not matter and energy have been seen from the first as suspended over entropic decay by anti-entropic buttressing, without which no form could resist the chute of imperative nothingness?

FALLING BODIES:

When we raised the first of our steel balls and let it descend along the arc of a pendulum, we accepted its motion, without asking what the axiom of Substance implied of falling bodies. In this case Leonardo had held to the old view:

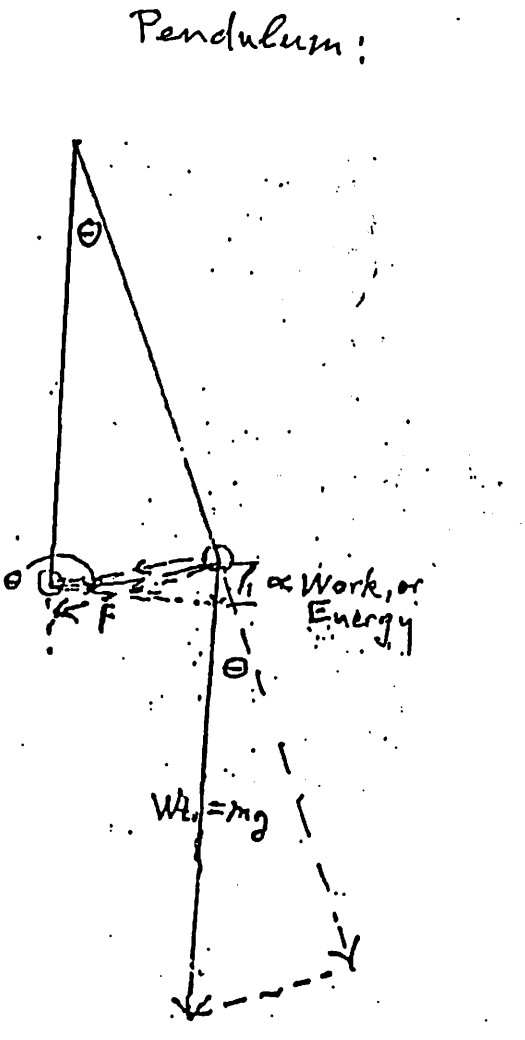
> Where there is the greater weight there is the greater desire, and that thing which weighs the most, if it is left free falls most rapidly...

Though thought, apart from observation could have told Leonardo: every unit of weight is not only pulled by an equal desire but restrained by an equal inertia. So for Galileo to state the new principle of constant acceleration did not depend on dropping bodies off the leaning tower of Pisa (the results, using cotton and lead, might have been misleading); mind had only to grasp what the axiom of Substance requires -- a classical continuity the opposite of quantum a-causality.

Conceive two like bodies. Dropped separately they should fall (the Aristotelians said) with a speed (they meant acceleration) proportional to their weight. But what if we bring them gradually together until they are in contact, and then glue them? At some indeterminate moment the new body, having twice the weight, would have to fall twice as fast. How is it to know when? The inert continuity of equation is defied. So bodies in constant force fields can only accelerate equally, and uniformly, whether one or many, heavy or light.

In such a descent, whether free or along a frictionless plane, Galileo's triangles of successive times and velocities, with their areas equal to the distance covered (equal also to the rectangle of time by average velocity, which is half the terminal height) enable us to write a priori these necessary laws:

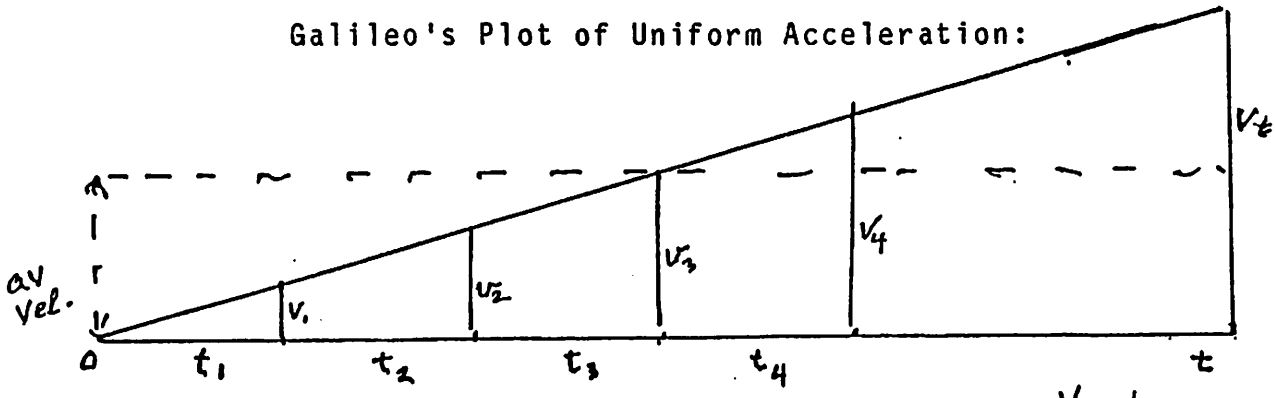
to axiomatize it requires a new mathematics harnessing the luminous paradox of vanishing ratios.



Conceive three triangles: above, the space triangle of the pendulum's swing; below, the force triangle of the weight components; between them, the small triangle of height and arc (displacement, approximating the tangent drawn at the bob, which is the restitutional component of its weight). All three triangles approach similarity as the amplitude is made less and less. Once that is grasped, we can simply read off the laws of the pendulum from the vanishing triangles.

Since arc (spatial displacement) and the restitutional tangent converge, $S\alpha - F$ (or $- a$), that is $s\alpha - \ddot{s}$, (displacement varies as its own second derivative oppositely

Galileo's Plot of Uniform Acceleration:



at any moment, s (the space or distance covered) = $\frac{v}{2} \cdot t$

(average velocity times the time).

since $v \propto t$, and since a (the acceleration, or slope) = v/t;

therefore $s = 1/2\ a\ t^2$

It is also clear, by the principle of conservation, that whatever the falling weight realizes in quantity of motion, must equal what we put into it by raising it up. Clear too that to lift it another equal height would give it as much again, and that to lift other weights equally would multiply the quantity in the same ratio. Therefore the product of weight times height lifted (which is force-times-distance) must equal the total realized motion or work done, which already, from Galileo's triangle, we might guess to be $1/2\ m\ v^2$.

THE PENDULUM

But that triangle was based on free fall or descent along a frictionless plane. And since our suspended weight falls down the always shifting incline of a pendulum's arc,

directed), which is the condition for sin-wave or simple harmonic oscillation. Since the vanishing arc approximates a parabola, the height, or subtence varies as the base (chord, arc, all indistinguishable) squared. But the force varies with that space (hence velocity with distance); so the period (T) must be constant for all amplitudes (so long as they are zero). Since for longer pendula the drawn figure increases symmetrically, but v as a square, the period will vary as the root of pendulum length. Everything falls out on inspection, if one makes the right pact with the Lucifer of vanishing ratios.

Thus the logic of wave motion throughout (Taylor, Euler, etc.) rests on the wave's not waving.

MOMENTUM AND ENERGY

Having deduced something about the ratio of height to the square of vanishing arc and the square of velocity, we drop the mass again. Our axiom has equated the work of lifting it against gravity, with the final realized quantity of motion. But how shall we define quantity of motion? Is it the directional product of velocity times mass, called momentum; or the absolute quantity of one half the mass times the velocity squared, to be called energy?

In any transfer of motion, action and counter-action, as consentaneous, must occupy the same time. So whatever is communicated by force (mass times acceleration) acting

through time (which multiplied, m s/t^2 times t reduces to ms/t, mass times velocity to be called Momentum) that must be equal for both bodies, equal and opposite. Thus for the compound whole, the progress of the center of mass cannot be changed by any action or energy transformation internal to the system (which is the first principle of motion, applied to a complex body).

If a shell is exploded in a cannon, the massive cannon is kicked back, the shell is sped forward. The same explosive pressure acting through the same time must produce the same Momentum (mv), which means, if the cannon is a thousand times as heavy, the velocity of the shell will be a thousand times that of the cannon's backward kick. So the center of gravity of the system remains as before, however much charge has been exploded.

But the chemical explosion delivered live force or energy, some dissipated as heat, the rest turning into motion. How much of that <u>energy</u> did the cannon get and how much the shell?

The action occurred not only in time but in space, and if the time was equal for cannon and shell, the spaces clearly were not, since the cannon was barely kicked back, while the shell was being thrust through the length of the bore. So the product of force through space has to be a thousand times as great for the shell, covering, at a thousand times the speed, a thousand times the distance.

What is that product of force times the space through which it acts? Examine the dimensionalities.

Where force times time reduced to mass times velocity, force (m s/t2) times distance puts another s in the numerator, yielding the dimensions of mass times velocity squared. It is this quantity (with a 1/2 thrown in, as from Galileo's triangular graph of accelerated motion) which Leibnitz would call Living Force, and we Work or Energy. And whereas cannon and shell sucked up equal portions of momentum -- of this absolute quantity, the shell has sucked up a thousand times as much as the cannon (luckily for those at the breech). But nature had pointed to this conserved quantity before, in the lifting and falling of a weight: that the distance lifted (the area of Galileo's triangle) varies as half the terminal velocity squared.

IMPACT:

Again, in act or thought, we lift our elastic sphere and let it fall. It strikes, and again the last ball on the other side pops out with comparable velocity. Why can't four balls move off with one fourth the velocity? It would answer for momentum; but not for that other quantity where velocity is squared. But if we glued them, they would have to stay together. How to predict the result? We drop two. Two pop out. We drop three. The middle one carries through. Conceive the two and the three (indeed any ratio

of masses) joined into unequal spheres approaching and overtaking at whatever speeds -- can we draw a general solution from our first principle of motion conserved?

Descartes tried. "If the bodies were exactly equal, moving with equal speeds in a straight line toward each other...they would rebound equally." Good. Reason requires it and the elastic spheres seem to agree.

"Second," Descartes writes: "If one were just a little greater, then only the lesser would rebound..since the lesser cannot compel the greater." That nominalist logic turns to nonsense under physical question: "How much less; how much greater? Not compel it at all?" Let the difference diminish to the weight of a hair, the weight of a molecule. A crisis must develop: "To move or not to move?"

Descartes protests:

> The demonstrations of all this are so certain that although experience may seem to show us the contrary, we should nonetheless be compelled to put more trust in our reason than in our senses.

That would be fine, if Descartes had used the right kind of reason. Indeed, no experiment is needed; only the intuition of substance, which implies continuity. Leibnitz: "it cannot come about that two bodies are perfectly equal and alike" and "no event takes place by a leap". What Descartes fumbled was the quantitative axiom itself.

How beautifully Huyghens, starting from the common first principle that "motion will be continued uniformly in

a straight line if no impediment is interposed", imagines the impact as occurring on a moving frame of reference -- a boat, seen from the shore; so that by changing the boat's motion each case can be adjusted to one of symmetry, where, the center of gravity stilled, equal momenta are exchanged.

But as Leibnitz would point out, that visualization was not required. We had only to reason from the applied principle of substance: that the motion of a body is conserved. But what is a body? It is not a mystical one, but a one-many: in this case the summed whole and a rebounding two. If the whole, around which we could draw an isolating circle, must, with its center of mass, continue as before; and if the parts must also preserve whatever motion they had relative to each other (as an elastic ball would bounce off a wall), Leibnitz' three equations automatically arise ("Essay on Dynamics"): -- the lineal equation:

$$v_1 - v_2 = v_2' - v_1'$$

(that the difference of velocities before impact equals the difference after, under a change of sign); the plane equation:

$$m_1v_1 + m_2v_2 = m_1v_1' + m_2v_2'$$

(that the net Momentum of the whole, or vector sum, must be the same after impact as before); but these two may be compounded (since one is plus and the other minus and with a little shuffling of terms they can be multiplied) to produce the third or Solid Equation, that the sum of the masses

times the velocities squared also remains unchanged: that is, $m_1v_1^2 \mp m_2v_2^2$ must equal the prime values of the same.

Marvelous, that by multiplying the two aspects of a complex motion, the progress of the whole and the inner velocity of the parts, we get the absolute, non-directional quantity, work, which had already appeared as force times distance, or as that $1/2mv^2$ acquired in gravitational fall from a measured height.

A deeper marvel if suddenly it dawns upon us, that what held of this body, which was a complex of two spheres bouncing against each other, must hold of the billions of interbouncing Lucretian parts within all moving masses.

So when the relative velocities subside from inner friction, when even the momentum of the whole dies away by attrition in the strings and with the air (while the axiom attests: all motion lost is lurking somewhere) -- what if the analysis into <u>one</u> and <u>many</u> has already pointed the way? -- that what has visibly disappeared must remain as a sum of squares in the heat dance of the constituent molecules? With what triumphant insight Leibnitz wrote of that frictional going-under of energy:

> But this loss of the total force, this failure of the third equation, does not detract from the inviolable truth of the law of the conservation of the same force in the world. For that which is absorbed by the minute parts is not absolutely lost for the universe, though lost for the total force of the concurrent bodies.

Ironic, that in Leibnitz' claim of live-force as indestructible (our First Law of Thermodynamics) the Second Law is also implied: "though lost for the total force of the concurrent bodies." No Newtonian System of the World would save the 18th century from a Deist Clockwork which can only run down hill. No calculus of determinist quantity could avert the dark encroachment of Entropy, or shake its axiomatic ground: that what had been introduced to keep the cosmos alive has become an equational pool of which it might be asked: why should it flow from here to there?

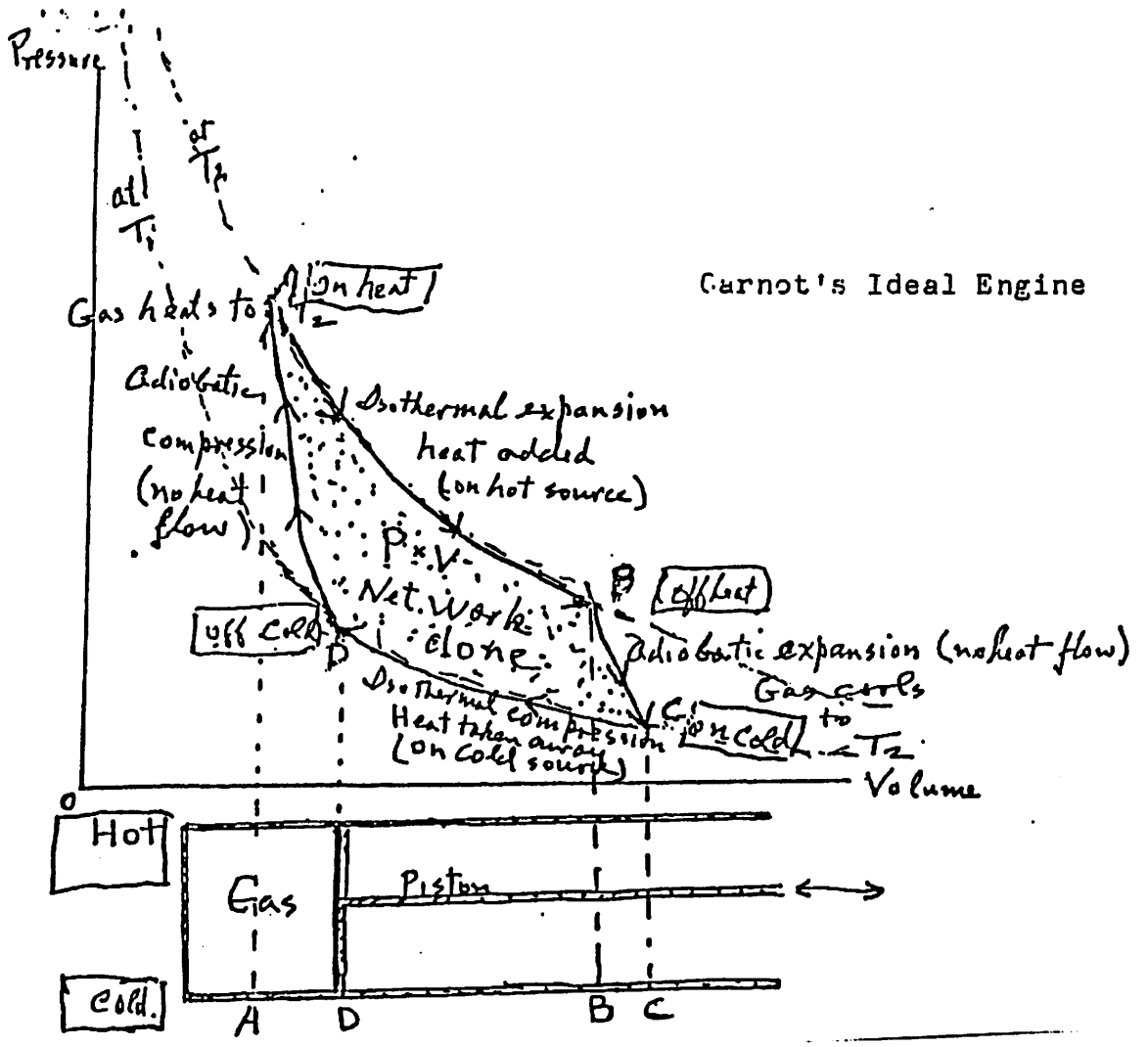
The irony looks back to the oldest distinction of Greek thought, Being and Becoming. Which is more real? Being, said the Eleatics and summed it into changelessness. Totaled. Becoming, said Heraclitus, and wondered at the life of fire. When Calculus took it up, the integral stood for Being, a summed function; the derivative for Becoming, a rate of change. And again Being came to rest. The integrating Sigma of force-through-distance made a squared eternal out of change itself, Leonardo's evanescent Force charmed to inert quantity: action that cannot act, energy ceasing to energize. So Newton, trying to see relative motion as absolute, points to the centripetal effects in the spun bucket of water, and says: "The thing is not altogether desperate." But Newton was deceived. The rate of change is not the thing itself. Just so his light-bearing AEther would be withdrawn, leaving only its

fluctuant modifications, fields and waves, more real than the medium they were supposed to agitate. So too Jamesian psychology would dissolve Mind into passing states of its own vanished being.

As for Leibnitz' Absolute Force, like an ocean without a wind, it would require a new potential to keep the stuff of flow flowing -- or besoul itself to that omnipresent contriver which Newton, on speculative tack (Optics), made of a space conceived as God's sensorium. Without such admission of animating spirit, the all-mover settles to the causal and statistical gradient of Entropy -- what gravitational analogy supplies to keep the process physical.

CARNOT:

Anyone skilled in the axiomatic field should have learned from Leibnitz what was going to happen; just as one could have fathomed without Carnot that you can't get a heat engine to operate between two bodies at the same temperature, since axiomatically motion is by disparity. The truth is, you can't prove anything but what you already know. Proof is the rhetoric of rigor. But what a glorious proof Carnot has given in his invention of an ideal engine (pub. 1824).



Carnot's Ideal Engine

The engine (a piston in a cylinder of gas) is outlined here beneath the graph of its own action above, where the pressure of the gas is plotted against its volume. Each hyperbola of the graph fulfills Boyle's law, that for an ideal gas, at constant temperature, pressure times volume remains the same. There are two curves, matching the two temperatures over which the engine operates. They exhibit the law of Charles and Gay-Lussac, that pressure times volume varies as Absolute Temperature (pv = T/273). In this engine of pure thought, the likes of which nobody could ever build, we imagine the cylinder as being applied to the source of heat. The piston goes out just fast enough for the absorbed heat to keep the gas, otherwise cooled by

expansion, at the same temperature. If we started at A, we follow the graph down the isothermal hyperbola to B, at a larger volume and lower pressure. At B we remove the heat, but let the piston go on out, expanding and cooling the gas (adiabatic, no heat flowing in or out). So it reaches the lower isothermal at C. Here we put the cylinder on the cold source and let the piston move back to the left, condensing the gas. Against its tendency to heat, we refrigerate it just enough to track the isotherm back to point D. There we remove the cold source but let the gas go on being compressed, adiabatic again, no heat flowing in or out; so it warms up until, by ideal management, it returns to point A where it began. Since every change of temperature has been directly associated with a change of volume, this engine has an ultimate efficiency beyond which no actual heat engine can go. And since every area on the graph is pressure times volume, or work, the net work done by the heat flow is simply the shaded area of the trapezoid or queer parallelogram ABCD.

If now, instead of that one engine operating over a temperature gap from T2 down to T1, we would conceive an infinite number, each operating over an infinitesimal gap, the most work we would ever get out would approach the area between the two hyperbolae and the straight lines dropped from A and B. But there's all that other energy between the lower isothermal and absolute zero, diffused and spread

around like lukewarm water. And Carnot, after such a leap of insight and proof, is simply telling us: This machine can't get anything out of that lukewarm water. Such the general proposition of The Motive Power of Heat: "its quantity is fixed solely by the temperature of the bodies between which the flow is effected."

From which Clausius, who invents the term entropy for the measure of the spent or useless energy in any system, extrapolates (from the divorced abstraction of the closed and inert) -- "The entropy of the universe tends toward a maximum" (though the closure of the universe rests under paradox). So the cosmic optimism of Leibnitz, to which Helmholtz as late as 1847 would subscribe:

> The universe possesses, once and for all, a store of energy which is not altered by any change of phenomena, can neither be increased nor diminished, and which maintains any change which takes place on it --

that euphoria of the First Law would bring forth after 1850 (and from the same causal womb) Kelvin's apocalyptic thunder of the Second:

> Within a finite period of time past, the earth must have been, and within a finite period of time to come the earth must again be, unfit for the habitation of man as at present constituted, unless operations have been, or are to be performed, which are impossible under the laws to which the known operations going on at present in the material world are subject.

Out of the most rational and equational science of all, the physics of matter in motion, has come this

contradiction: Work will endure forever, but not as work. To which the new Heraclitean would have been laughing, like Yeats' old Rocky Face, in tragic joy, having foreseen from the start the inevitable reduction of a priori quantity syllogistically applied to an organic universe of polyvalent energy exchanges.

And indeed, how anyone could have let the axiomatic subsidence of a merely conceptual substratum disturb him, in a cosmos peppy after fifteen billion years, is perhaps obscure.

POSTLUDE -- THE USES OF PARADOX

I have traced the Tao of the old physics here, as if I did not need the New, yet I grew up in the curved space of Einstein's relativity, trying, as Dante had done, to conceive a three dimensional sphere turned inside out. Before I knew of Heraclitus I had welcomed complementarity and indeterminacy. These broke for me the "misplaced concreteness" of the old determinist law.

Forty-five years ago I decided that when reason drives a sheer impasse into an activity which in fact goes on, we have to think of the polar cleavage as both real and unreal. Real, as mind's measure of the mystery of world-process, of its incommensurateness with the contrary truth of logic; unreal as in no way precluding the operation so denied. I found in paradox two rightful uses, as of night and day: of

night, soul's guide toward noumenal reverence; of day, thought's X and Y for mapping, clarifying, ultimately for navigating the experiential field. But that is a job as huge and demanding as Aristotle's, and for me at 70, just begun.

"Look," my friends say, "Bell's been doing the same thing since he was 25. About that time he had a vision of paradox as paradise, and he's been stuck there ever since." Can I deny it? You get a notion how to juggle when you're young and you go through life skirting Charybdis and Scylla on Odyssean voyage. They say: "That juggling comes too easy. 'Look, Ma, no hands'; and you're riding through the universe as if contradiction were fun and contraries could be fused whenever you wanted." But it's not as if a lifetime of labor hadn't gone into the articulation of that dangerous insight. Because for us the Heraclitean content must comprise the whole of modern knowledge, science, history, the creative arts.

Nor is it a glib or even a personal choice to rear thought over the horns of dilemma. Only on the precipitated axes of polar opposites (that modern replacement for the ambiguity of Platonic dialogue) can reason stretch the hyperbolic spectrum of knowledge, without arrogating beyond its own involvement in the shifting emergence of inner and outer, self and world. The philosophy which ignores this

may well be the glib one, deceiving itself and sometimes others.

Let Hume be our pot-bellied example. There is a picture of him in Edinburgh, flopped at a desk of papers, completely flabbergasted; you can't tell whether he's gorged on haggis or stunned by gout. Yet it may be the moment when, having posited in his great work, Concerning Human Understanding, which occupied him three years in France, nothing but an atomism of simple impressions, with ideas as their dim images -- though anyone might ask if simple impressions can exist, except as nameable fixes, red and the like, in the amorphous and relative, ingatherings already tinged with one and many, will and idea -- he discovers, how touchingly, that he has no way, true to the logic he has played, of accounting for any composition, self or substance, even to the power of thinking or saying "I am". As he writes in the appendix to those ambitious tomes:

> If perceptions are distinct existences...no connections are...discoverable...all my hopes vanish when I come to explain the principles that unite our successive perceptions in our thought or consciousness... For my part, I must plead the privilege of a sceptic, and confess that this difficulty is too hard for my understanding.

There's honesty. There's experience. And surely honest experience is a good. But could not the axiomatic syllogism, which pulls from the hat only the rabbits you put in, have tipped him off: "You expect conscious deliberation

from a grab-bag of perceptions stripped of organic coherence?"

Of course, not even Kant could spring the cage of Newtonian phenomenology. Within one-way logic the axiom of separation, throned over deterministic physics, could only leave mind-body unjoined. In field-thought, too, abstract polarity remains, but turned, like clouds at sunset, into light. Since both the evolution of consciousness from matter, and the appearance, in primal matter itself, of quantum uncertainty, have fused the separate realms in existential flame.

Yet still one hears, after almost a century: "isn't indeterminacy a cop-out, enthroning ignorance of the causes?" Well, since the regress of cause will always be bottomless, why make a faith-claim for a billiard-ball determinism incommensurate with the search we experience? Why insist on a universe in which the moment can never be decisive? It's kicking a fart out of a dead donkey.

"But this indeterminacy," they say, "only defines the limits of observation. What has that to do with free will?" No doubt when quantum theory surfaced, it was hailed from religious circles: "Now we've got a Holy Ghost because there's a swerving at the base of nature." Then came the counterswing: "How can you fetch volition from an experimental probability with a constant named after Planck?" Yet it was not a preacher but a scientist,

Schroedinger, who set anti-entropy against entropy, bringing choice from quantum resonance up the nerve and genetic thresholds of the organic stair -- although not noting that to rationalize organic building by giving it also a causal gradient was to endow energy with contrary impulses, stretching the whole over the paradox of spirit: "If wind move itself, bay the wind."

In any case, it is scientists today who have begun to realize that the precipitation of polarities is not the shipwreck of reason, but the delineation of its natural field. What is probability but the weft between absolute law and indeterminacy? So before Schroedinger, before quantum theory, Maxwell had invented a thermodynamic demon who might oppose the drift of entropy.

Conceive two boxes of gas, an opening between them large enough for a molecule, a frictionless trapdoor, in charge of a little demon. Say one box started hot and the other cold. The demon has gone to sleep. Soon Carnot would despair of running an engine between those two boxes. But the demon wakes up, like Lord Kelvin, shocked at entropy. The molecules still have a Gaussian distribution of motion. Every time a faster one comes he opens the trap; a slower one, claps her to. Inside a demon's working day, you'll have it hot as blazes on one side and cold on the other (as indeed chemicals are concentrated all the time in bodily tissues, against inorganic probability -- retu mirabile).

All you need is a frictionless intelligence. But that had been ruled out by Leonardo's axiom of separation: that a spirit can no more stir matter than Peter Ibbetson's astral self would be able to pluck a feather off a sleeve. Though surely the universe is reared over this contradiction.

It was clever of Maxwell to take his demon myth from the deeply rooted faith-world of pre-science. But can science plant demons at nature's trapdoors without defying the axiom of physicality: if they are disembodied, how can they work the traps?

Like all polarity, once precipitated, it is insoluble. We have only the trans-logical leap of conceiving (across the poles) through all organized structures (and what is unorganized?) an increment of perceptive purpose, both transcendental and inseparable from energy itself: some "virtue of a virtue", peaking up, through the feedback thresholds of living structure, to conscious will; as down the aggregates of the mineral it settles almost to the inertia of predictive law. To stretch this spectrum between the abstracted poles is not our choice but what is required of us.

The cosmos does not feed the mind on pabulum, but on the self-vaulting knot of contradiction. Those who quarrel with antinomy quarrel with gods and world. Of course, reason has planted the quarrel in us and it must go on; but within the embrace and celebration of generative enigma --

as walking weds stasis and falling, Descartes' assurance, Pascal's vertigo.

Since this much we see clearly and distinctly: that the quantitative and equational (the logic of Eleatic substance applied to things) is always determinate, like any resolution of mathemable forces (whether balanced or unbalanced); so the only axiomatic source of the exploratory, of probability, life and evolution, is the mated mystery of Sic et Non, Yes and No. It is the breathing of Paradox which besouls the worlds.

> You must sit downe, sayes Love, and taste my meat:
> So I did sit and eat.