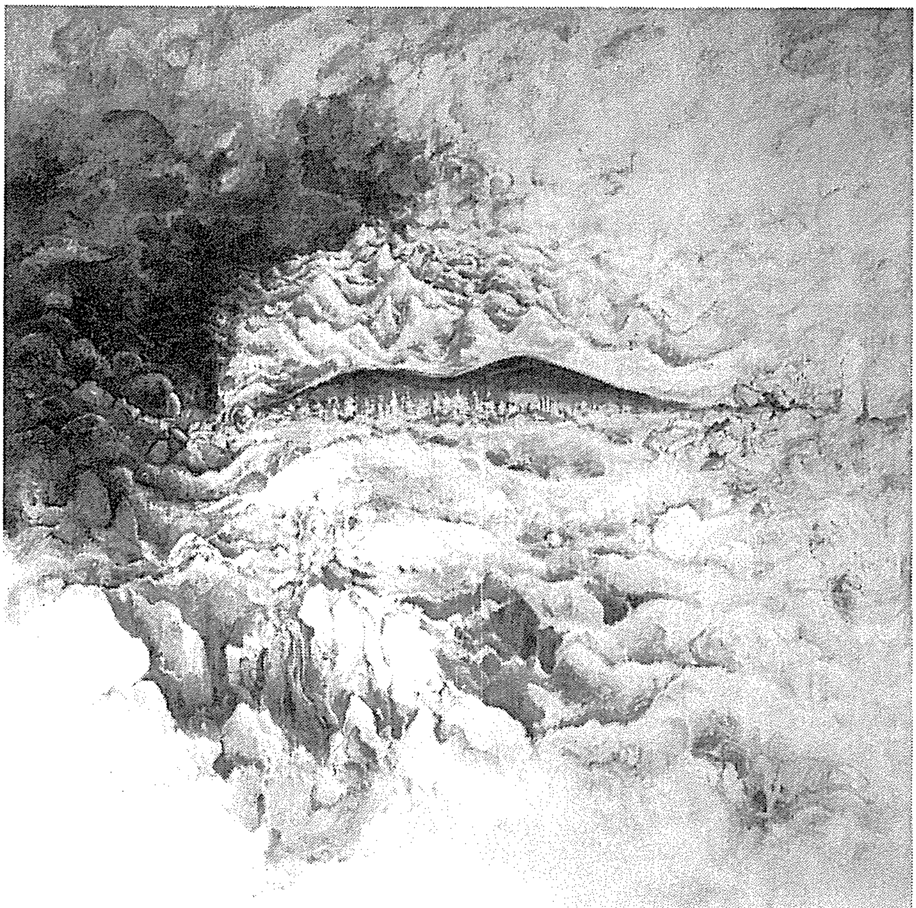
ANPA WEST

Journal of the Western Regional Chapter of the Alternative Natural Philosophy Association



Volume Two, Number Two - Fall 1990

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Journal of the Western Regional Chapter of the
Alternative Natural Philosophy Association

Volume Two, Number Two - Fall 1990
Editorial Office: Tom Etter, 409 Leland Avenue, Palo Alto CA 94306

IN THIS ISSUE

The new science now on the horizon will undoubtedly count the English logician G. Spencer Brown as one of its early pioneers. Lou Kauffman, a mathematician best known for his work in knot theory, here gives us an account in words and pictures of Spencer Brown's main ideas, and perhaps more important, of his pioneering style of thinking, in the context of the revolutionary changes that quantum theory is making in our conception of logic.

Page 35. Inertia and Tao by Tom Etter

Quantum mechanics is like the faint but persistent note of an alarm clock trying to rouse us from what Blake called Newton's sleep. Actually, Newton got a bum rap here – Newtonian mechanics was itself a fainter version of the same alarm clock, trying to wake us from what really should be called Aristotle's sleep. It didn't succeed at all; we skillfully managed to blend its quiet and harmonious note into our Aristotelian dream. This article is an attempt to turn up the volume.

Page 51. Basic Issues Concerning the Relationship between Consciousness and the PhysicalWorld

by Jean Burns

Jean Burns is a physicist currently doing research on consciousness. Together with computer scientist Ravi Gomatam she has recently founded an ongoing Consciousness and Science Discussion Group which holds regular public meetings at the Langly Porter Institute that could be of interest to our bay area readers (See News and Events). In this article she gives us some background on four of the major issues that dominate current thinking about the mind–body problem. These issues all occur within the broad conceptual framework of information processing, where the key ideas are information, causality, structure, isomorphism, modelling and computation. Most scientists feel at home in this framework, but for those few of us who are skeptical of it, it's important to stay in touch with what the rest of world is thinking.

Page 57. Report on ANPA 12 by Fred Young

COMING NEXT

The next issue of ANPA West will be a totally new kind of magazine. It will be interactive. All articles will appear in printed form, but some will also come out on computer disk in such a way that the reader can converse with the author.

Events leading up to this new turn began about 15 years ago when I and an author friend Bill Chamberlain found ourselves with a primitive computer on our hands and Bill wondered whether it might have literary abilities. As a matter of fact it had, and under Bill's tutelage they flourished. It's first work, a story called "Soft Ions", was published by Omni magazine[1] under the pen name Racter, short for raconteur. Several years later Racter's book "The Policeman's Beard is Half Constructed"[2], the first book authored by a computer, caused quite a stir in certain circles. My part in all this was to write the high level language which Bill used to tutor his computer protegé.

This language, now called Inrac, turned into a tool for writing interactive prose. We put out a demo disk for Inrac on which Racter occurs as a character who engages you in conversation. To everyone's surprise, it sold rather well as a product in its own right, and generated a good deal of publicity. Racter appeared on television, was quoted in The New York Times, The Scientific American and even The Wall Street Journal; he was featured by AT&T for two years in their NY technology exhibit as an example of artificial intelligence – though in his case it would be more accurate to call it artificial insanity. We tried to have Racter psychoanalyzed by the computer analyst Eliza, but as A. K. Dewdney reported in his Scientific American column[3], he was a hopeless patient.

Recently the Inrac language has reappeared on the scene in a very different context. Hale Chatfield, a poet and editor of the Hiram Poetry Review, wrote a piece of courseware in Inrac called Star Alpha that took on much of the job of teaching his poetry writing course at Hiram College[4]. It was a great success, and points to a new kind of educational program in which the student doesn't just wander like a rat through a maze of options but converses like a human being with a lively and intelligent tutor.

Every reading of an interactive article is potentially another article.

Teachers face the difficult problem of communicating ideas to restless students who would rather be playing baseball or watching TV. Scholars and scientists face much the same problem communicating to their colleagues, and without the teacher's armory of incentives and threats for keeping their audiences attentive. Who knows how many great ideas are languishing in the private ken of their inventors? With millions of scientific articles appearing every year, the word "publication" has lost most of its original meaning. Scien–

tific conferences are becoming places where people try to blurt out their life's work in 15 minutes and succeed only in giving each other headaches.

Various computerized solutions have been offered to this problem, but Chatfield's strikes me as one of the most promising. The general idea is that a publication should be a conversation with the author. Even in the most abstract subjects, we learn by doing: by asking questions, by searching for more information, by disagreeing, by sounding off, by making mistakes, and above all, by carefully reformulating what we have taken in. It doesn't take a very sophisticated computer program to enable all this to happen; it's a matter of creating fictional characters who allow openings and make responses, often based on nothing more than finding a keyword in the reader's input.

Here's an example that shows how this can help the writer, especially if he has writer's block. In a recent paper I wrote the sentence "Von Neumann defined propositions as projections on Hilbert space." I then wondered whether I should define the word *projection* and state some basic theorems, or perhaps give some background on measurement theory showing why von Neumann's definition makes sense. No, says one voice in my head; if the reader doesn't know what a projection is, he won't even have read this far. But on the other hand, says another voice, if the reader's memory is a bit hazy, a definition of projection would be both a reminder and a reassurance that his forgetfulness is OK – otherwise he might be embarrassed and I would lose him to less embarrassing reading matter. But then again on the other hand, says the first voice, when a knowledgeable reader comes to that definition he'll say "Yeah, yeah, I know all that – get to the point.", and I lose him to something more challenging; in any case, the definition takes up room and breaks the flow.

The dilemma here is the very stuff of writers block. In an interactive article, however, the dilemma evaporates; I would simply follow my sentence with a break for the reader's reaction. Here's a possible dialogue:

Interactive Article. Von Neumann defined a proposition as a projection on Hilbert space.
Reader. What does that mean?
Article. Do you want me to define projection, or do you want to know what motivated von Neumann's definition?
Reader. The latter.
Article. Eh?
Reader. His motivation.
Article. Oh. Alright, consider the following measurement situation etc.

Since the program was looking for such a question from the reader, it didn't have to do any very fancy parsing of his input to choose its reply; it only had to notice the word "mean", and then later the word "motivation" which it had already handed to him. Here's another possible dialogue:

Article. Von Neumann defined a proposition as a projection on Hilbert space.
Reader. That's wrong! He defined it as an ortho-projection.
Article. Of course you're right. I over-simplified, since we are eventually going to extend his definition to projections in general; we'll discuss ortho-projections a little later after some theorems about inner product.

If this very knowledgeable reader hadn't had a chance to complain at this point, he would have privately had the same thought anyway, followed by "That Etter doesn't know what he's talking about!", and I might have lost a big fish. I suspect that most of the soporific legalism in academic writing comes from trying to head off the "That's wrong!" from which there is no appeal. If the author can "answer" all the reader's anticipated criticisms, he can hang a lot looser as he writes.

We've looked at what the interactive format can do for the writer, but what can it do for the reader?

When you are reading and eagerly following a fascinating train of thought, one of the most frustrating things that can happen is to be stopped cold by a word you don't know, or whose meaning, as you remember it, doesn't seem to fit the case. You look it up in the dictionary and stumble over six other unknown words. Determined to get to the bottom of the matter, you get out the textbooks and try to give yourself an instant crash course in thermodynamics, or group theory, or whatnot. Reeling from overload, and hope-lessly confused, you return to what you were reading none the wiser, but with your enthusiasm spent.

All this frustration could be avoided if only you could ask the author what he means. Sometimes the right answer would be a simple definition. At other times, the author would realize that he needs to change his tack: "Look, you really don't have to know the technical meaning of 'idempotent' – I can make my point here with a simple example etc.". But then occasionally he will recognize that he has taken you beyond your depths: "I think you'll have an easier time with this if you'll go have a chat with Prof. von Altmann about linear algebra in quantum theory, and then come back and reread this section."

This kind of author's response is an easy job for the proxy author in an interactive article. The Inrac programming environment will have an expandable "dictionary" of standard terms to take care of routine reader requests for definitions without the human author having to plan for these requests. The human author will sometimes write different versions of the same text for readers with different backgrounds, their backgrounds being inferred from the words they stumble over. When the need for more background is unavoidable, Prof. von Altmann will always be waiting in RAM for the reader to chat with.

Just as the most important thing a psychoanalyst can do for a patient is to give him a chance to talk, probably the most important thing an interactive text can do for a reader is to give him a chance to write down his thoughts. That's how we learn. It's also how we invent: much excellent writing has been commentary on what the writer was reading. The interactive format will record the reader's responses if he so wishes; thus every reading of an interactive article is potentially another article.

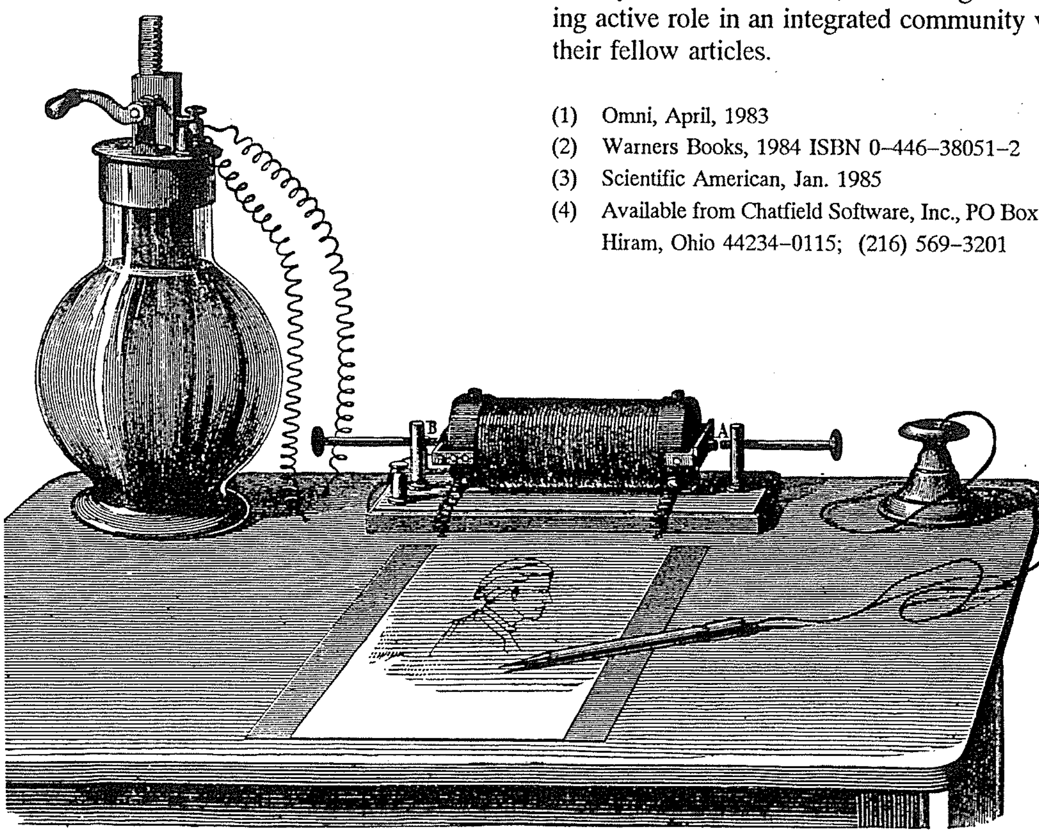
Let's now turn to practicalities. How does the would-be author of an interactive article proceed? He can of course write it in a general-purpose language like Basic or Pascal, but this is very tedious and time-consuming. Or he can write in Inrac, which has a range of special commands for situational parsing etc., plus some prose-generating resources that are useful for adding variety, and for addressing the reader more specifically. Acquiring skill in Inrac takes study and practice, though, and for ANPA West I see a different way to proceed.

Mostly our authors will be trying to get across their own ideas rather than trying to create wide-ranging conversational programs, so their interactive protocols can be fairly simple and standardized. In the early stages I'll supply these protocols and show the author how to fill in the particulars. As soon as possible, though, the author won't be dealing with me but with Dr. Inrac and his staff, who will be characters in a special interactive "article" which has the ability to generate new Inrac files. In effect, Dr. Inrac is enlisted as the co-author of the intended work, accepting text from his human partner and doing the technical part of the interactive programming.

Our goals for the first interactive issue are modest; it will be something like a cocktail party for getting acquainted with our authors, with a few speeches and discussions on the side. From then on we'll be feeling our way; this is an experimental venture, the first of its kind.

One last word on the general nature of interactive text. Written text as we know it grows linearly. Written knowledge is an ever-increasing accumulation of new things for the reader to master, until he is eventually overwhelmed. Interactive text, on the other hand, has another direction to grow in – it can grow as an accumulation of hidden resources for meeting the reader's needs. An "article" of interactive text may give the reader less to cope with rather than more. I hope to see the ANPA text world grow in this way, with successive articles not going side by side onto the shelf, but finding an ongoing active role in an integrated community with their fellow articles.

(1) Omni, April, 1983
(2) Warners Books, 1984 ISBN 0-446-38051-2
(3) Scientific American, Jan. 1985
(4) Available from Chatfield Software, Inc., PO Box 115, Hiram, Ohio 44234-0115; (216) 569-3201



EDISON'S ELECTRIC PEN.

NEWS AND EVENTS

Fred Young, currently president of ANPA West, is now president elect of ANPA worldwide, and will assume his new office at the beginning of next year. For those needing to contact him, his address is 128 Lyall St., Los Altos, CA 94022; phone (415)–949–4728

ANPA West will hold its 7th annual meeting at Cordura Hall, Stanford University, on the weekend of Feb. 16 and 17th, 1990. Informal discussions can continue on Monday Feb. 18, which is a Federal and school holiday. We expect papers by Tom Etter, David McGoveran, Pierre Noyes, Eddie Oshins and Fred Young, and we may also hear from Lou Kauffman and Pat Suppes. There will be the customary banquet at a local restaurant on Saturday night (Feb. 16), followed by the presentation of the ALTERNATIVE NATURAL PHILOSOPHY AWARD, which this year will go to Eddie Oshens.

There are a number of organizations in the Bay area that hold regular meetings which ANPA members might be interested in attending.

Parapsychology Research Group
3320 Sacramento St., SF, CA 94115
(415) 931–2593

This organization has for a long time been the Bay Area center for parapsychology; it sponsors research, publishes reports, and holds monthly meetings open to the general public at which many well–known scientists from diverse fields have spoken. The next meeting will be on Tues. Dec. 11, 1990, and the speaker is Nick Herbert, who will tell us about *Building a Quantum Mind Link Proposal for "Really New" New Physics.* The meeting after that will be on Tues. Jan 8, 1991, and features Glen Rein, PhD., and Leonard Laskow, M.D., who entitle their talk *Psychoenergetic Mechanisms of Healing; Role of Non–Hertzian Fields and Consciousness.*

The meetings are held at the above address and begin at 7:30 for socializing, with the talks beginning at 8:00. Write or call them for more information.

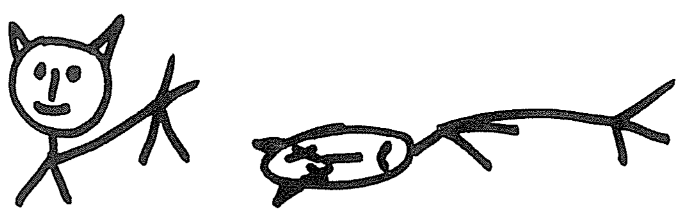
Consciousness and Science Discussion Group: Next Meeting: Dec. 14, 1990

- Place: Room N721, School of Nursing, U.C. San Francisco
- Speaker: John R. Smythies, Inst. of Neurology, U. of London, now Visiting Scholar, Philosophy Dept., Stanford.
- Topic: Brain and Consciousness.

If you want to attend, contact Kainila Rajan at (415) 735–8647/8648 or Jean Burns at (415) 481–7507. This is a new group, organized by physicist Jean Burns who several years ago helped found the Consciousness Research Group in the East Bay, and computer scientist Ravi Gomatam who organized a recent San Francisco conference on the study of consciousness in science. Recent speakers have included Henry Stapp and Ravi Gomatam. *(cont. on page 59)*

Schrödinger's Cat and the Cheshire Cat — Quantum Mechanics and Laws of Form

by Louis H. Kauffman



Schrödinger's Cat and the Cheshire Cat

– Quantum Mechanics and Laws of Form

by Louis H. Kauffman

I. Introduction

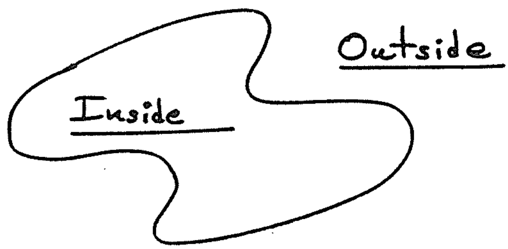
It is the purpose of this note to point out a deep relationship between the quantum mechanical viewpoint and the fundamental context of Laws of Form [4]. In the course of this discussion we shall also see the issues of indistinguishables [3] and the combinatorial hierarchy [1] in a new light.

This note is only a sketch of these relations. It is a first attempt to articulate matters that dive below the surface formed through words. A raid on the inarticulate is a foray into the inchoate.

II. Descent into the Form

Consider a distinction.

Let the distinction be drawn and
Let it be seen
To sever a space
Into
Inside and
Outside.



Let these states
of inside and outside
Be denoted
By I (for inside)
And O (for outside).

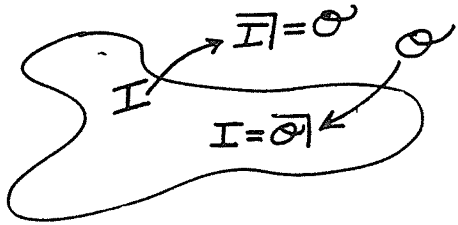
And let us agree upon
A transformation

$$X \mapsto \overline{X}\rceil$$

That takes
Inside to Outside
And
Outside to Inside.
And so we have
The equations

$$\overline{I}\rceil = O$$
$$\overline{O}\rceil = I.$$

Crossing from inside yields outside.
Crossing from outside yields inside.

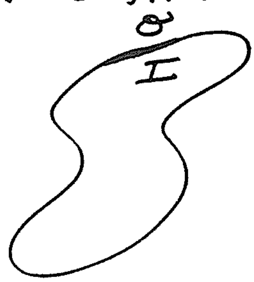


Here we have the
Language of
Not.
Not this, then that.
Not outside, then inside.

And O and I are surely names.
And ye could surely let us
Rest a bit
From the
Rigors of Infinite Repetition
By
Agreeing
That O being <u>identical with</u> O
(In the first place)
We could allow a bit (a wee bit)
Of
<u>Condensation</u> with
$OO = O$
and
$II = I$.

This can do no harm,
But if we would be counting then
Thee must re-think these
Collapses from infinity.

Be that as it may,
Here we are
In the very simple language
Of a first distinction.



$$\overline{\theta}\rceil = I \qquad \theta\theta = \theta$$

$$\overline{I}\rceil = \theta \qquad II = I$$

No quantum logic here.
This is the boolean realm.
Nor is this Laws of Form.
No, not yet.

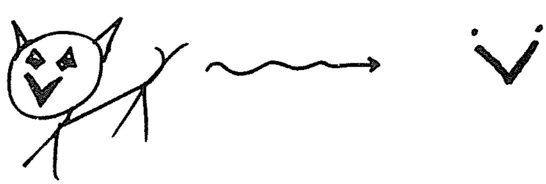
But look here.
Ye had best worry and worry well
On these collapses of identicals.
What gives here?
Can $\theta\theta = \theta$ if θ and θ are
Yet the same.
Can one yield two and still be one.
Aye 'tis a giant step that
And I'd not be trusting these

Mathematicians
Who think that
All you have to do
To count
Is just write down your
Rows of identicals that
Are not identical.
|, ||, |||, ||||, |||||, ||||||, ...
The whole world of definite
Solid
Clear
And perfect
Arithmetic
Is built on
A consideration of
A stroke

That
Is itself /
And
Is not itself //.
The very
Economy
Of our speech and reference
Is indivisibly woven
In the fabric of condensation.
In the context of
Fusion of
Likes and Nearly likes and even Un likes.

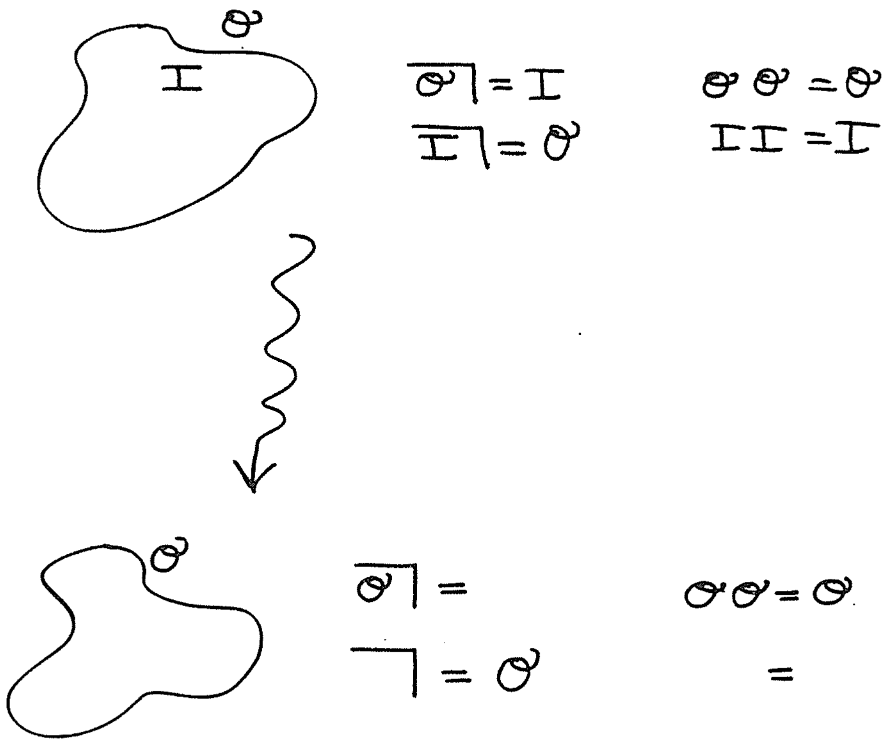
We walk above the
Shifting sands of
Chaos and Paradox.
And
Imagine
Solid Ground.

And yet there is something
Definite in this speech
And thee may suspect
That 'tis a creation
of the definite reference
of θ and I.
Let us embark on the
Story of the
Cheshire Cat.
(A precursor to Schrödinger's cat)
That Cheshire cat was
Neither alive nor dead
When he became
Nothing but
His smile.



The slightest mark will do.

And so we shall
Eliminate the I.



But this is
Half-way down.
Ye still can see 'his body
Through the fog.
The outside disappears as well
If inside you no longer tell.
But if the transform you will
Keep,
Then outside lives

Above the deep
As that which is
Not void.
And so we see
Writ large and clear
In these equations
For our ear

$\overline{\theta\,\vert} =$	:	not out is void
$\urcorner = \theta$	:	not void is out
$\theta\theta = \theta$	:	out out is out
$=$	:	void is void

No point in keeping θ around.
We'll just allow him to sink
Into the ground
Of transformation

$\urcorner$

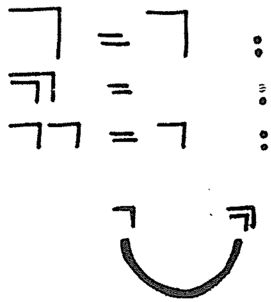
And we find

$\urcorner\urcorner =$

$\urcorner\urcorner = \urcorner$

The primary forms of
Indication's kind.
A mark ($\urcorner$) to mark a side.
A mark ($\urcorner$) to indicate the passage from the void.
A harmony of language on

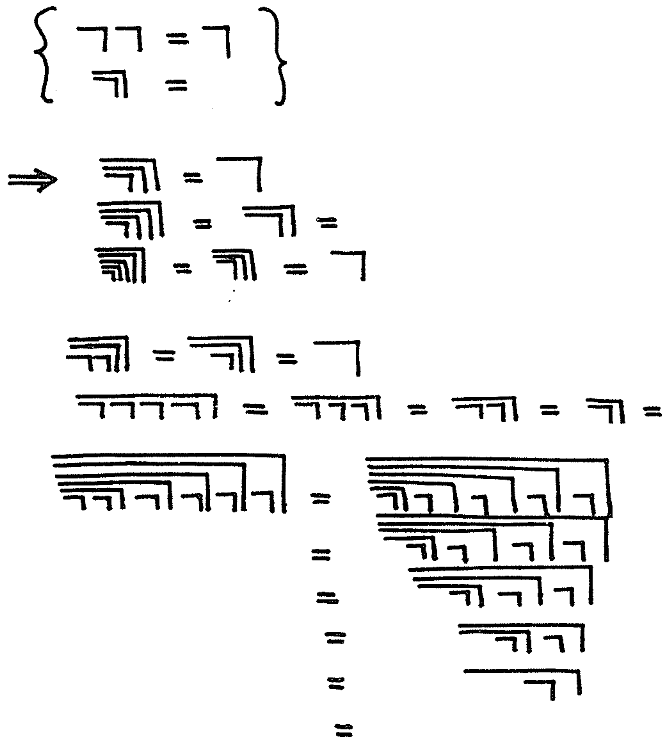
Arrival from
The other side.



<u>cross from void</u> equals <u>marked</u>
<u>cross from marked</u> equals <u>void</u>.
<u>marked marked</u> equals <u>marked</u>
(in the first place)

This completes the first descent—
Into the form.
"We take therefore the form of
distinction for the form."
It is not the mark (⌉) that
Marks this place, but the
Process of descent.
The process of going down,
Down into the
-east saying
Before
Silence
Overwhelms
The urge
To speak.
"Whereof we cannot speak we
must [choose to] remain silent."

III. Abandon Form to Indication



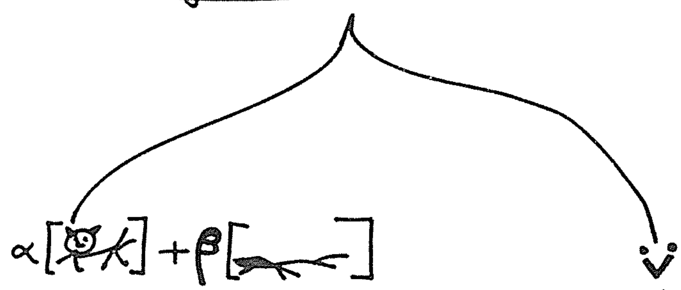
IV. Abandon Indication to Void

V. Schrödinger's Cat

This famous cat has gone well beyond the strictures of boolean logic. Unobserved, this catus is in a state of possibility. Not alive, not dead, described by a wave function, not-pinned-down and yet ready to spring forth into an eigenstate at the behest of an observer who opens the box.

The place fundamentale of confluence between the quantum scenario of the cat Schrödinger and the cat Cheshire is in

<u>ambiguity</u>.

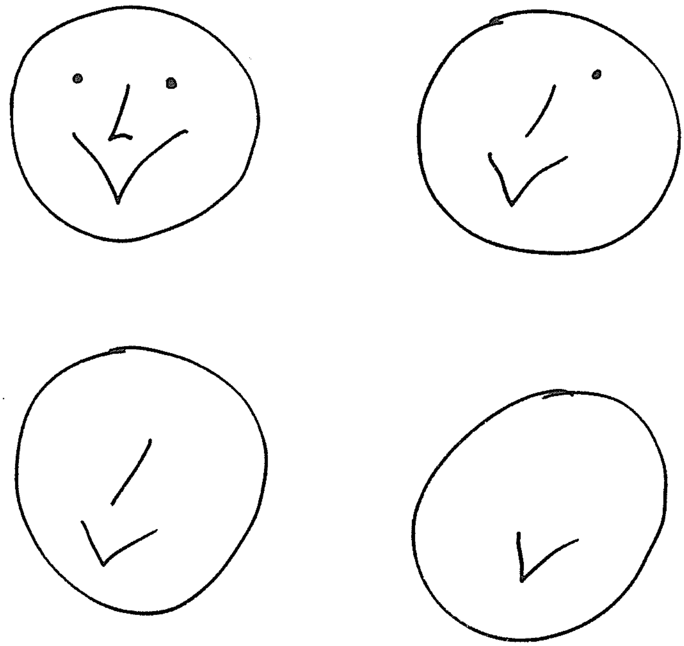


Schödinger Mixed State

Cheshire Mixed State

In the <u>Schrödinger mixed state</u> we live way <u>above</u> $\overline{I \urcorner \Theta}$ and indicate the confusion of possibilities by a linear superposition in Hilbert Space: $\alpha I + \beta \Theta$.

In the <u>Cheshire mixed state</u> we live way <u>below</u> $\overline{I \urcorner \Theta}$ and indicate the possibility of possibilities by a mark $\urcorner$ regarded as the smile of the cat. 

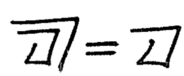


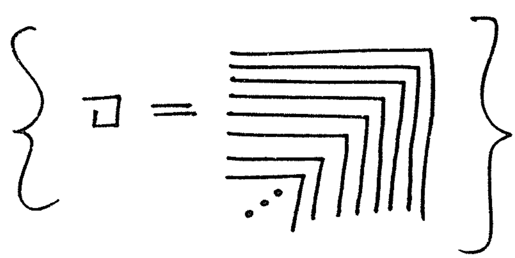
A Cheshire state unfolds into its multitude of "real" possibilities. The power of Laws of Form lies in its ability to evoke fundamental Cheshire Cat states near (as close as humanly possible) the first distinction.

As we go back up into articulation from Cheshire state the cat becomes real once again, but the process of becoming real is organic unfoldment, not mechanical eigenprojection. As quantum mechanics matures, it will become apparent that there is a whole world of quantum mathematics and quantum description that intermediates between the pure Cheshire world and the pure Schrödinger world.

A simple example of this intermediation is the emergence of eigenforms, the simplest being,

with





Here ⌉ is a "vector" of eigenvalue one for the operator ⌉. But ⌉ is a vector in a Hilbert space of forms and ideas, the non-numerical explosion from the void occasioned at the cusp of paradox/time/self-reference.

VI. Quantum Logic

The first step in classical quantum logic is the orthogonality structure of subspaces of a vector space. Let V be a vector space (say $\mathbb{R}^n$) with a standard inner product, hence notion of perpendicularity. Let $a \cdot b = 0$ mean a perp to b, and write

$$a \perp b \iff a \cdot b = 0.$$

If $W \subset V$ is a subspace, let $\overline{W|}$ denote the subspace perpendicular to W:

$$\overline{W|} = \{ v \mid v \cdot w = 0 \ \forall w \in W \}.$$

Then

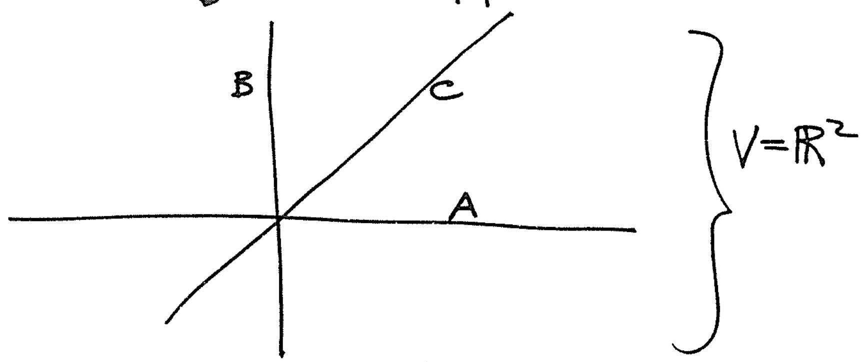
$$\overline{\overline{W|}|} = W$$

for any subspace $W \subset V$.

Let WW' denote <u>the subspace spanned by W and W'</u>.

Thus $WW' = \{w + w' \mid w \in W$ and $w' \in W'\}$. Also, let $W \cap W'$ denote the intersection of W and W' and (by analogy) let $W \cup W' = WW'$. Thus $\cup$ is not set theoretic union.

We then see that this algebra of subspaces is decidedly non-boolean. For example



let V be the plane, $\mathbb{R}^2$. Let A, B and C be the one-dimensional subspaces depicted above. Then $A \cup B = V$, $A \cap B = \phi$ (ϕ = the 0-subspace). But

$$(A \cup B) \cap C = V \cap C = C$$
$$(A \cap C) \cup (B \cap C) = \phi \cup \phi = \phi .$$

Thus the distributive law does not hold.

While $\overline{A} = B$, there are infinitely many intermediate states C. While each such state

C is <u>generated</u> by A and B (since A∪B = V) these intermediate states are nevertheless completely distinct from A or B taken separately. It is only through the cooperation of A and B that these intermediate states arise.

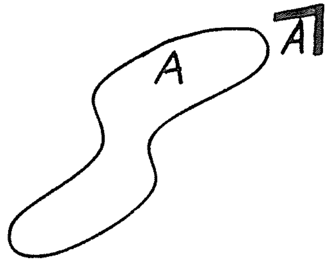
This is exactly the situation in the logic of quantum mechanics that gives rise to complementarity, the catus Schrödinger, non-locality and all manner of seemingly strange things.

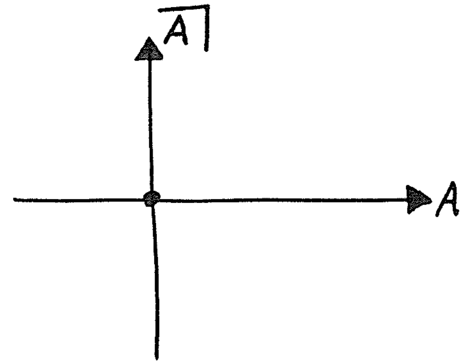
Nevertheless, we can understand this logic through the patterns of geometric orthogonality, and via the understanding that

A and $\overline{A}\rceil$

denote fully complementary spaces in a wider space. That A and $\overline{A}\rceil$ taken together generate a new space of even greater possibility than either taken separately. This is the moral of negation in the quantum logic.

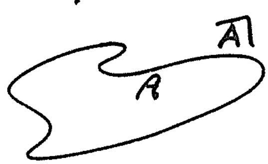
How are we to see this extra dimension in the picture of two sides?





All that space in-between,
Is it real
Or is it
Imaginary?

We must begin to
See the
Usual
Distinction/Form



As a
Cheshire Cat.
Apparent exclusivity
Is only the
Smile.
The
Whole is
Much Greater
Than the parts.

The models of
Orthogonal Subspaces
Or
Non-boolean lattices
Helps us
Follow a
Precise way
Into
Spaces of
Possibility.

Return now to
The Mathematics.

__Theorem__. $A, B \subset V$ subspaces.
Then

$$A \cap B = \overline{\overline{A}\rceil\,\overline{B}\rceil}\rceil .$$

__Proof__. $v \in A \cap B \Leftrightarrow v \in A$ and $v \in B$

$\Leftrightarrow v \in \overline{\overline{A}\rceil}\rceil$ and $v \in \overline{\overline{B}\rceil}\rceil$

$\Leftrightarrow v \perp \overline{A}\rceil$ and $v \perp \overline{B}\rceil$

$\Leftrightarrow v \perp \overline{A}\rceil\,\overline{B}\rceil$ (check it!)

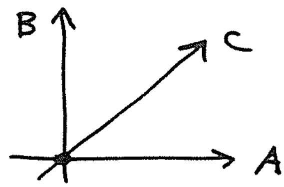
$\Leftrightarrow v \in \overline{\overline{A}\rceil\,\overline{B}\rceil}\rceil$.

QED

Thus, we see that this
Algebra of Subspaces
Can be expressed in a
Formalism

Quite similer to the
Algebra of Laws of Form.
But the law of transposition fails:

$$\overline{\overline{A}\,B}\;C \neq \overline{\overline{AC}\;\overline{BC}}$$



Other laws hold, and this
Heralds an
Investigation of
Axiomatics.
(To be done elsewhere, but note
that $\overline{\overline{A}\,B}\,A = A$, $\overline{\overline{A}\,A} = \phi, \ldots$)

But now it is
Time for
Tea.
New cups.
New cups.
Move down,
Move down.

VII. Beneath Quantum Logic

Let the zero subspace ϕ
Be denoted by
Void.

Then $\overline{V}\urcorner = \phi$ $\quad VV = V$

$\overline{\phi}\urcorner = V$ $\quad \phi\phi = \phi$

Becomes

$\overline{V}\urcorner =$ $\quad VV = V$

$\urcorner = V$ $\quad =$

A familiar scenario.

But now we are
Invited
To
Identify the
Operation of ortho-complementation ($\urcorner$)
With the
Whole space (V).

We are invited to identify the operation of complementation with the whole space. We are invited to find that the space of possibility is itself the transformation into the complementary point of view.

Space in and of itself
Can no longer be regarded as
An object.
Space is dynamic.

Space is the transformer of the Void.
And,
(Unfolding the Cheshire Cat)
Space (Whole space)
Acts
Upon its (Subspaces)
To produce
The logic of orthocomplementation in
A
Non-boolean mode.

In the land of the
Cheshire Cat,
At the level of
The Smile,
There is only
Space/Transformation /ㄱ
and
Void.
In this rarefied form of
Indication,
The distributive law holds:
$((())(())) = (()())()$.
And the primary algebra of
Laws of Form is
Seen as
The smile of the cat,
As Schrödinger's cat
Dissolves to Void.

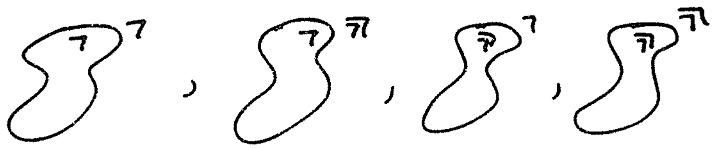
The space of quantum logic
Is a space distinguished by
An observer.
The observer and the space
Are,
In the Form,
Identical.
It is a fantasy of observers that
There is great importance to the
Distributive, boolean algebra of $\urcorner$ alone.
We have seen that the
Importance
Lies (sic)
In the
Potent
Condensation
Of a
Smile.

VII. <u>Indistinguishables</u>

$\urcorner$ and $\urcorner$ are indistinguishable.
And yet,
$\overline{\urcorner}\!\!\urcorner =$
While
$\urcorner\urcorner = \urcorner$.
Distinction is relative in the
Realm of
Language.

VII. <u>Hierarchy</u>

Here the program is to closely abide in the hierarchies arising from distinctions that arise from given realms of distinction. To use vectors and matrices (as in the Combinatorial Hierarchy [1]) is fine but needs to be slowed down so that we see the genesis of those very structures (vectors, matrix mappings) from the most primitive levels. I beg off doing this here, but point out that if we are <u>given</u> a distinction with evaluations ⌉, ⌉⌉ for its sides



then there are four possibilies (both sides marked, one marked, other marked, both unmarked) and <u>transformations of these states arise</u>. (Flip one side, Flip other side, Interchange, Leave alone) And this is a short step from the Pauli matrices, spinors, quaternions and the first levels of the Combinatorial Hierarchy. Matrix algebra unfolds from the smile of the Void.

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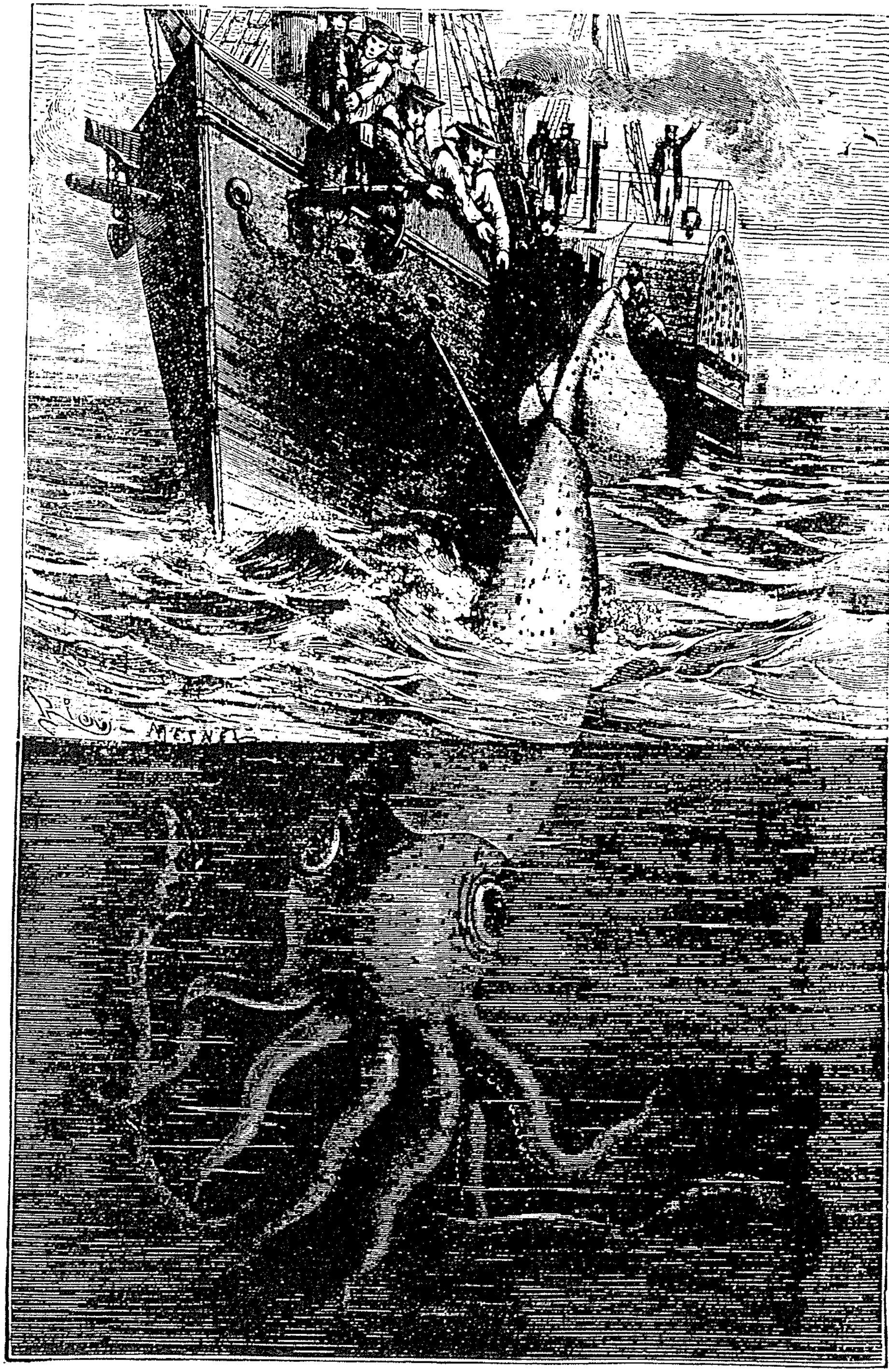


INERTIA AND TAO

by Thomas Etter

The Tao that can be expressed is not the eternal Tao.
Tao Te Ching, line 1.

In fragmented times, wholeness arrives on the scene in the guise of a neglected fragment. This happened in the early 17th century when Galileo finally grasped the meaning of inertia. His insight, at first an apparently minor detail in the lowly science of mechanics, quickly silenced the Aristotilean doubletalk about motion that had plagued medieval physics, and led to our modern unified conception of the physical world.

The word inertia literally means a tendency to remain inert, at rest. To move something at rest, we must make an effort, give it a push, apply a force. In most cases we don't distinguish the effort that starts the thing in motion from the effort that keeps it moving. There are some common exceptions, though; for instance, when we catch a ball the force we apply is not to move something but to stop it. Now the significance of these exceptions, which is obvious to us today, is that the inertia of an object is not a tendency to remain at rest but a tendency to remain in a state of uniform motion. It's an amazing example of "cultural inertia" that Aristotle's blindness about this became everyone else's blindness for 1900 years after his death. Even Kepler, despite his willingness to give up Aristotle's doctrine of circular motion, still thought that the sun must radiate a force to keep the planets moving in their elliptical orbits.

The West has always favored the strenuous life, its war-like gods urging us ever onward to victory over one thing or another: the Matterhorn, the infidel, sin, nature (including human nature), poverty, disease, ignorance etc. The civilization of China, though no less turbulent than ours, and no less energetic at its peak, developed a rather different philosophy of action, summed up in the word Tao.

Tao has no single definable meaning, but is rather the nexus of many strands of meaning. When you follow the Tao, you don't force things to happen, you let them happen. This doesn't mean walking away from them, but getting into harmony with the prevailing "state of change". For us, a state of change in human affairs means a trend, such as a rising stock market, caused by prevailing conditions. For the Taoist, on the other hand, causality is not of the essence, and the Tao can manifest itself in meaningful coincidences; for him the state of change is not something we intellectually understand and make use of, it's something we are inseparably part of.

I propose that Tao, interpreted as the state of change, is nothing mystical or inexpressible, but fits quite well into the vocabulary of Western science. Furthermore, I propose that it is a concept we desparately need, a crucial fragment of wholeness for our fragmented culture. And furthermore, and here is something to chasten our pride in progress, it is nothing more nor less than the 400-year old Galilean remedy all over again!

Tao is inertia, on a larger stage.

In our current obsession with conputers and computer modelling, which is part of a long–term trend toward seeing the world as "information", we have regressed to Aristotilean physics. The computer subroutine is the perfect paradigm of an Aristotilean object, and illustrates his four causes, the material, formal, efficient and final, in a way that we can easily grasp today. The material cause of the subroutine is its implementation in hardware. Its formal cause, i.e. what defines its unity as an object, is its description in some programming language. Its efficient cause is its call by the program. And its final cause is its role in the program as a whole, i.e., what it does.

Aristotle's four causes make good sense when we are making plans and devising practical procedures. Their fatal flaw, as a basis for physics, is that they leave no room for orderly but uncaused change. And yet this is exactly what confronts us when an object glides by without anything pushing it. In the absence of friction, steady motion is a succession of uncaused changes of position. When causality completely dominates our thinking, inertial motion, even though it is a commonplace of experience, is inconceivable. Tao is also a commonplace of experience, but in our current neo–Aristotilean mindset it's as foreign to us as inertial motion was to the medieval scholar.

Inertial motion became conceivable through a historical process that we shouldn't try to imitate too closely, since it involved manipulating new ideas in such an alienated abstract way that they never effectively challenged our gut level mistakes. Aristotileanism was never actually scrapped, but rather was cut loose from its biological and ethical roots, leaving it to wither away. It eventually degenerated into "flowchart thinking", with efficient causes becoming inputs, final causes outputs, and formal causes the functional relationhip between the two. The material cause was pretty much forgotten as the substantiality of matter itself evaporated, leaving in its old place merely an extension of the flowchart.

It's important not to make all of this into a morality play with Aristotle and abstraction as the bad guys. The canoe is a fine form of transportation, if you don't try to paddle it to the moon. Aristotle's physics is a very good instrument for limited purposes. Though abstraction is dangerous and can lead to deep alienation, we sometimes really need it to get around the emotions that defend our errors. In fact, we need it right now.

The concept of inertia is captured succinctly by Newton's first law: In the absence of external forces, an object moves in a straight line at uniform speed. Here's another way to say this: A freely moving body follows a geodesic in a space–time (a geodesic is the shortest path between two points). Here's a third way: a freely moving body follows a space–time path of least action, where action is defined as the time integral of energy. What's interesting about this third definition is that it remains true even when the body is subject to a force like gravity; the principle of least action can be taken as a starting point for all of Newtonian mechanics.

In Einstein's general theory of relativity, a body moving in a gravitational field follows a geodesic in curved space–time, thus satisfying our second definition of inertial motion. Could it be that all mechanical motion is inertial? Relativity breaks down the distinction between space–time and matter, so Newton's first law in its original form no longer has a clear–cut meaning; prior to objects, there is no space and time within which uniform motion can be defined. The essence of inertia seems to be more general than we first thought; something is minimized, whether it be distance or action or whatnot.

Eddington had a very appealing idea about what is minimized, namely improbability. This would mean that there is only one ultimate law of physics: events take the least improbable course! More exactly, he proposed that action is what Shannon called information, defined as the negative logarithm of probability. The path of least action is then the path of least information, which is also the path of greatest probability. Note, and this is important: this path is not the most probable path given where something starts, but the most probable path given where it starts together with where it ends up.

Eddington's idea runs afoul of quantum mechanics. But it was a near miss, and is worth a closer look. By basing physics on probability and information, it extends the concepts of physics, including inertia, to any situation in which there are recurring events which can be counted. If it were true, it would mean that the prevailing state of affairs always has a component of momentum, whatever affairs it may prevail over.

When momentum is negligible, as when inertial forces are overwhelmed by friction, Aristotilean flowchart thinking applies. This is the case in most of chemistry, and also in most of the information sciences, especially computer science, where the only role of inertia is to regulate the speed of the computer's clock.

What about momentum in human affairs? Remember, we're not talking now about the mechanical momentum of cars and baseballs but Eddington's momentum, defined only in terms of probability. Human affairs momentum, if it exists, is a drift, a trend, among many events. But, and this is its signature, it's an uncaused trend, a manifestation of coincidences among events that are causally iso–lated. It's like the unforced motion of the sled gliding by on frictionless ice, only it's not all gathered together in one package like a moving sled, but is distributed among the many things we are doing.

Nonsense! says scientific common sense, i.e. Aristotilean flowchart thinking. However, modern physics is not scientific common sense, and there is one quantum–mechanical phenomenon that is very suggestive of Eddington's momentum: superconductivity. If you start an electric current circulating around a superconducting ring, it circulates forever, or until you apply a force to stop it. This isn't because it's isolated from frictional contact, like a planet going around the sun; the individual electrons bump into atoms and get confused just as common sense and classical physics say they should. What makes for super–conductivity – and this is the really weird part – is that the electrons making up the super–current come is pairs that get confused in exactly opposite ways; if husband zigs, then wife zags, even if she is on the opposite side of the ring, and even if the ring is the size of the galaxy!

When you think you can visualize a quantum effect, you've probably got it wrong, and the above account is not to be taken literally. What it omits is that the coupled zigs and zags of husband and wife are inviolably private; they are in a deep sense unobservable. It's not just that you can't, in fact, observe them – it's that if you even imagine observing them, even with the serene detatchment of Apollo, you will get the wrong numbers. This is how Eddington's proposal runs afoul of quantum mechanics: it only involves probabilities, and since probabilities can always be imagined as case counts among observable events, it gives the wrong numbers.

It can be fixed, though. Actually, fixed is the wrong word; it can be reinterpreted in a more subtle way that allows for the mutual privacy of case counts so as to make it consistent with quantum mechanics (see appendix). With this modification, the Eddington inertia in human affairs and the inertia of the gliding sled are now instances of the same general concept; let's call this general concept the Eddington Tao.

Like the oversimplified "probability Tao", the Eddington Tao is a manifestation of uncaused coincidences. These are mostly private, though, like the zigs and zags in a superconducter; as individual events they are logically unknowable, or to put it even more strongly, they don't enter into history. Why bother with them, then – how could they make a difference? The answer comes from physics: they are only private indivually, not en masse. The super–current constituted by the zigs and zags of enough paired electrons is not only observable, it can float a train.

Coda: Where do we go from here?

What would be the experimental science of the Eddington Tao? It must address itself to private events, which are most likely to be:

1. Individually small (low energy).
2. Tied to ongoing human activities and concerns.
3. Individually uncaused, e.g. triggered by "random" fluctuations.
4. Individually forgotten, leaving no trace.
5. Accessible through some aspect of their group behavior, an aspect that leaves reliable records and that we can interact with in a planned way.

I believe that the best arena in which to start looking at such events is a virtual computer world. This world should have a number of human "inhabitants", or regular visitors, and it should have an ongoing history in which they are humanly involved. For simplicity we should start with an interactive text world; later we could add graphics, music, force feedback etc. The nice thing about a computer is that it lets us carefully control just which events are remembered, which are forgotten, how forgotten events are averaged or otherwise combined into remembered events, and how randomness enters into the flow of events.

As in traditional science, we can expect theory and experimentation to develop apace. However, I suspect that it won't be so easy to practice this new science from a distance through abstract manipulation. The Tao is only accessible to those who have some inclination to follow it.

Appendix: Quantum and Tao.

A mathematically precise definition of inertia that includes the workings of the Tao in human affairs cannot be found in present-day physics. Proposals for "quantum models" of human events miss the mark; quantum ideas, though suggestive, are much too narrow. What's needed is an essential generalization of quantum theory that applies to a much wider range of situations than the mass behavior of small bits of matter. I believe that this need can be met by a general theory of amplitude, of which this appendix is a brief sketch.

Amplitudes in quantum mechanics resemble probabilities in that they apply to propositions, and satisfy the same additive and multiplicative laws, i.e.:

Rule 1. Amplitudes add for mutually exclusive cases.

Rule 2. Amplitudes multiply for independent cases.

They differ from probabilities in that they can be less than 0 or greater than 1; indeed, any real number can be an amplitude (complex amplitudes are pairs of real amplitudes). Pascal defined probability as the number of favorable cases divided by the total number of cases. There is an analogous definition of amplitude as the number of favorable cases minus the number of unfavorable cases divided by a normalizing factor; we shall not make use of it here, though, since it involves developments in logic going well beyond our present topic (refs.).

Amplitude will be taken as an undefined concept, subject to rules 1 and 2. It will be convenient to regard amplitude as an attribute of sentences; rules 1 and 2 then become:

Rule 1. If sentence A contradicts sentence B, amp(A or B) = amp(A)+amp(B).

Rule 2. If sentences A and B are independent, amp(A&B) = amp(A)amp(B).

The consequences of these rules will be explored using the predicate calculus, not as an artificial language, but as a tool to pull apart ordinary sentences at boundaries marked by words like "and", "or", "not", "some", "all" and "is". The sentences in question may be about electrons, or football, or true love; all we are concerned with is how their amplitudes relate to their "logical grammar". We shall see that quantum theory emerges as a natural large-number case in any universe of discourse to which amplitudes apply, with quantum probability being a special case of amplitude itself.

Quantum Theory

Most introductions to quantum mechanics define the quantum state of an object as a unit vector in Hilbert space subject to the following two rules:

Rule 1.1. Observation: The probability that an object in state v will pass a test for state w is the square of the absolute value of their inner product.

Rule 2.1. Dynamics: A change of state, whether due to the passage of time or change of viewpoint, is given by a unitary transformation of Hilbert space.

These two rules sum up quantum theory proper. Despite their esoteric appearance, we shall see that in essence they are just rules 1 and 2 of amplitude theory.

A point of Hilbert space, referred to a particular basis, is an amplitude distribution on some variable, e.g. a wave function on the position variable. We'll be taking a kind of "wave function" approach here by studying the amplitudes of sentences containing state variables. Von Neumann prepared the way for this approach with his important insight that projections on Hilbert space correspond to propositions about the outcome of measurement. If we think of a (pure) state as a projection onto a 1–dimensional subspace, then rules 1.1 and 2.1 become:

Rule 1.2 The probability of a proposition P given a state (ray projection) R is trace(PR).

Rule 2.2 A change is represented by a unitary transformation T which takes any proposition P into the proposition TPT^{-1}.

Bohr's concept of complementarity can be simply described in terms of projections: To say that two propositions P and P' are complementary means that, as projections, they don't commute. If they do commute, then the projection PP' is the proposition P AND P'. If they don't, then PP' isn't even a projection, which clues us in to the fact that "P AND P'" is a nonsensical phrase; it's not a proposition at all.

PP' = 0 means that proposition P contradicts proposition P'. Define a *spectrum* to be an exhaustive set of mutually contradictory propositions, i.e. a set of projections whose sum is the identity operator, and all of whose products are 0. Spectra lead naturally to two other concepts which play central roles in quantum physic: density operator and observable.

A mixture of (pure) states can be represented by a weighted sum of a spectrum of ray projections; such a sum is called a von Neumann density operator. Since trace(A+B) = trace(A)+trace(B), and probabilities are additive for mutually exclusive conditions, rule 1.2, stated in terms of projections, can be extended to mixtures, i.e.

Rule 1.3. prob(P) = trace(PS) for any proposition P and density operator S.

We begin to see the mathematical power of the projection approach when we realize that there is no analogous generalization of rule 1.1. This power shows itself again in the treatment of averages, which are the very stuff of experimental physics. Suppose we measure a quantity q. Then propositions of the form "q=2", "q=3" etc. are mutually exclusive, and the set of all of them form a spectrum of projections P_q – call it the spectrum of q. Now the average of q for a state S is the sum of all values of q weighted by their probabilities. By rule 1.3 this average is $\sum \mathrm{trace}(P_q S)q = \mathrm{trace}((\sum P_q)Sq)$. The self-adjoint operator $Q = \sum qP_q$ is called an *observable,* so this result can be stated as:

Rule 1.4. The average of observable Q given state S is trace(QS).

A projection is an observable with eigenvalues 0 and 1; if we interpret 1 as "true" and 0 as "false", then probability is average truth value, and 1.3 becomes a special case of 1.4.

Trace is a linear invariant, which means that the average of a quantity is the same for all observers. Even though a position observer can't observe the momentum of indi vidual particles, for instance, he can observe their average momentum – this is how quantum physics becomes classical in the large-number limit.

The dynamical rule 2.2 can be restated in terms of density operators, which is the so-called Schrodinger representation, or it can be restated in terms of observables, which is the so-called Heisenberg representation.

Rule 2.4A. $S' = TST^{-1}$ (Schrodinger).

Rule 2.4B. $Q' = T^{-1}QT$ (Heisenberg).

The Schrodinger rule, which we can think of as the most general form of Schrodinger's equation, describes the changing state of an object for an observer whose viewpoint remains fixed. The Heisenberg rule, on the other hand, assumes that the object's state remains fixed and that what changes is the observer's viewpoint. Since trace(AB) = trace(BA), we have trace(Q'S) = trace(T^{-1}QTS) = trace(QTST^{-1}) = trace(QS'), so as far as observation is concerned, these two rules are equivalent, which means that quantum change is relative, like uniform motion.

One way to get to a general theory of amplitude is to start with quantum theory, as given in rules 1.4 and 2.4, and drop, or relativise (to use Finkelstein's term) the inner product. This enlarges the community of "viewpoints" on the quantum object to include every basis on Hilbert space, not just the ortho-normal bases. Since trace is invariant under all non-singular linear transformations, this larger community still agrees on averages according to rule 1.4. Quantum theory results when we shrink the community of observers to those sharing a particular inner product in terms of which we can define orthogonality, adjoints, and unitary transformations. Requiring projections to be ortho-projections makes S and Q self-adjoint, and keeps probabilities in the range of 0 to 1, which they can go beyond in the larger community. Although all observers agree on averages, they must share an inner product in order to agree on what set of things these averages are averaged over; it's the lack of such a common set that makes probabilities go haywire.

Complex amplitudes are a useful shortcut for describing another important restriction on the class of quantum viewpoints. Start with real amplitudes and an inner product. Pick a unitary operator I whose square is minus the identity. Let T_{dt} be the infinitesimal element of a one-parameter subgroup of unitary transformations which commute with I. There is always a unique self-adjoint operator (observable) H which also commutes with I such that $T_{dt} = 1 - IHdt$, and any such H uniquely determines a T_{dt} by the same equation. The requirement of commuting with I puts the observables in a natural 1-1 correspondence with the one-parameter unitary subgroups.

Combining the above equation with rule 2.1, and doing a bit of hocus-pocus to turn I into the scalar i, we get dw/dt = -iH, which is Schrodinger's equation in a more form familiar.

Though the definition of I assumes an inner product, a given I is consistent with many different inner products, and a given inner product is consistent with many I's. It appears that the physical world as we know it is connected to a particular I, so the larger world described by real quantum theory contains many "alternative" physical worlds.

To sum up: Von Neumann's approach to quantum physics, instead of starting out with the state of an object, starts out with the class of all things that can be said about an object, or more exactly, with the class of all those statements that can be tested by measurement. Such statements, and the relationships among them, are described using the concepts of projection, linear transformation and trace in linear algebra, which enables us to define the concepts of physics in terms of the structure of the language of measurement.

Amplitude

We'll start out by assuming we are dealing with a class of sentences that can be analyzed and combined using the operations of the predicate calculus, which we'll take to be "and", "not" and "there exists", written A&B, ~A and ∃xA. Every closed sentence A in this class has an *amplitude,* written ampA, which is a real number (by closed sentence is meant a sentence without free variables). We can think of amplitude as a wide generalization of truth value; true sentences have amplitude 1, false sentences amplitude 0. Probability is a special case of amplitude, and most of our results can be illustrated by examples from probability theory.

If A is not closed, i.e. if it contains free variables, then it doesn't have an amplitude, but we shall assume that it has as an amplitude-valued function of its free variables, also written ampA, or ampA(x,y..). For instance, the amplitude-valued function of the sentence "x>y" is the truth-valued function of x and y which is 1 if x>y, otherwise 0. In the context of repeated coin tossing, "I will toss n coins and they will all come out heads" has the probability-valued function 1/2n. To avoid technicalities that are irrelevant to our main concerns, we'll proceed as if all free variables range over finite sets; our results can be extended to infinite and continuous sets by the usual tricks.

We shall only allow free variables to occur once in a sentence, and we shall require every bound variable to occur exactly twice within the scope of its quantifier, not counting its occurrence in the quantifier itself. We can translate any sentence into a form that satisfies these rules by using the triple equality predicate x=y=z. For instance, the forbidden sentence ∃xA(x), in which the bound variable x occurs only once, is equivalent to the allowed sentence ∃y∃x(y=y=x & A(x)) in which x occurs twice. A(x,x) is forbidden because free x occurs twice, but we can translate it into ∃y∃z(x=y=z & A(y,z)) in which free x occurs only once. We can write x=y as ∃z∃w(x=y=z & z=w=w), so we can take x=y=z to be the primitive equality relation. These notational rules are not just cosmetic; they will strongly direct our analysis in the direction of quantum theory. Among other things, they create a natural correspondence between propositions and projections, as we shall soon see.

Variables are pronouns, and like "he" and "she" we'll assume that they all have gender. More exactly, we'll assume that every predicate place where a variable occurs has gender. Gender may be assigned to places arbitrarily, subject to the following rule:

Gender rule. Two occurrences of the same variable in a sentence must occur in places of opposite gender.

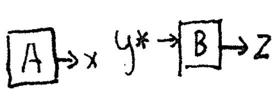
This rule of course implies that no variable can occur more than twice. Free variables, which occur only once, will themselves be called male or female according to the gender of their place, while bound variables are, so-to-speak, hermaphroditic. We'll write female variables with a star, e.g. x* is female; unstarred variables are male or bound.

We shall only be concerned with bound variables whose existential quantifiers can be moved to the outside; this is true of x, for instance, in A & ∃xB, which is equivalent to ∃x(A&B) (note that our rules prevent x from occurring in A). Other bound variable will simply be ignored, and the part of the sentence within the scope of their quantifiers treated as logically primitive, not subject to further analysis.

The purpose of variables is to link various places in a text, and our present task becomes very much easier if we adopt a kind of wiring diagram notation in which the role of variables is taken on by arrows. Here are some examples that should convey the general idea:

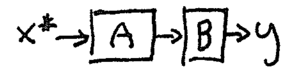
A&B =

A(x)&B(y*,z) =

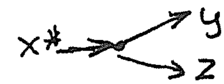


∃xA(x,x) =

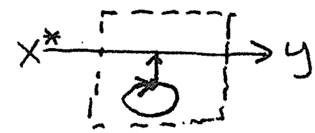
∃y(A(x*,y) & B(y,z)) =



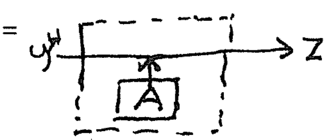
x*=y=z =



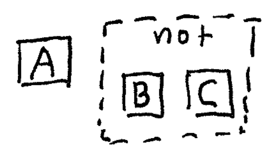
x*=y =



∃x(y*=z=x & A(x)) =



A & not(B&C) =



These are the rules: Separate boxes are to be considered logically conjoined, like sentences in English. A free variable is an arrow with one end free, outgoing arrows being male, ingoing female. A bound variable is a connecting arrow, its two ends being its two occurrences. There is no need to show quantifiers, since their scope is always the same: the entire expression. The triple equality relation x=y=z is written as a three-arrow node, as in electrical wiring diagrams. It's not necessary to label arrows with letters unless you want to link them to variables in linear text. You can enclose boxes in boxes, and by writing "not" in the enclosing box you negate its contents. With these rules, you can write any sentence in the predicate calculus plus equality.

Let's now turn to amplitude rule 1, which says that amp(A or B) = ampA+ampB if and only if A contradicts B. Here's an example from ordinary life. Suppose we are weighing packages in the post office, and let A(x) be the sentence "This package weighs x pounds". AmpA(x) will be interpreted as the probability that the package weighs x. Since each package has a unique weight, the sentences A(1), A(2), A(3) etc. are mutually exclusive and rule 1 says that amplitude for x is additive. Variables like x are sometimes called *attributes;* informally, we say that weight is an attribute of the package.

This example is in the classical world, and our reasoning about it doesn't extend to the larger "para-quantum" world without an inner product, where mutual exclusivity is not always preserved by the non-unitary transformations connecting different observers. This larger world is what we are concerned with here, so we can't assume rule 1 as an axiom about amplitude, since its truth depends on who is observing. What we'll do instead is to use rule 1 backwards, so-to-speak, to *define* a generalized form of exclusivity called *distributivity,* which becomes the normal kind when amplitude becomes probability.

Distributivity. A set of sentences {A,B,C...} is called *distributive* if amp(A or B or C...) = ampA+ampB+ampC...

Distributive variable. A free variable x in A(x) is called *distributive* if any set of sentences formed by substituting constants for x is distributive.

If x is distributive in A(x), we call ampA(x) an *amplitude distribution* on x; in case amplitude is probability, ampA(x) is a probability distribution. Note, however, that from amplitude being probability we can't conclude that x is distributive; if ampA(x*,y) is a matrix of transition probabilities, for instance, y is distributive but x* is not!

Variables like position and weight that apply to the state of a physical object are always distributive. When we say that the package has weight, we are saying "∃w(the package weighs w)"; this motivates the following important definition:

State variable: A distributive bound variable. (Remember, we are only considering bound variables whose quantifiers can be moved to the outside.)

Variables in abstract mathematical statements are usually not distributive. Take x in $x<5$. Since true statements have amplitude 1, amp($2<5$ or $3<5$) = 1, whereas amp($2<5$)+amp($3<5$) = 2. Sentences like $x>5$ whose amplitude function is a truth function will be called *propositions.*

Proposition: A sentence that becomes either true or false for any assignment of values to its free variables. (The more traditional name for such a sentence is *propositional function*, but we are adopting a terminology closer to von Neumann's).

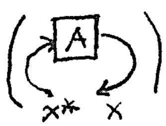
Can a free variable in a proposition be

distributive? Yes, but only if the proposition is true for less than two values of that variable; for instance, x is distributive in x=5, and also in x>x. A proposition may of course contain distributive bound variables, i.e. state variables, which are not subject to this restriction.

Most sentences that occur in science and in practical life take the form of *attributions;* we say "The package weighs less than 5 pounds", "The apple is red", etc. Now such a sentence can always be broken into two clauses, where the first defines an attribute and the second is a proposition about that attribute. "The apple is red" breaks into the defining clause "There exists a color which the apple has" and the proposition "It's red". We shall now see that this kind of analysis leads to a generalized version of the quantum observation rule prob(P) = trace(PS), where the state S is derived from the defining clause, the projection P from the qualifying clause. The first step is to define what we mean by the *state* of a state variable:

State is very easy to define in box notation. To get the state of x, you simply "cut it's wire" and take the amplitude of the resulting sentence, e.g.

state of x in 

= amp 

Actually, there's a little more to it than this. The real-valued function ampA(x*,x) gotten by separating the two ends of x and taking amplitude will be regarded as a *matrix* in which x is the row index and x* the column index, and what we are calling the *state* of x is not exactly this matrix itself but the linear operator represented by it. Thus the state of x is a linear operator on a real vector space whose dimension is the cardinality of the range of x. We make our first contact with quantum theory. In more formal terms:

State. If x is a state variable in a closed sentence $\exists x$A, define the *state* of x to be the linear operator represented by the matrix ampA(x*,x) of two variables gotten by replacing the female occurrence of x by x* and taking amplitude. If A is not closed, then this procedure leads to a state-valued function of its free variables.

We'll regard the function ampA(x) of one variable as the representation of a vector – a column (ket) vector |A> if x is male, a row (bra) vector <A| if x is female. More generally, ampA(x,y,z etc.) represents a tensor, with male and female variables being upper and lower indices. The three-index tensor amp(x=y=z), for instance, is a kind of delta function, being 1 on the "diagonal" where all indices are equal, 0 elsewhere.

The sentence $\exists x$A is shorthand for the disjunction of all sentences that result from substituting constants for x in A. This means that if x is distributive, amp$\exists x$A = amp(A1 or A2 or A3 etc.) = $\sum_x$ampA. This fact has a very important corollary which is most easily expressed in terms of tensor contraction:

Contraction. The *contraction* of ampA(x*,x) is defined as $\sum_x$ampA(x,x).

Fundamental Theorem. If x is a state variable in A, then ampA is the contraction of ampA(x*,x).

Suppose A is closed and let S be the state of x. Then the contraction of ampA(x*,x) is trace(S), the sum of the diagonal of the matrix representing S. If A has free variables, then we can regard S as a function of these variables, and thus also trace(S); this leads to a simpler and deeper statement of the fundamental theorem:

Fundamental Theorem again: The amplitude function of a sentence is the trace of the state of any of its state variables.

Trace is a linear invariant, i.e. it belongs to the operator S, not just to the matrix that represents it, so this statement of the fundamental theorem ties the predicate calculus directly to the theory of operators on a linear algebra. We are now very close to the two basic rules of quantum theory in a generalized form.

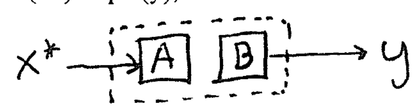
But first we must deal briefly with amplitude rule 2, which says that amplitudes of independent sentences multiply.
Independence doesn't yet have an established meaning in our larger theory, so we'll do with rule 2 what we did with rule 1, use it backwards as a definition:

Independence. If sentences A, B, C, .. have no free variables in common, and amp(A&B&C..) = ampAampBampC.., we say that A, B, C.. are *independent.*

Two variables are called *independent* if their joint distribution can be written as a product of separate distributions in each of them, i.e. x and y are independent in A(x,y) if ampA(x,y) = ampB(x)ampC(y) for some B and C. B and C are not unique; the same equality holds for B' and C' such that ampB' = k(ampB) and ampC' = 1/k(ampC). Thus if we start with the larger sentence A(x,y), there is an arbitrary normalizing factor k on the partial distribution ampB(x). This tells us that the sum of a distribution is not always a significant quantity, and normalization is often best left to the end of a calculation.

A pure quantum state has the form |v><v|, which says that its matrix is the product of identical independent distributions on its male and female variables. We shall generalize the term:

Pure state: A state whose variables are independent. In Dirac notation it has the form |v><w|, in sentence notation ampA(x*)ampB(y), and in box notation

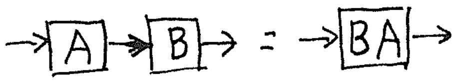


We can now make explicit something that has been implicit in our use of box notation, which is that unconnected boxes are independent.

Box Axiom. If B is a box in a diagram, the box B' that results from cutting all of B's wires is independent of the rest of the diagram.

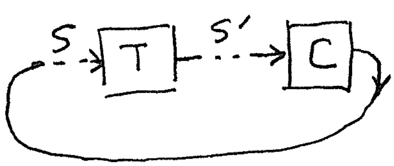
If A, B etc. are all disconnected boxes, and if we think of ampA, ampB ect. as tensors, then the box axiom says that amp(A&B etc.) is their tensor product. From this it is a short step to the very important theorem that, as far as amplitudes are concerned, we can combine operator boxes connected by a state variable by multiplying their operators – in box notation:

Operator box theorem:



Here the middle arrow is a state variable, and we are using boxes and their labels to denote matrices rather than their sentences, so BA denotes a matrix product. We shall now define transformations on states and find that this theorem leads quickly to quantum rule 2.3.

Transformation. If x and y are state variables in A with states S and S', and if when we split x into x*,x and y into y*,y, the pair x*,y is independent of the pair y*,x, then we can rewrite A as the double contraction of a sentence of the form T(x*,y)&C(y*,x). The operator given by the matrix ampT(x*,y) is called the *transformation* from S to S', while C(y*,x) is called the *context* or *background*. This is clearer in box notation:

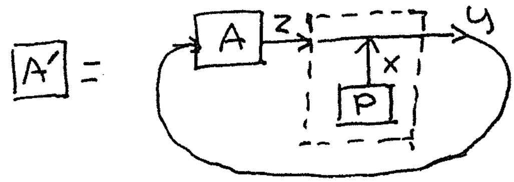


Rule of dynamics. If T is a non-singular transformation from S to S', then $S' = TST^{-1}$.

Proof. Then by the box theorem, S=CT and S'=TC. From the first equality, $C=ST^{-1}$; substituting for C in the second yields $S'=TST^{-1}$.

Let ∃xA(x,x) be a closed sentence that defines x as a state variable. How do we assert a proposition P(x) about x? We can't put it inside the quantifier ∃x, since that would introduce an illegal third occurrence of x; the simplest legal solution is:

∃x,y,z(x=y=z&A(z,y)&P(x)), or in box notation:



Pay special attention to the dotted box. It's an operator box with a diagonal matrix consisting of 1's and 0's, which of course represents a projection operator!

Projection. If P(x) is a proposition, define the *projection* P corresponding to P(x) as the operator represented by the matrix amp∃x(y*=z=x & P(x)).

By the operator theorem, the state of z in A' is PS. By the fundamental theorem, ampA = trace(PS), which is a generalized form of the quantum observation rule 1.3.

Observation rule. If a sentence asserts a proposition P about a state S, the amplitude of that sentence is trace(PS).

Notice once again that although we started out with predicates and variables that define amplitude-valued matrices, our principle results are in terms of linear operators, and don't depend on the choice of basis. This concludes our rather summary account of amplitude theory. Here's a one-paragraph summary of the summary:

We start with sentences that can be taken apart and put together with the operations of predicate calculus. We assume that closed sentences have amplitudes and that open sentences determine amplitude-valued functions of their free variables. We ignore bound variables unless they are existentially quantified on the outside. We require that these bound variables occur exactly twice and that all free variables occur exactly once; this does not restrict our expressive power provided we make use of the triple equality predicate x=y=z. We arbitrarily classify occurrences of a variable into male and female, and require that the two occurrences of a bound variable be of opposite sex. A free variable on which the amplitude of its sentence is an (additive) amplitude distribution is called *distributive,* a term we also apply to a bound variable if it becomes distributive after removing its quantifier. We define the *state* of a distributive bound variable to be the linear operator represented by the matrix that results from removing its quantifier, making its male and female occurrences into separate variables, and taking amplitude. We define a *proposition* as a sentence whose amplitude takes only the values 0 and 1. We define a *transformation* as an independent two-place predicate in a sentence whose variables are state variables of opposite gender and whose matrix is non-singular. We then find that states, propositions and transformations so defined satisfy the two basic rules of quantum theory in a generalized form where amplitude replaces probability and transformations needn't be unitary.

Quantum Theory Explained.

Quantum theory is the specialization of amplitude theory that results from requiring transformations to be unitary and states to be von Neumann density operators, i.e. self-adjoint operators of unit trace whose matrix representations have no negative elements in the diagonal. We shall now see why this specialization is just what we should expect.

As Niels Bohr stressed, quantum mechanics begins in the classical world where there are definite events that can be recorded, classified, compared and counted. The big shock about the micro-world is that it doesn't seem to contain such events; we can only know this "nether-world" at all by studying the classical side of our encounters with it. Most of these encounters are with averages, as given by trace(QS).

Our male-female arrow scheme is patterned on the macroscopic arrow of causality. We project this arrow in imagination when we encounter the micro-world, the micro-end being male when we measure it, female when we make a so-called preparation. However, there is every reason to believe that the direction of this projected arrow has only to do its macro-end, since causality has an orientation in time, and there is no time direction in the quantum dynamics of unitary transformations.

If this is true, we are just flipping a coin when we assign gender to the variables in a micro-state. Therefore, when we are dealing with a state S which is the average of many separately encountered micro-states, S will be symmetrical in its two matrix indices, i.e. it will be self-adjoint! Whatever kind of states may actually occur in the micro-world, it's only self-adjoint states that we will encounter when we study the micro-world with empirical procedures based on averages and probabilities. If the measured averages are indeed probabilities, then the state in question must be a von Neumann density operator, which gives us the quantum observation rule.

Changing our macroscopic viewpoint on

the micro–world can't effect its gender symmetry, so the transformations representing such changes must preserve the self–adjointness of states, i.e. they must be unitary. This gives us quantum dynamics.

Just as the universe is San Francisco plus all the places you can travel to from San Francisco, so our larger world of amplitude states is the classical world plus all the "places" you can "travel" to from the classical world via linear transformations. If you want to want to remain in the world of the entities you can name and count, your mode of transportation is restricted to unitary transformations, and the world you can reach is the quantum world.

Tao

As mentioned, our box arrows are patterned on the flowchart arrow of causality, the arrow of input and output. This arrow is so pervasive in ordinary life that it's very hard to imagine its absence, just as it's hard to imagine the absence of up and down. And yet it is for the most part absent in the realm of states, propositions and transformations; in most cases there is nothing intrinsic about a sentence or its amplitude to suggest whether a variable is male or female. This is why amplitude theory is difficult, and why we must approach it rather abstractly to avoid being mislead by commonsense expectations.

There is, however, one class of states and transformations that do define arrow direction, and define it in the commonsense way; I shall call these *causal.*

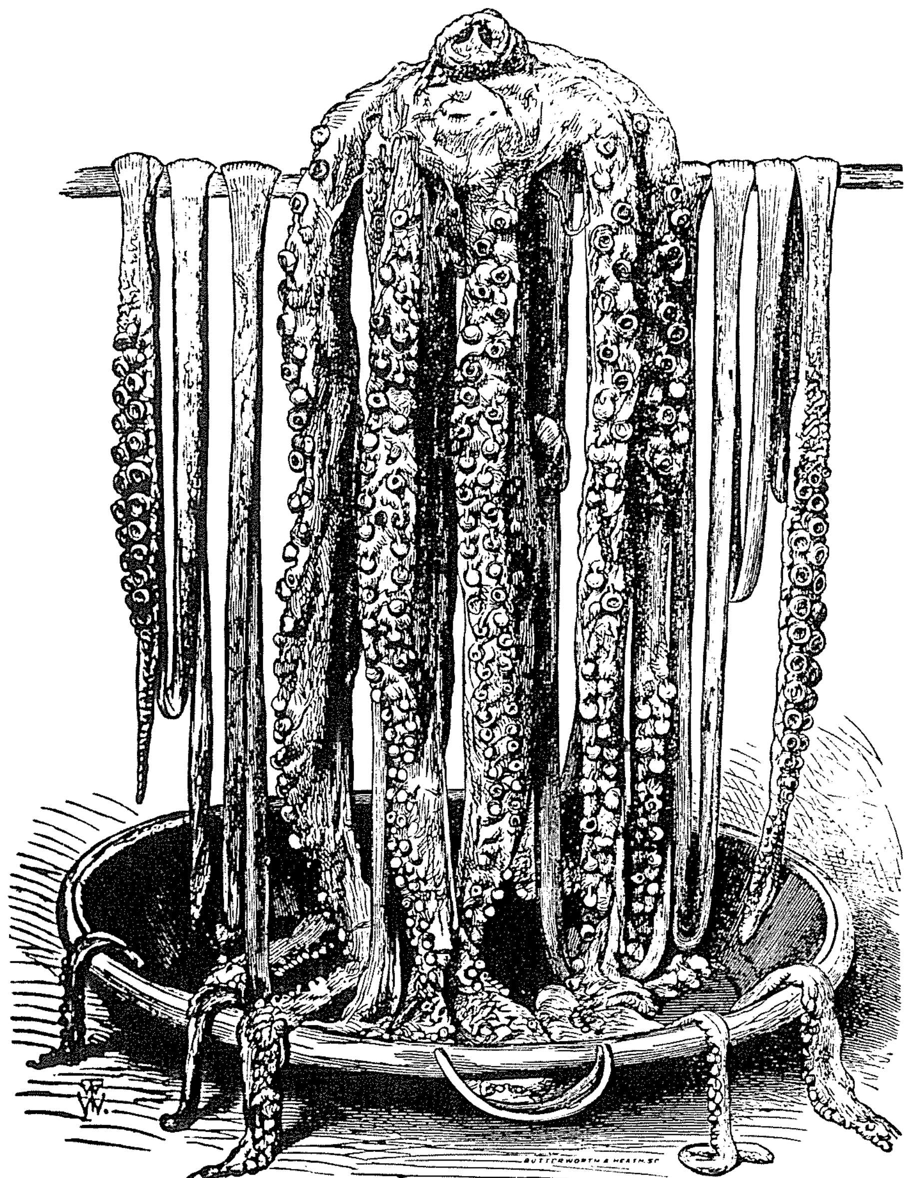
Causal state: A pure state of the form $|v\rangle\langle 1|$, where v is a probability distribution and $\langle 1|$ is the vector whose components in the given basis are all 1's.

There's a more general definition of causal state that encompasses impure states, though we don't need it here. Note that the definition of causal state isn't invariant under linear transformation; it only makes sense for a particular basis. Causality is a *classical* concept.

Causal transformation: A transformation in whose matrix every column is a probability distribution. A more familiar term for such a matrix is *transition matrix.* It can be shown that a transformation is causal if and only if it maps causal states onto causal states; this shows that a transformation being causal, like a state being causal, is relative to a basis.

These two definitions capture what is meant by state and transformation in classical science; the two "quantum" rules, when confined to causal states and transformations, define today's paradigm of scientific explanation. Causal box diagrams are essentially equivalent to computer models with random inputs, and that's what almost all scientists are looking for today, even those who use words like "field" and "mind" and "consciousness". Beyond causality there be dragons – Chinese dragons, in fact.

I shall define Tao to be order that evades causal explanation. Quantum mechanics reveals a few obscure examples of Tao, like the singlet state and superconductivity. Amplitude theory shows that causal order and quantum order are special cases of a much more general kind of order; they are like square and round in the domain of shapes. Even when we restrict amplitudes to proba bilities, states needn't be causal; for instance, Eddington's idea that action is information involves a–causal states of the form |v><w|, where <w| is a probabilistic constraint from the future. Could it be that science is bringing the Tao into its fold? The Tao works in curious ways; maybe it's letting itself be contained in order to dissolve the container●



BASIC ISSUES CONCERNING THE RELATIONSHIP BETWEEN CONSCIOUSNESS AND THE PHYSICAL WORLD

By Jean Burns

In exploring the relationship between consciousness and the physical world, it's important to realize that there are a number of quite different questions that can be asked about it. In this article I shall discuss four independent questions about mind and brain, and consider various hypotheses which have been offered by current models of consciousness. (References for specific models are listed in two recent review papers, [1,2] and will not be listed here.) I won't try to evaluate these hypotheses; rather I shall discuss, in the context of each of the four question, whether empirical methods are known by which they can be tested.

First, let me define some terms. By the term *consciousness* I shall mean the aggregate of all possible conscious experiences, and I shall use *mind* as a synonym for consciousness. Because we attribute very different qualities to consciousness and to the physical world, I shall speak of them as different realms; this is not an ontological commitment, but a distinction between two types of description.

Here, then, are the four questions:

1. What is the causal relationship between consciousness and the brain/physical world (physicalism, dualism, etc.)?
2. What physical characteristics are associated with the mind/brain interface?
3. Is all of the information content of conscious experience encoded in the brain? [3]
4. Can consciousness act on the brain independently of any brain process?

The Causal Relationship Between Consciousness and the Physical World

The postulate of *physicalism* holds that all qualities of consciousness derive from the physical world, and the postulate of *dualism* holds that consciousness and the physical world are independent realms. Obviously, many qualities of consciousness are very different from qualities of the physical world. The physical world, for instance, is objective (it can be described independently of the observer), but conscious experience is subjective. Thus physicalism is faced with the problem of explaining how qualities which are so unlike those of the physical world can derive from it. However, this problem can be resolved by describing such qualities as *emergent,* and considering the causal relationship to hold even though the discrepancy in description is not presently accounted for.

Another postulate (presented by Goswami[1]) is that mind and brain have a relationship of causal circularity, i.e. each one causes the other. And yet another possibility (presented by Bohm[1]) is that mind and brain have no direct connection, but act synchronously.

Unlike some of the other issues, there is no known way to distinguish between different postulates of causality on empirical grounds. Thus the issue of causality must be considered a philosophical question.

Physical Characteristics Associated with the Mind/Brain Interface

We should understand that the mind/brain interface would be construed somewhat differently in models of physicalism and of dualism––in the former the interface would be construed as causing consciousness and in the latter it would be construed as mediating independent realms. However, the question of what physical characteristics are associated with the mind/brain interface is a separate question from that of the causal relationship between the realms.

A number of different hypotheses have been made about the physical nature of the brain/mind interface:[1] Some models of consciousness propose that the mind/brain interface is associated with an overall quantum mechanical wave function in the brain. Other models suggest that it is associated with cooperative electrochemical phenomena in the brain. And yet others suggest that consciousness is associated with presently unknown physical principles having to do with complexity or a large number of interconnections.

In order to establish empirically which hypothesis about the physical nature of the interface is correct, we would need some way to determine what entities (animal or mechanical) are conscious. If we could make that determination, we could compare animal species known to be conscious with those which are not, for instance, look for distinguishing characteristics, and ask which hypotheses are compatible with these findings. We could also construct computers which were supplied with various types of (postulated) interface, and check which ones were conscious. The problem is that we have no definitive way to know who (or what) is conscious. We are not certain which animals have conscious experience, with not everyone agreeing on whether dogs, cats and horses are conscious. Furthermore, if a human being is not able to communicate, it is not always apparent whether that person is conscious. For instance, several years ago a news account described the experience of a man who had a massive stroke which left him conscious, but completely paralyzed. In the hospital he was thought to be in a coma, and he went through the nightmarish experience for many days of being unable to let anyone know that he was conscious. Finally a doctor who was examining him at some length discovered that this man had voluntary control of his eyelids and established communication with him.

It might be thought that certain behaviors can demonstrate the presence of consciousness. However, a sufficiently complex computer might communicate as well as a person, i.e. it would pass the Turing test, but it would not necessarily be conscious. Therefore, we are left with something of a problem as to how to verify which interface postulate is correct.

In spite of this difficulty, the question of what the mind/brain interface consists of can still be pursued in an empirical way. It is not known whether it is possible for a non-biological system to be conscious; nevertheless, we could construct various models of the mind/brain system, with each model consisting of a computer which resembles the brain to some degree, together with a (postulated) brain/mind interface. If one of the models were conscious, we might suspect this fact, even if we could not prove it. In such case we could explore that system further.

The idea of building a model of the mind/brain interface is not as far-fetched as it may seem. Designers of the next generation of computers expect that computers will rival the brain in the number of interconnections relatively soon, perhaps within 40 years. If the mind/brain interface depended solely on the number of interconnections in a system, these computers would be conscious. A counter-argument can be made to the latter idea: Not all processing in the brain is conscious, but only a small portion of it; therefore, the presence of a large number of interconnections is not of itself sufficient to account for the association of conscious experience with the brain.[1] Besides, the interface may not have anything to do with the number of interconnections. Thus we have no reason to suppose that coming generations of connectionist computers will fulfill the conditions needed for the presence of consciousness. On the other hand, producing a conscious physical system probably does not depend on replicating the entire processing ability of a brain, but only certain key physical attributes; we might be able to produce a conscious system now--if we knew how.

Is All of the Information Content of Conscious Experience Encoded in the Brain?

It is well known that a great deal of our conscious experience is dependent on the brain. For instance, conscious experience can be influenced or interfered with through damage to the brain, chemicals introduced into the brain, and electrical probes touching the cortex. For that reason, some models of consciousness postulate that *all* of the information content of conscious experience is encoded in the brain.[2] On the other hand, Eccles considers that mind can "think about" information encoded in the brain, with the implication that some thoughts have an information content which is not encoded in the brain.[2]

The question of whether some thoughts are encoded in mind but not in the brain can be decided by empirical test. If we completely understood how information is encoded in the brain, we could compare the information content of conscious experience with the known encoding in the brain, and ask if any of the content of conscious experience is unaccounted for. Completely understanding how the brain encodes information is a far more ambitious undertaking than building a computer which replicates the number of interconnections in the brain, and we have no guarantee that we will have this knowledge even in the next century. Nevertheless, this question can ultimately be answered empirically.

If some of the information content of conscious experience is not encoded in the brain, we would then have a way to demonstrate the presence of consciousness—we would only have to show that the behavior of a being (or output of a system) reflected the use of information which was not encoded in the brain (or physical system). This demonstration would depend not only on behavior, but also on detailed knowledge of how the brain (or physical system) encodes information.

If all of the content of conscious experience is associated with encoding in the brain, we can say that there is an isomorphism between this content and the encoding. (If not all content is associated with encoding, we can say there is an isomorphism to the extent that there is such an association.) The existence of an isomorphism between consciousness and the physical world does not imply that these realms are identical in other respects, however, just as two mathematical spaces may be isomorphic, but not identical. Similarly, the existence of isomorphisms between these realms does not carry any implication about the causal relationship between them, just as two mathematical spaces could be isomorphic, yet without one causing the other.

On the other hand, it seems reasonable that we can discover the nature of the interface which links these realms by examining the isomorphisms between them. Thus many models inquire as to what aspects of consciousness are parallel (i.e. are isomorphic) to the physical world; for instance, a model may discuss the way conscious experience resembles quantum mechanical principles. Not all such models discuss the information isomorphism; however, it would probably be productive to inquire as to the place of the information isomorphism in any such models.

Does Consciousness Act Independently of the Brain?

Does consciousness process information which is encoded in the brain, with this action taking place independently of any brain process? If consciousness does independent processing, then evolution could act in two ways: (1) it could increase the processing ability of the brain; (2) it could make greater use of the mind/brain interface and thereby greater use of the processing ability of consciousness. In that case consciousness might occur relatively early in the animal kingdom, with more advanced animals having a richer and more complex experience.

Two types of independent processing have been proposed in current models of consciousness: free will and holistic information processing.[2] Free will is the ability to select among alternatives; in current models it is assumed that free will acts on the brain and carries out its selections by activating brain programs.[2] Holistic information processing is the ability to correlate, activate and modify brain programs on a holistic basis. It could provide overall correlation of behavior through the correlation of the information content of feature processors in different parts of the brain and the activation of various motor programs in the brain. It might also be involved in the experience of insight, by modifying or adding to existing brain programs to produce encoding for a thought or action not previously present.

Because free will can act simply as a

switch to choose among alternative brain programs, this process can take place even if all information is encoded in the brain. Similarly, in holistic information processing the information content of the various feature processors and motor programs involved can be encoded in the brain; thus holistic information processing can act even if all information is encoded in the brain. Therefore, the issue of whether independent processing takes place is different from, and independent of, the issue of encoding.

The postulate that independent processing is done by consciousness has been made by both physicalist and dualistic models, as well as those which propose other ideas of causality.[2] In physicalist models such processing would be considered an emergent property of consciousness, and in dualistic models it would be considered an independent property; however, the question of whether such processing takes place is a different issue than that of causality.

As several researchers have pointed out, independent processing by consciousness contradicts the second law of thermodynamics.[2] This conclusion has been demonstrated in several different ways; the basic idea of one argument is as follows: By the second law of thermodynamics, physical processes tend to go in a certain direction--heat flows from warm to cold, for instance, but not the other direction. In independent processing the brain changes its physical state in a way which is independent of the direction actions in the brain would otherwise take; these changes will generally be different from what would have occurred in purely physical actions, and in such cases the second law will be contradicted.[2] Another argument is that the second law produces disorder, but holistic information processing, by making correlations, produces order; therefore, holistic information processing contradicts the second law.[2]

Sometimes the concern is raised that independent processing might violate conservation of energy (the first law of thermodynamics): if such processing can cause electrochemical changes in the brain, then a source of energy is needed for these. However, if such processing can violate the second law, it can take energy from any local source, such as the thermal fluctuations of molecules.[2]

If independent processing violates the second law, it cannot be isomorphic to any physical process. However, as has been said, in physicalism such processing can be considered as an emergent property of consciousness. Consciousness has other aspects, such as the subjective character of experience, which are unlikely to be isomorphic with any physical property; thus one need not expect that all emergent properties are isomorphic to physical properties.

The question of whether consciousness does independent processing is subject to empirical test. We would need to have complete understanding of all processing done by the brain, and this may not occur for some time, probably not in the next century. However, once we have such knowledge, we can ask whether all behavior can be accounted for in terms of brain processes. If some behavior takes place which cannot be accounted for in this way, then the presence of independent processing is demonstrated.

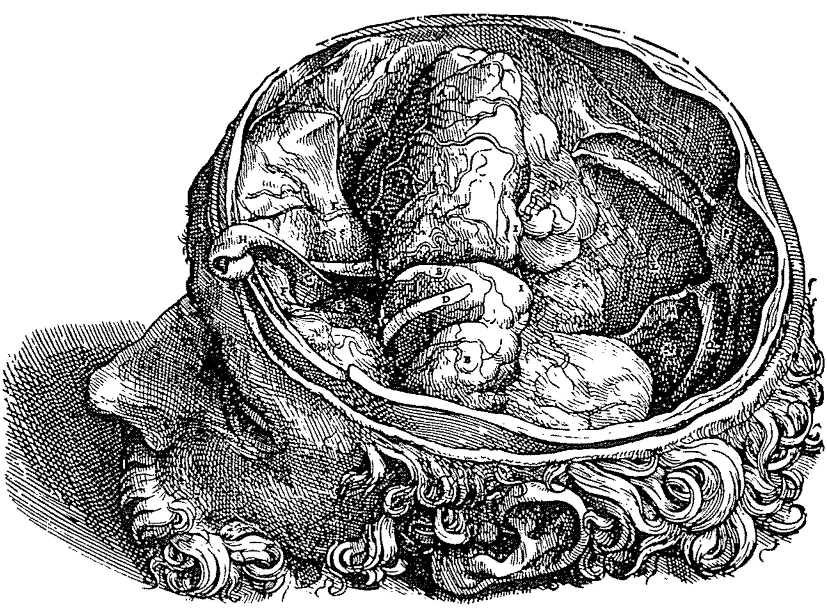
Finally, let us return to the question of how we can demonstrate the presence of consciousness in non–human entities (animal or mechanical). If consciousness is entirely passive to the brain/physical system, such that all behavior (output) of an entity can be accounted for in terms of its physical system, then we have no objective way to demonstrate the presence of consciousness. We could describe the latter idea by saying that all aspects of consciousness which are relevant to behavior are isomorphic to the physical system involved, and that any non–isomorphisms (such as the subjective nature of consciousness) are non–significant to behavior. This idea can be described as *epiphenomenalism,* the view that consciousness arises from the physical world but is entirely passive to it.

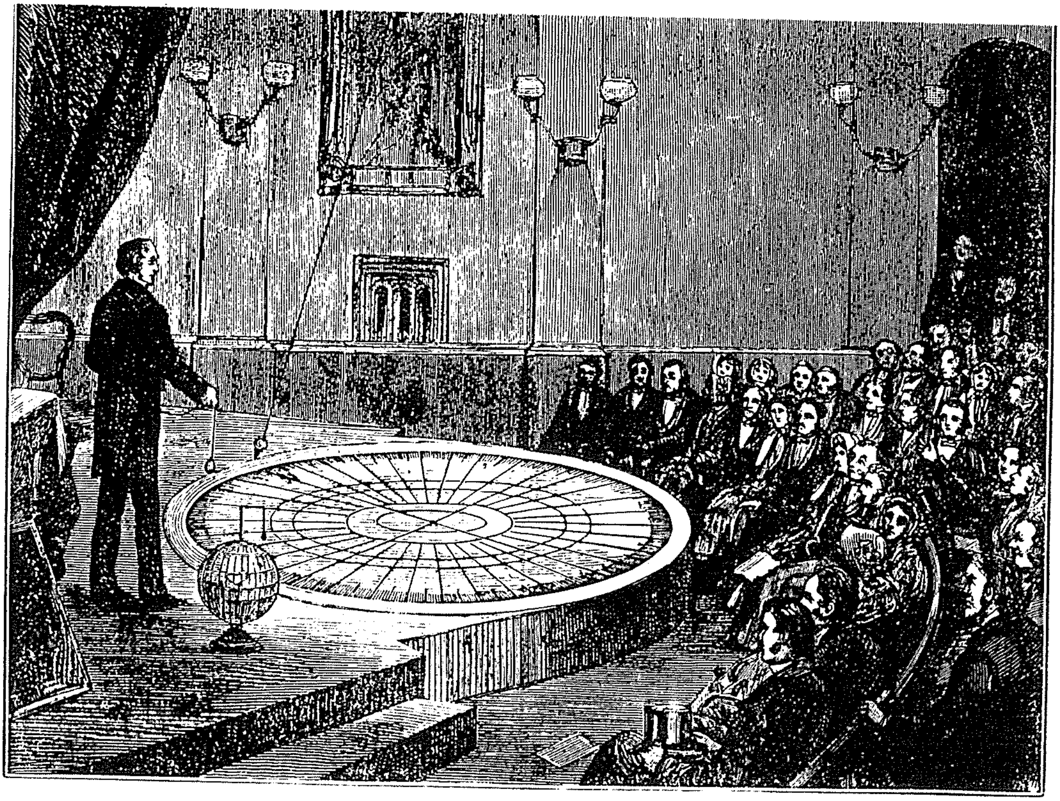
On the other hand, if some behavior (output) of the entity makes use of information which is not encoded in the physical system, or if some behavior involves processing of information, yet without that pro cessing taking place in the physical system, then we can demonstrate the presence of consciousness. We should note that this demonstration does not depend on behavior *only,* but on behavior plus knowledge of the relevant aspects of the physical system. We conclude that it is only possible to know that an entity (animal or mechanical) is conscious if its behavior does not derive solely from its physical system, but derives in part from independent (non–isomorphic) qualities of consciousness.

1. J. Burns, "Contemporary Models of Consciousness: Part I," *Journal of Mind and Behavior, 11,* 153–172 (1990)

2. J. Burns, "Contemporary Models of Consciousness: Part II," (Manuscript submitted for publication. For a reprint, when available, write Jean Burns, 1525 – 153rd Ave., San Leandro, CA 94578.)

3: This presupposes that it makes sense to speak of the information in consciousness, which may not always be true if consciousness is closely tied to the quantum world.





Report on ANPA 12

by Fred Young

ANPA 12 took place in the Department of History and Philosophy of Science at Cambridge, England, on Sept. 13–16, 1990. It was attended by approximately 25 people including, on Saturday, a reporter from *New Scientist Magazine.*

The meeting opened on Thursday with Clive Kilmister explaining what the Combinatorial Hierarchy is in the context of the history of ANPA. He explained how the overall approach originated in some work in the 50's by himself and Ted Bastin which resulted in two papers entitled *Concept of Order.* David McGoveran next listed 12 motivations for using the Combinatorial Hierarchy. His motivations could be seen as an elaboration and refinement of the type of approach which originally motivated Bastin and Kilmister to search for a "Concept of Order." McGoveran also described some explorations of a calculation of the proton mass which was not satisfactorily dealt with by Parker–Rhodes.

Geoffrey Read began the afternoon session by reading a paper which critiqued the reductionist approach and then proposed a model somewhat reminiscent of bit strings. Tony Deakin next described a promising preliminary attempt to show that gravity is a quantum mechanical effect.

Ted Bastin opened the Friday morning session with a list of 8 principles which are fundamental in his approach to the derivations. This was his attempt to specify, as McGoveran did, the motivations behind the work. Pierre Noyes next made some remarks on the relation between his derivation, the thermodynamics of black holes, and Wheeler's "It from Bit." He began to show how he got to quaternions from bit strings. His paper opened an ongoing discussion with Kilmister on the problems of deriving 4-space. The session ended with McGoveran presenting Eddie Oshins arguments for why Karl Pribram and followers of Spencer Brown are misusing and misrepresenting Quantum Mechanics in their work on memory and logic respectively.

On Saturday, Fred Young presented an explanation of how universality in chaos brings about the particular types of pattern and form seen in natural systems including living systems. He used the Mandelbrot set to demonstrate the universal harmonics of natural form. The use of visualization in the research and communication of the concepts was illustrated by color slides. Brian Goodwin, the invited speaker, presented a paper on biological morphogenesis. He showed how the pattern in developmental mutants seems to result from topological alterations affecting the decoding of the positional information in morphogenetic fields

In the afternoon session Keith Bowden described relations between Kron's method of hierarchical tearing in systems theory, and Bohm's holomovement. Mike Manthey then gave the presidential address entitled, "Are Conservation Laws Absolute?" He summarized his work on synchronization and the cycle hierarchy, and showed how conservation laws fit in. He concluded that conservation laws could only be absolute in a completely closed system. At the banquet it was announced that Soren Engstrom would open a chapter of ANPA in Stockholm to be called ANPA North. His work centers on some new realizations concerning William Rowan Hamilton's work on quaternions and other subjects.

Peter Marcer opened Sunday with his unified derivation which emphasizes the central importance of Conway's surreal numbers. Kilmister next chronologically reviewed the work of Eddington and read quotes from the Mathematical Theory of Relativity which showed how close to the ANPA approach Eddington's conceptions really were. In the afternoon, Kilmister summarized a contribution by Zimmerman which covers his overall view of the topics covered at ANPA meetings. Brian Clement talked on the physical basis of mathematics, and William Honig ended the meeting with a discussion of imaginary and transfinite numbers, and the logical structure of special relativity and quantum mechanics. The proceedings of this conference should make very interesting reading. ●

(News and Events, cont. from page 8)

The following news items were supplied by Herb Doughty.

ANPA members may be interested in the following cluster of mathematics meetings in San Francisco in mid January of 1991 --

MACWORLD EXPO: *Thurs Jan. 10 through Sun. Jan. 13.* A big annual Mackintosh festival at Moscone center, Brooks Hall, and Civic Center. Registration at all three sites throughout. Exhibits only: $25. Conferences and exhibits: $80.

For more information, call MACWORLD hotline: (617) 361-3941.

MATHEMATICA CONFERENCE: *Sat. Jan. 12 through Tues. Jan. 15* (see note below.) At Hyatt Regency Hotel, Embarcadero Center. On-site registration begins at noon on Sat, Jan. 12. Before Dec. 14, regular admission is $275, educational $175, and students $50. After Dec. 14, regular registration is $325, educational $225, and student $75. For more information, contact: 1991 Mathematica conference, PO Box 3848, Champaign, Ill. 61826-3848; phone (217) 398-0700; Fax (217) 398-0747.

note: Mathematica is a mathematics software package which runs on a variety of computers including the PC, Mackintosh and various UNIX workstations and mainframes. Mathematica often allows one with minimal change to rerun a program over in different fields, finite or infinite. I consider it a good choice for finite physics.

Mathematica was designed and written by Stephen Wolfram and staff at Wolfram Research Inc. Wolfram, a graduate of Eton and Oxford, received a PhD. in theoretical physics from Cal. Tech. in 1979, and is known for his view that the universe may operate on finite mathematics. He is also known for his books on cellular automata and for his pioneering research in mathematics, physics and computer science. In 1986 he founded the journal of complex systems.

ANNUAL JOINT MATHEMATICS MEETING: *Wednesday, Jan. 16 through Sat. Jan. 19* including --

- The 97th annual meeting of the American Mathematical Society.
- The 74th annual meeting of the Mathematical Association of America.
- The 1991 annual meeting of the National Association of Mathematicians.
- The 20th anniversary celebration of the Association of Women in Mathematics.

mainly at the San Francisco Hilton Hotel on Hilton Square.

The prices if received by Dec. 17th: members $105, emeritus $25, non-members $163. Later: 30% more. There are also charges for some separate related events.

For more information, see the Oct. 1990 issue of the Notices of the AMS. or call the Mathematics Meeting Service Bureau at (401) 455-4143. For electronic preregistration with credit card via E-mail -- MEET@MATH.AMS.COM •

ALTERNATIVE NATURAL PHILOSOPHY ASSOCIATION

Statement of Purpose

1. *The primary purpose of the Association is to consider coherent models based on minimal number of assumptions to bring together major areas of thought and experience within a natural philosophy alternative to the prevailing scientific attitude. The combinatorial hierarchy, as such a model, will form an initial focus of our discussion.*
2. *This purpose will be pursued by research, conferences, publications and any other appropriate means including the foundation of subsidiary organizations and the support of individuals and groups with the same objective.*
3. *The Association will remain open to new ideas and modes of action, however suggested, which might serve the primary purpose.*
4. *The Association will seek ways to use its knowledge and facilities for the benefit of humanity and will try to prevent such knowledge and facilities being used to the detriment of humanity.*

Illustrations:

Our thanks to *The Wonders of the Universe* by Charles Barnard, 1899, Akron, Ohio for all illustrations with the exception of p. 56: Vesalius, *De Humani Corporis Fabrica,* Book VII, 1543.

COVER: Dr. Helgi Schweizer, Diessen, Germany.