ON

SCIENCE

also
see CHURCHMAN's
small spiral notebook

1991 # 67

J@\PRLG1.P51 DISK:~~JOURNYEAR02~~ TIME May 2, 1991

THE FENG SHUI OF SPACE AND TIME

If we ask a physicist, does space have quality? He or she would probably not know what we meant, but would say that space has size and dimensions, attributes that we can measure, but space having quality? Does that mean anything?

If we ask an architect, does space have quality? He or she would probably say, that's how I make my living, shaping the quality of space. It is my job to make space as useful, beautiful, and interesting as possible.

Dogma: The only properties that exist are those we can measure

Similarly with regard to time.

Ask a physicist, does time have quality? Again the reply would probably be, what do you mean by that? Time has duration and we can measure that, but quality?

Ask a musician, does time have quality? He or she would say that's how I make my living--organizing the qualities of time into pleasing, arousing, or ~~quieting~~ calming exciting patterns.

The space and time of the physicist has only those attributes that can be measured by meter sticks and clocks. The space of the architect and the time of the musician also can be measured by meter sticks and clocks, but possess other qualities which can be experienced, felt, and described, but not always measured.

Whitehead said that nothing can be experienced which does not recur and nothing can be measured which does not recur regularly. Since more recurs than recurs regularly, it follows that we can experience more than we can measure and that the world of the physicist is a restricted one. This dichotomy: Measurable vs unmeasurable, is more fundamental than the physical & spiritual dichotomy

. . . . . .

With the architect and the musician we experience quality in space and in time. The quality of space varies from place to place, and the quality of time varies from day to day. Each moment is not the same as every other moment, (except possibly to a ball rolling down an inclined plane). So what determines the quality of space and the quality of time? What are the tools the architect uses to shape the quality of space and the musician uses to shape the quality of time?

But prior to the architect shaping space, the earth has already shaped it, and prior to the musician shaping time, the ~~earth and sky~~ seasons have already shaped it. The tools of the earth for shaping space are the distribution of matter and energy, the tools of the earth and sky for shaping time are light and rhythm, the beat of various drummers. These effect the basic feng shui of space and of time.

1991 #90

SCIFIWN.P51 DISK:ESSAYS1-P51 August 14, 1991

SCIENCE FICTION WITH NUMBERS

Every vital area of human endeavor possesses a penumbra of speculation. However, the relation between the hard core of a discipline and its penumbral sunyata varies from the sharply defined orthodox/heresy relation in theology to the fuzzy non-fiction/fiction frontier in literature. In general, the more blurred the boundary the more vital the area.

In the case of science, the relation between its hard core of what-is-science and its penumbra of speculation is unique. Science idealizes open endedness so it proclaims to have no orthodoxy. But through its traditional publication procedures, it supports a powerful curia of journal editors with almost absolute control of imprimatur. [insert Max Planck's quote and the cold fusion story here] How then, does science maintain its vitality? Rather than with unrestricted commerce across a broad fuzzy frontier, science maintains a symbiotic trade relation, mostly export with occasional reluctant imports, with a second carefully defined but distinctly separate discipline called science fiction. In effect science has created a medieval castle protecting itself within the walls of the keep and insulated further from the outside by the bailey of science fiction. Except for occasional missiles hurled over the walls by the catapults of mathematics research [e.g. fractals] and technology, does anything get into the keep that has not passed through the bailey.

Perhaps this description explains why speculative ideas such as those of Fred Hoyle, who is both a scientist and a science fiction author (as many scientists are), receive negative notice. Hoyle finds there is no place to stand between the bailey and the keep. Science's limited relationship with speculation--speculation must be kept private--has restricted its progress as much as theology's love affair with the orthodox has limited it. Science needs a domain for speculation other than that of science fiction. It needs a non-private respected publishing domain.

peer review

Imagination — Einstein Quote
role of technology =

what if's
might be's

politics replaces the process which in turn misdoes the replaces the Protagonists Wins

COMEAREC.WP6 NEW EPIONT March 20, 1995

COMPLEMENTARITY-MEASUREMENT-RECOGNITION

COMPLEMANTARITY: held basic by Kafatos and Nadeau
The Conscious Universe

Complementarity is a special (two-fold) case of facetism. What we view of the universe depends on the experiment we perform, the question we ask, the measurements we make. The results are neither consistent nor inconsistent. Facetism transcends consistency.

MEASUREMENT: held basic by Albert Z. David
Quantum Mechanics and Experience

Measurement collapses the wave function. Measurement truncates potentiality, asking a question truncates potentiality, all actualization truncates potentiality. Is all actualization related to the collapse of a wave function? Measurement destroys possibilities (K&N p43) Science is based on measurement therefore it deals with a partially destroyed world. Science truncates the world. Is it possible to know without truncation or does knowledge contain the seed of its own limitation, creating limits to the world it can know. (cf. the tree of knowledge and Godel's Thecrem) Measurement and observation convert global → local potential → actual Eating of one tree precludes...

RECOGNITION: Recognition Physics J.A.Wheeler
Lost Paradigms--Casti p419

See also 95#10, #14

Recognition implies non-localism, not only non-localism in spacetime but a more general non-localism. It implies a basic linkage, or even identity, between our thought processes and event-occurrence in the universe. Recognition's mechanisms may lie within the spacetime world or beyond it or both. Wheeler asks how do space, time and dimension arise both as concept and as structure of reality. Concept may be the structurer of reality.

= "the Cosmic Mind" Hamming non-localism Constructor "In the beginning was the Word"

{{ Measurement creates information example of constraint → creation what is created is information

A human is a device for organizing events

The creation of information is what is involved in the collapse of the wave function in the conversion of potential into actuality into localism, i.e. space, time

The Sunyata is informationless no form - void - no information }} with death the information ceases

"[illegible] clarified [illegible] the [illegible] of the [illegible] measur[illegible] [illegible] the [illegible] [illegible] been a superposition of [illegible] [illegible] addressed with the experimental question [illegible] "[illegible] where are you" [illegible] either for one or the other [illegible]

[illegible] Polkinghorne.

Physics, Philosophy & Theology p 336

[[illegible] [illegible] modulation of [illegible] [illegible] by [illegible] [illegible]?]

1996 #43
rev

SCICOM1.WP6 June 16, 1996 REV June 29, 1996

SOME COMMENTS REGARDING SCIENCE

TOWARD A LIBERATION FROM APOLLO

If it isn"t repeatable, it's not science.
If it is repeatable, it's not art.

Li Kiang

Before science, rounded people lived on a flat earth.
After science, flattened people lived on a round earth.

Li Kiang

Science suffers from several procedural agendas that restrict the breadth of its applicability. There are several areas of human experience for which the scientific method is not productive and even within those areas for which it is suitable, there are limitations to the extent of its successful operation. Some of these limitations are intrinsic to the scientific method, others are due to arbitrary metaphysical assumptions which are present for historical rather than logical reasons.

There is a difference between logic and wisdom.

- First, the domain of science is restricted to those phenomena that occur with sufficient frequency and regularity to be repeatably observed or demonstrated. If results are always to be reproducible, there can be no science of the unique and very little science of the rare. One of science's basic tools, induction, falsifies phenomena of limited repeatability

- Second, the logic of science, Aristotelian deduction, is based on the law of the excluded middle: Everything is either true or false. Though facts can sometimes be true and sometimes false, such facts are usually ignored unless an explicit temporal gate can be determined for them.

- Third, the most important scientific validifier and measure of science's usefulness is predictability. Without predictability there is no test of science. But predictability depends on causal determinism, so to protect its metaphysical base, science proclaims a dogma of universal determinism. However, causality is one-dimensional and it follows that for many areas of experience, "You can't get there from here" by science. Of course, the idea, "You can't get there from here" is an absurdity in a connected, causal-based topology or metaphysics. But Gödel demonstrated that there exist places that cannot be reached by deductive or causal steps from a familiar or axiomatic base. In holding firmly to causality, science insists that all circuits be series circuits, parallel circuits are forbidden. Lately trouble has risen in connection with Chaos Theory which claims certain unpredictable systems are nonetheless deterministic. The historic link between predictability and determinism is now open to question.

∃ a difference between logic + common sense

- Fourth, the success of the analytic method has led to the promotion of reductionism to the rank of sacred cow. This limitation: the whole is equal to the sum of the parts, is being challenged by complexity theory which allows the whole to be greater than the sum of the parts, leading to emergence.

- Fifth, is the metaphysical assumption that the universe consists of one level, all is to be explained by the properties of matter in its many configurations. All explanations are to be horizontal. To posit more than one level, to allow the vertical, ~~is~~ would be to reintroduce superstition into the world.

REGULAR REPETITION [SUNRISE, ECLIPSES]	DETERMINISTIC AND PREDICTABLE
IRREGULAR REPETITION [EARTHQUAKES, WEATHER]	DETERMINISTIC BUT UNPREDICTABLE CHAOS {really deterministic?}
NON REPEATING [3 BODY PROBLEM]	DETERMINISTIC BUT COMPUTABLE
NON REPEATING [N BODY PROBLEM]	DETERMINISTIC BUT STATISTICALLY PREDICTABLE
RANDOMLY REPEATING	RANDOM AND UNPREDICTABLE
UNIQUE AND RARE	BEYOND SCIENCE

Is there an alternative approach?

Years ago Lance Whyte said the paradigm of the future would be **pattern.** Pattern which is multi-dimensional will replace causality which is one-dimensional. This approach was naturally adopted by anthropologists such as Gregory Bateson, who have had to deal with parallel "circuits". Patterns emerge from the juxtaposition of several systems. Juxtaposition and parallelism are to pattern epistemology what induction and deduction are to scientific epistemology. There is already a long standing example of pattern inference in Law. This is circumstantial evidence, a multi-dimensional pattern that provides a picture of what happened even when certain jig-saw pieces are missing. On the other hand, linear evidence is halted anytime that one of the links is absent. This is also true of mathematical proof, but Gödel goes further and says even with no links missing, all available theorems do not complete the set of all possible theorems. Causality not only cannot exhaust possibility, it cannot exhaust reality.

Question: what is the relation between the non-linear (Chaos) and multi-dimensional?

Science is the π-view of the world; Pattern is the ϕ-view of the world.

Li Kiang

SCICOM2.WP6 June 18, 1996

MORE COMMENTS ON SCIENCE

Localization Chauvinism
There is a great prejudice that localization must be an attribute of entity. Sensory derived attributes have given us the idea that all things that exist cluster their attributes in close spatial (and other?) proximity. Localization chauvinism is behind the astronomer's lecture on human insignificance based on the ratio of human scale to trans-galactic scales. This assumes that a human is a localized entity. The nature of quantum reality is beginning to erode our built in localization mind set. Perhaps the internet will also contribute to its demise.

"All knowledge refers to items of experience, but it is an open question whether all forms of experience are public."
-----?

"The cardinal virtue of the scientific method consists, above all, in its stubborn refusal to countenance expressions which have no empirical referents."

The more unexpected an event, the greater its information content. Thus rare events contain more information than common events. Science concentrates on the repeatable and reproducible, that is on the most common events, the domain of least information and of greatest entropy. What we must conclude is that science is about systems in or close to thermodynamic equilibrium. This is why science projects determinism onto the world.
Is this not somewhat close to Ilya Prigogine's conclusion?

Ernst Mach on Empiricism The Age of Ideology pp248-249

1. The thesis of empiricism: Sensations alone provide the real data or stuff of knowledge. The corollary of phenomenalism: The only terms of reference allowed are those which, directly or through definition, refer to sensations.
2. Auxiliary concepts may be admitted to scientific discourse, but only for the purpose of organizing hypotheses into a coherent system. [The pragmatic principle of economy]

{[For the special case of science this concurs with Wilson's two levels of epistemology: the data of experience and the unifying schema. see, for example, SCICOM1.WP6, the difference is that Wilson allows also for non-sensory experience, such as mathematics.]}
The basis of Mach 2 is the property of mathematics to represent the sensory world.

SAGAN2.WP6 April 2, 1997

I read somewhere that Carl Sagan, like Thomas Huxley the great defender of Darwin, at one point wished that the scientific view of the world could support a dimension of reality that permitted life after death. Carl said he longed to have more time with his father. Both men, Huxley and Sagan, let their rational aspect rule out other paths to knowing that are available to humans.

Carl wanted **proof** for the existence of God. What is proof? Proof is a demonstration using a sequence of arguments "whenever A happens B will also happen". Proof thus restricts itself to that which is causally determined. It can play no role where there is option, choice, or freedom. Those trained in science, which studies only the repeatable, reproducible, and causally deterministic aspects of the world, lose sight of the fact that much that happens in the world is not repeatable, but is special and unique. Science looks at, and can only look at, a particular subset of human experience. In the 20th century the deterministic mechanistic worldview that science built over a period of three centuries was overturned by science itself. I am referring to current interpretations of quantum reality.

With all of this well known to most physicists and philosophers of science, it is hard to understand why Carl was still hung up on mechanistic materialism. But all of his writing was pervaded with either overt or subliminal preaching of this 18th century philosophy. But what interests me is that Carl nonetheless was a believer. His heaven was not metaphysical, it was physical. It was to be reached literally through our development of space flight. For Carl, God would be found when we encountered life and intelligence beyond the earth.

The aliens would be the Messiah

TIME AND LOGIC

Aristotle's law of the excluded middle [see Scraps 1999#54, 2000#69] in effect has instituted a way of thinking that precludes our seeing the world as it really is. His logic derives from basic human experience of the world portrayed to us by our senses, but not reflecting the many other facets that the world possesses. For example, in our sensory experience of the world two objects cannot occupy the same place at the same time, nor can a single object be two different places at the same time. These indisputable "facts" are at the root of Aristotle's logic, and are the basics underlying true-false polarization and the law of the excluded middle. For over two thousand years this two valued logic has not been questioned, but now...

But now comes Schrödinger's Cat, who defies polarization, and confounds our thinking about him in Aristotelean terms. The cat is not governed by the polarization canon of the excluded middle which says he must be either dead or alive. It is absolutely non-Aristotelean to have a cat who is *both* dead and alive or possibly *neither* dead nor alive. Quantum mechanics forces us to admit that the world as we have always thought it to be is but a special case of a larger cosmic reality, and our way of thinking is but an adaptation to [or creation of] that special case.

Let us introduce another cat. This cat belongs to the Chinese sage, Li Kiang. Li's cat is one of those who, if inside, wants out; if outside, wants in. And except for the minor periods of transit, at any one time the cat is either inside or outside. No confusion about that. But Li nevertheless sometimes becomes confused, for Li is one of those sages who is able to speed or slow the rate at which his sensory clock tics, that is, the rate at which subjective time flows. One of the meditations that Li practices enables him to halt the movement of the secondhand of a clock. [If the clock had a microsecond hand Li could also halt its movement, a nanosecond hand? Perhaps]. When in such a meditative state, Li does not have to worry about the cat. It is permanently either inside or outside, as motionless in its position as the everlasting hills. Thus, when Li uses this meditation, the apparent glacial rate-of-flow of external time transfers him to a Parmenidean world.

But Li is also able by slowing his subjective clock to speed the apparent rate-of-flow of external time, and this is where his confusion begins. [But not only is Li confused, but those who know and watch Li are confused. He can remain absolutely motionless for days at a time.] What Li observes during his slowed time meditations is that everything about him moves very rapidly. For Li, the cat is simultaneously *both* inside and outside, because an "instant" of time for Li spans many transitions by the cat. But when Li goes to the extreme and stops his subjective clock, then everything moves so rapidly that it vanishes from his perception, and Li's cat, like its cousin the Cheshire Cat, disappears. The cat is then *neither* inside nor outside.

We conclude: There is a different logic proper to different ratios of subjective rate of time flow to external rate of time flow. Logics employing the law of the excluded middle are proper with "normal" rate ratios, but lead to erroneous conclusions when observing a world with a widely different ratio, such as the micro world of quantum mechanics or the universe itself.

Re 9f1

Quine's result that both analytic and synthetic propositions are ultimately empirical

Willard VAN ORMAN QUINE [BYB 2001 - obituaries]
1908 - 2000

Book "Word and Object" Attacked the distinction between analytic statements [those whose truth depends on the synonymy of the terms it contains] and synthetic statements [whose truth depends on correspondence with experience]

Quine concluded that ultimately all statements depended on experience.

Vienna Circle: Logical Positivists
Alfred Tarski
Kurt Gödel
Rudolph Carnap
Moritz Schlick

The future is neither true nor false
The past is both true and false
Only the present is true or false
- Li Kiang
李 ii

Can experience be contradictory?

Certainly interpretations can.

Rewrite of Dumatch

EXPLCREA.WP6 December 9, 1993 rev: June 18, 1996

EXPLORATION AND CREATION

TWO VARIETIES OF EXPLORATION:
1) The Search for the Common, the General, the Ubiquitous, the Repetitive, the Reproducible, and the Universal;
2) The Search for the Individual, the Unique, the Special, the Rare, the Miraculous, and the Possible.

We usually associate science with exploration and usually with type 1) exploration. But science is also concerned with such matters as the varieties of organisms, rocks, stars, atoms, particles etc. and in that sense is doing exploration of type 2). But science collects "2)" in order to do "1)" that is, science's ultimate focus is on the unity underlying diversity.

In order to develop a unity underlying diversity, we proceed by constructing an infrastructure or organizing schema. While this is essential for 1), it is also useful, but difficult for 2). Ofttimes 2) must remain a "miscellany file" for a lack of sufficient elements to suggest a schema. Two levels are involved: The collection level, and the organization level. The collection level gives us facts and data, the organization level gives us information and interpretation, i.e. what we call knowledge. An organization schema is derived from the data with the help of imagination, afterwards facts are interpreted with the help of the schema and are not solo, but become associated with interpretations. The schema becomes a 'ground' against which the figure of facts are perceived. Since the schema is a construct from our experience, it does not have the same validity as do its contents.

The construction of a schema requires imagination. Einstein said that imagination is more important than knowledge (data), and Feynman said that too much knowledge is paralyzing. Both of these statements infer that the construction of unifying frameworks is held to be the essence of scientific creativity. It is often asked how much of our knowledge is from the world and how much of it is projected on the world. A component of the answer to that question is that the data is from the world, while the schema is projected onto the world. Exploration is determining what is already there, creation is giving it an organizing framework.

Returning to 2), is it important or possible to find a framework for organizing the unique? Is it not more important to savor the uniqueness than to try to classify it? Sometimes a scientist focusing on "2)" does so not to build a framework nor to find ultimate unity, but to relish uniqueness for its own sake. Here the work of Loren Eisley comes to mind. But delving into uniqueness in the manner of Eisley is not regarded as science. It departs from the purely objective and focuses on what happens to the observer in making the observation. Quantum mechanics tells us we cannot make an observation without affecting what is observed. Is it not also true that we cannot make an observation without affecting the observer? In this sense, in exploring the world we are recreating it, and not only the world, but we are recreating ourselves. I would conclude that exploration which focuses on savoring the unique is an act akin to what has been traditionally called worship. Science can become a spiritual path when we are willing to let our exploration change us. The interface between exploring and creating, collecting and organizing, knowing and imagining, defining and evaluating, may be the same interface as that between recollecting and recognizing, between intellect and spirit.

SCIENCE

BOORSTIN.P51 01/25/93

In the following paragraph taken from *The Discoverers* by Daniel J. Boorstin (p295), are enumerated the epistemological parameters of a scientific theory:

> To understand the paradoxical beginnings of modern science, we must recall that this beautiful symmetrical scheme, much ridiculed in the modern classroom, actually served very well for both astronomer and layman. 1) Accuracy It described the heavens precisely as they looked and fitted the observations and calculations made with the naked eye. The scheme's 2) Simplicity simplicity, symmetry, and comnmon sense made it seem to confirm 3) Comprehensiveness countless axioms of philosophy, theology, and religion. And it actually performed some functions 4) Explanation of a scientific explanation. For it fitted the available facts, was a reasonably satisfactory device for 5) Prediction prediction, and harmonized with the accepted view of the rest of nature. In addition, 6) Economy it aided the astronomer's memory with a convenient coherent model, replacing the list of miscellaneous facts then known about the heavens. More than that, while this much maligned geocentric, or "Ptolemaic," scheme provided the layman with a clear picture to carry around in his head, 7) Usefulness it helped the astronomer reach out to the unknown. Even for the adventurous sailor and the navigator it served well enough, as Columbus proved. The modern advance 8) Stepping Stone to Copernicus' heliocentric system would be hard to imagine if the geocentric system had not been there available for revision. Copernicus would not change the shape of the system, he simply changed the location of the bodies.
>
> Of course the traditional geocentric system of Aristotle and Ptolemy and so many others over centuries had its own weaknesses. For example, the system did not explain the irregularities observed in the motions of the planets. But the layman hardly noticed these irregularities, and anyway they seemed adequately described by the supposed movement of each planet within its own special ethereal sphere. Astronomers were adept at explaining away what seemed only minor problems by a variety of complicated epicycles, deferents, equants, and eccentrics, which gave them a heavy vested interest in the whole scheme. **The more copious this peripheral literature became, the more difficult it became to retreat to fundamentals**. If the central scheme was not correct, surely so many learned men would not have bothered to offer their many subtle corrections.

We see the same archetype being repeated in modern cosmology.

My italics (underlining)

cf. MODELSO1.P51 1992 ①

"

cf. Tall, Skinny, Box

SCIEPOST.WPD August 25, 2005

THE FOCUS OF SCIENCE

While the scientific method is a process designed to explore, represent, and organize phenomena, it has placed certain limits on how this is to be done. Apodictically, limits are essential for convergence to a product, [in the case of science, knowledge], but limits while expediting process also delimit the domain of the product. What are the limits, acknowledged or hidden, that have been adopted by science? Limits can become pitfalls.

Unidirectional

Reductionism, Causality, vs Mutuality
especially of time

Repetitive

Regularity Whitehead quotes SYMMETRIES
and the intentionally repetitive - reproducibility

Materialistic Explicable per particles

Nodes vs Links, Structuralism The essence is in the links not the nodes. In the unmanifest not in the manifest.

Convergence

There exists one truth, proscribing alternatives

Cosmological Principle

As here, so everywhere

Quantification

Measurable

Contiguity-Continuity

While these self imposed limits make science effective in what it does, they preclude the claims of absolutism made by some scientists.

Among the positive aspects of science is its ability to place process above product and replace and update any product in the light of new evidence. Another positive aspect is the acceptance of greater mystery in the penetration of existing mystery. Science's best product is new questions. So long as science is a search, not a quest, it is vital. But it is periodically seduced by a glamorous result to replace the process with the product. [theory of everything] eschewing alternatives.

While the scientific imperative may be the Search, the technological imperative is Ozbekian's, "Can do requires must do"

Brick by Brick Science
The laid bricks determine the next bricks
The creation replaces the creator
and the bricks are in charge
Scientists are not in charge - Science is
~ Generals are not in charge - War is

Creator, ~ artists, are not locked, their creations take over (and usually die
but they, so long as they are not serving their
creations - can continue to create

COMEAREC.WP6 NEW EPIONT March 20, 1995

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= "The Cosmic Mind"

Constructor

Hamming non-localism

In the beginning was the Word

{[Measurement creates information

example of constraint → creation
what is created is information

The creation of information is what is involved
in the collapse of the wave function
in the conversion of potential into actuality
into localism, i.e. space, time

The Sunyata is informationless
no form - void - no information]}

with death the information disappears

COPENHGN.WP6 SCRAPS

THE COPENHAGEN INTERPRETATION

"It is a rejection of the presumption that nature could be understood in terms of elementary space-time realities. According to the new view, the complete description of matter at the atomic level was given by the probability functions that referred, not to underlying microscopic space-time realities, but rather to the macroscopic objects of sense experience. The theoretical structure did not extend down and anchor itself on fundamental microscopic space-time realities. Instead it turned back and anchored itself in the concrete sense realities that form the basis of social life...This pragmatic description is to be contrasted with descriptions that attempt to peer behind the scenes and tell us what is really happening"

Henry Stapp The World of Physics Vol 2. p398

BOHR ON COMPLEMENTARITY

"Just as the freedom of the will is an experiential category of our psychic life, causality may be considered as a mode of perception by which we reduce our sense impressions to order. At the same time, however, we are concerned in both cases with idealizations whose natural limitations are open to investigation and which depend upon one another in the sense that the feeling of volition and the demand for causality are equally indispensable elements in the relation between subject and object which forms the core of the problem of knowledge."

Niels Bohr The How and the Why p332

STANDMOD.WP6 JULY 4, 1997

THE STANDARD MODEL

There are 61 basic particles, including anti-particles. These are 36 quarks, 12 leptons, and 13 guage bosons.

Particles marked with an asterisk are considered **stable*.**	FERMIONS SPIN = 1/2 OBEY PAULI PRINIPLE	BOSONS SPIN = 0,1 NO PAULI PRINCIPLE
HADRONS CONTAIN QUARKS STRONG FORCE PRESENT	BARYONS 3 QUARKS	MESONS 2 QUARKS
NO QUARKS NO STRONG FORCE	LEPTONS	GUAGE BOSONS FORCE CARRIERS

GUAGE BOSONS

The force exchangers employed by the four forces. All have spin 1

FORCE	MASS	CARRIER
STRONG	0	GLUONS (EIGHT TYPES)
WEAK	83 GeV	INTERMEDIATE VECTOR BOSONS, W+, W-; Z 93GeV
ELECTRIC	0	PHOTONS*
GRAVITY	0	GRAVITONS spin +2

LEPTONS

All have 1/2 spin, are not subject to the strong force, but obey the Pauli Exclusion Principle. [ν is symbol for neutrino]

PARTICLE	MASS	CHARGE	ANTI-PRTCL	MASS	CHARGE
ELECTRON*	0.511 MeV	-1	POSITRON*	same as	+1
MUON	105.6 MeV	-1	ANTI-MUON	particle	+1
TAU PRTCL	1.784 MeV	-1	ANTI-TAU	"	+1
e NEUTRINO	< 50 eV	0	ANTI-eν	"	0
μ NEUTRINO	< 0.5 MeV	0	ANTI-$\mu\nu$	"	0
τ NEUTRINO	< 70 MeV	0	ANTI-$\tau\nu$	"	0

THE STANDARD MODEL

QUARKS

All quarks come in three colors: red, blue, green, making a total of 36quarks.

QUARKS			ANTI-QUARKS		
FLAVOR	SYMBOL	CHARGE	FLAVOR	SYMBOL	CHARGE
UP*	u	+2/3	ANTI-UP	$\bar{u}$	-2/3
DOWN	d	-1/3	ANTI-DOWN	$\bar{d}$	+1/3
STRANGE	s	-1/3	ANTI-STRANGE	$\bar{s}$	+1/3
CHARM	c	+2/3	ANTI-CHARM	$\bar{c}$	-2/3
BOTTOM-BEAUTY	b	-1/3	ANTI-BOTTOM	$\bar{b}$	+1/3
TOP-TRUTH	t	+2/3	ANTI-TOP	$\bar{t}$	-2/3

MESONS

NAME	MASS	CHARGE	SPIN	QUARKS
PION Pi-0	135 MeV	0	0	$u\bar{u}$ or $d\bar{d}$
Pi+	140 MeV	+1	0	$u\bar{d}$
Pi-	140 MeV	-1	0	$d\bar{u}$
KAON K-0	498 MeV	0	0	$d\bar{s}$
K+	494 MeV	+1	0	$u\bar{s}$
K-	494 MeV	-1	0	$s\bar{u}$
J/PSI	3.1 GeV	0	1	$c\bar{c}$
D-0	1.87 GeV	0	0	$c\bar{u}$
D+	1.87 GeV	+1	0	$c\bar{d}$
UPSILON	9.46 GeV	0	1	$b\bar{b}$

THE STANDARD MODEL

BARYONS

Baryons all have spin 1/2.

NAME	LIFETIME	MASS	CHARGE	QUARKS
PROTON*	STABLE	938.3 MeV	+1	uud
ANTI-PROTON*	STABLE	"	0	$\bar{u}\bar{u}\bar{d}$
NEUTRON	15 MINUTES	939.6 MeV	-1	ddu
ANTI-NEUTRON	"	"	0	$\bar{d}\bar{d}\bar{u}$
LAMBDA	~10^-10 s	1.115 GeV	0	uds
ANTI-LAMBDA	"	"	0	$\bar{u}\bar{d}\bar{s}$
SIGMA+	"	1.189 GeV	+1	uus
SIGMA-	"	1.197 GeV	-1	dds
SIGMA-0	~10^-20 s	1.192 GeV	0	uds
XI-	~10^-10 s	1.321 GeV	-1	dss
XI-0	"	1.315 GeV	0	uss
OMEGA-	"	1.672 GeV	-1	sss
CHARMED Λ	~10^-13 s	2.28 GeV	+1	udc

THE PLANCK PARTICLE LEVEL

In TABLE 2 the subscript "o" is used when refering to an attribute of the Planck Particle. The values in the table are taken from TABLE 1 or are derived using the equations given below. The tabular entries in the columns marked $\hbar$ G c α μ S are the powers to which these values are raised.

TABLE 2

QUANTITY	$\hbar$	G	c	α	μ	S	$\log_{10}$(cgs value)	$\log_{10}$(cgs value)/2
m_o^2	1	-1	1	0	0	0	-9.324399	-4.662199
l_o^2	1	1	-3	0	0	0	-65.583090	-32.791545
t_o^2	1	1	-5	0	0	0	-86.536732	-43.286366
$[Gm_o/c^2]^2$	1	1	-3	0	0	0	-65.583090	-32.791545
T_o^2	1	1	-5	0	0	0	-86.536732	-43.268366
E_T^2	1	-1	5	0	0	0	32.582886	16.291443
E_G^2	1	-1	5	0	0	0	32.582886	16.291443
ρ_o	-1	-2	5	0	0	0	93.712439	
$E_T t_o$	1	0	0	0	0	0	-26.976924	
$m_o l_o$	1	0	-1	0	0	0	-37.453744	
m_o/l_o	0	-1	2	0	0	0	28.129326	

Gm_o/c^2 is the gravitational radius which is equal to l_o for the Planck Particle.
T_o is the density time given by $\sqrt{(l_o^3/Gm_o)}$, equal to t_o for the Planck Particle.
E_T is the total energy = m_oc^2.
E_G is the gravitational energy = Gm_o^2/l_o, equal to E_T for the Planck Particle.
ρ_o is the density = m_o/l_o^3
From the above values, the following relations may be seen to hold.

$$\rho_o = c^5/\hbar G^2, \qquad E_T = \hbar\sqrt{(G\rho)}, \qquad t_o = 1/\sqrt{(G\rho)}, \qquad E_T\, t_o = \hbar$$

$$m_o l_o = \hbar/c \qquad m_o/l_o = c^2/G \qquad Gm_o/l_oc^2 = 1$$

$$e^2 = \hbar\alpha c = \alpha c m_o l_o = \alpha G m_o^2 \qquad T_e = \hbar^3/m_e e^4$$

THE BARYON -- LEPTON LEVEL

TABLE 3A THE ELECTRON

QUANTITY	$\hbar$	G	c	α	μ	S	$\log_{10}$(cgs value)	$\log_{10}$(cgs value)/2
m_e^2	1	-1	1	1	-1	-1	-54.081022	-27.040511
r_e^2	1	1	-3	1	1	1	-25.100136	-12.550068
t_e^2	1	1	-5	1	1	1	-46.053778	-23.026889
$[Gm_e/c^2]^2$	1	1	-3	1	-1	-1	-112.339714	-56.169857
T_e^2	1	1	-5	1	2	2	-3.433989	-1.716995
E_{Te}^2	1	-1	5	1	-1	-1	-12.173938	-6.086969
E_{Ge}^2	1	-1	5	1	-3	-3	-97.413518	-48.706659
ρ_e	-1	-2	5	-1	-2	-2	10.549693	
$E_{Te}t_e$	1	0	0	1	0	0	-29.113858	
$E_{Te}T_e$	1	0	0	1	1/2	1/2	-7.803964	
$E_{Ge}t_e$	1	0	0	1	-1	-1	-71.733648	
$E_{ge}T_e$	1	0	0	1	-1/2	-1/2	-50.423754	
$m_e r_e$	1	0	-1	1	0	0	-39.590579	
m_e/r_e	0	-1	2	0	-1	-1	-14.490443	

The dimensionless parameters α and (μS) are introduced here through the equations: $m_e r_e c/\hbar = \alpha$ and $Gm_e/r_e c^2 = 1/(\mu S)$

$T_e = \sqrt{(\mu S)}\, t_e$, $E_{Te} = \mu S E_{Ge}$, $E_{Te}T_e = \sqrt{(\mu S)}\, E_{Te}t_e$, $E_{Ge}T_e = \sqrt{(\mu S)}\, E_{Ge}t_e$

$E_{Te}t_e = \alpha\hbar$, $E_{Te}T_e = \sqrt{(\mu S)}\alpha\hbar$, $E_{Ge}t_e = \alpha\hbar/\mu S$, $E_{Ge}T_e = \alpha\hbar/\sqrt{(\mu S)}$

$m_e r_e = \alpha m_0 l_0$

THE BARYON -- LEPTON LEVEL

TABLE 3B THE PROTON

QUANTITY	$\hbar$	G	c	α	μ	S	$\log_{10}$(cgs value)	$\log_{10}$(cgs value)/2
m_p^2	1	-1	1	1	1	-1	-47.553204	-23.776602
r_e^2	1	1	-3	1	1	1	-25.100136	-12.550068
t_p^2	1	1	-5	1	1	1	-46.053778	-23.026889
$[Gm_p/c^2]^2$	1	1	-3	1	1	-1	-105.811896	-52.905948
T_p^2	1	1	-5	1	1	2	-6.697898	-3.348949
E_{Tp}^2	1	-1	5	1	1	-1	-5.646120	-2.822960
E_{Gp}^2	1	-1	5	1	1	-3	-84.357682	-42.178841
ρ_p	-1	-2	5	-1	-1	-2	13.873605	
$E_{Tp}t_p$	1	0	0	1	1	0	-25.849949	
$E_{Tp}T_p$	1	0	0	1	1	1/2	-6.172009	
$E_{Gp}t_p$	1	0	0	1	1	-1	-65.205829	
$E_{Gp}T_p$	1	0	0	1	1	-1/2	-45.527889	
m_pr_e	1	0	-1	1	1	0	-36.326670	
m_p/r_e	0	-1	2	0	0	-1	-11.226534	

The dimensionless parameters μ and S are differentiated (discriminated or separated) here through the equations: $m_pr_ec/\hbar\alpha = \mu$ and $Gm_p/r_ec^2 = 1/S$.

$T_p = \sqrt{(S)}\, t_p$, $E_{Tp} = SE_{Gp}$, $E_{Tp}T_p = \sqrt{(S)}\, E_{Tp}t_p$, $E_{Gp}T_p = \sqrt{(S)}\, E_{Gp}t_p$

$E_{Tp}t_p = \alpha\mu\hbar$, $E_{Tp}T_p = \alpha\mu\hbar\sqrt{(S)}$, $E_{Gp}t_p = \alpha\mu\hbar/S$, $E_{Gp}T_p = \alpha\mu\hbar/\sqrt{(S)}$

$m_pr_e = \alpha\mu\, m_o l_o$

THE BARYON -- LEPTON LEVEL

TABLE 4A ELECTRON VALUES IN PLANCK UNITS

QUANTITY	$\hbar$	G	c	α	μ	S	$\log_{10}$(PL value)	$\log_{10}$(PL value)/2
m_e^2	0	0	0	1	-1	-1	-44.756624	-22.378312
r_e^2	0	0	0	1	1	1	40.482954	20.241477
t_e^2	0	0	0	1	1	1	40.482954	20.241477
$[Gm_e/c^2]^2$	0	0	0	1	-1	-1	-44.756624	-22.378312
τ_e^2	0	0	0	1	2	2	83.102742	41..551371
E_{Te}^2	0	0	0	1	-1	-1	-44.756624	-22.378312
E_{Ge}^2	0	0	0	1	-3	-3	-129.996202	-64.998101
ρ_e	0	0	0	-1	-2	-2	-83.102743	
$m_e r_e$	0	0	0	1	0	0	-2.136835	
m_e/r_e	0	0	0	0	-1	-1	-42.619789	

$E_{Ge} = m_e^2/r_e = \sqrt{(\alpha/\mu^3 S^3)} = E_{Te}/\mu S$, $t_e = r_e = \tau_e/\sqrt{S}$, $\tau_e^2\, \rho_e = 1$

QUANTITY	$\hbar$	G	c	α	μ	S	$\log_{10}$(PL value)	$\log_{10}$(PL value)/2
e^2	0	0	0	1	0	0	-2.136835	-1.068418
							$\log_{10}$(cgs value)	$\log_{10}$(cgs value)/2
e^2	1	0	1	1	0	0	-18.636938	-9.318469

THE BARYON--LEPTON LEVEL

TABLE 4B PROTON VALUES IN PLANCK UNITS

QUANTITY	$\hbar$	G	c	α	μ	S	$\log_{10}$(PL value)	$\log_{10}$(PL value)/2
m_p^2	0	0	0	1	1	-1	-38.228806	-19.114403
r_e^2	0	0	0	1	1	1	40.482954	20.241477
t_p^2	0	0	0	1	1	1	40.482954	20.241477
$[Gm_p/c^2]^2$	0	0	0	1	1	-1	-38.228806	-19.114403
T_p^2	0	0	0	1	1	2	79.838434	39.919417
E_{Tp}^2	0	0	0	1	1	-1	-38.228806	-19.114403
E_{Gp}^2	0	0	0	1	1	-3	-116.940568	-58.470284
ρ_p	0	0	0	-1	-1	-2	-79.838834	
$m_p r_e$	0	0	0	1	1	0	1.127074	
m_p/r_e	0	0	0	0	0	-1	-.39.355880	

$E_{Gp} = m_p^2/r_e = \sqrt{(\alpha\mu/S^3)} = Etp/S$, $t_p = r_e = T_p/\sqrt{S}$, $T_p^2\,\rho_p = 1$

$t_p = t_e$, $T_p = \sqrt{(\mu)}\,T_e$

QUANTITY	$\hbar$	G	c	α	μ	S	$\log_{10}$(PL value)	$\log_{10}$(PL value)/2
a_o^2	0	0	0	-3	1	1	49.030294	24.515147
							$\log_{10}$(cgs value)	$\log_{10}$(cgs value)/2
a_o^2	1	1	-3	-3	1	1	-16.552798	-8.276399

PLNCK2BN1.WPD April 28, 1999

PHYSICAL QUANTITIES

$\log_{10}$ cgs units

Fundamental Constants:

$c = 10.476821$ [L/T]; $G = -7.175705$ [L^3/MT^2]; $\hbar = -26{,}976924$ [ML^2/T]

$c^2 = 20.953642$; $c^3 = 31.430463$; $c^4 = 41.907284$; $c^5 = 52.384105$

$c^2/G = 28.129347$[M/L]; $c^3/G = 38.606168$ [M/T]; $c^4/G = 49.082989$ [ML/T^2] (Force);

$c^5/G = 59.559810$ [ML^2/T^3] (Power) ; $\hbar G/c^4 = -76.059913$ [LT];

$\hbar/c = -37.453745$ [ML]; $\hbar/\alpha^2 c = -33.180075$; $\hbar/c^2 = -47.930386$ [MT]; $\hbar/\alpha^2 c^2 = -43.656896$

The Planck Particle

$m_o = \sqrt{(\hbar c/G)} = -4.662199$ [M] $l_o = \sqrt{(\hbar G/c^3)} = -32.791545$ [L]

$t_o = l_o/c = -43.268366 = \sqrt{(\hbar G/c^5)}$ [T] = $\tau_o = \sqrt{(l_o^3/Gm_o)} = -43.268366 = \sqrt{(\hbar G/c^5)}$ [T]

$E_o = m_o c^2 = 16.291442 = \sqrt{(\hbar c^5/G)}$ [ML^2/T^2] = $\epsilon_o = Gm_o^2/l_o = 16.291442 = \sqrt{(\hbar c^5/G)}$ [ML^2/T^2]

$\varrho_o = c^5/\hbar G^2 = 93.712439$ [M/L^3]; $G\varrho_o\tau_o^2 = 1$; $E_o t_o = \epsilon_o \tau_o = \hbar$; $\hbar\nu_o = 16.291442$

The Baryon:

$m_p = -23.776602$ [M] $m_n = -23.776004$ [M]

$r_e = -12.550068$ [L]

$t_b = -23.026889 = r_e/c$ $\tau_b = -3.348949 = \sqrt{(r_e^3/Gm_p)} \sim$ [$= 4.48 \times 10^{-4}$ sec] [T]

$\varrho_b = 13.873602 = m_p/r_e^3$ [M/L^3];

The Electron:

$m_e = -27.040511$ [M]

$t_e = -23.026889 = r_e/c$ $\tau_e = -1.716994 = (G\varrho_e)^{-1/2} \sim$ [$= 1.9187 \times 10^{-2}$ sec] [T]

$e = -9.318469$ $e^2 = -18.636938 = \hbar\alpha c$ [ML^3/T^2] $e/\sqrt{G} = -5.730617$ [M]

$\varrho_e = 10.609693$ [M/L^3]

Dimensionless Constants:

$\alpha^{1/2} = -1.068418$; $\alpha = -2.136835$; $\alpha^{3/2} = -3.205253$; $\alpha^2 = -4.273670$

$\alpha^{1/8} = -0.267104$; $\alpha^{2/3} = -1.424556$

$\mu^{1/2} = 1.631955$; $\mu = 3.263909$; $\mu^{3/2} = 4.895864$; $\mu^2 = 6.527818$

$(\alpha\mu)^{1/2} = 0.563537 = n$; $\alpha\mu = 1.127074$; $(\alpha\mu)^{3/2} = 1.690611$; $(\alpha\mu)^2 = 2.254148$

$(\alpha\mu)^{2/3} = 0.751383$; $(\alpha\mu)^{3/4} = 0.845306$; [$\log_{10} 7 = 0.845098$]

$S^{1/2} = 19.677940 = N$; $S = 39.355880$; $S^{3/2} = 59.033820$; $S^2 = 78.711760$

Mathematical Quantities:

$\pi = 0.497150$; $2\pi = 0.798180$; $4\pi^2 = 1.596360$; $4\pi/3 = 0.622089$; $8\pi/3 = 0.923119$

$e = 0.434294$; $\Phi = 0.208988$;

Miscellaneous Quantities:

No. sec in year: = 7.499112; $T_U = 17.456065$ seconds;

$\hbar/[(\alpha c)^2 t_o] = -0.388530$ [M] ~ 0.408762 g

PLNK2BN8.WPD MAY 9, 1999

THE PLANCK PARTICLE

PARAMETER	SYMBOL	DIMENSION	FORMULAE	VALUE $\log_{10}$(cgs)
MASS	m_o	[M]	$\sqrt{(\hbar c/G)}$	- 4.662199
LENGTH	l_o	[L]	$\sqrt{(\hbar G/c^3)}$	- 32.791545
V-TIME	t_o	[T]	$\sqrt{(\hbar G/c^5)}$ l_o/c	- 43.268366
ϱ-TIME	τ_o	[T]	$\sqrt{(\hbar G/c^5)}$ $\sqrt{(l_o^3/Gm_o)}$	- 43.268366
MOMENTUM	Q_{ot}	[ML/T]	$\sqrt{(\hbar c^3/G)}$ $m_o l_o/t_o$	5.814622
MOMENTUM	$Q_{o\tau}$	[ML/T]	$\sqrt{(\hbar c^3/G)}$ $m_o l_o/\tau_o$	5.814622
ANG. M'NTUM	Ω_{Ot}	[ML²/T]	$\hbar$	- 26.976924
ANG. M'NTUM	$\Omega_{O\tau}$	[ML²/T]	h	- 26.976924
REST ENERGY	E_O	[ML²/T²]	$\sqrt{(\hbar c^5/G)}$ $m_o c^2$	16.291442
GRAV ENERGY	E_{OG}	[ML²/T²]	$\sqrt{(\hbar c^5/G)}$ Gm_o^2/l_o	16.291442
ν - ENERGY	$E_{O\nu}$	[ML²/T²]	$\sqrt{(\hbar c^5/G)}$ $\hbar\nu$	16.291442
t - POWER	P_{ot}	[ML²/T³]	c^5/G $m_o l_o^2/t_o^3$	59.559810
τ - POWER	$P_{o\tau}$	[ML²/T³]	c^5/G $m_o l_o^2/\tau_o^3$	59.559810
t - CHARGE	e_{ot}^2	[ML³/T²]	$\hbar c$ $m_o l_o^3/t_o^2$	- 16.500102
τ - CHARGE	$e_{o\tau}^2$	[ML³/T²]	$\hbar c$ $m_o l_o^3/\tau_o^2$	- 16.500102
FORCE	F_o	[ML/T²]	c^4/G $m_o c^2/l_o$	49.082989
G - FORCE	F_{oG}	[ML/T²]	c^4/G Gm_o^2/l_o^2	49.082989
e - FORCE	F_{oe}	[ML/T²]	c^4/G e^2/l_o^2	49.082989
DENSITY	ϱ_o	[M/L³]	$c^5/\hbar G^2$ m_o/l_o^3	93.712439
VELOCITY	c	[L/T]		10.476821
ACTION	h	[ML²/T]		- 26.976924
"NEWTON"	G	[L³/MT²]		- 7.175705
CHARGE	e^2	[ML³/T²]		- 18.636937
e - ENERGY				

Volume $\left(\frac{\hbar G}{c^3}\right)^{3/2}$ −98.374635

ELECVOLT.WPD February 20, 2000 rev JANUARY 18, 2001

ELECTRON VOLT UNIT CONVERSIONS

The electron volt has become popular among particle physicists as a unit to measure many things. Although the electron volt is basically a unit of energy,[1] it is also used to measure mass, frequency, wavelength, and other physical parameters. Energy can be used as a basic measure whenever one other physical parameter, such as mass or frequency, can be dimensionally equated to energy through the fundamental constants, c, G, and/or ħ. That is,

$$E^n = \text{function}(M, \text{ or } \nu, \text{ or } \lambda, \text{ etc; } c, G, \hbar)$$

where n is some power of the energy, E. For example, the relation between energy and mass, $M = E/c^2$; or between energy and frequency, $\nu = E/\hbar$; or energy and wavelength, $\lambda = \hbar c/E$.

ENERGY CONVERSIONS:

As a unit of energy, one electron volt = $1.602\ 137\ 33 \times 10^{-12}$ ergs or $1.602\ 137\ 33 \times 10^{-19}$ joules

When expressed as logarithms base 10,

a) one ev = -11.795300260 ergs = -18.795300 joules
b) one Mev = 10^6 ev = -5.795300260 ergs = -12.795300 joules
c) one Gev = 10^9 ev = -2.795300260 ergs = -9.795300 joules

To convert:

Energy in electron volts to ergs: subtract 11.7953; ergs to joules: subtract 7
Energy in mev to ergs subtract 5.7953
Energy in Gev to ergs subtract 2.7953
Energy in ergs to electron volts: add 11.7953
Energy in ergs to mev: add 5.7953
Energy in ergs to Gev: add 2.7953

For example, the energy of the Planck Particle is 16.291442 ergs.(value in $\log_{10}$)

$16.291442 + 2.795300260 = 19.086742$ Gev

(Planck in ergs) + (Gevs/erg) = (Planck in Gevs)

ENERGY TO FREQUENCY:

In using electron volts as a measure of frequency, the convention is to obtain frequency from the equation $\nu = E/\hbar$, where E is the energy in ergs, ν is the frequency in hertz, and ħ is Planck's constant.

Add 15.181624 to the energy in electron volts to obtain the frequency in hertz
Add 21.181624 to mev to get frequency in hertz
Add 24.181624 to Gev to get frequency in hertz

---

[1] The electron volt is the amount of work required to move a unit charge through a potential difference of one volt. Among other units used to measure energy are the erg, the joule, the calorie, the BTU, and the kilowatt-hour.

ENERGY TO MASS:

In using electron volts as a measure of mass, the convention is to obtain mass from the mass-energy relation $m = E/c^2$, where E is the energy in ergs, m the mass in grams, and c is the velocity of light.

The mass in grams = the energy in electron volts –32.748941
The mass in grams = the energy in mev –26.748941
The mass in grams = the energy in Gev –23.748941

ENERGY TO WAVELENGTH:

In using electron volts as a measure of wavelength, the convention is to obtain wavelength from the relation, $\lambda = \hbar c/E$, where E is the energy in ergs, λ the wavelength in centimeters, c is the velocity of light, and $\hbar$ is Planck's constant.

The wavelength in centimeters = –(the energy in electron volts + 4.704802)
The wavelength in centimeters = –(the energy in mev + 10.704802)
The wavelength in centimeters = –(the energy in Gev + 13.704802)

ENERGY TO TEMPERATURE:

One GeV = 1.1604×10^{13} K ; log +13.064608 K

ENERGY TO POWER:

One $GeV^2 = 2.4341 \times 10^{21}$ ergs/sec log +21.386338 watts

ENERGY TO MASS DENSITY:

One $GeV^4 = 2.3201 \times 10^{17}$ g/cm^3 log +17.365507 g/cm^3

Energy to Power

$\nu = \frac{E}{\hbar}$

$P = \frac{E}{t} = E \cdot \nu = \frac{E^2}{\hbar}$

$(GEV)^2$ −2.795300 2
−5.590600
$\hbar$ −26.976924
+21.386324 watts

e.g. P 19.086742 2
38.173484
21.386324
59.559808

Energy to Mass Density

$\rho = \frac{M}{L^3}$, $M = \frac{E}{c^2}$

$L = \frac{\hbar c}{E}$

$\rho = \frac{E^4}{\hbar^3 c^5}$

$E^4 = -11.181200$
$\hbar^3 c^5 = -28.346667$
+17.365467

e.g. P 19.086742 4
76.346968
17.365467
93.712435

also see 1998 #43

STANUNIT.WPD JUNE 6, 2000

STANDARDIZATION OF UNITS

While the scientific world has long since discovered the value of standardization of units, it is surprising that it still tolerates a bog of diverse units among and within its various disciplines. As much as the cgs and SI systems were improvements over furlongs and rods, grains and drams, matins and complines, there still exist disparate units obtained with diverse apparati and various theoretical assumptions needing to be linked. While the history and evolution of measurements, including the methods and apparatus used in their determination, is important, we have reached a level when additional convergence of units is possible. Now that the values of the fundamental constants are known with improved accuracy, it would seem feasible that a system of units based on the Planck mass, length, and time could be adopted by all the physical sciences and for parts of biology and possibly even some aspect of the social sciences.

PART I. UNITS OF CHARGE:

The dimensionality of charge is $[ML^3/T^2]$

Four units of charge:

The Coulomb, C, = an ampere-second

The electrostatic unit, q, esu = equal charges separated by 1 cm, force = 1 dyne

The charge on electron = e, $\log_{10} e = -9.318469$ esu

$\log_{10} e^2 = -18.636938 = \hbar\alpha c = Gm_o^2\alpha$

The planck unit of charge = e_p, $\log_{10} e_p = -8.250052$ esu

$\log_{10} e_p^2 = -16.500103 = m_o l_o^3/t_o^2 = e^2/\alpha = \hbar c$

Conversion factors FROM ROW TO COLUMN

	COULOMB C	esu q	electron e	PLANCK P
C	1	2.998141E+9	6.241506E+18	5.331777E+17
q	3.333540E-10	1	2.081944E+9	1.778492E+8
e	1.602177E-19	4.803203E-10	1	11.706228
P	1.875547E-18	5.622740E-9	0.085425	1

Conversion factors Log_{10} values

	COULOMB C	esu q	electron e	PLANCK P
C	0	9.476852	18.795289	17.726872
q	-9.476852	0	9.318469	8.250052
e	-18.795289	-9.318469	0	1.068417
P	-17.726872	-8.250052	-1.068417	0

$\log_{10}(\alpha^{1/2}) = 1.068417$

Some of these numbers are based on Most $^{12}C/12$ ∴ different

where $m_p = -23.779751$ rather than -23.776602

PLANCKUN.WPD January 13, 2000

PLANCK UNITS

NAME	DIMENSION	SYMBOL	FORMULA	$\log_{10}$ cgs VALUE
MASS	[M]	m_o	$(c\hbar/G)^{1/2}$	- 4.662199
LENGTH	[L]	l_o	$(\hbar G/c^3)^{1/2}$	- 32.791545
TIME	[T]	t_o	$(\hbar G/c^5)^{1/2}$	- 43.268366
VELOCITY	[L/T]	c	c	10.476821
ACTION	$[ML^2/T]$	$\hbar$	$\hbar$	- 26.976924
G	$[L^3/MT^2]$	G	G	- 7.175704
ENERGY	$[ML^2/T^2]$	ϵ_o	$(\hbar c^5/G)^{1/2}$	16.291442
ENERGY	$[ML^2/T^2]$	ϵ_o^4	$(\hbar c^5/G)^2$	65.165768
FORCE	$[ML/T^2]$	k_o	c^4/G	49.082989
POWER	$[ML^2/T^3]$	w_o	c^5/G	59.559810
DENSITY	$[M/L^3]$	ρ_o	$c^5/G^2\hbar$	93.712439
PRESSURE	$[M/LT^2]$	y_o	$c^7/G^2\hbar$	114.666081 *
electron charge	$[ML^3/T^2]$	e_o^2	$\hbar\alpha c$	- 18.636938
CHARGE	$[ML^3/T^2]$	q_o^2	$\hbar c = e_o^2/\alpha$	- 16.500103
	[M/L]	m_o/l_o	c^2/G	28.129374
	[ML]	$m_o l_o$	$\hbar/c$	- 37.453745
	[M/T]	m_o/t_o	c^3/G	38.606168
	[MT]	$m_o l_o$	$\hbar/c^2$	- 47.930386
	[LT]	$l_o t_o$	$\hbar G/c^4$	- 76.059913
	$[M^3L]$	$m_o^3 l_o$	$\hbar^2/G$	- 46.778144
			c^2	20.953642
			c^3	31.430463
			c^4	41.907284
			c^5	52.384105
$e_o/\sqrt{G}$	[M]	$m_o\sqrt{\alpha}$	$(\hbar\alpha c/G)^{1/2}$	- 5.730617

* $\left(\frac{5}{\alpha\mu}\right)^3 = 114.686418$

$\delta \simeq 0.020337$

PHYSICAL QUANTITIES

all values are $\log_{10}$ cgs units

Fundamental Constants:

$c = 10.476821$ [L/T]; $G = -7.175705$ [L^3/MT^2]; $\hbar = -26{,}976924$ [ML^2/T]

$c^2 = 20.953642$; $c^3 = 31.430463$; $c^4 = 41.907284$; $c^5 = 52.384105$, $c^6 = 62.860926$

$c^2/G = 28.129347$ [M/L]; $c^3/G = 38.606168$ [M/T];

$c^4/G = 49.082989$ [ML/T^2] (Force); $c^5/G = 59.559810$ [ML^2/T^3] (Power); 876

$\hbar c = -16.500103$ [ML^3/T^2]; $\hbar/c = -37.453745$ [ML] $\hbar/c^2 = -47.930386$ [MT];

$\hbar\alpha c = -18.636938 = e^2$ [ML^3/T^2]; $\hbar/\alpha^2 c = -33.180075$ [ML]; $\hbar/\alpha^2 c^2 = -43.656896$ [MT]

$\hbar G/c^4 = -76.059913$ [LT]; $\hbar^2/G = -46.778143$ [M^3L]; $a_o = -8.276399$ [L]

Dimensionless Constants:

$\alpha^{1/2} = -1.068418$; $\alpha = -2.136835$; $\alpha^{3/2} = -3.205253$; $\alpha^2 = -4.273670$; $\alpha^3 = -6.410505$

$\alpha^{1/8} = -0.267104$; $\alpha^{2/3} = -1.424556$

$\mu^{1/2} = 1.631955$; $\mu = 3.263909$; $\mu^{3/2} = 4.895864$; $\mu^2 = 6.527818$; $\mu^3 = 9.791727$

$(\alpha\mu)^{1/2} = 0.563537$; $\alpha\mu = 1.127074$; $(\alpha\mu)^{3/2} = 1.690611$; $(\alpha\mu)^2 = 2.254148$

$(\alpha\mu)^{2/3} = 0.751383$; $(\alpha\mu)^{3/4} = 0.845306$; [$\log_{10}7 = 0.845098$]

$S^{1/2} = 19.677940$; $S = 39.355880$; $S^{3/2} = 59.033820$; $S^2 = 78.711760$; $S^3 = 118.067643$

The Planck Particle

$m_o = \sqrt{(\hbar c/G)} = -4.662199$[M]; $l_o = \sqrt{(\hbar G/c^3)} = -32.791545$ [L]

$t_o = l_o/c = -43.268366 = \sqrt{(\hbar G/c^5)}$ [T]; $\tau_o = \sqrt{(l_o^3/Gm_o)} = -43.268366 = \sqrt{(\hbar G/c^5)}$ [T]

$E_o = m_o c^2 = 16.291442 = \sqrt{(\hbar c^5/G)}$ [ML^2/T^2]; $\epsilon_o = Gm_o^2/l_o = 16.291442 = \sqrt{(\hbar c^5/G)}$ [ML^2/T^2]

$\varrho_o = c^5/\hbar G^2 = 93.712439$ [M/L^3]; $G\varrho_o\tau_o^2 = 1$; $E_o t_o = \epsilon_o\tau_o = \hbar$; $\hbar\nu_o = 16.291442$

The Baryon:

$m_p = -23.776602$ [M]; $m_n = -23.776004$[M]

$r_e = -12.550068$ [L]; $r_e^3 = -37{,}650204$ [L^3]

$t_b = -23.026889 = r_e/c$ [T]; $\tau_b = -3.348949 = \sqrt{(r_e^3/Gm_p)}$ [T]

$\varrho_b = 13.873602 = m_p/r_e^3$ [M/L^3]; Lifetime of neutron = 2.947924 = 887 sec

The Electron:

$m_e = -27.040511$ [M]

$t_e = -23.026889 = r_e/c$ [T]; $\tau_e = -1.716994 = (G\varrho_e)^{-1/2}$ [T]

$e = -9.318469$ (charge); $e^2 = -18.636938 = \hbar\alpha c$ [ML^3/T^2]; $e^2/\alpha = -16.500103$ [ML^3/T^2]

$\varrho_e = 10.609693$ [M/L^3]; $e/\sqrt{G} = -5.730617$ [M] $\hbar/[(\alpha c)^2 t_o] = -0.388530$ [M]

Mathematical Quantities:

$\pi = 0.497150$; $2\pi = 0.798180$; $4\pi^2 = 1.596360$; $4\pi/3 = 0.622089$; $8\pi/3 = 0.923119$

$e = 0.434294$; $\Phi = 0.208988$;

Miscellaneous Quantities:

Earth: Mass = 27.776243 [M]; $\rho = 0.74153$ [M/L^3]; $g = 2.991521$ [L^2/T];

Rotation Period (fixed stars) = 4.935236; Rotation Period (sun) = 4.936514; $\delta = 236$ sec

Schuster period = 3.704137 [T];. Schuman frequency = 0.874433 [1/T]; Sec in year: = 7.499112

Mean radius: Earth = 8.804208 [L]; Moon = 8.2401 [L]; Sun = 10.842302 [L];

Mass (Earth+Moon) = 27.781552 [M]; Moon = 25.866465 [M]; Sun = 33.298645 [M]

A.U. = 13.174927 [L]; L.Y. = 17.975932 [L]; MPC = 24.489352 [L]

Heliopause = 14.95 to 15.175 [L]; Cosmic time 17.456065 sec [T]

BASIC TIMES AND FREQUENCIES

ITEM	FORMULA	LOG_{10} VALUE	SECONDS	HERTZ
electron	$2\pi\sqrt{(r_e^3/Gm_e)}$	-0.918814	0.120555	8.294954
baryon	$2\pi\sqrt{(r_e^3/Gm_p)}$	-2.550769	0.002813	355.442210
hydrogen	$2\pi\sqrt{(a_o^3/Gm_p)}$	+3.859735	7239.9405	0.0001381
earth Schuster	$2\pi\sqrt{(R_e^3/GM_e)}$	+3.704223	5060.8446	0.0001976
earth Schumann	$2\pi R_e/c$	-0.874433	0.133526	7.489158
earth Schwarz..	GM_e/c^3	-10.829925	1.479364×10^{-11}	6.759662×10^{10}
orbit Schumann	2π(A.U.)/c	+3.496286	3135.3498	0.0003189
earth rotation ⊙		+4.9365137	86400	1.157407×10^{-5}
earth rotation ☆		+4.9353263	86164.09054	1.160576×10^{-5}
earth geosync*	$2\pi R_g/c$	-0.052906	0.885307	1.12955
neutron star	$\alpha\mu S\ t_p$	-2.785412	0.001639	610.1154
sun Schuster	$2\pi\sqrt{(R_s^3/GM_s)}$	+4.000163	10003.7539	0.00009996
sun Schumann	$2\pi R_s/c$	+1.163661	14.576760	0.068602
Sun Schwarz..	GM_s/c^3	-5.307523	0.000004926	203012.6031
Univ Schuster	$\sqrt{(R_u^3/GM_u)}$	+17.456065	9.056 gyr	
Univ Schumann	R_u/c	+17.456065	"	
Univ Schwarz...	GM_u/c^3	+17.456065	"	

* This is the Schumann period at the distance R_g, = 42241 km (26,247 miles) for synchronous satellites in equatorial orbits.

Notes:
(earth Schuster)^4 = (earth rotation ⊙)^3 , 14.817 = 14.810 $\Delta = 0.007$
(earth Schuster)/(hydrogen) = 0.699017 or 7/10 $\Delta = 0.001$
(log day) = (log hydrogen) x (log 19) 4.9365 = 4.9357 $\Delta = 0.0008$
(log hydrogen) = (log earth Schuster) x (log 11) 3.860 = 3.858 $\Delta = 0.002$

⇒ (log day) = (log earth Schuster) x 1.33168 or $\frac{4}{3}$

Middle C 520 hz

~~(1) geo × electron = 957~~

FUNDCONS.~~W01~~ P81		FUNDAMENTAL PHYSICAL CONSTANTS -- 1986		
CONSTANT	SYMB	DIMENSION	VALUE	LOG_{10}VALUE
VELOCITY OF LIGHT	C	[M/L]	2.997924580e+10	10.476820703
GRAVITATIONAL CONSTANT	G	[L3/MT2]	6.672598500e-08	-7.175705006
PLANCK'S CONSTANT	H	[ML2/T]	6.626075540e-27	-26.178743617
PLANCK'S CONSTANT/2PI	J	[ML2/T]	1.054572675e-27	-26.976923486
FINE STRUCTURE CONST	AL	[1]	7.297353083e-03	-2.136834640
RECIPROCAL OF AL	ED	[1]	1.370359896e+02	2.136834640
BOHR RADIUS	A0	[L]	5.291772492e-09	-8.276398836
PROTON MASS	MP	[M]	1.672623110e-24	-23.776601907
ELECTRON RADIUS	RE	[L]	2.817940936e-13	-12.550068114
ELECTRON MASS	ME	[M]	9.109389754e-28	-27.040510716
ELECTRON CHARGE	EC	[M0.5L1.5/T]	4.803206829e-10	-9.318468712
COULOMB/GRAVITY RATIO	S	[1]	2.269238825e+39	39.355880205
PROTON/ELECTRON MASS	U	[1]	1.836152701e+03	3.263908796
PLANCK LENGTH (h)	PL	[L]	4.0508366235e-33	-32.3924552722
PLANCK MASS (h)	PM	[M]	0.00005456202832	-4.26310949334
PLANCK TIME (h)	PT	[T]	1.3512130113e-43	-42.8692761814
PLANCK LENGTH (h/2PI)	PLJ	[L]	1.6160500000e-33	-32.7915452064
PLANCK MASS (h/2PI)	PMJ	[M]	0.0000217671	-4.66219942755
PLANCK TIME (h/2PI)	PTJ	[T]	5.3905600000e-44	-43.2683661157

MEMORANDUM

June 20, 1968

To: L. Larmore, G8

From: A. G. Wilson, G8-52

Subject: PULSARS

The attached sheets give a summary of the salient present knowledge concerning pulsars. Optical objects suspected of being associated with CP.1919 are probably spurious. No satisfactory theory has yet been evolved. Preliminary ideas range from rotating neutron stars, binary white dwarfs, to "little green men." The empirical relation, $d^2 = AT$ (note d) is a DARL contribution to the subject.

A. G. Wilson

AGW/jbg

ASTRONOMY

THE LOWELL OBSERVATORY 1953--1957
SOME RECOLLECTIONS

Albert Wilson

There are two kinds of history: First, the official record which seeks to provide a comprehensive view of evolution and major accomplishments covering an extended period of time and, second, the several personal 'snapshots' taken by all those who have come and gone over the years. Although the perspective of these snapshots is an individual one whose focus is only on some brief interval of time, they may illuminate some of the preliminary and ofttimes abortive events that provided the experiential foundation on which lasting accomplishments were later built. History is a record of success and survival, but much was learned from the failures and the forgotten. Here follows a brief summary of the years at Lowell from June, 1953 to June, 1957 as I find them impressed on memory a third of a century after the events.

1953--1957, was of a period of 'perestroika' at Lowell. Mr. Roger Putnam, the Trustee, wanted to resurrect the observatory from a period of stagnation into which it had fallen a few years after the discovery of Pluto in the 30's. Mrs. Lowell's health was failing and she was well along in years, so Mr. Putnam reasoned that additional funds might be available in the not distant future for reassignment to the support of the observatory. It must be recalled that this was all before there was such a thing as government monies for research in astronomy. There was no National Science Foundation, no NASA and astronomy depended almost entirely on private funds.

I came to Lowell in June of 1953 as Assistant Director with the assignment to assist in the initiation of a revitalization program. My first impressions of the observatory were not so much of stagnation as of the remarkable achievements which had been made with minimum resources. There is a definition of a professional that goes, "A professional is one who can solve the problem at hand with the means at hand". According to this definition, those at Lowell, right from the founding, were real professionals. Much more so than those with fatter budgets and lucrative connections. I suppose the pioneers had brought from New England their values of hard work along with a strong measure of Yankee ingenuity. Such devices as floating the 24" dome on pontoons attest to this. But the tradition was ongoing. It was decided to aluminize the mirror of the 40" reflector. Henry Giclas' engineering in fabricating the aluminizing tank by adapting local facilities and coming through with first rate results was professionalism at its best. The ratio of accomplishment to budget was high in those days.

There were three basic on-going research programs in 1953. These were E. C. Slipher's work in planetary photography, especially experiments with composite images. Henry Giclas' search for high proper motion stars with the 13". And most recently

instituted, Harold Johnson's photo-electric studies of H-R diagrams in star clusters. There was also a photo-electric observational program of Pluto by Bob Hardie to ascertain its rotation period.

There was an important opposition of Mars in 1954, best observed from the Southern Hemisphere. We were able to interest the National Geographic Society in a joint NGS-Lowell Observatory 'Mars Expedition', which supported E.C. Slipher's photographic research by enabling him to observe the opposition with the large refractor at Pretoria in South Africa. He obtained some important results on the blue clearing and colors of Martian dust storms.

Also during this time period, with the financial assistance of TWA, the Lowell Observatory jointly with Arizona State University sent Dr. Arthur Adel of ASU to Trincomalee in Sri Lanka to observe the total eclipse of the sun.

Clyde Tombaugh had calculated that with the 13inch he could make a survey of cislunar space for the detection of possible natural satellites as small as a tennis ball. The negative results of this program were reassuring to the gestating U.S. space program that damage from collisions with natural meteoroidal material was not a major hazard.

Another cooperative research program during this time frame was with Drs John Strong and Ralph Sturm of Johns Hopkins University. Sturm had developed a sensitive image orthicon (grandfather of the charge coupled device) and a low noise amplifier which they felt might be used to obtain superior photographs of planets. The results were better than direct photography on a night of average seeing but fell far short of what E. C. Slipher had obtained under optimum conditions.

It had long been recognized that there would be great value in keeping Mars under continuous surveillance for several months before and after an opposition. To this end the Lowell Observatory set up the "International Mars Committee" soliciting the cooperation of observatories throughout the world. This organization paid good research dividends in the 1956 opposition.

Other things I recall while serving as director of the observatory, 1954-1957:

Holding the first ever "Astrobiology Seminar" (with Major Simons and Dr. Strughold, U.S. Air Force)
Cooperating with Disney studios in their filming of movies about the planet Mars and the exploration of space (Ward Kimble and Bill Bosche)
Setting up the TIAA program for the observatory staff.
Beginning a site survey to find a location with a darker sky than Mars Hill.
The gift of the Morgan telescope (Morgan of Odessa, Texas)
Observing-time exchanges with the Steward Observatory (Ed Carpenter).

Initiating seminar and guest investigator programs.
Friday lunches at the Monte Vista Hotel attended by the staffs of the Lowell Observatory, the A.S.U. Observatory, and the Museum of Northern Arizona.
The death of Mrs. Percival Lowell
The death of Mr. Stanley Sykes, pioneer machinist and "professional"
And many recollections of visiting astronomers, Fred Hoyle, George McVittie, Gerard Kuiper, Bok, Meinel, Popper, ...
It should be remembered that it was in this time interval that Aden Meinel began his site survey for what was to become the Kitt Peak Observatory, and Bill Miller of Mt. Wilson Observatory found the glyphs at White Mesa which were interpreted as an Anasazi record of the supernova of 1054.

In June 1957 in my last week in Flagstaff, the Lowell Observatory came of age in hosting the annual meeting of the Astronomical Society of the Pacific. The revitalization stage was over. Then in October 1957 came sputnik, followed by the space age and a new era for astronomy.

LOWELL2.W52 March 31, 1994

In the age of the Hubble Space Telescope, the giant Keck telescopes on Monakea, the planned super telescopes, the era of big budgets, and the information super highway there is good question whether small institutions, modestly funded, can still make significant contributions to the march of astronomical knowledge. Can the magnificent and trail blazing contributions made by the Lowell Observatory in the past 100 years be sustained.? The answer to this lies in the why and how were Lowell's past contributions made.

There used to be a rubric common at Palomar in the first decade of its operation, that the bootleg plate made during a scrap of observing time squeezed into a regular program ended being a main program three years hence.

We do two things in scientific research: We seek the answers to questions formulated around or derived from our hypotheses, and we just look for what may be there. As a discipline progresses, as a coherent picture or model is constructed, there is more emphasis on research related to the model (usually of the sort to confirm it) and less on looking for what might be overlooked. This motivation stems in part from Karl Popper's assymetry of verification and falsification. Beware of the single observation that could falsify the entire structure. The sociology of science moves in the direction of adding to and improving whatever is current. This is where security for the individual researcher lies. I recall a conversation over a beer that we once had with the late Otto Struve. He said he spent his research career developing things which he felt had high probability of pay off, but that in doing this he had put aside the questions that he felt were really the important ones, but which one could spend a life-time on with no assurance of success. He added, he might do it differently if he were to start over. Struve was no different from most.

There are two keys for the small institution in the age of big global telescope conglomerates. These are imagination and courage. These are the ingredients in the success of the Lowell observatory. Lord Rutherford was asked how it was they did such good research on such small budgets. He replied,"When we lacked funds, we had to employ a substitute. We substituted thinking for money."

There are some parallels between the work at Lowell and the work of Kepler. You have an idea you wish to confirm, but observations indicate you were off base. Being wrong is perhaps a greater opportunity than being confirmed. You become free to explore what is really there. Kepler had a model of the solar system he wished to verify based on the regular polyhedra, it was ok, but not satisfying, he persisted and ended up where no one had been before. Looking at spiral nebulae in the light of the nebular hypothesis as origin of planetary systems, didn't go far, but out of this motivation came today's expanding universe.

LOWELL3.W52 April 1, 1994

The metaphoric wisdom of myth tells us that Dionysus is always escaping the forms that Apollo is building for him. One way of saying that the human spirit refuses to be contained in the prisons created by its intellect. The history of science illustrates this well. The usual perception of science is Apollonian. Scientists are ever seeking to bring order to experience, building models to organize the observations, constructing theories to explain how the world works. All the worship of Apollo. But after a time it becomes tiresome to be shackled to explanations which keep repeating "This is nothing but...", "nothing more than..." whatever. The Dionysian feelings begin to stir: is there more in this than we have thought?; aren't we overlooking some possibility?; isn't there some alternative way of looking at this? All Dionysian urges for alternatives, for liberating the imagination, for reopening the door to greater potential.

All scientists are apollonians, but the great scientists are also dionsysians. The work of apollonian scientists, most of us, is the masonry of adding brick upon brick to existing edifices. The dionysian scientists, Copernicus, Kepler, Einstein, to name some of the more prominant, are the architects whose work leads to more coherent and comprehensive structures.

My thesis on the occasion of the 100th anniversary of the founding of the Lowell Observatory is that Percival Lowell belonged to the company of important dionysians and that the Lowell Observatory, which he founded, was an outstanding temple of Dionysus.

LOWELL3.W52 April 1, 1994

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FZWICKY.WPD AUGUST 28, 1999

FRITZ ZWICKY

Feb 14, 1898–Feb 8, 1974

Fritz Zwicky came from the canton of Glarus, that part of Switzerland exemplifying the extreme independence and individuality typical of those whose lives are blessed with the presence of towering mountains. Perhaps it is not coincidence that the 16th century monk, Henricus Glareanus, (Heinrich Loris) who took musicology beyond its prescribed and proscribed bounds, and Fritz Zwicky, who did the same for astronomy, both came from Glarus.

Zwicky's contributions were numerous: Identification of supernovae, prediction of dark matter, identification of alternate modes of jet propulsion, designer and manager of the first attempt to place an object in orbit (1946, 11 years before sputnik), and what he felt to be the most significant, morphological analysis, a new way of thinking. And it was Zwicky's new way of thinking that was the infrastructure of all his other contributions.

Today, some 25 years after his death, professionals who derided him during his lifetime, have come to recognize that Zwicky's ideas may have a greater shelf life than had theirs. However, Zwicky was controversial, indeed dedicated to controversy. This not only because his proposals conflicted with conventional ones, but because Zwicky appreciated the value of controversy itself. His credo was that any party-line was stagnating. Disagreements led to deeper insights and heresies led to the destruction of dogmas. But Zwicky paid the price required of heretics: isolation and repudiation. He acquired the reputation of being abrasive and belligerent. But those who knew him saw through this facade, seeing that Zwicky, like Gurdjief, chose shock as a prod to keep awake the otherwise somniferous.

Zwicky thought of himself as a "lone wolf". He would not hear to having disciples. Disciples and lineages destroyed freedom of thought and the power to view the world anew and think about it in new ways. Indeed, the only way one could be considered a disciple of Zwicky would be also to become a lone wolf, not necessarily agreeing with anything he said or did, but continuing the search for meaningful alternatives on one's own. .

I consider those years in which I had the privilege of working with Fritz, to have been the most rewarding of my life. Even though he loudly boasted that he was a lousy teacher, he was a great teacher. Students in his classes complained that Zwicky didn't teach the listed subject but each lecture was on what he was currently thinking about, and unless you already knew all the necessary mathematics, physics, and astronomy, you were left in the penalty pen. True, Zwicky certainly did not exposit ideas entertainingly or simplicitly , but in the sense of example he was a great teacher to those who wanted to learn to think.

Einstein once said that we shall require an entirely new way of thinking if we are to survive. Zwicky added a question mark: He said, "To 'save' the world might take still greater freedom of thought than we are capable of." I believe that Zwicky, struggling to find that freedom, left us a legacy of hope.

THE FIRST TIME I SAW ZWICKY

The occasion of my first meeting with Zwicky was in 1946 at the first seminar at Mt. Wilson Observatory following World War II. Hubble and several other astronomers had just returned to Pasadena after war time service. Hubble called the seminar to discuss the state of research, to review where we were when interrupted by the war, and to plan projects needing to be finished and others needing to be initiated. Much of the planning was in anticipation of the completion of the 200 inch Palomar telescope.

The seminar was held in the old library at the Santa Barbara street offices and included not only the staff of the observatory but physicists and astronomers from CalTech. I was still in the navy stationed at the San Pedro naval shipyards, but fortuitously was able to attend because of the timing of the seminar. Hubble called the meeting to order and proceeded to outline in considerable detail the state of knowledge of extragalactic astronomy. I was fascinated with the scope of the problems to be solved and with the implications of the answers when forthcoming. Was the universe open or closed? Would it continue to expand forever or collapse back for continuing repeat performances? When Hubble had finished he said he would appreciate any comments. No one said anything immediately, but after about a minute Fritz Zwicky stood up and waving his arm at the blackboard said, "Dot's all wrong." and sat down.

The room fell silent. There were suppressed coughs, people looked at the floor. Hubble slowly removed his pipe from his jacket pocket, and dramatically took his time lighting it, took a couple of puffs, then said, "Perhaps Professor Zwicky would favor us by amplifying why he thinks this is all wrong." Zwicky then stood up and went through what was on the black board item by item pointing out some assumptions that had not been tested, measurements that were unreliable and should be repeated, and suggesting some alternative hypotheses that should be considered. Hubble listened and when Zwicky finished, rebutted some of his remarks. A dramatic dialog ensued, both Hubble and Zwicky seeming to enjoy their performances. After a few minutes of exchanges a synthesis of ideas began to emerged. Everyone present, Hubble, Zwicky, and the others all profited by the exchange. I was very impressed. We had witnessed a clash of egos, each with his own dramatic style. But when it came down to research itself, both men could subdue their egos and turn to exploratory discourse.

THE FIRST TIME I SAW HUBBLE

Recently, probably because of the fame of the telescope named for him, books and other biographical material about Edwin Hubble himself have appeared. There is no question that Hubble is the most famous astronomer of the 20th century. Not every astronomical discovery gives us an entirely new view of the universe. Copernicus (1473-1543) took us from a geocentric to a heliocentric universe. Thomas Digges (1543-1595) recognized the stars as suns and as being spread through space rather than located on a single sphere. Thomas Wright (1711-1786) perceived the fuzzy patches in the sky as other milky way systems. Harlow Shapley (1885-19) measured the extent of the milky way. Edwin Hubble (1889-1953) proved the external nature of the spiral nebulae and discovered the expanding universe. But such momentous discoveries are never the work of one man. There are many whose names are hardly known who contributed to the discoveries, or perhaps made them first. But Hubble is famous not only because of his role in important discoveries, but because Hubble knew how to play the role of celebrity.

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The room fell silent. There were suppressed coughs, people looked at the floor. Hubble turned red, slowly removed his pipe from his jacket pocket, took his time lighting it, took a couple of puffs, then said, "Perhaps Professor Zwicky would favor us with some amplification of why he thinks this is all wrong." Zwicky then stood up and went through item by item pointing out assumptions that had not been tested, measurements that were unreliable and should be repeated, and raising some questions regarding the Doppler interpretation of the redshifts. Hubble listened and when Zwicky finished, rebutted some of his remarks. A dialog ensued in which a synthesis of ideas emerged. Everyone present, Hubble, Zwicky, and the others all profited by the exchange. I was very impressed. We had witnessed a clash of giant egos, and Hubble had proved his caliber by transcending the provocativeness in the situation and turning it to exploratory discourse.

The biographical material coming out on Hubble emphasizes his towering ego. But this one event showed me that whatever the power of his ego, when research itself was involved, Hubble could subdue it to second place.

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I woke up recalling something Fritz Zwicky said after one of his meetings with Einstein. He said that Einstein had the most remarkable talent of seeing the implications of any physical proposition in all its contexts. Tell him of a research result and he could immediately point out its affirmations or contradictions in other areas of physics, and suggest its implied hypotheses. What kind of different thinking did Einstein use? This same man who called for us to find a new way of thinking or risk extinction. If we look for some commonalities between this thinking mode of Einstein and the thinking of Newton, we note in both thinkers the imaginative ability to put normally unassociated events in juxtaposition: The falling of an apple and the path of the moon; the force of gravity and the geometry of space. Certainly to escape from our conditioned associations is one key to seeing the world in a new way, the way it might really be instead of the way we habitually think it to be. And the method of systematic juxtaposition is a powerful tool for this escape.

The method of our time is to use not a single model but multiple models for exploration. [cf Fritz Zwicky] The technique of the suspended judgement is the discovery of the twentieth century as the technique of invention was the discovery of the nineteenth.
Marshall McLuhan

As Zwicky put it, "Our task is not to find the answer but to find all the possible answers."

A pioneering recognition of the value of alternatives was made during WWII by the astrophysicist Fritz Zwicky at the California Institute of Technology. Zwicky developed a method which he called morphological analysis that allowed him to realize several alternate solutions to a problem. Using this method he invented a plethora of jet engines, including ram jets, pulse jets, ... independently coming up with the German V1 and V2 weapon systems. Zwicky felt that too long humans had not only been content with a single solution but had fallen into being dogmatic about that single solution, persecuting those who proposed alternatives. The time had come to change this and welcome all possible alternatives as providing a rich smorgasbord from which we could choose the best solution for the situation at hand. It is this philosophy that causes us to include ALTERNATIVES in our mantra for the 21st century.

NEW COGNITIVE STRATEGIES

We Shall Require a Substantially New Manner
Of Thinking If Mankind Is to Survive.