

Synergy and the

Fate of Humankind

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Center for Cooperative Phenomena

CMSU

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Thunderstorm

Beautiful Mind

Synergy refers to cooperative effects produced by relationships among the components of various systems, effects which are not possible with individuals acting alone.

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- 1st Law of Thermodynamics - ENERGY
- 2nd Law of Thermodynamics - ENTROPY
- Synergy

Furnace example: 70% energy efficient
 4% entropy efficient

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- Synergy of SCALE

Bigger organization may be able to accomplish more

Ridley sea turtles in Costa Rica swarm the beaches to lay 40 million eggs, more than predators can consume

Limited Partnerships in finance pool their money



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Threshold effect -

straw that broke the camel's back

rush-hour traffic jam

SRO events

population beyond critical -> emigration, etc.

Yosemite, Glacier, Grand Tetons -> regulation

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Phase transition -

liquid → solid e.g., HOH

ferromagnet & temperature

superconductivity

laser

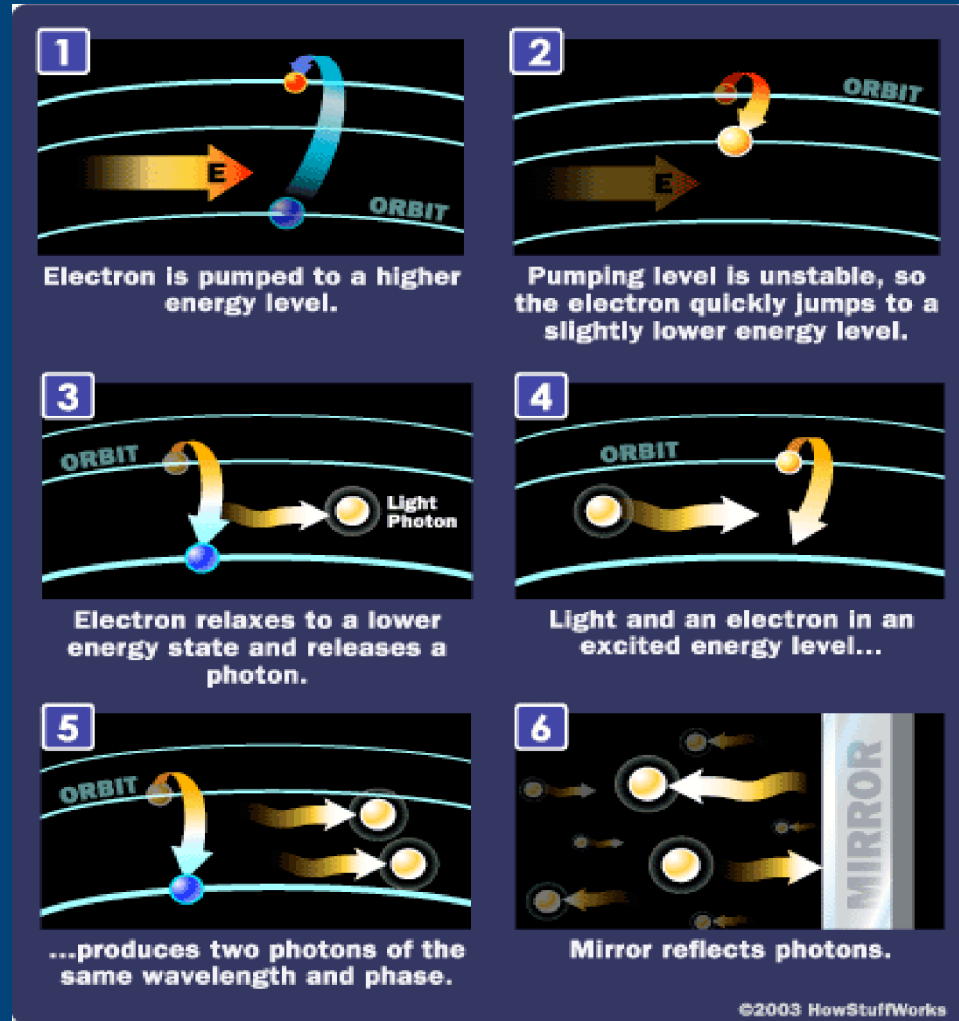
self-organized criticality, e.g., sand pile



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$$\text{Prob} \propto N^2$$

Inversion
Non-inversion



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- Gestalt effects – patterns, arrangements

M_ddle-class

M_ddle-headed

Automobile parts vs. automobile



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- New functional characteristics

Drug A and Drug B

Complementary amino acids – beans & corn

Bricks and mortar

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- Emergent phenomena – different parts merge, lose their identity, and possess new physical or functional properties

Table salt NaCl (with some KCl) [sea salt?]

Human body - $>10^{13}$ cells !!

Automobile

Cell phone

Brain (most of body via feedback!)

Slime mold colony from cells

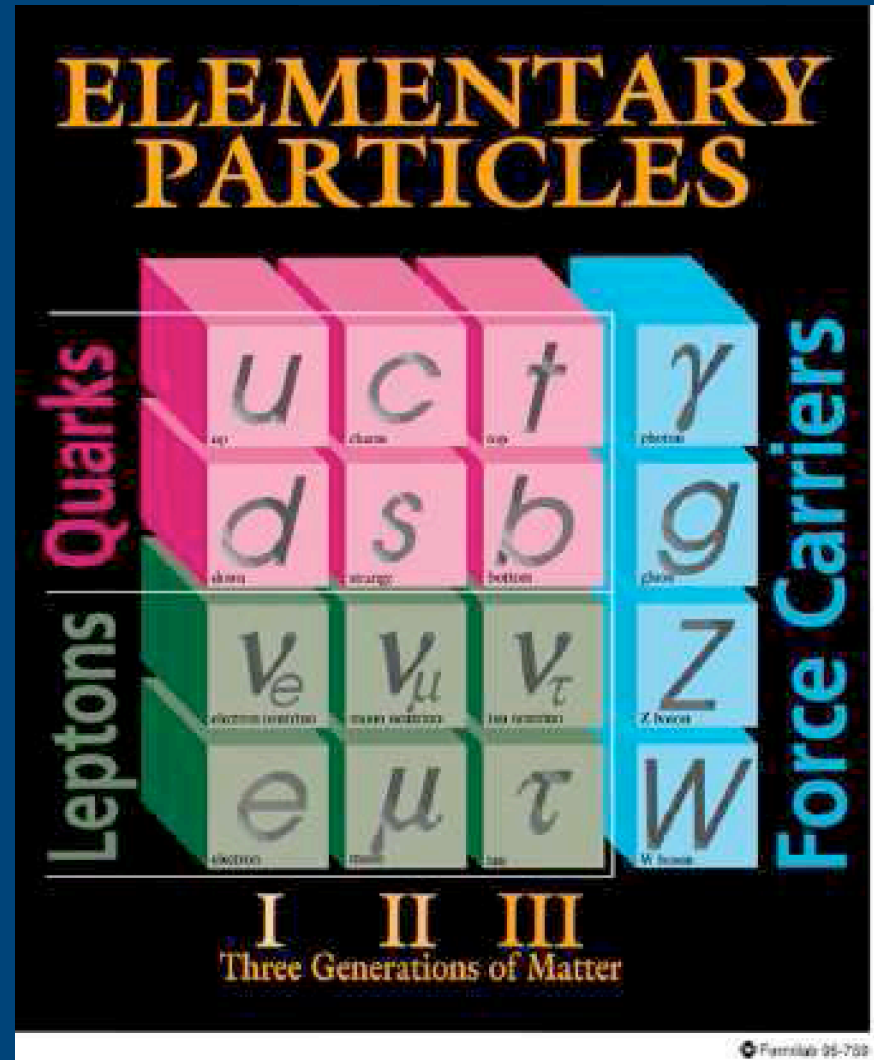
Leptons & Quarks ?

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Standard Model

Continuous spacetime
Spacetime + Internal
Gauge group

Speculation
Superstrings (M-theory)
Supersymmetry



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•Leptons and Quarks

Standard Model is extremely good

Some speculation:

1. Space is discrete – nodes (not continuous)
2. Nodes have no measurable properties
3. Nodes combine into new geometric entities
4. Entities have discrete rotational symmetry
5. Entities are leptons and quarks - emergent
6. Leptons & quarks have measurable properties
7. Math dictates their physical properties
8. Agrees with Standard Model as subgroups

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- Predictions:

1. 3 lepton families, but 4 quark families
 2. Spacetime 4-D, not 10-D or larger
 3. 80 – 100 GeV b' -quark to be seen at LHC in 2007?
 4. No Higgs particle needed for mass generation
 5. Fundamental math dictates physical properties
 6. One universe only – no multiple universes
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- Facilitation

Catalysts – decrease activation energy
Hemoglobin – O uptake – binding affinity

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- Joint actions

Emperor penguins – huddling saves 20-50% energy

Honeybee – temperature regulation in hive

Mexican desert spiders – cluster reduces HOH loss

Humans – communal shelters, crops, CO₂ emission, etc.

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- Risk- and Cost-sharing

Fish schools

Bird flocking

Collective hunting

Lookout duty for predators

Synchronized breeding



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- Combination of Labor

3 types of RNA in cells

Photosynthesis

Glycolosis - ~ 100 precise sequential steps

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- Information sharing

Insects, birds sharing info about food sources

Animals calling alarms

Video gamers telling friends about new game !

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- Quantum Mechanics

Quantum coherence – wave function Ψ

$$\Psi = \Psi_1 + \Psi_2 + \Psi_3 + \dots$$

→ Schrödinger equation

Quantum computer – cup of Java

Fermions vs. Bosons: existence of matter !!

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- SYNERGY

Is everywhere

May be positive, negative, or neutral

As science of relationships ?

Where are the 'non-linear' equations ??

Linear: y_1 , y_2 , $y_1 + y_2$, etc.

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- Korteweg-de Vries equation

Korteweg and de Vries (1895) which described weakly nonlinear shallow water waves – SOLITARY WAVES (solitons)

$$\frac{\partial \eta}{\partial t} = \frac{3}{2} \sqrt{\frac{g}{h}} \left(\eta \frac{\partial \eta}{\partial x} + \frac{2}{3} \frac{\partial \eta}{\partial x} + \frac{1}{3} \sigma \frac{\partial^3 \eta}{\partial x^3} \right)$$

A stable isolated (i.e., solitary) traveling nonlinear wave solution to a set of equations that obeys a superposition-like principle (i.e., solitons passing through one another emerge unmodified).

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- Many types of non-linear equations
 - Most (all?) can be separated into sets of linear equations
 - Schrödinger equation of quantum mechanics is often in the set
 - Solitons appear to be ubiquitous
 - It is expected that **eventually** all the different cooperative phenomena (synergy) will be describable by non-linear equations
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- Fate of Humankind ?

Cooperation or Competition ?

Local, State, Nation, Continent, Global

Is it the United States vs. the World ?

Wealth, Food, Resources, Ingenuity, Insight, Compassion

Cooperate with regard to What ?

Priorities, Scale, Distribution

Gaia hypothesis – Earth is a synergistic organism



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- Some references

QM: Mad About Modern Physics - Chapter 8

Institute for the Study of Complex Systems (ISCS)

<http://www.complexsystems.org/>

NetLOGO – computer simulations

<http://ccl.northwestern.edu/netlogo/>



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- Thank You

Special thanks to the

Center for Cooperative
Phenomena

for inviting me.

