

Sustainability as Symbiosis,
and
How Technology, Ethics and Culture
Can Help Us Get There

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Philosophy

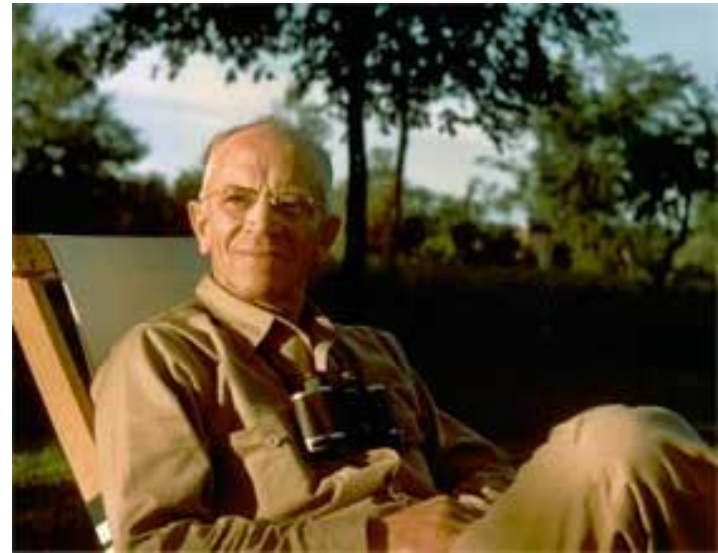
University of Lethbridge

Two Problems...

- What is the nature of the biosphere/Earth system/Gaia?
- What are the possibilities for human relations with it?

Leopold and the Land Ethic

- Aldo Leopold (1887-1948), forester, farmer, philosopher
- “The Land Ethic,” in *Sand County Almanac* (1948)
- Holistic “symbiotic” ethic”



Leopold's Land Ethic

- “A thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community. It is wrong when it tends otherwise.”
- “...a land ethic changes the role of *H. sapiens* from conqueror of the land community to plain member and citizen...”

Leopold on Ecological and Philosophical Parallels in Ethics

- “An ethic, ecologically, is a limitation on freedom of action in the struggle for existence. An ethic, philosophically, is a differentiation of social from anti-social conduct. *These are two definitions of one thing ...* [which] has its origin in the tendency of interdependent individuals or groups to evolve modes of cooperation.”

Symbiotic Origin of Ethics

- “The ecologist calls these *symbioses*. Politics and economics are advanced symbioses in which the original free-for-all competition has been replaced, in past, by co-operative mechanisms with an ethical content.”

The Ethical Sequence

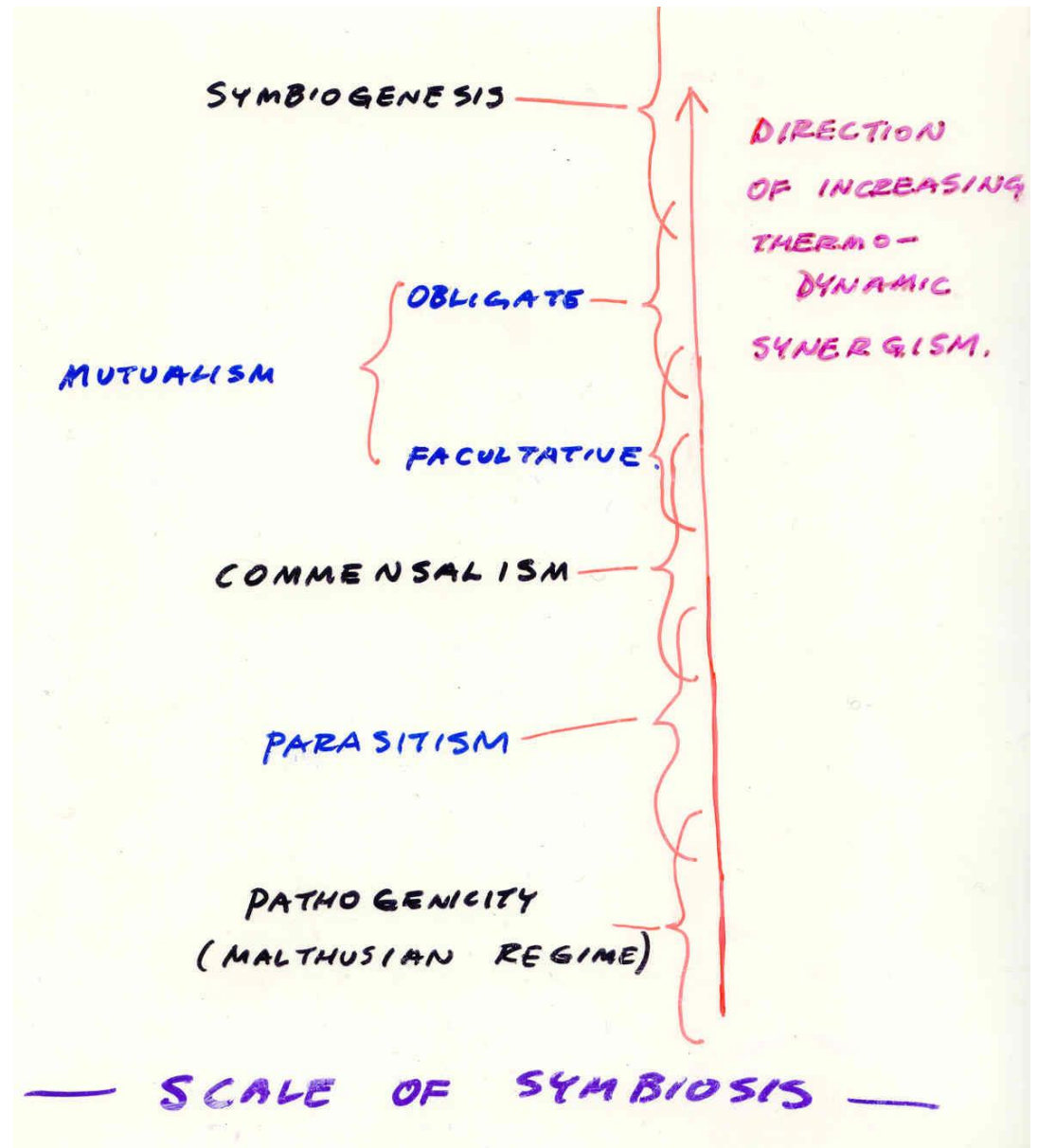
- Leopold argued that human cultural evolution shows a progressive expansion of the “ethical circle” within which entities are taken as being worthy of ethical regard.
- We now have to move to the stage where we include the “land” (our supporting environment) within the circle of regard.
- The land is “not merely soil [but] a fountain of energy flowing through a circuit of soils, plants, and animals.”

Ethics as a Substitute for Instinct

- Humans have very high degree of neurological adaptability; we have to learn what other creatures get by instinct
- Ethics is a “kind of community instinct in-the-making” which is the human way of being symbiotic
- Ethics is therefore a cultural construct and a learned skill (cf. Aristotle) which must be continually revised as we learn more and as our environment’s demands shift

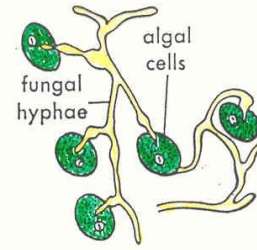
The Scale of Symbiosis

- Symbiosis means “living together” but does not in itself denote cooperation or mutual benefit; chronic parasitical relationships are symbiotic
- Can be described as a scale of increasing degree of cooperation (which is understood strictly in a descriptive sense, not an intentional sense as in human cooperation)
- Symbiogenesis is well established (lichen, eukaryotic cells) and according to Lynn Margulis is a major source of evolutionary novelty; this has not yet been fully digested by evolutionary biologists!
- I have been working on explanations of how natural selection can “see” the symbiotic unit



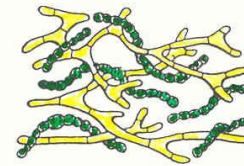
Symbiotic Shift

- Margulis and Eugene Odum emphasize the importance of the phenomenon of the symbiotic shift, where opportunistic parasites can shift to mutualists (and sometimes back again)
- This can be illustrated by trends in the evolution of lichen (mutualistic association of fungi and algae)



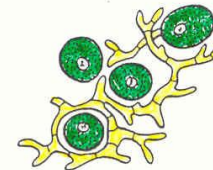
A

fungal hyphae actually
penetrate into algal cells



B

fungal hyphae intermingle
with algal filaments



C

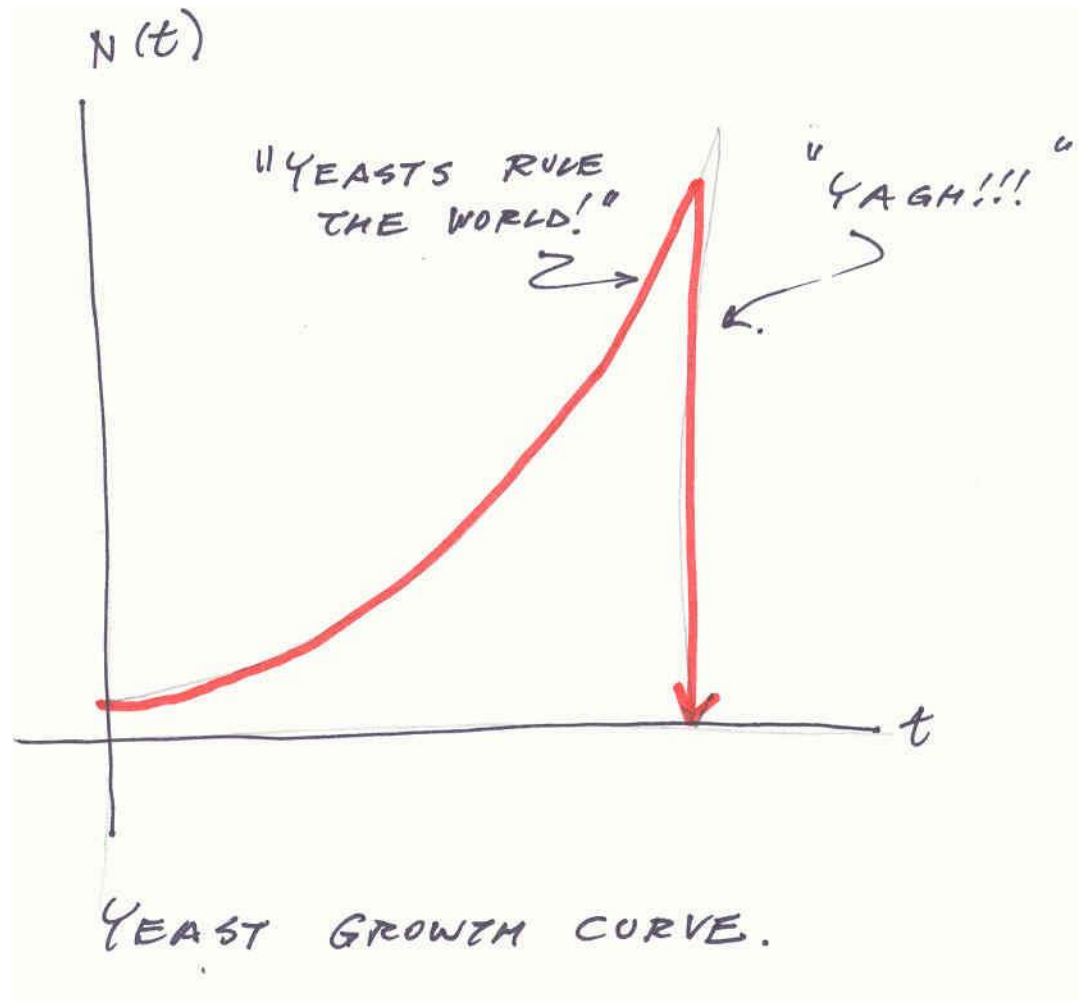
fungal hyphae are closely
appressed to algal cells but
do not penetrate them

A trend in evolution from parasitism to mutualism in the lichens.

— from Odum 1971, 233.

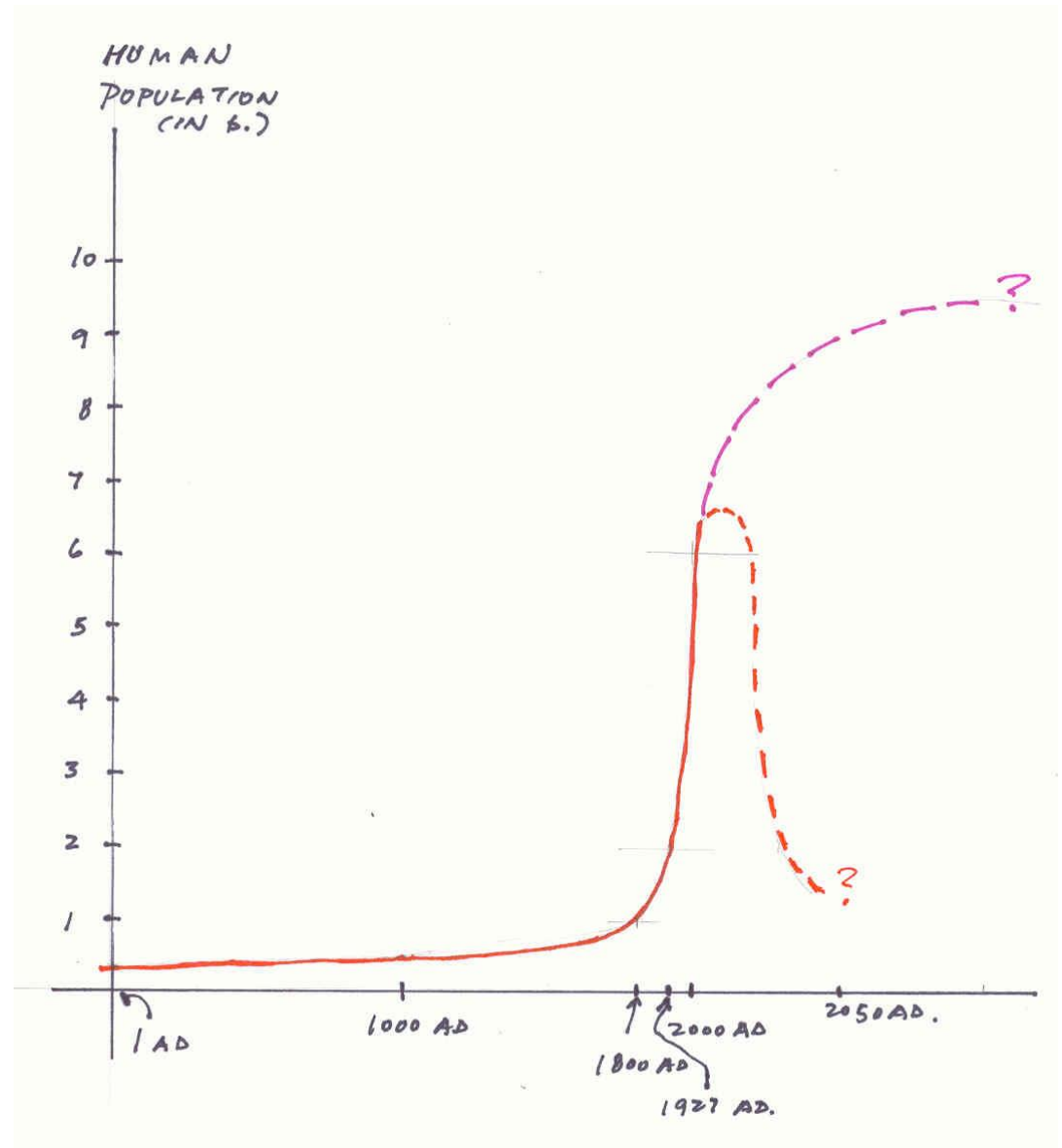
Malthusian Regime

- When reproduction is unchecked, we get the typical Malthusian picture
- Malthus's mistake was to assume that this is the only possible population dynamic
- Malthus' argument also was a covert sermon against birth control



Human “Yeast”

- Are we any smarter than yeast?
- It does not look promising so far!



- Lynn Margulis and other biologists have found much evidence that organisms from bacteria upwards can form cooperative (“mutualistic”) associations when their environments are constrained.
- Transition from opportunistic parasite (such as us!) to symbiote appears to be important factor in evolution, although this remains controversial.

Eugene Odum (1913-2002)

- “The ‘lichen model’...is perhaps a symbolic one for man. Until now man has generally acted as a parasite on his autotrophic environment, taking what he needs with little regard to the welfare of his host.”
- “Obviously it is time for man to evolve to the mutualism stage in his relations with nature...”

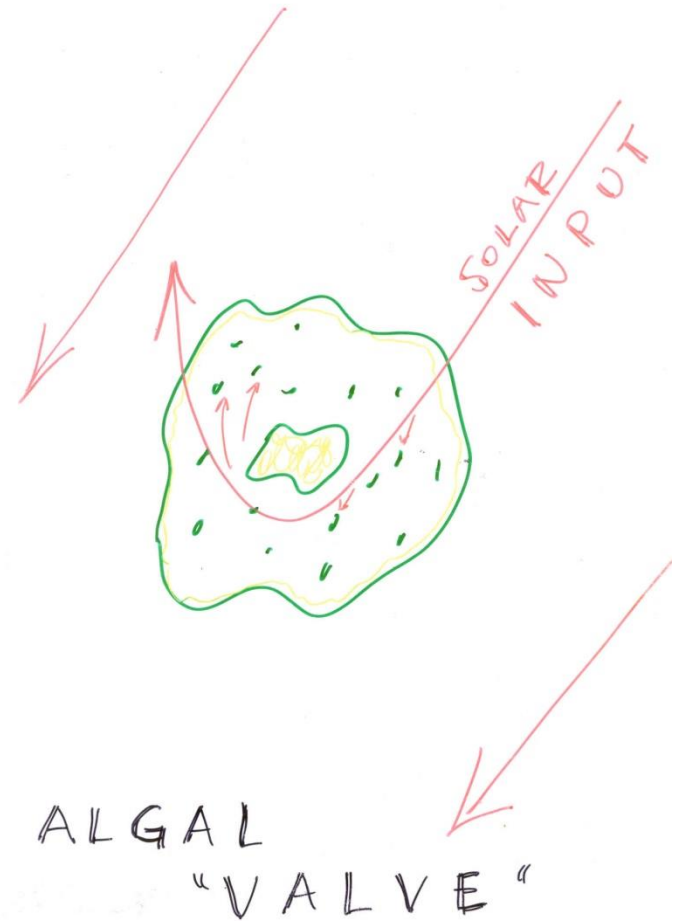
“...if understanding of ecological systems and moral responsibility among mankind can keep pace with man’s power to effect changes, the present-day concept of ‘unlimited exploitation of resources’ will give way to ‘unlimited ingenuity in perpetuating a cyclic abundance of resources.’”

Eugene Odum (1913-2002)

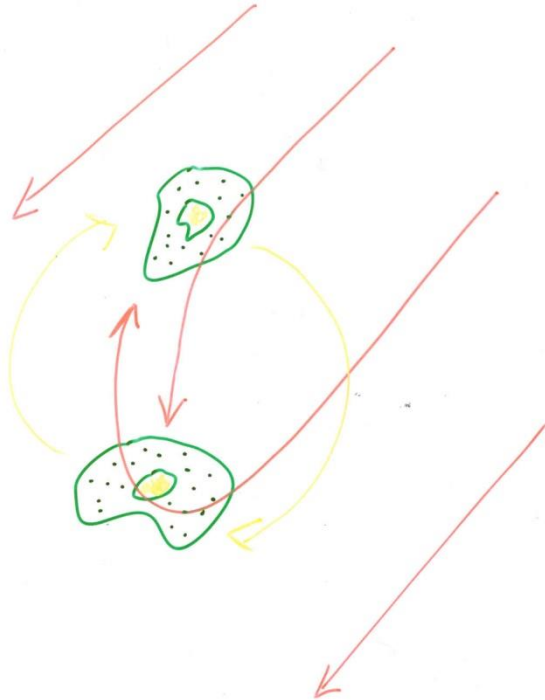
- Hence our similarity to micro-organisms might be encouraging as well as depressing!
- Are we smart enough to do what bacteria and amoebae can already do?

How Does Mutualism *Work*?

- The trick is to explain how heterotrophs can be mutualistic
- Compare with algae, which acts like a “vane” diverting solar energy into the earth system through its body.



Share and Share Alike...



- The algae needs much less free energy for its own metabolism than it can trap
- It is possible for it to share this free energy (negentropy) with other organisms
- An ecosystem!

"AN ECOSYSTEM IS BORN!!"

The Essential Point...

- Thermodynamically, what counts is the “capture and storage” process
- The fact that the algae does this using biochemical mechanisms within its own body is irrelevant
- Heterotrophs can in many ways arrange for capture and storage of energy as well
- The evolution of heterotrophic life greatly increased the opportunities for autotrophic life to proliferate

An Expanded Perspective on “Fitness”

- Ability to compete (of course)..
but also
- Ability to cooperate (share fixed free energy pie)
- Ability to *construct* (as emphasized by A. J. Lotka, 1922); to expand the energy storage capacity of the system

Gaia Hypothesis

- Margulis: “Gaia is symbiosis seen from space”
- Minimal Gaia hypothesis: the collective ecosystems of the planet are in net mutualistic; otherwise, the persistence of life for 3.8 b.y. is truly a “miracle”
- Are humans merely an emergent parasite, soon to destroy itself, or are we (via cultural evolution) capable of reaching the mutualism stage with earth system posited by Odum and Leopold?

Sustainability as Symbiosis

- Brundtland Report: the aim is to meet “the needs of the present without compromising the ability of future generations to meet their own needs.”
- Implies a non-parasitical and likely actively mutualistic mode

Lifeboat Thermodynamicists Demur

- “Low entropy is the ultimate resource which can only be used up and for which there is no substitute.” --- Herman E. Daly (1989)
- “...in thermodynamic terms, all material ‘production’ is in fact ‘consumption’...The thermodynamic interpretation of the economic process therefore suggests a new definition of sustainable development: [it is that which] minimizes resource use and the increase in global entropy.”

Symbiotic Interpretation of Sustainability

- Very abstractly, it is the care, maintenance, and upgrading where possible of the capacity of the planetary ecosystem to trap usable energy
- Not merely the hoarding and conserving of existing stocks of “negentropy”
- An understanding of how life works based on non-equilibrium thermodynamics, which says that life can exist only in a generous external flow of free energy such as from the Sun
- The lifeboat thermodynamicists in effect made the mistake of applying *equilibrium* thermodynamics to the earth system

Role of Culture

- Thermodynamic point of view: what mutualists *do* is redirect and modulate flows of energy into their ecosystems
- Signals can be imposed on the flow; very subtle variations in the way we do things can therefore be amplified into arbitrarily large output
- Subtle features of our aesthetic choices (e.g., in architecture) could have a large impact on our very survival

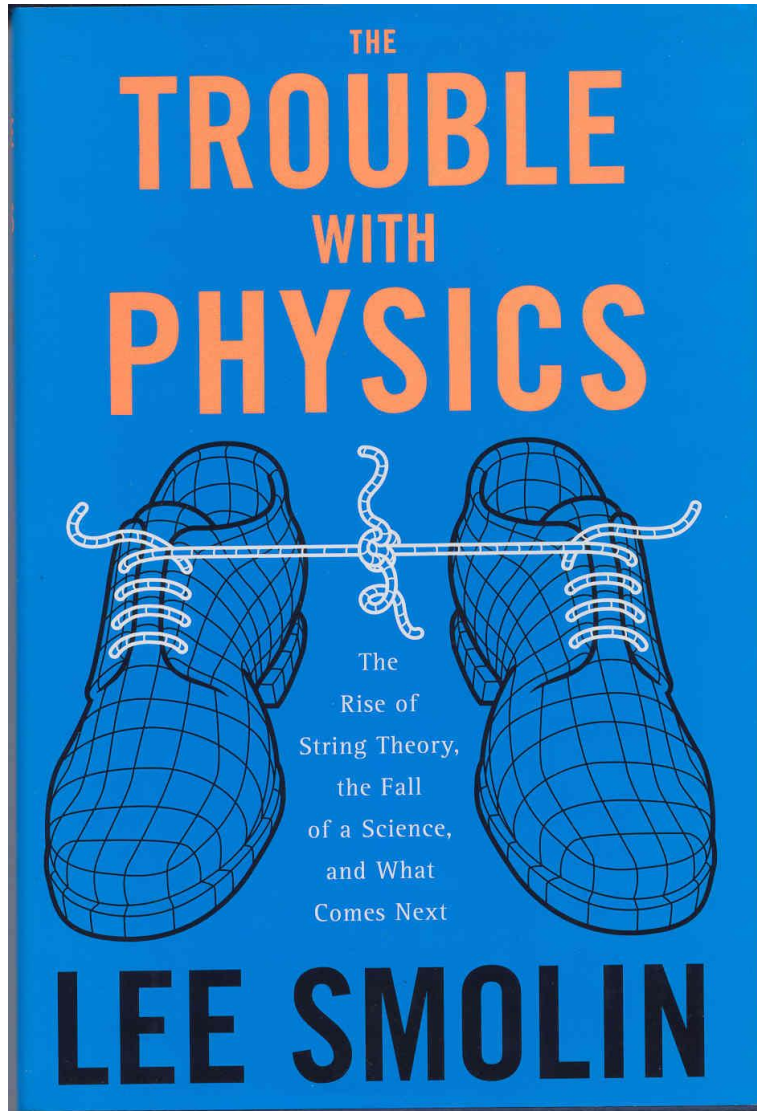
Our Present Peril...

- Accelerating climate change; probable irreversible tipping points within 20 years at current rates (Hansen, Broecker, Ward)
- *Must* reduce CO₂ emissions 80% by 2030
- Critical biodiversity loss
- Impending exhaustion of petroleum bonanza
- Current modality of support for human system *cannot* go on much longer!

Waiting for Mr Fusion...

- ITER plods along, but there are other promising approaches to controlled fusion (e.g., Bussard polywell) that are very hopeful
- Stay tuned!





- Smolin's question:
“Why, despite so much effort by thousands of the most talented and well-trained scientists, has fundamental physics made so little definitive progress in the last twenty-five years?”

Last Word:

*"Our ignorance
is not so vast as
our failure to use
what we know."*

--- M. King Hubbert (1903-1989)

