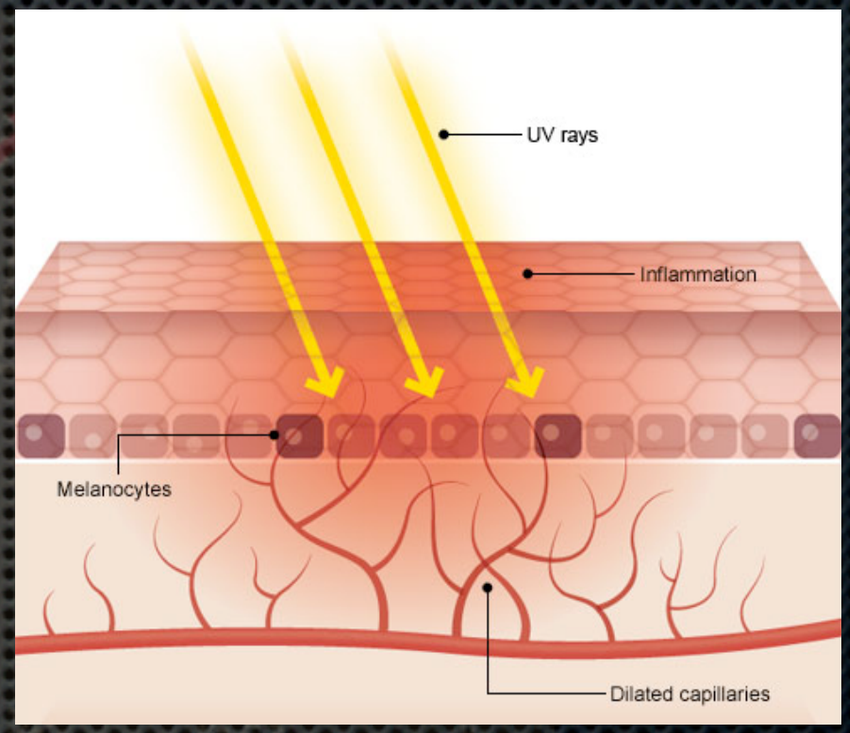
a scientific awakening

our moment in an evolving universe

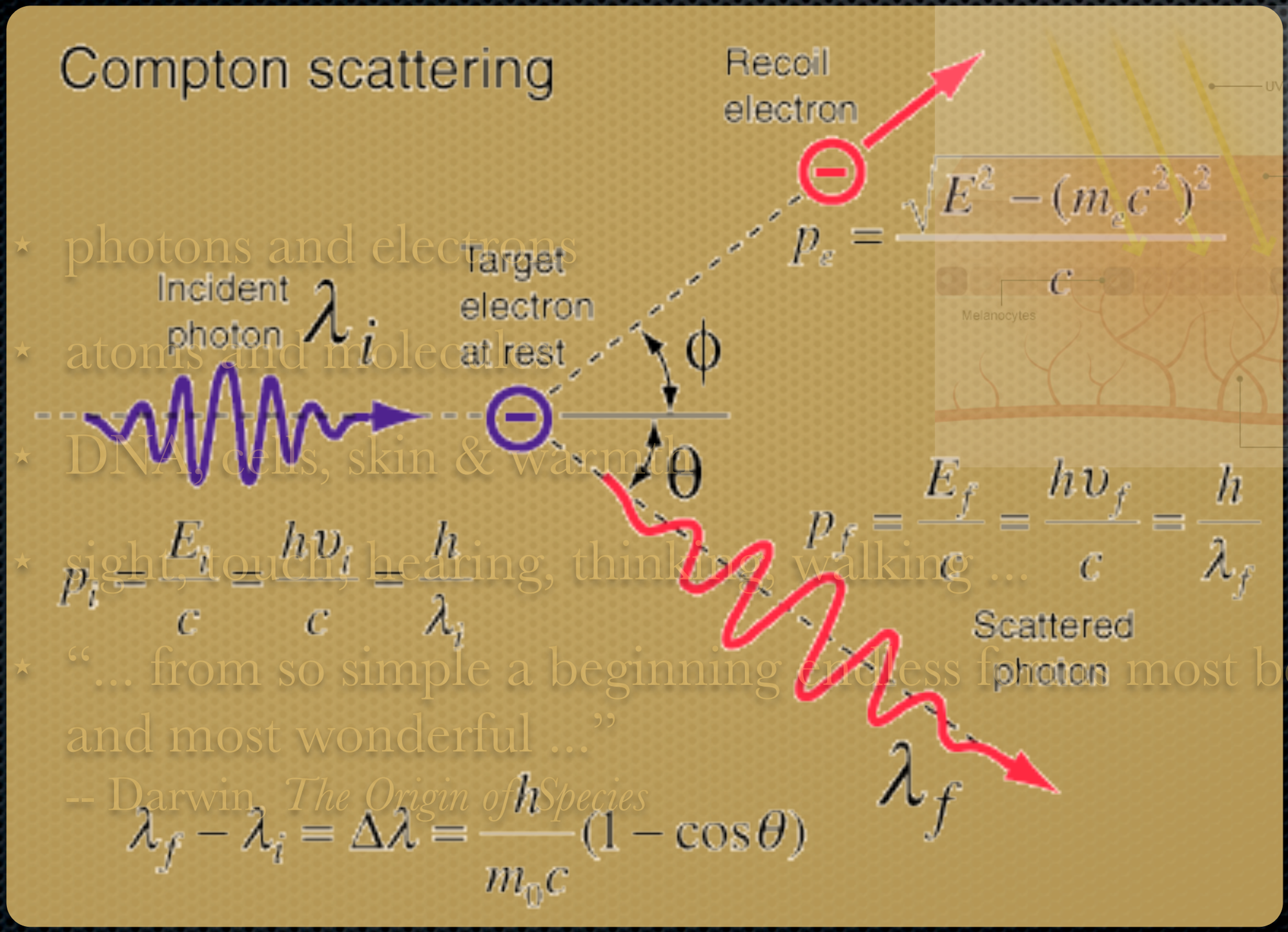
Craig Tyler
Physics & Engineering
Fort Lewis College

a tale of two particles



- photons and electrons
- atoms and molecules
- DNA, cells, skin & warmth
- sight, touch, hearing, thinking, walking ...
- "... from so simple a beginning endless forms most beautiful and most wonderful ..."
  -- Darwin, *The Origin of Species*

a tale of two particles



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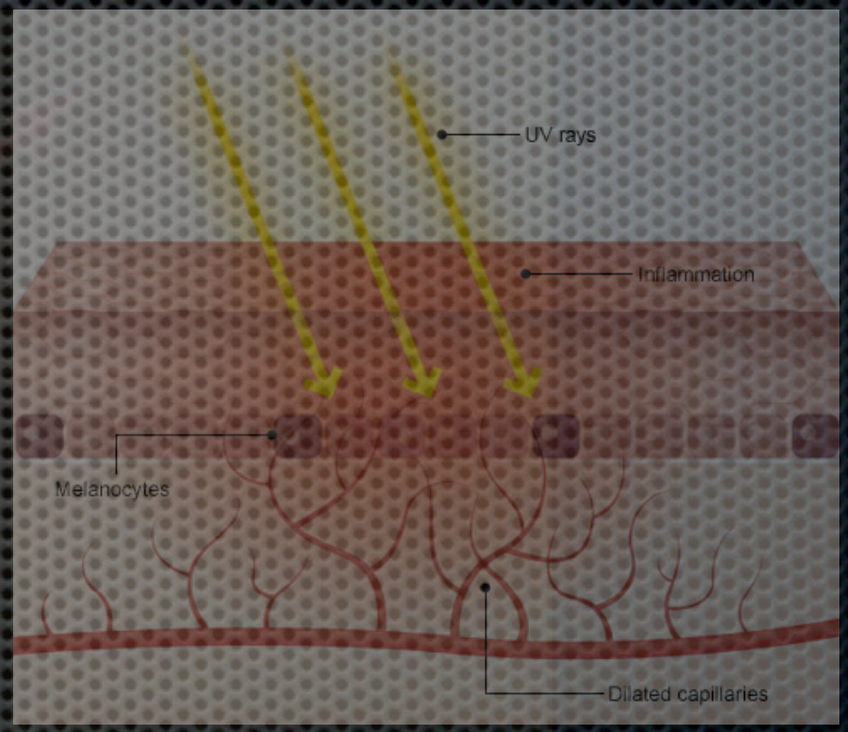
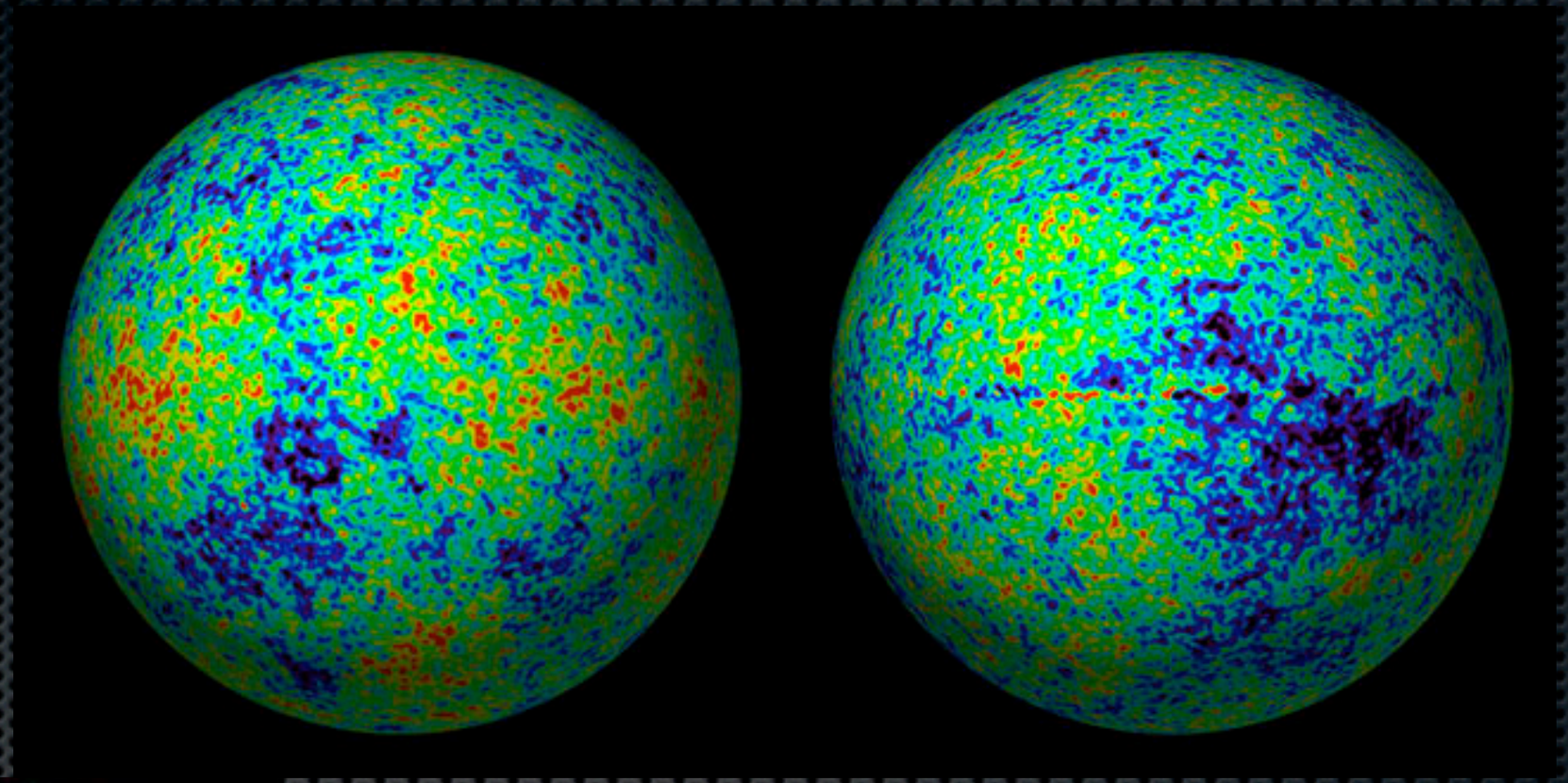


cosmic evolution

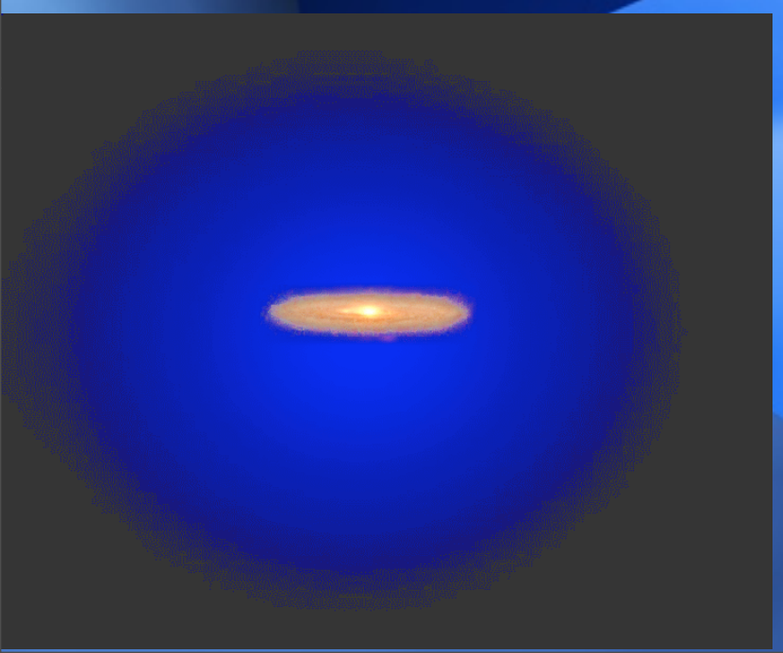
- particulate evolution
- galactic evolution
- stellar evolution
- planetary evolution
- chemical evolution
- biological evolution
- cultural evolution

Particles
Light Nuclei
Light Atoms
CMB



p^+, n, e^-
light
neutrinos
dark matter

particulate
evolution



galactic evolution


galactic
evolution

stellar evolution

Protostar

Sun-like, low mass star

Youth and middle age

Main sequence (H-burning core)

High mass star

Protostar

(figure not to scale)

C,O

Red giant (He core) and possibly red supergiant (C,O core)

Old age and death

Planetary nebula

White dwarf

And if the white dwarf gains too much mass from another star,

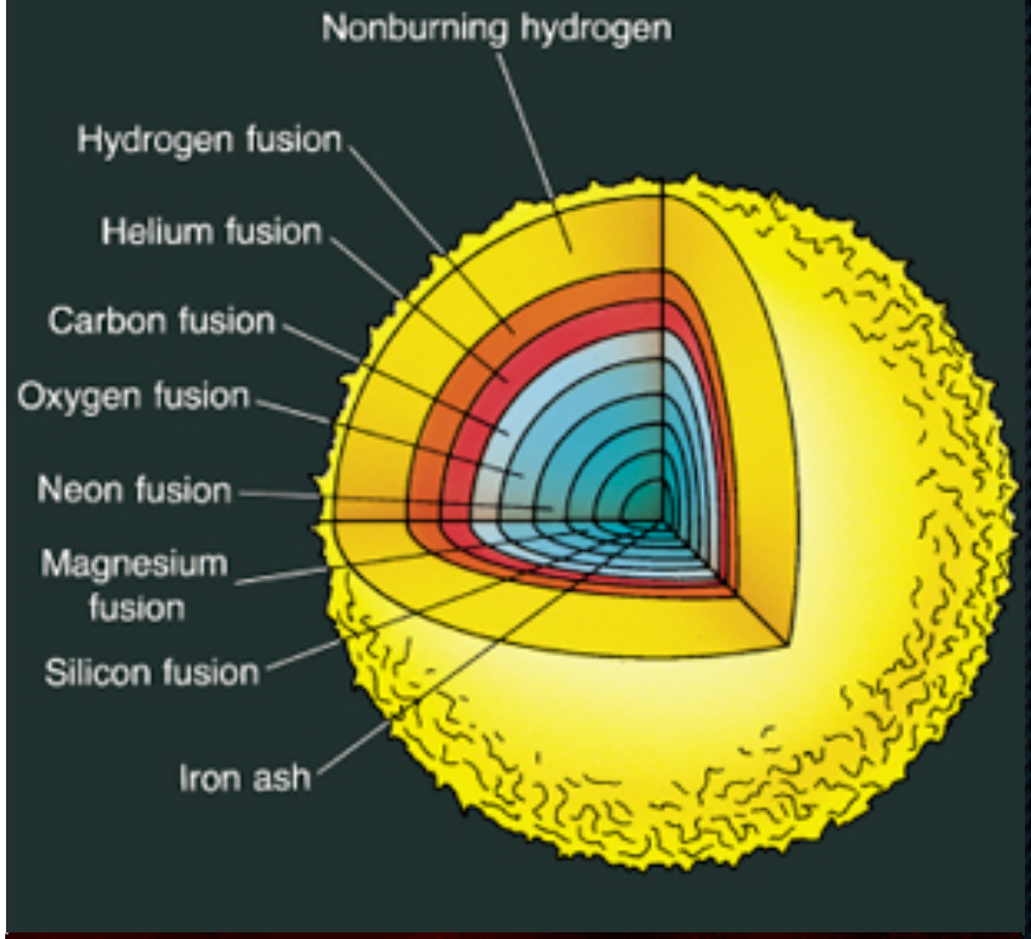
Type Ia supernova

"Onion-skin" structure, iron core

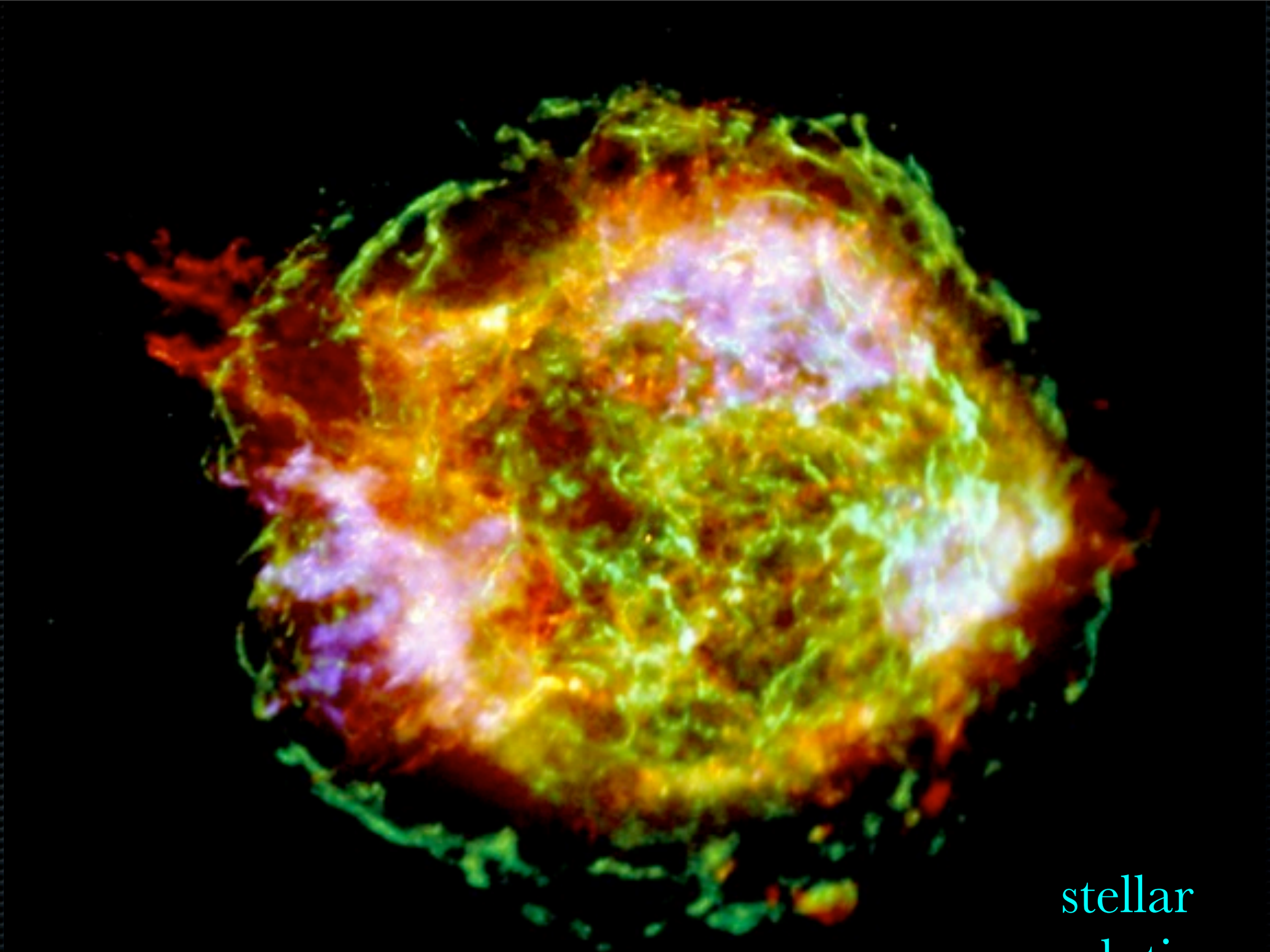
Type II supernova

Supernova remnant (gas cloud)

Neutron star or black hole



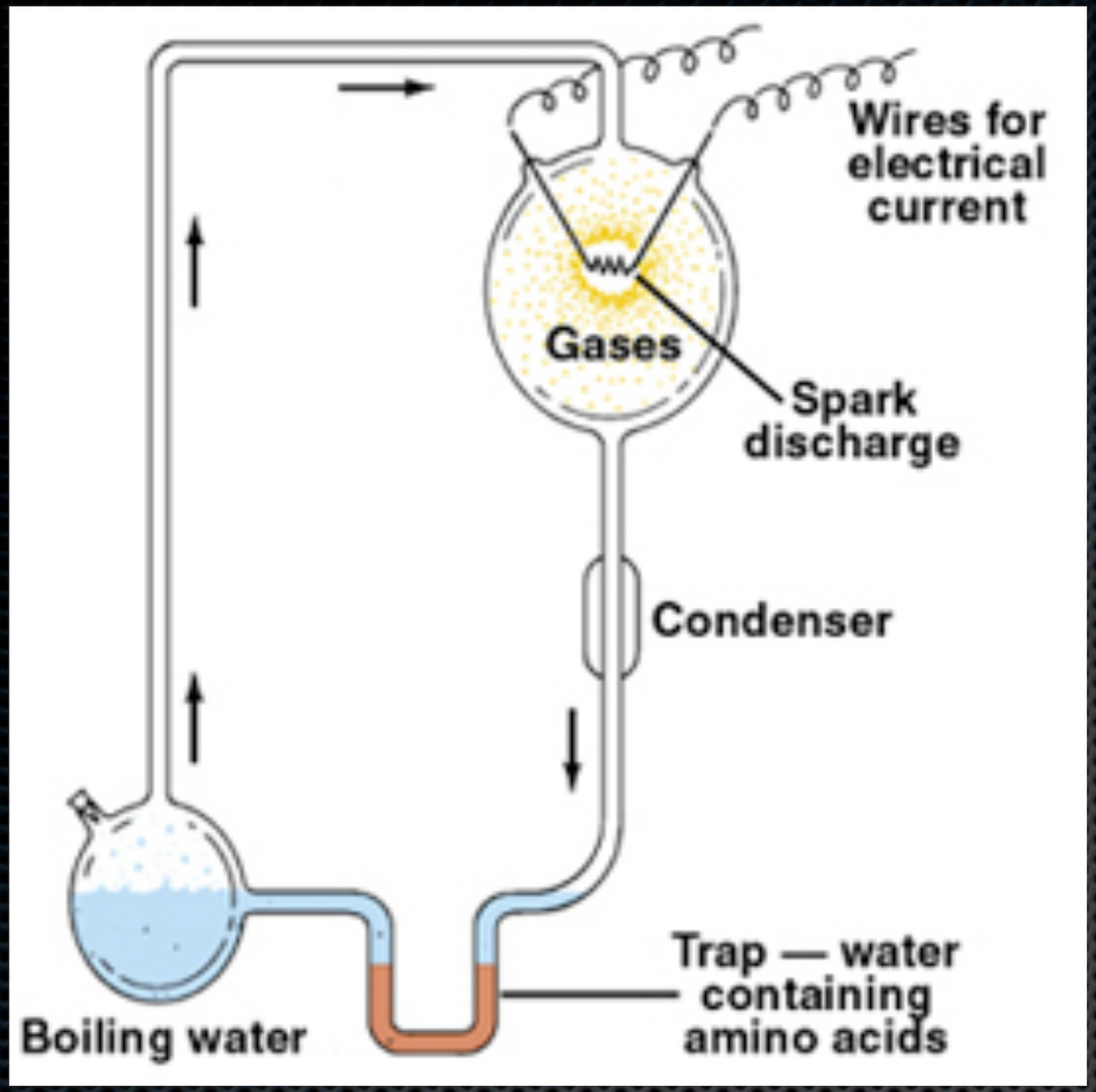

stellar
evolution

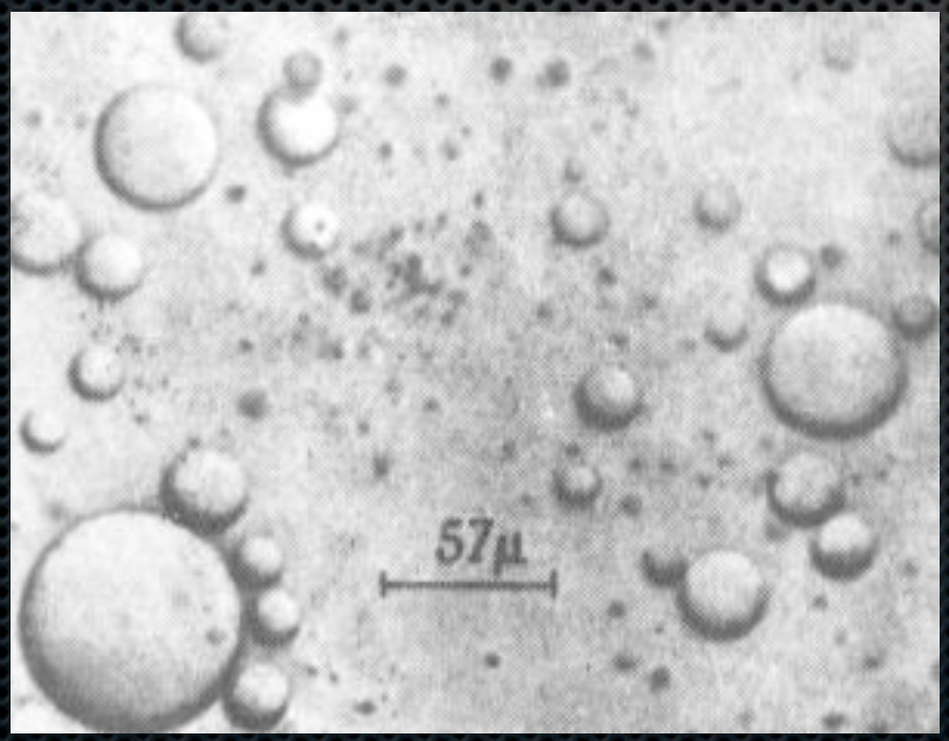


stellar
evolution

planetary
evolution

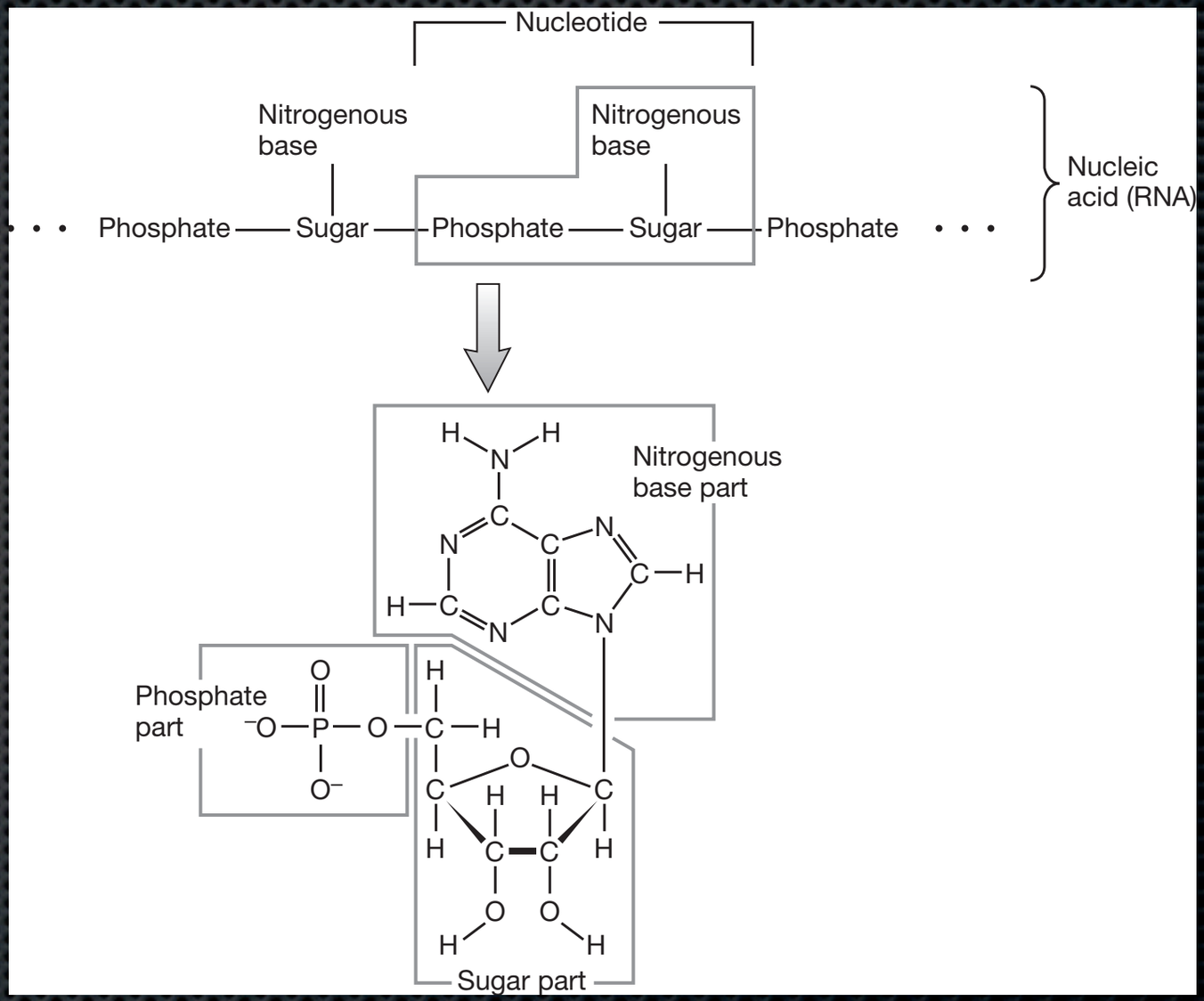

planetary
evolution



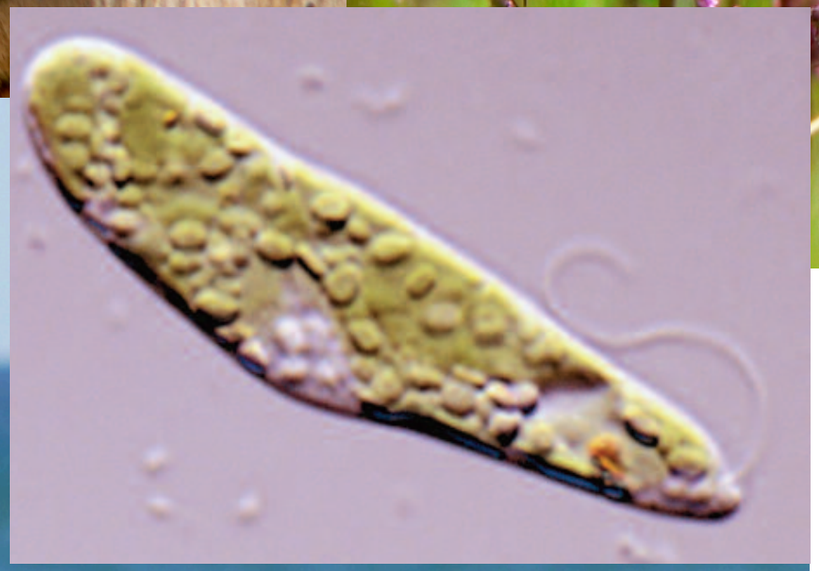


most abundant chemical elements in the universe:

H, He, O, C, Ne, N



chemical evolution

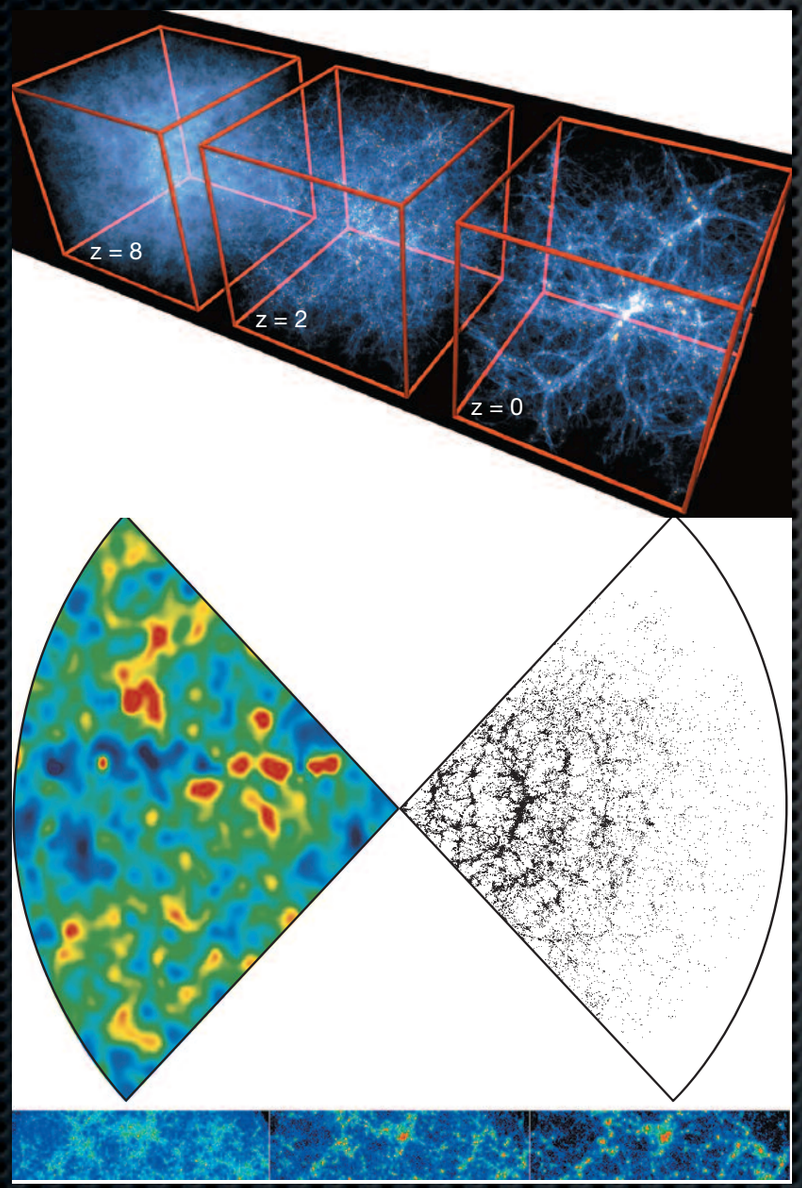


biological evolution

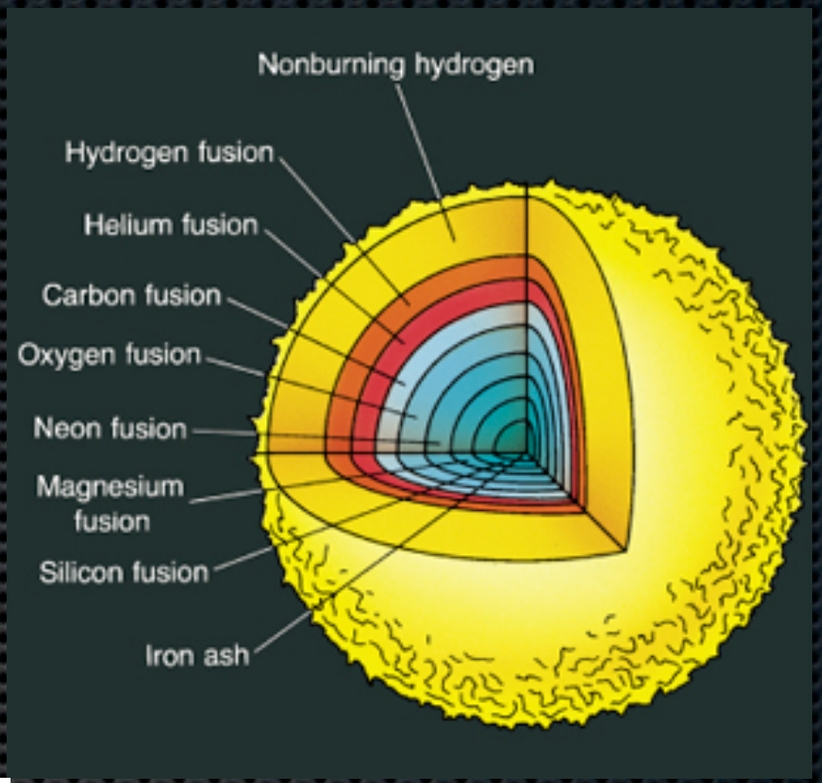
cultural
evolution

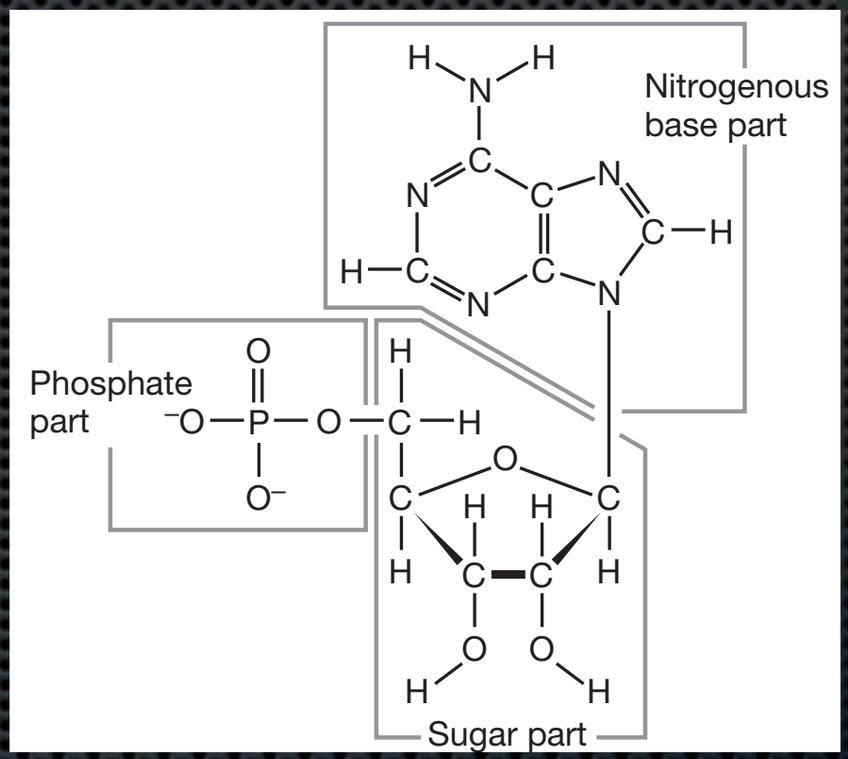
from so simple a beginning...

structure formation



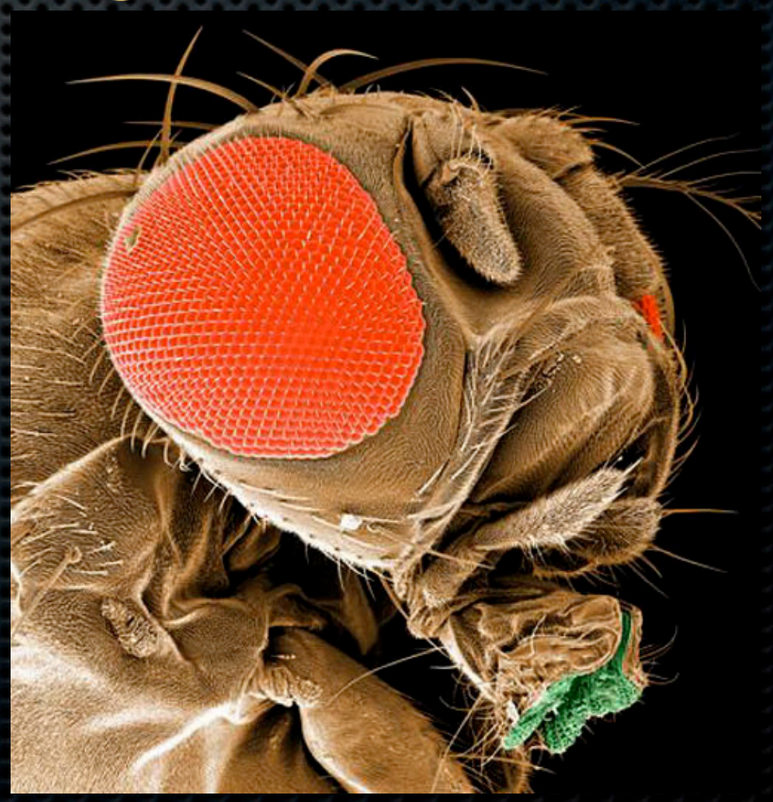
synthesis of the elements





organic molecules

genetic evolution



OVER 25% OF HUMAN GENES ARE THE SAME AS THOSE OF A BANANA

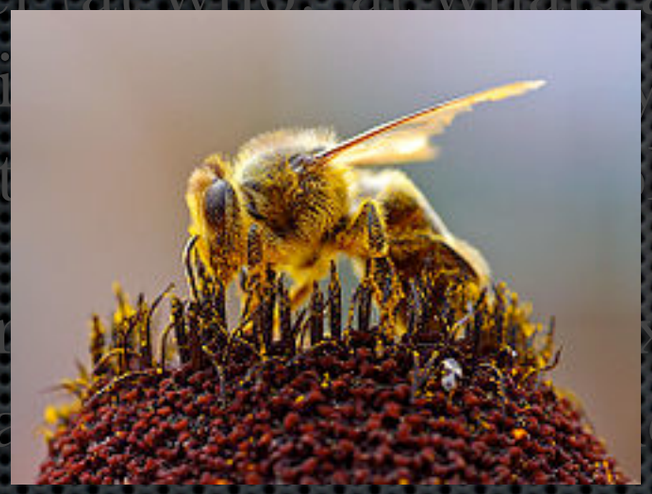
GET OVER YOURSELF

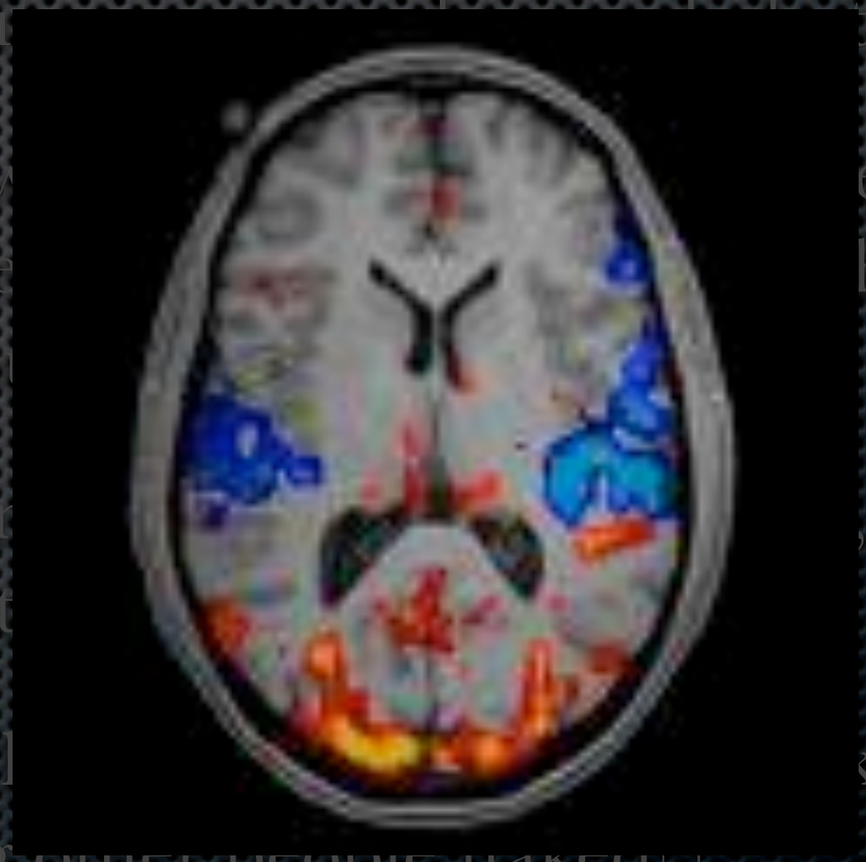
What are we, and why are we that way?

tee shirt from
northernsun.com

evolutionary psychology

- altruistic bees and moral tribes (morality surveys, C. S. Lewis vs. the fMRI, the ACC, and evolutionary benefits)
- fear (the freeze response, snakes and spiders, heights, and even public speaking; but not electrici[illegible]terol)
- laughter (at who? at what? and w[illegible]er./Put those ci[illegible]y to le[illegible]handle this./I t[illegible]ld yo[illegible]
- love (str[illegible]xual r[illegible], and "an ada[illegible]ecept[illegible]
- a basis for human intelligence? (l[illegible]kills, facial recognition, and ... getting other people naked?)
- and, of course, there's emotion ...





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- [illegible]
- a basis for [illegible]ocial skills, facial recogni[illegible]?)
- and, of cour[illegible]

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- love strategies (interpersonal mental
- an adaptive form of self-deception
- a basis for human intelligence (language
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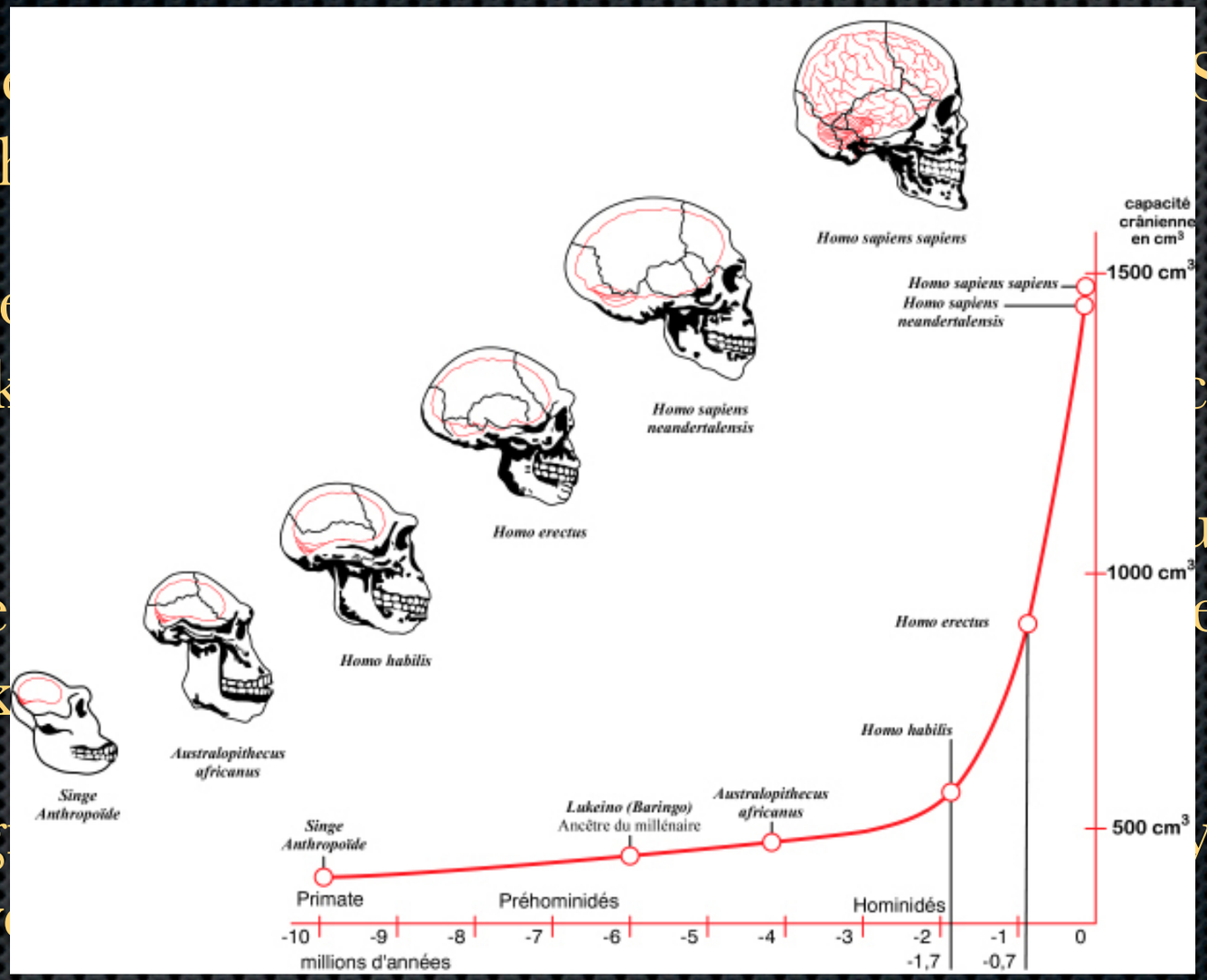

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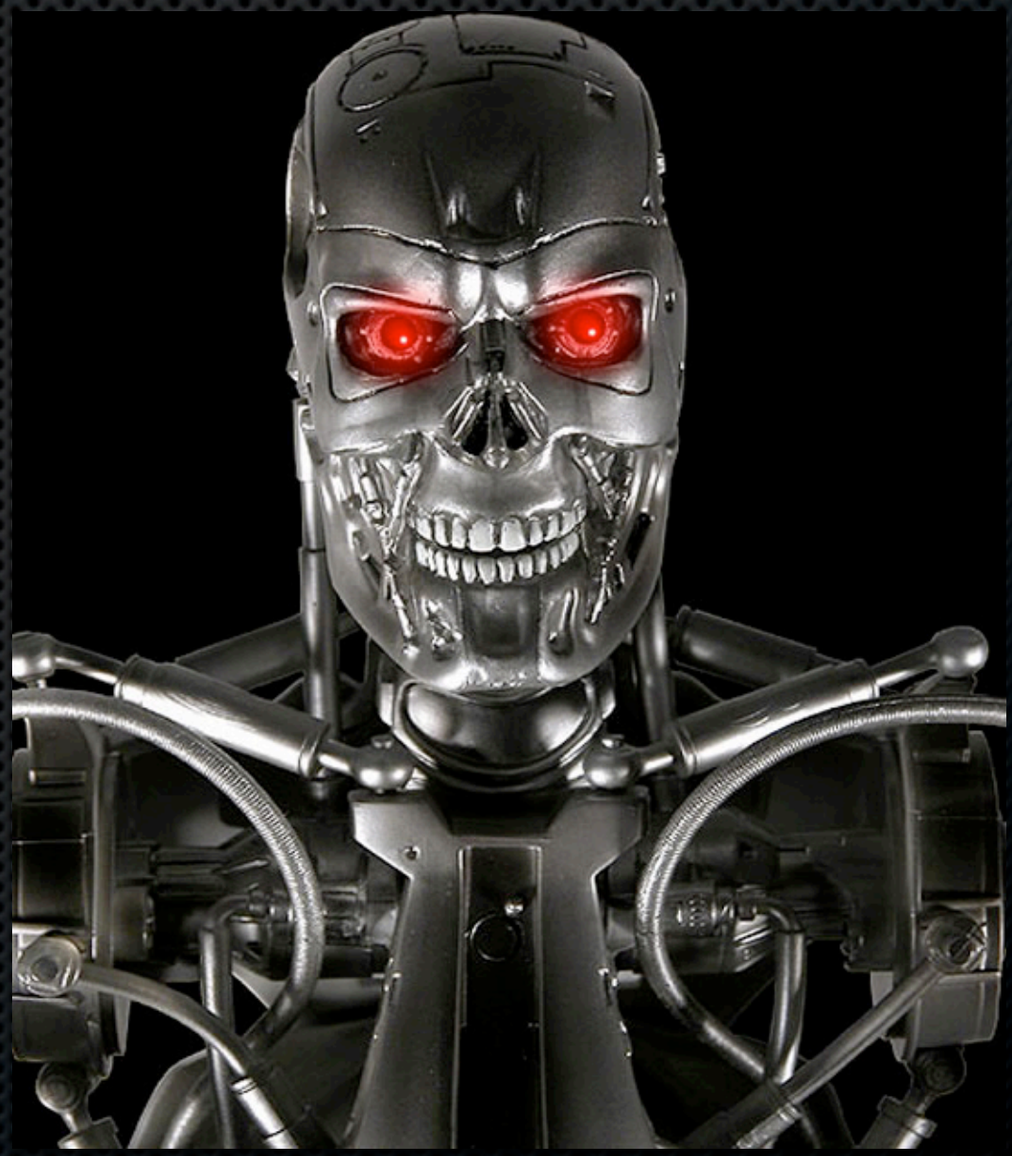
are we just machines?

- emergent rules for photons and electrons?
- hydrogen that has learned to study itself?
- where are all the robots?
- ELIZA (1965)



the robots

- Moore's law: 2040
- Vision and other senses?
- Arms, legs, and coordination?
- Common sense?
- Consciousness?
- Free will?

does God have free will?

"... Being omnipotent, God must be able to peer into his own future, to view it in all it's perfect detail.

"... [but] if he sees his own future, then his choices are predetermined. Or, if he can't see the future, then he's not omnipotent."

– Scott Adams (creator of Dilbert), in *God's Debris*

physics, old and new

Newton:

* laws of motion (1687)
  $F = ma$.

* a clockwork universe:
  determinism

Bohr, Einstein, Heisenberg, Schrodinger & others:

* quantum mechanics (1900s)
  $H\Psi = E\Psi$.

* an unpredictable universe:
  probabilism

"Consequence Argument"

If determinism is true, then our acts are the consequences of the laws of nature and events in the remote past. But it is not up to us what went on before we were born; and neither is it up to us what the laws of nature are. Therefore the consequences of these things (including our own acts) are not up to us.

– Peter van Inwagen (incompatibilist)

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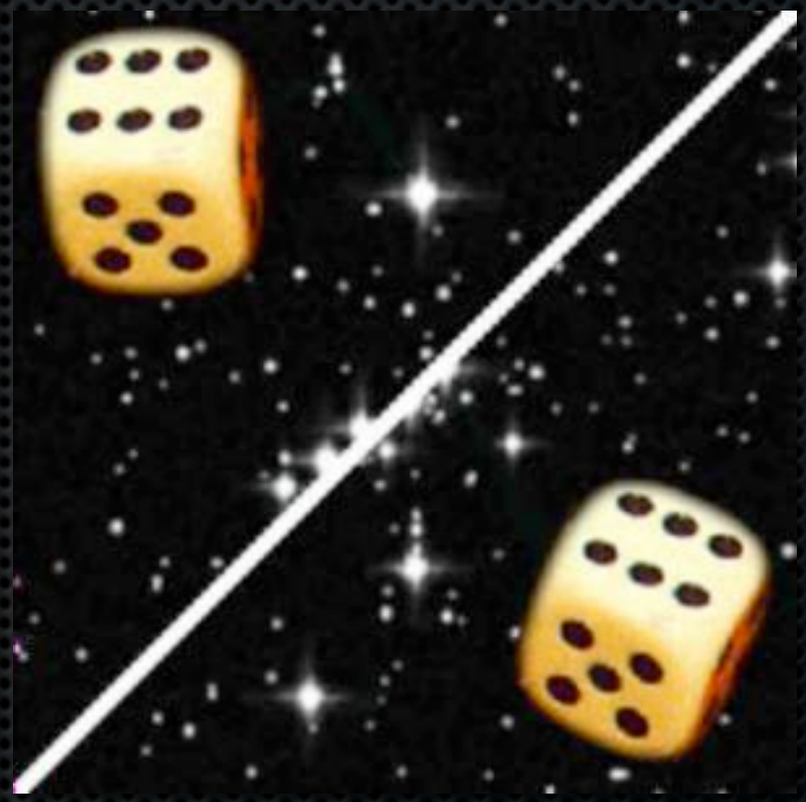


biology and free will

"Everything we do is an evolutionary adaptation designed to carry out a major function. The illusion of free will falls into this category."

– Steven Pinker (prof. of psychology at Harvard)

"Free will ... is an evolved creation of human activity and beliefs, and it is just as real as such other human creations as music and money."

– Daniel Dennett (prof. of philosophy at Tufts)

All the while I'm working as if
everything depends on what I do,
I remember that nothing depends on
what I do.

– Ram Dass

(American psychologist and spiritual leader)

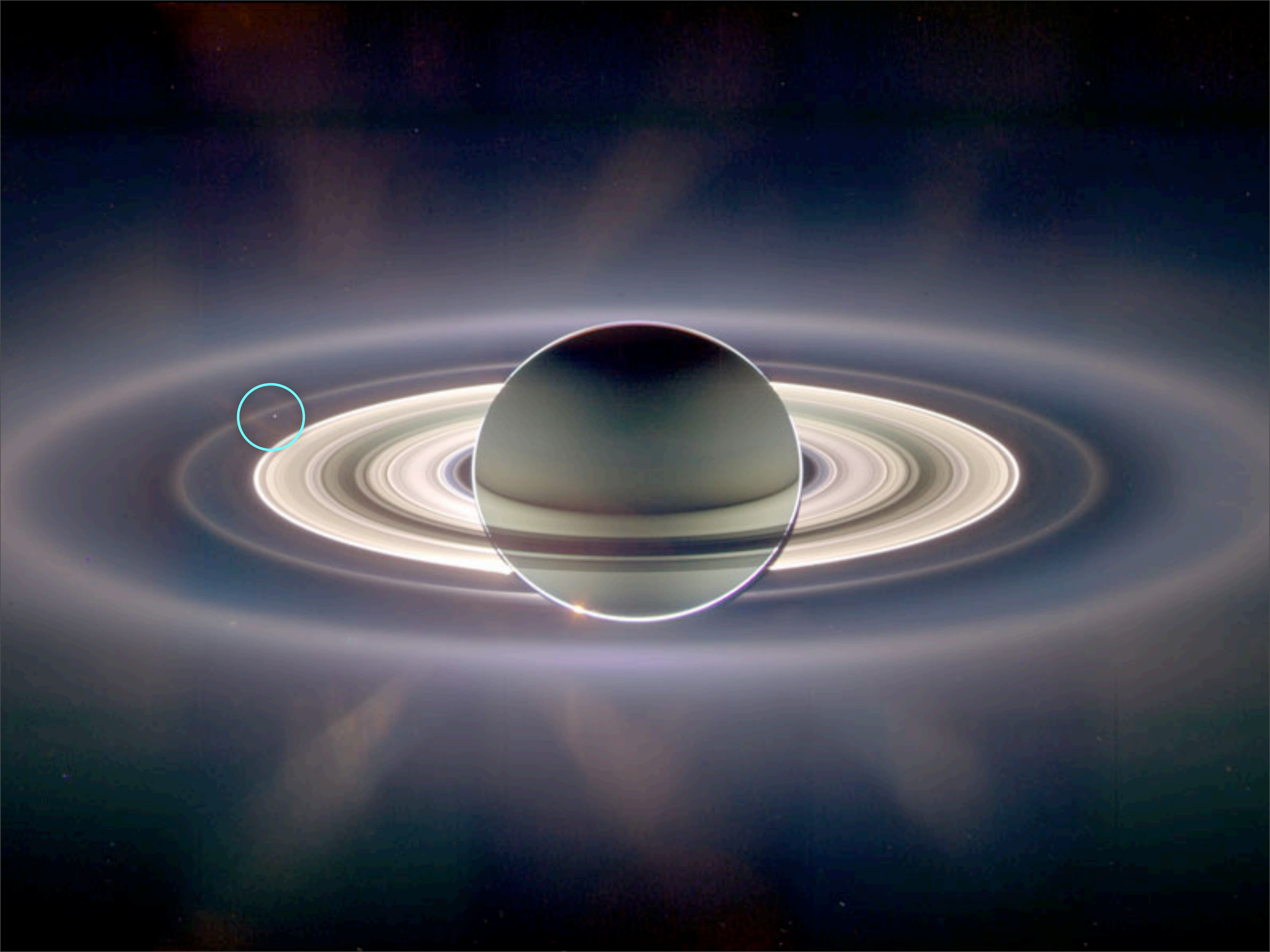
“Causal explanations for behavior, both biological and environmental, do not corrode responsibility.”

– Steven Pinker
(professor of psychology at Harvard)

a scientific awakening

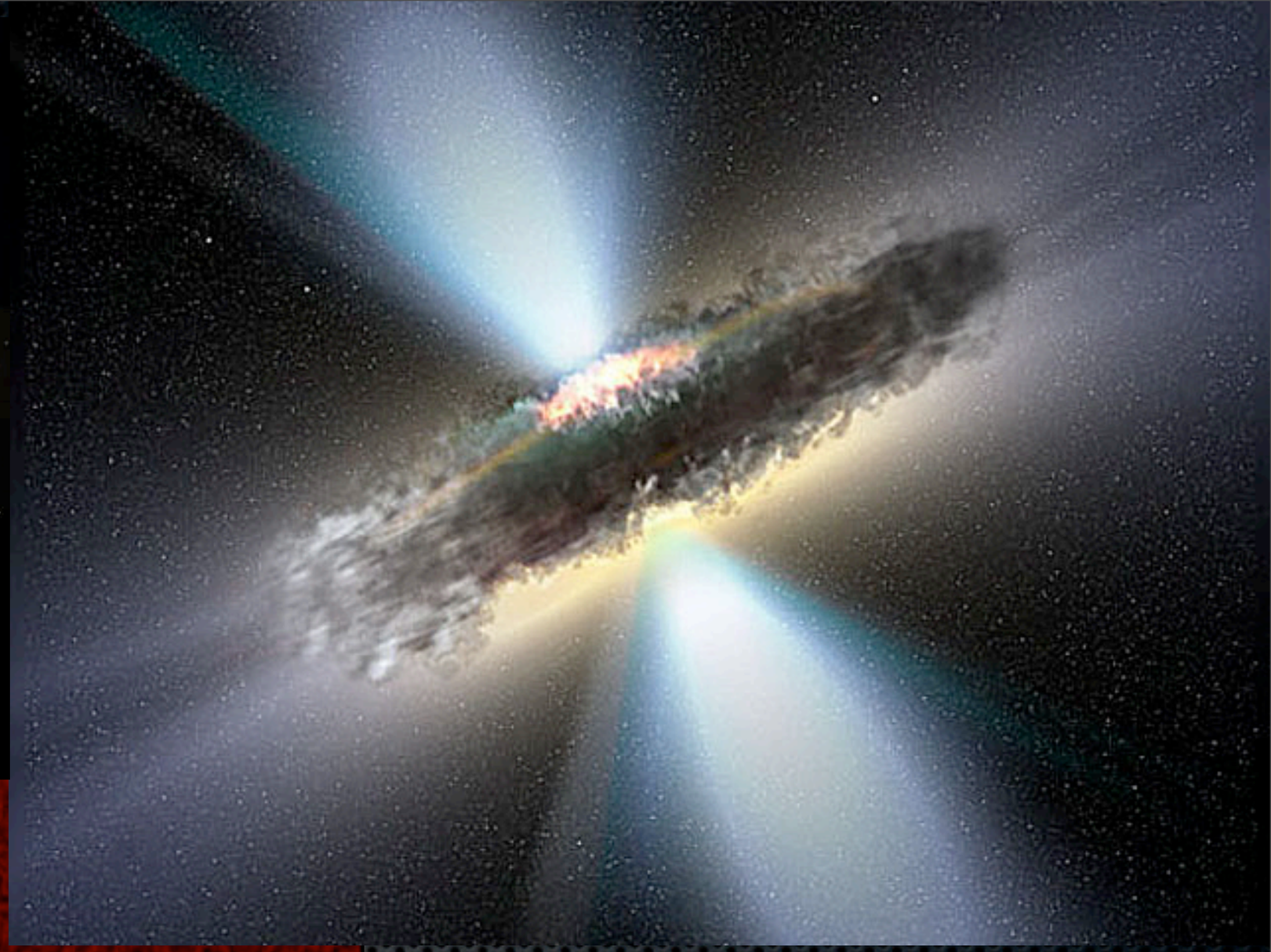
Can we use what we've learned?

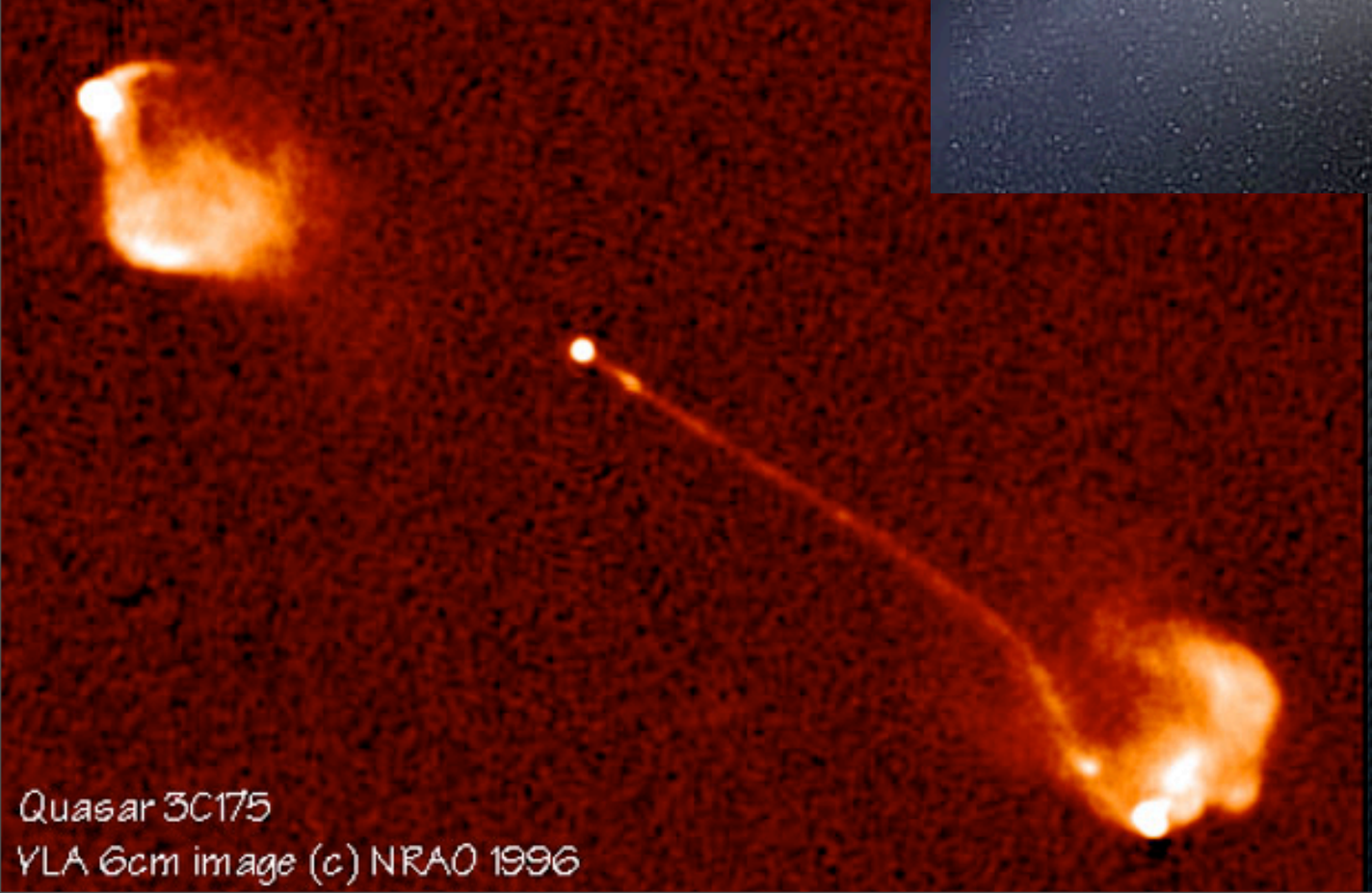
- human nature: gossip, conflict, family, securing resources, creativity ... local (not global) issues!
- the environment, biodiversity, public health, poverty, depletion of resources, WMDs, overpopulation
- cultural evolution and runaway technology (carbon emissions? AI? genetic engineering?)
- as *participants* in 13.7 billion years of history, let's take the long view: sustainable technology, sustainable economics, *and a big picture education*



"Whether or not it is clear to you,
no doubt the universe is
unfolding as it should."

– Max Ehrmann,
Desiderata





Quasar 3C175
VLA 6cm image (c) NRAO 1996

galactic
evolution

galactic
evolution


galactic
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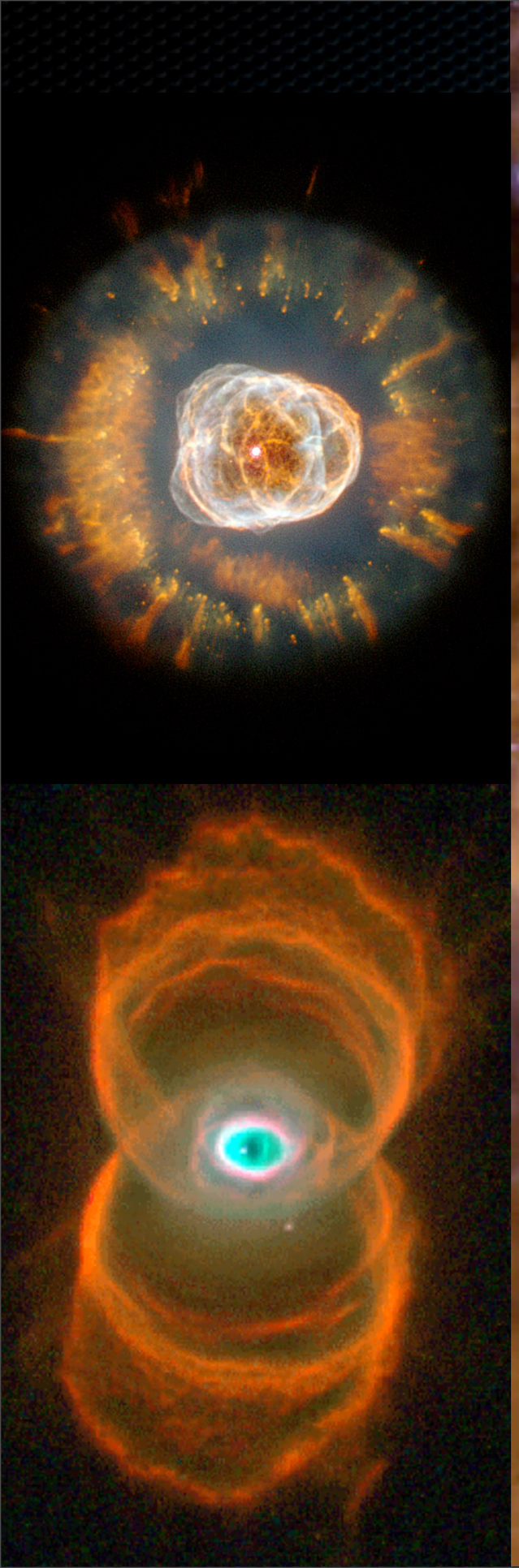
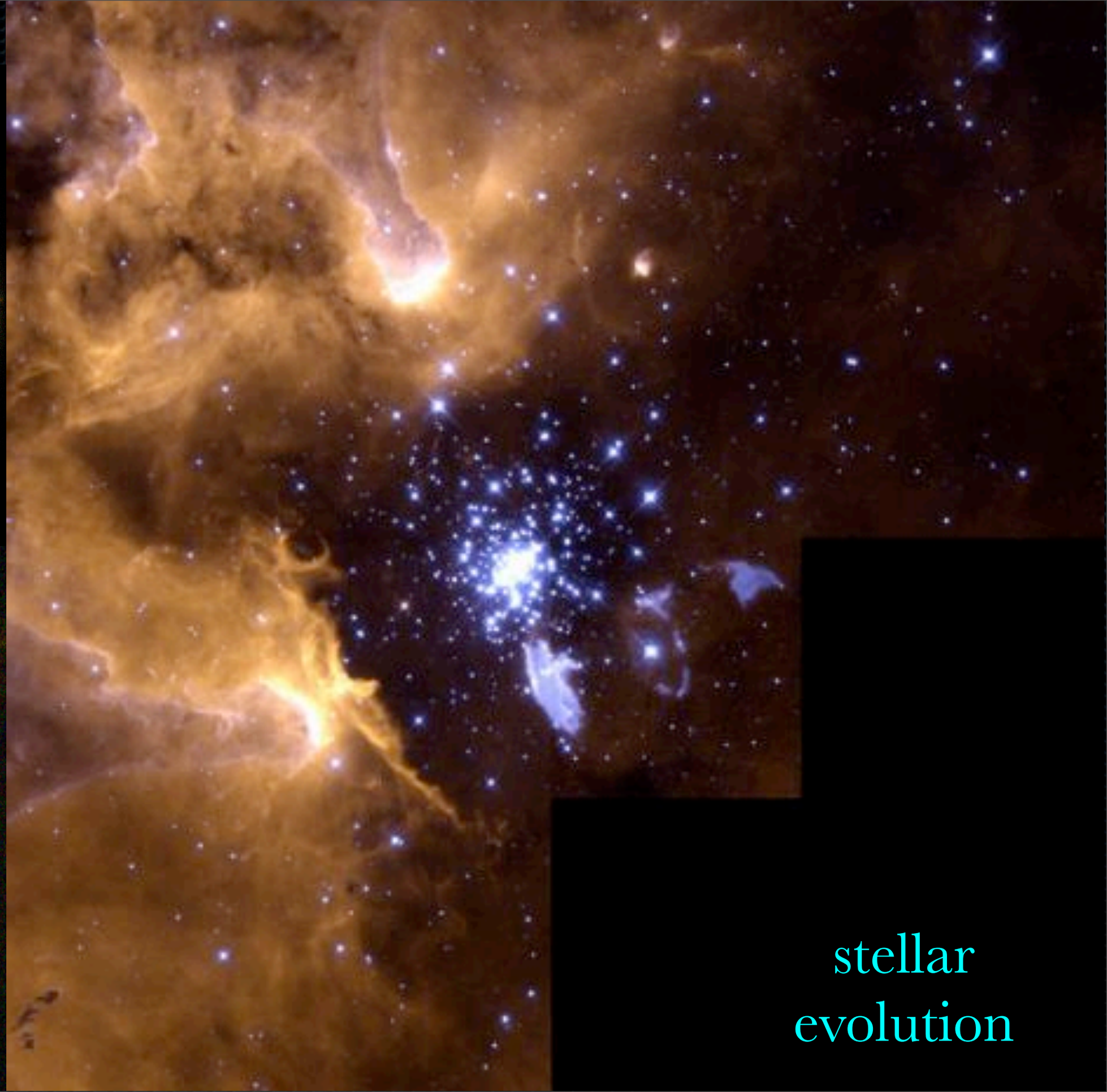
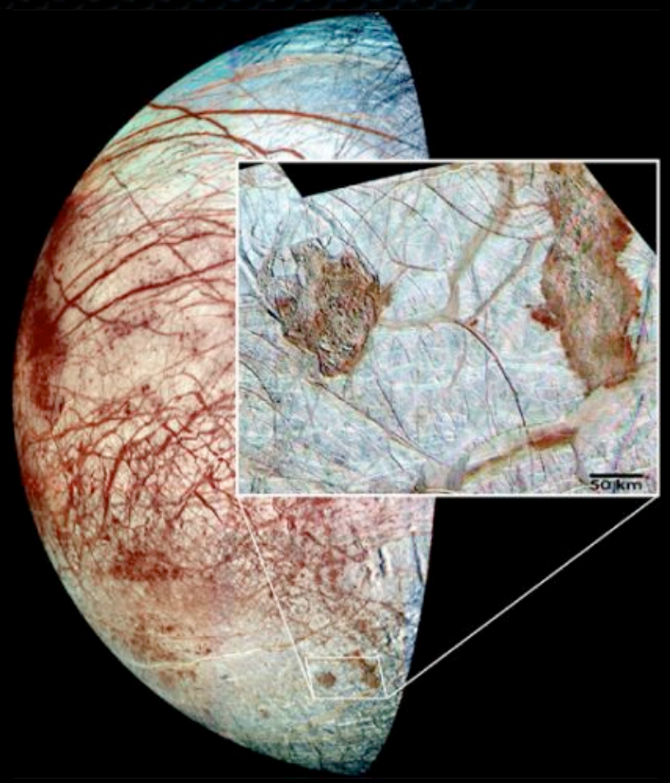
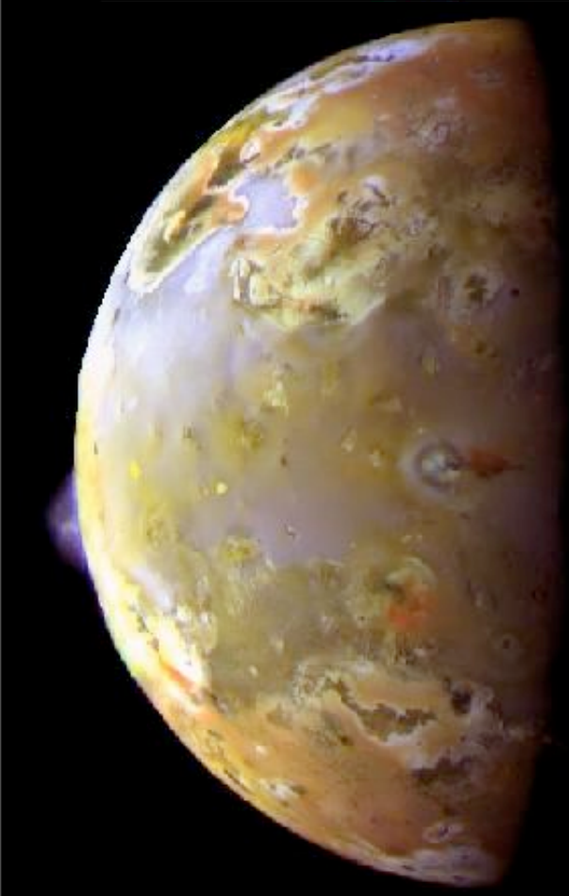


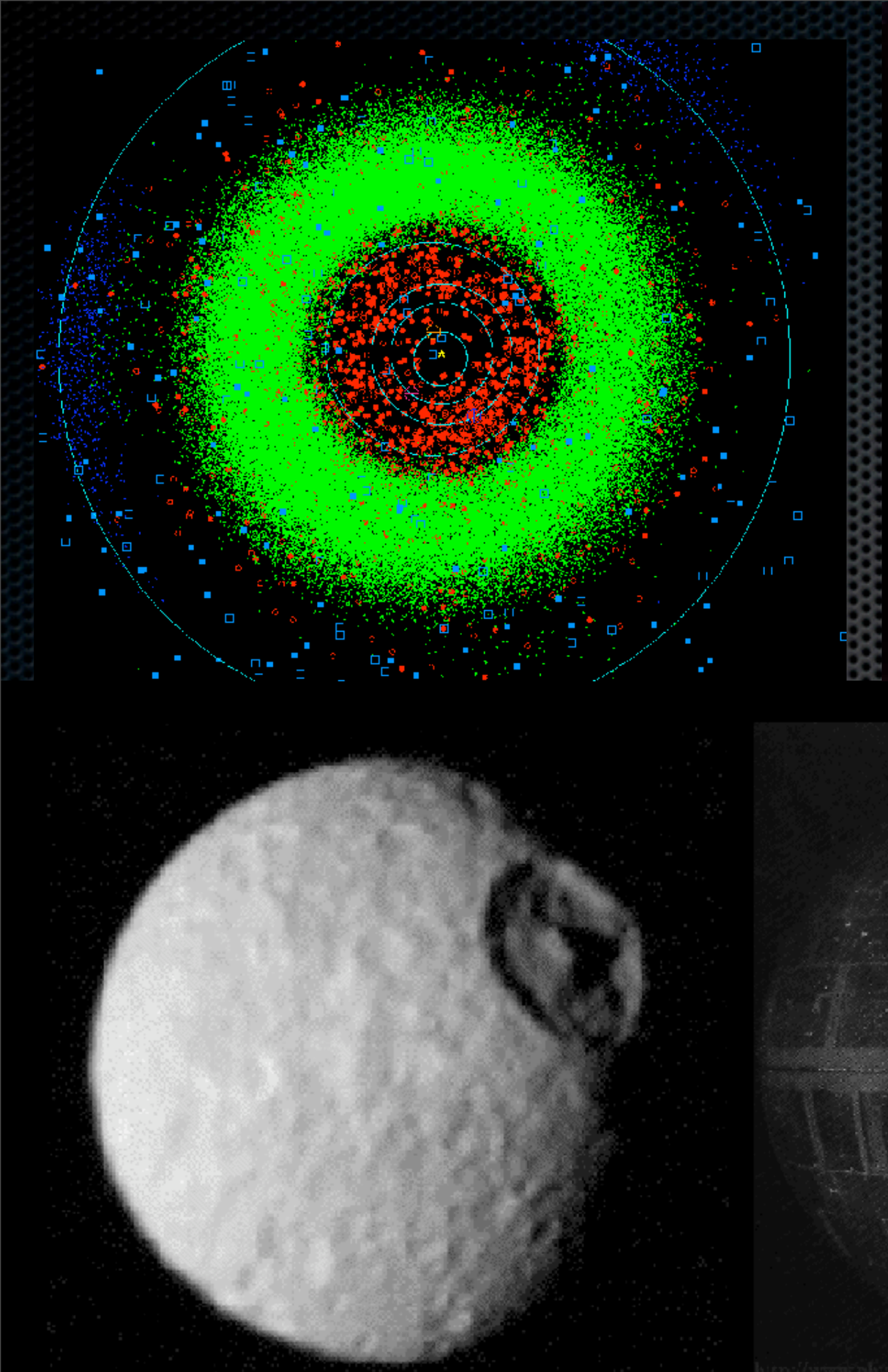


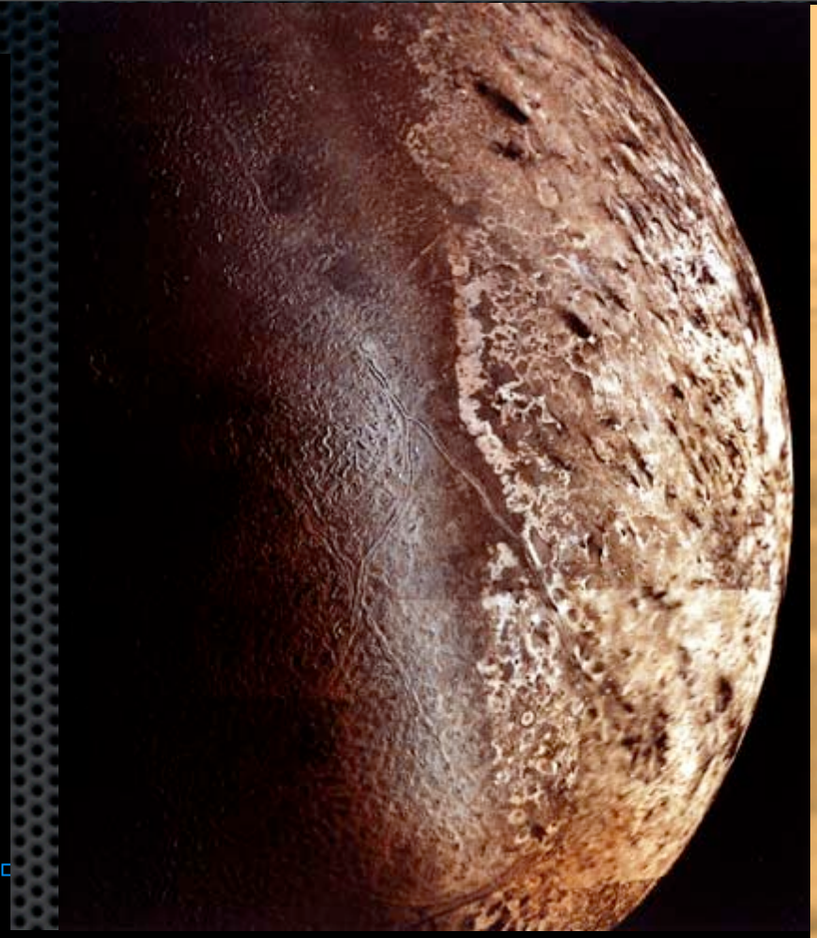
stellar
evolution

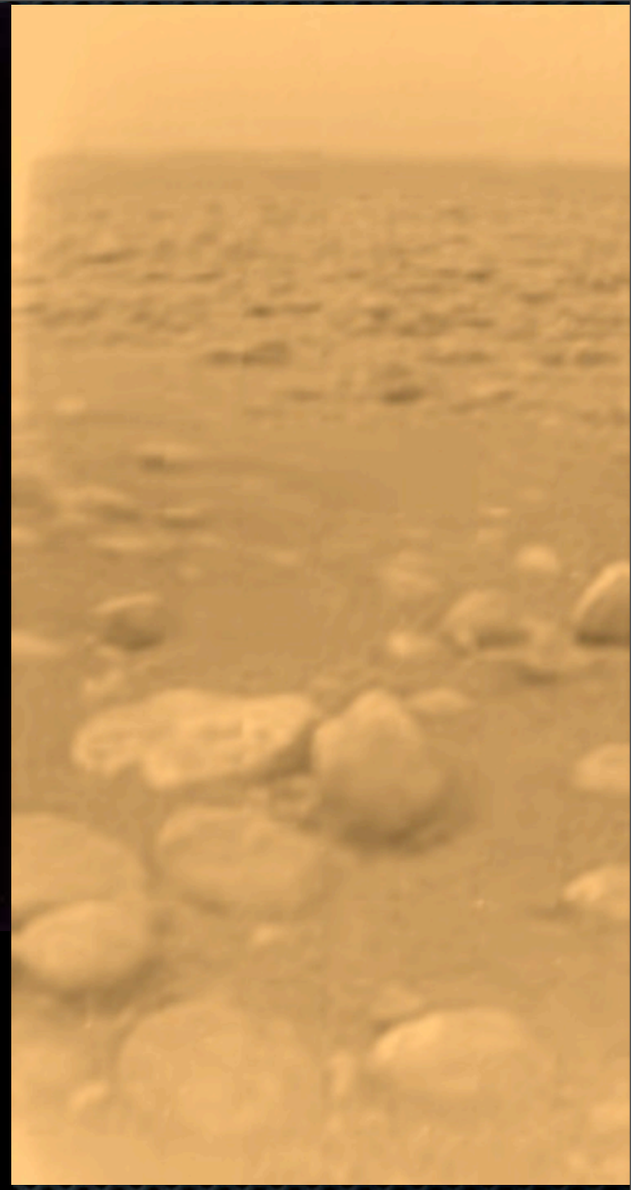


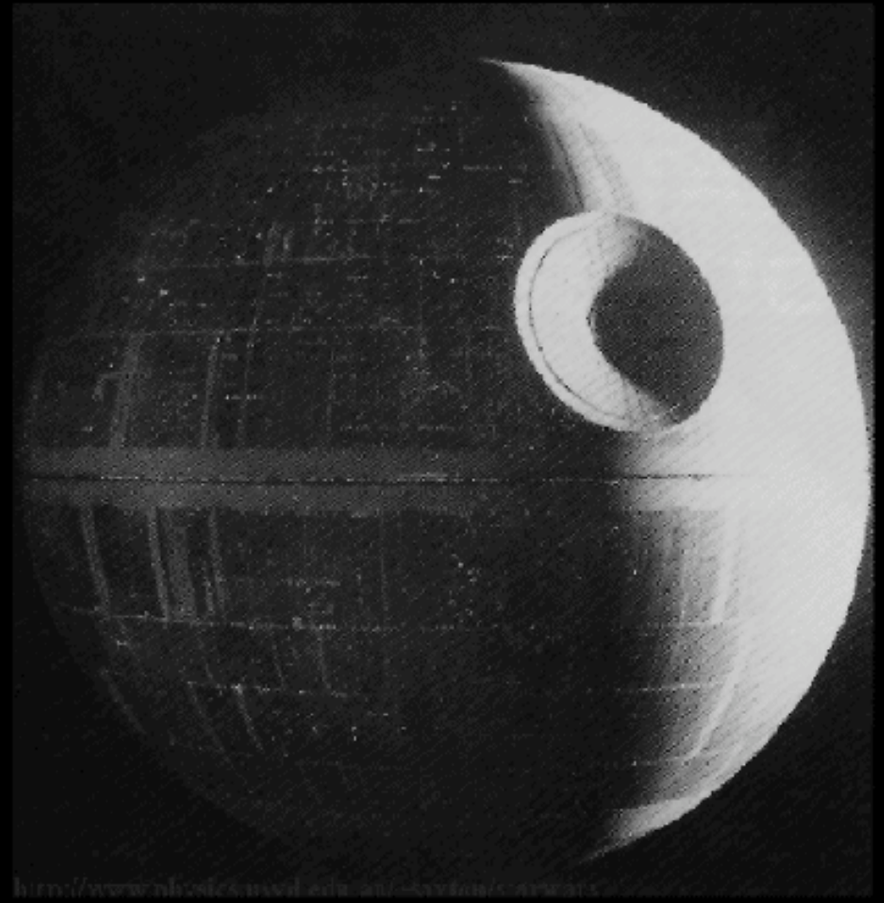


planetary
evolution

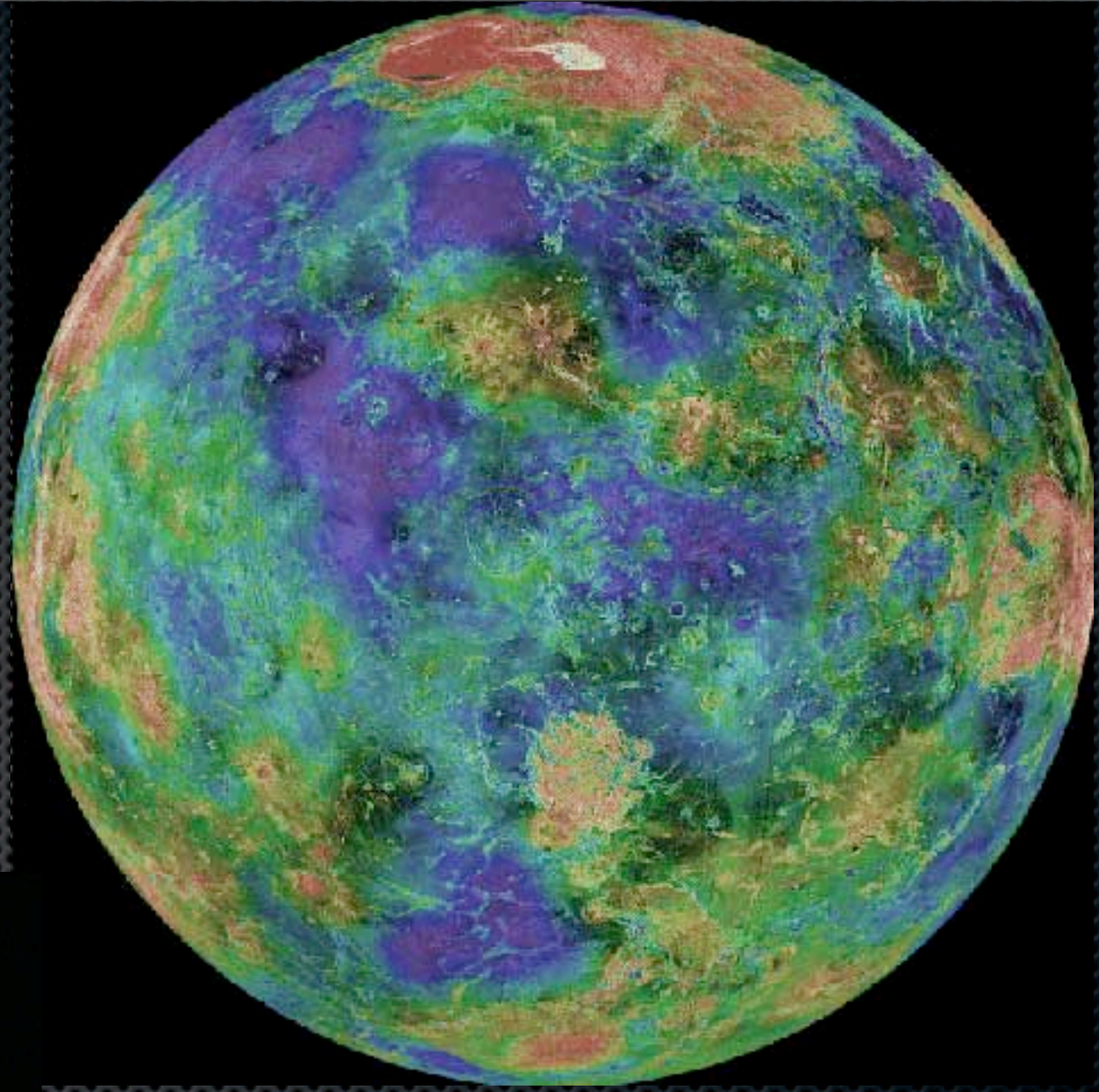


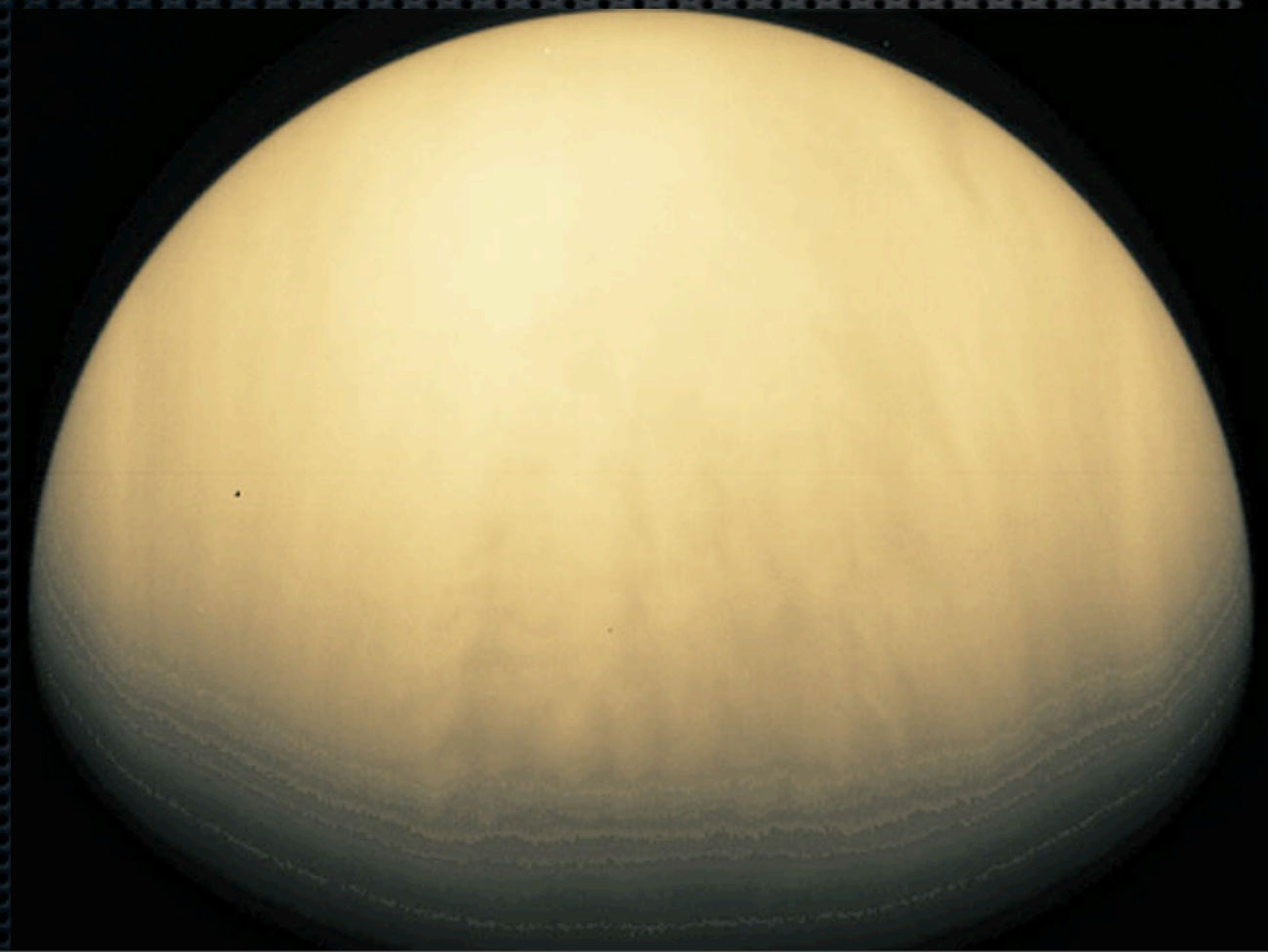






planetary evolution





planetary
evolution

planetary
evolution

from simple rules for simple particles to complex rules for complex systems

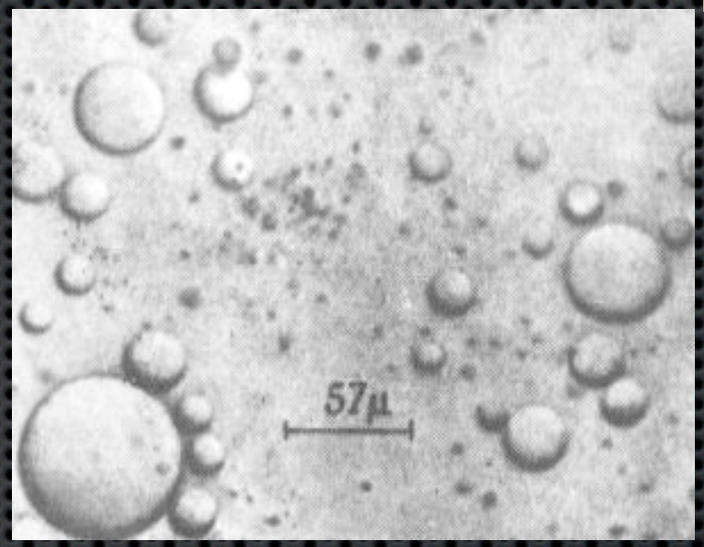
- *from* … photons and electrons, big bang particle soup, dark matter halos and nuclear powered stars …
- *to* … geology, chemistry, biology, genetics, psychology, morality & laws, human art & culture & technology …
- *but what's next?* … self-destruction? robots with AI? or maybe education toward a species in some kind of harmony with the universe?

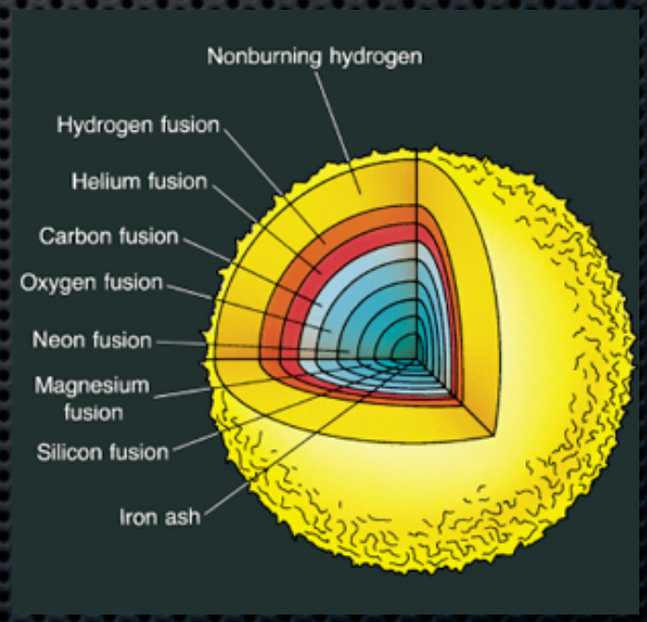
philosophy of free will

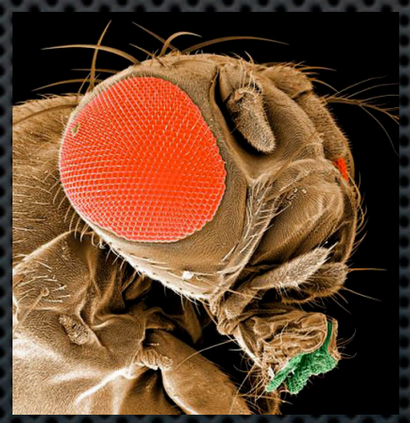
	yes determinism	no determinism
yes free will	**compatibilists** claim that "free" means power or ability with no impediments	**libertarians** example: dualism of body and mind/soul (agency/mysticism)
no free will	**hard determinists** nature and nurture are both part of your past that you didn't choose	**some quantum physicists?** undetermined mind or soul is arbitrary, not free

OVER 25% OF HUMAN GENES ARE THE SAME AS THOSE OF A BANANA

GET OVER YOURSELF







What is “alive”? What is “free”?

What are we ???