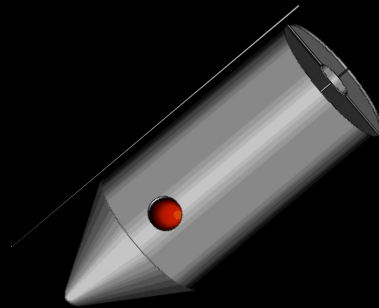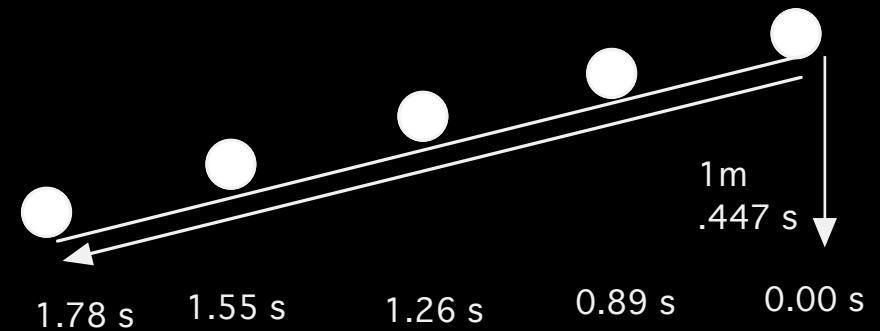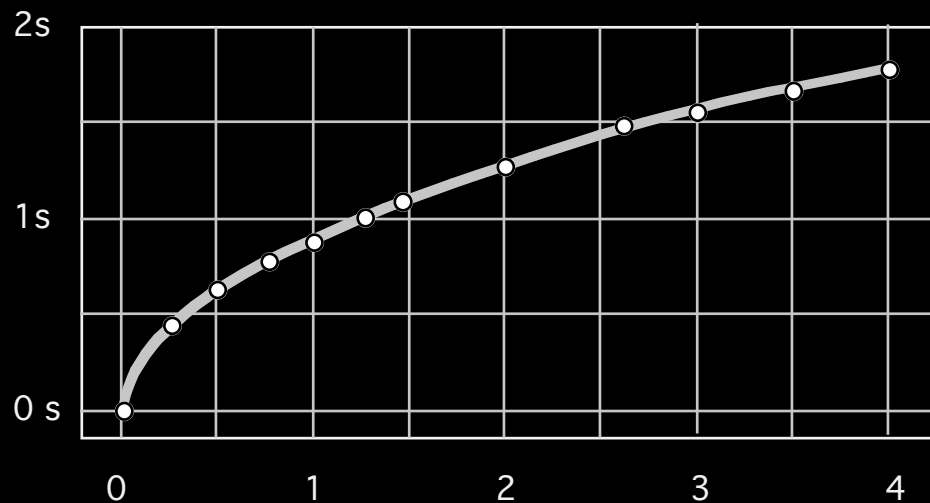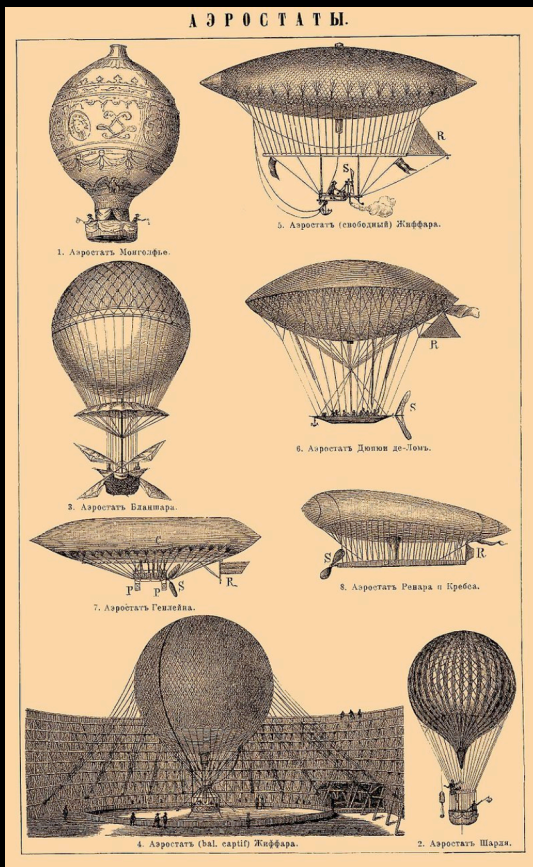# Anticipation
and The Laws of Nature

A Law of Nature is

what always happens

(within accuracy of
    measurement and
    range of observations)

Law: Distance traveled is proportional to time squared

1m
.447 s

1.78 s   1.55 s   1.26 s   0.89 s   0.00 s

Theory: $F = m\, G\, /\, r^2$

Boyle's and Charles' Law
Pressure is directly proportional to temperature and inversely proportional to volume.

Empirical Equations:
P_1/P_2 (T)= V_2/V_2(T)
P_1/P_2 (V) = T_1/T_2 (V)

Atomic Theory: $P\,V = n\,R\,T$

Range: Classical Gas
Doesn't work: Liquids, Solids
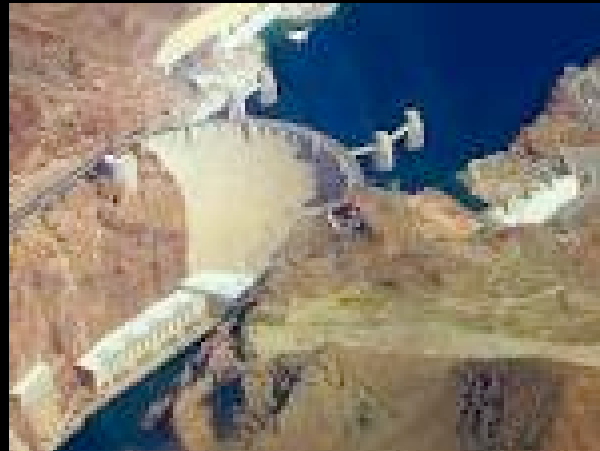Plasma, Quantum level

Conservation of Energy &Momentum

Law: The Total Energy and Momentum are the same before and after any event.

Empirical : $E_1 = E_2$ and $m_1 v_1 = m_2 v_2$

Theory $E^2 = p^2 c^2 + (m_o c^2)^2$

Range: Subnuclear to Galaxies

Doesn't Work: Dark Energy?

Lorentz Invariance: Time and distance intervals appear different on objects moving with respect to an observer in a way that makes the speed of light and Maxwell's Equations stay the same.

Empirical equation:
(in units of c)
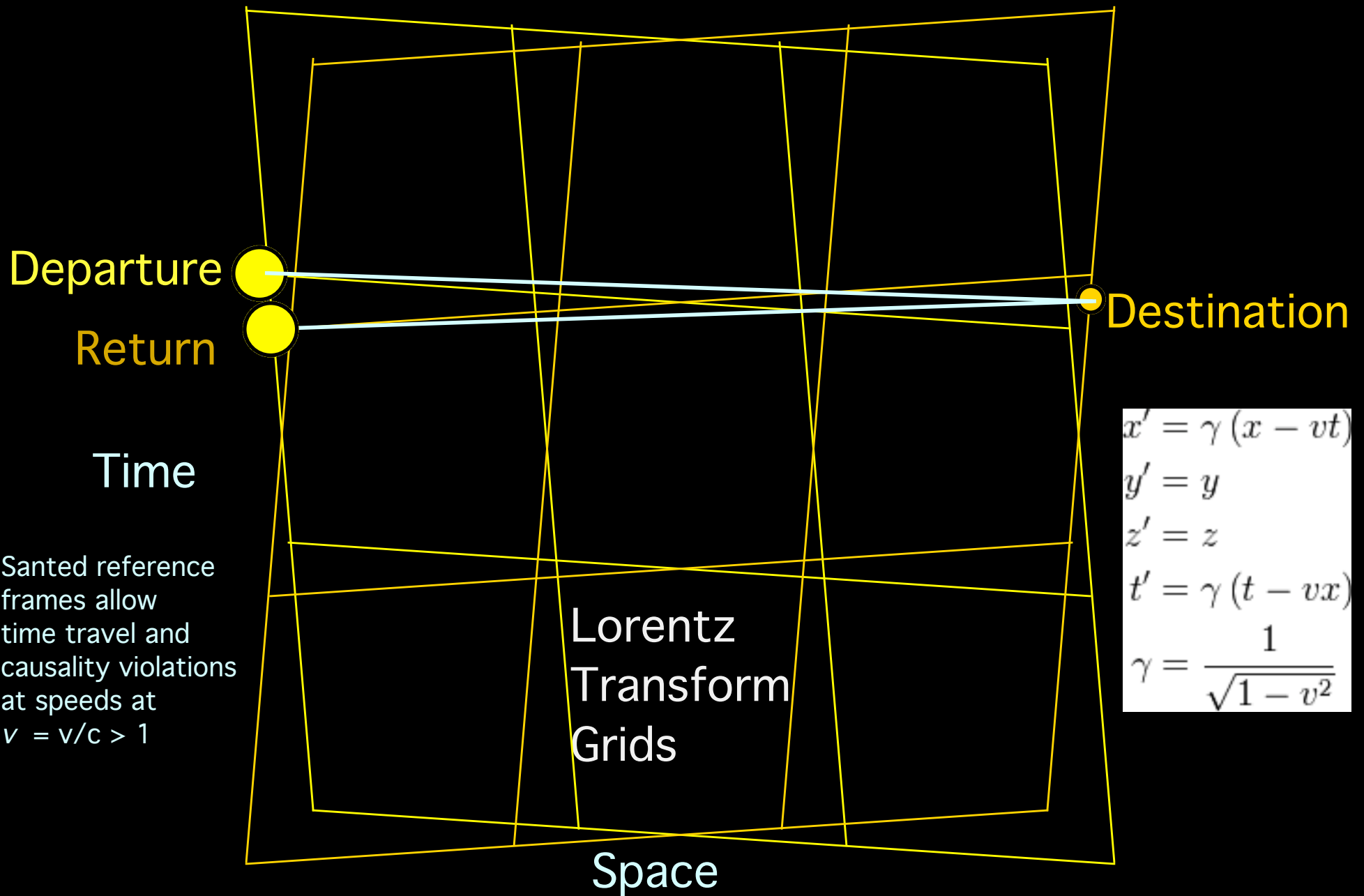Larmor, Lorentz &
Poincaré, circa 1899)

$$x' = \gamma\,(x - vt)$$
$$y' = y$$
$$z' = z$$
$$t' = \gamma\,(t - vx)$$
$$\gamma = \frac{1}{\sqrt{1 - v^2}}$$

Einstein's later theory: the same.

Range: Nuclear to Universal
Doesn't work (yet) at quantum level

The "Lady Bright" Problem

Departure

Destination

Return

Time

Santed reference frames allow time travel and causality violations at speeds at v = v/c > 1

Lorentz Transform Grids

Space

$$x' = \gamma (x - vt)$$
$$y' = y$$
$$z' = z$$
$$t' = \gamma (t - vx)$$
$$\gamma = \frac{1}{\sqrt{1 - v^2}}$$

Ceci n'est pas une pipe.

$$x' = \gamma(x - vt)$$
$$y' = y$$
$$z' = z$$
$$t' = \gamma(t - vx)$$
$$\gamma = \frac{1}{\sqrt{1 - v^2}}$$

Ceci n'est pas une loi de la nature

The equations we fit to observations of nature are not the laws them-selves. One cannot "overthrow" a law of nature by attacking a model nor a theorist who replicates it.

Some Observations on Laws of Nature

Laws of Nature come from observations, not theories

They can't be changed by changing theories;
any subsequent theory must fit the same observations.

Theories that extend beyond the range of observations
can be wrong, but that doesn't change the data within
the range of observations.

Laws of nature are immune to future engineering or
scientific discovery, and so constitute a constraint on
what can be done in the future.

People write for different reasons.

In science fiction,
  some try to explore the possible future
  some make displaced comments on the present
  some want to relive an exciting past

All of them should have some understanding of the laws of nature we know. A violation of a law of nature should be deliberate, not a result of bad research.

H.G. Wells: *Nothing remains interesting where anything may happen.*

As soon as the magic trick has been done the whole business of the fantasy writer is to keep everything else human and real. Touches of prosaic detail are imperative and a rigorous adherence to the hypothesis. Any extra fantasy outside the cardinal assumption immediately gives a touch of irresponsible silliness to the invention.

The "S" Curve

"A" When something new starts out, it usually take a lot of time, effort, and (if big) money to get it working at all. There's a "learning curve."

"B" Eventually, the nature of the beast is understood and improvements come rapidly. From an anticipation standpoint, it's hard to deal with "B", even more so when a number of interacting technologies are involved. Which is going to take off first? Does the order things happen in matter.

"C" is where the laws of nature constrain what can be done, no matter how much effort.

Physical Limit

Performance

C

B

A

Time and/or Effort
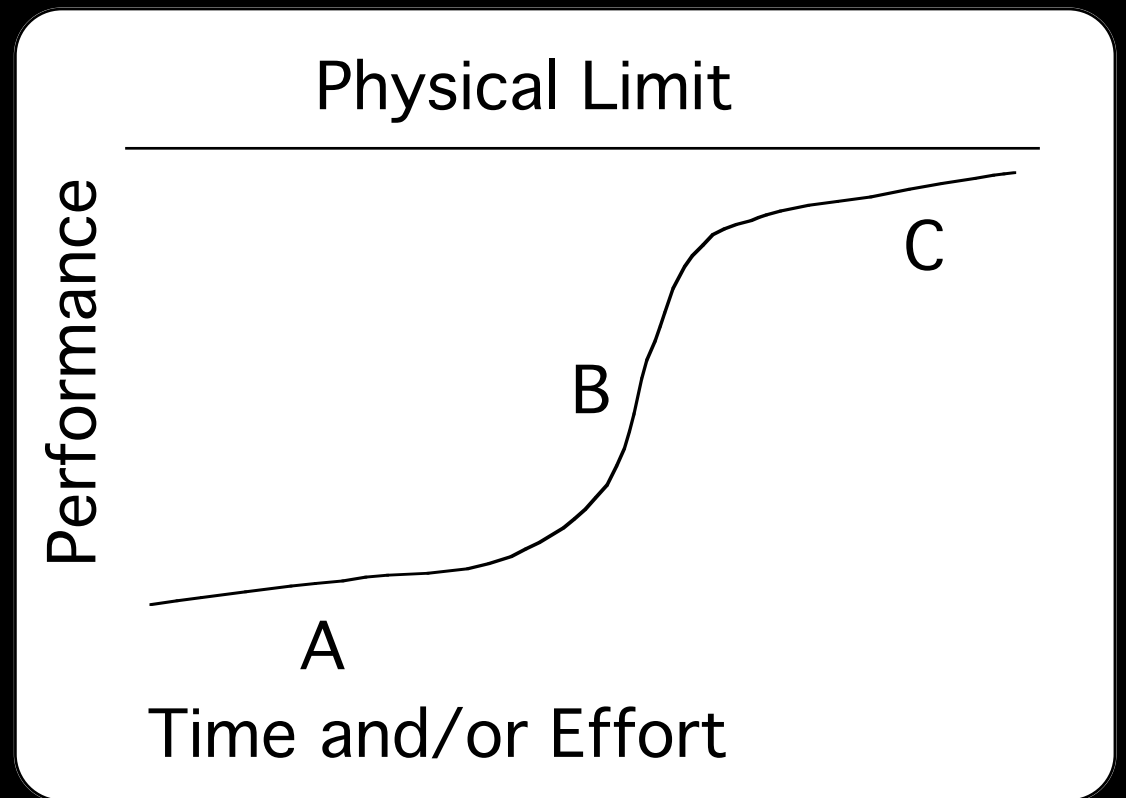
"C" is easier for a writer to deal with. Just figure out what the best performance possible is, back off a bit, and assume your aliens or advanced human society has it. Don't explain how it works--after all, you're anticipating hundreds, thousands, if not billions of years of engineering. As long as "it" performs within the laws of nature, you should be okay.

Household Lighting

≈90%

≈20%

≈10%

LEDs

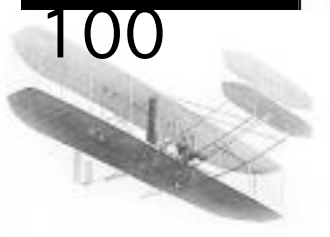Millennia   Centuries   Decades   Years   Decades
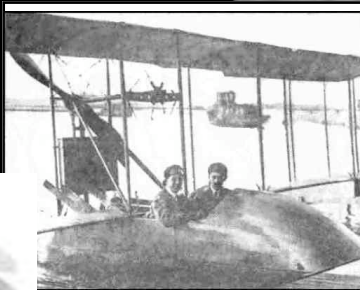
Speed of Sound------------------

500 mph

400

300

Economically viable
Subsonic
transports

200

100

1905 1915 1925 1935 1945 1955   2005

Magnalia Natureae

Praecipue quoad usus humanos

The prolongation of life
The restitution of youth in some degree
The retardation of age

The curing of diseases counted incurable
The increasing of strength and activity.
The mitigation of pain.
The increasing of ability to suffer torture or pain,
....
The altering of complexions, and fatness and leanness
The altering of statures
The altering of features
The increasing and exalting of the intellectual parts
Versions of bodies into other bodies

FRANCIS BACON ≈400 years ago

Making of new speciea
Transplanting of one species into another
Instruments of destruction, as of war and poison
Exhilaration of the spirits, and putting them in good disposition
Force of the imagination, either upon another body, or upon the body itself
Acceleration of time in maturations
...
Impressions of the air, and raising of tempests
Turning crude and watery substances into oily and unctuous substances
Drawing new foods out of substances not now in use.
Making new threads for apparel; and new stuffs; such as paper, glass, etc....
Deceptions of the senses
Greater pleasures of the senses
Artificial minerals and cements

S-Curve Lessons

Engineering difficulties are not Laws of Nature and not constraints on ET's present nor our future. They may still have a lot to do with what is done when. When the S curve plateaus may be decades, centuries, millennia, or maybe never* if there is a better way.

Avoid thinking it can't be done because someone hasn't shown *how* it can be done. Arguments of personal incredulity are non sequitor. Nor can one discount something because it would change everything. Change happens.

But know and observe the laws of nature. Avoid thinking *anything* can be done because "they" have been wrong before. That's just ignorance.

Think like Bacon, Franklin, Verne, Fermi, Clarke & Dyson
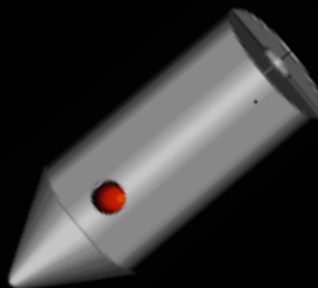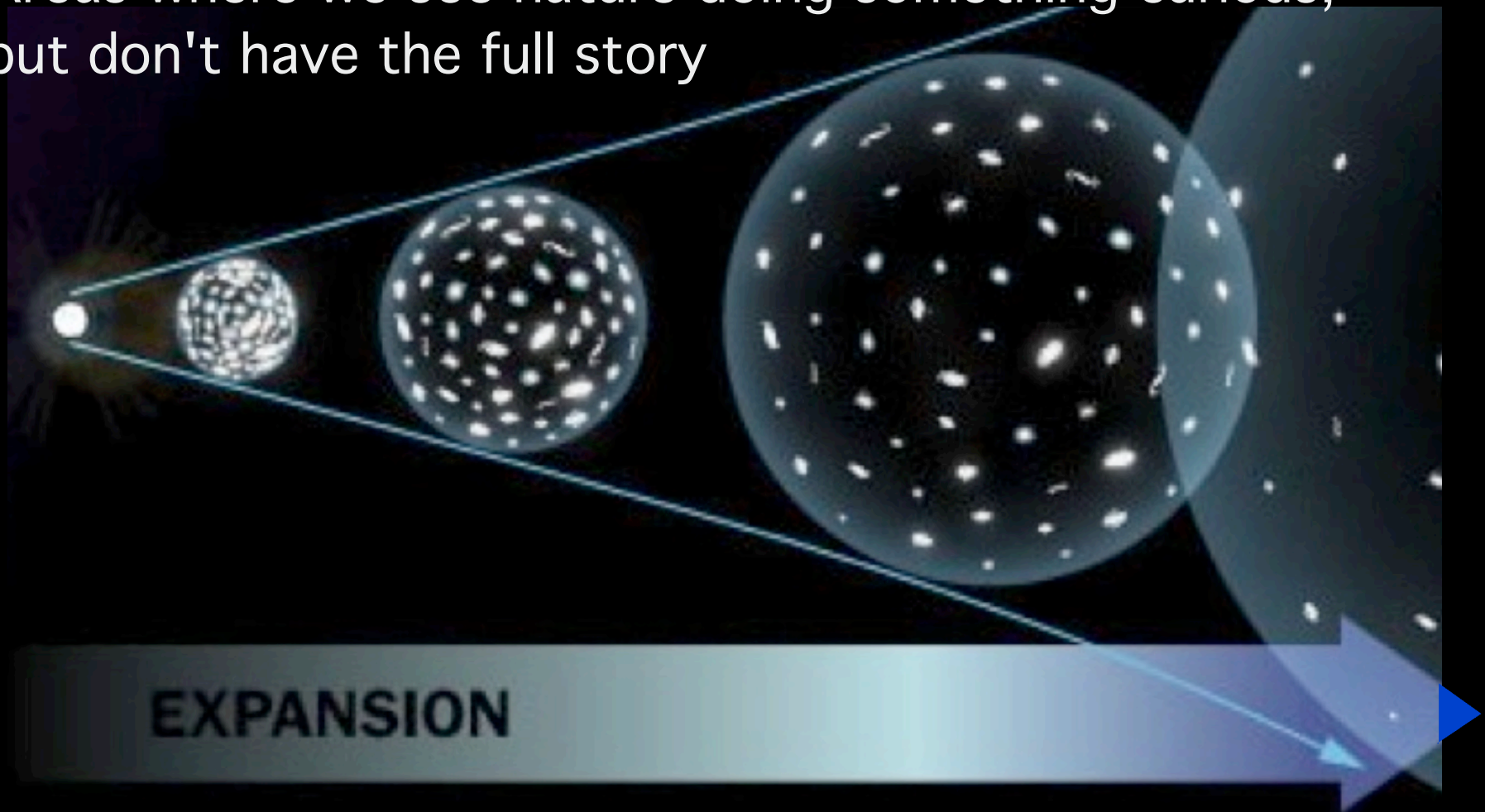
* Some challenges are irresistible, however little sense they make....

New Natural Laws Yield New Constraints, Possibilities

Dark Energy, Dark Matter, Plank scale stuff (strings?)

Areas where we see nature doing something curious, but don't have the full story

EXPANSION

Some things to take away...

Laws of Nature are what nature always does
(violate them, and you're writing fantasy)

Theory is fit to nature, not vice-versa.
("Overthrowing" theories doesn't change data.)

Laws of Nature both enable and constrain
(Given time, difficulties are overcome.)

New laws of nature are to be discovered
(That won't change the data, either.)

Do the Research. Think

Ceci n'est pas une pipe.

Physical Limit

Performance

Time and/or Effort

C

B

EXPANSION
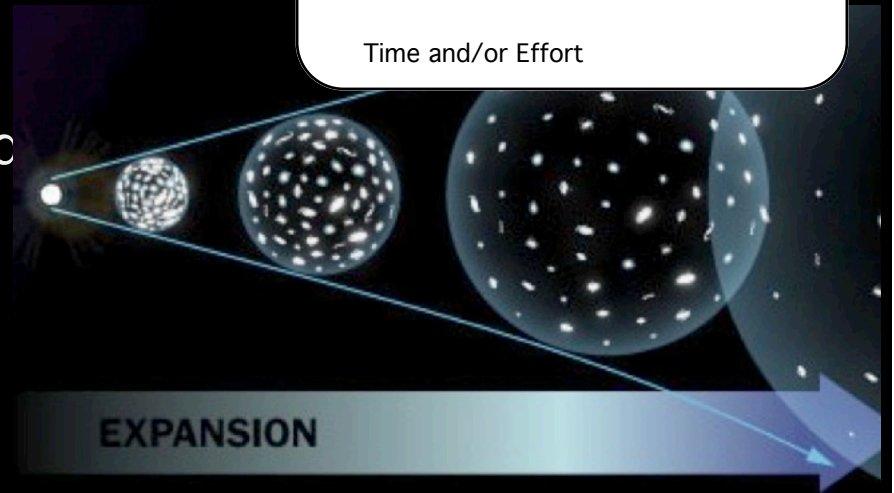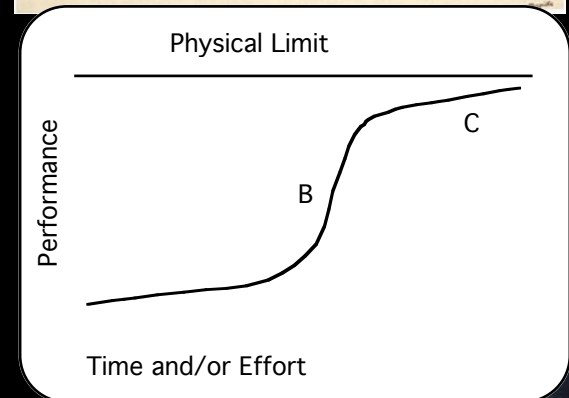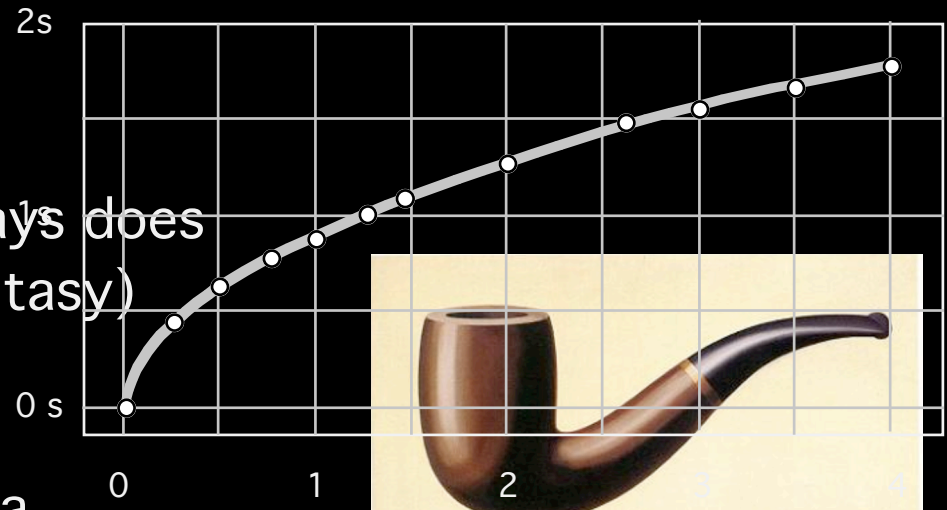
To Paraphrase AA

As world builders, futurists, and ETI searchers:

Grant us the courage to anticipate what can be

The equanimity to accept what cannot be

And the wisdom to know the difference.

King Knute & the Tide