the Greeks

Sumerian
3500 BC – 2500 BC

Mycenaean
3000 BC – 1100 BC

Egyptian
2800 BC – 60 AD

Minoan
2800 BC – 1400 BC

Assyrian–Babylonian
2700 BC – 800 BC

Greek Dark Ages
1200 BC – 800 BC

"Classical" Greece
600 BC – 200 BC

Greek Action
400 BC

us
1776 AD – 2006 A

| 3500 BC | 3000 BC | 2500 BC | 2000 BC | 1500 BC | 1000 BC | 500 BC | 1 AD | 500 AD | 1000 AD | 1500 AD | 2000 AD |

Egypt

Sumerian
3500 BC – 2500 BC

Mycenaean
3000 BC – 1100 BC

Egyptian
2800 BC – 60 AD

Minoan
2800 BC – 1400 BC

Assyrian–Babylonian
2700 BC – 800 BC

Greek Dark Ages
1200 BC – 800 BC

"Classical" Greece
600 BC – 200 BC

Greek Action
400 BC

us
1776 AD – 2006 A

3500 BC   3000 BC   2500 BC   2000 BC   1500 BC   1000 BC   500 BC   1 AD   500 AD   1000 AD   1500 AD   2000 AD

their art

Funerary Scene, Egyptian, ~1450 B.C.

static

conceptual...abstract?

Portrait Head, Egyptian, ca 2550 B.C.

death
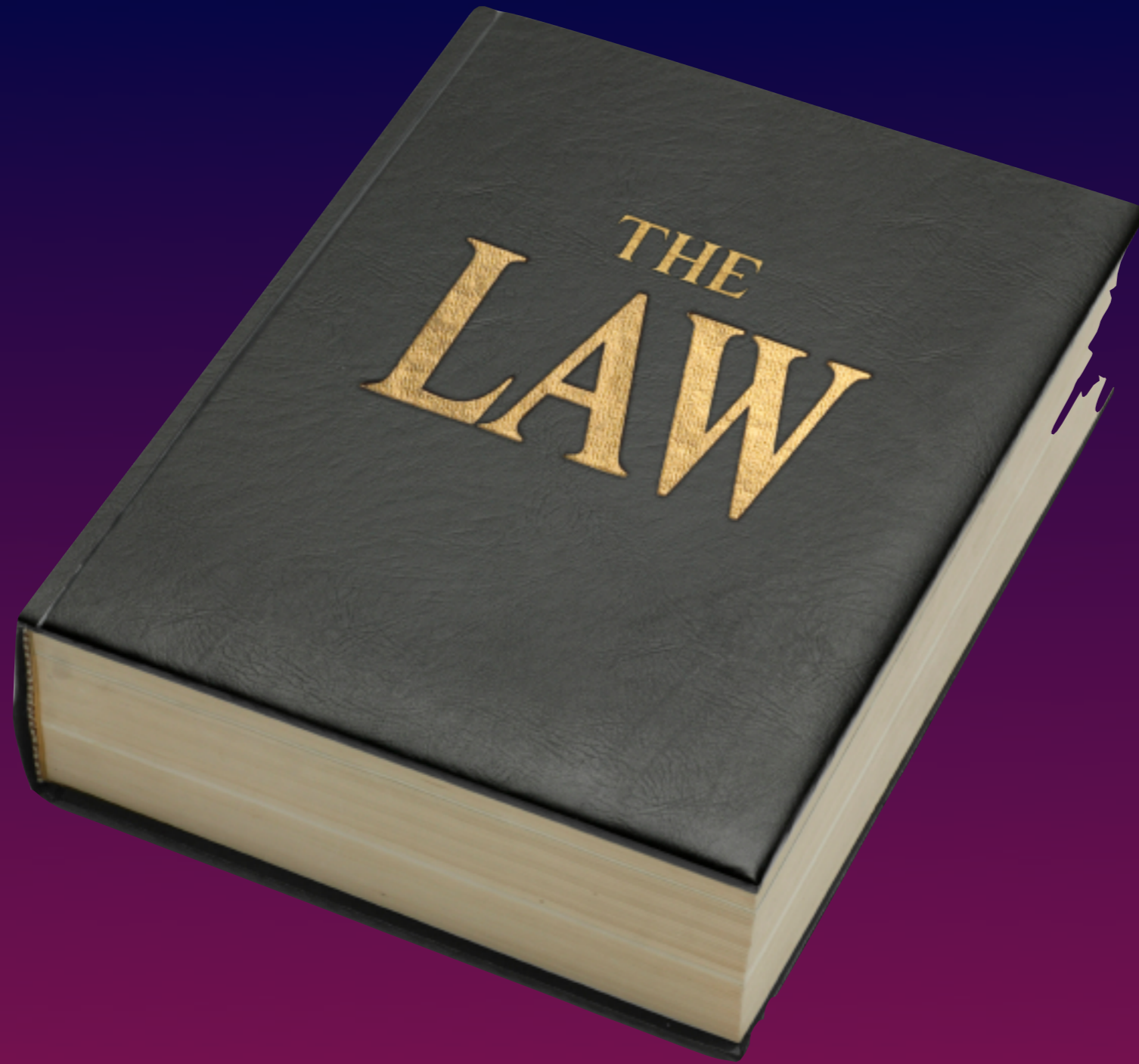
draw your hand

c'mon

Portrait of Hesire, Egyptian,
~2770 B.C. a wooden door

Fowling Scene, Egyptian, ~1450 B.C. limestone

Geese, Egyptian, ~2500 B.C.

ecclesiastical rules

unchanged

for a thousand years

influential

for all that time

"There is a land called Crete, in the middle of the wine-dark sea, beautiful and fertile, surrounded by water; and in it there are many people, countless, and in ninety cities...and among them is Knossos, the great city, where Minos was king...

Odyssey

Sumerian
3500 BC – 2500 BC

Mycenaean
3000 BC – 1100 BC

Egyptian
2800 BC – 60 AD

Minoan
2800 BC – 1400 BC

Assyrian–Babylonian
2700 BC – 800 BC

Greek Dark Ages
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"Classical" Greece
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1776 AD – 2006 A

3500 BC   3000 BC   2500 BC   2000 BC   1500 BC   1000 BC   500 BC   1 AD   500 AD   1000 AD   1500 AD   2000 AD

Minoa

Minoa

an astonishing people

the first sophisticated European culture

Knossos

a written language

"Linear A"

"Linear B"

syllabic

Linear B

Phoencian

Linear B decoded in 1953...an ancient form of Greek.

poof.

Sumerian
3500 BC – 2500 BC

Mycenaean
3000 BC – 1100 BC

Egyptian
2800 BC – 60 AD

Minoan
2800 BC – 1400 BC

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2700 BC – 800 BC

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1776 AD – 2006 A

3500 BC 3000 BC 2500 BC 2000 BC 1500 BC 1000 BC 500 BC 1 AD 500 AD 1000 AD 1500 AD 2000 AD
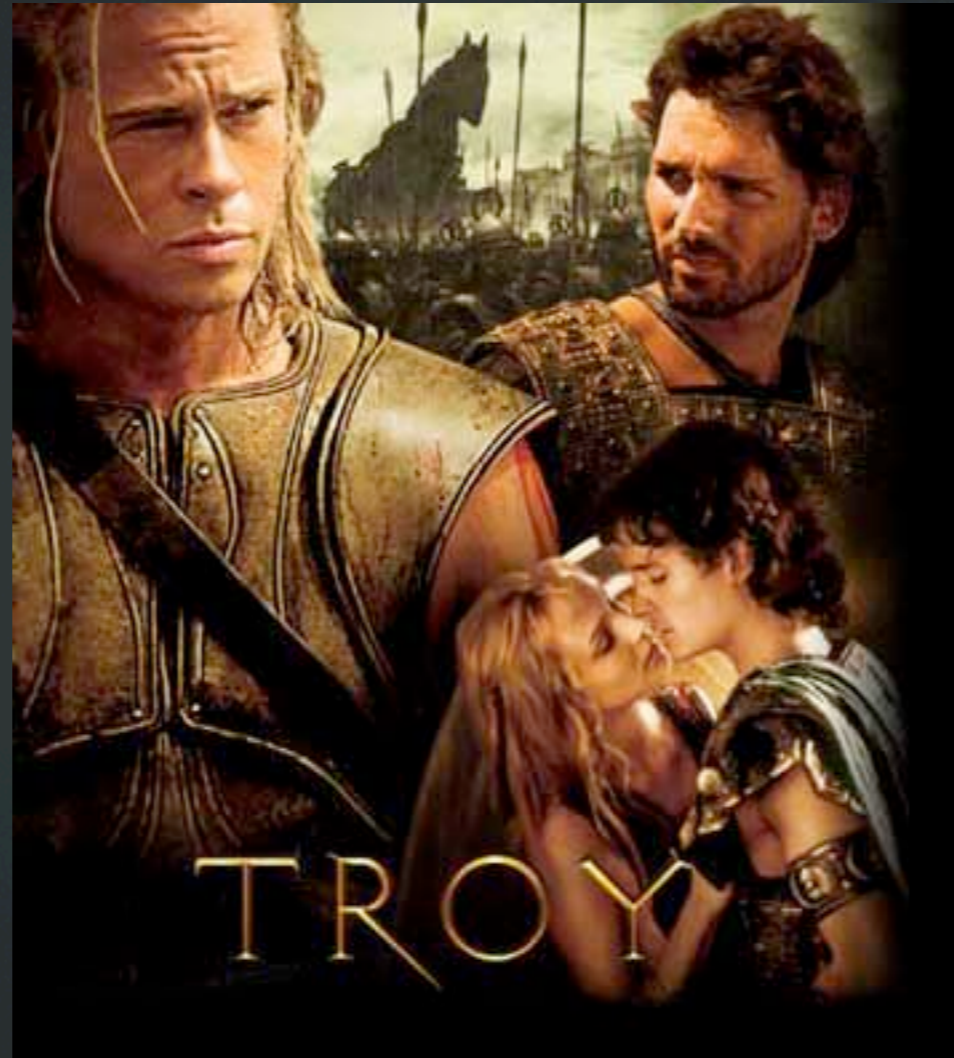
Mycenaeans

severe bunch

© 2000 IRC
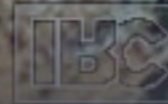
Minoan

Mycenaean

Homer's folks

the pilliage of Troy ~10 years, 1250 BC

(contemporary with Moses & Ramses II)

Dorians invaded in 1100 BC

lights out

from ~1100-800 BC

a "Greek Dark Ages"

Sumerian
3500 BC – 2500 BC

Mycenaean
3000 BC – 1100 BC

Egyptian
2800 BC – 60 AD

Minoan
2800 BC – 1400 BC

Assyrian–Babylonian
2700 BC – 800 BC

Greek Dark Ages
1200 BC – 800 BC

"Classical" Greece
600 BC – 200 BC

Greek Action
400 BC

us
1776 AD – 2006 A

3500 BC   3000 BC   2500 BC   2000 BC   1500 BC   1000 BC   500 BC   1 AD   500 AD   1000 AD   1500 AD   2000 AD

eventually

a mixed culture emerged

expansion and migration

true to Minoan roots: a sea-faring people

a unique political federation of City States

early Greek art

three phases

Geometric Period: 1000 - 776BC

Orientalizing Period: 776 - 600BC

Archaic Period: 600 - 480BC

upon awakening: aeiou

Mourning of the Dead,
Greek, ~750 B.C.

by ~600 BC…they had spread out

the Aegean was their backyard

Olympic Games, Iliad/Odyssey, Persia on the rise

"Classical" Greece
600 BC – 200 BC

Pythagoras
575 BC – 500 BC

Anaximenes
570 BC – 525 BC

Heraclitus
544 BC – 480 BC

Parmenides
514 BC – 450 BC

Persian Wars
499 BC – 479 BC

Pericles
495 BC – 430 BC

Herodotus
484 BC – 424 BC

Socrates
469 BC – 399 BC

Democritus
455 BC – 370 BC

Peloponnesian War
431 BC – 404 BC

Plato
427 BC – 348 BC

Corinthian War
395 BC – 387 BC

Aristotle
384 BC – 322 BC

Alexander
366 BC – 323 BC

Thales
624 BC – 546 BC

Anaximander
610 BC – 545 BC

Euclid
365 BC – 280 BC

Archimedes
287 BC – 212 BC

Hipparchus
190 BC – 120 BC

Wars with Rome
168 BC – 148 BC

| 650 BC | 600 BC | 550 BC | 500 BC | 450 BC | 400 BC | 350 BC | 300 BC | 250 BC | 200 BC | 150 BC | 100 BC | 50 BC | 1 AD | 50 AD |

600's BC:

something happened

Kouros, Greek, ~6th century B.C.

Polymedes of Argos, Greek, ~615-590 B.C.

they began to practice

unsafe art

" I feel prompted to put forward the ... hypothesis: when classical sculptors and painters discovered the character of Greek narration, [then] they set up a chain reaction which transformed the methods of representing the human body–and indeed more than that.

Gombrich ...he goes on...

"For what is the character of Greek narration as we know it from Homer? Briefly, it is concerned not only with the "what" but also with the "how" of mythical events.

Gombrich

yup. how.

~600 BC the beginning of us.

our scientific parents:

"presocratics"

Ionians (Milesians)

Pythagoreans (from Italy)

Eleatics (Elea, IT)

Pluralists (IT and Asia Minor)

let me make a point:

nobody works in isolation in science

The last 3 pages of a couple of hundred from our experiment at Fermilab in Illinois

109 references.

Therefore, the only correlation terms are those between the background (B) and the acceptance (A) and between the background (B) and the integrated luminosity ($\mathcal{L}$). The corresponding uncertainties are given by the equations

$$\delta_{BA}^2 = \sum_\mu (\delta_{BA})_\mu^2 \qquad (E20)$$

and

$$\delta_{B\mathcal{L}}^2 = \sum_\mu (\delta_{B\mathcal{L}})_\mu^2. \qquad (E21)$$

The error corresponding to a given uncertainty (μ) is calculated from first principles according to the equations

$$(\delta_{BA})_\mu^2 = \langle BA \rangle_\mu - \langle B \rangle_\mu \langle A \rangle_\mu \qquad (E22)$$

and

$$(\delta_{B\mathcal{L}})_\mu^2 = \langle B\mathcal{L} \rangle_\mu - \langle B \rangle_\mu \langle \mathcal{L} \rangle_\mu, \qquad (E23)$$

where the symbol $\langle ... \rangle$ represents the average of the enclosed quantities when they are varied according to the uncertainties μ. The correlation coefficients are given by

$$C_{BA} = \frac{\delta_{BA}^2}{\delta_B \delta_A} \quad \text{and} \quad C_{B\mathcal{L}} = \frac{\delta_{B\mathcal{L}}^2}{\delta_B \delta_{\mathcal{L}}}. \qquad (E24)$$

In the linear/quadratic approximation, these correlation coefficients simplify to

$$C_{BA} = \frac{1}{\delta_B \delta_A} \sum_\mu C_{BA\mu} (\delta_B)_\mu (\delta_A)_\mu, \qquad (E25)$$

$$= \frac{1}{\delta_B \delta_A} \sum_{\mu = \text{sys}} (\delta_B)_\mu (\delta_A)_\mu, \qquad (E26)$$

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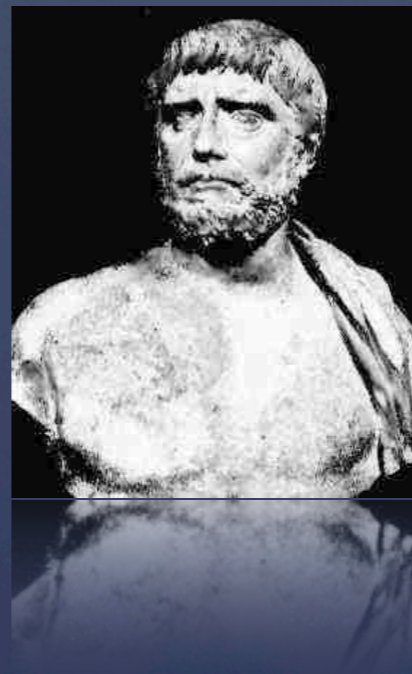
this just floors me:

Ionian's Bibliography:

nobody ever thought like them before
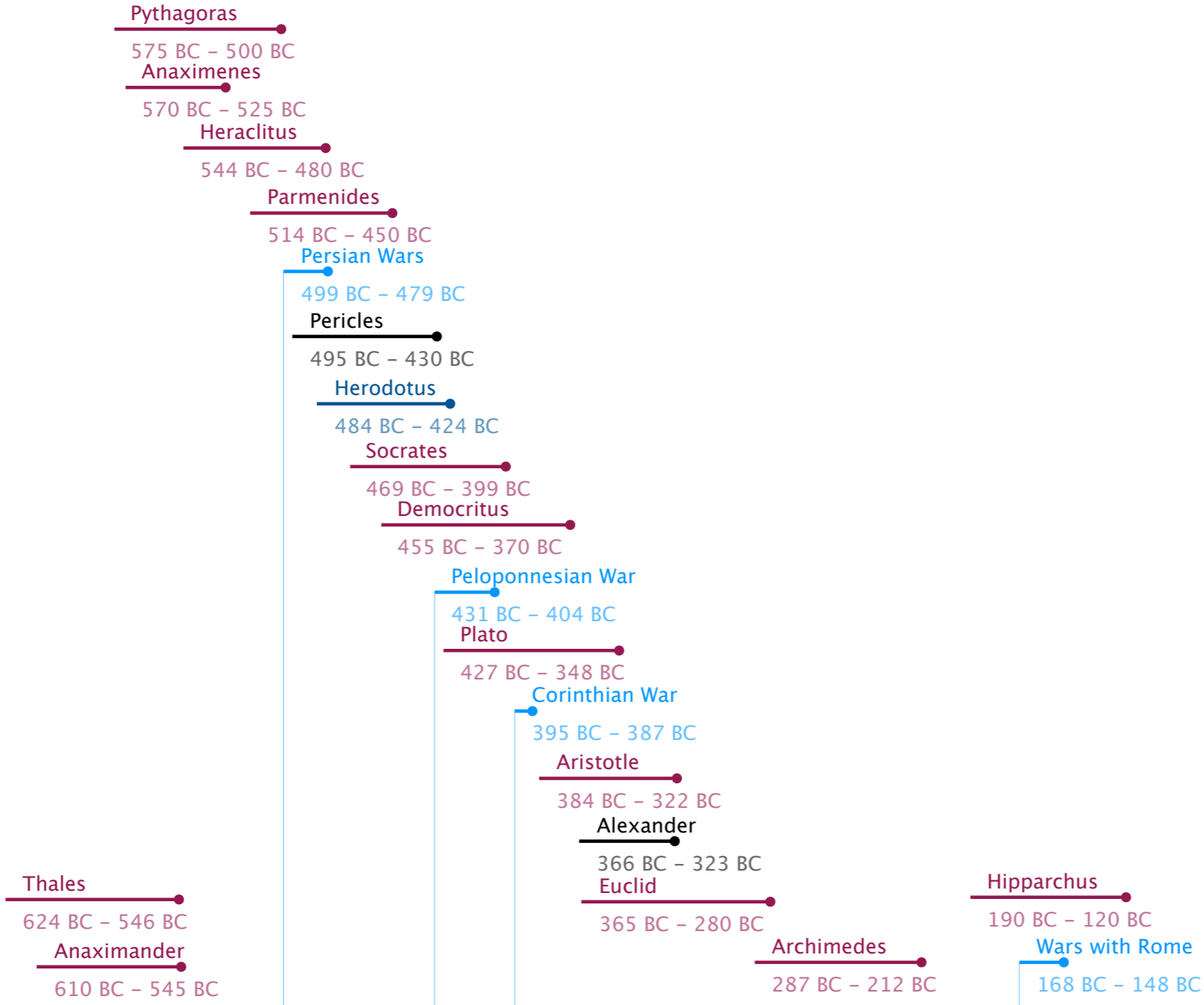
now everyone thinks like them

the big cheese:

Thales of Miletus (ca 624-547BC)

"Classical" Greece
600 BC – 200 BC

Pythagoras
575 BC – 500 BC

Anaximenes
570 BC – 525 BC

Heraclitus
544 BC – 480 BC

Parmenides
514 BC – 450 BC

Persian Wars
499 BC – 479 BC

Pericles
495 BC – 430 BC

Herodotus
484 BC – 424 BC

Socrates
469 BC – 399 BC

Democritus
455 BC – 370 BC

Peloponnesian War
431 BC – 404 BC

Plato
427 BC – 348 BC

Corinthian War
395 BC – 387 BC

Aristotle
384 BC – 322 BC

Alexander
366 BC – 323 BC

Thales
624 BC – 546 BC

Anaximander
610 BC – 545 BC

Euclid
365 BC – 280 BC

Archimedes
287 BC – 212 BC

Hipparchus
190 BC – 120 BC

Wars with Rome
168 BC – 148 BC

650 BC | 600 BC | 550 BC | 500 BC | 450 BC | 400 BC | 350 BC | 300 BC | 250 BC | 200 BC | 150 BC | 100 BC | 50 BC | 1 AD | 50 AD

May 28, 585 B.C

typical academic?

everything around you

is different

yet, he asked:

what is the fundamental common structure of the Universe

water.

not crazy

think about it

what's most noticeable about Life?

moisture and water are a necessity

so, pretty good guess, right?

this is new thinking

for Thales

the universe is regularly structured

and it's knowable

students and followers

others came after Thales

but,

the "research problem" was the same

the details were different

Thales' "A" students:

Anaximander & Anaximenes

substance

Anaximander: "Aperion"

tension and balance among elements: "justice"

substance

Anaximenes: air

air->fire->condensation->water->earth: processes, lawlike

this is scientific

at least in procedure:

took Thales' assertions

and worked on them

the pied piper
Pythagoras of Samos (ca 582-497BC)
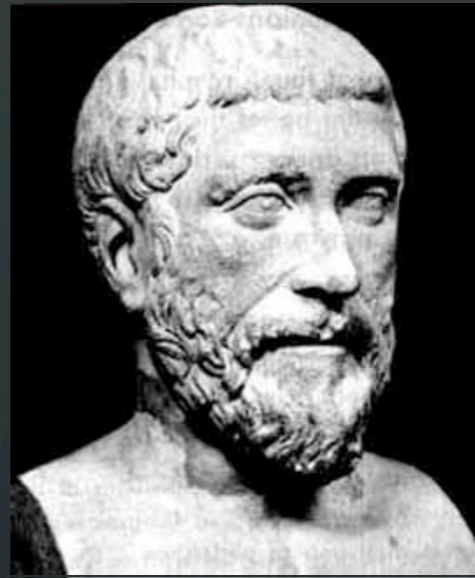
abstract mathematics

proofs in number theory...

but not what you're thinking!

"

All things have form, all things are form; and all forms can be defined by numbers.

Pythagoras

music

4 strings of a lyre

tuned to pleasurable tones

lengths:

the octave   1:2

the fourth   2:3

the fifth   3:4
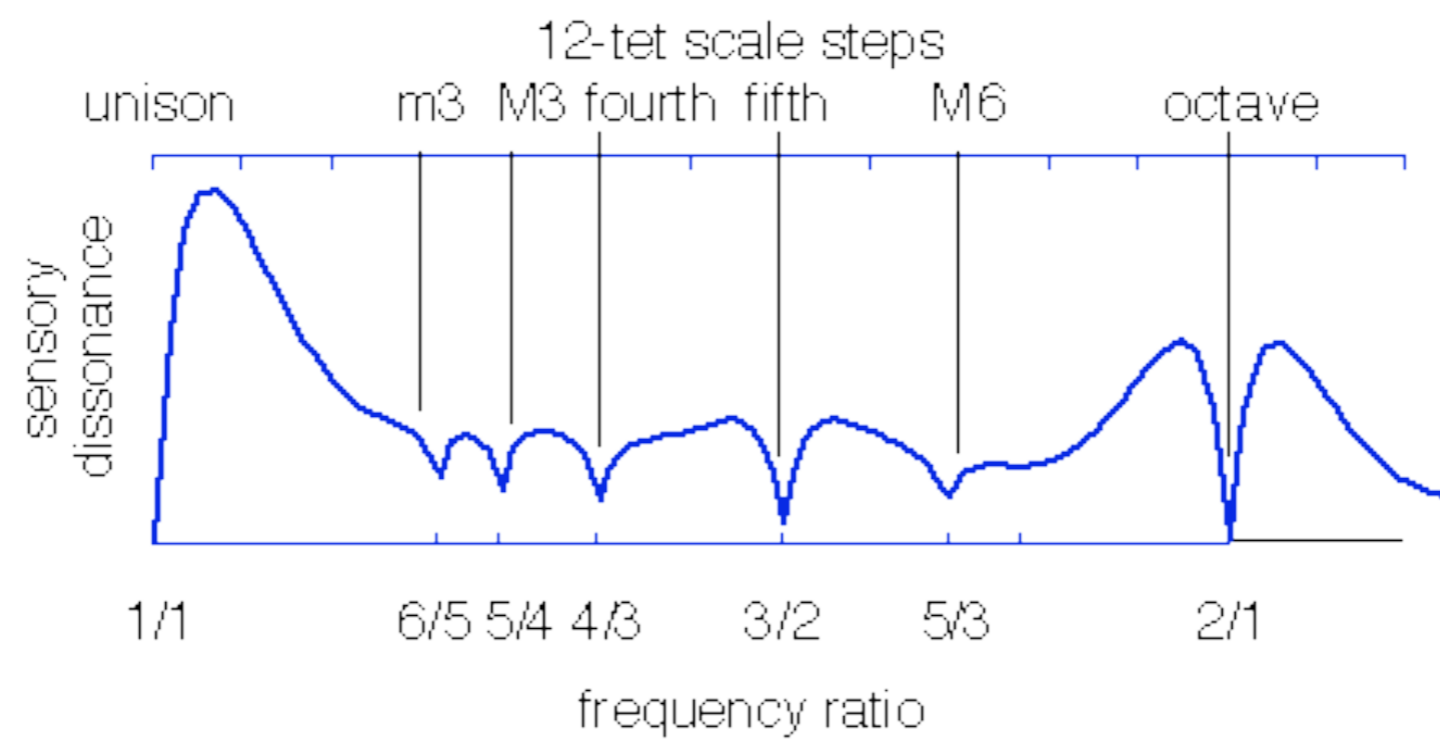
Number

a fundamental entity of Nature

integers: sacred...1,2,3,4

harmony: tones themselves

orderliness in Nature

= orderliness in Number

world as number

essential part of our heritage

And, nope; it's not necessarily his theorem:

Egyptians knew: $3^2 + 4^2 = 5^2$

Babylonian cuneiform: $119^2 + 120^2 = 169^2$

$3367^2 + 3456^2 = 4825^2$

Maybe the idea of mathematical proof from him.

They were the first to represent geometrical figures with numbers

square numbers, rectangular numbers, triangular numbers

square numbers
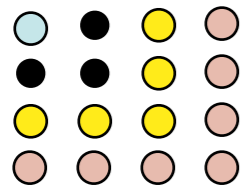
$$1 + 3 = 2^2$$

$$1 + 3 + 5 = 3^2$$

$$1 + 3 + 5 + 7 = 4^2$$

But look:

and rectangular numbers
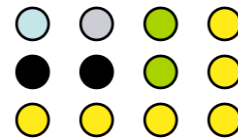
$$2 + 4 = 2 \times 3$$

$$2 + 4 + 6 = 3 \times 4$$

divide by 2:

$$1 + 2 + 3 + \ldots N = N(N + 1)/2$$

in particular, for N = 4…this was a magical number: the *tetraktys*

10

!
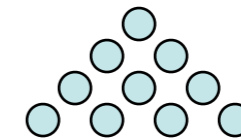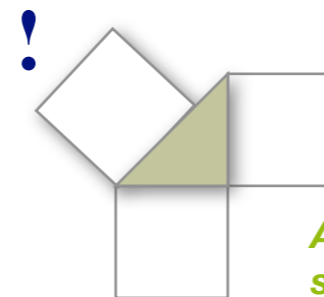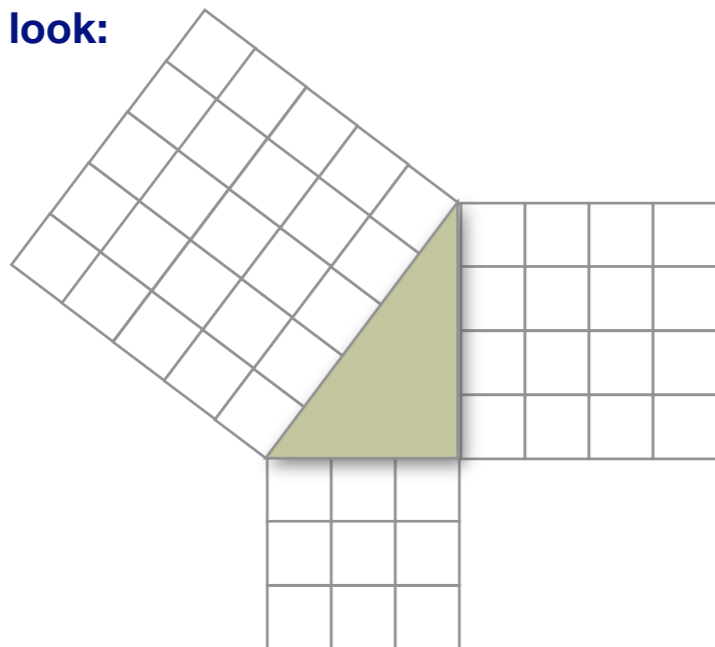
As the story goes, a shocking development

it's a secret

$$1^2 + 1^2 = (\sqrt{2})^2$$

irrational
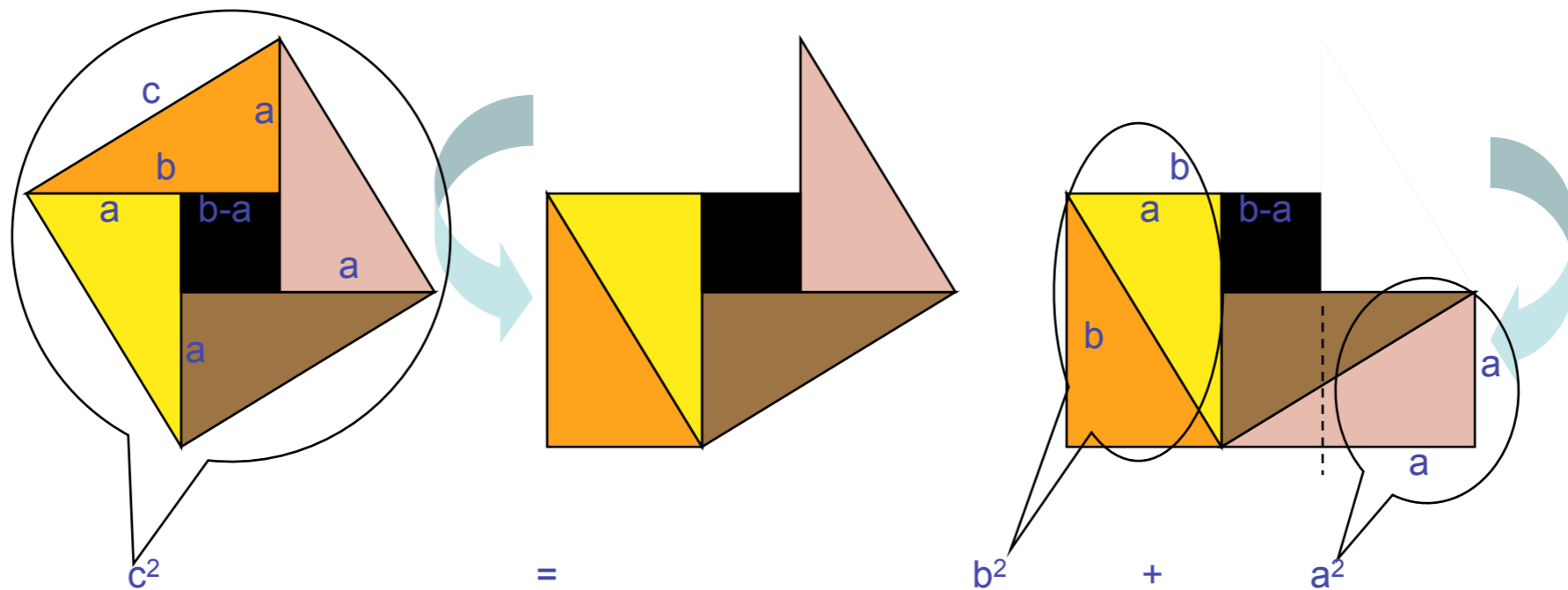
Pythagoreanism

directly influential on:

Plato, Kepler

modern day theoretical physics

MSU = 150 years old

Pythagoras' school: 300 years after his death

a distinction

Milesians: fundamental structure:

substance or matter

Pythagoreans: fundamental structure:

mathematical form

I'm easily amused

in about a century:

1. fundamental Substance and Process

2. recognition of permanence + change

3. beginnings of mathematical analysis

4. myth is gone as an explanation for natural phenomena

Greek

invention of art.

a creative act

preGreek: liturgical

symbolism

especially, Egyptian

can't change

autocratic

death

Greek?

people and now.

Greek gods?

frat boys

connected with humans

mingled in every sense

They didn't know that Clapton is God.

Greek painting...

survives largely on vases

and their evolution can be followed

contemporaneous with Pythagoras

two kinds: black figure and red figure

Neck Amphora, *Exekias*, Greek, ca 540 B.C.
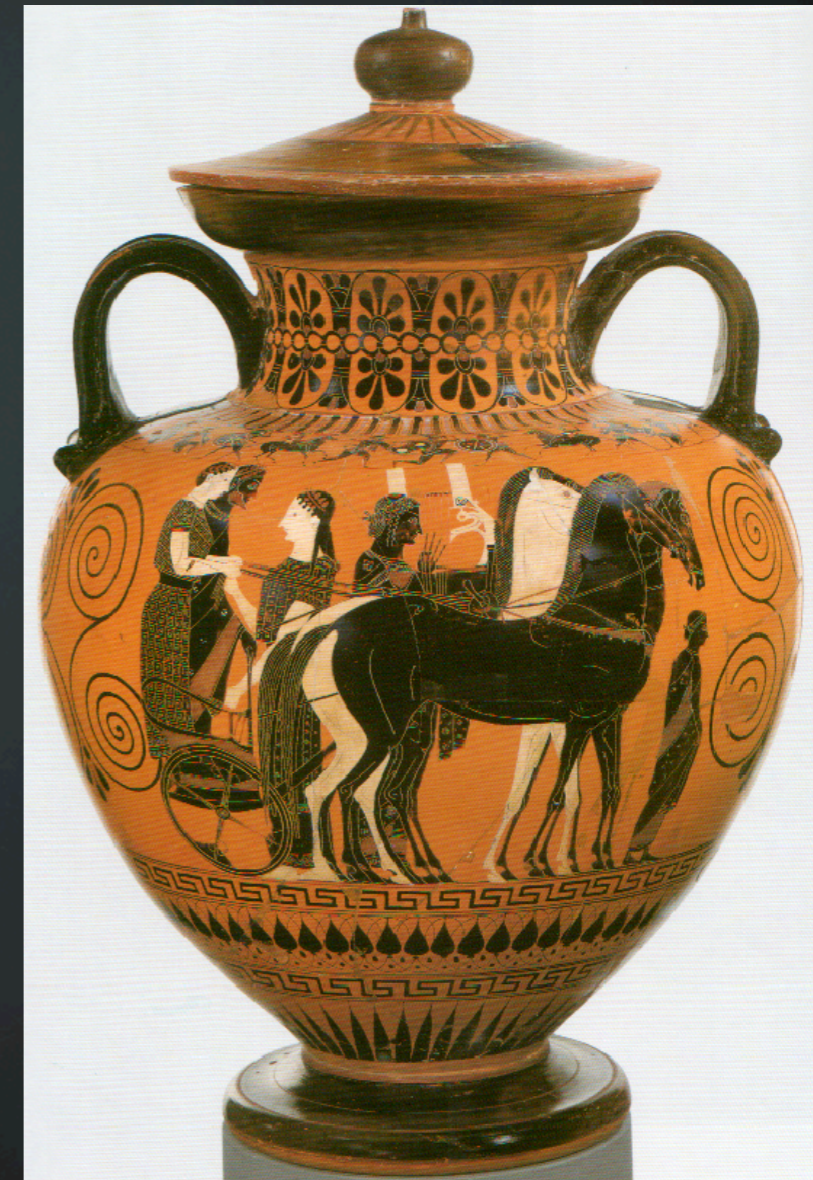
Calyx Krater, *Euphronios*, Greek, ca 515 B.C.

painting like you see it
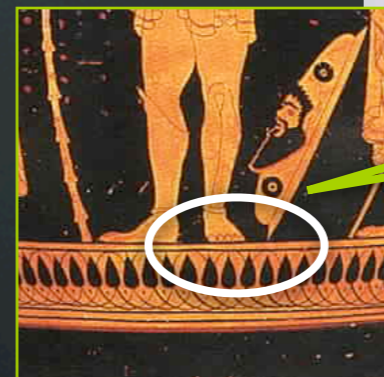
510BC Foreshortening

Euthymedes, 510 BC

a spark of divinity

in humans

Greek art seems to have set out to find it

the perfection in the human form

Kritios

is and isn't a natural rendering

interpretation

of a universal
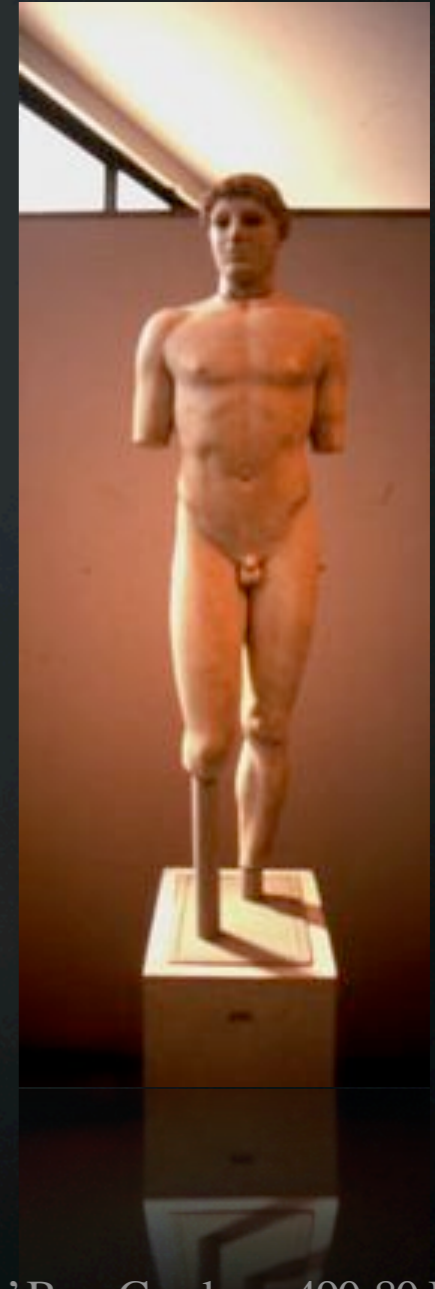
Kritos' Boy, Greek, ca 490-80 B.C.

four defining moments

1. government...occasionally democratic

"Classical" Greece
600 BC – 200 BC

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514 BC – 450 BC

Persian Wars
499 BC – 479 BC

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Wars with Rome
168 BC – 148 BC

{ **2. Persian wars**...including destruction of Athens

{ **3. Pericles**...golden age of Athens
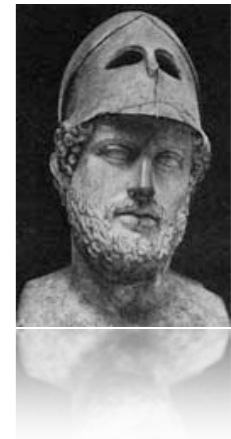
{ **3. Peloponnesian war**

650 BC   600 BC   550 BC   500 BC   450 BC   400 BC   350 BC   300 BC   250 BC   200 BC   150 BC   100 BC   50 BC   1 AD   50 AD

http://ccwf.cc.utexas.edu/~kallet/greece/pictures.html

3. Peloponnesian war

Greek against Greek

Orientalizing era | Archaic Period | Classical era | Hellenistic era

Persian Wars | Peloponnesian War | Macedonian Wars

-600 | -500 | -400 | -300 | -200

Pythagoras | Socrates | Aristotle | Archimedes

Thales | Parmenides | Plato

Anaximander | Heraclitus | Democritos | Euclid

Herodotus | Alexander

Anaxagoras | Philip of Macedon

Perikles
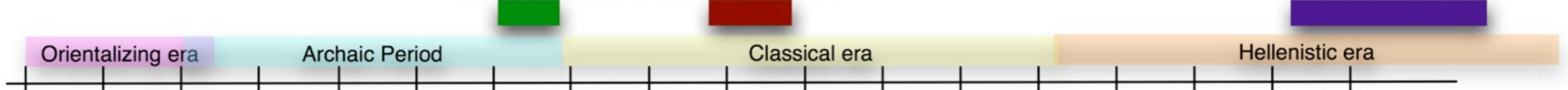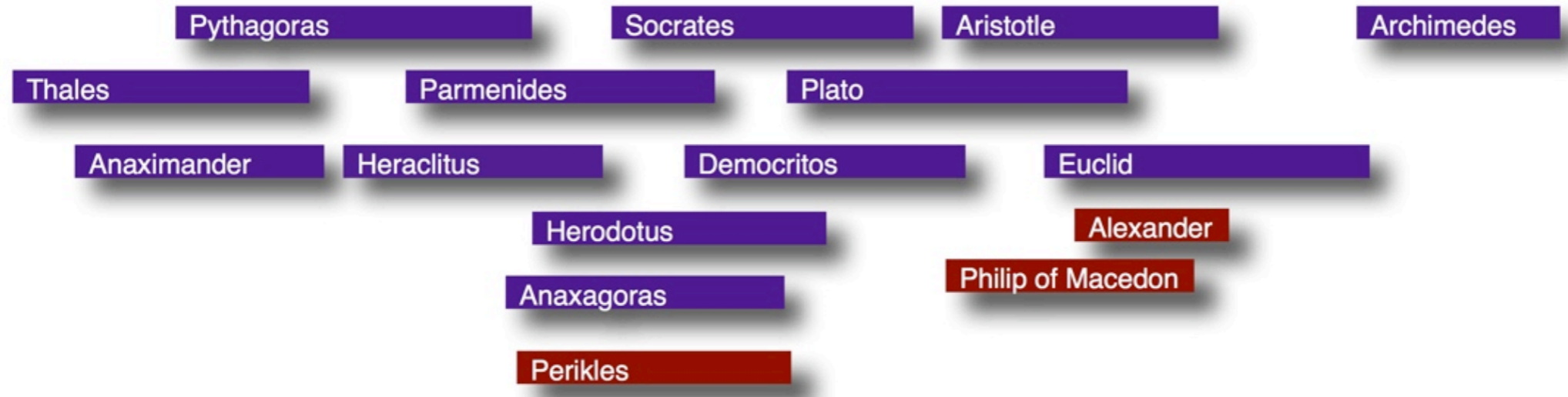
explosion of creativity

mid-5th C BC

civics, medicine, literature, drama, sculpture, architecture, philosophy

balance

"Nothing in excess."

on the Delphi shrine

notsomuch, politically

artistic discoveries

another construction...

By this time, reliance on Proportion was explicit...and known to be psychologically pleasing

the dodecahedron was special (universe) even in Pythagoras' time. Take a pentagon face...
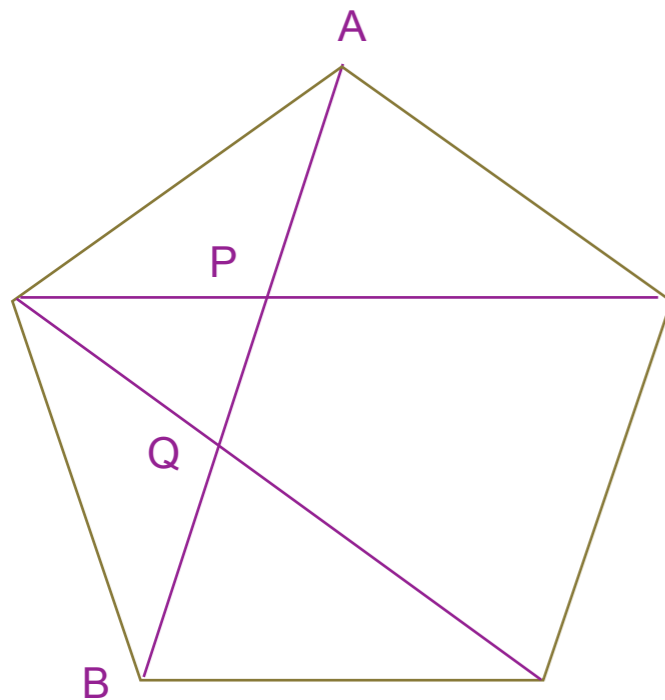
"divine proportion" (Kepler):

$$\frac{AP}{PQ} = \frac{AQ}{AP}$$

$$= (1 + \sqrt{5})/2$$
$$= 1.61803...$$
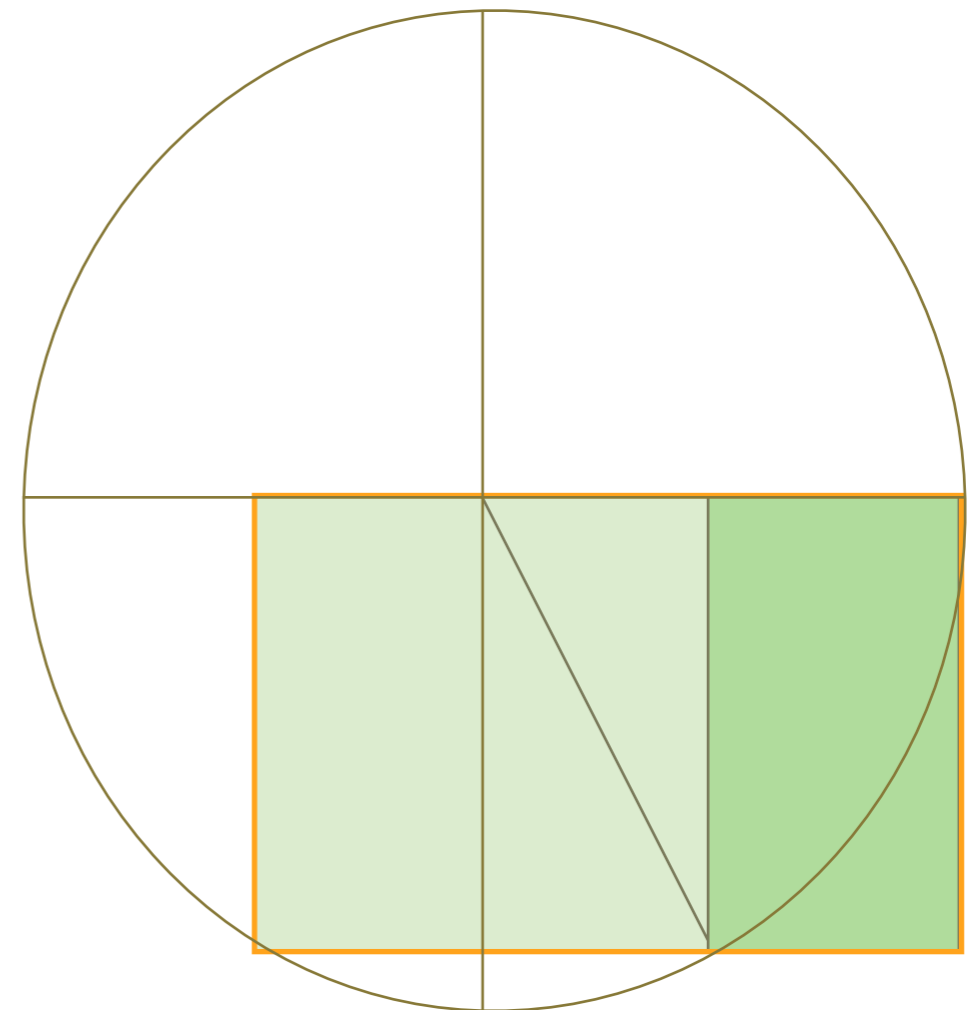
"Golden Rectangle"...an especially pleasing (tested!) shape

Temple of Poseidon in Paestrum, Italy ~470BC

Segesta Doric temple in Sicily ~450BC
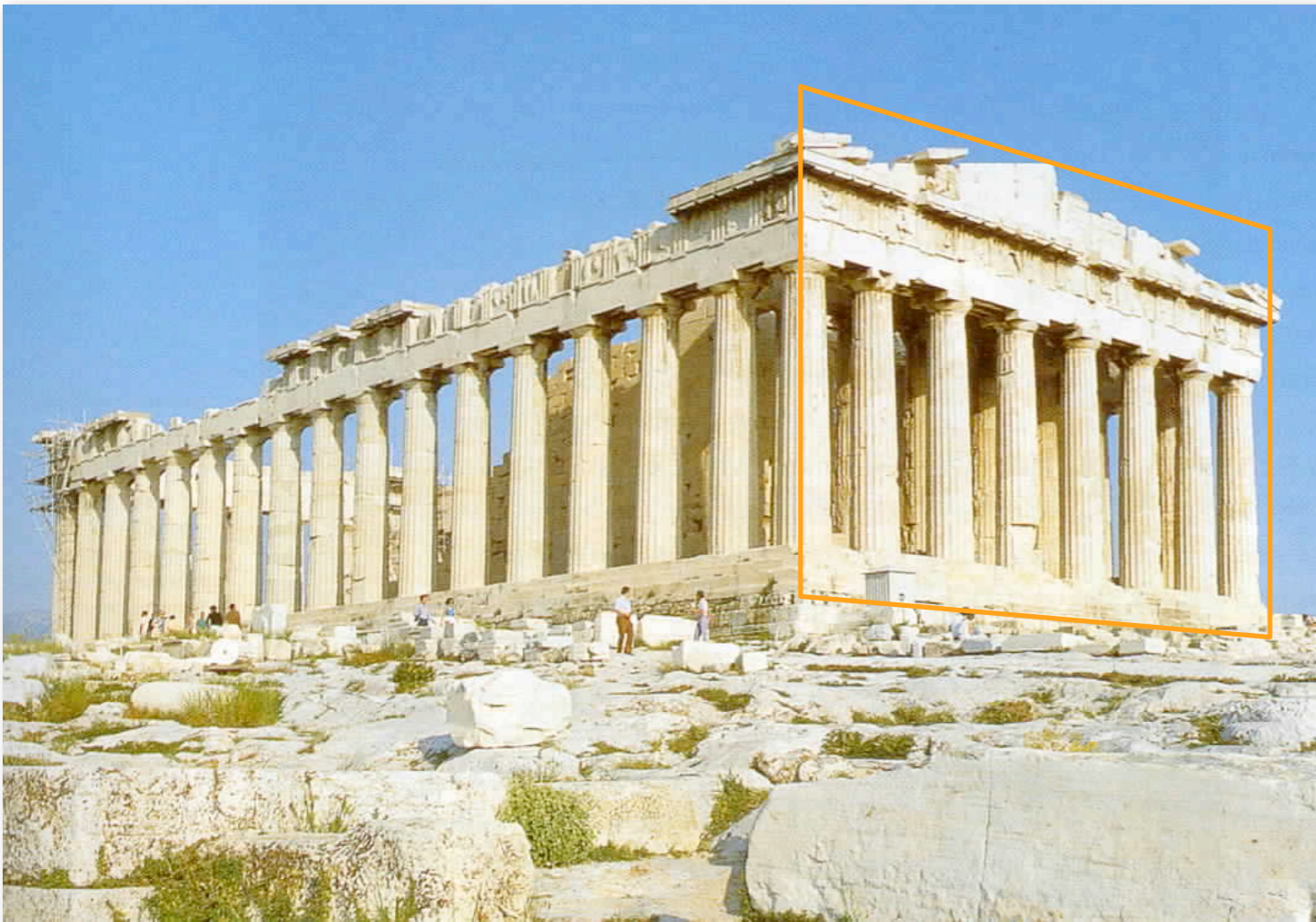
The Parthenon was constructed after 480 B.C. (while Socrates was a child) by Perikles

Look at the columns - the taper a the top and the almost **muscular** structure. Perfectly suited to hold the roof of this perfectly proportioned building.

There are no straight lines!

a part of the reason this building is so pleasing?

the Golden Rectangle.

Anavyssos Kouros , Greek, ca 480 B.C.

Kritos' Boy, Greek, ca 490-80 B.C.

Charioteer, ca 475 B.C.
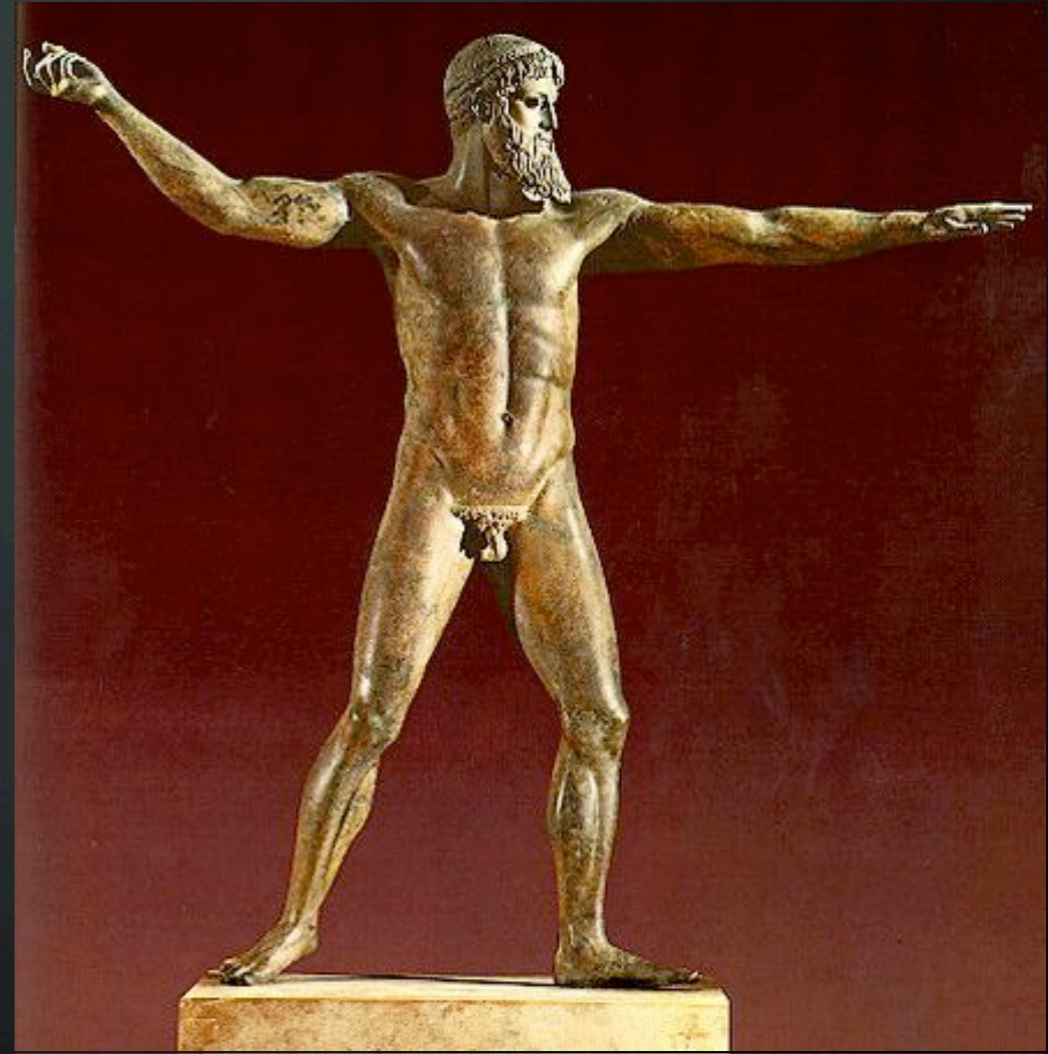
The Poseidon of Artemision, ca 460 B.C.

style

Discobolos, *Myron*, ca 450 B.C.

model, Athena Parthenos, *Pheidias*, ca 5th B.C.

The Master

Polycleitus

"wrote the book" kanon (or canon)

Architect
theater at Epidaurus

Theater at Epidaurus, *Polycleitus*, ca 440 B.C.

still used today. Upper part added 2nd B.C.

head, 1/8 of height

crown-eyebrows, 3/8;
eyebrow-chin, 5/8

Doryphorus (spear bearer),
Polycleitus, ca 440 B.C.

essential tension

change vs permanence

think about it

Both Milesians & Pythagoreans

stressed permanence

and tried to explain change.

"1" permanent thing?

How...

do you get <u>stuff</u>??

ideas of substances evolving, changing, transforming

the Riddler

Heraclitus (ca 540-480 BC)

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aphorisms:

"We step and do not step in the same river twice."

"Praying to a statue is like chatting with your house."

"Nature likes to hide."

"We are and we are not."

"That which is in opposition is in concert...and from that and from things that differ comes the most beautiful harmony.

Heraclitus

doctrine

"binary opposites"

the river

is and isn't the same

important for H:

Process

change is the only constant
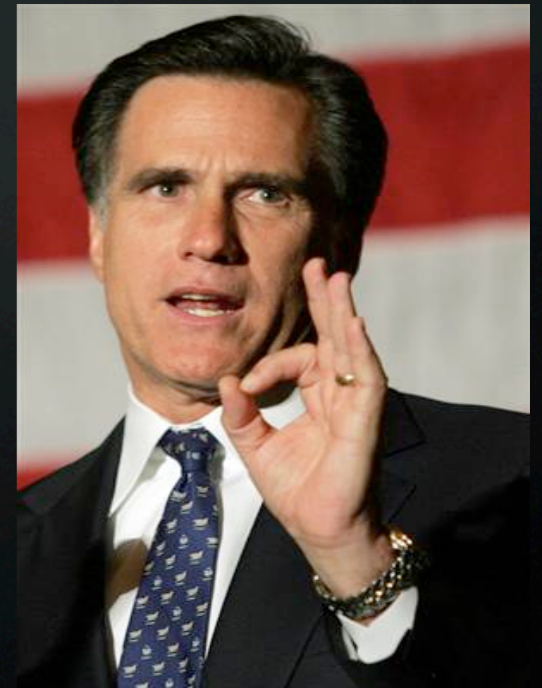
balance

birth of fire -> death of air,

d of air -> b of water,

d of water -> earth -> fire -> etc

everything is in balance through tension between opposites

Process

very modern idea

note:

change is a threat

to those trying to account for unity

but it's hard to argue away "change"

the antidote:

Parmenides of Elea

the first Eleatic

all change is....

illusion

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the first reasoning from logic

before?

Pronouncements

one poem fragment

"Only one story of a path

remains, that it is.

... being without origin...is also indestructible, whole, of
one kind, unwavering and complete.

... ⬅ the first logical
argument

So development is extinguished and destruction silenced."
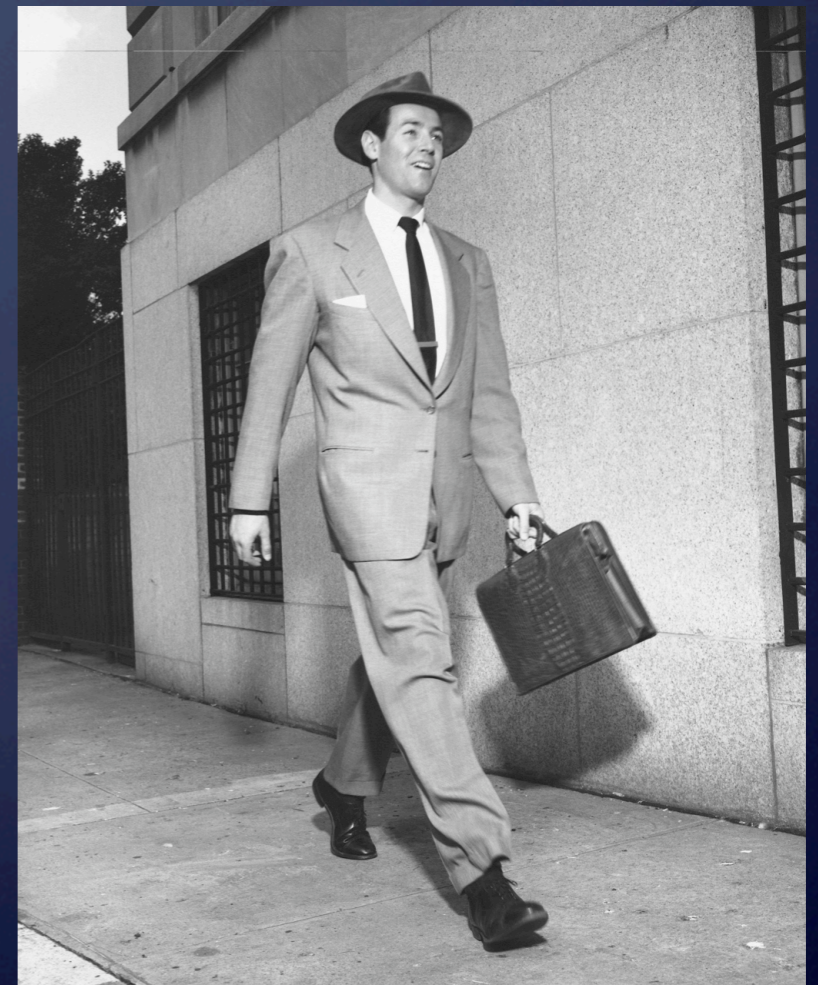
he worried about

two things.

nothing → stuff?

one thing → another?

" **What is, is. What is not, is not.**

Parmenides

"Nothing" cannot exist:

That which **is** cannot have come from anything, since it would have previously been in a state of **Not**.

so, creation is impossible

Creation of something that IS implies creation from something *different from* what IS

Something different from what IS

is something that… IS-NOT!

But, what is NOT cannot be

Therefore, Creation cannot be

1st logical proof

accept the premises

"forced" to accept the conclusions

"To Be"
vs
"Becoming"

"becoming" means that

motion is impossible

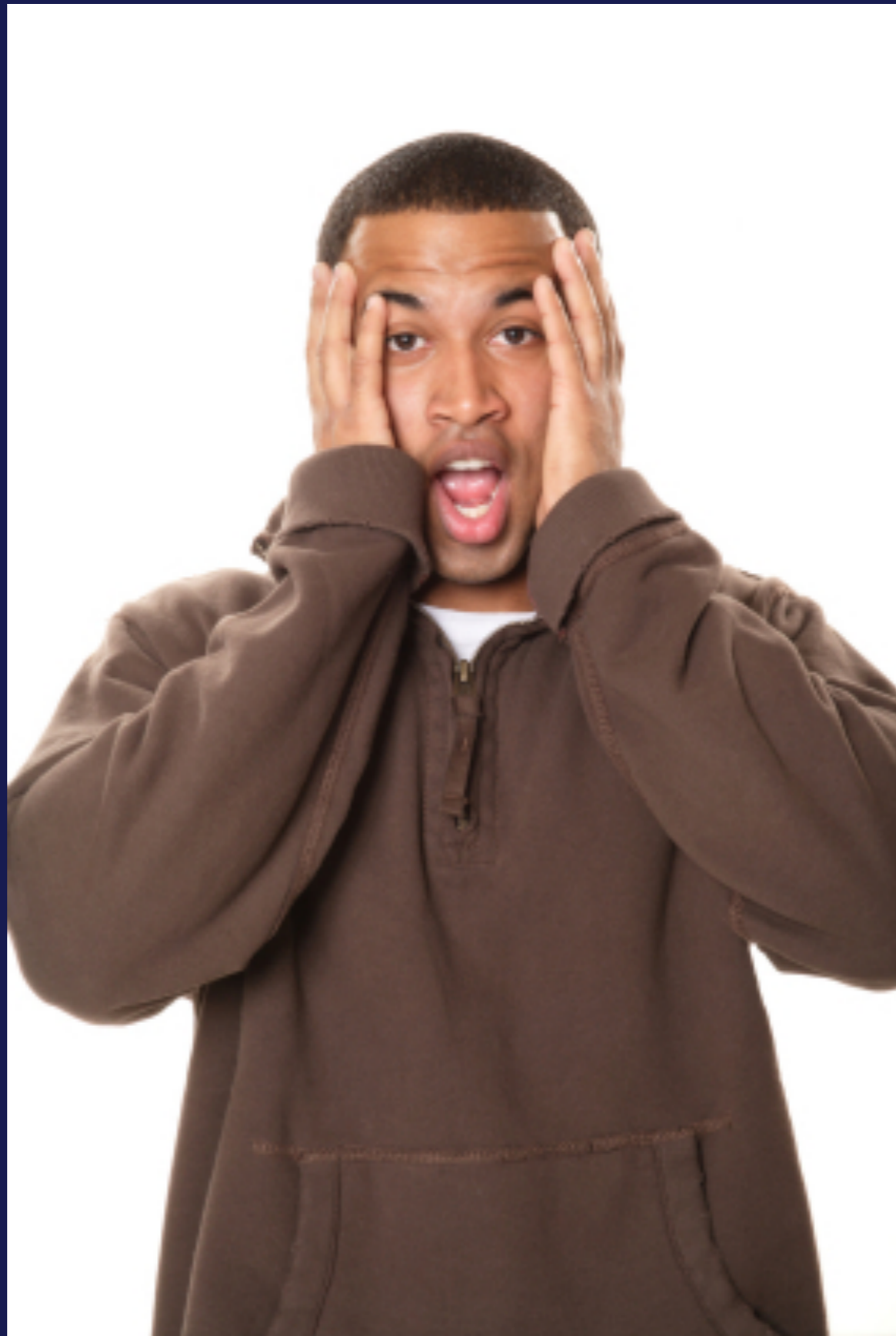requiring somewhere for something to move *to*

and a "void" can't be!

Zeno

was his personal posse

"Thou canst not know what is not – that is impossible – nor utter it: for it is the same thing that can be thought and that can be.

Parmenides

you cannot think

of what does not exist

bbbut

you sputter...

change and motion is everywhere!

change?

because our senses are fallible

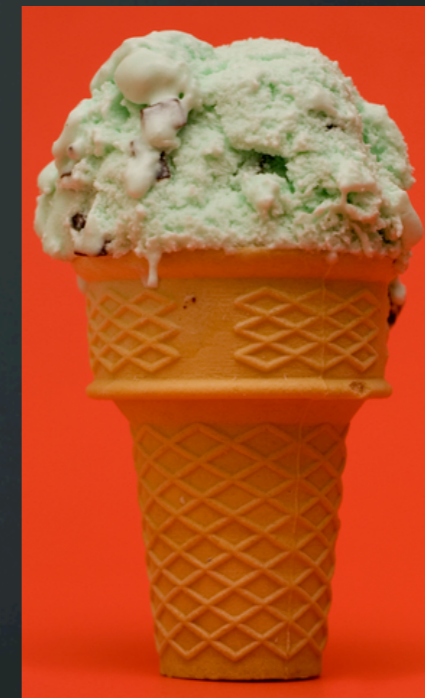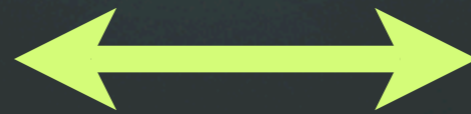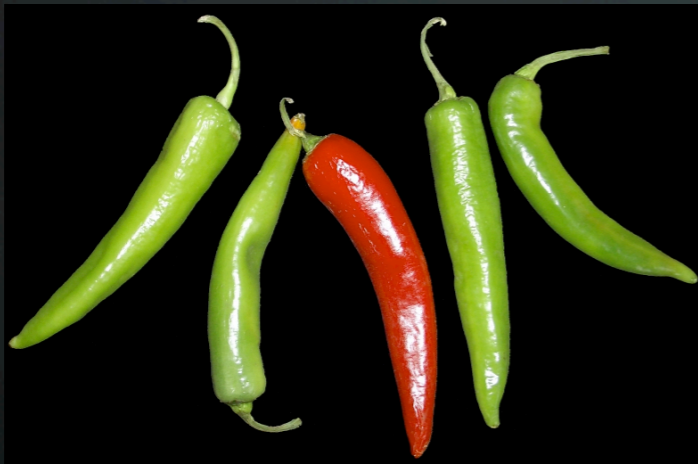Reality: (true, permanent, knowable through rational thought)

Opinion: (senses...that's where change lives)

importance

impossible to overestimate:

invented logical argument

Heraclitus

hot and cold

Parmenides

cold does not exist

just not-hot

he's wrong

in at least one way:

can we think about what *might* exist?

essential to science

the permanence idea

has legs

Conservation "laws"

physics equivalent of Parmenides