Plato's Timaeus:

Some Resonances in Modern Physics

and Cosmology

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A few specific anticipations of modern ideas, e.g.

37c–38b “block” universe.

52b Kantian notion of space.

53d–57c the “triangles”: a quasi-molecular theory of matter?

67b relation of frequency to perceived pitch

72 b–c autonomic nervous system (?)

but, generally, it is Plato’s questions rather than his answers that have modern resonances.

1. <u>27d–38b</u>
   isotropy and uniqueness of Universe, nature of time
2. <u>47c–52d</u>
   νοῦς (mind) vs. ἀνάγκη (necessity), idea of the ὑποδοχὴ (“receptacle”): sameness and difference, kinematics vs. dynamics, necessity vs. contingency
3. <u>part C</u>
   relation of the physical Universe to human existence and perceptions.

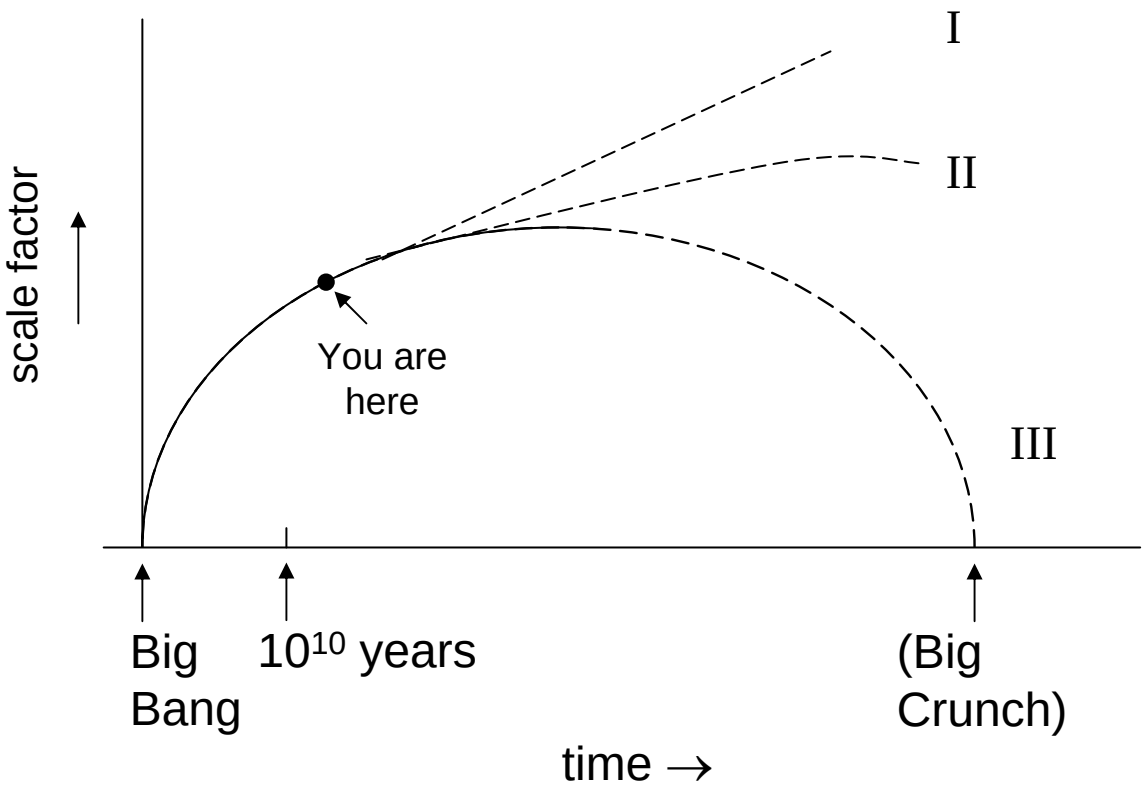
Timaeus 28b: “Has it (the Universe) always been? Was there no origin from which it came to be? Or did it come to be and take its start from some origin?”

Plato’s answer: “It has come to be.”

Modern answer:

- Pre-1929: Universe unchanging in time, eternal
- Post-1929: Universe expanding, and if we extrapolate laws of physics as we believe them today backwards in time, had a beginning (the “hot Big Bang”) (but, is isotropic and homogeneous in space)

The post-Hubble picture:



These possible futures for Universe, depending on (current) mass density:

I.	expand for ever	(“open” Universe)
II.	saturate	(“flat”)
III.	recontract to Big Crunch	(“closed”)

Some conceptual problems of the Big Bang cosmology:

(1) What was "before" the Big Bang?

a) nothing

b) a previous Universe, causally connected to ours

c) a previous Universe, causally disconnected from ours
("document-shredder" picture).

(2) Is the Universe in time, or does time derive its meaning from the Universe? (cf. Clarke-Leibniz controversy)
Timaeus 37c: "for before the heavens came to be, there were no days or nights, no months or years."
In modern terms: how exactly do we define time?

— Cs atomic standard: but no Cs atoms until first supernova

— H atom clock: but no hydrogen until ~300,000 years after Big Bang

— in terms of masses of "elementary" particles?

(3) Did the Big Bang really occur a finite time (~14 billion years ago)?
Rescale:

$t_{new} = t_o \ell n(t_{old} / t_o)$ (t_{old} measured from HBB)

t_o = (e.g.) time at which 50% of the hydrogen in the Universe recombined

then, $t_{new} = 0$ when $t_{old} = t_o$

when $t_{old} = t_{HBB}$, $t_{new} = \ell n 0 = -\infty$!

(4) Is the Universe unique: (Plato: yes) Some possible senses of "other Universes":

(a) in time

(b) in space

(c) in other ways, e.g. other dimensions (or "many-worlds" scenario)

Most but not all modern cosmologies: yes

(5) What is the status of "time", anyway?

(a) primitive concept, parallel with space (cf. Timaeus, 37a–38b: "block Universe" picture?)

(b) derivative, "emergent" from the relations of more primitive, timeless "events" (loop quantum gravity)

(6) Why the Big Bang? (Why the cosmos?)
For Plato, creation by the δημιουργὸς ("craftsmen")

in modern cosmology. ??? (quantum fluctuation? "just one of those things….")

(7) Why is the Universe so smooth?

Note: one modern concern absent in Plato is "arrow" of time (only a serious problem post-Newton)

II. νοῦς (mind), ἀνάγκη (necessity), ὑποδοχὴ (“receptacle”), Timaeus 47c–52d):

several distinctions implicit:

— necessity vs. contingency

— kinematics vs. dynamics

— general laws vs. particular initial conditions

(“being” vs. “becoming”) substrate vs. form

These distinctions make sense for particular parts of the Universe: do they make sense when applied to the Universe as a whole? (Smolin).

is the ὑποδοχὴ a <u>physical</u> entity (anal. “vacuum”), or rather an intellectual <u>scheme</u>?

if the latter, may correspond to general structure of Lagrangian quantum field theory and be the result of ἀνάγκη (“necessity”): the specific types of elementary particles actually realized, and their interactions, are contingent (the effect of νοῦς (“mind”), according to Plato).

Is this picture final? Current “Standard Model” involves 17 a priori undetermined (“contingent”) parameters. Are some or all of these fixed by “necessity”? (hope of underlying theory)

What is “natural”?

One line of thought: maybe all possible species of particle/interaction realized in some “other Universe”!

III. Part C: anthropocentricity

Is the Universe designed so as to support human life and consciousness?

Timaeus (41d–47c and part C, passive): yes!

18th century (post-Newtonian) Enlightment: no!

Modern physics/cosmology: ??

(a) Anthropic principle

underlying observation: physical conditions for genesis and evolution of human life extremely delicate

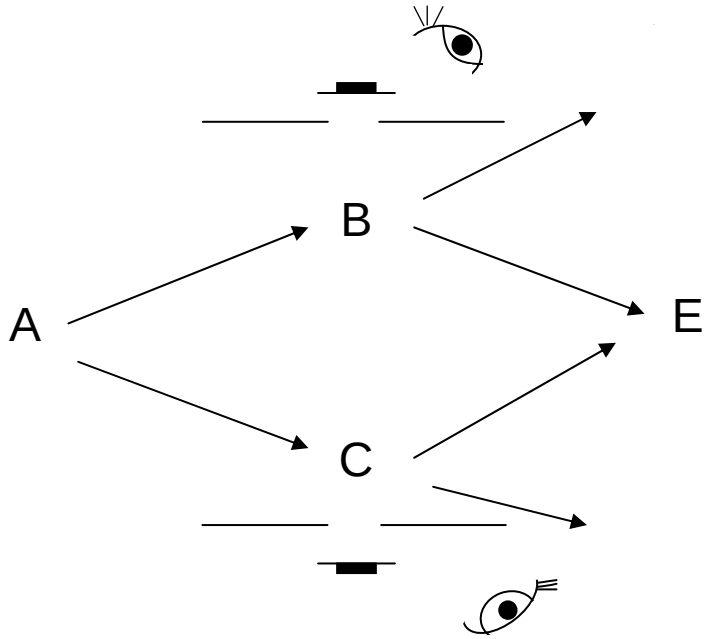
strongest form (quasi-teleological): the reason the fundamental constants have the values they do is to permit human life.

weakest form: simply a list of coincidences

medium form: many possible and perhaps actual different Universes (in time, space, "elsewhere" . . .): not an accident we live in this one!

“Anthropocentricity” in modern physics/cosmology (cont.)

(b) the quantum realization problem



If we “inspect,” each atom (etc.) chooses either alternative B or alternative C.

If we do not “inspect,” apparently neither alternative uniquely realized!

QM description by “amplitudes” A_B, A_c for B and C: when both A_B and A_c non-zero, and no inspection, neither B nor C uniquely realized.

But, sometimes QM, extrapolated, leads to descriptions of everyday world in which amplitudes for two different outcomes are non-zero! (ex: Schrödinger’s Cat).

So … is there any “realization” in the absence of observation? And observation by what/whom?

Was the state of the Universe definite before there were human beings around to inspect it?

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