Alternative cosmologies

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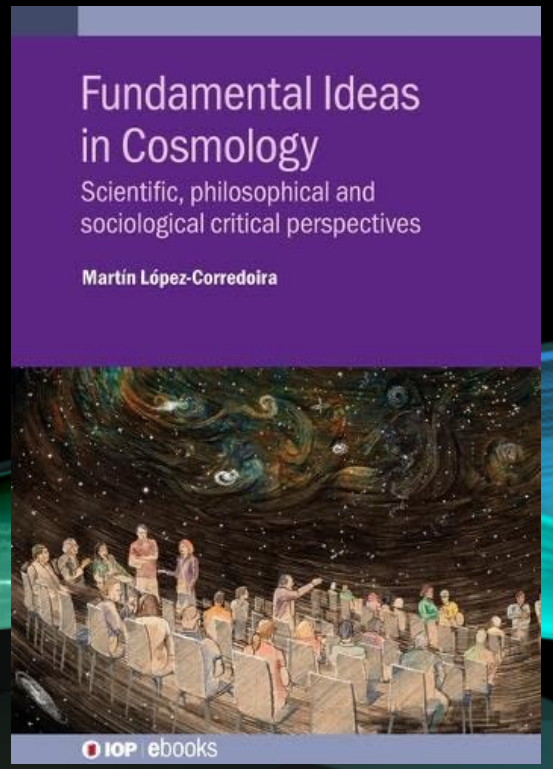

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IOP science

Dogmas of BIG BANG

- *General relativity + FLRW metric, homogenous+isopropic Universe*
- *Ad hoc elements: CP violation, inflation, non-baryonic dark matter, dark energy*
- *Redshifts due to expansion*
- *CMBR produced at decoupling matter-radiation at $z \approx 1100$*
- *Abundance of light elements produced in primordial nucleosynthesis*
- *Formation and evolution of galaxies+large-scale-structure produced by gravity*

Alternative models

Minor variations on the standard model

- New scenarios of CP violation.

- Multiple variations on inflation or alternative proposals such as cosmic strings, walls and other textures.

- Primordial nucleosynthesis: different number of neutrino species; quark-hadron transition stage;...

- Different equations of state of dark energy (cosmological constant or quintessence), or without dark energy.

- Different types of non-baryonic dark matter (cold or warm), or scenarios with only baryonic dark matter.

- Monolithic (galaxies all forming at once) instead of hierarchical structure formation (galaxies being formed in continuous episodes of accretion and merging).

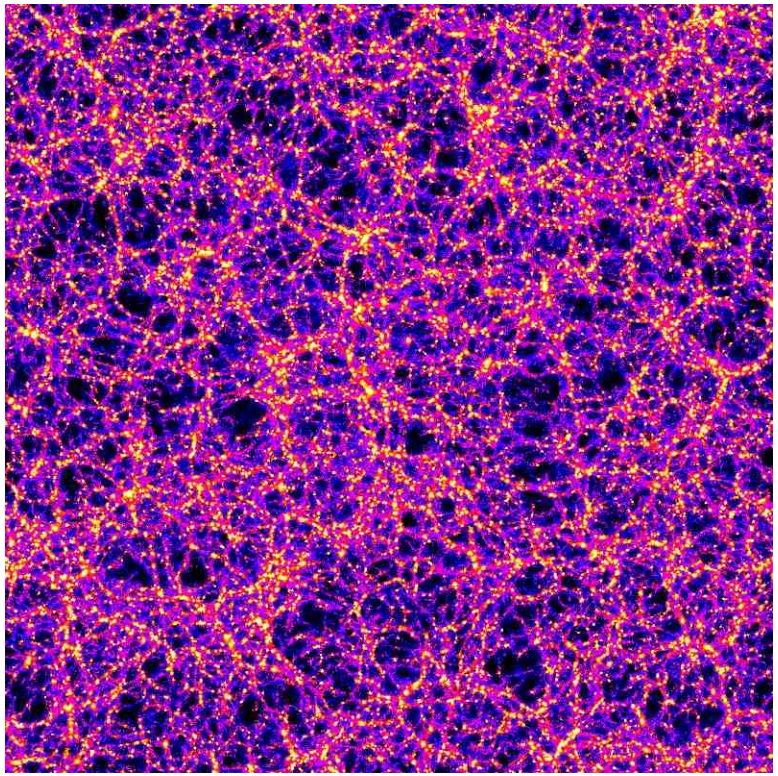
ETC.

Alternative models

Major variations on the standard model

- Fractal Universe: the large-scale structure of the Universe is not homogeneous but a fractal.

The density distribution of the universe is not homogeneous on very large scales. It obeys a fractal distribution, where the mass within a sphere of radius R is not proportional to R^3 for large enough R (in the regime in which there should be homogeneity), but proportional to R^D with a fractal dimension $D < 3$.



Alternative models

Major variations on the standard model

- Cold Big Bang: beginning of the Universe with T=0 K.

Explanations are offered for the origin of the light elements in primordial and/or stellar nucleosynthesis, the CMBR in terms of thermalization by intergalactic particles — a mixture of carbon/silicate dust and iron or carbon whiskers — of stellar radiation originating in Population III, and other phenomena explained by the standard Hot Big Bang.

Alternative models

Major variations on the standard model

- Variations/oscillations in the constants of the Physics with time or distance:

* Speed of light (c)

* Gravitational constant (G)

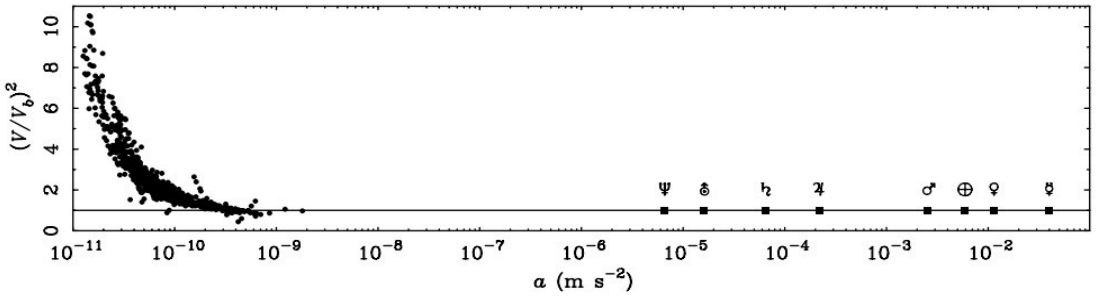
* Fine-structure constant (α) or Planck's constant (h).

...

Alternative models

Major variations on the standard model

- Modified gravity laws: MOND, MOG, f(R), Einstein–ether theory, bimetric or general higher-order theories, Horăva–Lifschitz gravity, Galileons, Ghost Condensates, and models of extra dimensions, including Kaluza–Klein, Randall–Sundrum, Dvali–Gabadadze–Porrati model 4D gravity on a brane2 in 5D Minkowski space, or higher co-dimension braneworlds, Weyl conformal gravity (invariant under Weyl transformations), etc.



MOND (Modified Newtonian Dynamics): Newtonian acceleration is divided by a factor $\mu(a/a_0)<1$ for very low accelerations, with a_0 constant for all galaxies:

$a=a_{Newton} / \mu(a/a_0)$; $\mu = [1/(1+x^{-2})]^{1/2}$

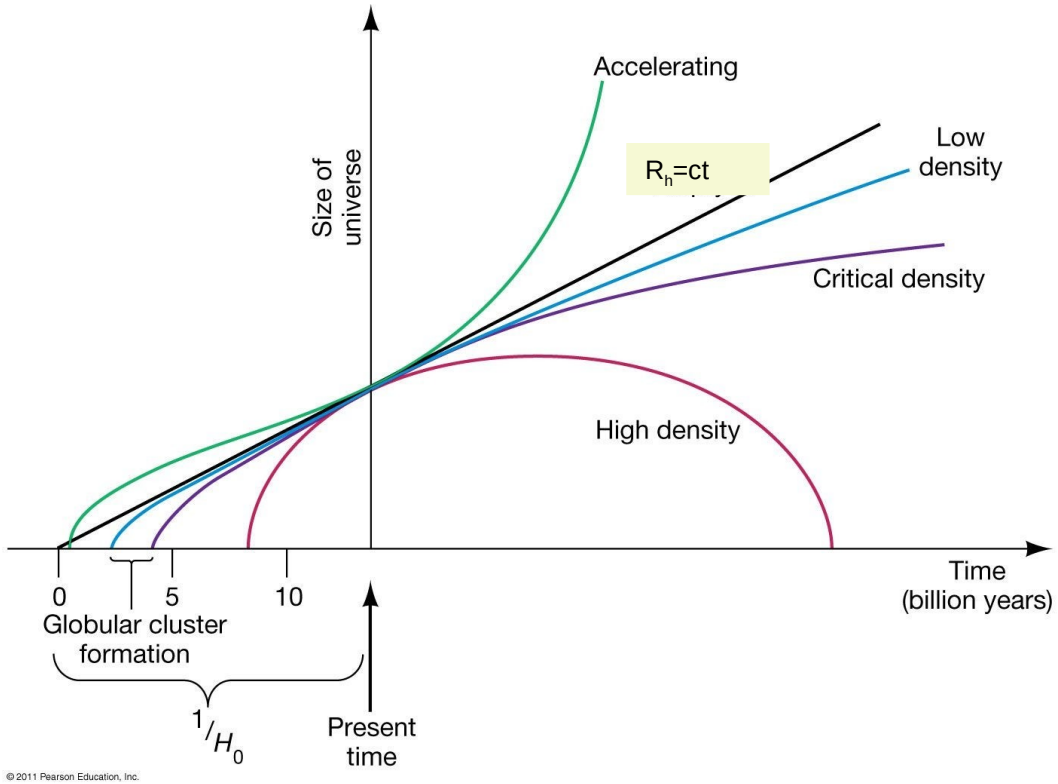
Its proponents attempted to incorporate elements that make it compatible with more general gravitation theories; for example, the AQUAdratic Lagrangian theory (AQUAL) or the Quasi linear approximation of MOND (QMOND), which expanded MOND to preserve the conservation of momentum, angular momentum, and energy, and follow the weak equivalence principle.

There is a “relativistic” version of MOND called TeVES (Tensor vector scalar gravity).

Alternative models

Major variations on the standard model

- Other Friedmann models different from ΛCDM: $R_h=ct$ (also called zero active mass), Milne.



- There is the coincidence that now the deceleration of the Hubble–Lemaître flow is compensated by the acceleration of the dark energy.

- Assuming zero active mass ($\rho+3p/c^2=0$), we get constant expansion ratio ($R_h=ct$)

- The age of the Universe is 14.6 Gyr instead 13.8 Gyr of ΛCDM (for the same H_0), which solves many problems of high z galaxies; but CMBR should be formed at z~20.

- Fulvio Melia is the main supporter of the $R_h=ct$ model.

- Milne cosmology is a special case of $R_h=ct$ model with $\rho=0$.

Alternative models

Major variations on the standard model

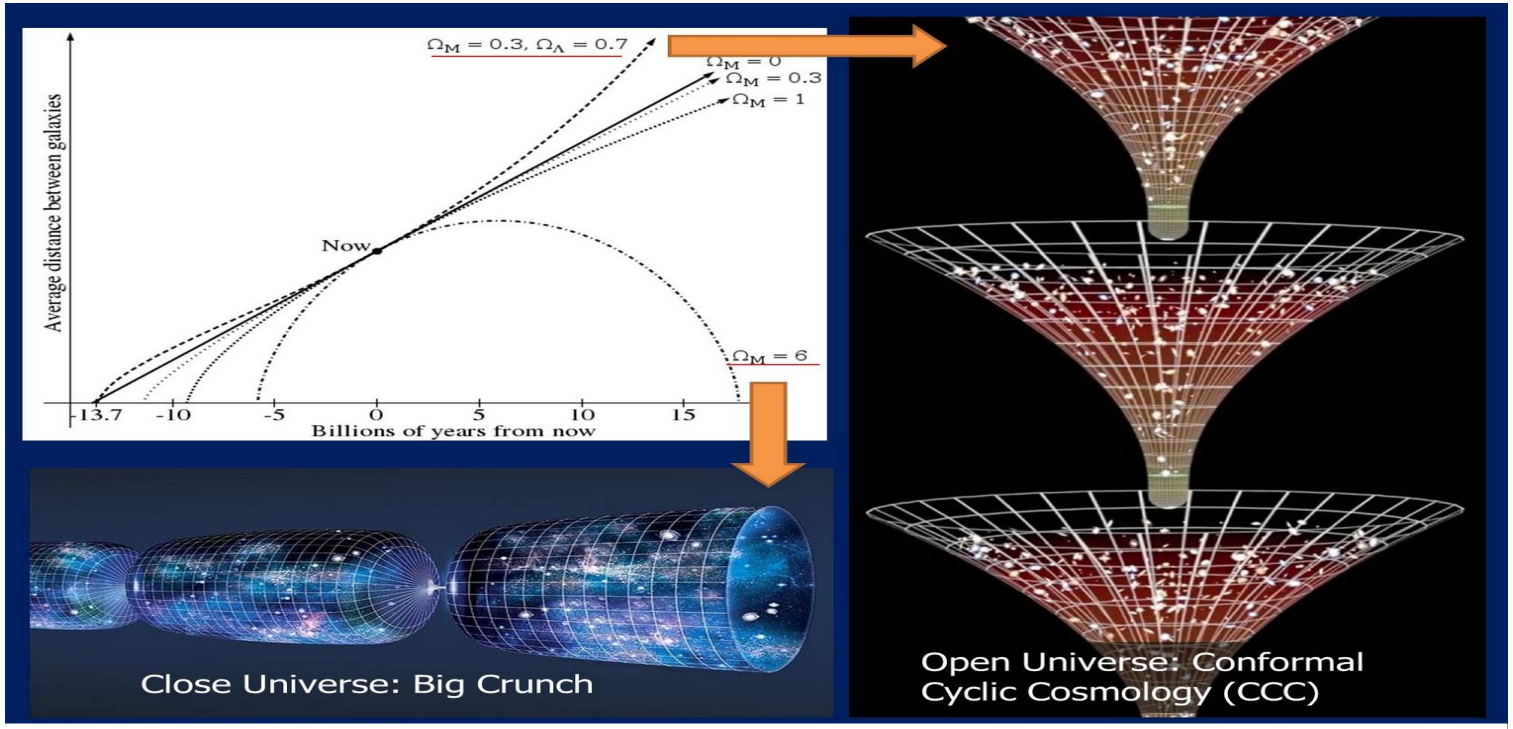
- Cyclical (eternal) Universes with continuous series of Big Bangs.

* Collapse (Big Crunch),...

* ‘Conformal cyclic cosmology’ model (Penrose), based in the framework of general relativity, the Universe iterates through infinite cycles.

The Big Bang of each is taken to be a smooth conformal continuation of the remote future of the previous one via an infinite conformal rescaling; there is no collapsing phase (Hawking evaporation of black holes provides a key ingredient).

* Dynamic Universe (Tuomo Suntola).



Alternative models

Cosmological models very different from Big Bang scenario

- (Quasi-)Steady State Cosmology.

- Plasma Cosmology.

- Other Universe models as hypersphere (a set of points at a constant distance from its centre, constituting a manifold with one dimension less than that of the ambient space) different from *Dynamic Universe* theory.

- Static, euclidean, infinite space; eternal time;...

Problems of alternative models very different from Big Bang

- Olbers' paradox: why do not we see infinite flux in an infinite eternal Universe?

- Expansion: either it is a fact (and needs some speculation to argue there was not a beginning of the Universe: continuous creation of matter, repulsion matter/antimatter, etc) or it needs an alternative explanation for the redshift different to Doppler/expansion, and none of them has firm evidences in favour.

- CMBR: not well understood its thermalization (black body spectrum) and the idea of whiskers/electron absorption/reemission has not evidences in favour. The anisotropies are also poorly understood in comparison with the standard model.

- Light elements: it needs some *ad hoc* assumptions to explain why light elements were produced by very old stars and not heavier elements.

- Large scale structure and galaxies formation/evolution: there are toy models but they are not able at present to give detailed explanations of the facts.

Difficulties to create alternative models

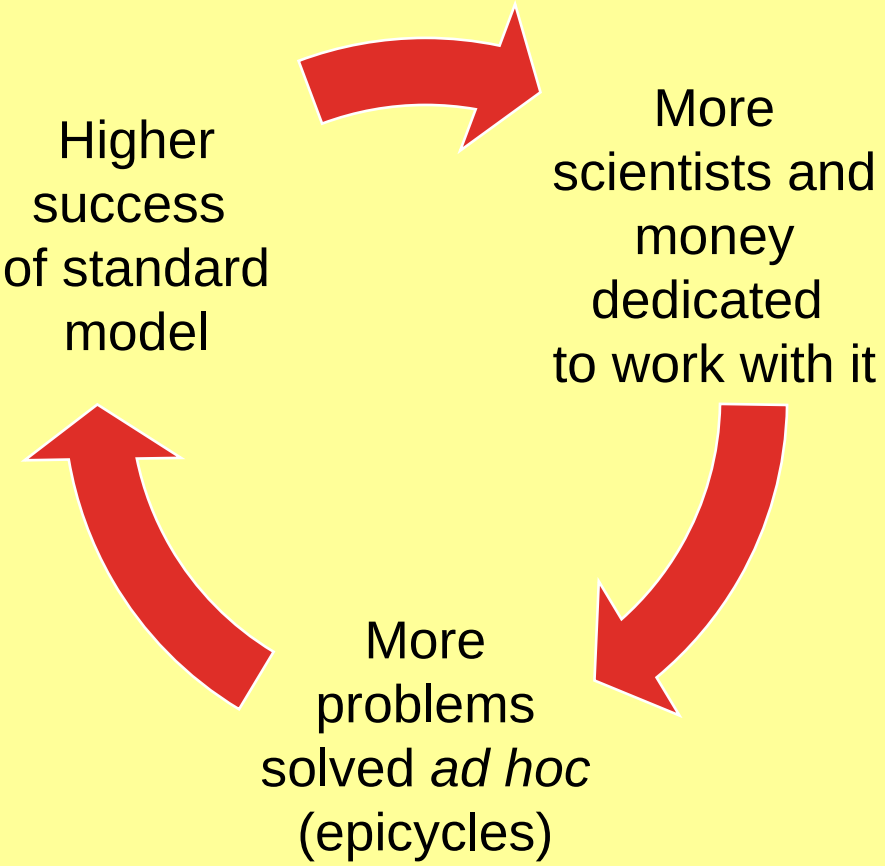
Snowball effect

“The snowball effect arising from the social dynamics of research funding drove more researchers into the Standard Cosmology fold and contributed to the drying out of alternative ideas.” (Narlikar 2001)

Jayant V. Narlikar (1938-)

Difficulties to create alternative models

Snowball effect

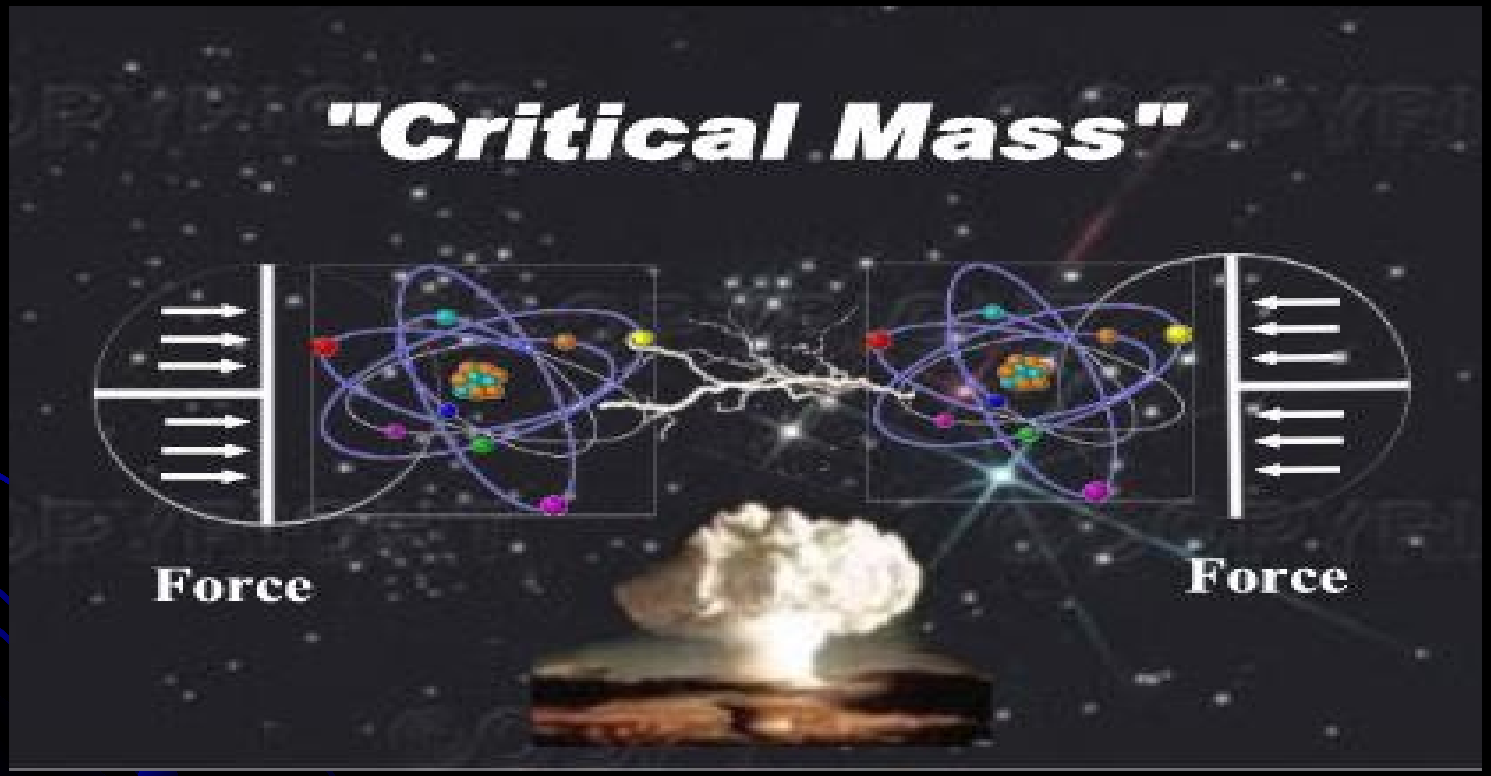


The snowball effect referred by Narlikar is also called Matthew effect, after the sociologist Robert K Merton (1910–2003), who gave it this name from the Bible Gospel of St. Matthew (25:29):

‘*Unto every one that hath shall be given, and he shall have abundance: but from him that hath not shall be taken away even that which he hath.’*

Orthodox vs. heterodox

Like in nuclear chain reactions, knowledge/culture needs a critical mass (of people and money) to produce a reaction.



See:

The Twilight of the Scientific Age

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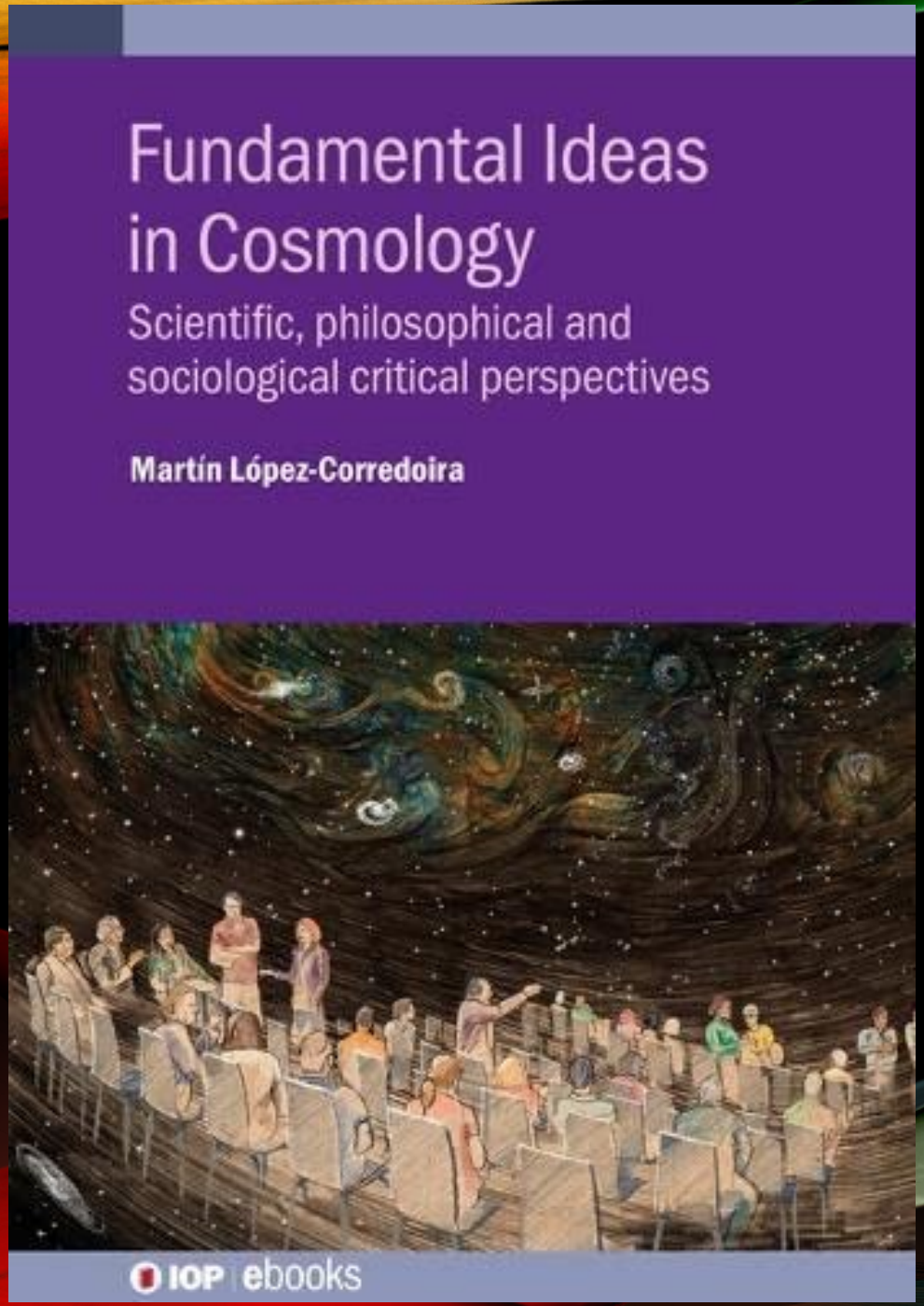

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Another review of alternative cosmologies: López-Corredoira & Marmet (2022, IJMPD, 31, 2230014)