

The Physical World and Possible Worlds

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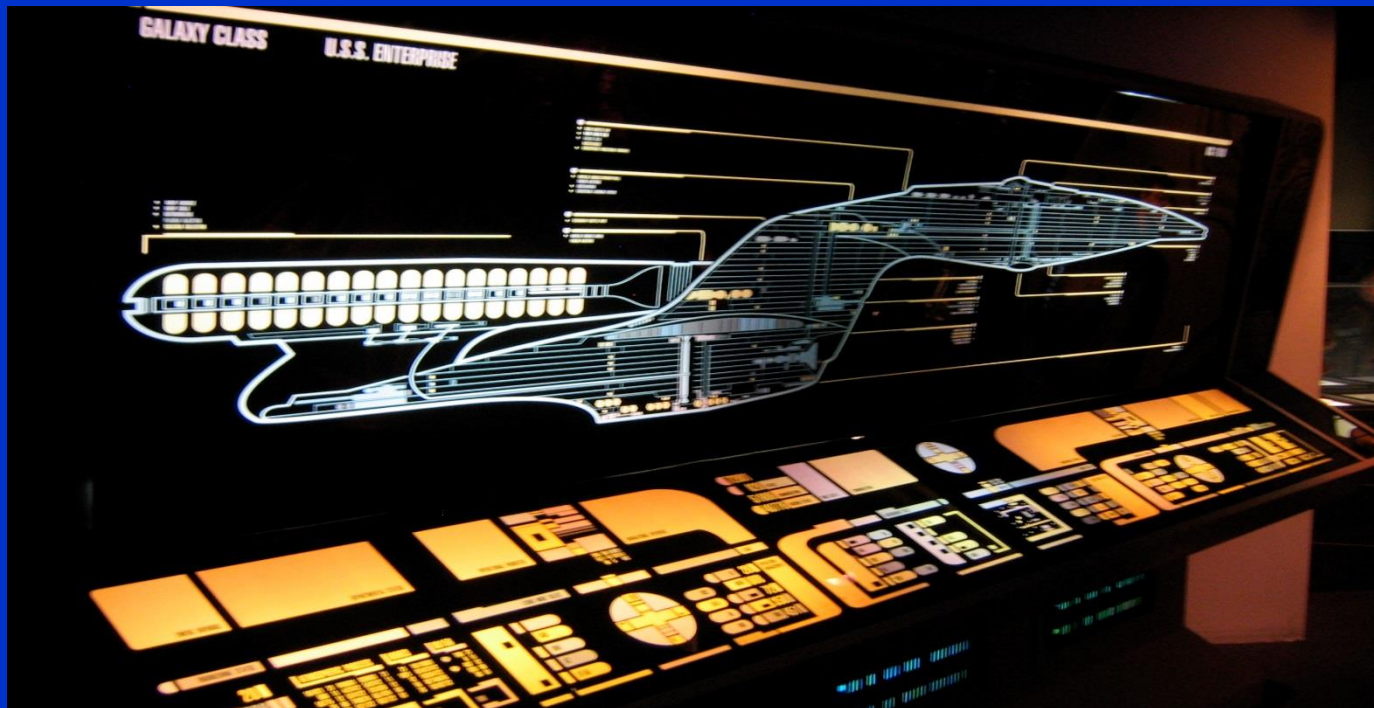
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Outline:

- Our world as one of possible worlds
- What are possible worlds?
- In fiction, in philosophy?
- What role play possible worlds in physics?
- Five conclusions

Science Fiction

- Literature, where possible worlds with different laws and/or technical devices are described



Fiction precedes or follows the trend:

- Space age: Technology is good for you
- Vietnam war: science fiction becomes pessimistic and introverted, emphasizes dangers
- Dramatic expansion of computer power favours talk of virtual reality
- Alternative worlds –Parallel worlds:
- Characteristic question: What would happen, if

Fiction or reality?

Die Welt am Draht (World on wire):

Film by Fassbinder 1973; Matrix: 1999



Actionfilm with partially
philosophical-
theological content

„Rechnender Raum, K. Zuse 1969,

„Are we living in a computer simulation?“ Nick Bostrom
Oxford 2003, Philosophical Quarterly 53 no 211“

Constraints on the Universe as a Numerical Simulation

Silas R. Beane,^{1,2,*} Zohreh Davoudi,^{3,†} and Martin J. Savage^{3,‡}

Possible worlds in Philosophy :

- Actuality-Potentiality by Aristoteles;
- Piece of wood and the wooden sculpture
- Dominance of the Real versus the Possible
- Our World is the best of all possible worlds, says Leibniz
- Since god is omnipotent, omniscient and perfectly good, he has created the best of all possible worlds.

Process und Reality

- Whitehead sees in the change of impure potentials and eternal objects or pure potentials the origin of becoming.

(ii) That in the becoming of an actual entity, the *potential* unity of many entities in disjunctive diversity[‡]—actual and non-actual—acquires the *real* unity of the one actual entity; so that the actual entity is the real concrescence of many potentials.

- We ask: Is the world of possibilities smaller or larger than the real world?

Arguments:

For:

- In order to have a real possibility, it must be realisable, therefore
- It must be part of reality.

Against:

- Possibilities form extra worlds, possible worlds, which exist besides our actual world. They can be closer or further away from our actual world.

Possible worlds in contemporary philosophy

- Actual world and other worlds in so far as they do not contain contradictions inside themselves.
- They are used as a tool in modal logic.
- D. Lewis considers them as real.
- S. Kripke also assumes that probable histories or outcomes form possible worlds.
- The opinions are split, whether possible worlds must be complete

Truth Criteria for conditional (modal) statements

- Counterfactuals: “If A were the case, C would be the case”
- IS true; if and only if there is an auxiliary set S of true statements consistent with the antecedent A , such that the members of S , when conjoined with A , imply the consequent C .
- “If A were the case, C would be the case” is *true* in the actual world W if and only if some A -world where C holds is closer to the actual world W than any A -world where C does not hold. (D.K. Lewis using “Possible Worlds”)

Define: True, false, possible, contingent, necessary

The actual world

- Every person sees the actual world as his world
- The concept „real“ serves as an index
- A. Koch: Therefore in every possible world there must be subjects (with feelings, thinking, consciousness etc.)
- D. Chalmers uses possible worlds to show the existence of a non physical consciousness.

Chalmers argument:

1. According to physicalism, all that exists in our world (including consciousness) is physical.
2. Thus, if physicalism (A) is true, (B) a possible world in which all physical facts are the same as those of the actual world must contain everything that exists in our actual world. In particular, conscious experience must exist in such a possible world.

A→B

3. In fact we can conceive of a world physically indistinguishable from our world but in which there is no consciousness (a zombie world).

(not B)

4. Therefore, physicalism is false (not A) . (The conclusion follows from 2. and 3.)

Possible worlds in physics

Physical world: Elementary particles, atoms, gases, solids, membranes, neurons, galaxies, the whole universe.

Nonphysical worlds: art, politics, poetry

Other physical possible worlds:

other universes, other histories, other laws of nature, ...

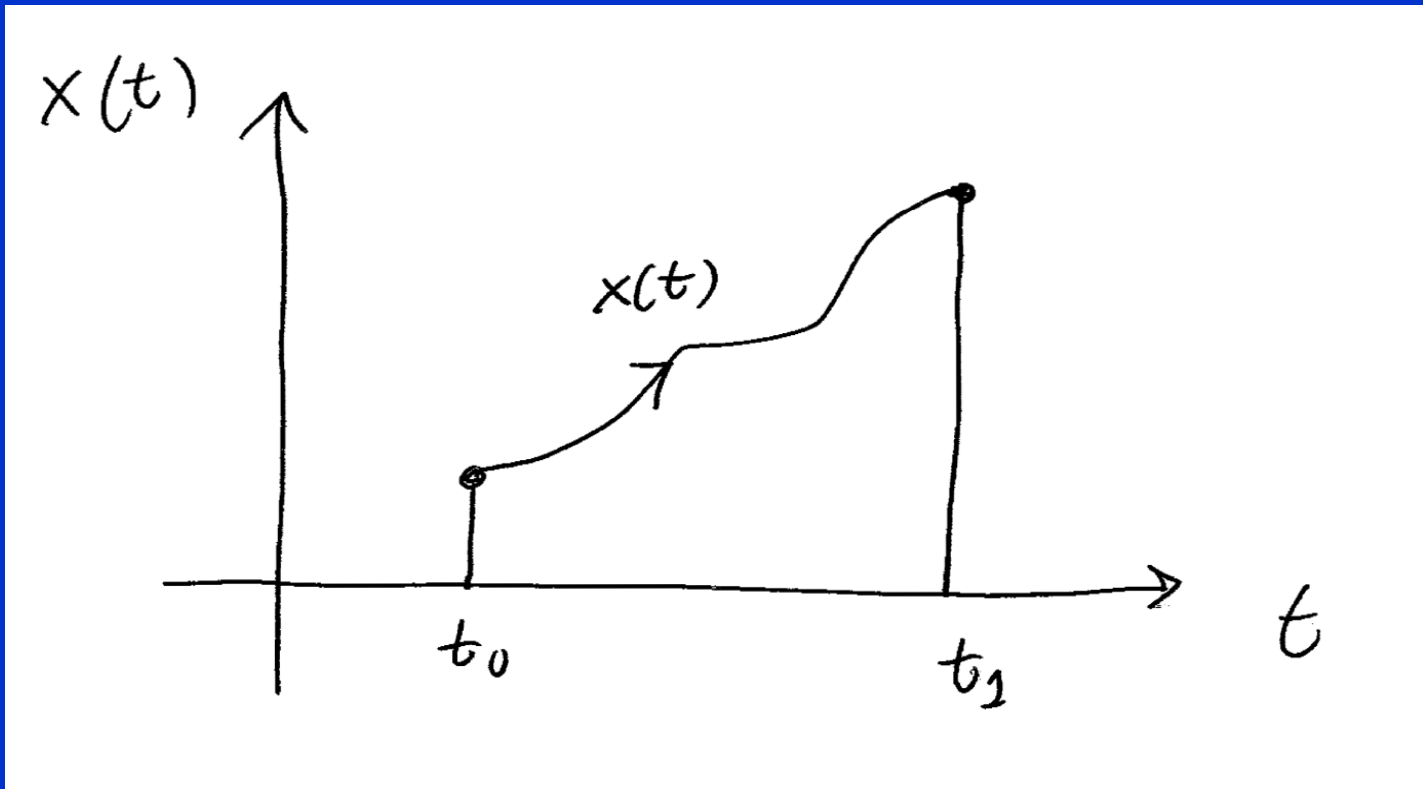
Thought (Gedanken) Experiment

Imagines a possible world
e.g. Galileo imagines an
experiment with reduced
gravity : Finds inclined plane

Possible trajectories in
mechanics?



Trajectory $x(t)$ minimizes the action



The physically realised trajectory is one among many possible trajectories. It is selected by the principle of least action. "Our world is the best of all possible worlds." Leibniz precedes Euler by 50 years.

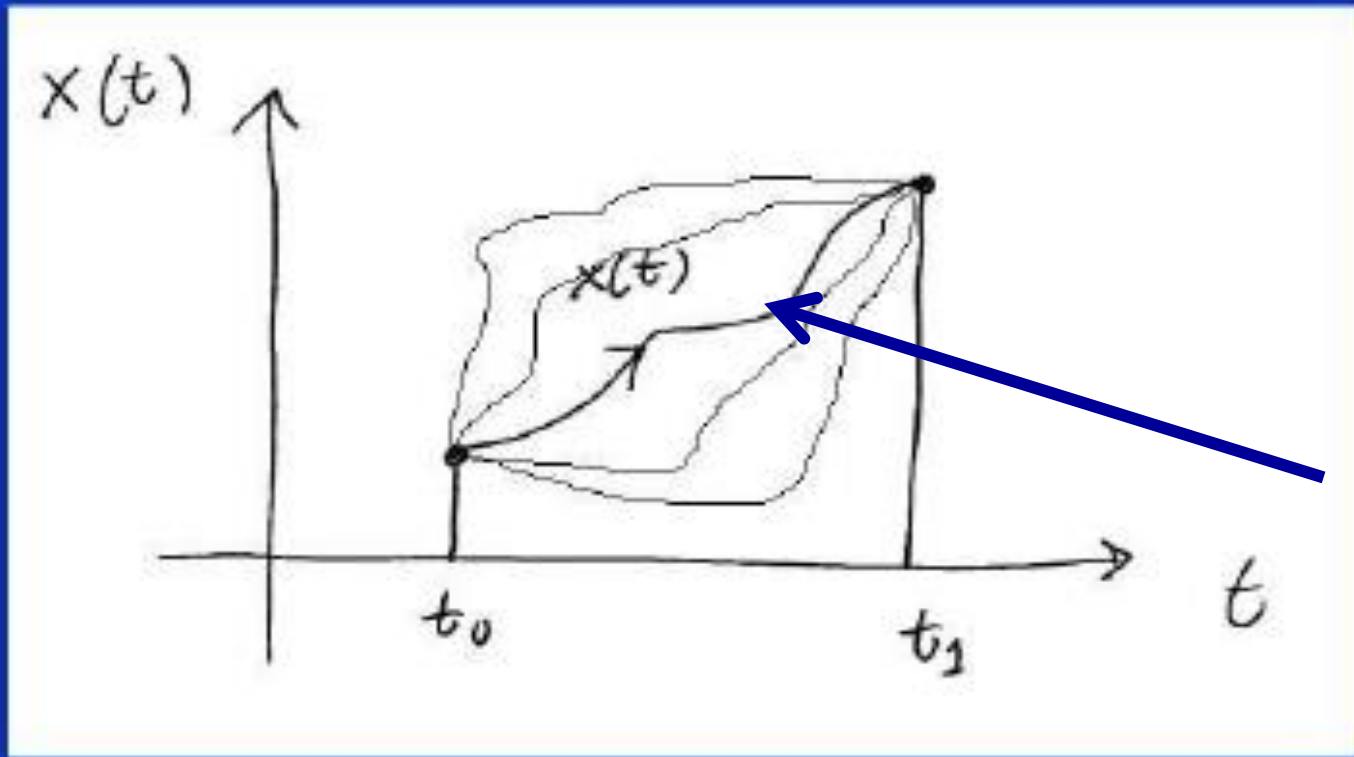
Physical World as the Best of all possible Worlds

- Principle of least action :
- $S = \int dt(\text{kin. energy} - \text{pot. energy})$
- Given fixed initial and final positions, the physical motion corresponds to the motion with the least action S .
- The physical world is the optimal world.
- How does the particle know about the right trajectory, asks Feynman?

Possible versus probable

- We know a collection of possible worlds in statistical mechanics: the ensemble of microstates constrained e.g. by fixed N, T, V
- Differentiate probable $p(E)$ and $\text{poss}(E)$:
 $p(E) \leq \text{poss}(E)$
- $\text{poss}(E) = \sup(p_1(E), p_2(E), \dots)$
- Subjective probabilities?

Quantum Mechanics sums all possible Paths



Klassischer
Weg

Path integral as generalization of the two slit experiment

World in Quantenmechanics

- No longer like in the Tractatus of Wittgenstein:
- “The world is everything that is the case.”
- But in Quantenmechanics:
- Quantum state describes everything which is possible,
- „all possible worlds“

Many world theory

THE THEORY OF THE UNIVERSAL WAVE FUNCTION

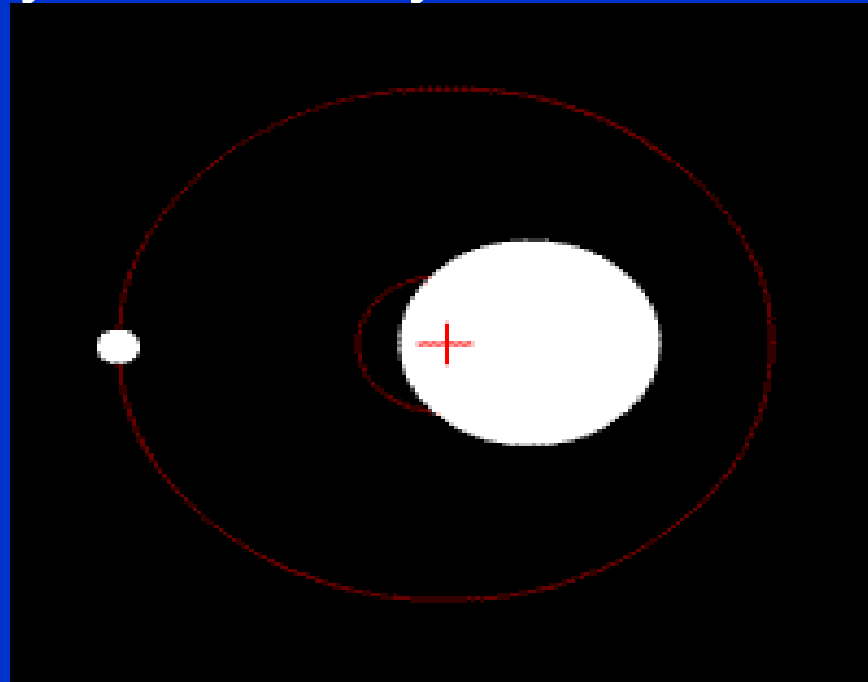
Hugh Everett, III

I. INTRODUCTION

For hard-core Modal Realists like D. Lewis these quantum worlds form a subset of possible worlds

Possible world in Astronomy

- Exoplanet is a planet which belongs to another solar system, and has similar conditions as our world. Kepler 186f-
- 490 light years away

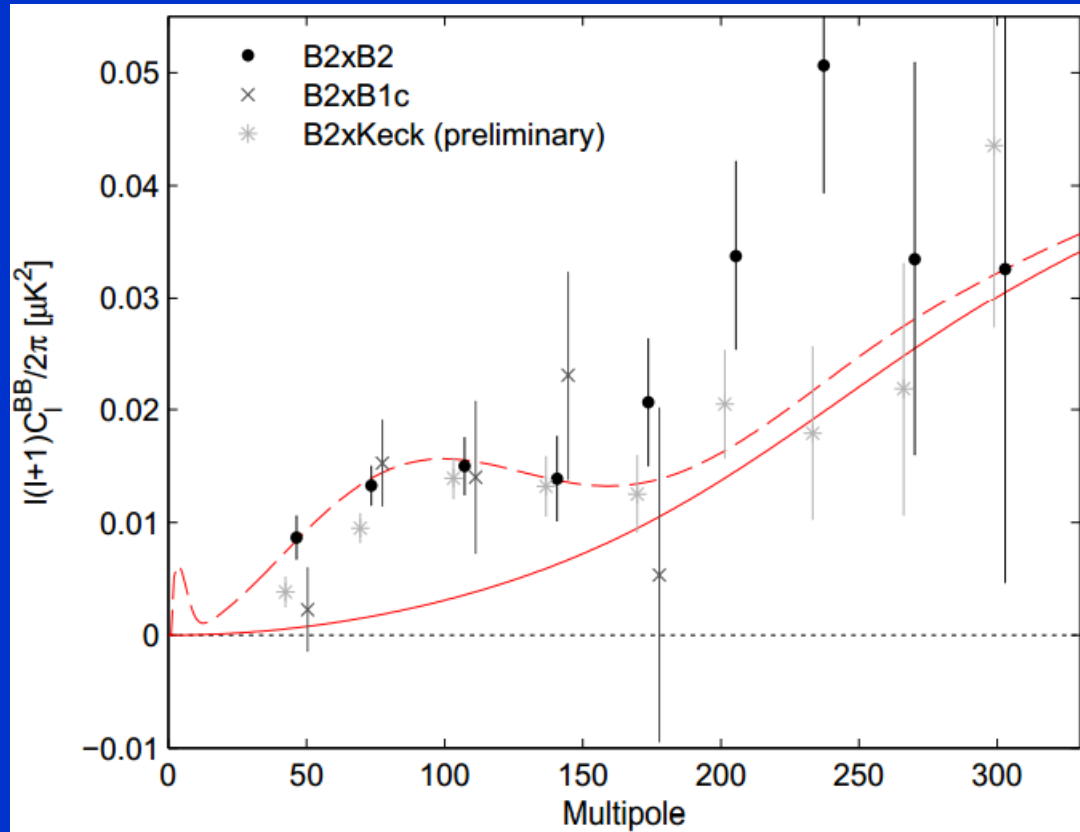


The Multiverse



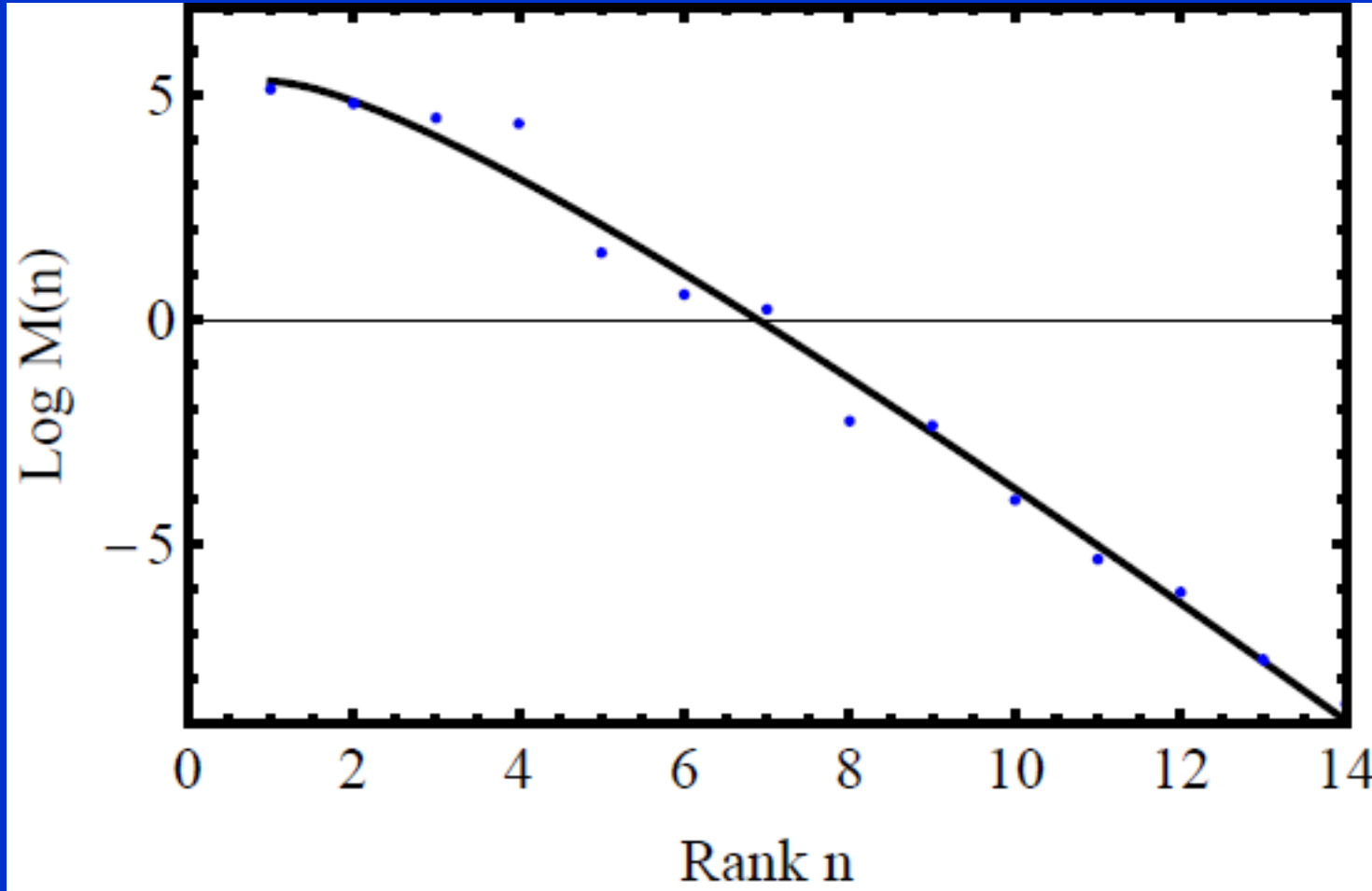
Inflation as reasonable cause for the homogeneity of the cosmic microwave background- but eternal inflation?

Strong support for Inflation from newest Bicep Data



The BB auto and cross correlation function: The vertical axis gives the amplitude of the correlation, the horizontal axis represents angular scale (large angles on the left, small angles on the right).

Possible Standard Worlds



Model: $M(n) = M_0 n \exp[-n 1.09] / \text{Norm}$ fails symmetries:
GUT SU5, see $W, Z (3,4) - b, \tau (5,6) - \mu, s (8,9)$

Conclusions:

- Gedankenexperiments are important.
- Physics can handle probable worlds quite well, possible worlds „not yet“
- Possible trajectories select classically the minimal action, quantum mechanically they are real
- Quantum many worlds and multiverse are debated.
- Model with standard worlds works, but light particles are missing and where are the other standard worlds?