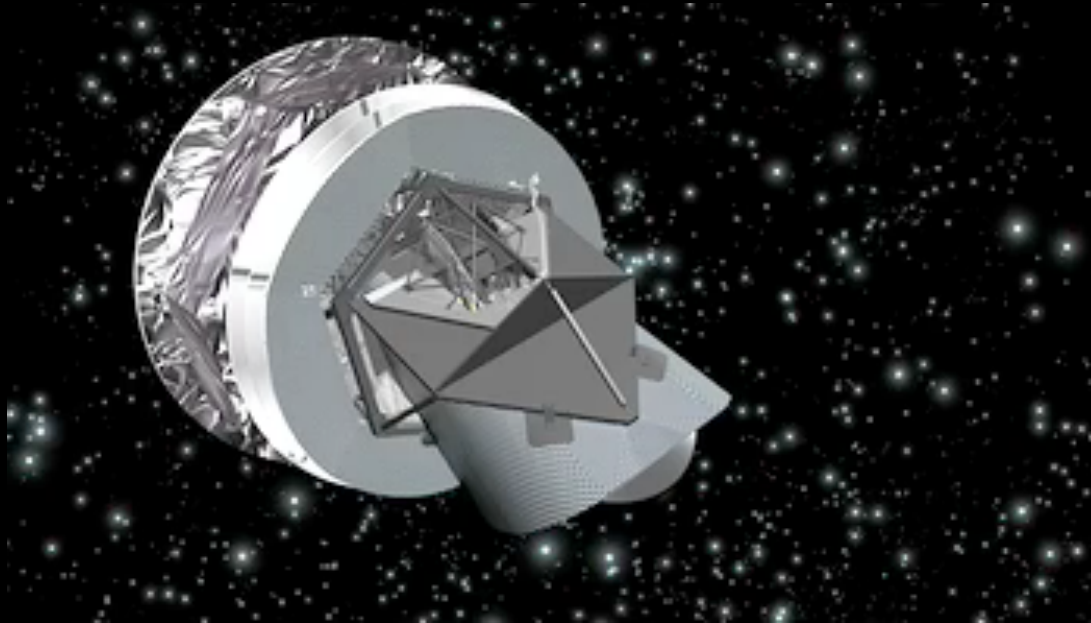


Astro 220: Galaxies and cosmology

Nov 10 2010



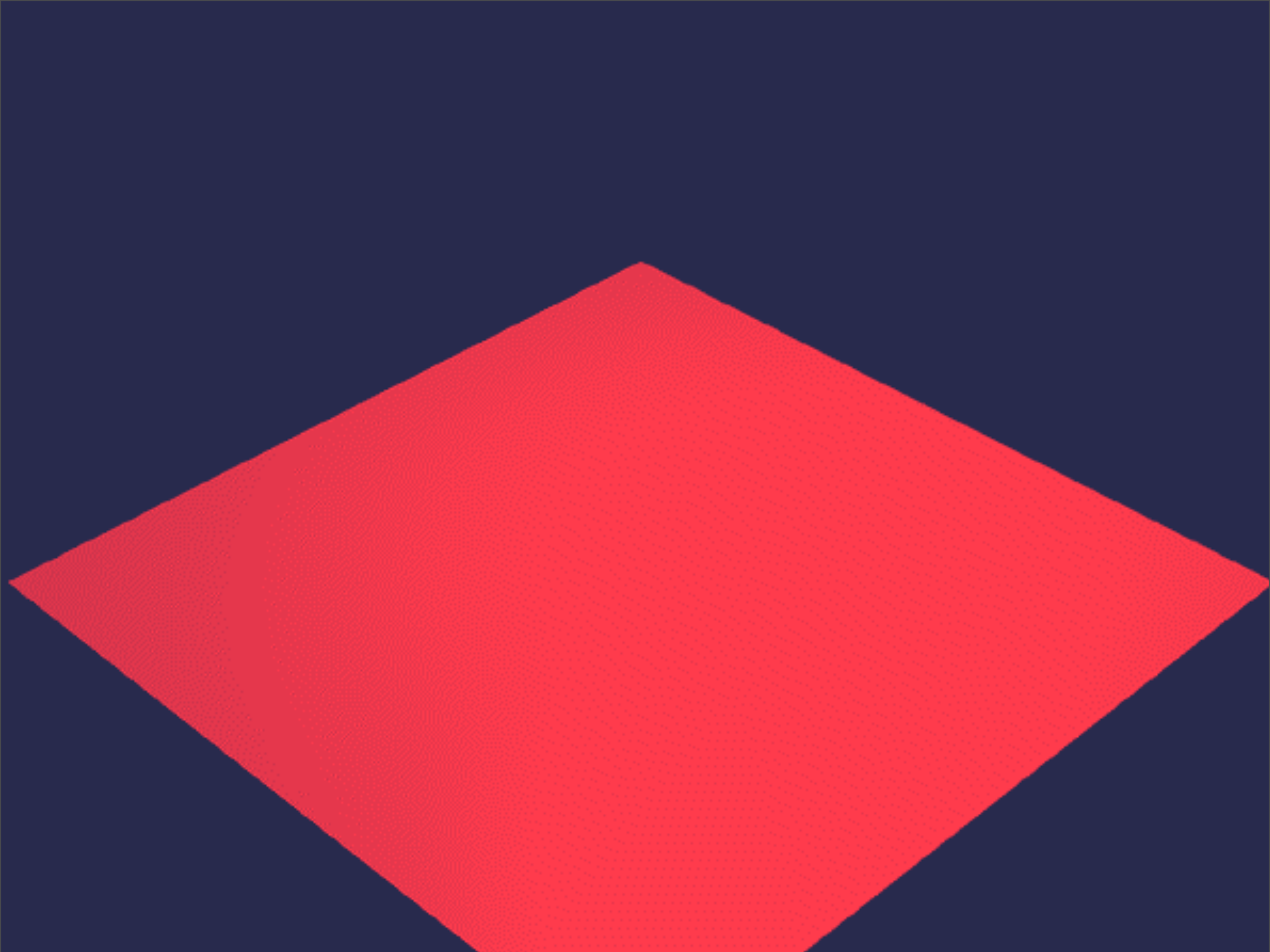
Description	Symbol	Value	+ uncertainty	– uncertainty
Total density	Ω_{tot}	1.02	0.02	0.02
Equation of state of quintessence	w	< -0.78	95% CL	—
Dark energy density	Ω_Λ	0.73	0.04	0.04
Baryon density	$\Omega_b h^2$	0.0224	0.0009	0.0009
Baryon density	Ω_b	0.044	0.004	0.004
Baryon density (cm^{-3})	n_b	2.5×10^{-7}	0.1×10^{-7}	0.1×10^{-7}
Matter density	$\Omega_m h^2$	0.135	0.008	0.009
Matter density	Ω_m	0.27	0.04	0.04
Light neutrino density	$\Omega_\nu h^2$	< 0.0076	95% CL	—
CMB temperature (K) ^a	T_{cmb}	2.725	0.002	0.002
CMB photon density (cm^{-3}) ^b	n_γ	410.4	0.9	0.9
Baryon-to-photon ratio	η	6.1×10^{-10}	0.3×10^{-10}	0.2×10^{-10}
Baryon-to-matter ratio	$\Omega_b \Omega_m^{-1}$	0.17	0.01	0.01
Fluctuation amplitude in $8h^{-1}$ Mpc spheres	σ_8	0.84	0.04	0.04
Low- z cluster abundance scaling	$\sigma_8 \Omega_m^{0.5}$	0.44	0.04	0.05
Power spectrum normalization (at $k_0 = 0.05 \text{ Mpc}^{-1}$) ^c	A	0.833	0.086	0.083
Scalar spectral index (at $k_0 = 0.05 \text{ Mpc}^{-1}$) ^c	n_s	0.93	0.03	0.03
Running index slope (at $k_0 = 0.05 \text{ Mpc}^{-1}$) ^c	$dn_s/d \ln k$	-0.031	0.016	0.018
Tensor-to-scalar ratio (at $k_0 = 0.002 \text{ Mpc}^{-1}$)	r	< 0.90	95% CL	—
Redshift of decoupling	z_{dec}	1089	1	1
Thickness of decoupling (FWHM)	Δz_{dec}	195	2	2
Hubble constant	h	0.71	0.04	0.03
Age of universe (Gyr)	t_0	13.7	0.2	0.2
Age at decoupling (kyr)	t_{dec}	379	8	7
Age at reionization (Myr, 95% CL))	t_r	180	220	80
Decoupling time interval (kyr)	Δt_{dec}	118	3	2
Redshift of matter-energy equality	z_{eq}	3233	194	210
Reionization optical depth	τ	0.17	0.04	0.04
Redshift of reionization (95% CL)	z_r	20	10	9
Sound horizon at decoupling (°)	θ_A	0.598	0.002	0.002
Angular size distance to decoupling (Gpc)	d_A	14.0	0.2	0.3
Acoustic scale ^d	ℓ_A	301	1	1
Sound horizon at decoupling (Mpc) ^d	r_s	147	2	2

Weak Anthropic Principle:

"The observed values of all physical and cosmological quantities are not equally probable but they take on values restricted by the requirement that there exist sites where carbon-based life can evolve and by the requirement that the Universe be old enough for it to have already done so."

Strong Anthropic Principle:

"The universe must have those properties which allow life to develop within it at some stage in its history."



Wednesday, November 10, 2010

Level 1: Regions beyond our cosmic horizon

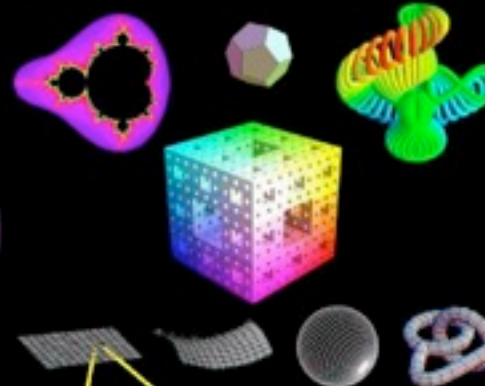
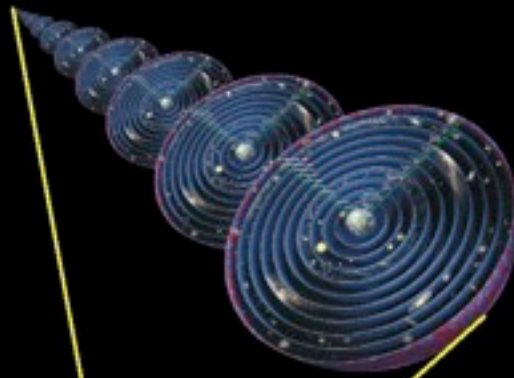
Features: Same laws of physics, different initial conditions
Assumption: Infinite space, ergodic matter distribution
Evidence:

- Microwave background measurements point to flat, infinite space, large-scale smoothness
- Simplest model

Level 4: Other mathematical structures

Features: Different fundamental equations of physics
Assumption: Mathematical existence = physical existence
Evidence:

- Unreasonable effectiveness of math in physics
- Answers Wheeler/Hawking question: "why these equations, not others"



Level 2: Other post-inflation bubbles

Features: Same fundamental equations of physics, but perhaps different constants, particles and dimensionality
Assumption: Chaotic inflation occurred
Evidence:

- Inflation theory explains flat space, scale-invariant fluctuations, solves horizon problem and monopole problems and can naturally explain such bubbles
- Explains fine-tuned parameters



Level 3: The Many Worlds of Quantum Physics

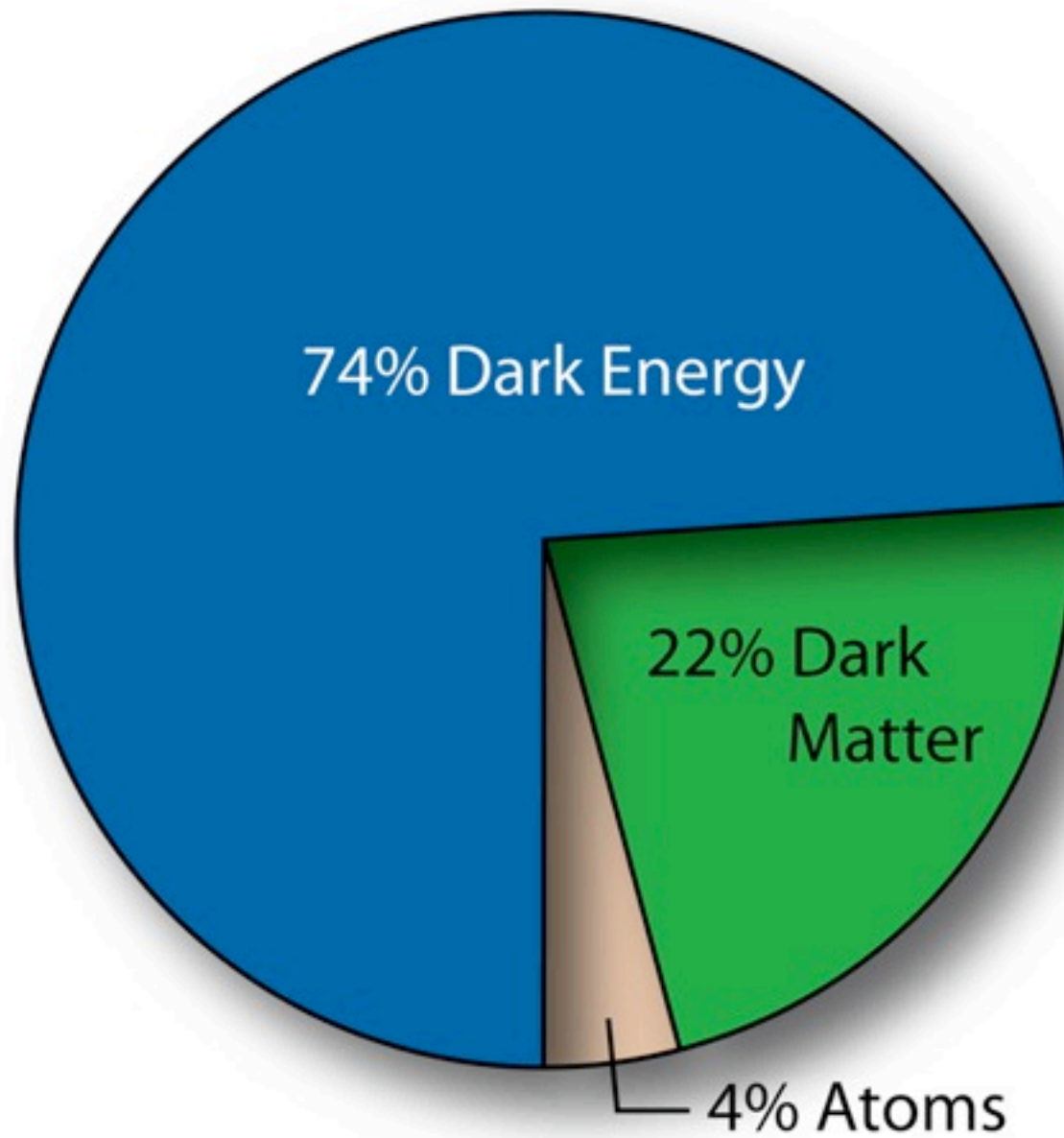
Features: Same as level 2
Assumption: Physics unitary
Evidence:

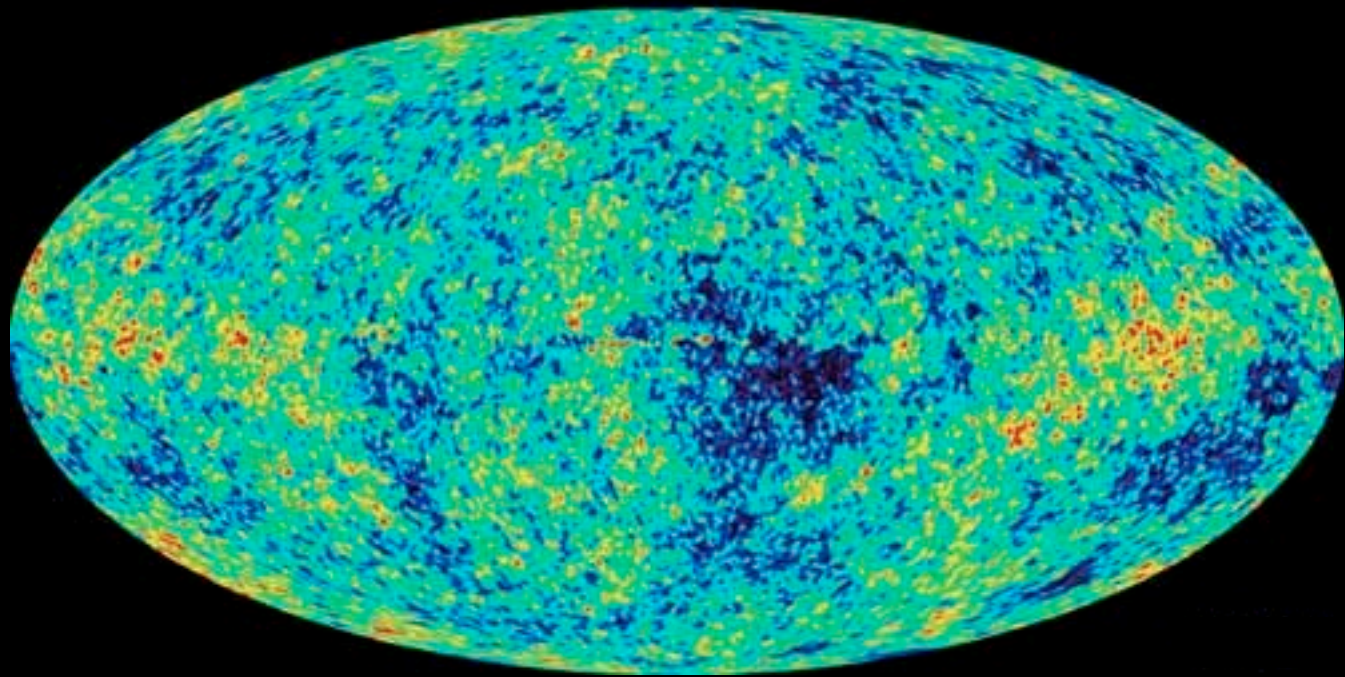
- Experimental support for unitary physics
- AdS/CFT correspondence suggests that even quantum gravity is unitary
- Decoherence experimentally verified
- Mathematically simplest model

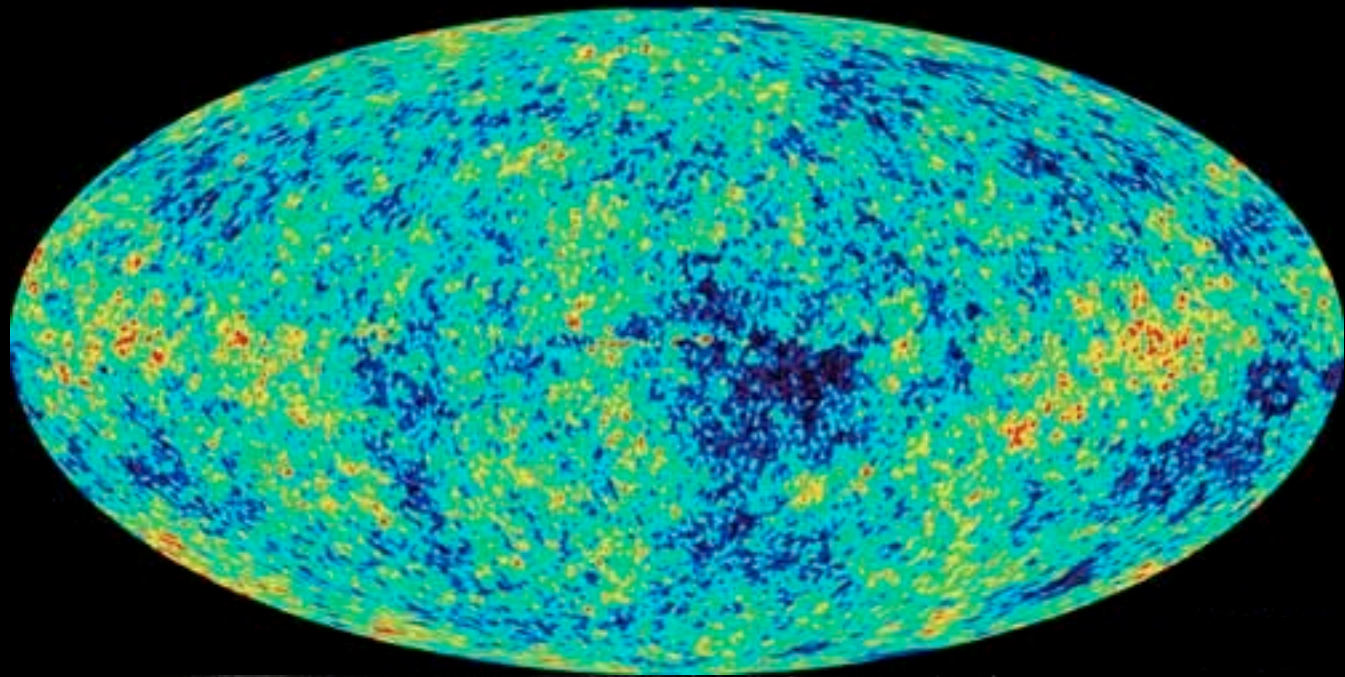


"Our aesthetic judgment therefore comes down to what we find more wasteful: many worlds or many words. Perhaps we will gradually get more used to the weird ways of our cosmos, and even find its strangeness to be part of its charm."

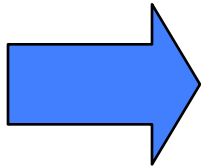
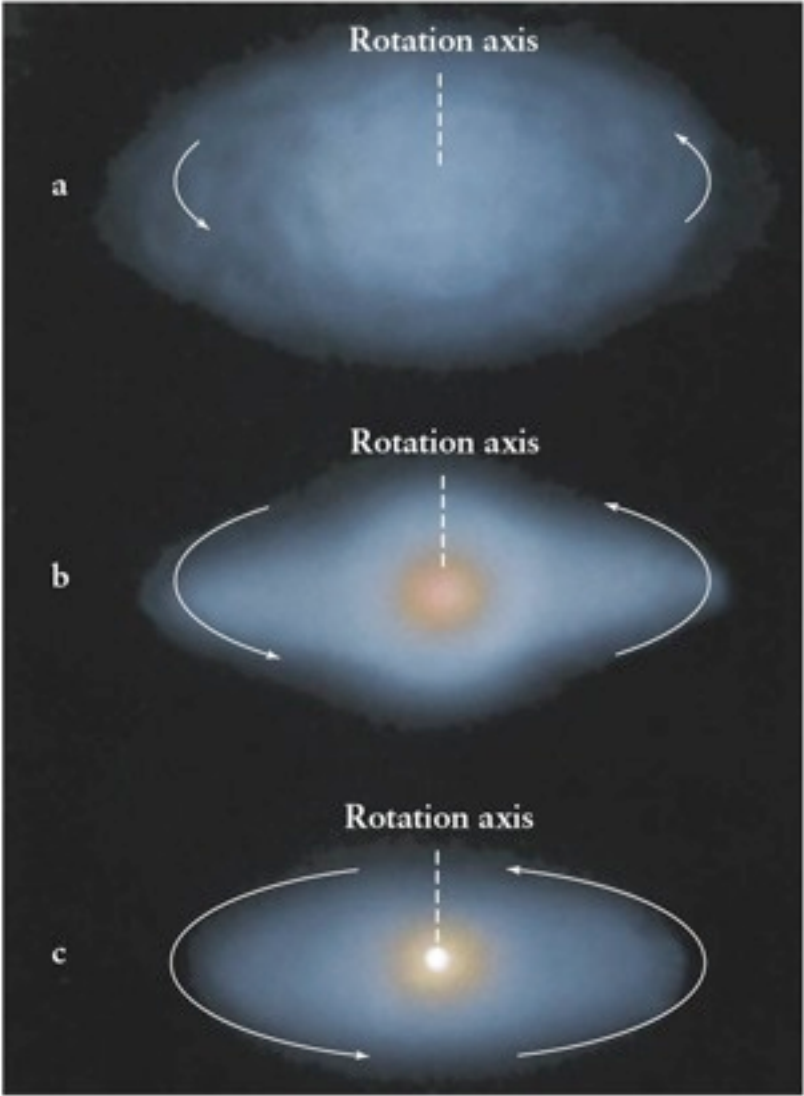
- Max Tegmark



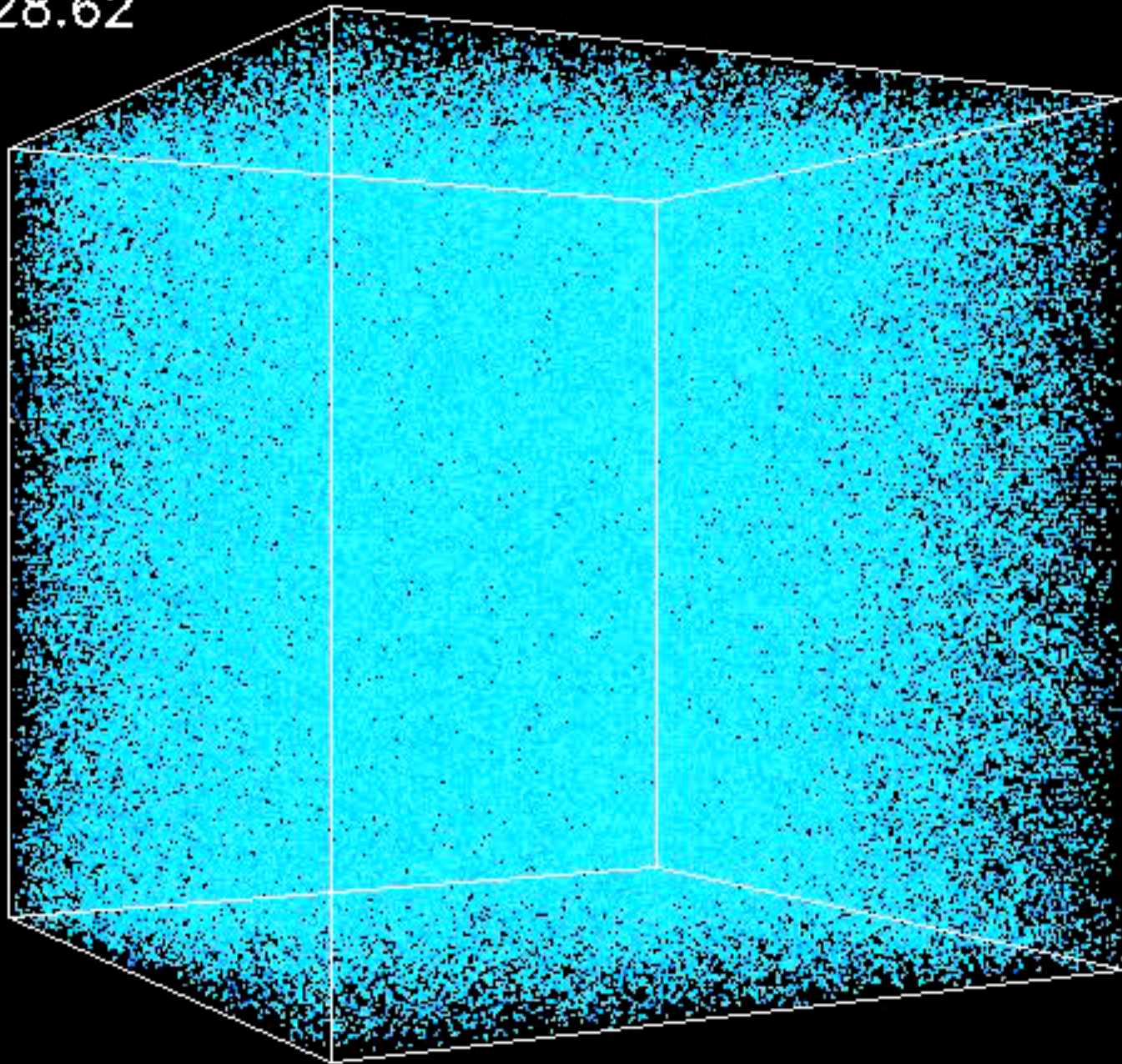








$Z=28.62$



$Z=28.62$

