

CU MIC CU MARE

…PRIN UNIVERS

Drd. Ana Caramete – Institutul de Stiinte Spatiale, Magurele

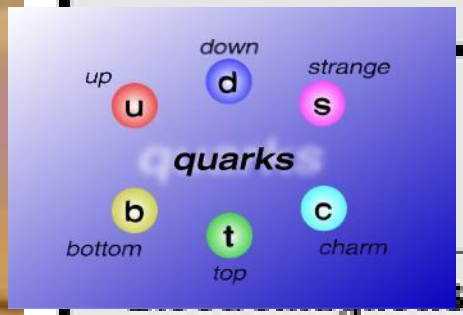
evolutia universului depinde de conditiile initiale…



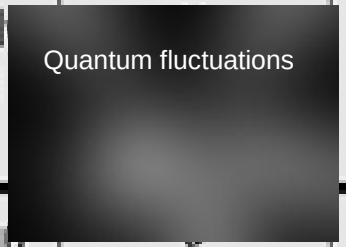
“Cow and Chicken - Time Machine”
www.youtube.com

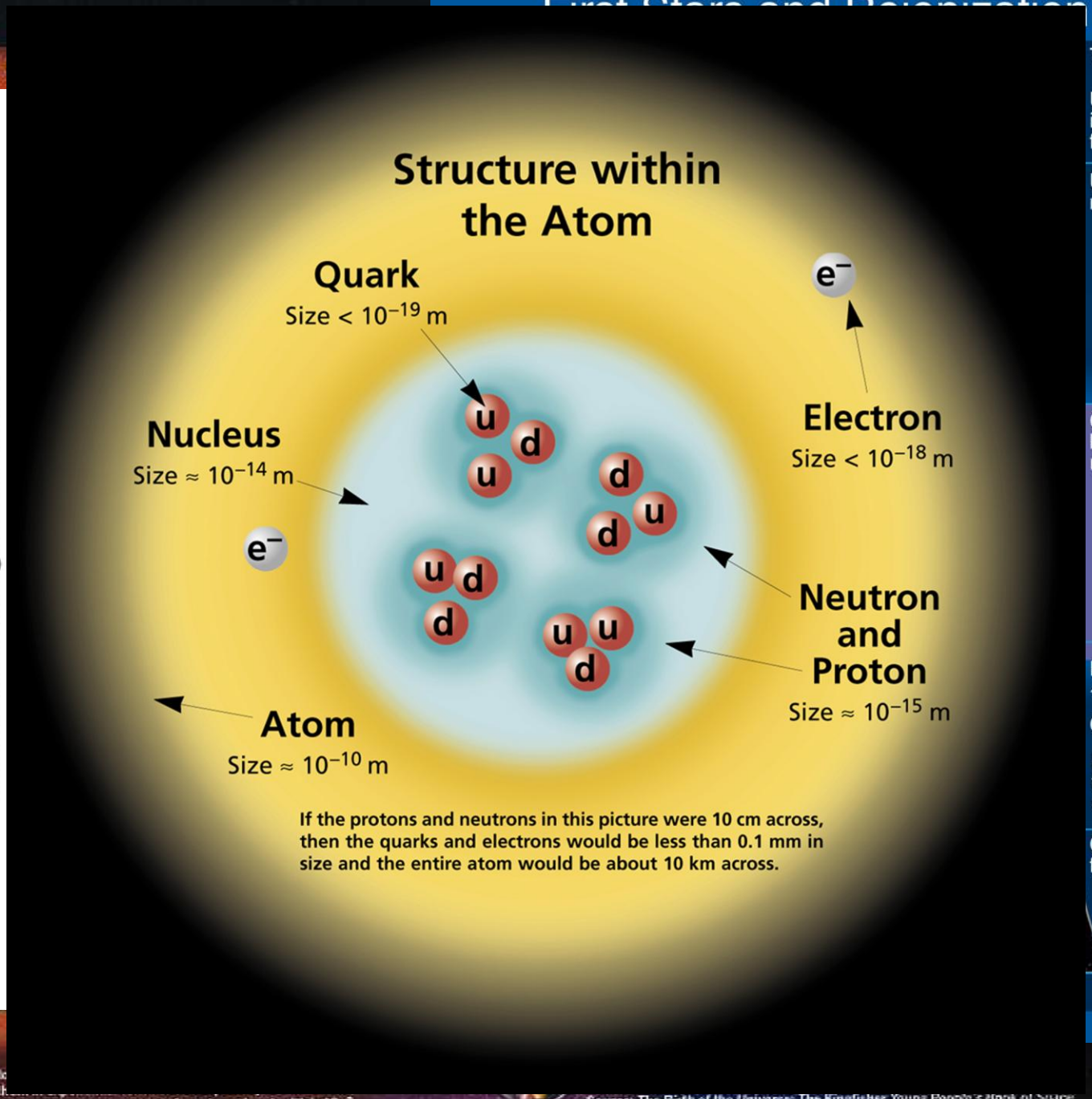
Fundamental Force Particles

Force	Particles Experiencing	Force Carrier Particle	Range	Relative Strength*
Gravity acts between objects with mass	all particles with mass	graviton (not yet observed)	infinity	much
	quarks and leptons	W^+, W^-, Z^0 (W and Z)	s ra	
acts between electrically charged particles	electricall charged		infinity	
Strong Force** binds quarks together	quarks and gluons	(gluon)	short range	much stronger



ν_e	e neutrino
e^-	electron
ν_μ	μ neutrino
μ^-	muon
ν_τ	τ neutrino
τ^-	tau




Structure within the Atom
Quark
Size < 10^{-19} m
Nucleus
Size ≈ 10^{-14} m
Atom
Size ≈ 10^{-10} m
Electron
Size < 10^{-18} m
Neutron and Proton
Size ≈ 10^{-15} m
e⁻
u
d
If the protons and neutrons in this picture were 10 cm across, then the quarks and electrons would be less than 0.1 mm in size and the entire atom would be about 10 km across.

relative strength of force
-360
-370
-380
-390
-400
-410
-420
-430
0: Linea
Time
Temper
1 Th
go
a supe
"inflat
expan
the si
atom
grape
tiny fr
of a s
NOTE: The numbers in cosmolo
is often necessary to express th
One thousand is written as 10^3. Similarly, one-tenth is 10^{-1}, and one-hundredth is 10^{-2}.

Era
The Big Bang/Inflation
Universe filled with ionized gas: fully opaque
Universe becomes neutral and transparent
Galaxies and Quasers begin to form - starting reionization.
Reionization complete ~ 10% opacity
Galaxies evolve
Dark Energy begins to accelerate the expansion of space
Our Solar System forms
NASA/WMAP Science Team

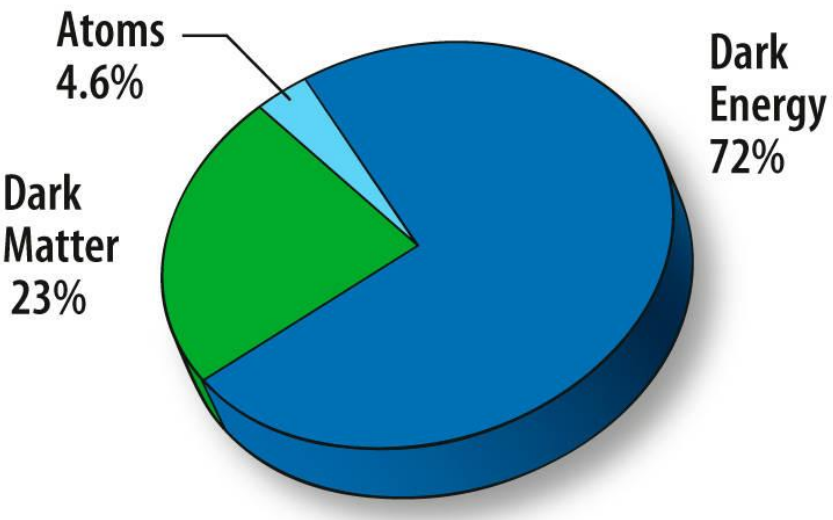
Source: The Birth of the Universe, The Kingfisher Young People's Book of Space
TIME Graphic by Ed Gabel



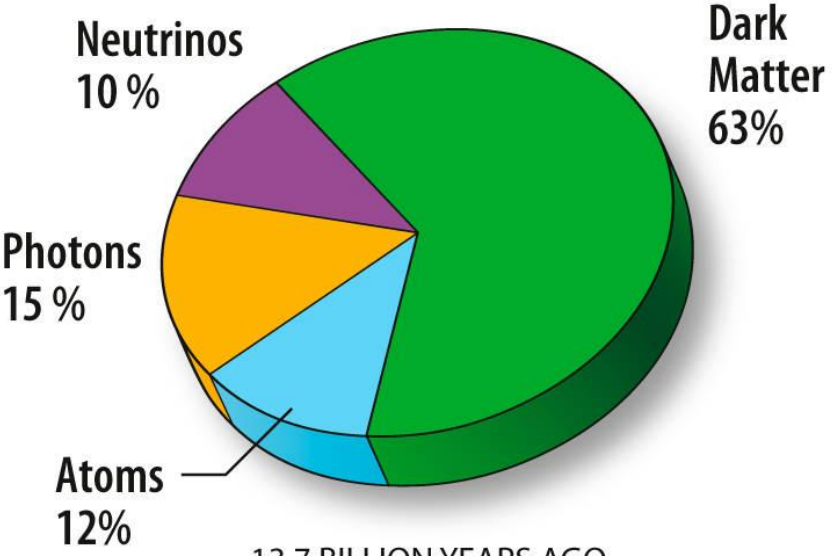
GRAVITATIONAL LENSING:

1 A Distant Source
Light leaves a young, star-forming blue galaxy near the edge of the visible universe.

2 A Lens Of 'Dark Matte
Some of the light passes through a cluster of galaxie rounding dark ma line of sight betw distant galaxy. Th acts like a lens, b



TODAY



13.7 BILLION YEARS AGO
(Universe 380,000 years old)



Source:
Bell Labs,
Lucent Technologies

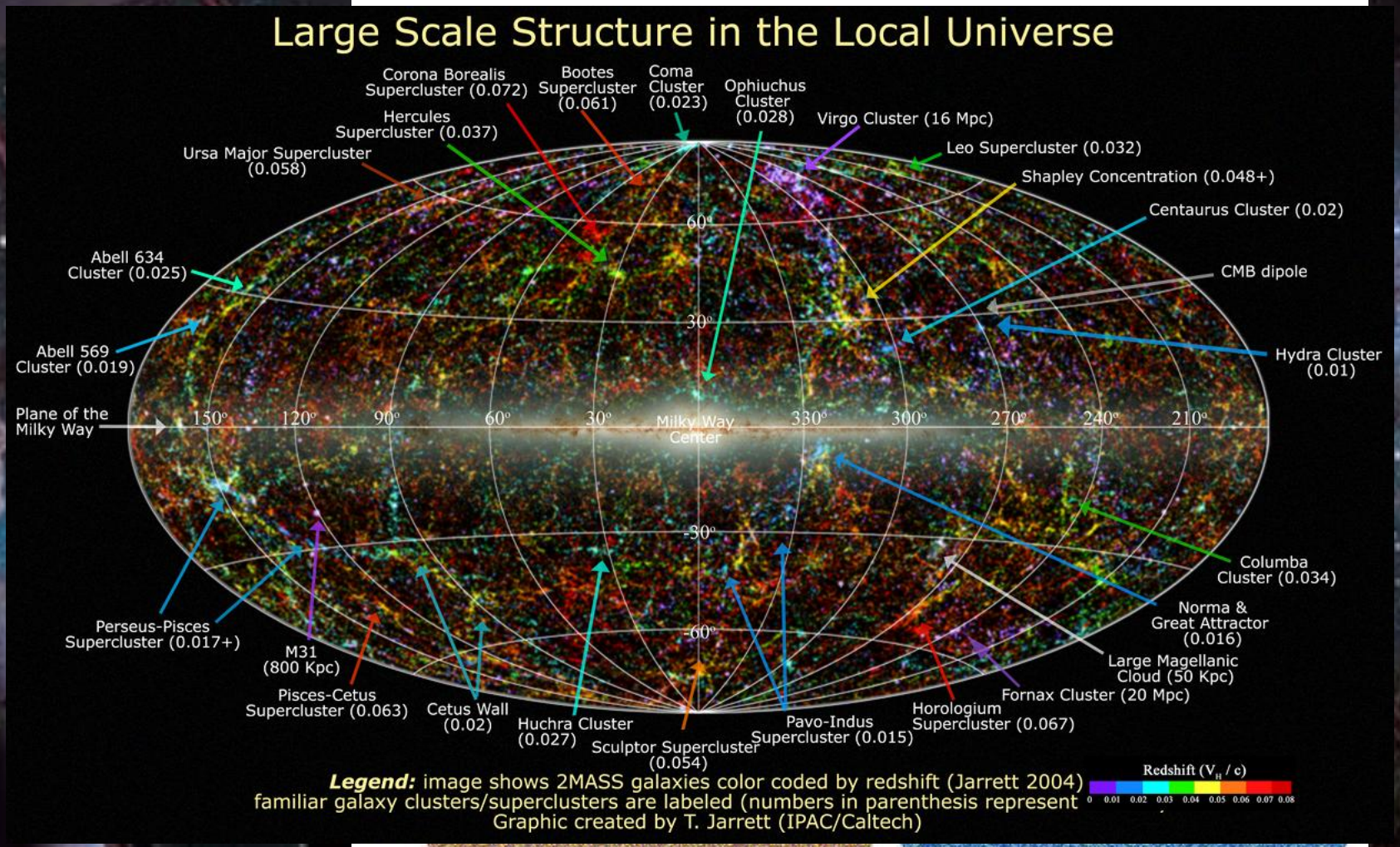
Tony Tyson, Greg Kochanski and Ian Dell'Antonio
Frank O'Connell and Jim McManus/ The New York Times



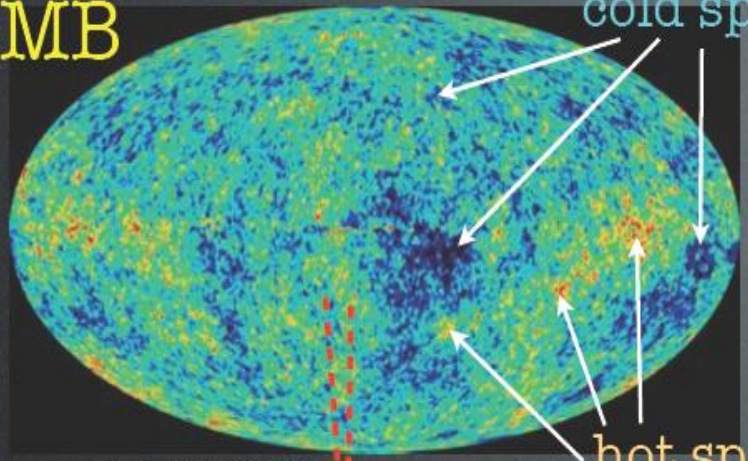
TIME Graphic by Ed Gabel

NOTE: The numbers in cosmology are so great and the numbers in subatom is often necessary to express them in exponential form. Ten multiplied by it One thousand is written as 10^3. Similarly, one-tenth is 10^{-1}, and one-hundredth is 10^{-2}.

Source: The Birth of the Universe: The Kingfisher Young People's Book of Space


Large Scale Structure in the Local Universe
Corona Borealis Supercluster (0.072)
Bootes Supercluster (0.061)
Coma Cluster (0.023)
Ophiuchus Cluster (0.028)
Hercules Supercluster (0.037)
Virgo Cluster (16 Mpc)
Ursa Major Supercluster (0.058)
Leo Supercluster (0.032)
Shapley Concentration (0.048+)
Centaurus Cluster (0.02)
60°
Abell 634 Cluster (0.025)
CMB dipole
30°
Abell 569 Cluster (0.019)
Hydra Cluster (0.01)
Plane of the Milky Way
150°
120°
90°
60°
30°
Milky Way Center
330°
300°
270°
240°
210°
-30°
Columba Cluster (0.034)
Norma & Great Attractor (0.016)
Perseus-Pisces Supercluster (0.017+)
-60°
M31 (800 Kpc)
Large Magellanic Cloud (50 Kpc)
Fornax Cluster (20 Mpc)
Pisces-Cetus Supercluster (0.063)
Cetus Wall (0.02)
Huchra Cluster (0.027)
Pavo-Indus Supercluster (0.015)
Horologium Supercluster (0.067)
Sculptor Supercluster (0.054)
Legend: image shows 2MASS galaxies color coded by redshift (Jarrett 2004)
familiar galaxy clusters/superclusters are labeled (numbers in parenthesis represent
Graphic created by T. Jarrett (IPAC/Caltech)
Redshift (V_H / c)
0 0.01 0.02 0.03 0.04 0.05 0.06 0.07 0.08

CMB

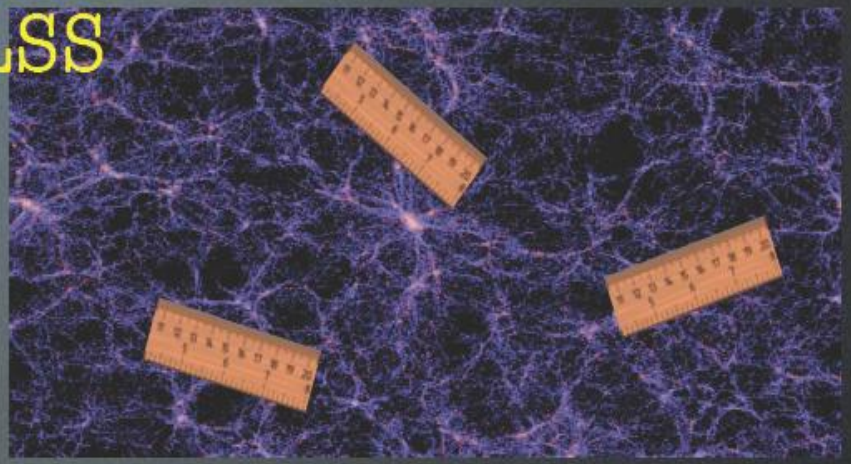


$T = 2.725° K$

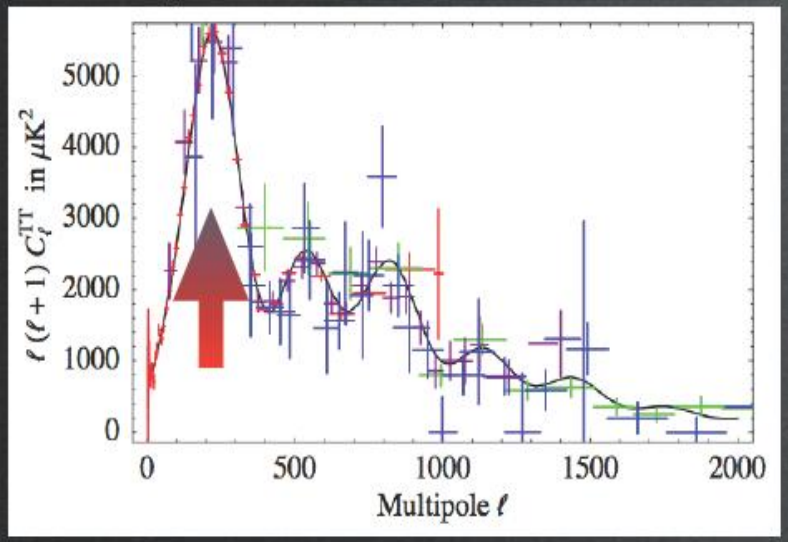
$\frac{\delta T}{T} \sim 10^{-5}$

$1°$

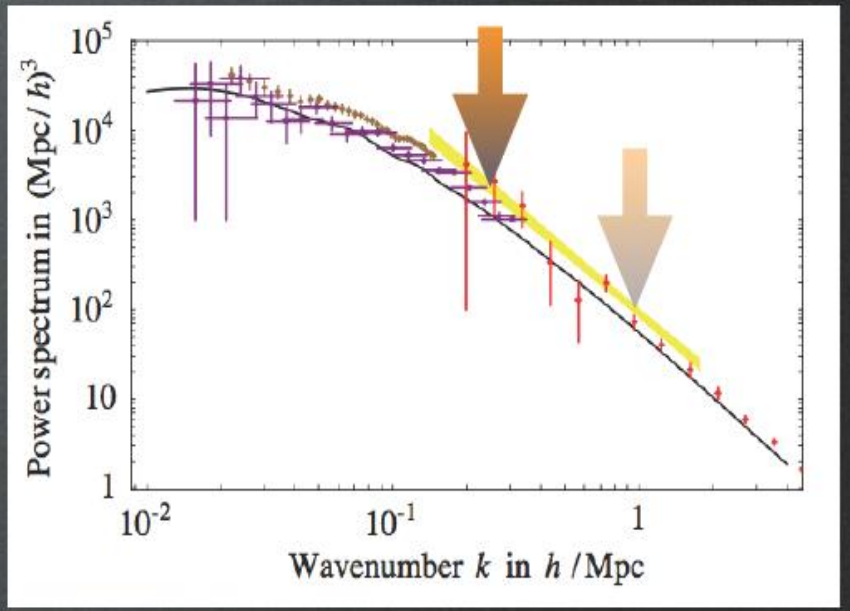
LSS



CMB spectrum



LSS matter power spectrum

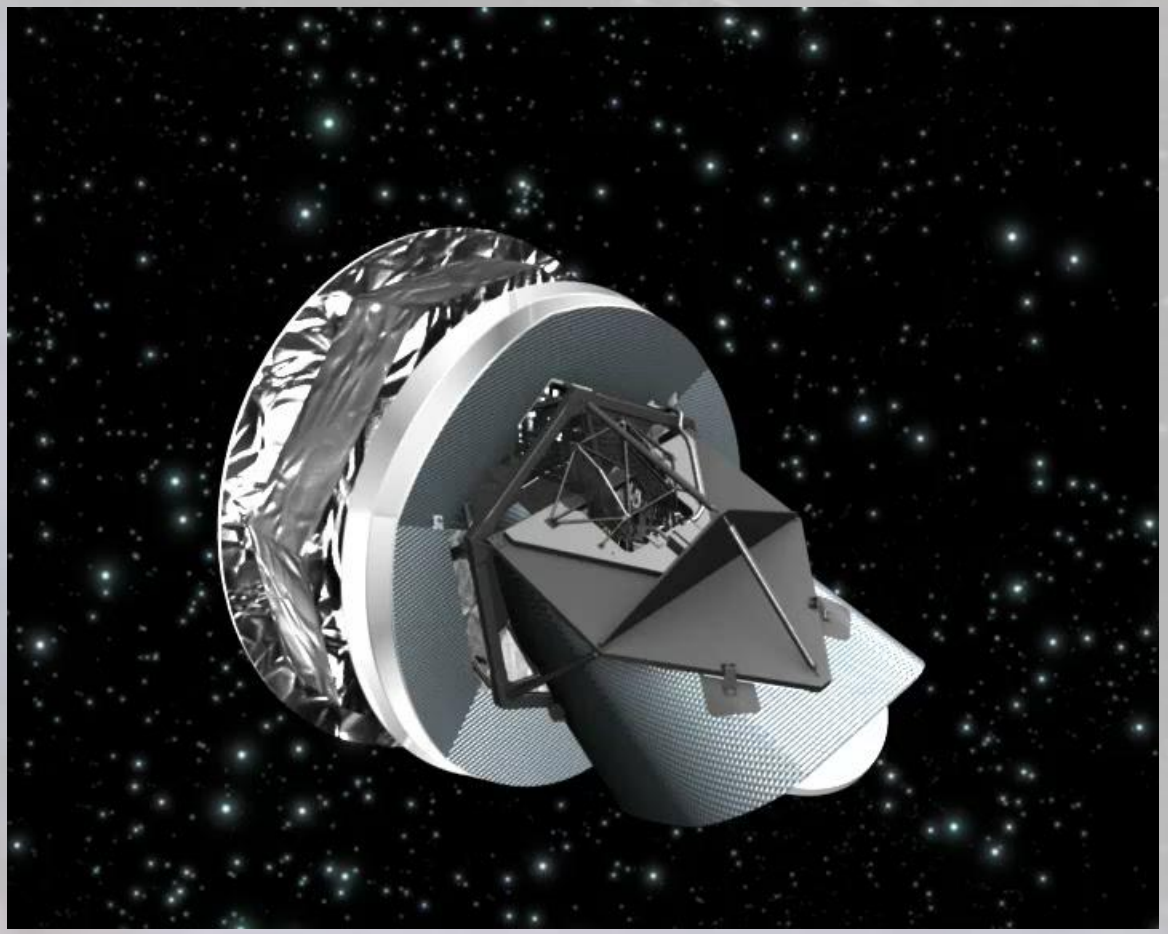


Planck este prima misiune Europeana destinata studierii

Radiatiei Cosmice de Fond in domeniul Microundelor

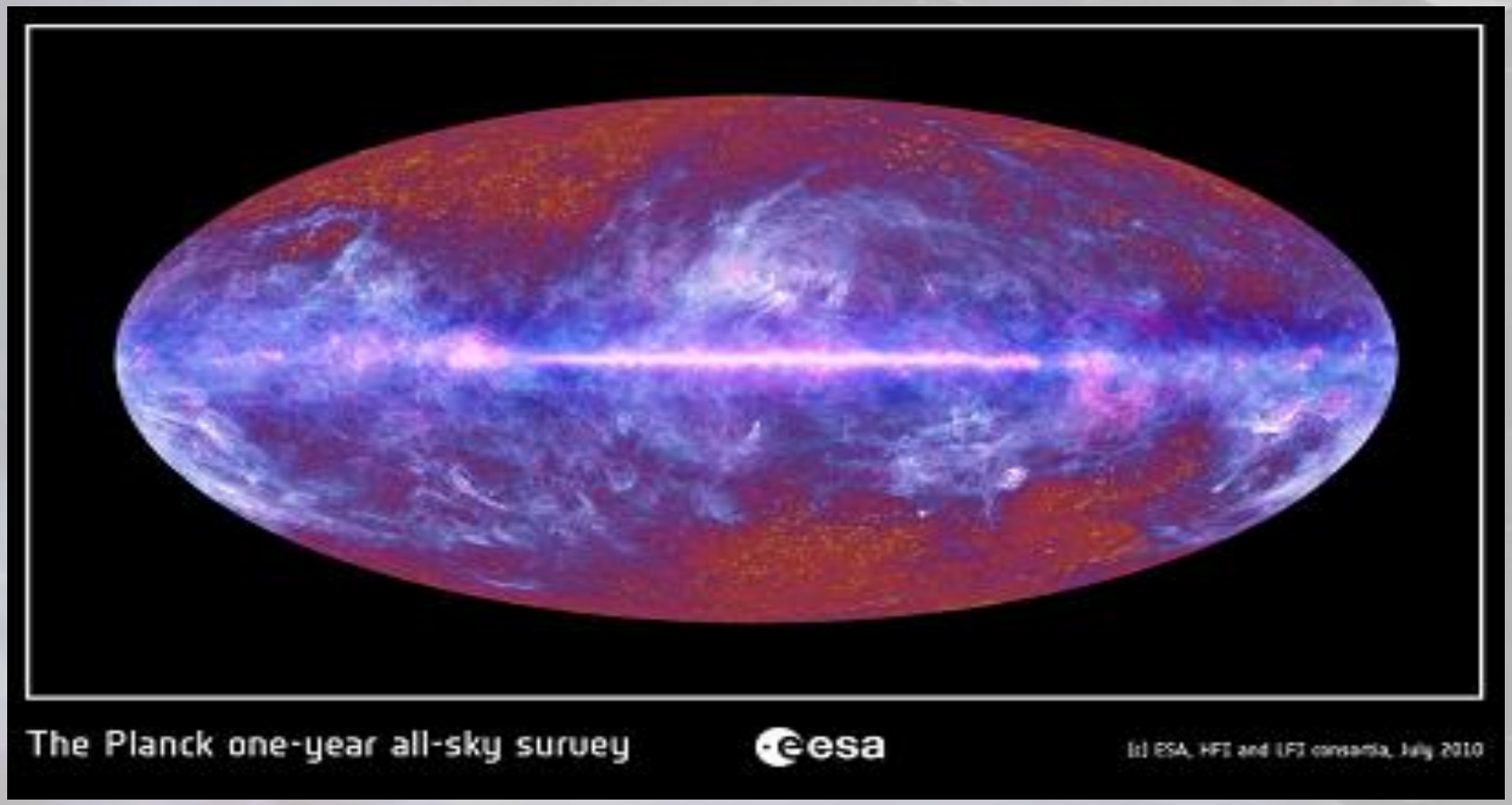
(CMB)





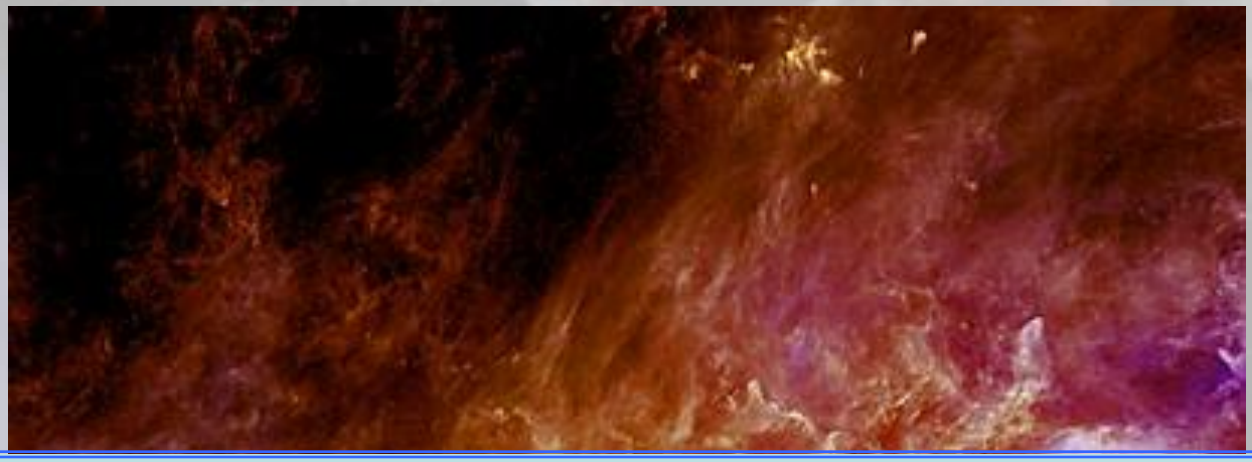
Statutul misiunii

Iulie 2010 : prima scanare a fost terminata



Statutul misiunii II

O retea galactica de praf rece (+12 K)

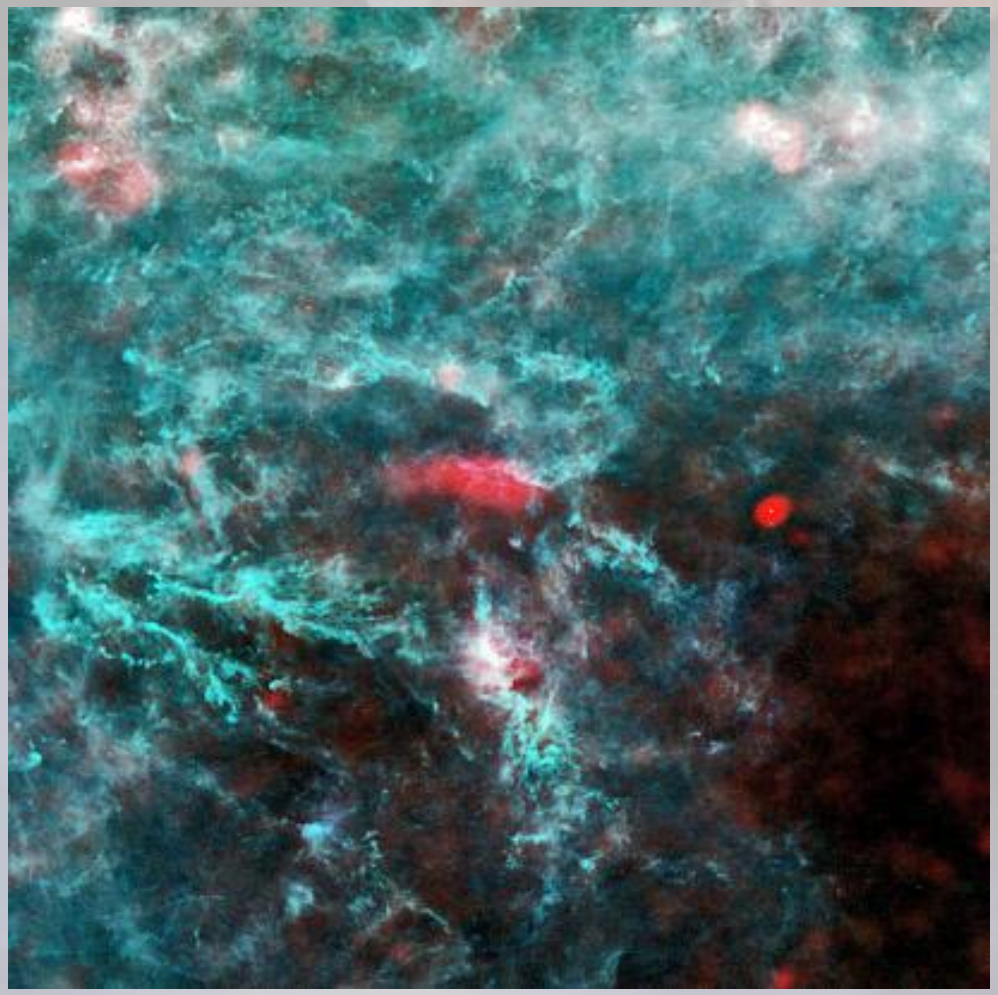


Abilitatea lui Planck de a masura temperatura celor mai reci particule de praf va constitui un indicator important al proceselor fizice ce se petrec in mediul interstelar si in regiunile unde se formeaza stele.



Statutul misiunii III

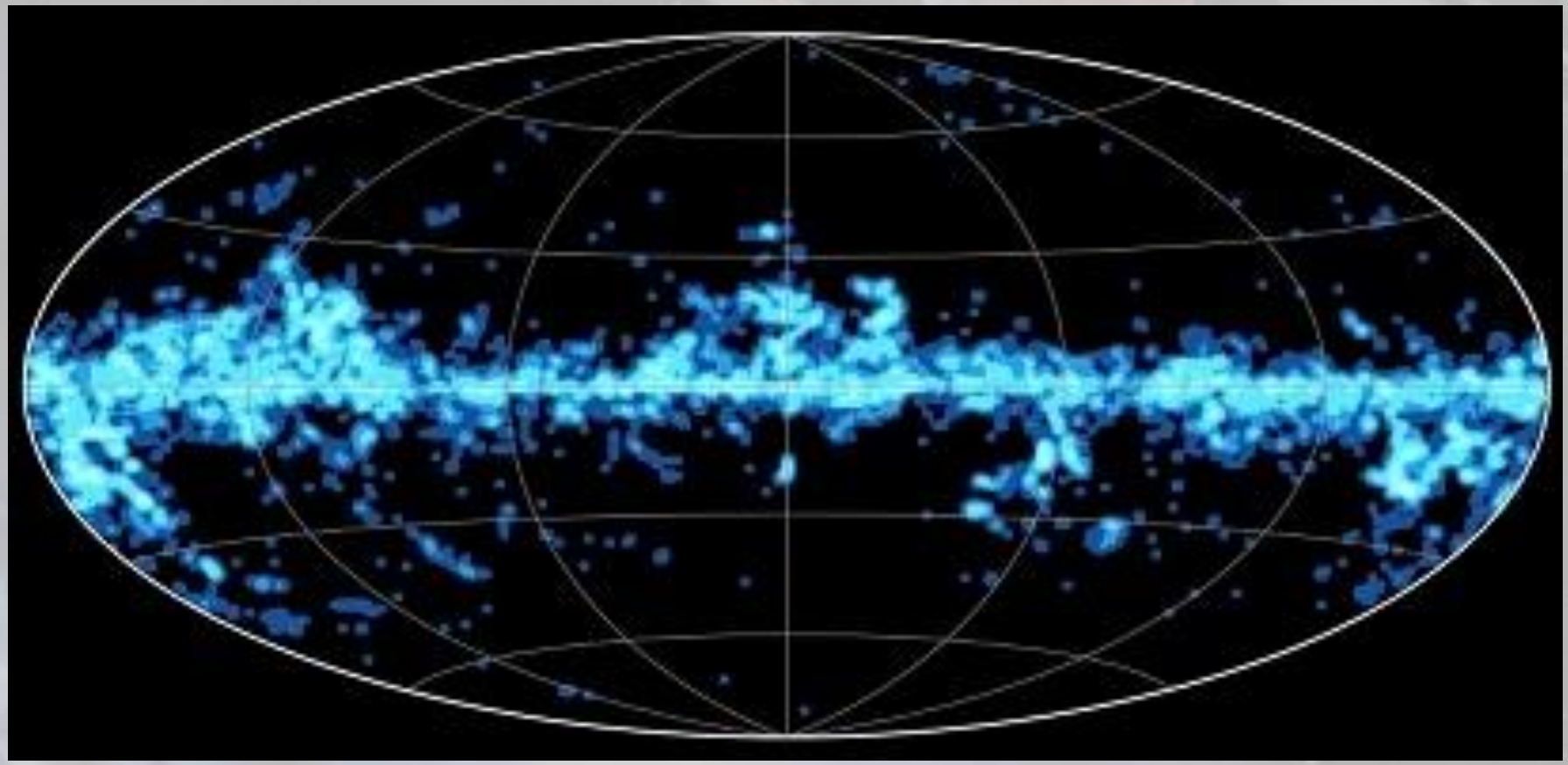
Imaginea Constelatiei Perseu



o zona cu activitate scazuta de formare stelara

Statutul misiunii IV

Distributia nucleelor reci din Milky Way



extrem de importante pentru a intelege primele faze ale formarii stelare

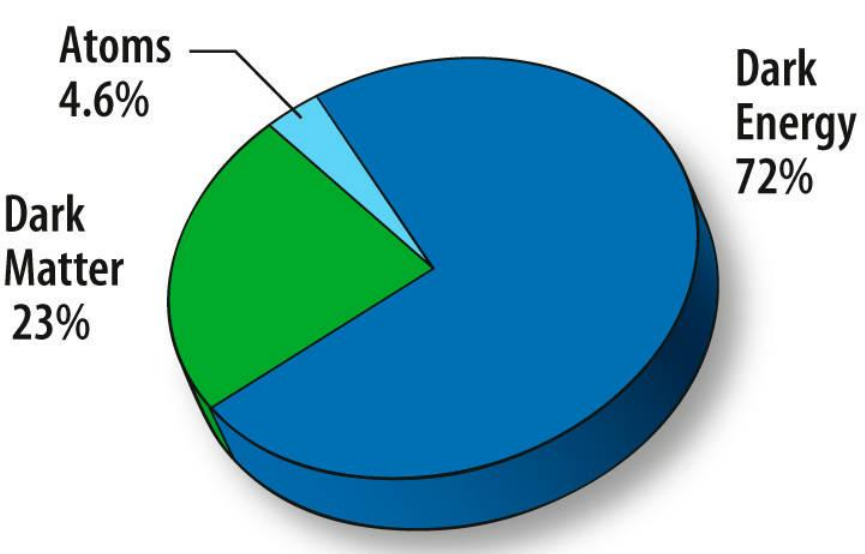
Statutul misiunii V



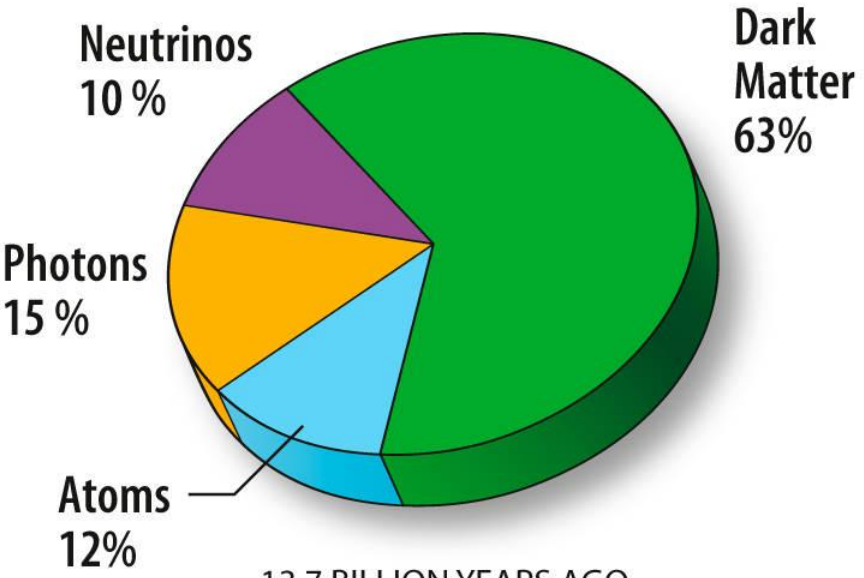
ERCSC cuprinde o varietate de obiecte astronomice, atat galactice (stele cu invelis de praf, nuclee reci de nori moleculari, etc) cat si extragalactice (radio galaxii, blazari, clustere de galaxii, etc) si reprezinta o baza de data robusta pentru intreaga comunitate stiintifica

Datele procesate vor fi livrate comunitatii spre sfarsitul anului 2012 si vor tine cosmologii si astrofizicienii ocupati pentru zeci de ani de acum incolo





TODAY



13.7 BILLION YEARS AGO

(Universe 380,000 years old)



Premiul Nobel pentru fizica 2011: A. G. Riess, S. Perlmutter si B. P. Schmidth

1) Supernovae type Ia:

'standard candles'

$$\mathcal{L} = 4\pi F\, d_{\mathrm{L}}^2 = 4\pi F\, \chi^2 (1+z)^2$$

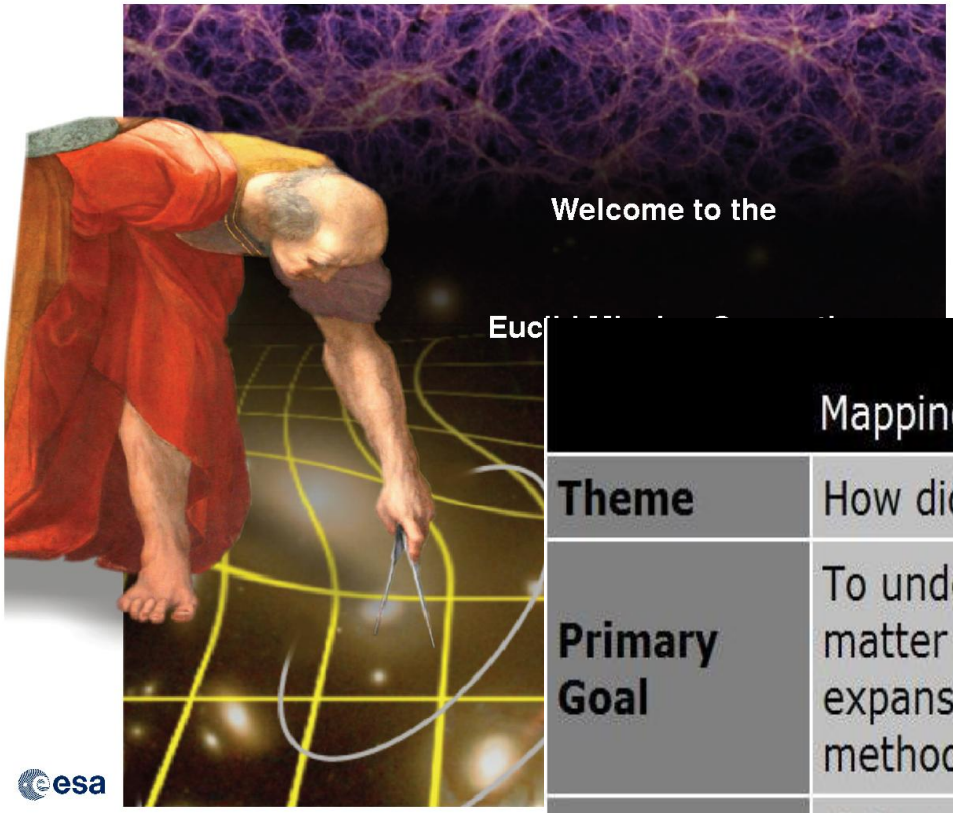
$\mathcal{L}$: Luminosity; χ: comoving distance



$$\chi(z) = \int_0^z \frac{dz'}{H(z)} = \int_0^z \frac{dz'}{H_0 \sqrt{\Omega_{\mathrm{M}}(1+z')^3 + \Omega_\Lambda}}$$

so $\mathcal{L}$ as fnct of z and $\Omega_{\mathrm{M}}, \Omega_\Lambda$

Supernovele indepartate apar mai putin luminoase decat ar fi intr-un univers care nu accelereaza



Euclid este o misiune a ESA menita sa cartografieze geometria Universului intunecat

Euclid
Mapping the geometry of the dark Universe

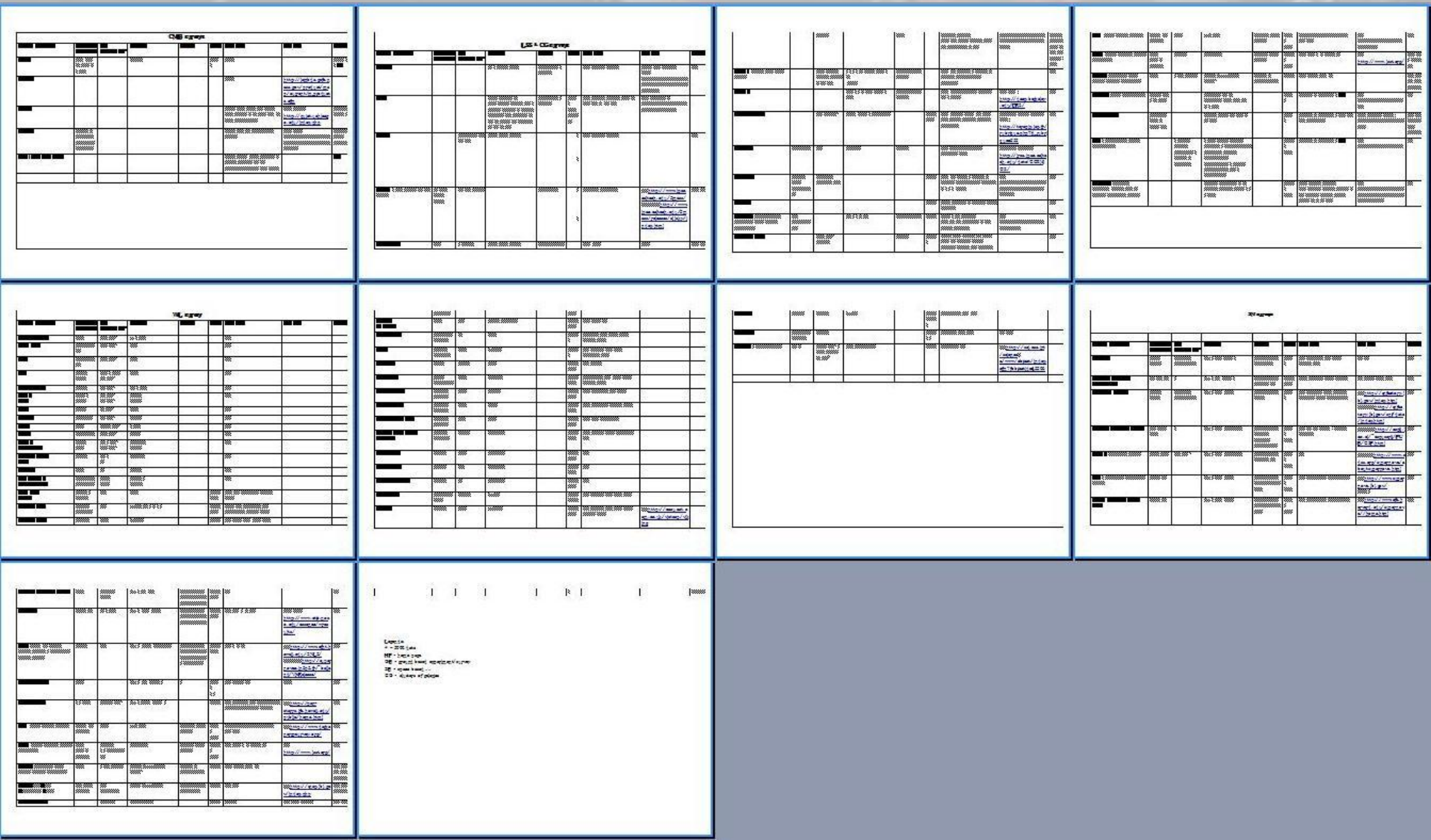
Theme	How did the Universe originate and what is it made of?
Primary Goal	To understand the nature of dark energy and dark matter by accurate measurement of the accelerated expansion of the Universe through different independent methods.
Targets	Galaxies and clusters of galaxies out to z~2, in a wide extragalactic survey covering 15 000 deg², plus a deep survey covering an area of 40 deg²
Wavelength	Visible and near-infrared
Telescope	1.2 m Korsch
Orbit	Second Sun-Earth Lagrange point, L2
Lifetime	6 years
Type	M-class mission

Euclid Primary Science Objectives

ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

Issue	Our Targets
Dark Energy	Measure the DE equation of state parameters w0 and wa to a precision of 2% and 10%, respectively, using both expansion history and structure growth.
Test of General Relativity	Distinguish General Relativity from the simplest modified-gravity theories, by measuring the growth factor exponent γ with a precision of 2%
Dark Matter	Test the Cold Dark Matter paradigm for structure formation, and measure the sum of the neutrino masses to a precision better than 0.04eV when combined with Planck.
The seeds of cosmic structures	Improve by a factor of 20 the determination of the initial condition parameters compared to Planck alone.

… doar jumatate din experimentele trecute, prezente si viitoare



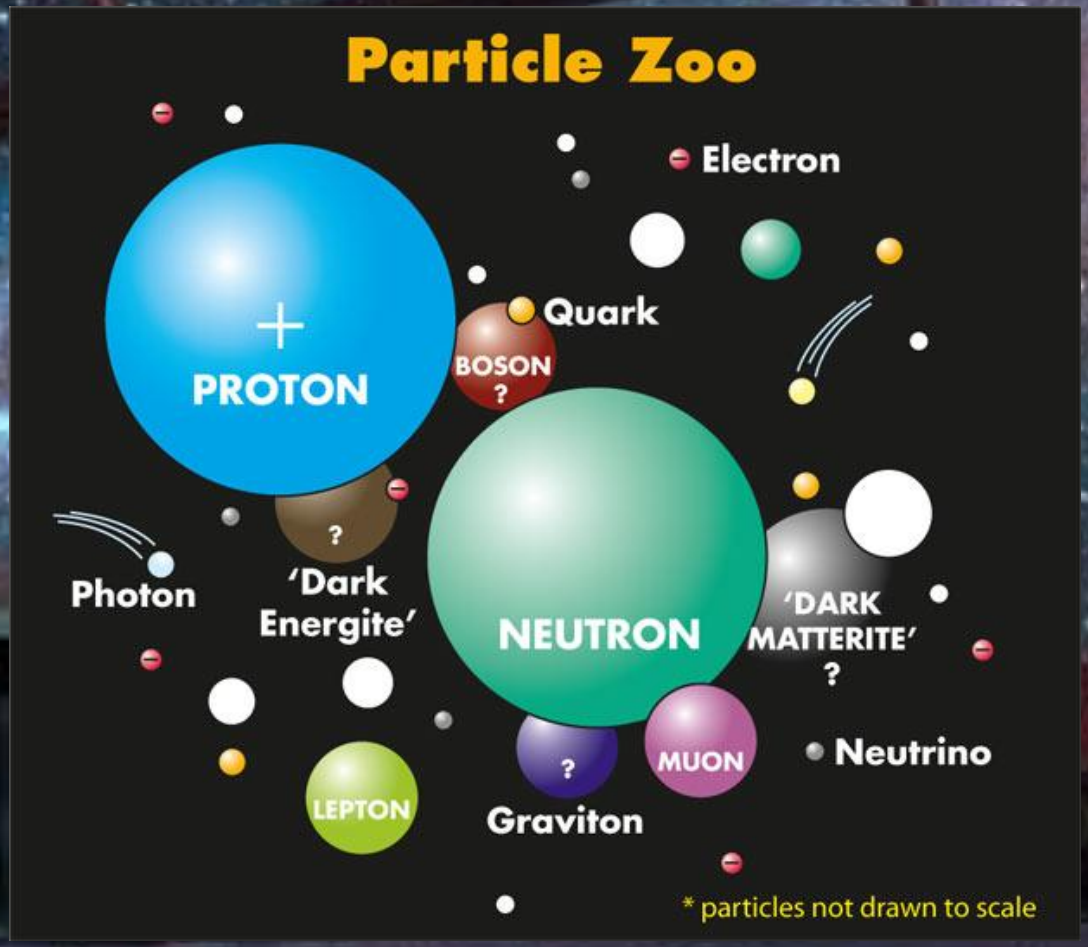
CMB surveys								
Survey/ Experiment	**Telescope/ Instrument**	**Sky coverage deg^2**	**Depth/z**	**Method**	**Years**	**Main goals**	**Data link**	**Other**
Planck	HFI, LFI, 27 GHz to 1 Thz	whole sky	z~1100		2009 –	CMB	HP:http://www.sciops.esa.int/index.php?project=PLANCK	Space based **SP**
WMAP7	1.4 x 1.6 m	whole sky	z~1100		-2001	CMB	http://lambda.gsfc.nasa.gov/product/map/current/m_products.cfm	SP
QUIET	3x2m + 1x7m		z~1100		future	CMB; very large 20% band-width arrays of 40 GHz and 90 GHz polarimeters	date: 2010+; HP:http://quiet.uchicago.edu/index.php	Ground based **GB**
SPIDER	arrays of cryogenic bolometric detectors;	10% of the full sky	z~1100		future	CMB; map the polarization pattern	Data 2011: HP:http://www.astro.caltech.edu/~lgg/spider/spider_front.htm	balloon borne experiment
ACT – Atacama Cosmology Telescope	6m		z~1100; N_{cc} ~1000	SZ effect	2007 –	CMB; CG	HP: http://wwwphy.princeton.edu/act/	**GB**
SPT – South Pole Telescope	10m	4000	z~1100	SZ effect	2007 –	CMB; CG	HP:http://pole.uchicago.edu/index.php	**GB**
AMI – Arcminute MicroKelvin Imager	10 x 3.7m; 8 x 13m		12-18GHz;	SZ effect	2005 –	CMB; CG	HP:http://www.mrao.cam.ac.uk/telescopes/ami/	**GB**
APEX-SZ	12m	0.4 degree field of view	Centered on 150 GHz	SZ effect	2005 – 12	CMB; CG	HP+data:http://www.apex-telescope.org/	**GB**

LSS + CG surveys

Survey/ Experiment	Telescope/ Instrument	Sky coverage deg^2	Depth/z	Method	Years	Main goals	Data link	Others
2dFGRS			b_j < 19.45; z<0.3	photometry + spectra		LSS; redshift survey	public data release, 2003: http://www2.aao.gov.au/2dFGRS/Public/Release/index.html	GB
SDSS			depth r<17.77 *; main galaxy sample has a median redshift of 0.1; for luminous red galaxies as far as z=0.4, for quasars as far as z=5	photometry + spectra	2008 – 2014 (SDSS III)	LSS; redshift survey; aims to map 25% of the sky	data realease 6: http://www.sdss.org/dr6/access/index.html	
6dFGS		mapnearly half the sky	depth K<14 (2006)		2 –	LSS; redshift survey		GB
2MASS – Two Micron All Sky Survey	2x 1.3m JHKs bands	All sky survey		photometry	1 2	LSS(local universe);	HP:http://www.ipac.caltech.edu/2mass/ Data2003:http://www.ipac.caltech.edu/2mass/releases/allsky/index.html	GB; near I
COMBO-17	22m	1 square	depth R<24 (2006)	spectrophotom		LSS; WL;	date:	GB; found

WL survey								
Survey/ Experiment	Telescope/ Instrument	Sky coverage deg^2	Depth/z	Method	Years	Main goals	Data link	Others
VLT-DESCART	VLT	0.65 deg^2	I_{ab} = 24.5			WL		
Groth Strip	HST/WFPC2	0.05 deg^2	I=26			WL		
MDS	HST/WFPC2	0.36 deg^2	I=27			WL		
RCS	CFHT CTIO	16.4 + 45.4 7.6 deg^2	R=24			WL		
Virmos-Descart	CFHT	8.5 deg^2	Iab = 24.5			WL		
Keck + WHT	Keck + WHT	0.6 deg^2 1.0 deg^2	R=25.8 R=23.5			WL		
CTIO	CTIO	75 deg^2	R=23			WL		
SUBARU	SUBARU	2.1 deg^2	R=25.2			WL		
FIRST	VLA	10000 deg^2	1 mJy			WL		
GEMS	HST/ACS	0.22 deg^2	I=27.1			WL		
WHT + COMBO-17	WHT 2.2M	4.0 + deg^2 1.25 deg^2	Rab=25.8 R=24.0			WL		
CFHTLS Deep+ Wide	CFHT	2.1 + 22	Iab=24.5			WL		
GaBoDS	2.2m	15	R=24.5			WL		
ACS parallel + GEMS+GOODS	HST/STIS HST/ACS	0.018 0.027	R=27.0 ? V=27.0			WL		
Deep Lens Survey	Mayall + Blanco	7x4	R=25		2001- 2005	WL, DE, Clusters, High-z Univ.		
CFHTLS Deep	CFHT/ Megacam	4x1	I_{ab}=27, 0.3 < z < 1		2003- 2008	SNIa, DE, Clusters, P(k) WL(z<2.0), High-z Univ.		
CFHTLS Wide	CFHT/	3x50	I_{ab}=24.5		2003-	WL (z<1), DE, P(k), Bias		

+ particle physics experiments (LHC)



Avem nevoie de o teorie unitara, care sa puna de acord datele privitoare la Universul primordial si cel prezent. Construirea acestei teorii presupune anumite asumtii asumtii (existenta bozonului Higgs, masa neutrinilor, unde gravitationale primordiala, etc) pe care experimentele si actuale si viitoare se focuseaza.

Unitaritatea trebuie sa fie atat din punct de vedere al fizicii particulelor (GUT care incearca sa puna impreuna fenomenologia partticulelor elementare) dar si partea cosmologica.

Aceste doua teorii trebuie sa fie in concordanta pentru ca traim intr-un unic Univers si presupunem ca sursa/momentul generarii a fost unic, deci trebuie sa explicam lucrurile intr-un frame comun