Theoretische Physik – Fundamentale Wechselwirkungen

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Institute for Theoretical Physics
Vienna University of Technology

Proseminar LV 138.039,
27. Mai 2011

Outline

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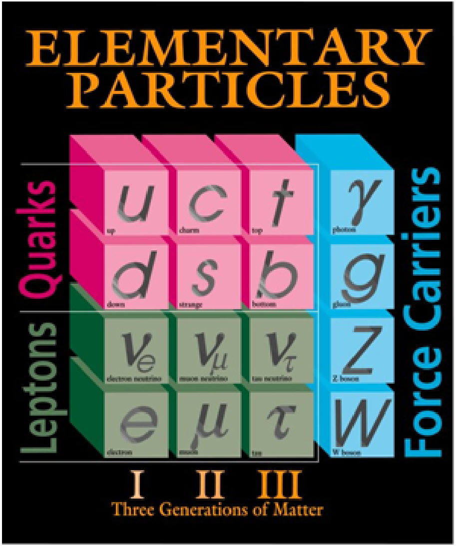
Fundamentale Wechselwirkungen

- Particle Physics
- Cosmology
- Energy budget of the Universe

Personen am Institut

Periodic Table of Elementary Particles

Particles we know and have observed:



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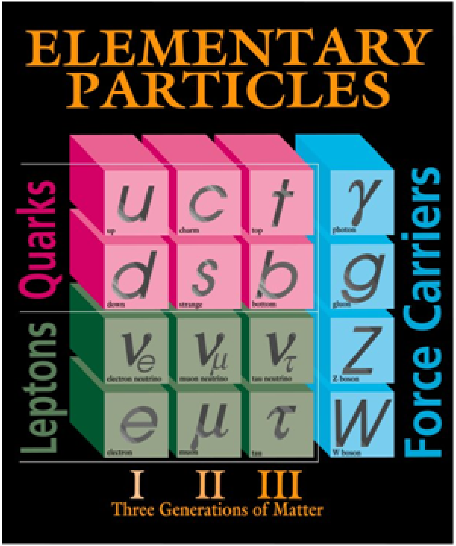

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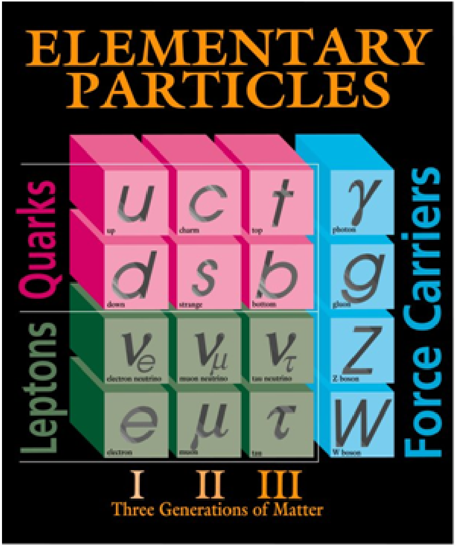

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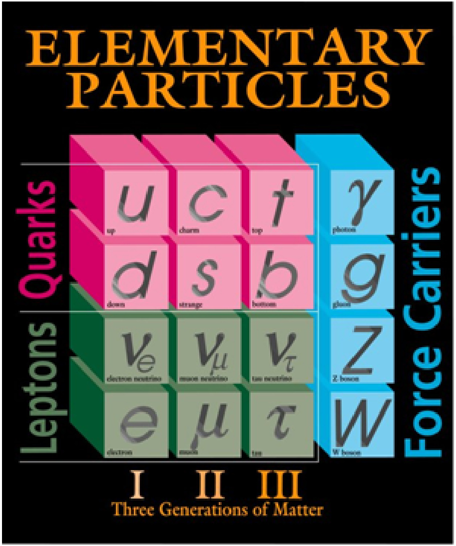

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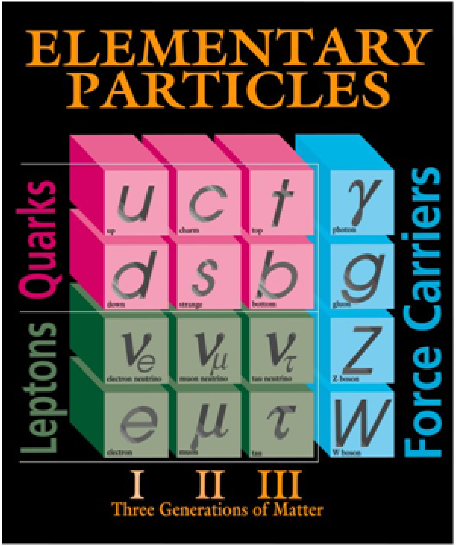

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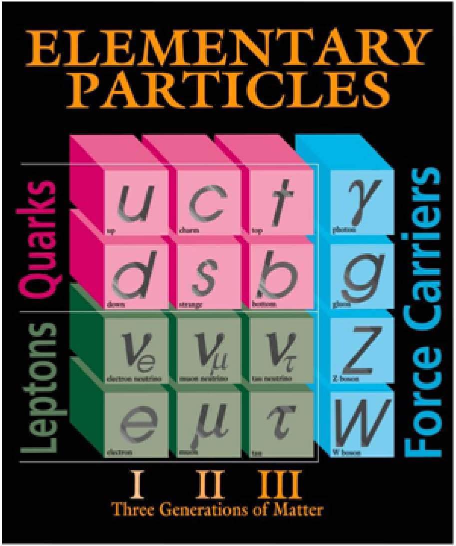

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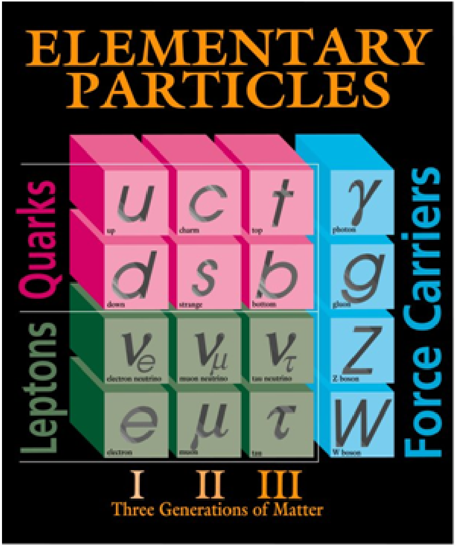

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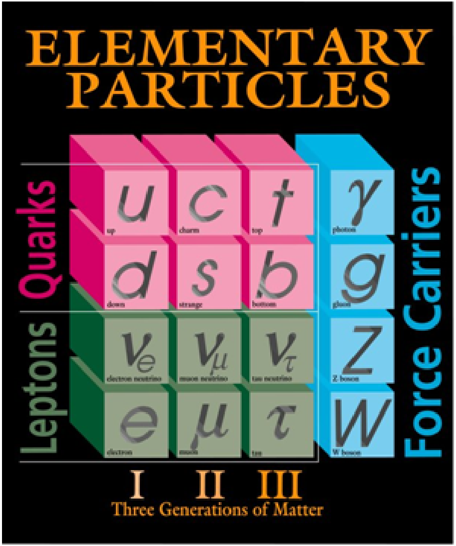

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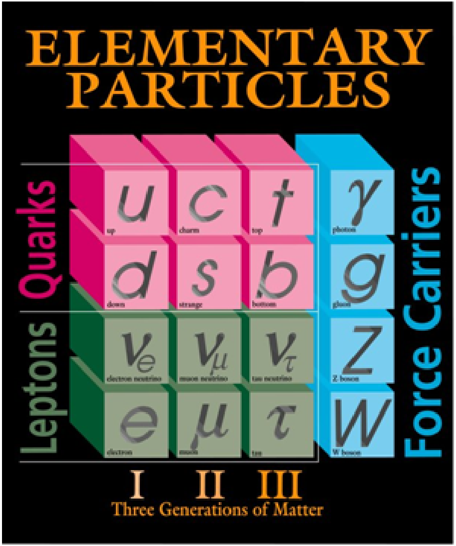

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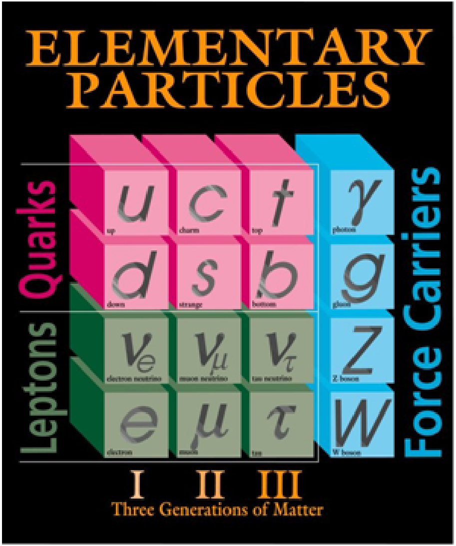

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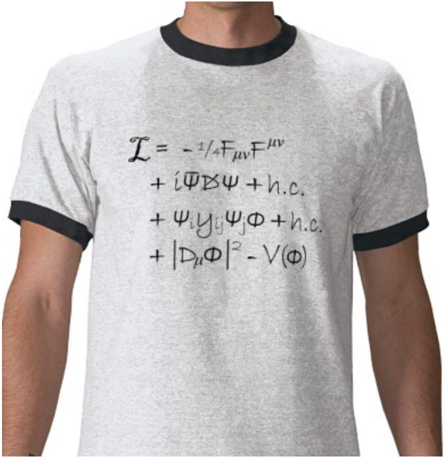
- That's it! (well, almost...)

Standard Model of Particle Physics

A theory of (almost) everything:



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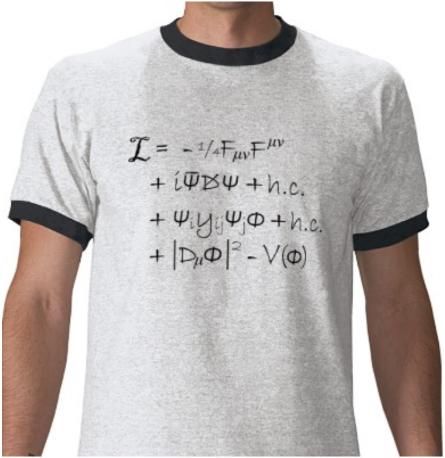

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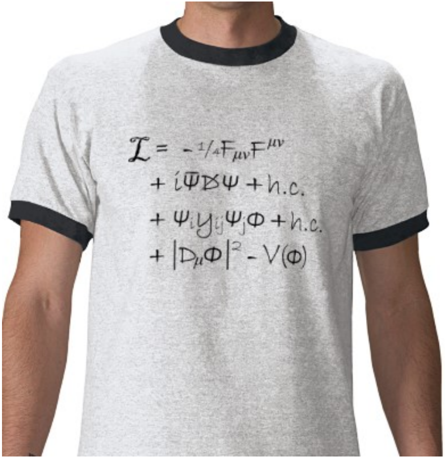

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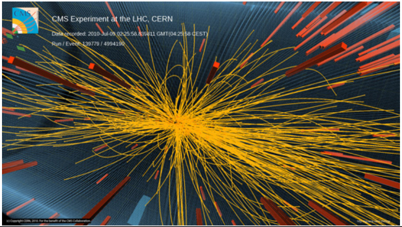
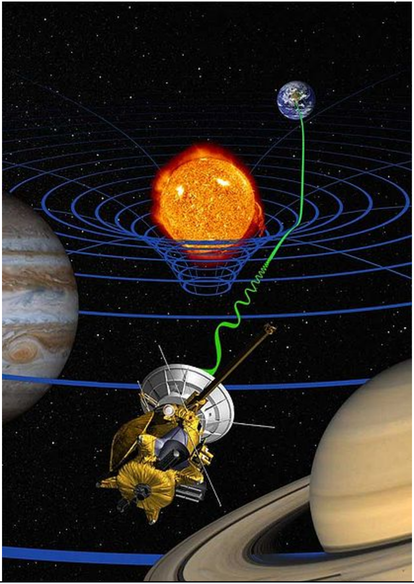
- Currently SM improved at LHC



Gravity

Gravity = Geometry



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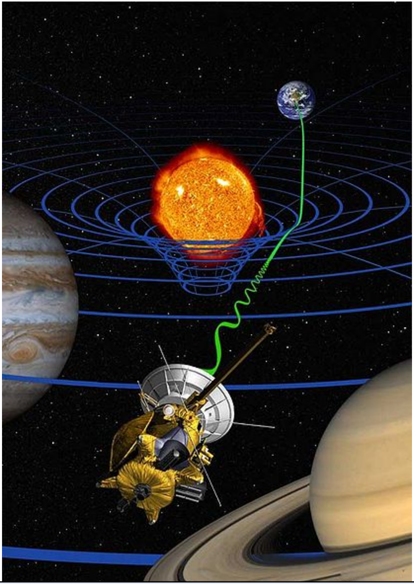

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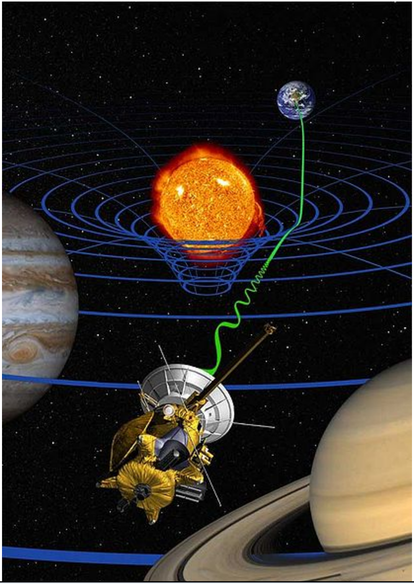

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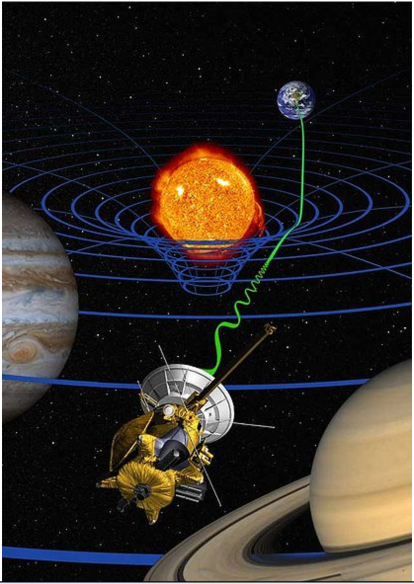

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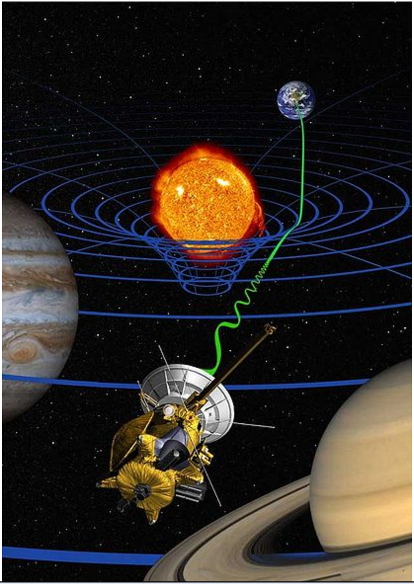

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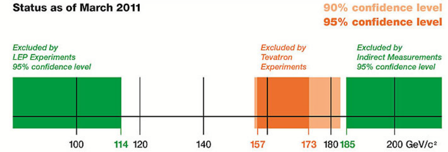
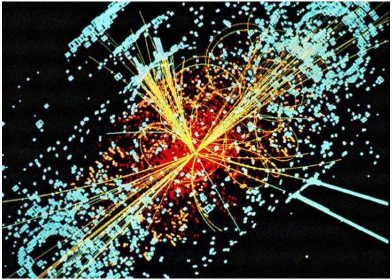
  left: geometry, right: matter
- Tested to high accuracy:
  Perihelion shifts ($\beta - 1 < 2 \cdot 10^{-4}$)
  Radar echo delay ($\gamma - 1 < 2 \cdot 10^{-5}$)
  Binary pulsars ($\alpha_3 < 4 \cdot 10^{-20}$)

Missing Entries in the Periodic Table

Particle in the SM not found yet:





Higgs particle! (or whatever causes electro-weak symmetry breaking...)
LHC will find it this decade!

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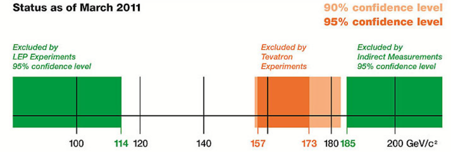

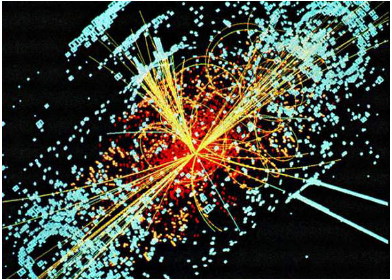

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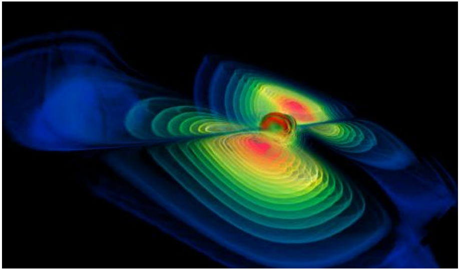

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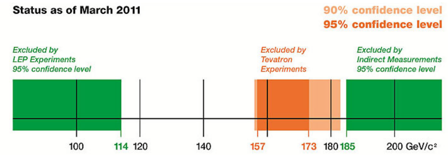

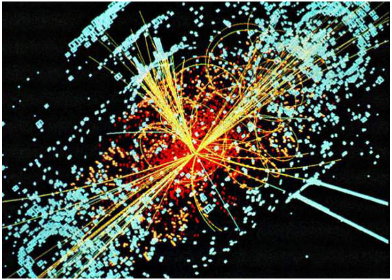

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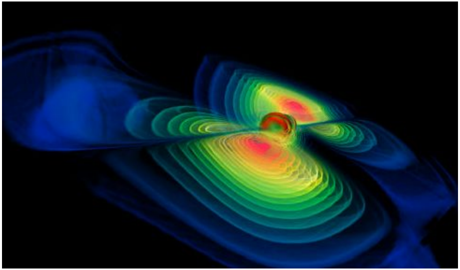

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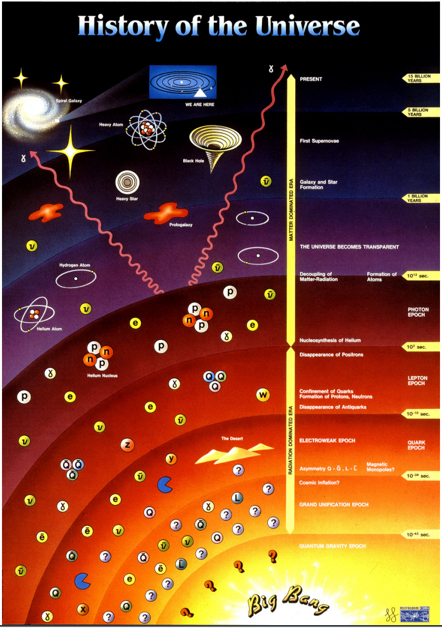
Further particles beyond SM? Inflaton?, SUSY?, Axions?, Dark Spinors?, Kaluza–Kleins?, ...
LHC and Astro/Astroparticle- -physics may find clues!

Brief History of the Universe



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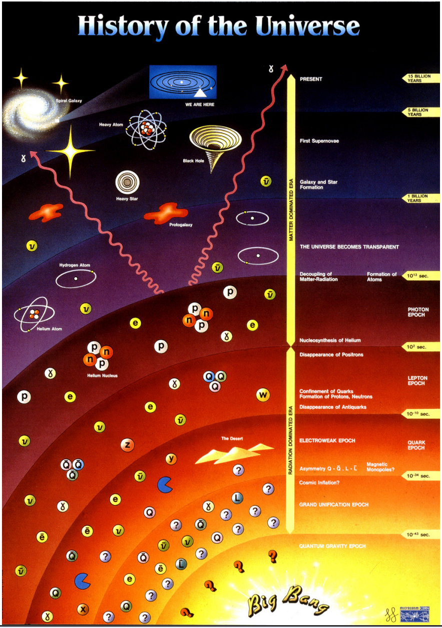

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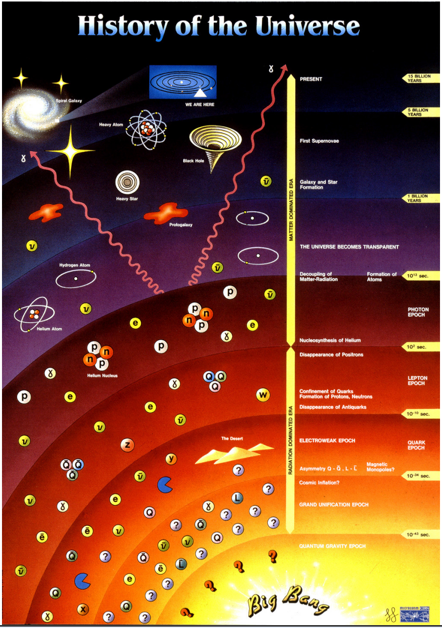

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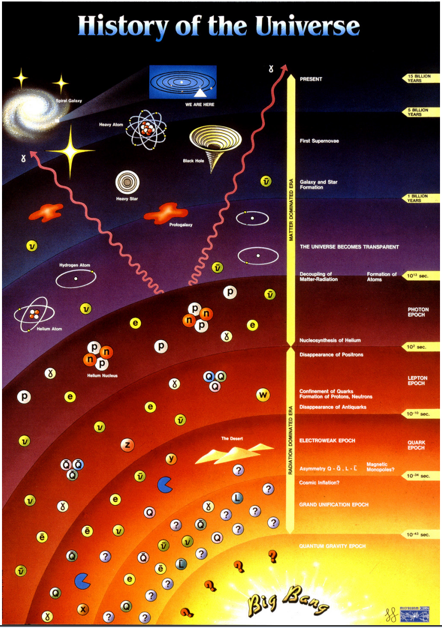

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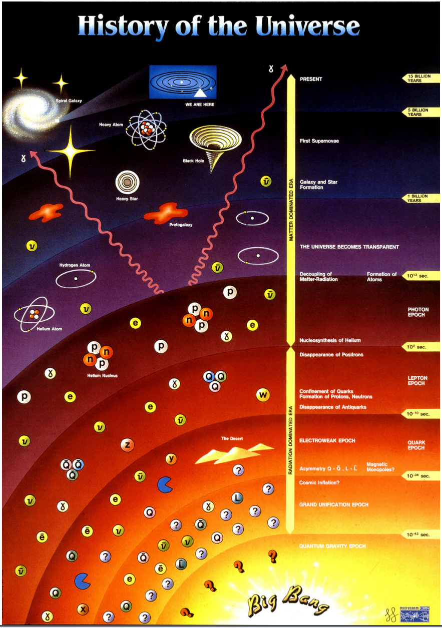

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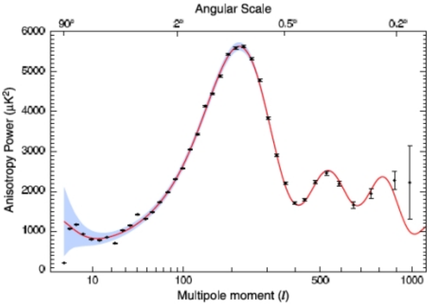
- COBE (1989-1993), WMAP (since 2001), Planck (since 2009)



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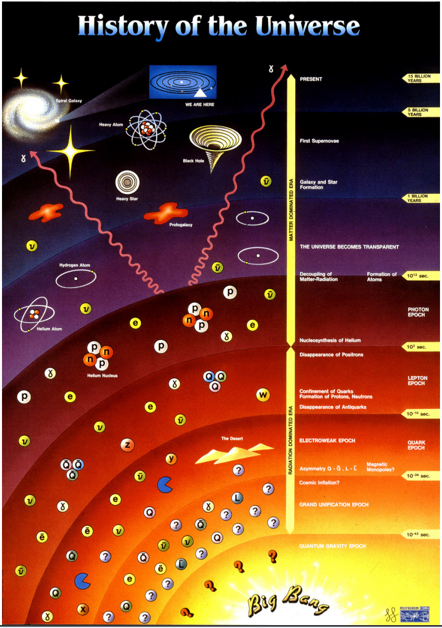

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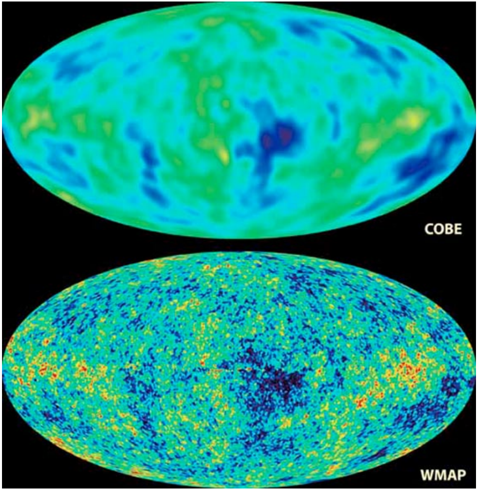

Above: COBE satellite (900km)
Below: WMAP satellite at Lagrange point L2 ($1.5 * 10^6$km)

Standard Model of Cosmology

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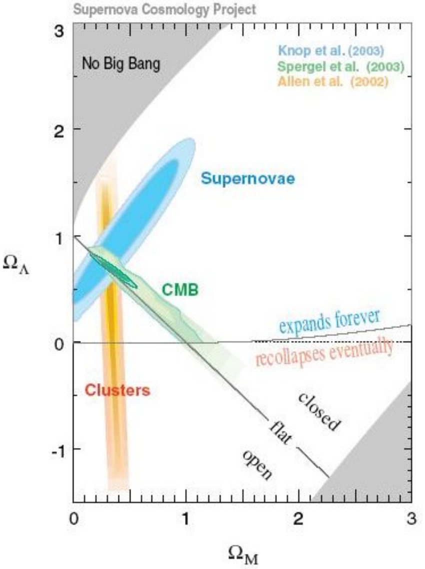

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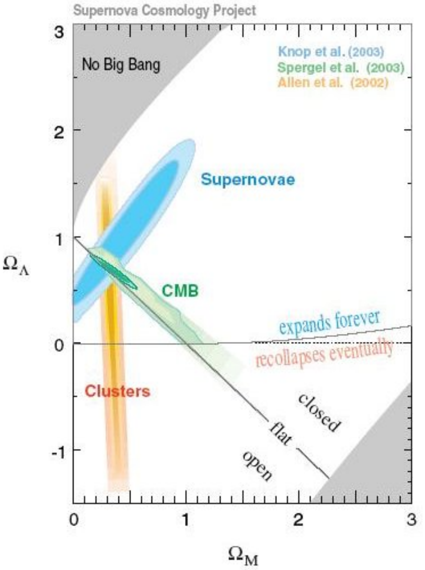

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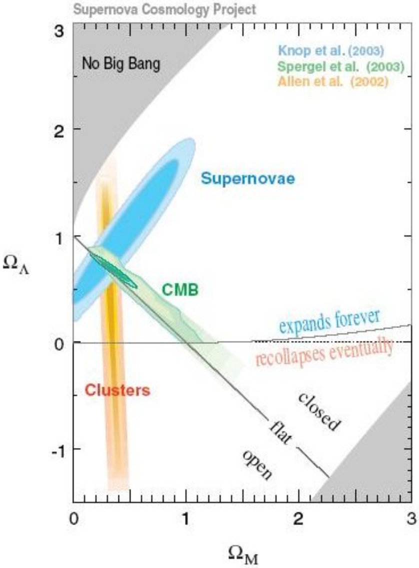

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- Currently many experiments!

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Is anything else missing?

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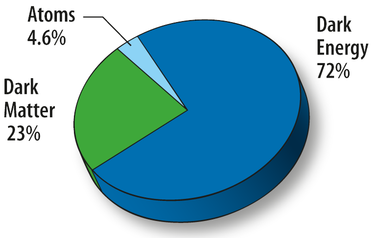
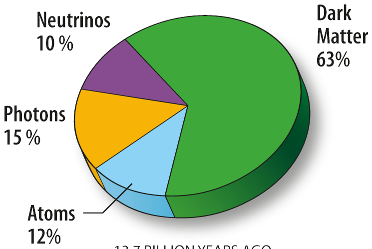


TODAY



13.7 BILLION YEARS AGO

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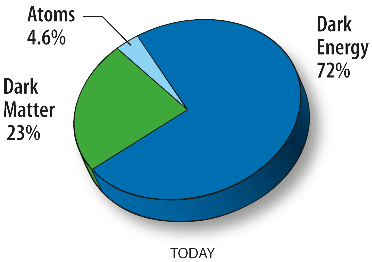

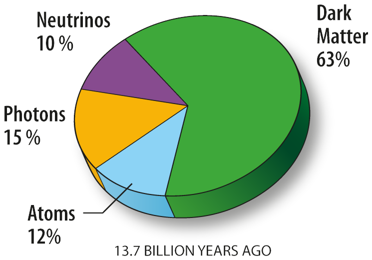

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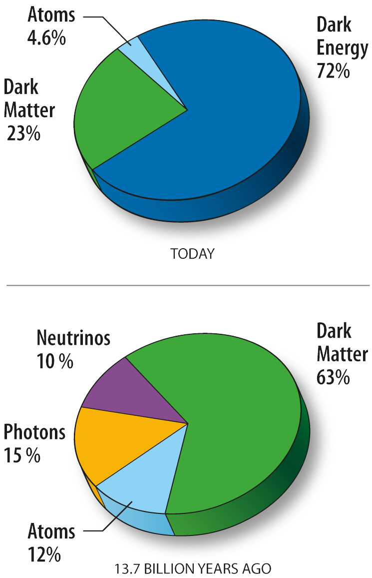

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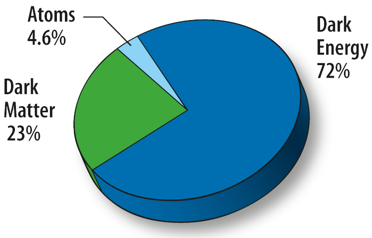

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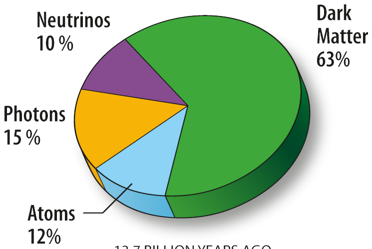

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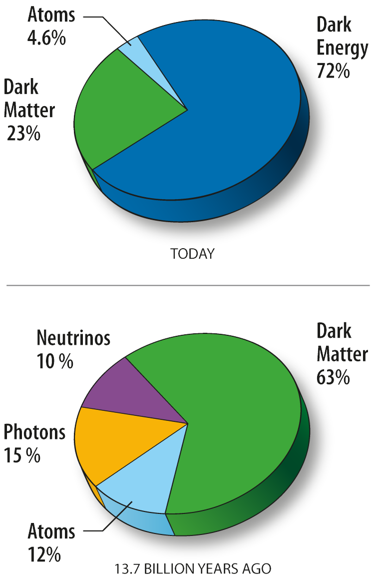

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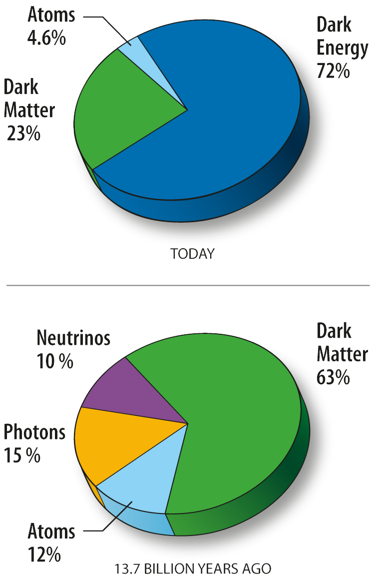

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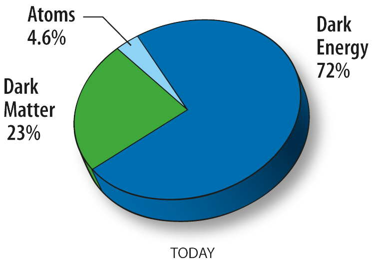

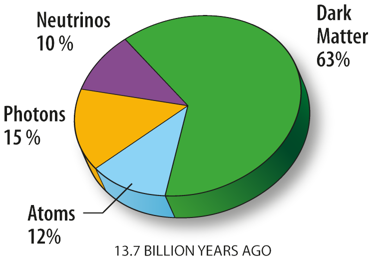

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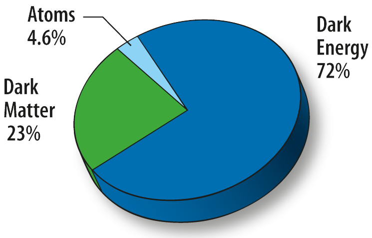
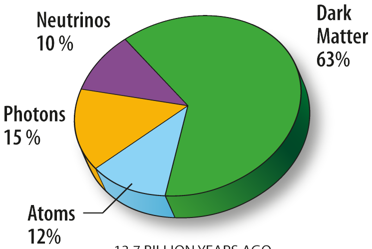
- Plausible candidate: SUSY
- Might be discovered at LHC
- More than 70% "Dark Energy"
- Simplest correct explanation: cosmological constant
- BUT: why so small??? 10^{-123}

What is the Universe made of?



TODAY



13.7 BILLION YEARS AGO

Collect all the available data:

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Unresolved fundamental issues!

Outline

Herbert Balasin — Allgemeine Relativitätstheorie
Klassische und Quantenaspekte

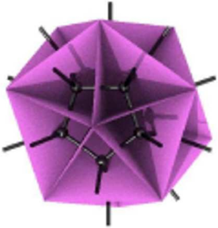
Steckbrief:

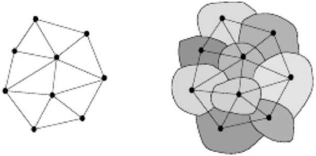
Herbert Balasin

27 publications

Recent collaborations:
U. Brünn
U. Tours
Vienna U.

Distributionelle Relativitätstheorie und Schleifen-Quantengravitation





Ultrarelativistische Schwarze Löcher
Quantisierung von pp-Gravitationswellen

Daniel Grumiller — Schwarze Löcher

Quantengravitation, das holographische Prinzip und Anwendungen

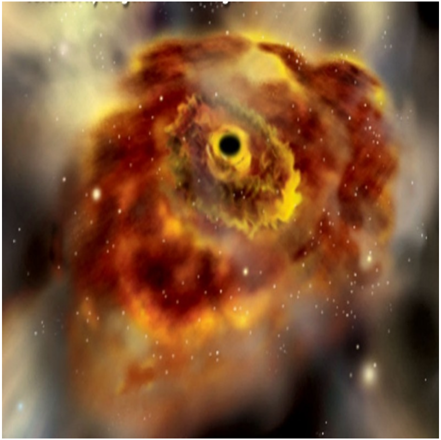
Steckbrief:

Daniel Grumiller

67 publications

Recent collaborations:
ASC and LMU Munich
Brown U.
Charles U.
ESA
ETH Zurich
Leipzig U.
Michigan U.
MIT
Pamukkale U.
Penn State U.
Perimeter Institute
Sao Paulo ABC Federal
St. Petersburg State U.
Uppsala U.
Waterloo U.
Washington U. (Seattle)
Waterloo U.
YITP Stony Brook

Schwarze Löcher in Astrophysik und Kosmologie...

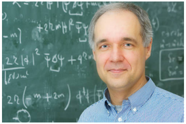


... und neuerdings auch in Elementarteilchenphysik und kondensierter Materie mittels der AdS/CFT Korrespondenz

Anton Rebhan — Quark-Gluon-Plasmaphysik

Schwerionenstösse am RHIC und am LHC

Steckbrief:

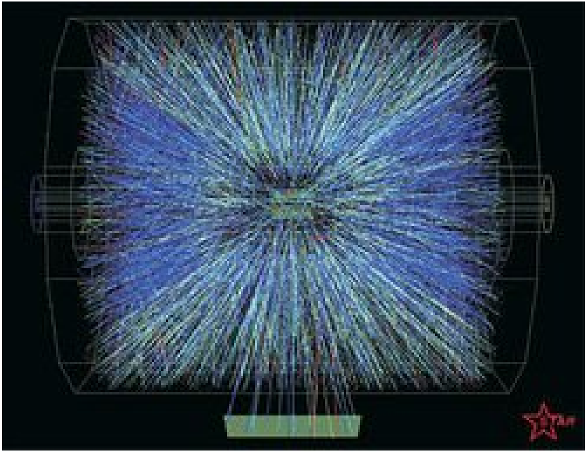


Anton Rebhan

135 publications

Recent Collaborations:
Bielefeld U.
Brandon U.
Cambridge U. DAMTP
Chicago U.
Dubna JINR
Ecole Normale Superieure
ECT Trento
Frankfurt U. FIAS
Gettysburg Coll.
Hannover U.
Helsinki U.
Leipzig U.
Madrid IFT and AU
Saclay SPhT
Santa Barbara KITP
Washington U. (Seattle)
Winnipeg U.
YITP Stony Brook

Schwerionenkollisions-Event im STAR Detektor am RHIC:



Theoretische Beschreibung mit thermischer Quantenfeldtheorie und AdS/CFT Korrespondenz

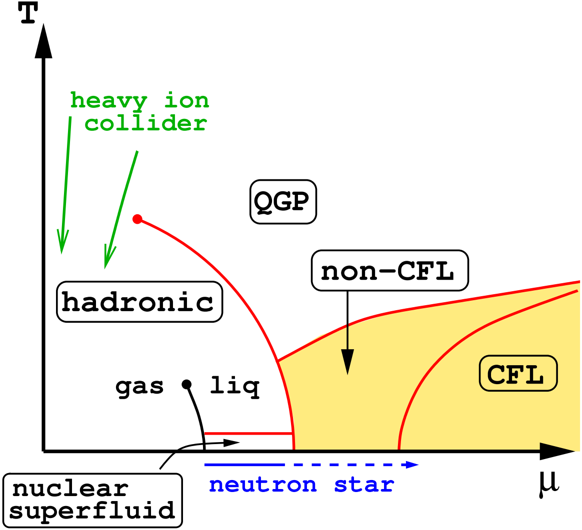
Steckbrief:

Andreas Schmitt

30 publications

Recent collaborations:
Frankfurt U.
Hefei CUST
MIT
North Carolina State U.
Saga U.
Washington U. (St. Louis)
YITP Stony Brook

Das Phasendiagramm der QCD — ein ungelöstes Problem!



Manfred Schweda — Nicht-kommutative Quantenfeldtheorie

Physikalische Gesetze in nicht-kommutativer Raumzeit

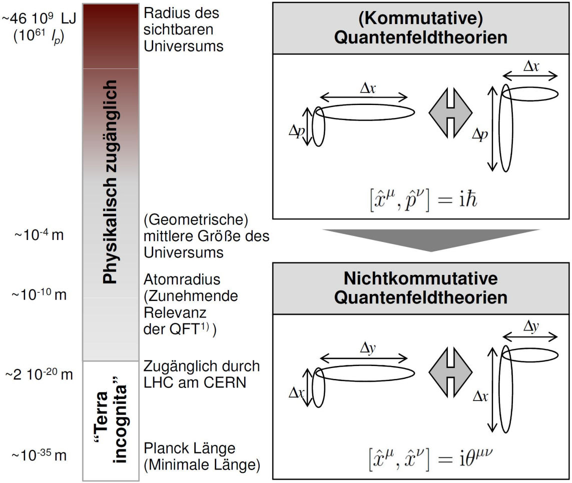
Steckbrief:

Manfred Schweda

112 publications

Recent collaborations:
Espirito Santo U.
Fed. Fluminense U.
Lyon IPN
Leipzig MPI
U. Vienna
Vicosa federal U.

Kurze Distanzen: Unschärfe in Raumzeit!



QFT = Quantenfeldtheorie

Harald Skarke — Stringtheorie

Die Geometrie der verborgenen Dimensionen

Steckbrief:

Harald Skarke

33 publications

Eine Calabi-Yau Mannigfaltigkeit: