Pandora's Cluster a cosmic crash test

Visit of RISE scholars

Heidelberg, July 22, 2011

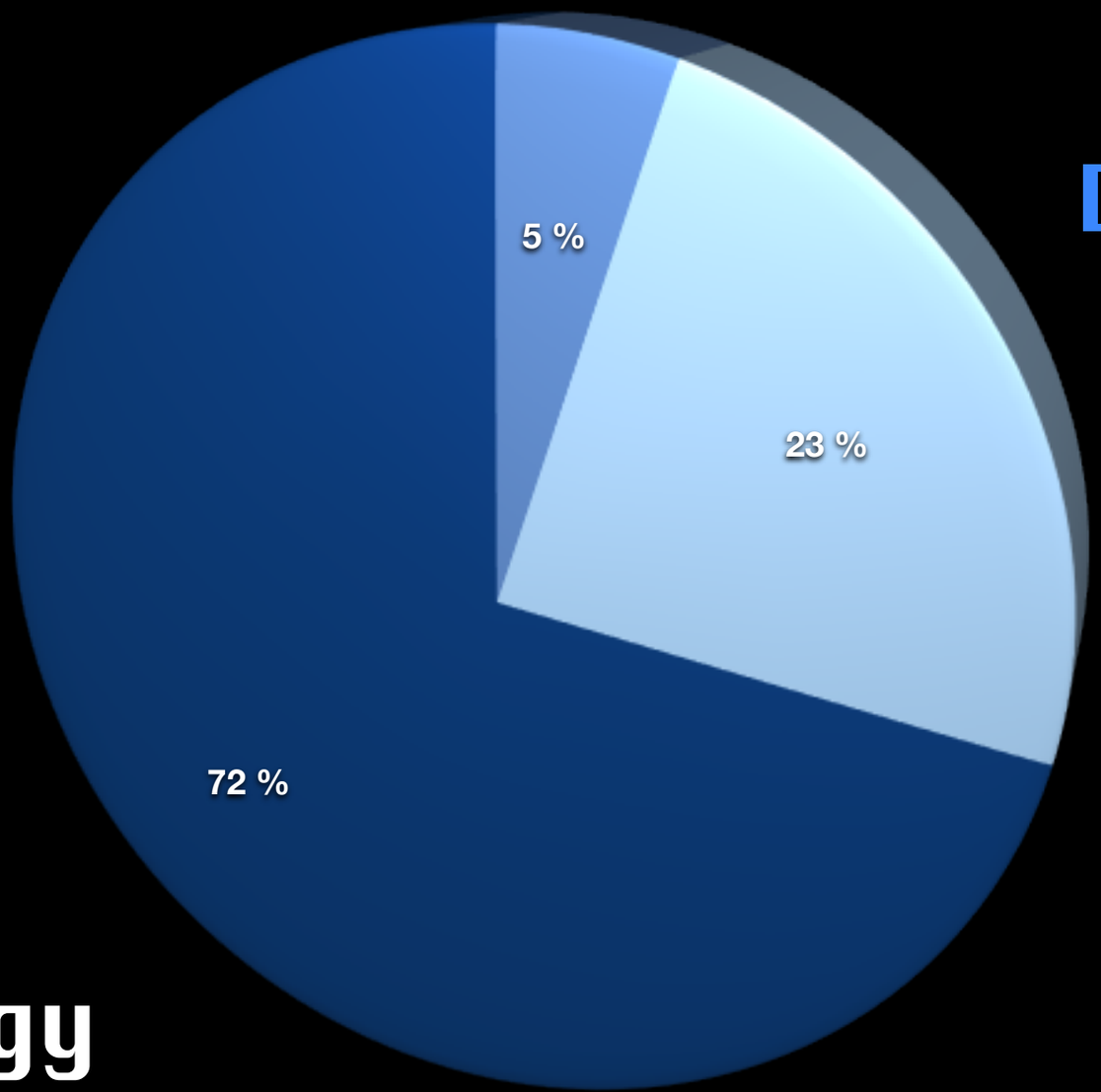
Julian Merten
Institute of Theoretical Astrophysics

University of Heidelberg

Cosmology today

Contents

‘Baryons’

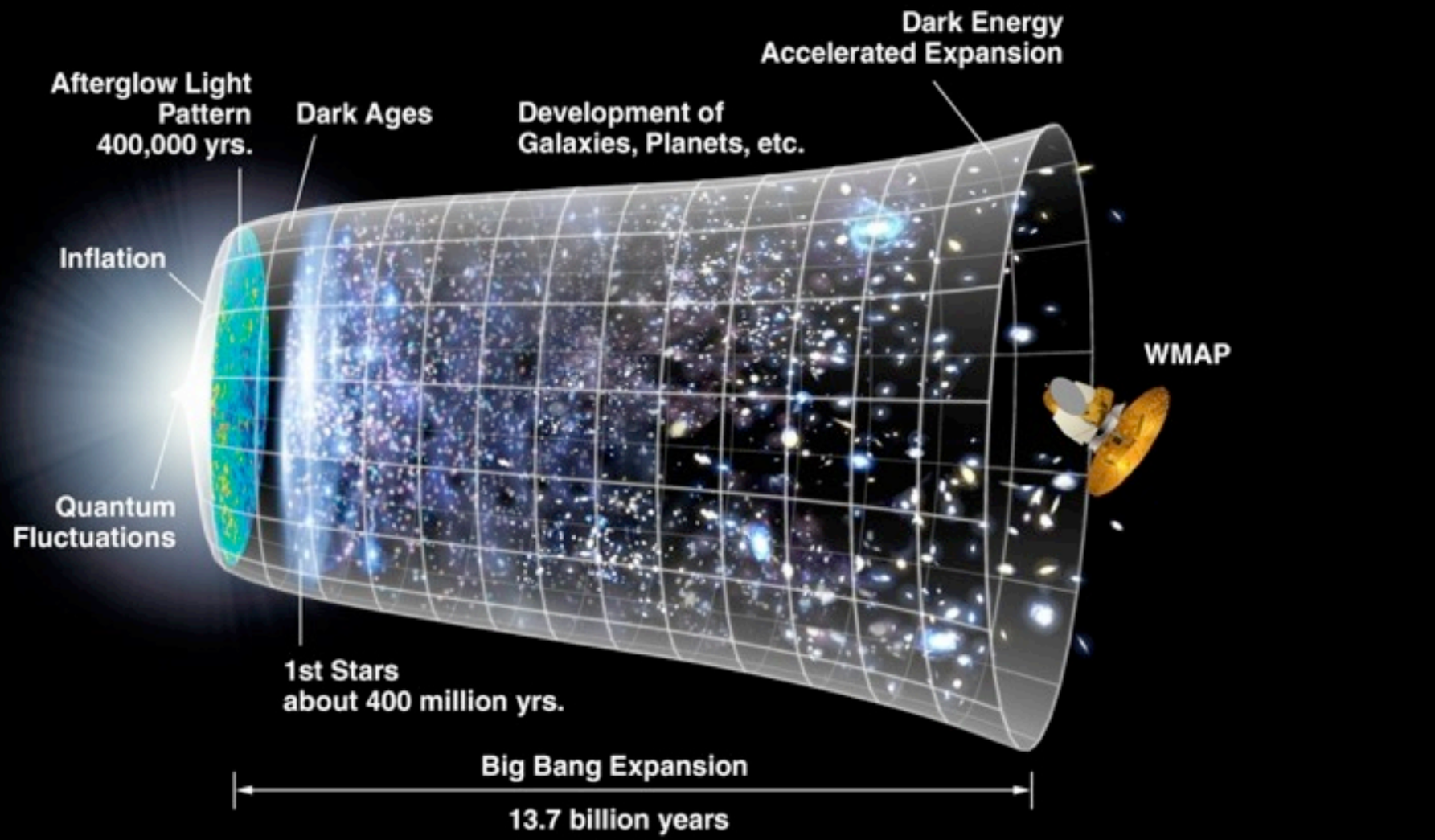


Dark Matter

Dark Energy

Cosmology today

Timeline

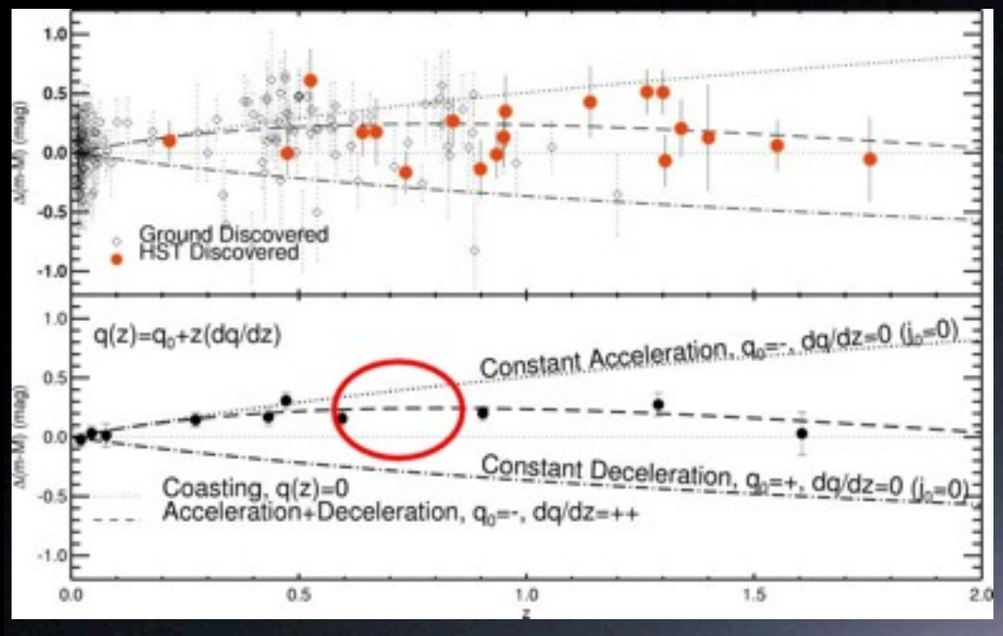


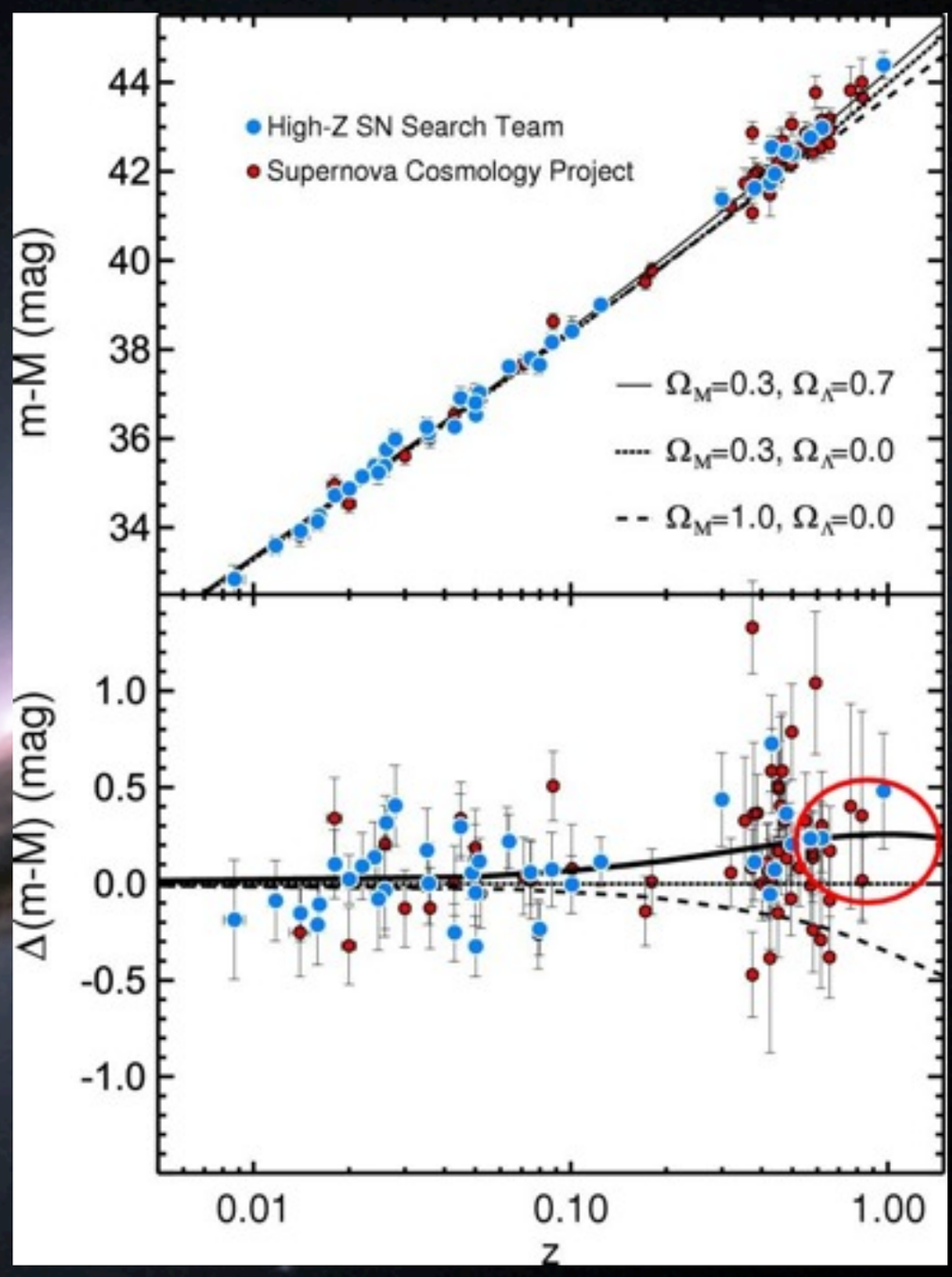
Cosmology today

Why should anyone believe this?

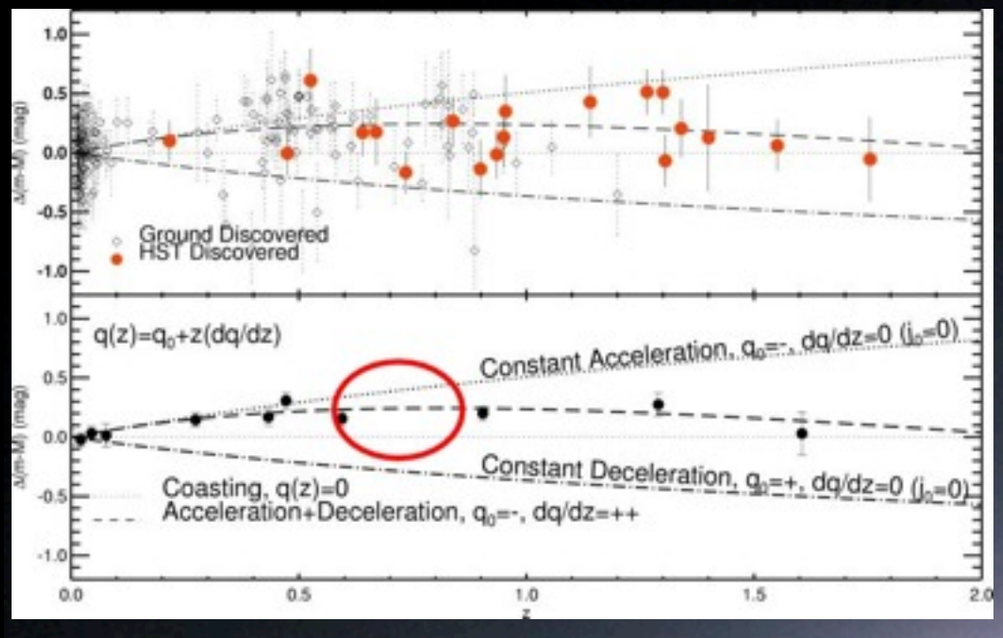
Dark energy

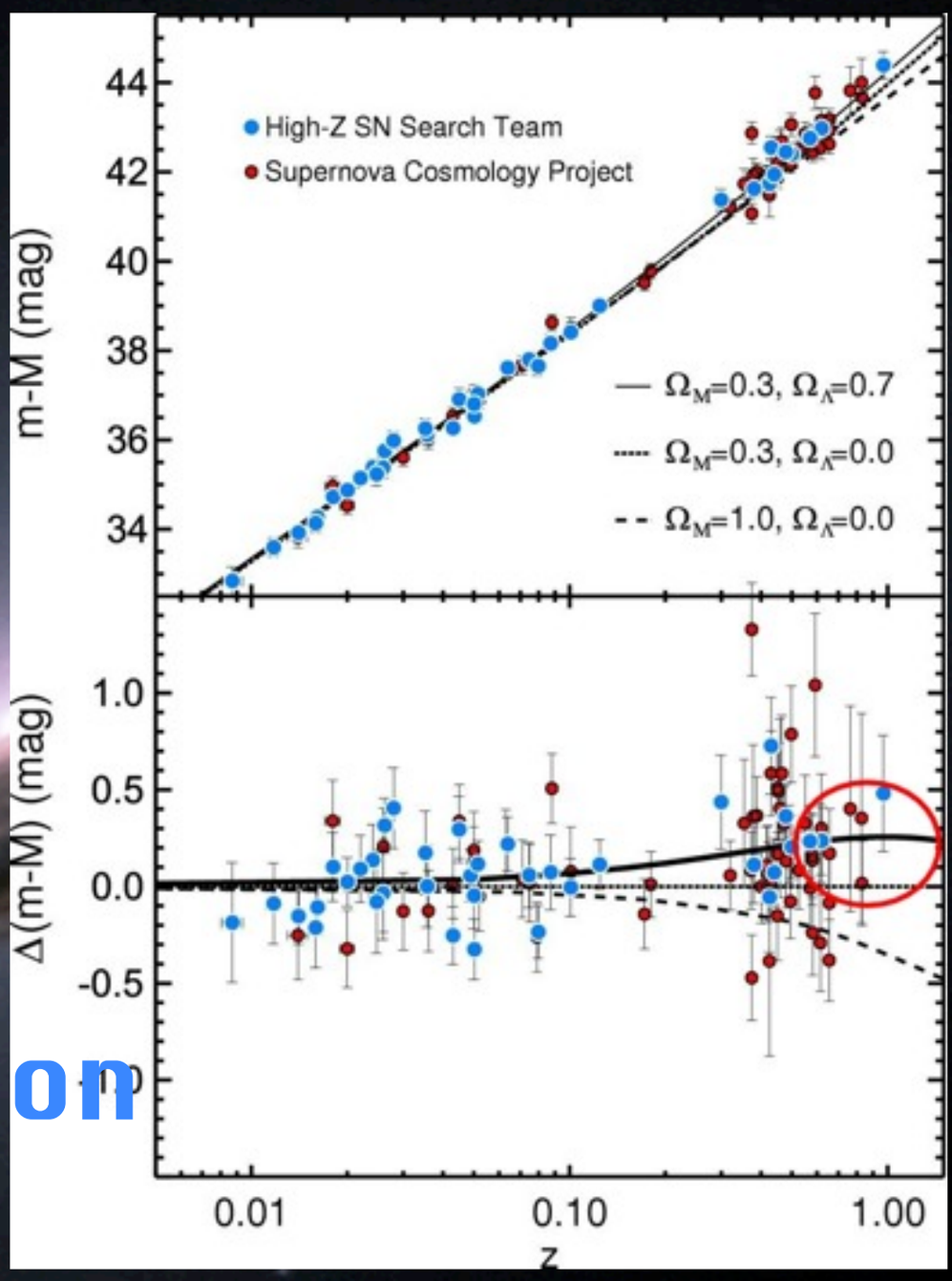
Dark energy


Ground Discovered
HST Discovered
q(z)=q0+z(dq/dz)
Constant Acceleration, q0=-, dq/dz=0 (j0=0)
Constant Deceleration, q0=+, dq/dz=0 (j0=0)
Coasting, q(z)=0
Acceleration+Deceleration, q0=-, dq/dz=++
Δ(m-M) (mag)
z


High-Z SN Search Team
Supernova Cosmology Project
ΩM=0.3, ΩΛ=0.7
ΩM=0.3, ΩΛ=0.0
ΩM=1.0, ΩΛ=0.0
m-M (mag)
Δ(m-M) (mag)
z

Dark energy



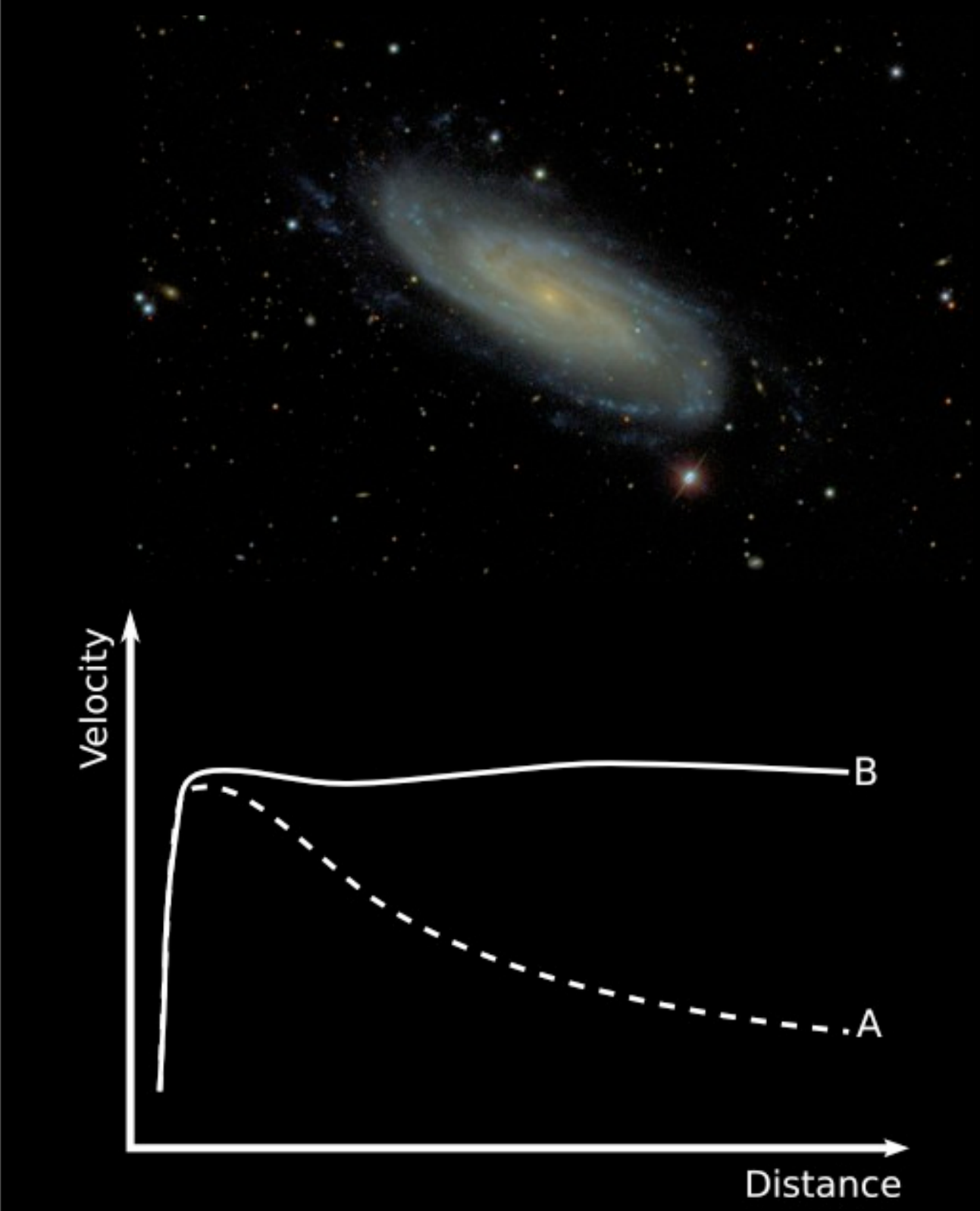


In its recent past
the Universe
seems to undergo
accelerated expansion

We call this DARK ENERGY

Dark matter

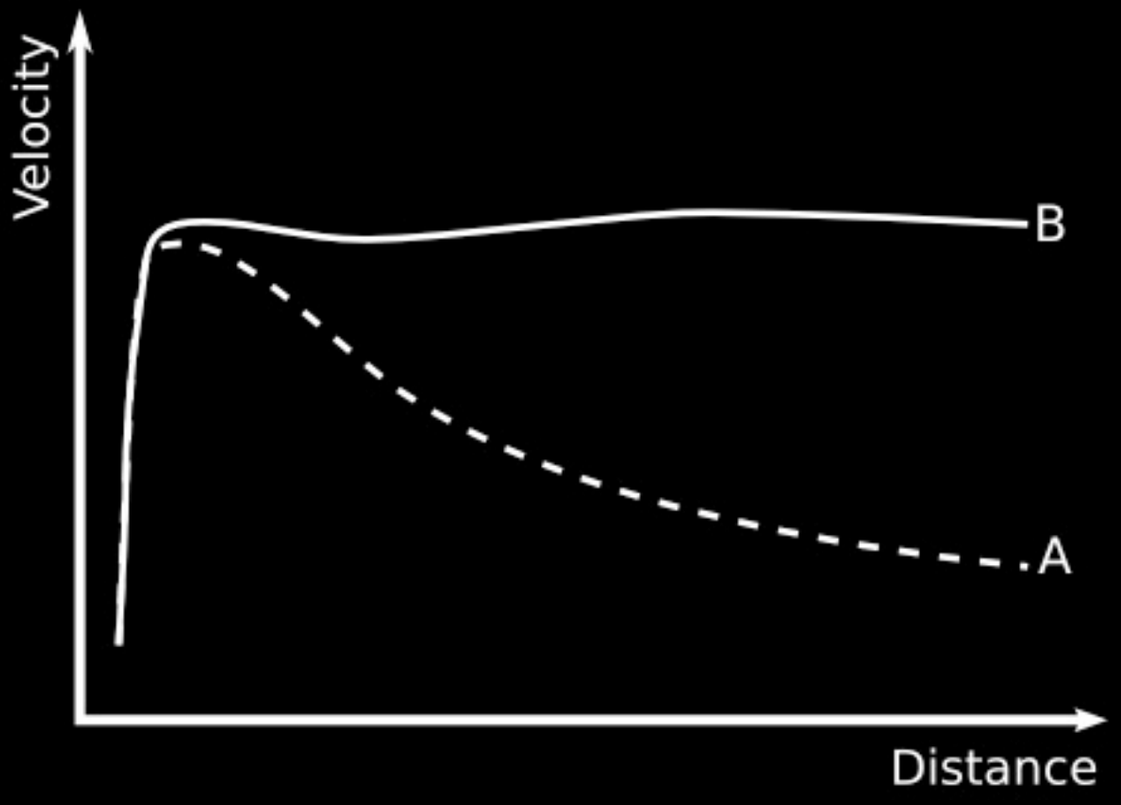
Dark matter



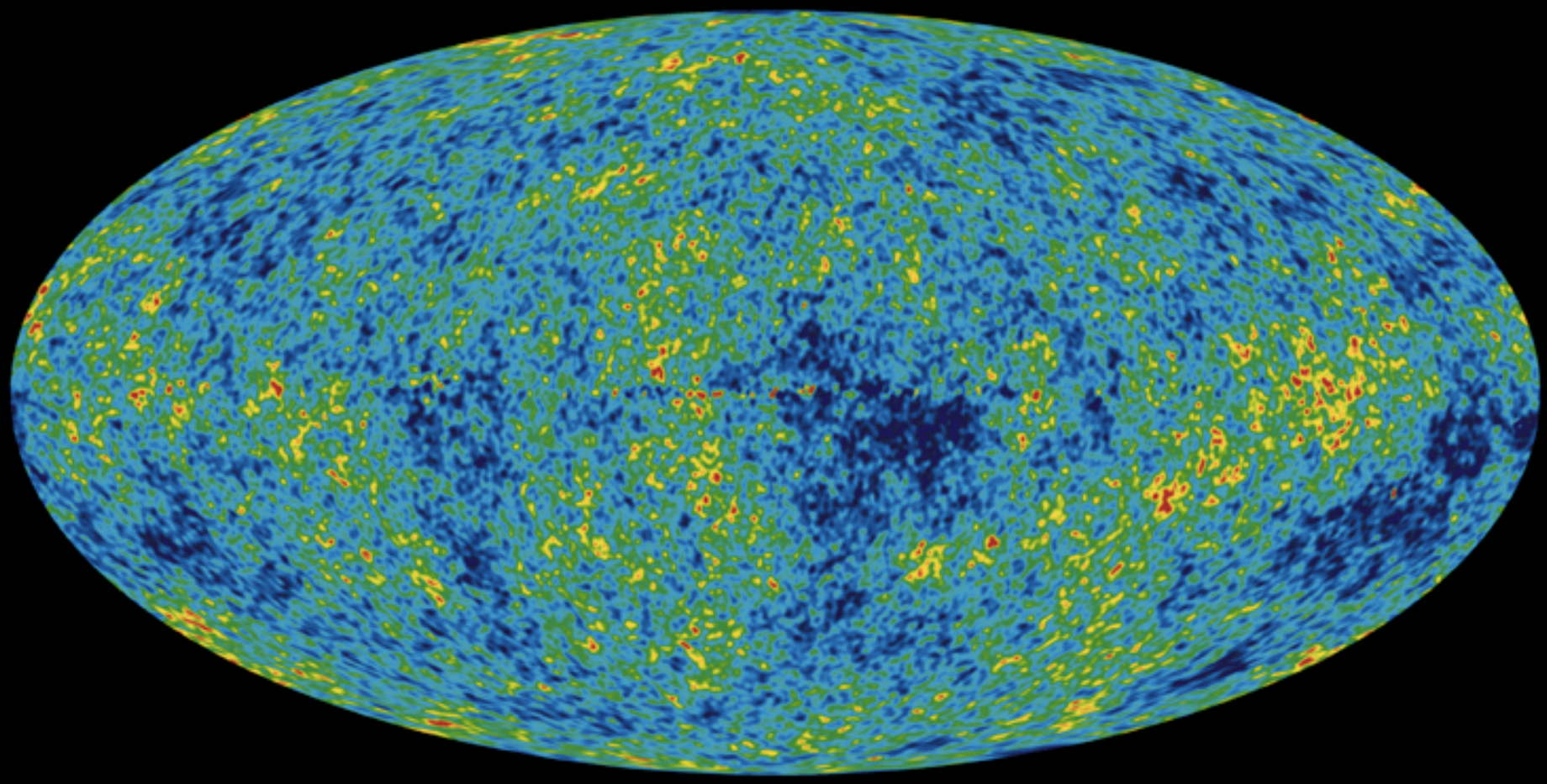
Dark matter

There must be more matter than we can see:

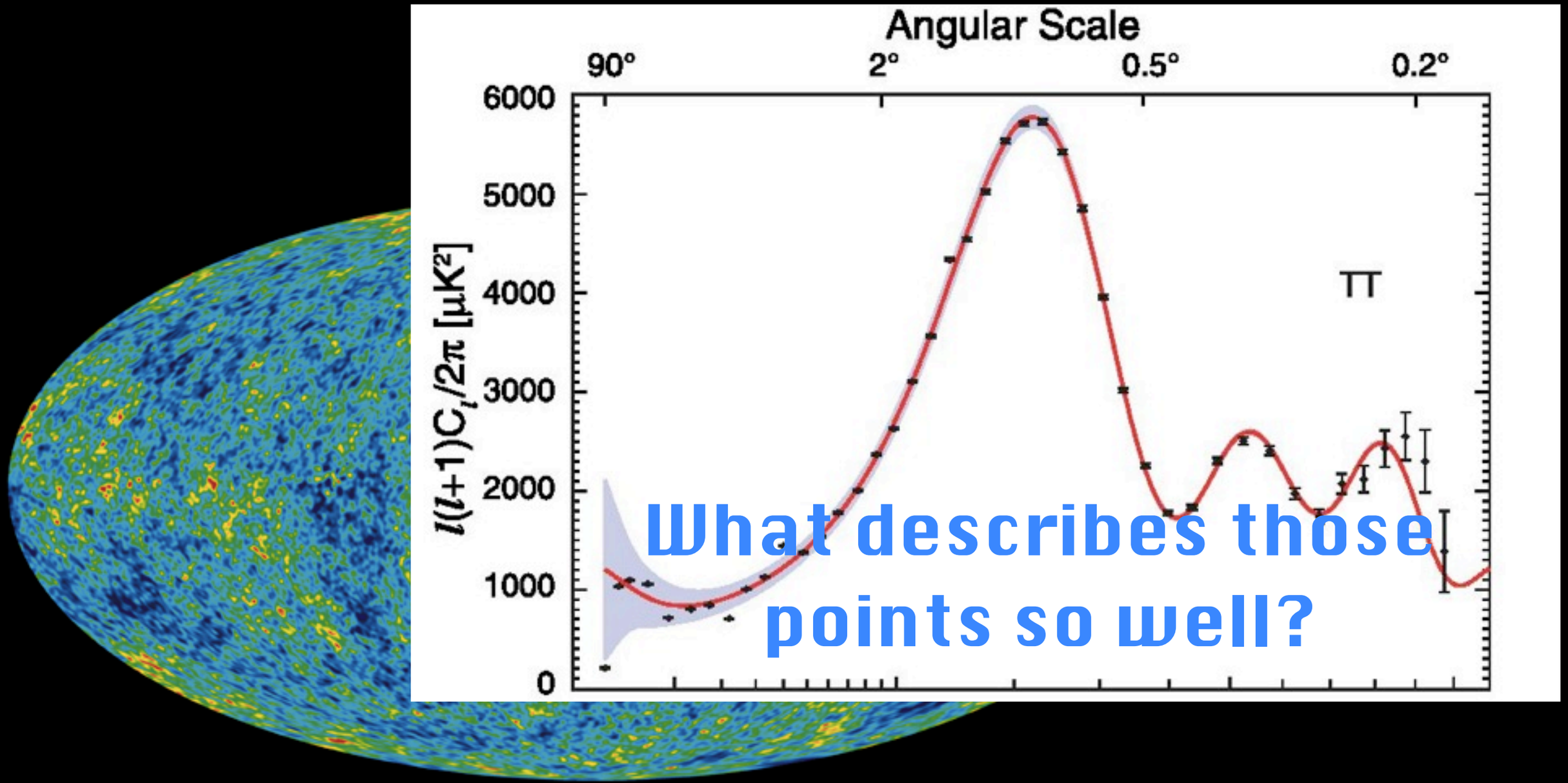
DARK MATTER



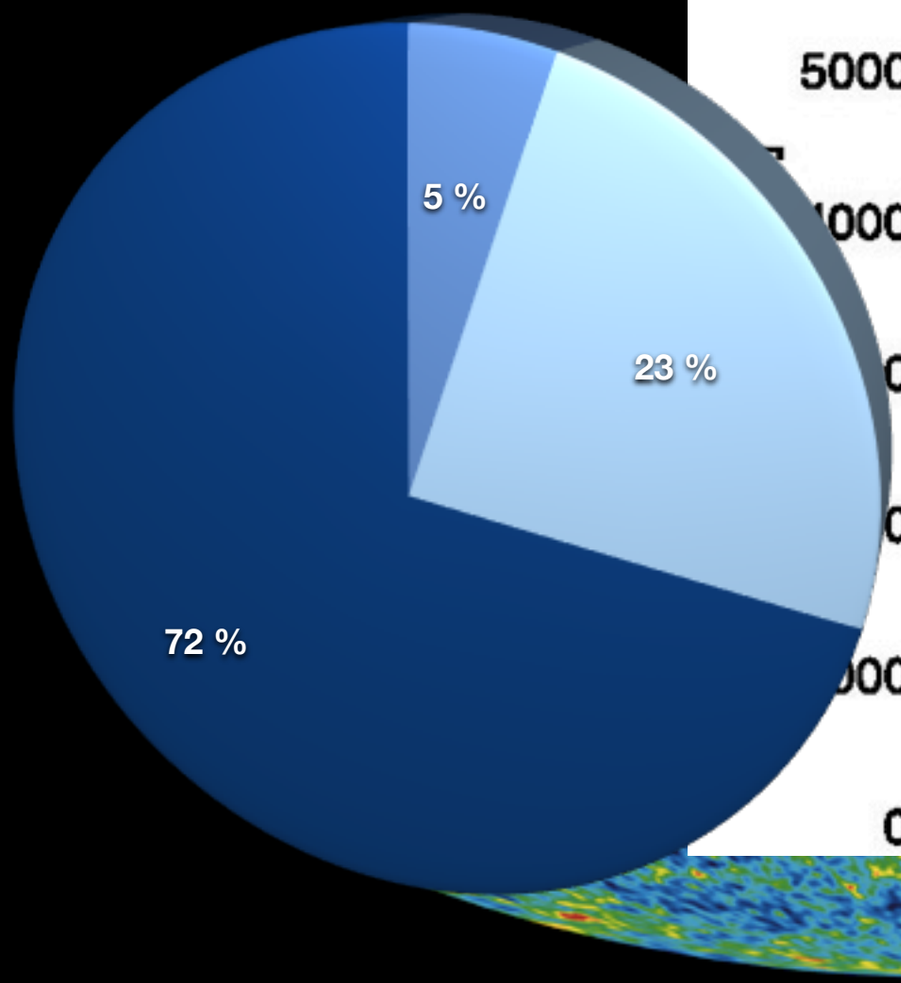
Bringing the pieces together

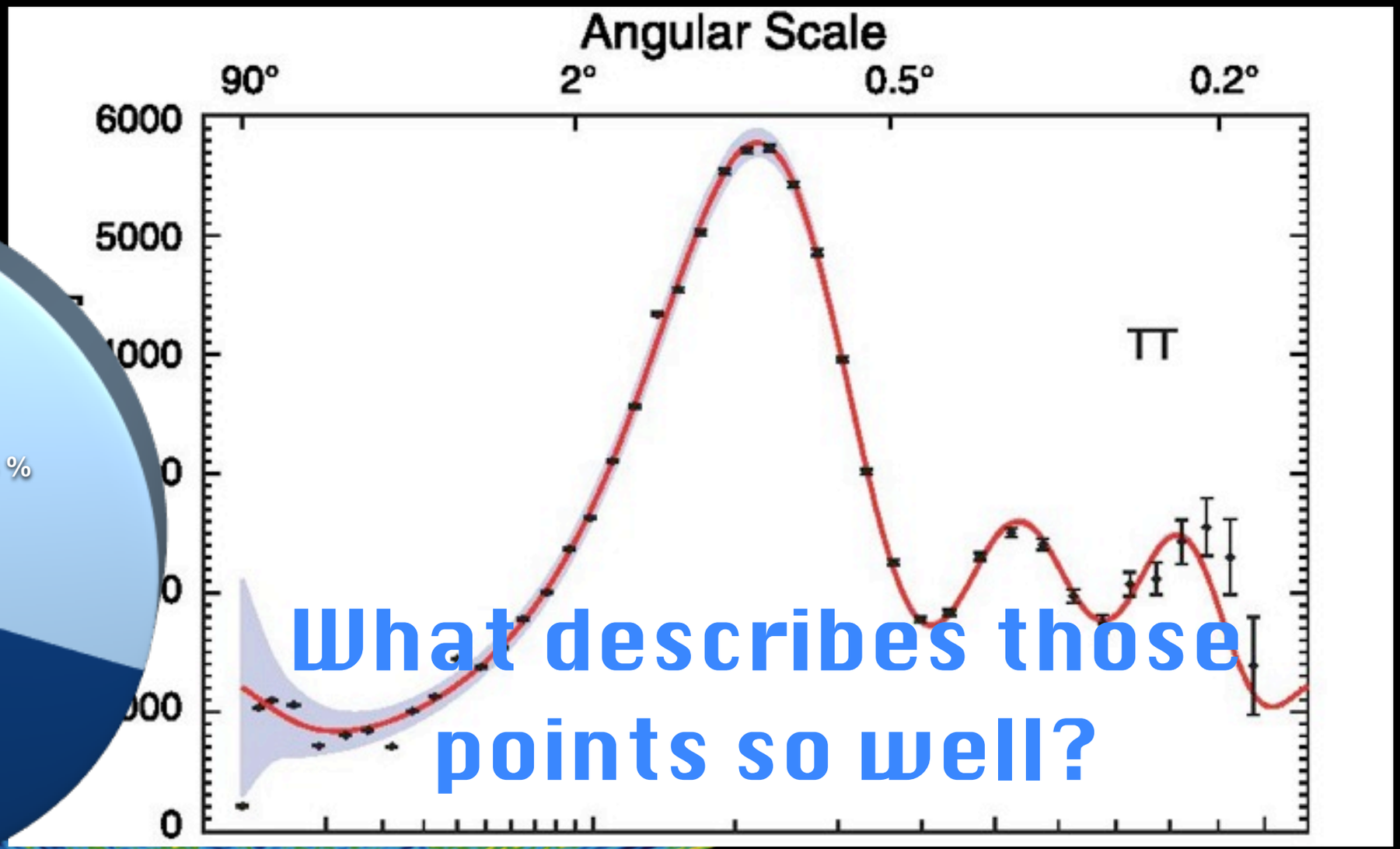


Bringing the pieces together



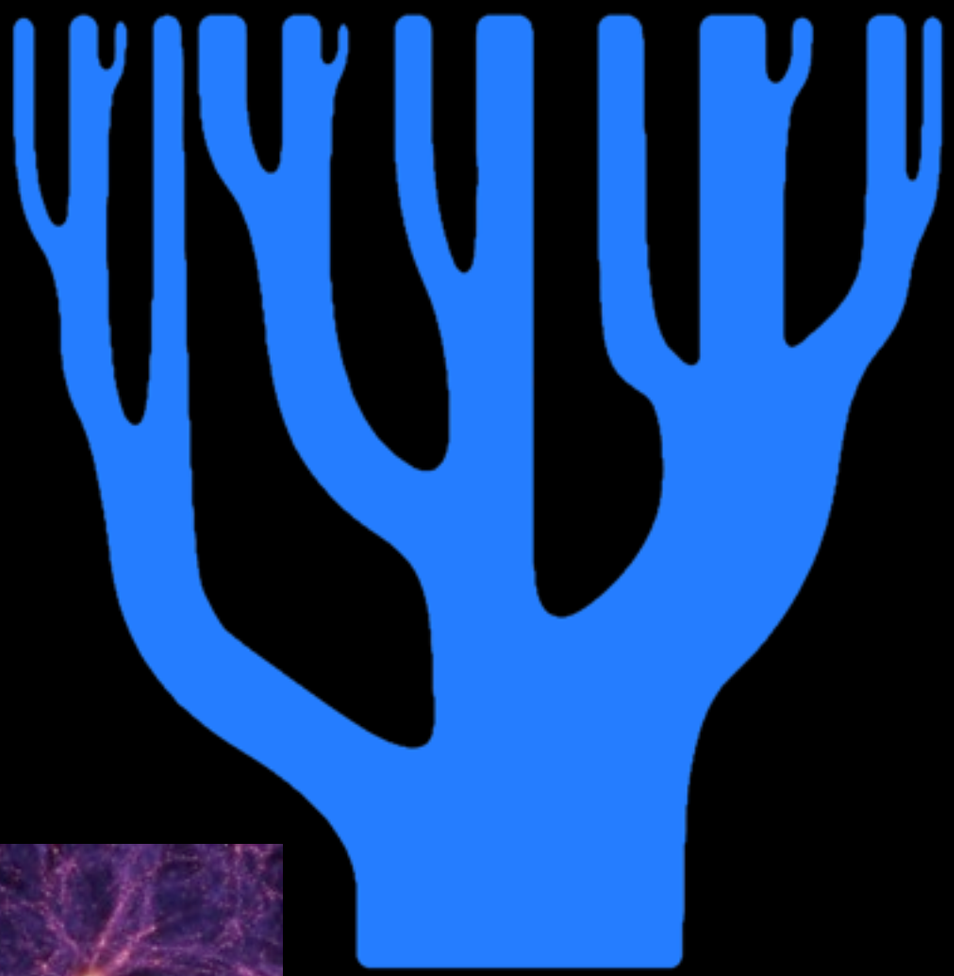
Bringing the pieces together

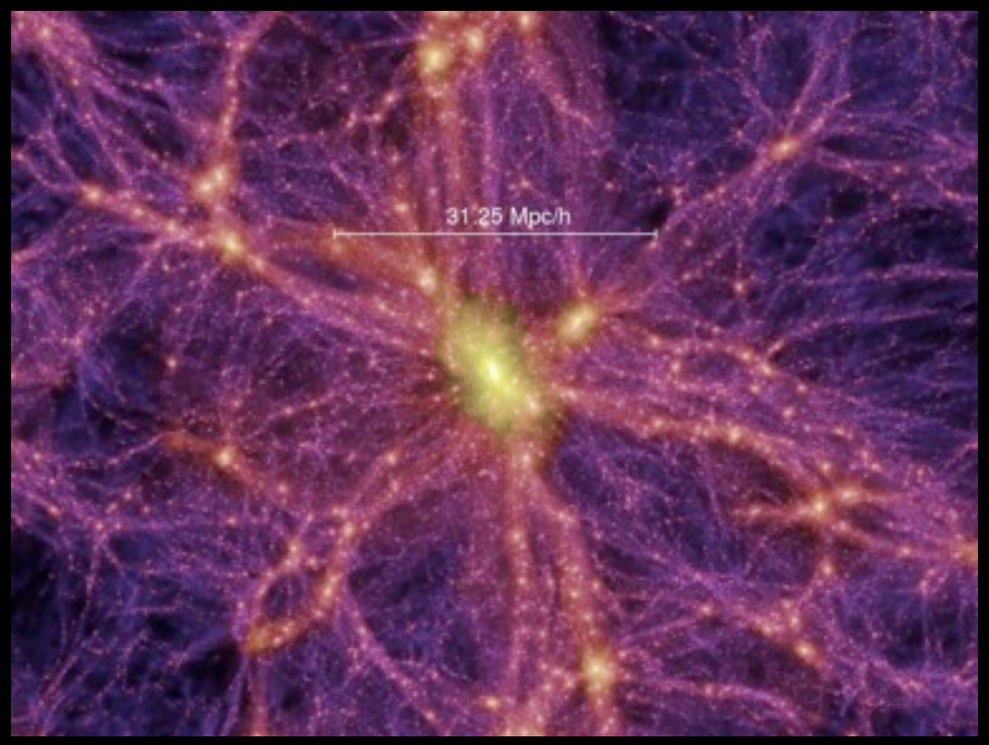




Structure forms hierarchically

time





Structure forms hierarchically

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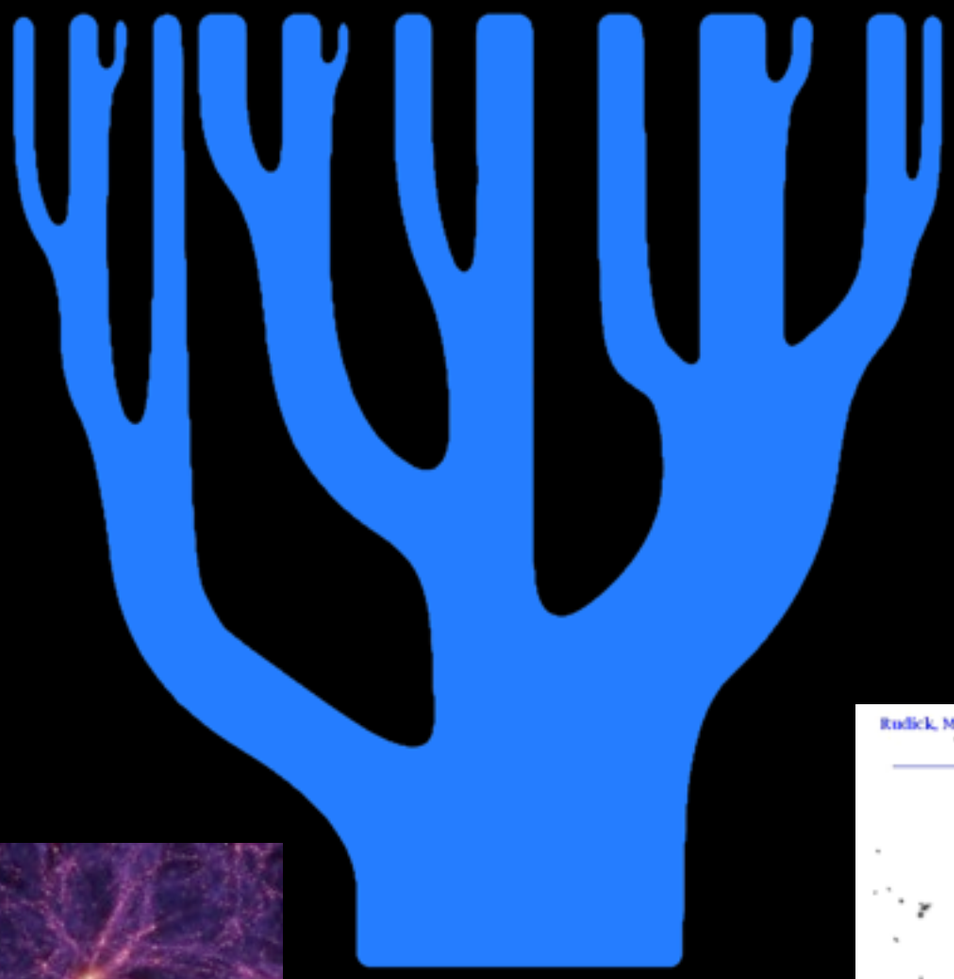
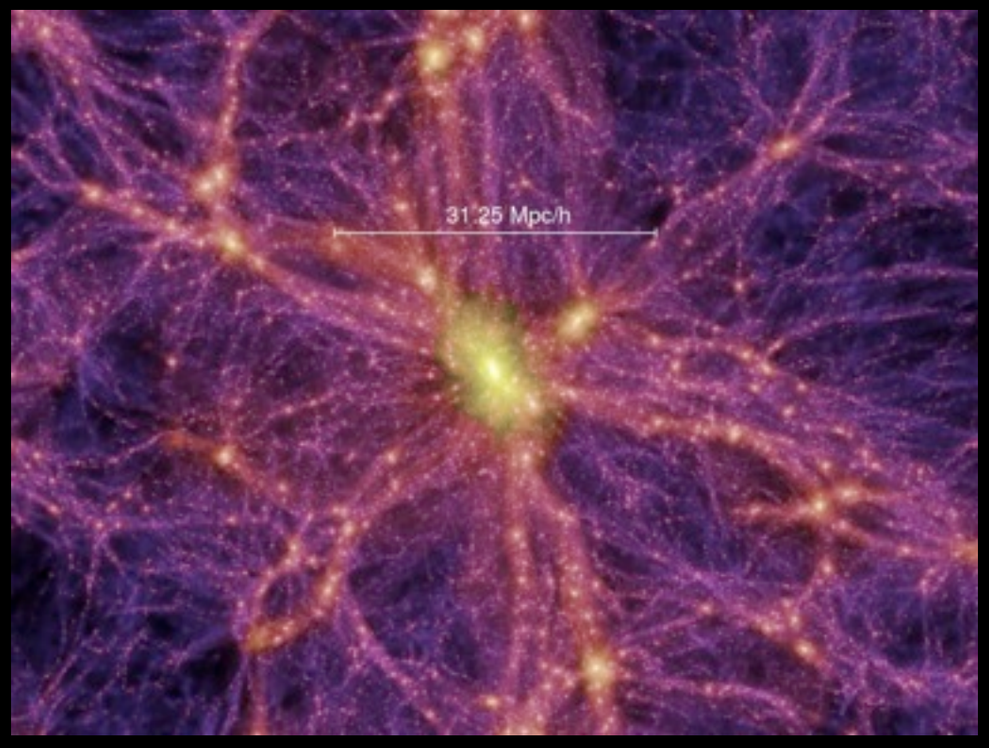
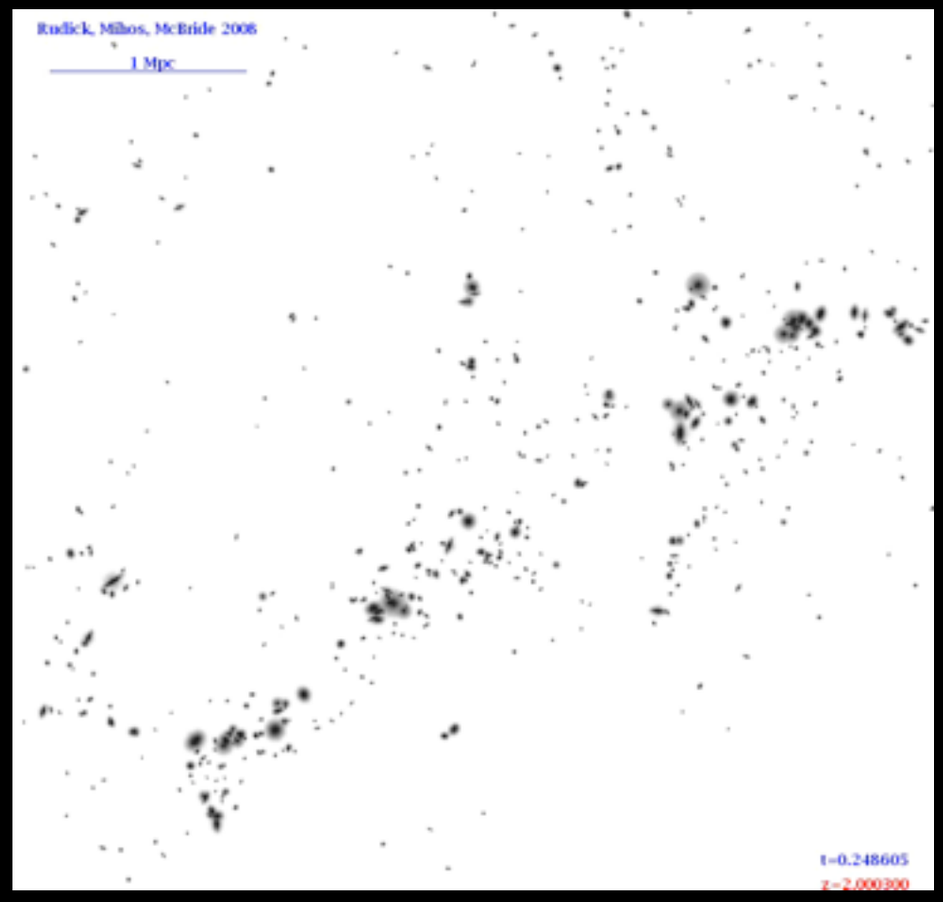






Cosmic giants

Typical scales:

$\sim 10^{15} M_\odot$

$\sim$ Mpc $\cong$

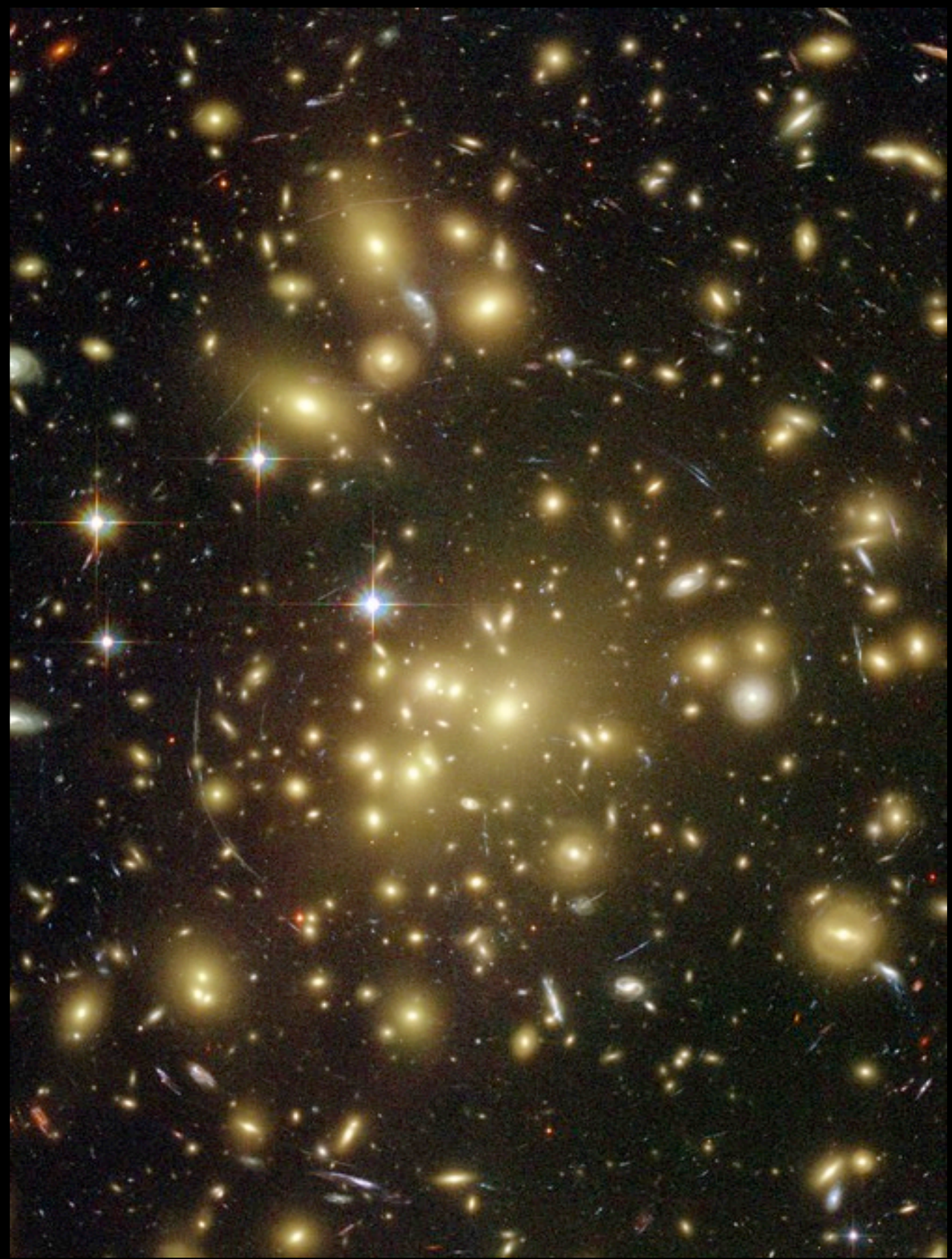
3.2 Million light years

Ingredients:

5% are actually galaxies

20% is hot ionised gas

75% is dark matter



...and laboratories

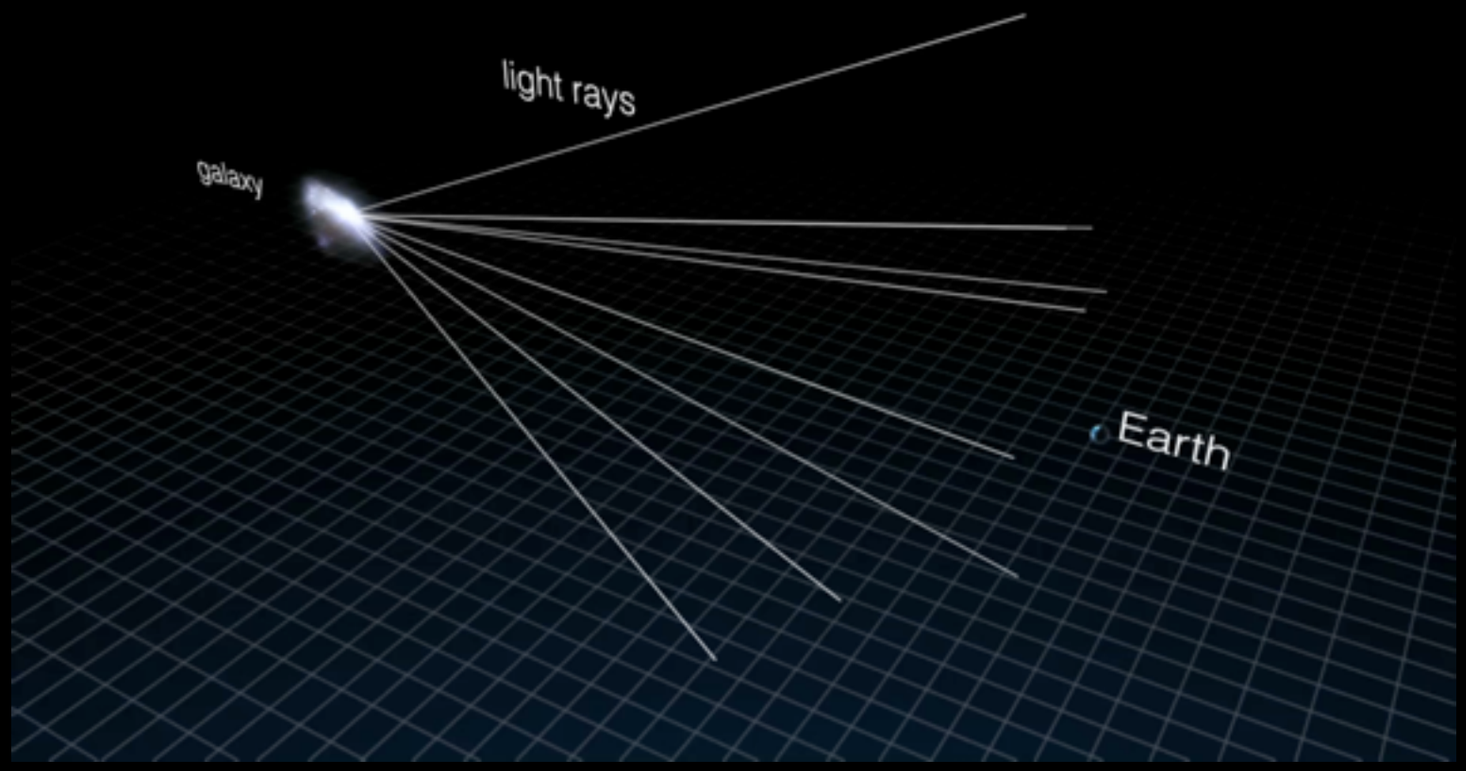
dark matter revealed through grav. lensing

the galaxies and the gas
can be observed directly

computers create
simulated clusters
quite accurately

...and laboratories

dark matter revealed through grav. lensing



the galaxies and the gas
can be observed directly

computers create
simulated clusters
quite accurately

A cosmic crash test

Europe

J. Merten

R. Massey

F. Braglia

Y. Jimenez-Teja

N. Benitez

T. Broadhurst

M. Meneghetti

North America

D. Coe

R. Dupke

B. Frye

J. Rhodes

L. A. Moustakas

J. Krick

J. N. Bregman

South America

E. S. Cypriano

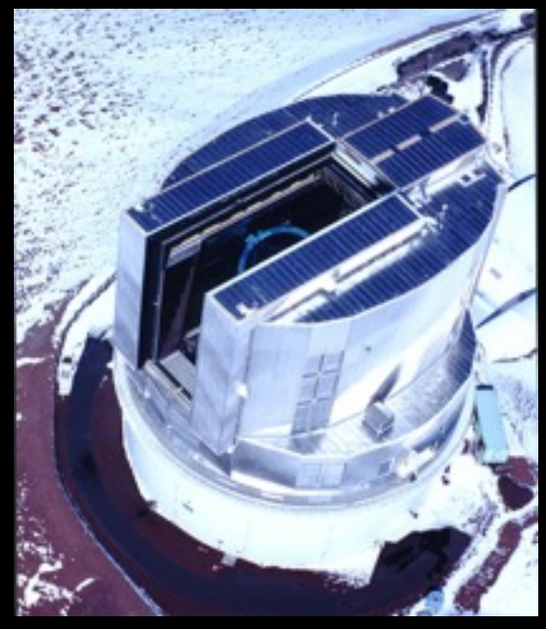
L. Sodre Jr.

Rest of the World

A. Zitrin

N. Okabe

We used some of the best telescopes...



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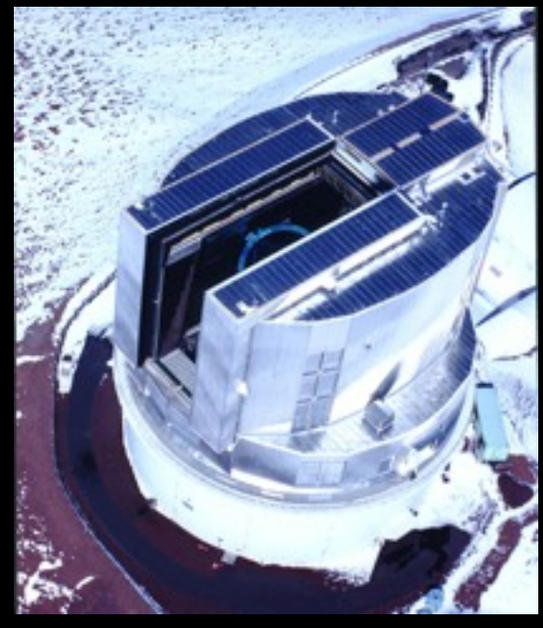

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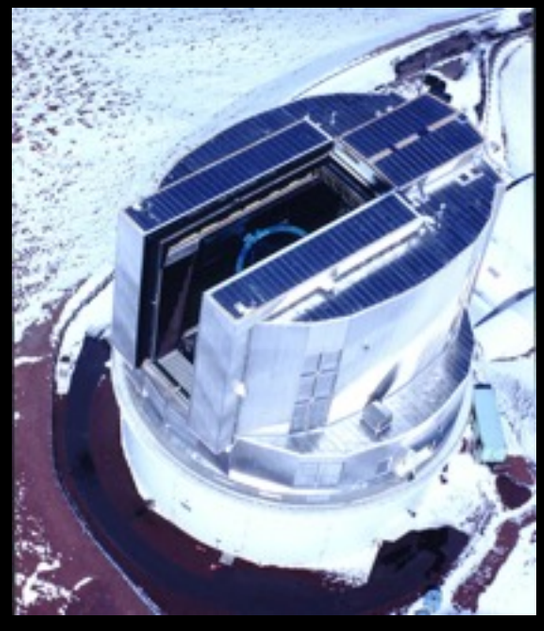

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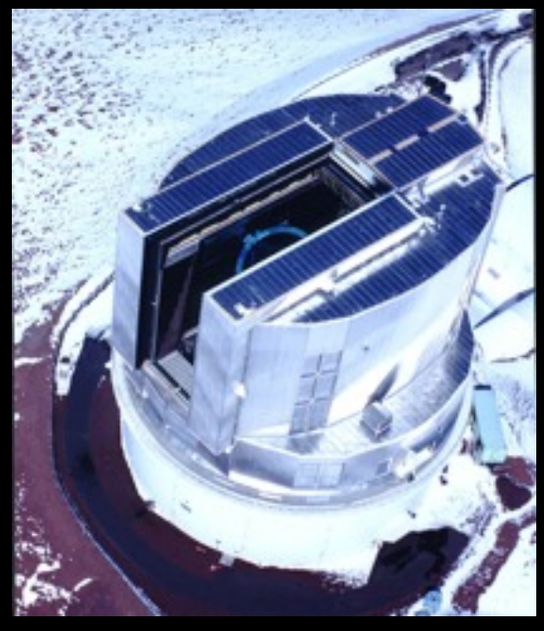

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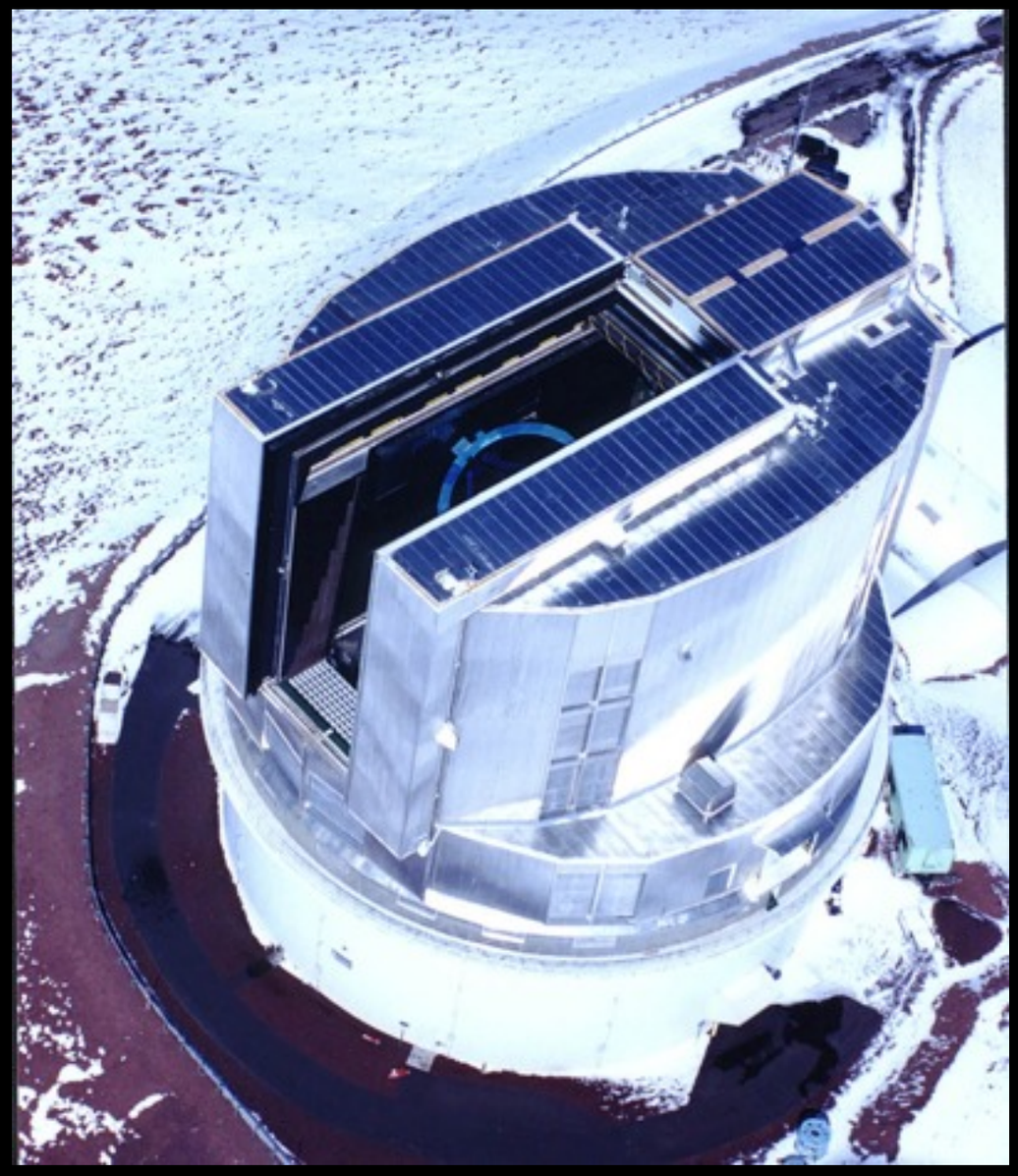


... and a lot of numerics

$$g = \frac{\gamma}{1-\kappa}$$

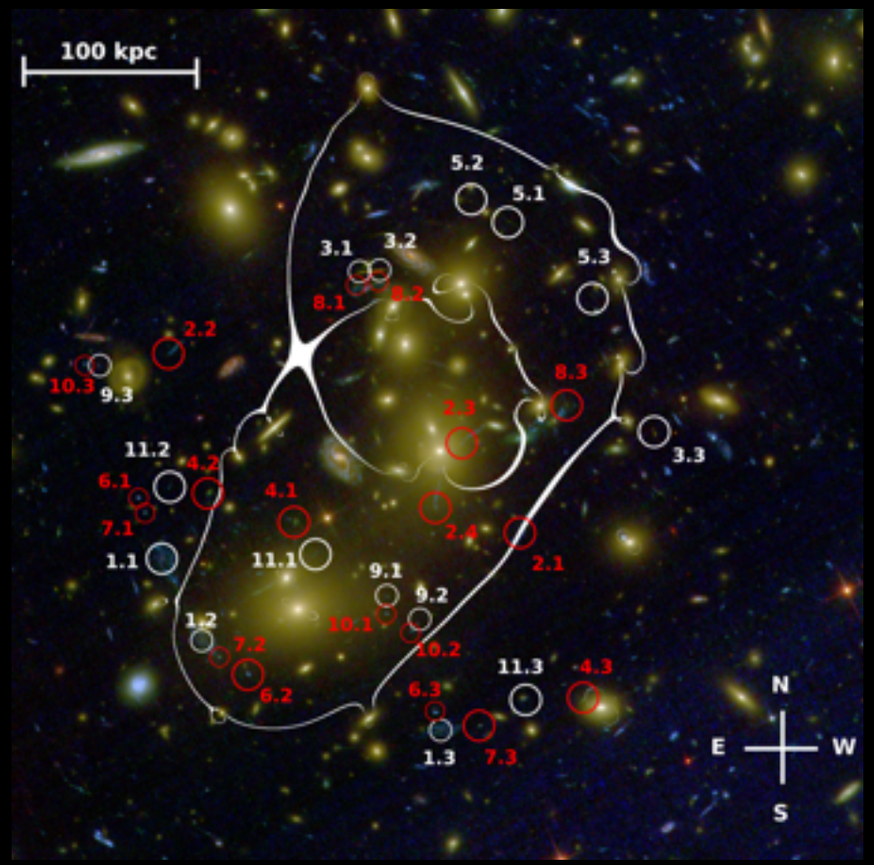
$$\chi^2(\psi) = \chi_w^2 + \chi_s^2 + \eta R$$

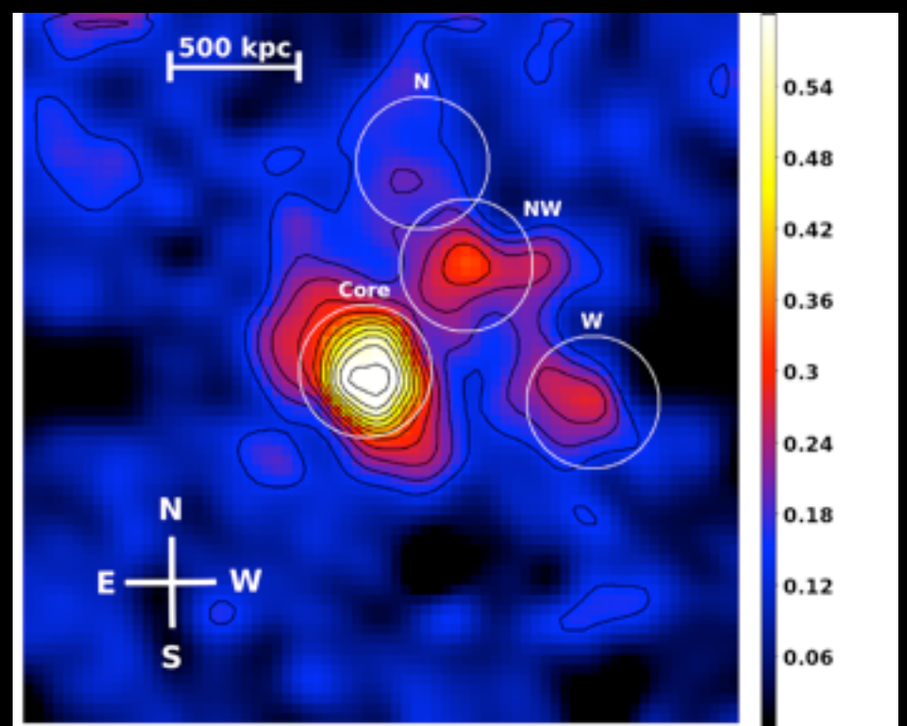
$$\boldsymbol{\beta} = \boldsymbol{\theta} - \boldsymbol{\alpha}(\boldsymbol{\theta}, \psi)$$

$$\frac{\partial \chi^2}{\partial \psi} = 0$$

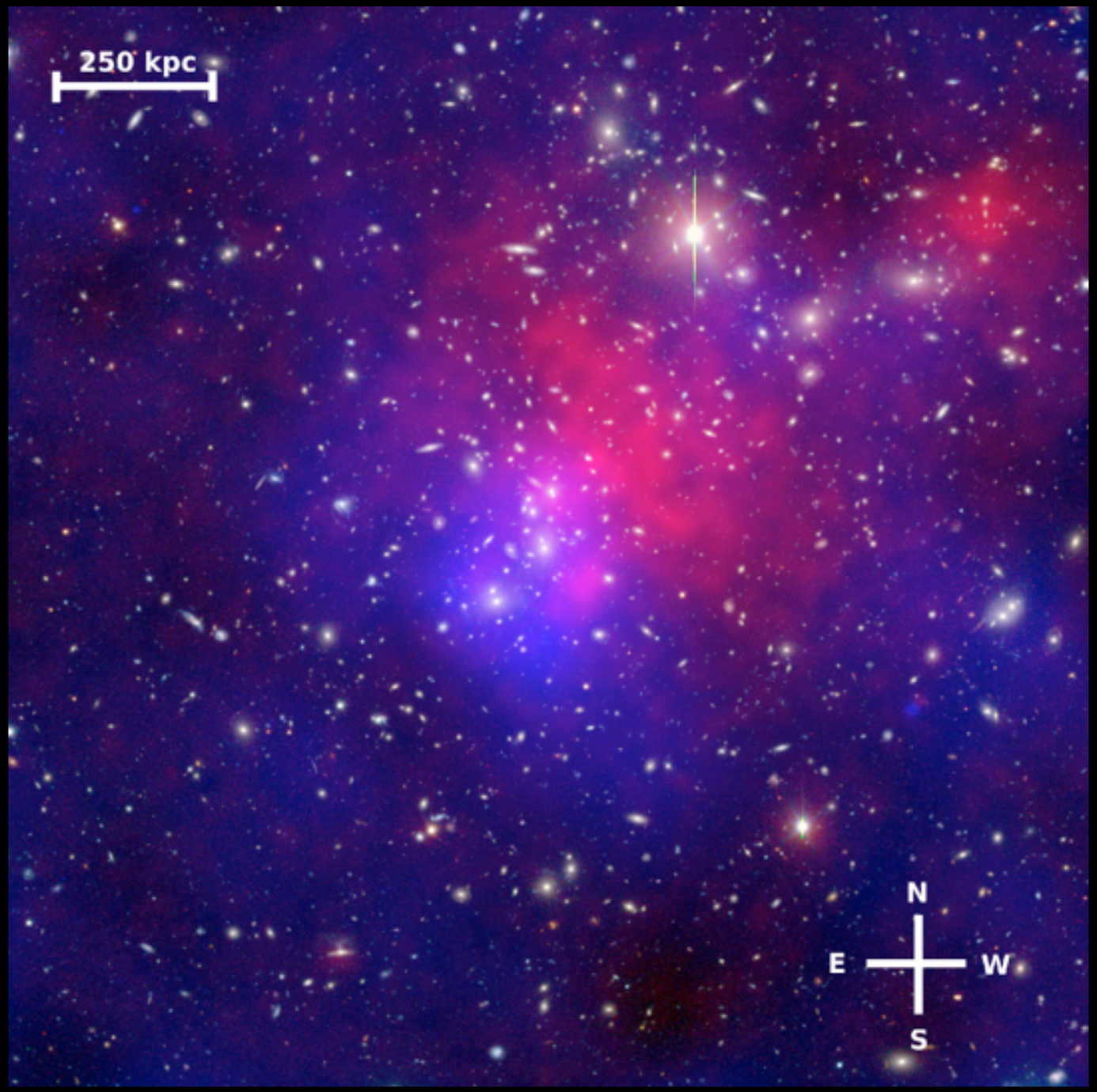
$$\det \mathcal{A}(\psi) = (1-\kappa)^2 - \gamma^2 = \mu^{-1}$$

It turned out to be a treasure trove



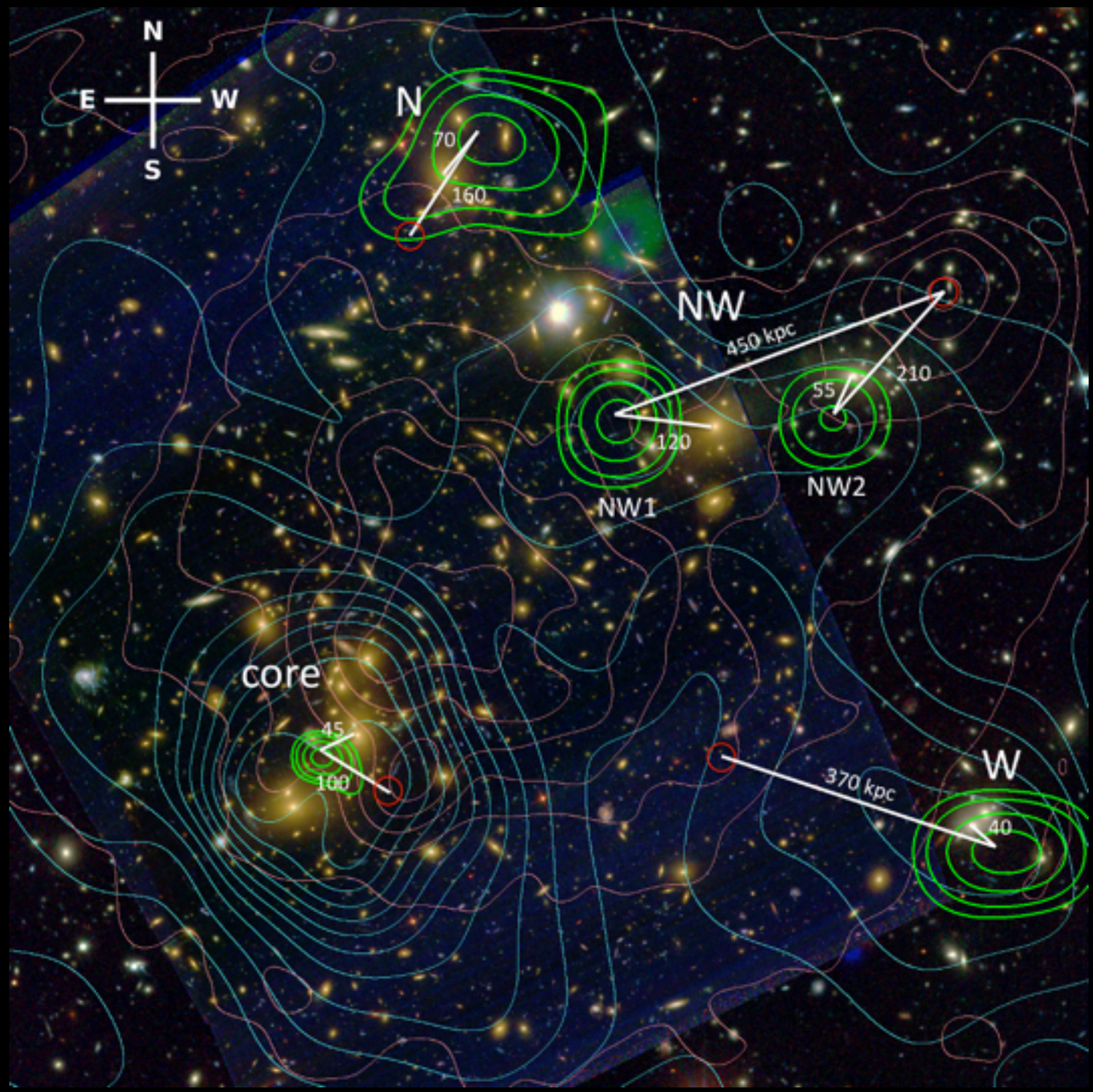


Pandora's Cluster



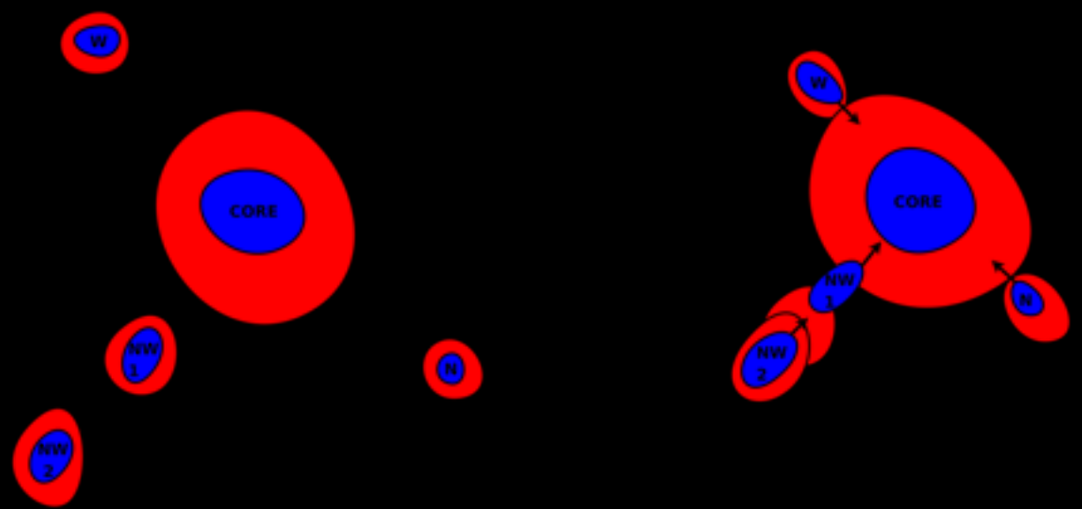
NASA, ESA, CXC, D. Coe & J. Merten

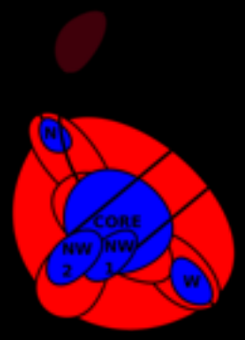
Pandora's Cluster

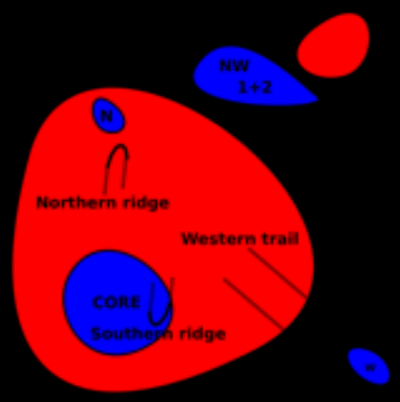


JM+ 11, MNRAS in press

Pandora's Cluster







JM+ 11

This will become a real challenge for simulations

Collaboration with V. Springel's group in Heidelberg

A first search in MXXL was already successful

Voice matters while telling a story!

ESO, ESA, NASA, J. Merten and D. Coe

Voice matters while telling a story!

ESO, ESA, NASA, J. Merten and D. Coe

Thanks and enjoy Heidelberg

Hope to see you soon again.