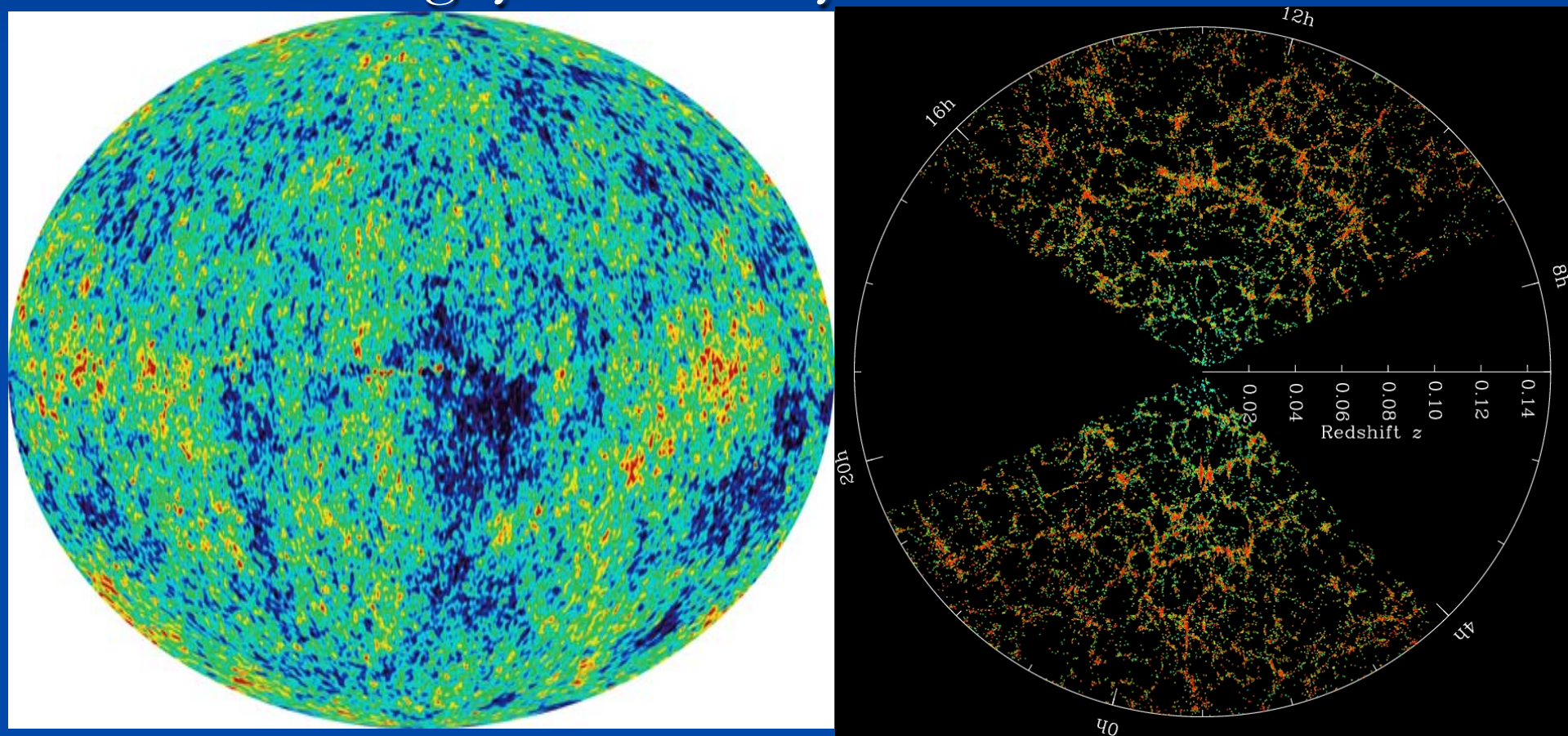


A03

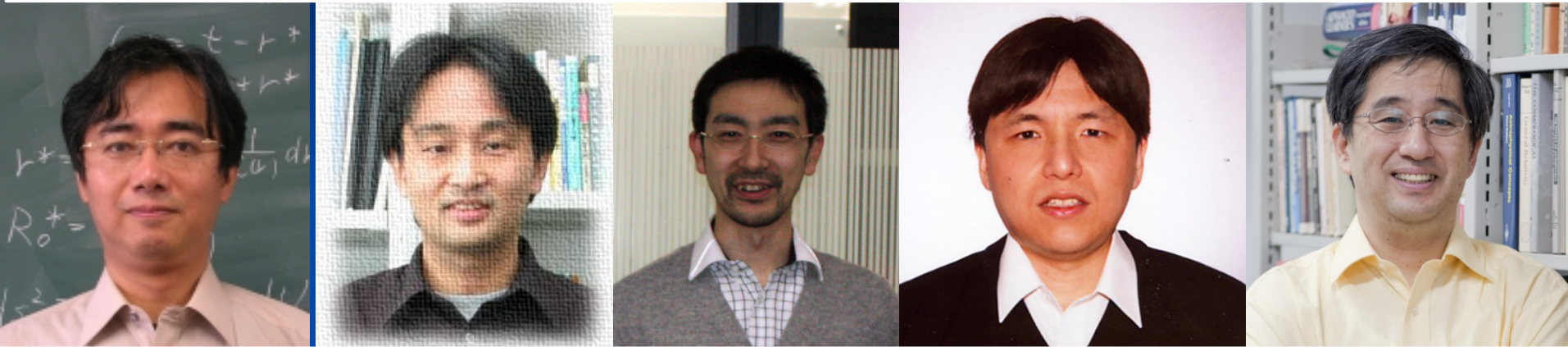
Structure of the Universe and Dark Energy

Naoshi Sugiyama

Nagoya University & Kavli IPMU



A03 Structure of the Universe and Dark Energy



S. Nojiri

T. Matsubara

K. Ichiki

S. Tsujikawa

N. Sugiyama

From Particles, Field Theory
to Observational Cosmology

Our Target is ...

Dark Energy

✓What is Dark Energy?

Shinichi Nojiri's Talk

- ✓Dark Energy v.s. Modified Gravity
- ✓Time Evolution of Dark Energy

✓What are Observational Probes of DE?

Kiyotomo Ichiki's Talk

- ✓Large Scale Structure
 - ✓BAO,
 - ✓Gravitational Lensing
 - ✓Peculiar Velocity ...
- ✓CMB Anisotropies
- ✓Red-shifted 21cm line

Dark Components and Structure Formation

■ Dark Energy

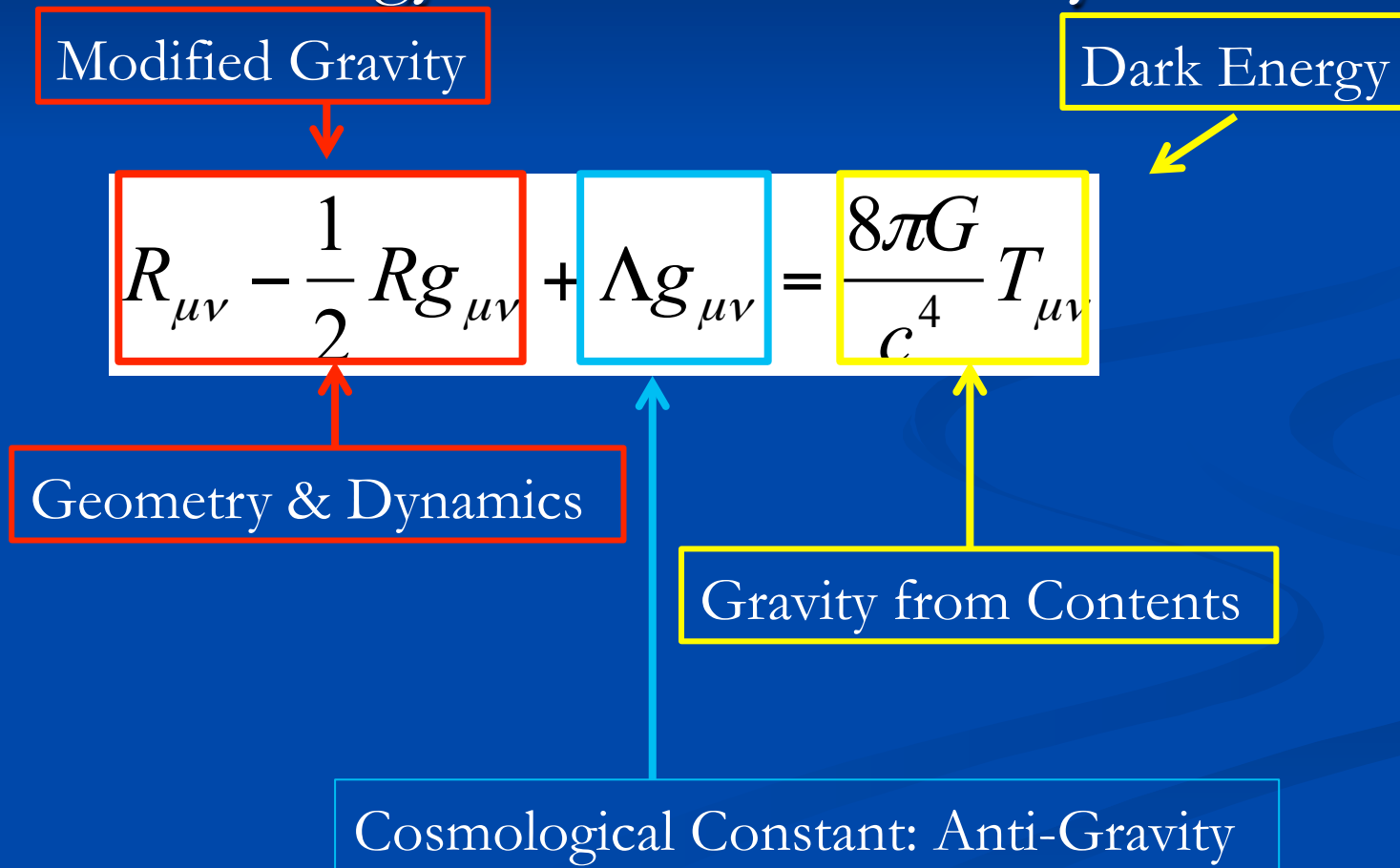
- Prevent a growth of density fluctuations due to the acceleration of the Universe
- If it is a scalar field, field itself can have density fluctuations

■ Dark Matter

- Form large scale structure of the Universe
- Dark halo of galaxies
- Only can detect gravitationally: lensing, peculiar motion of galaxies, ...

Dark Energy

■ Dark Energy or Modified Gravity?

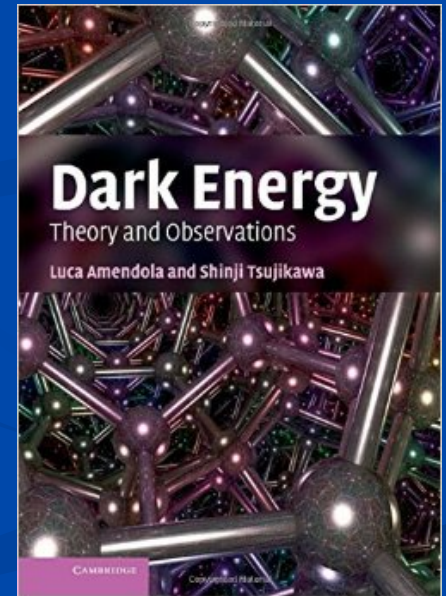
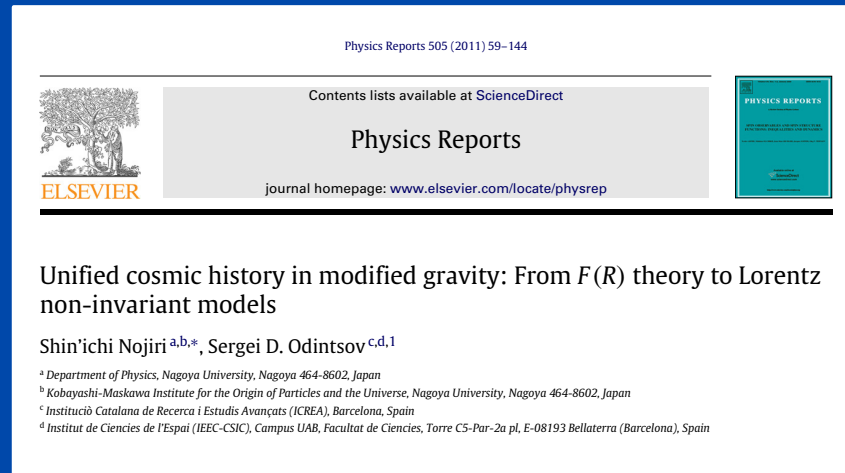


Modeling Dark Energy

■ Modified Gravity

- $f(R)$ Gravity
- TeVeS
- DGP

Shinichi Nojiri Shinji Tsujikawa



Probing the model by cosmological observations

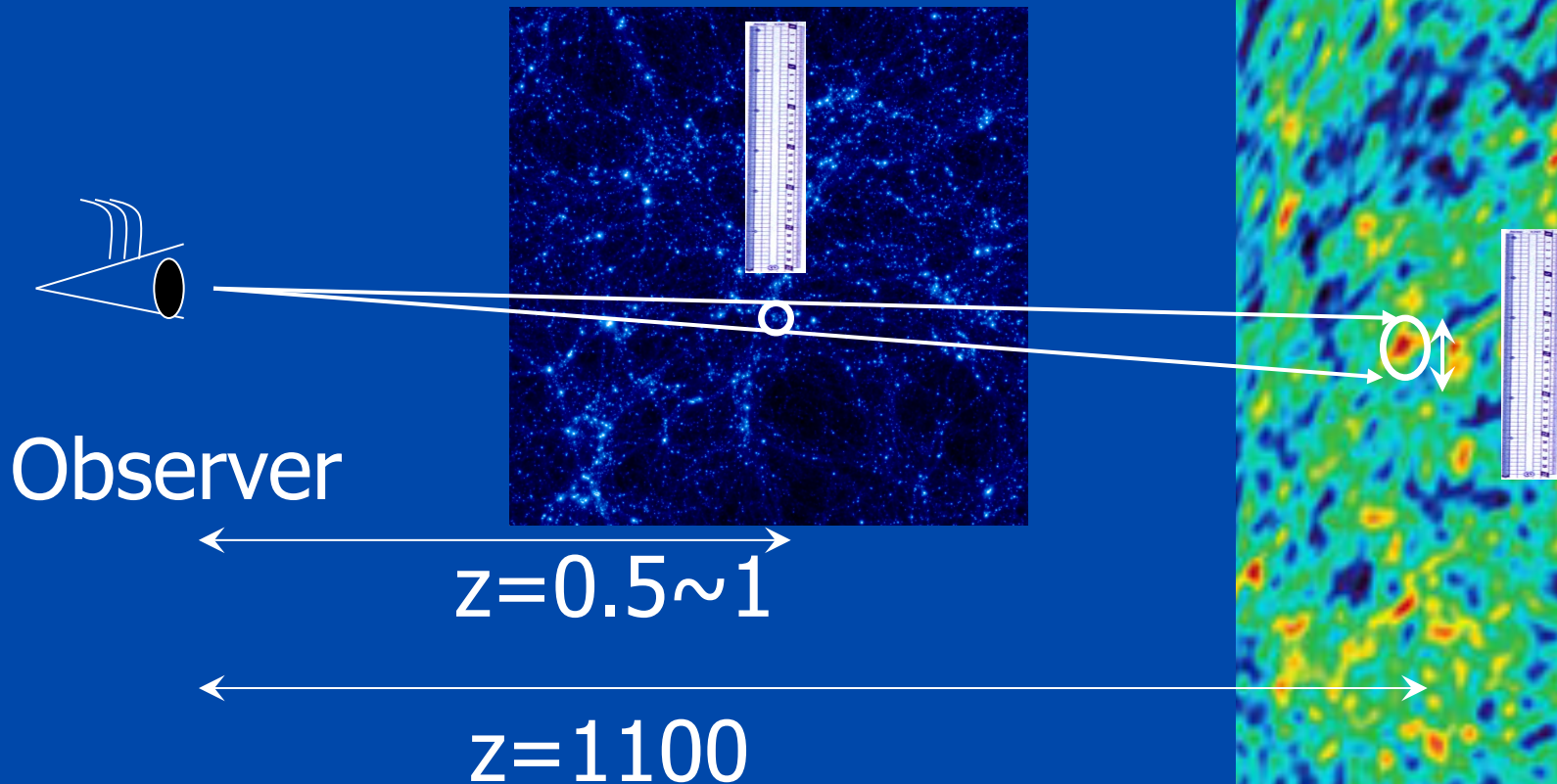
Probe Dark Energy

- SNe
- Weak Lensing
- Baryon Acoustic Oscillation
- Peculiar Velocity

Two Principles

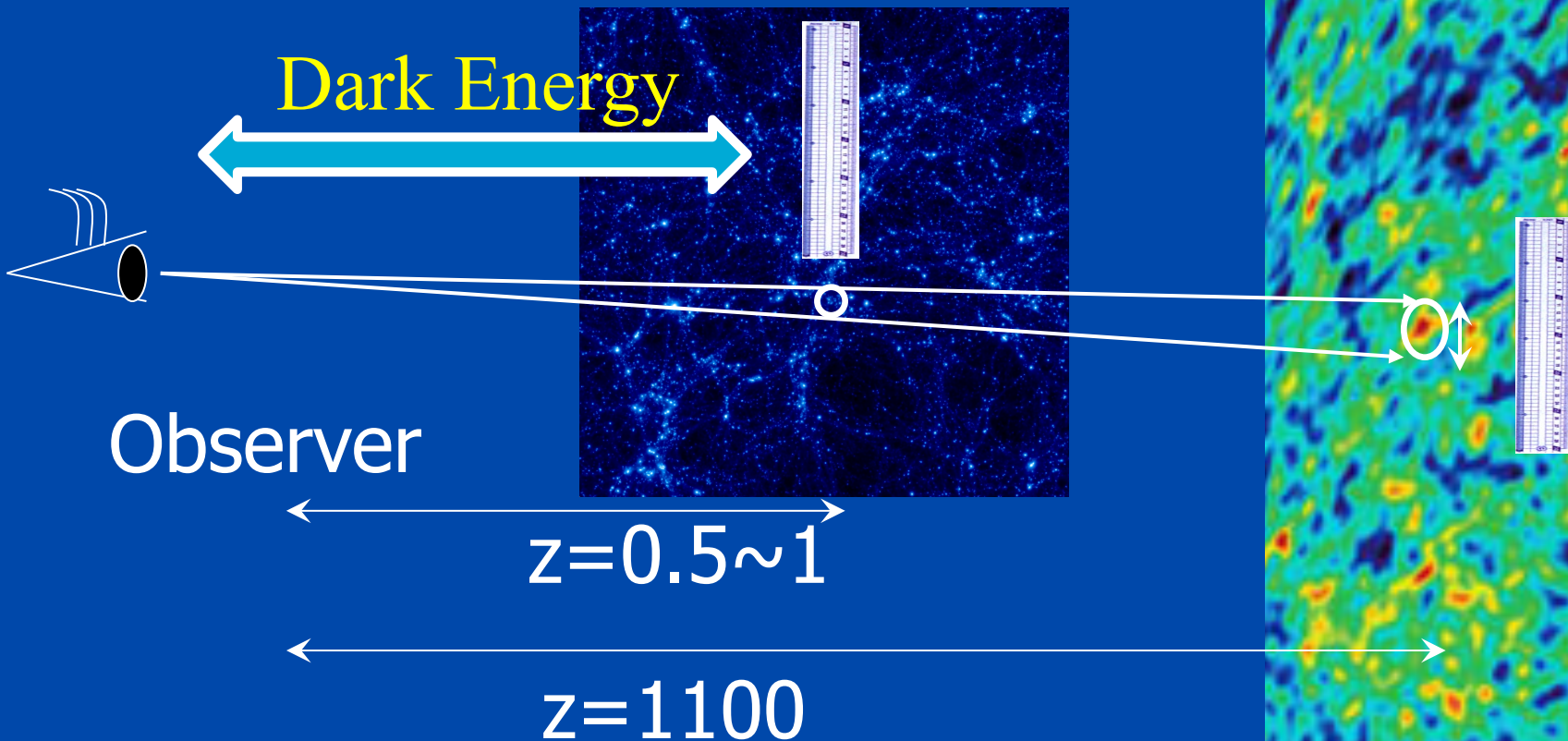
- Distance
- Growth Rate of Density Fluctuations

BAO is a new ruler in the universe
at the epoch of dark energy domination

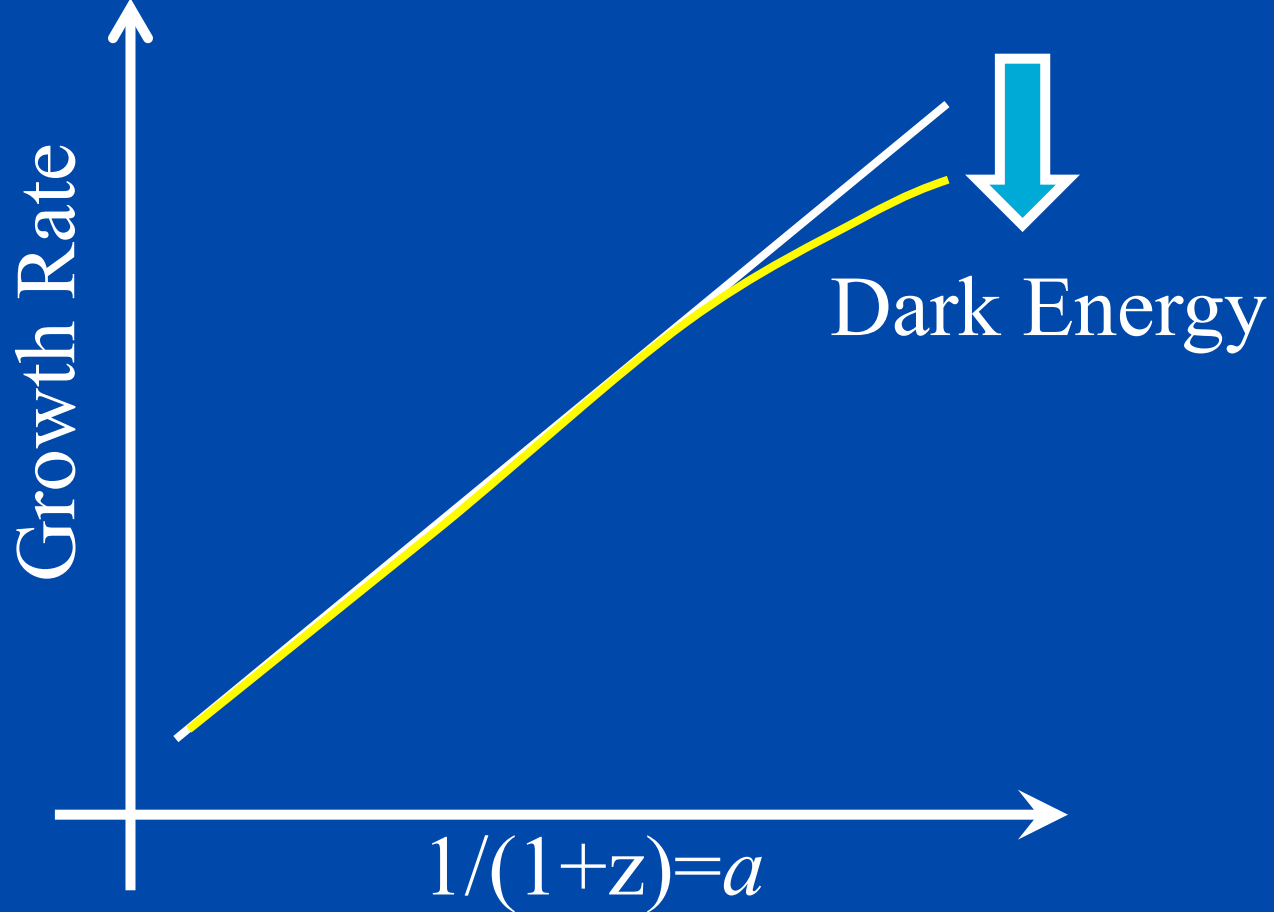
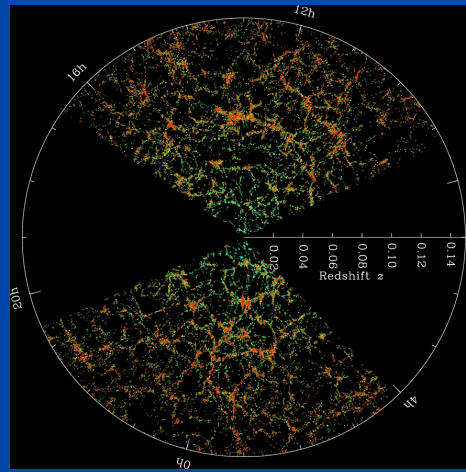
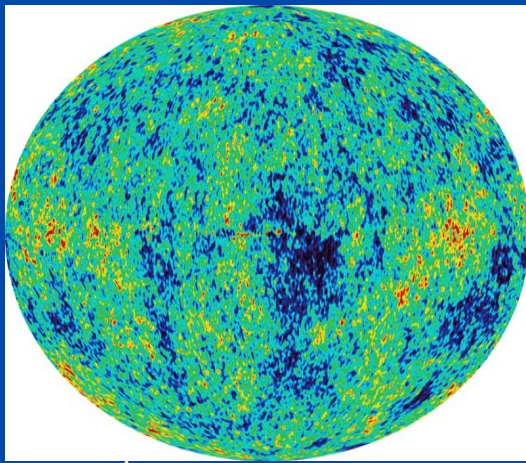


Without Dark Energy

BAO is a new ruler in the universe
at the epoch of dark energy domination



With Dark Energy

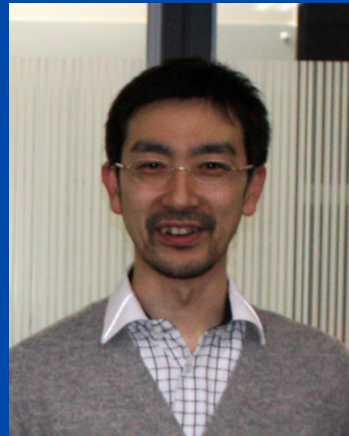


Probe Dark Energy

- SNe
- Weak Lensing
- Baryon Acoustic Oscillation
- Peculiar Velocity



BAO & AP Test



Observational Probes

Faculty members involving this grant (mostly in Nagoya)

C Lab: Obs. Cosmology Group in Nagoya

■ Faculties

■ Professor

■ Naoshi Sugiyama 杉山直

Yellow: tenured

■ Associate Professor

■ Takahiko Matsubara 松原隆彦

Structure Formation, Perturbations

■ Lecturer

HSC

Magnetic Fields, 21cm

■ Atsushi Nishizawa 西澤淳, Hiroyuki Tashiro 田代寛之

■ Assistant Professor

Magnetic Fields, Neutrino

■ Kiyotomo Ichiki 市來淨與

Primordial Gravitational Wave

Inflation

■ Yuko Urakawa 浦川優子, Sachiko Kuroyanagi 黒柳幸子

■ Kenji Hasegawa 長谷川賢二

Radiative Transfer Simulation, 21cm

■ PD

■ Daisuke Nitta 新田大輔

General Relativity

■ PhD Students

■ Hayato Shimabukuro, Shinsuke Asaba, Daichi Kashino, Shohei Saga, Shoichiro Horiguchi, Hanako Hoshino, Masato Kobayashi

■ Master Course Students

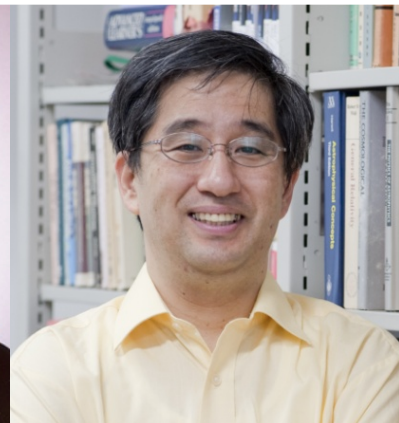
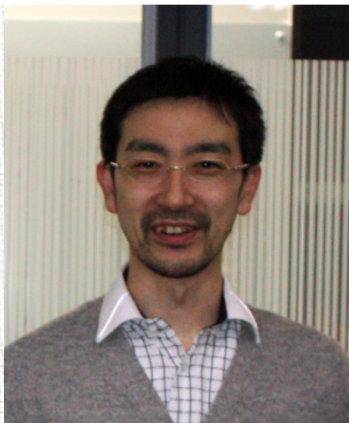
■ Yuki Mori, Koutaro Maeda, Junpei Ohba, Shun Arai, Takao Endo, Toshihiro Horii, Yuka Matsui

■ Researchers from other groups

■ Shinichi Nojiri 野尻伸一

Models of Dark Energy, Modified Gravity

■ Tsujikawa Shinji 辻川信二(東京理科大)

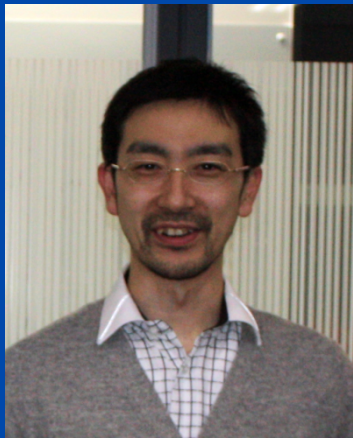


✓What is Dark Energy?



Shinichi Nojiri's Talk

✓What are Observational Probes of DE?



Kiyotomo Ichiki's Talk

