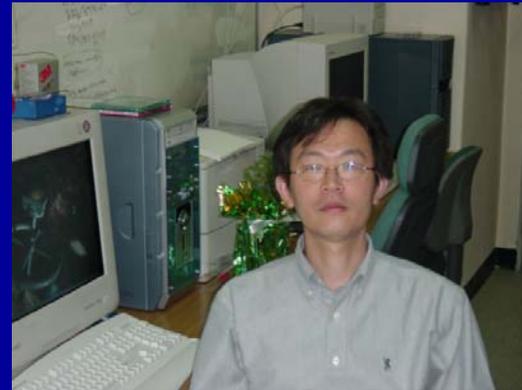


# Discussion topics

須藤 靖

1<sup>st</sup> China-Japan-Korea Joint Workshop on Cosmology  
and Galaxy Formation (November 9-12, 2005)

# Different and complementary strategies numerical simulation



**observation**



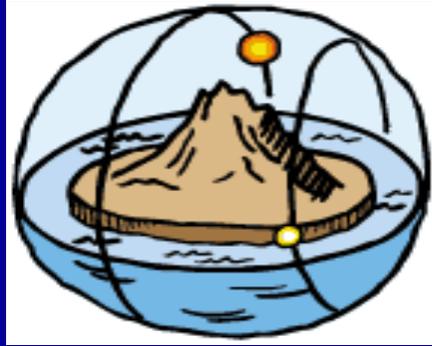
**theory  
(working hypothesis)**

# Did we make progress at all ?

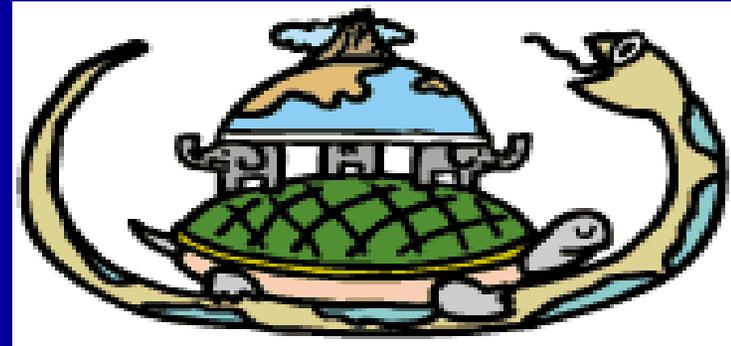
Egypt



Chinese



Indian



Why can we conclude that this is a better picture before knowing the nature of dark matter and dark energy ?

# Roadmap towards the universe

1. the n-th order parameterized model of the universe
  - $\Omega_\Lambda, \Omega_m, \Omega_b, h, \sigma_8 \dots$
2. improve the precision/accuracy of the numbers
3. understand why
  - (variants of) inflation, superstring, brane...
4. look for something that cannot be described in the n-th order model
  - $w = -1 \Rightarrow w = w_0 + w_1 z \Rightarrow w(z) \Rightarrow w(z, r)$
  - linear bias  $\Rightarrow$  nonlinear bias  $\Rightarrow$  non-deterministic bias
  - virialized spherical halo  $\Rightarrow$  triaxial  
 $\Rightarrow$  shocked + magnetic + conductive + cosmic ray
5. repeat the above steps 1~4 until you become tired (or retire) for  $n=1, 2, 3, 4, 5 \dots$

# Can we understand the dark sides of the universe in foreseeable future ?

## ■ Dark matter

- maybe new results from on-going experiments in next 5-10 years, but not from astronomy

## ■ Dark energy

- unlikely to have any breakthroughs from future experiments and/or theories in high energy physics in this century
- astronomy is the key !

## ■ Dark baryons

- only astronomical observations can make a scientific new contribution since high-energy physicists already know baryons too well !

# Dark matter

- high-energy experiments in near future are very promising
- still room for cosmology to help understanding dark matter ?
  - density profile of dark matter halos
  - what is the “true” density profile ? core vs. cusp
  - modeling substructure statistics
  - non-spherical modeling
  - baryonic effect; star formation, feedback, , ,

# Galaxy bias

- plays a key role in extracting cosmological information from all observational data
  - cannot be worked out from the first principles
  - very unsatisfactory/uncomfortable methodology for physicists' point-of-view
  - but no other choice than empirical modeling
  - how to convince the validity of extrapolating any empirical modeling which were constructed to explain the existing data
  - any predictive power ?

# Dark energy

- Meaningful theoretical breakthroughs are unlikely during this century
- $\Rightarrow$  observational/empirical approaches !
- something really there or just virtual ?
  - right-hand-side in the Einstein equation
- VS
- modified gravity theory (c.f., Shirata's talk)
- already (too) many proposals for future observational projects
  - need more accurate modeling
  - need to control systematic effects (with very realistic mock samples)



# Towards nice collaborations



We already had a nice collaboration !



My pleasure !

最高幸福  
於我人生

謝謝合作

# Collaboration possibilities

**We, Japanese groups, desperately need good numerical simulation data**

- Baryonic oscillation
- Generic properties of bias
- Effect of cosmic ray pressure on SZ
- Effect of dust extinction correction on the LSS
- Locating and characterizing WHIM
- Simulation of star-planet misalignment

# Baryonic oscillation

- the most promising probe of dark energy
- how accurate can we recover the height and the location of the peaks ?
  - c.f., Yipeng's talk
  - which is better,  $\xi(r)$  or  $P(k)$  ?
  - linear bias (c.f., Nishimichi's talk) ?
  - nonlinear gravitational growth ?
  - redshift-space distortion (c.f., Kayo's talk) ?
  - Is the Milky Way dust map reliable enough for the purpose ? (c.f., Yahata's talk)
  - optimal analysis methodology ? (c.f., Okumura and Nishizawa's talks)



# See you again in 2007 at Japan

A great Chinese philosopher, Confucius (孔子), was born in 551, B.C. at 中国山东省曲阜.

論語 卷第一 學而第一章 (<http://www.confucius.org/>)

子曰、學而時習之、不亦說乎、有朋自遠方來、不亦樂乎、人不知、慍、不亦君子乎。

공자께서 말씀하셨습니다.

“배우고, 때때로 익히니 즐겁지 아니하냐? 먼곳에서 찾아와 줄 친구 '가 있으니 행복하지 아니하냐? 남들이 알아주지 않아도 패념치 않으니 이것이 군자다움이 아니겠느냐?”

