Opening Remark

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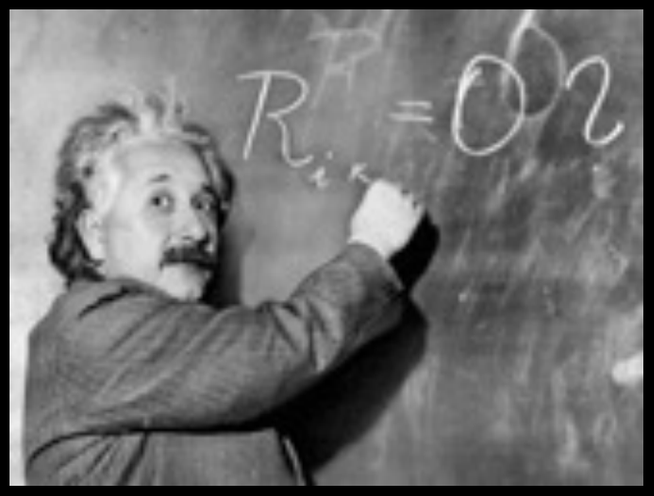
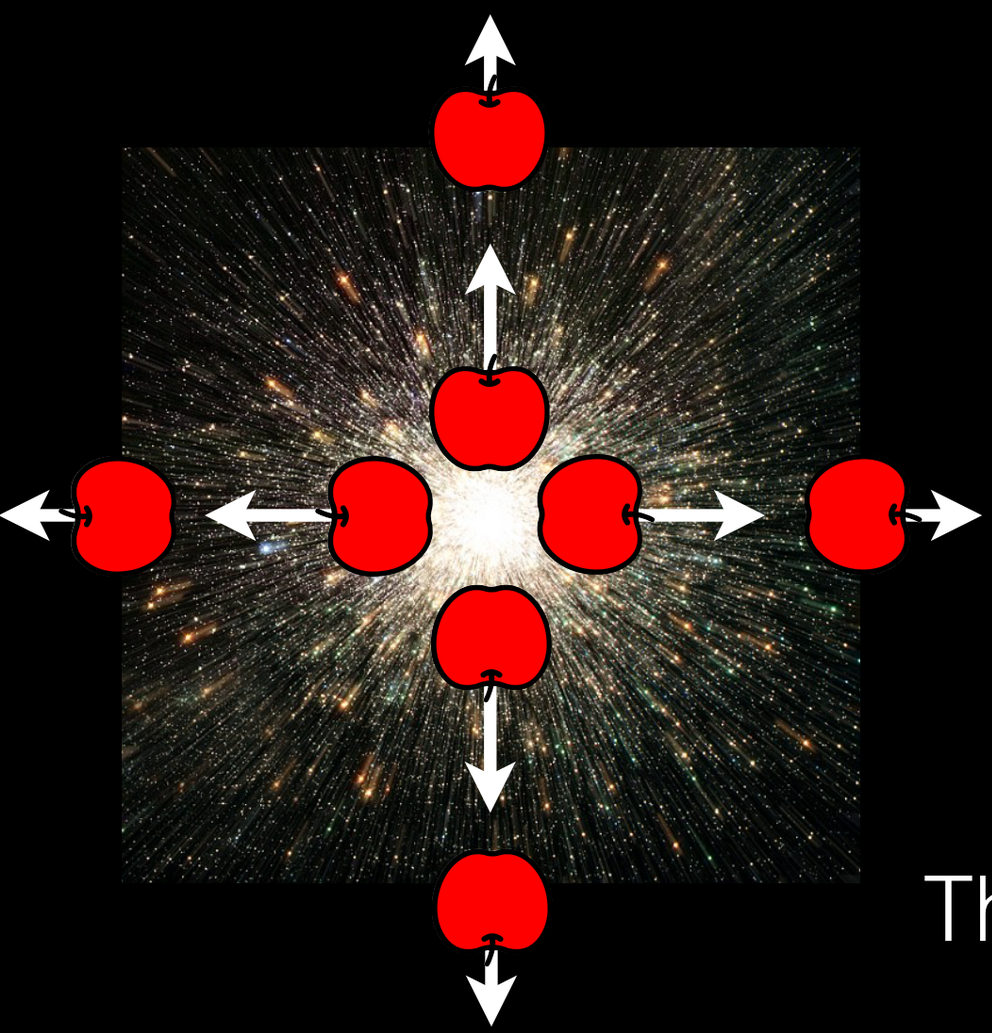
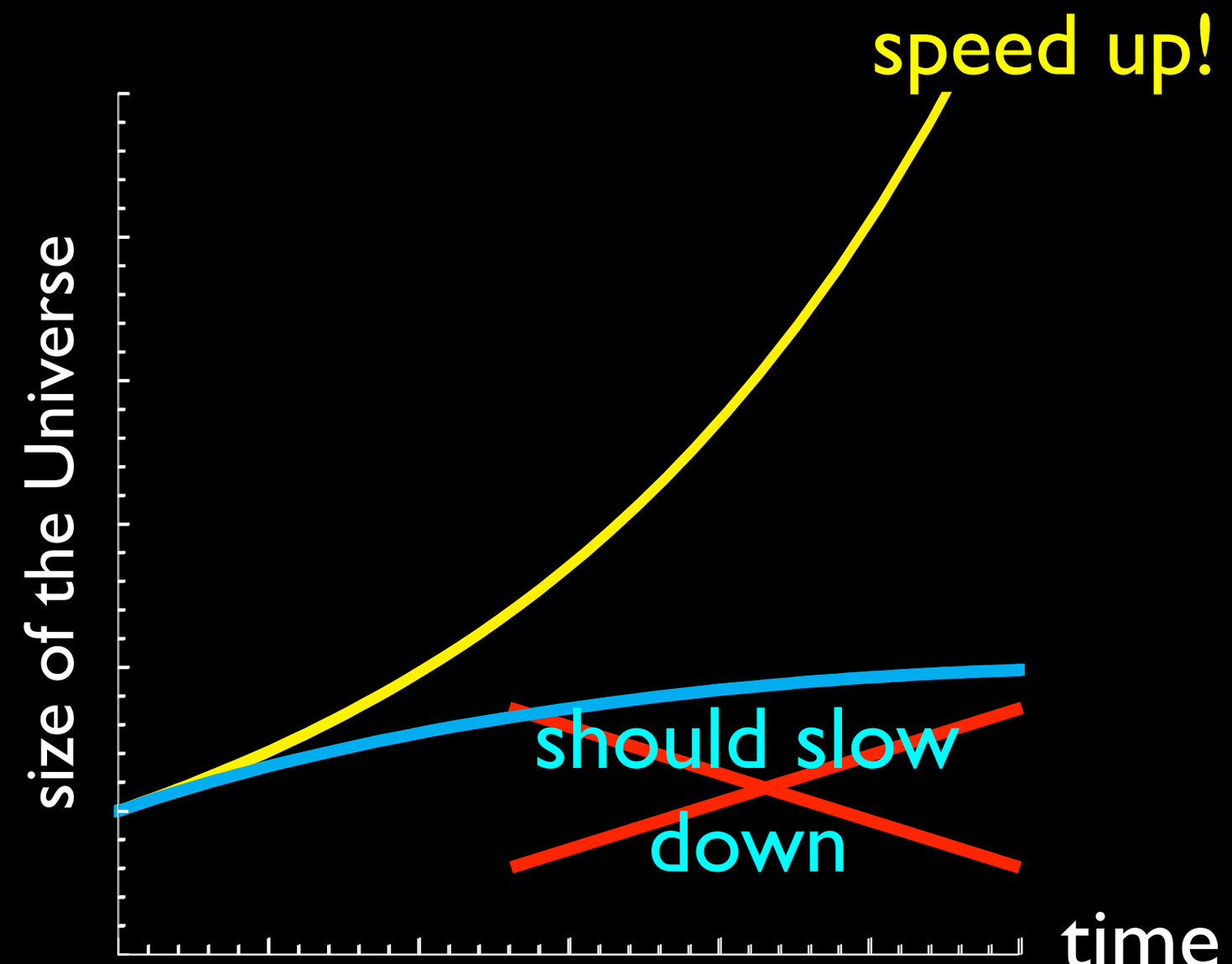
Cosmic Expansion







Gravity only pulls
Something is pushing the expansion
The biggest mystery in modern physics!

Phases of cosmic expansion

3 pillars of science

A01
Inflation

A02 dark matter
deceleration

acceleration

A03
dark energy

acceleration

time

size of the Universe

Cosmic Microwave Bkgd
CMB

2011 Nobel Prize in Physics

Slides from Sendai 2018

NASA/WMAP Science Team

3 pillars of science (theory)

4 approaches (expt, obs)

	[A01] Inflation Sasaki (Kyoto)	[A02] fluent. & struct. Takahashi (Tohoku)	[A03] Dark Energy Sugiyama (Nagoya)
[B01] CMB polariz. Hazumi (KEK)	ζ, r, n direct (	CMB lensing isocurv. m_ν, N_ν	cosmo. params CMB lensing
[B02] Subaru galaxy imaging Miyazaki(NAOJ)	Lensing → $b(k)$ $\rightarrow P_{\rm primod}(k)$	weak lensing γ l. DM	weak lensing γ
[B03] galaxy spectroscopy Takada(KIPMU)	primord. NG Ω_K, n_s, α_s	isocurv. DM in d $P($	BAO, RSD $\Omega_{\rm de}$
[B04] TMT Usuda (NAOJ)	QED coupling (α) space time var.	Lyman-α forests IGM	direct detection of acceleration

Simons Observatory construction

PBH limits on Subaru

HSC cosmic shear

PFS galactic archaeology

PFS construction

important observables at each intersection

C01: ultimate theory Ooguri(Caltech)

Universe before inflation?
Birth of time?
quantum gravity? string?
other dims? end of Universe?
Multiverse?

swampland de Sitter conjecture

[A01]インフレーション 佐々木(京都大)

[A02]掴らざと構造 高橋(東北大)

[A03]ダークエネルギー 杉山(名古屋大)

[B01] CMB偏光 海老沢(KEK)

[B02] すばる銀河イメージング 宮崎(NAOJ)

[B03] 銀河系外 高田(KIPMU)

[B04] TMT 臼田(NAOJ)

ζ, T, n_s 直接検出

Lensing → $P_{\rm primod}(k)$

primord. NG $f_{\rm NL}, n_s, \alpha_s$

微細構造定数(α) 空間・時間変化

CMB lensing isocurv. m_ν, N_ν

weak lensing m_ν non-std. DM isocurv. DM in dSph gals. $P(k), m_\nu$

Lyman-α forests IGM

cosmo. params CMB lensing

weak lensing SNe, γ

BAO, RSD $\Omega_{\rm de}(z), \gamma$

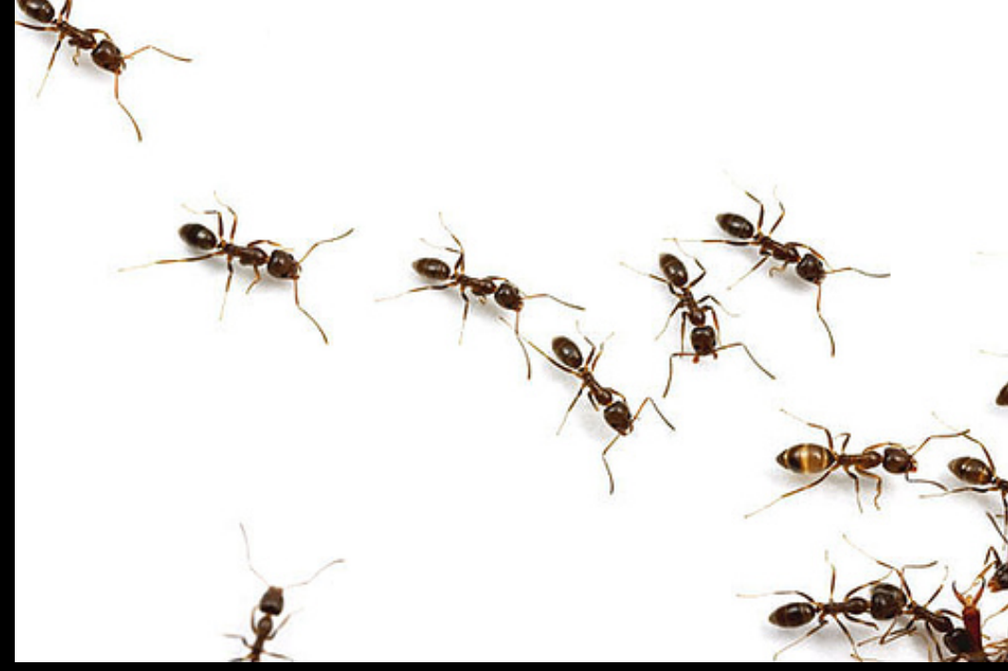
宇宙加速膨張の直接検出

log normal analyses

X00: organization
Murayama (IPMU)

D01: ultimate analysis Komatsu(MPA)

ideas



- write papers with other groups!
- modified gravity A01,03:
  - testability using Web App by D01
  - connection to string theory C01
  - theory space and HSC constraint: B02
- direct measurement of acceleration B04&D01
  - study of systematics, *e.g.*, motion of solar system
- time-dependent physical constants A01,03,C01,D01
- software tools and analysis methods on CMB: B01&D01
- multi-messenger:
  - gravitational wave, neutrinos, cosmic rays
- papers on instrumentation also needed
- "*unexpected*"

Looking forward to work by Solicited proposals (Koubo-Kenkyu)

near term

- public lectures all around Japan happening
- schools for students & postdocs with career development workshops
- press conference on HSC SSP results Feb 27 success
- unblinding HSC data on cosmic shear! success
- Hope for
  - LiteBIRD approval
  - TMT progress