Activities of A03 group
(Late-time cosmic acceleration)

Shinji Tsujikawa

Members of A03 group

- Naoshi Sugiyama (Nagoya)
- Shin'ichi Nojiri (Nagoya)
- Kiyotomo Ichiki (Nagoya)
- Atushi J. Nishizawa (Nagoya)
- Shinji Tsujikawa (Tokyo University of Science)

Papers written in 2019-2020 by A03 members

SLAC Inspire:
find a Naoshi Sugiyama or Kiyotomo Ichiki or Shinji Tsujikawa or S Nojiri or Atsushi J. Nishizawa and d 2019

52 papers in 2019

HEP **52** のレコードが見つかりました。 1 - 25 ▶ ▶▶ レコードへジャンプ： 1　検索にかかった時間： 0.38 秒

1. **Unifying Inflation with Early and Late-time Dark Energy in $F(R)$ Gravity**
Shin'ichi Nojiri (Nagoya U. (main) & KMI, Nagoya), Sergei D. Odintsov (ICREA, Barcelona & Barcelona, IEEC & TUSUR, Tomsk & Tomsk State Pedagogical U.), V.K. Oikonomou (Aristotle U., Thessaloniki & TUSUR, Tomsk & Tomsk State Pedagogical U.). Dec 30, 2019. 12 pp.
e-Print: **arXiv:1912.13128 [gr-qc]** | **PDF**
References | BibTeX | LaTeX(US) | LaTeX(EU) | Harvmac | EndNote
ADS Abstract Service
レコードの詳細 - Cited by 1 record

2. **Density Fluctuation Reconstruction using KS test and D'Agostino's K-squared test**
Kiichi Yoshida, Kiyotomo Ichiki, Atsushi J. Nishizawa. Dec 18, 2019. 12 pp.
e-Print: **arXiv:1912.08384 [astro-ph.CO]** | **PDF**
References | BibTeX | LaTeX(US) | LaTeX(EU) | Harvmac | EndNote
ADS Abstract Service
レコードの詳細

3. **The Subaru HSC Galaxy Clustering with Photometric Redshift I: Dark Halo Masses Versus Baryonic Properties of Galaxies at 0.3**
Shogo Ishikawa *et al.*. Dec 11, 2019. 33 pp.
e-Print: **arXiv:1912.05668 [astro-ph.GA]** | **PDF**
References | BibTeX | LaTeX(US) | LaTeX(EU) | Harvmac | EndNote
ADS Abstract Service
レコードの詳細

4. **Active gas features in three HSC-SSP CAMIRA clusters revealed by high angular resolution analysis of MUSTANG-2 SZE and XXL X-ray observations**
Nobuhiro Okabe (Hiroshima U. & Hiroshima U., HASC) *et al.*. Nov 20, 2019. 32 pp.
e-Print: **arXiv:1911.09236 [astro-ph.CO]** | **PDF**
References | BibTeX | LaTeX(US) | LaTeX(EU) | Harvmac | EndNote
ADS Abstract Service

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7 papers in 2020

HEP **7** のレコードが見つかりました。　検索にかかった時間： 0.47 秒

1. **The Alcock Paczynski test with 21cm intensity field**
Takao Endo, Hiroyuki Tashiro, Atsushi J. Nishizawa. Feb 2, 2020. 10 pp.
e-Print: **arXiv:2002.00348 [astro-ph.CO]** | **PDF**
References | BibTeX | LaTeX(US) | LaTeX(EU) | Harvmac | EndNote
ADS Abstract Service
レコードの詳細

2. **Spherically symmetric black holes with electric and magnetic charge in extended gravity: Physical properties, causal structure, and stability analysis in Einstein's and Jordan's frames**
E. Elizalde (Barcelona, IEEC), G.G.L. Nashed (British U. in Egypt), S. Nojiri (KMI, Nagoya), S.D. Odintsov (Barcelona, IEEC & ICREA, Barcelona & Tomsk Pedagogical Inst.). Jan 29, 2020. 27 pp.
Published in **Eur.Phys.J. C80 (2020) no.2, 109**
DOI: 10.1140/epjc/s10052-020-7686-3
e-Print: **arXiv:2001.11357 [gr-qc]** | **PDF**
References | BibTeX | LaTeX(US) | LaTeX(EU) | Harvmac | EndNote
ADS Abstract Service; Link to Article from SCOAP3
レコードの詳細

3. **Neutron stars with a generalized Proca hair and spontaneous vectorization**
Ryotaro Kase (Tokyo U. of Sci.), Masato Minamitsuji (Lisbon, IST), Shinji Tsujikawa (Tokyo U. of Sci.). Jan 29, 2020. 18 pp.
e-Print: **arXiv:2001.10701 [gr-qc]** | **PDF**
References | BibTeX | LaTeX(US) | LaTeX(EU) | Harvmac | EndNote
ADS Abstract Service
レコードの詳細

4. **Updated Design of the CMB Polarization Experiment Satellite LiteBIRD**
H. Sugai *et al.*. Jan 6, 2020. 11 pp.
Published in **J.Low Temp.Phys. (2020)**
DOI: 10.1007/s10909-019-02329-w
e-Print: **arXiv:2001.01724 [astro-ph.IM]** | **PDF**
References | BibTeX | LaTeX(US) | LaTeX(EU) | Harvmac | EndNote
CERN Document Server; ADS Abstract Service; OSTI.gov Server; Fermilab Library Server (fulltext available); Link to Fulltext; Link to Fulltext
レコードの詳細 - Cited by 2 records

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Organization of international conference

Participants～50（Foreigners～20）

Held in KMI (Nagoya University) on 3, 4, 5 December (2019)

6-th Korea-Japan workshop on dark energy at KMI

Keynote Speakers
Luca Amendola (University of Heidelberg)
Myungkook James Jee (Yonsei university)
Jiro Soda (Kobe)
Takahiro Tanaka (Kyoto)

Organized by members of A03 group and Arman Shafieloo (next speaker)

Scientific Organizers
Shinji Tsujikawa (Tokyo University of Science, chair)
Arman Shafieloo (KASI, co-chair)
Naoshi Sugiyama (Nagoya)
Shin'ichi Nojiri (Nagoya)

Local Organizers
Kiyotomo Ichiki (Nagoya University, Chair)
Atsushi Nishizawa (Nagoya University)
Shuichiro Yokoyama (Nagoya University)

Confirmed Invited Speakers
Antonio De Felice (YITP)
Shinji Mukohyama (YITP)
Atsushi Taruya (YITP)
Takeshi Chiba (Nihon)
Tsutomu Kobayashi (Rikkyo)
Sachiko Kuroyanagi (Madrid)
Ryotaro Kase (TUS)
Shintaro Nakamura (TUS)
Atsushi Naruko (YITP)
Ryo Saito (Yamaguchi)
Hironao Miyatake (Nagoya)
Katsuki Aoki (YITP)
Kyungjin Ahn (Chosun University)
Kenji Kadota (IBS)
Jinn-Ouk Gong (KASI)
Ryan Keeley(KASI)
David Parkinson (KASI)
Jacobo Asorey (KASI)
Jurgen Mifsud (KASI)
Satadru Bag (KASI)
Benjamin L'Huillier (Yonsei)
Hanwool Koo (KASI)
Zong-Hong Zhu (Beijing Normal University)
Xiaolei Li (Hebei Normal University)
Norihiro Tanahashi (Kyushu)
Stephen Appleby (KIAS)
Feng Shi (KASI)
Cristiano Sabiu (Yonsei University)

Research activities of A03 group

There are two aspects of dark energy research.

1. Construction of theoretically viable models and make their observational predictions.

Mostly worked by Shin'ichi Nojiri and Shinji Tsujikawa

2. Observational constraints on dark energy models and their discrimination

Mostly worked by Naoshi Sugiyama, Kiyotomo Ichiki, and Atsushi J. Nishizawa

Both are important to approach the origin of late-time cosmic acceleration.

Hereafter, I briefly explain the results achieved by the members of A03 group and summarize them in the end.

Theoretical aspects of cosmic acceleration

The simplest dark energy model is the LCDM model, but there are also other possibilities. In the latter case, there are usually additional degrees of freedom (DOFs) beyond those appearing in standard model of particle physics and general relativity.

Additional DOFs can be

1. Scalar field (spin 0) → Coupled to gravity → Scalar-tensor theories

One scalar + two tensor modes = 3 DOFs

2. Massive vector field (spin 1) → Coupled to gravity → Vector-tensor theories

One longitudinal scalar + two transverse vectors + two tensor modes = 5 DOFs

3. Massive graviton (spin 2) → Massive gravity

6 DOFs with one BD ghost in general.
The BD ghost is absent in DRGT massive gravity.

Theoretical Works of Shin'ichi Nojiri (10 published papers)

Gravitational Waves in several models

- Gravitational Waves in the Presence of Viscosity
  I. Brevik, S.N., Int.J.Mod.Phys. D28 (2019) no.10, 1950133

- Propagation of Gravitational Waves in Chern-Simons Axion Einstein Gravity
  S.N., S.D. Odintsov, V.K. Oikonomou, A.A. Popov, Phys.Rev. D100 (2019) no.8, 084009

Application of Modified Gravities to Cosmic Acceleration or Early Universe

- k-essence f(R) gravity inflation
  S.N., S.D. Odintsov, V.K. Oikonomou, Nucl.Phys. B941 (2019) 11-27
- Holographic inflation
  S.N., S.D. Odintsov, E.N. Saridakis, Phys.Lett. B797 (2019) 134829
- Viable inflationary models in a ghost-free Gauss–Bonnet theory of gravity
  S.N., S.D. Odintsov, V.K. Oikonomou, N. Chatzarakis, T. Paul,
  Eur.Phys.J. C79 (2019) no.7, 565,
- Holographic bounce
  S.N., S.D. Odintsov, E.N. Saridakis, Nucl.Phys. B949 (2019) 114790
- Nonsingular bounce cosmology from Lagrange multiplier F(R) gravity
  S.N., S.D. Odintsov, V.K. Oikonomou, T. Paul, Phys.Rev. D100 (2019) no.8, 084056

Theories constrained by the GW170817

vent

The GW170817 event constrained the speed c_t of gravitational waves very close to that of light:

$$-3 \times 10^{-15} \le c_t/c - 1 \le 7 \times 10^{-16}$$

Redshift: $z \le 0.009$

If we require that $c_t = c$, the constrained Lagrangians are the following:

- Scalar-tensor (Horndeski) theories

$$L = G_2(\phi, X) + G_3(\phi, X)\Box\phi + G_4(\phi)R$$

K-essence | Derivative interaction | Nonminimal coupling

Scalar field ϕ

$X = -\partial_\mu\phi\partial^\mu\phi/2$

- Vector-tensor (generalized Proca) theories

$$L = \frac{M_{\rm pl}^2}{2}R + G_2(X, F) + G_3(X)\nabla_\mu A^\mu$$

Vector field A_μ

$X = -A_\mu A^\mu/2,$

$F = -F_{\mu\nu}F^{\mu\nu}/4$

⇨ Models containing the power-law dependence of X in $G_{2,3}$ can realize the late-time cosmic acceleration compatible with observations.

De Felice, Heisenberg, ST (2017)

Observationally favored dark energy model in scalar–tensor theories

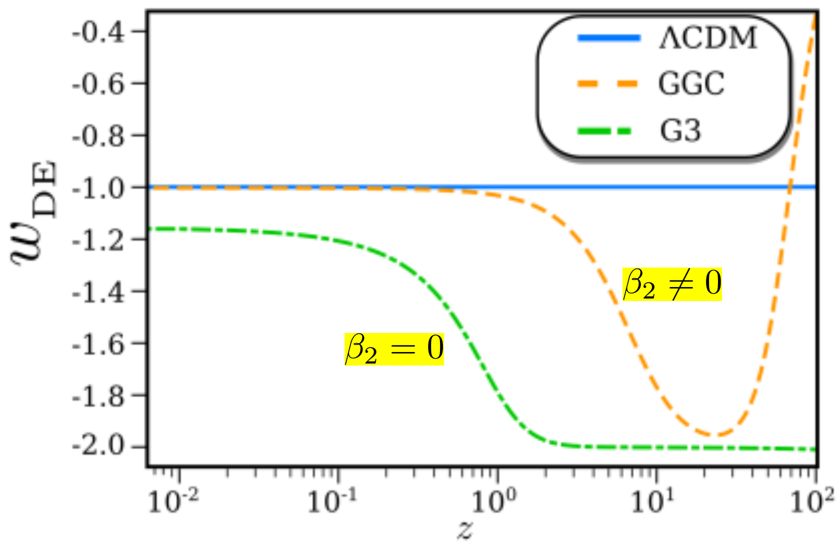
Galileon ghost condensate (GGC): $L = \frac{M_{\rm pl}^2}{2}R - X + \beta_2 X^2 + \beta_3 X \Box \phi$

- $\beta_2 = 0$ ⇒ Cubic Galileon

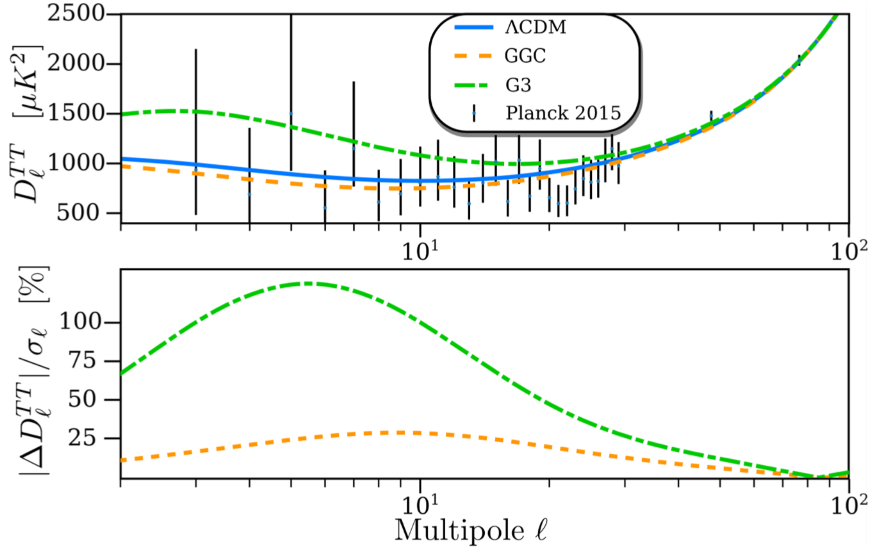
  ⇒ Observationally disfavored both at the background and perturbation levels.

- $\beta_2 \neq 0$ ⇒ This allows the better compatibility with the data (CMB, SNIa, BAO, RSD) in comparison to the LCDM.

Dark energy equation of state



CMB TT spectrum

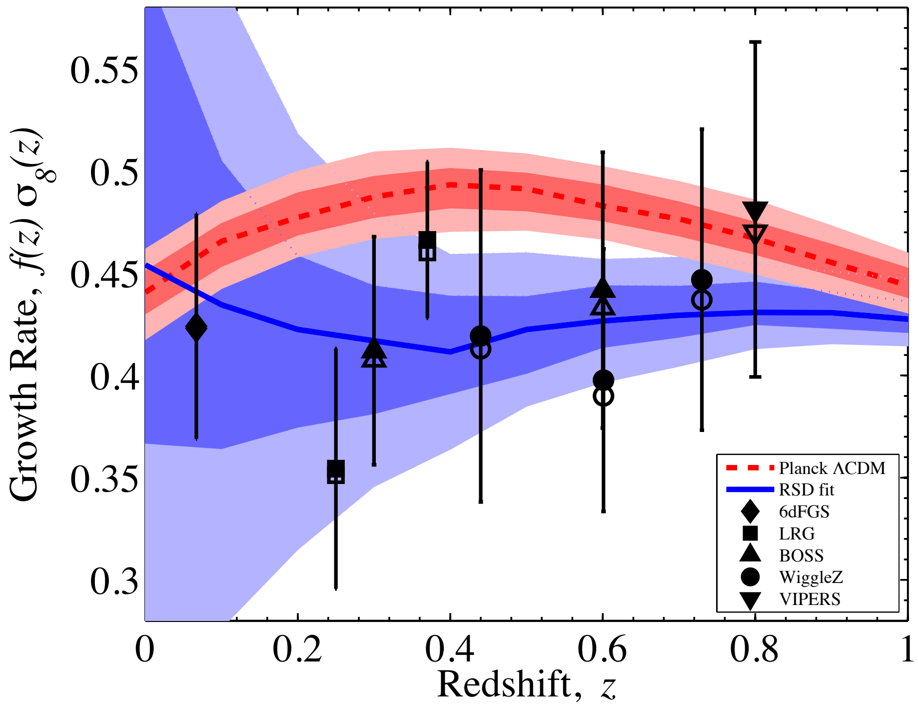


Even with two additional models parameters in comparison to the LCDM, the Bayesian statistics favor the GGC relative to the LCDM.

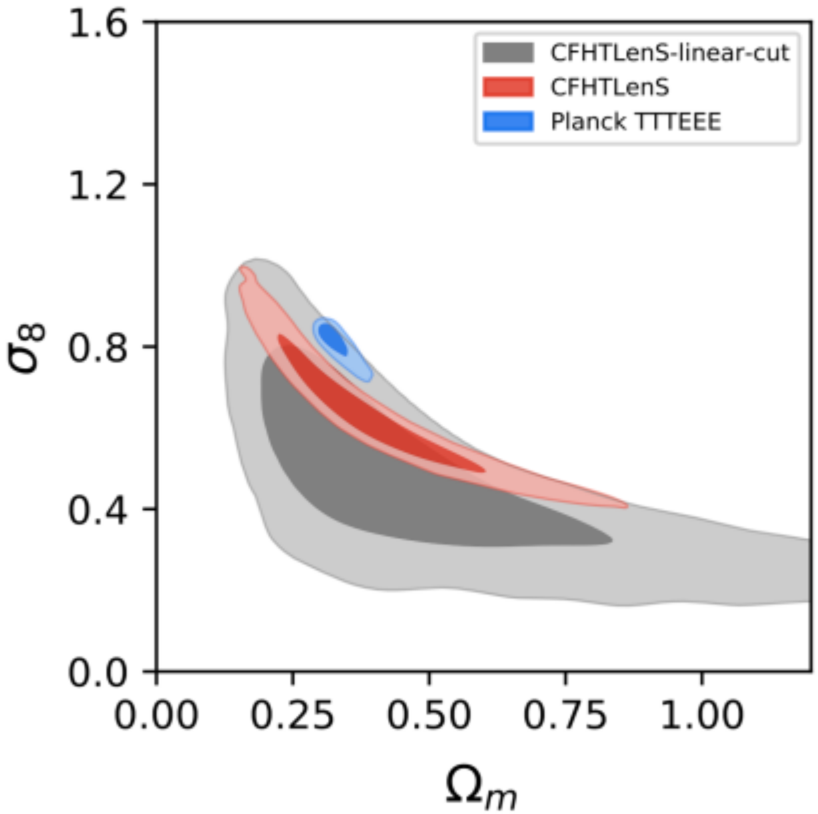
S. Peirone, G. Benevento, N. Frusciante, ST, PRD 100, 064540 (2019)

σ_8 tension between CMB and low-redshift data

Planck vs redshift-space distortions (RSDs)



Planck vs weak lensing



The observed cosmic growth rate is lower than that predicted by the LCDM model.

→ This is difficult to be addressed in scalar-tensor and vector-tensor theories, as they predict the effective gravitational coupling $G_{\rm eff}$ larger than the Newton constant G.

Coupled dark energy and dark matter model realizing weak cosmic growth

We consider a quintessence scalar field with a perfect-fluid CDM action:

$$\mathcal{S} = \int d^4x\sqrt{-g}\left[\frac{M_{\rm pl}^2}{2}R + X - V(\phi)\right] - \int d^4x\left[\sqrt{-g}\,\rho_c(n_c) + J_c^\mu \partial_\mu \ell_c\right] + \mathcal{S}_{\rm int}$$

DE sector (scalar field) — CDM sector (perfect fluid) — Interaction

Let us consider the simple interaction of the form

$$\mathcal{S}_{\rm int} = \int d^4x\sqrt{-g}\, f(X, Z)$$

$$X = -\partial^\mu\phi\partial_\mu\phi/2,$$
$$Z = u_c^\mu\partial_\mu\phi$$

Constructed from the first derivative of ϕ

u_c^μ: CDM four velocity

The Z dependence in f gives rise to the momentum transfer, in contrast to the energy transfer associated with the coupling $f_1(\phi, X)\rho_c$.

→ Allowing the realization of weak cosmic growth

R. Kase and ST, arXiv:1911.02179 (2019).
See also Pourtsidou et al (2013), Boehmer et al (2015).

Suppressed cosmic growth rate

Consider the coupling: $f(X,Z) = \beta \left(\sqrt{2X}\right)^{2-n} Z^n$ → $f = \beta\dot{\phi}^2$ on the background.

Effective CDM gravitational couplings: $G_{cc} = G_{cb} = G/(1+r_f)$ with

$$r_f = \frac{\beta n \dot{\phi}^2}{3H^2 M_{\rm pl}^2 \Omega_c c_s^2}$$

→ Positive for $\beta n > 0$.

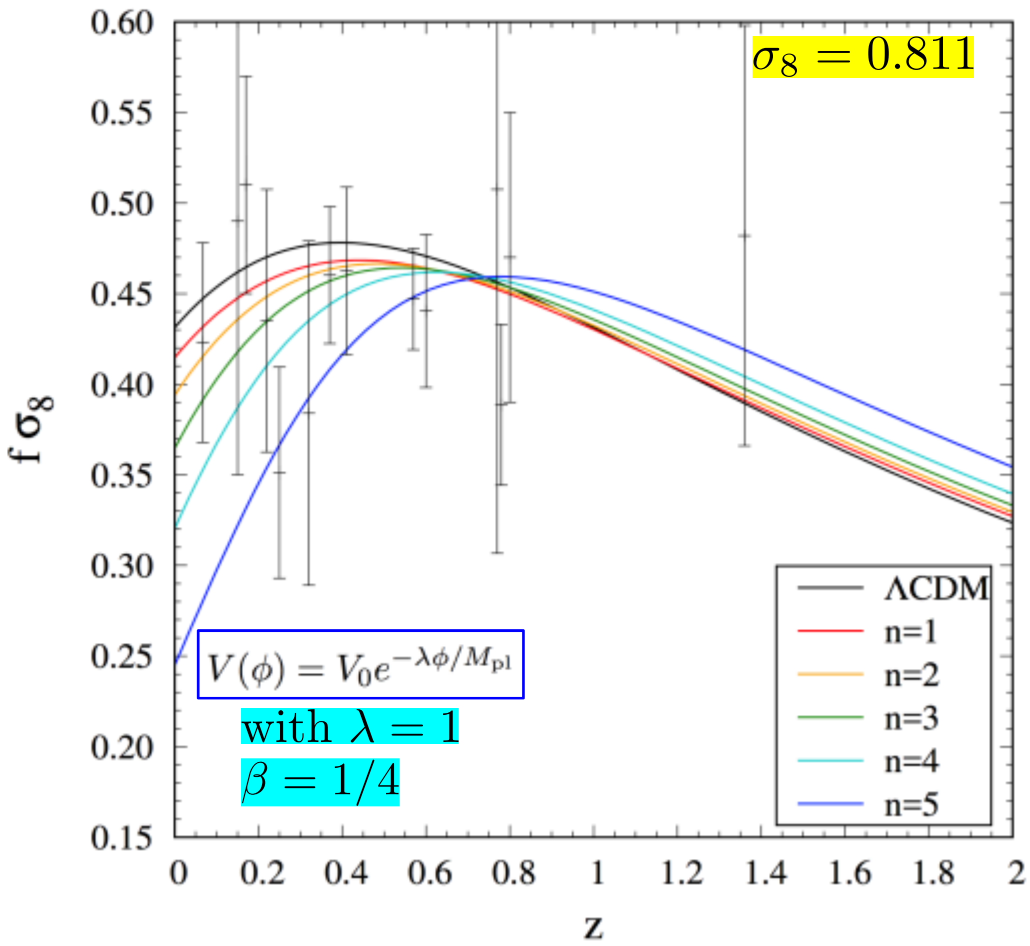
For $\beta n > 0$, we have $G_{cc} = G_{cb} < G$.

As βn increases, the growth rate of matter perturbations tends to be smaller.

The model should exhibit the better fit to the redshift-space distortion data in comparison to the LCDM.

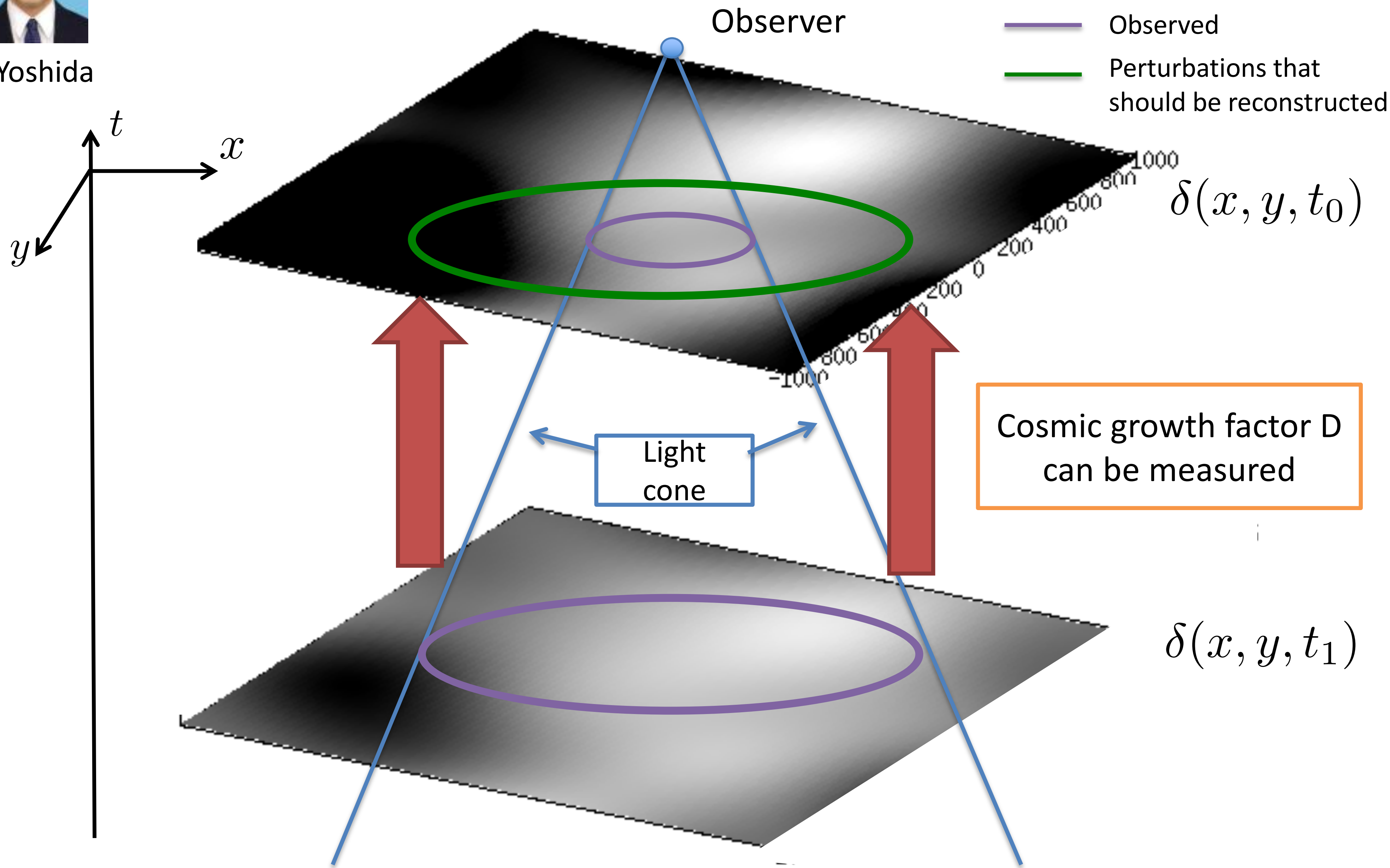
→ K. Ichiki, R. Kase and ST, in preparation.

R. Kase and ST, arXiv:1911.02179



K. Yoshida

Direct reconstruction of density perturbations

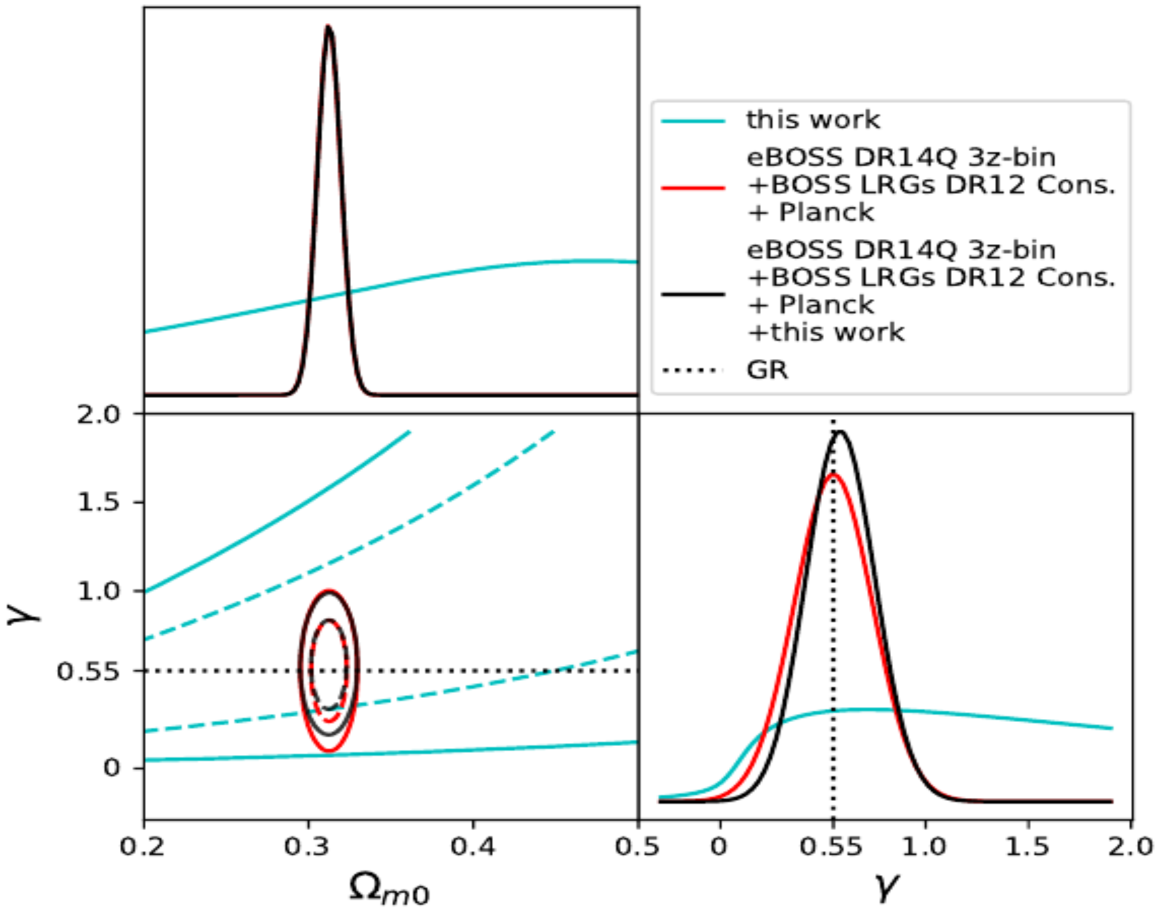


K. Yoshida, K. Ichiki & A.J. Nishizawa, arxiv:1912.08384

Constraints on dark energy using the direct reconstruction of density perturbations

K. Yoshida, K. Ichiki, A. J. Nishizawa,
Arxiv: 1912.08384

This nonparametric method allows one to estimate the cosmic growth factor D by using one point distribution of the density field.



The linear growth rate:

$$f = \frac{\dot{D}}{HD} = \Omega_m^\gamma$$

γ is the growth index.

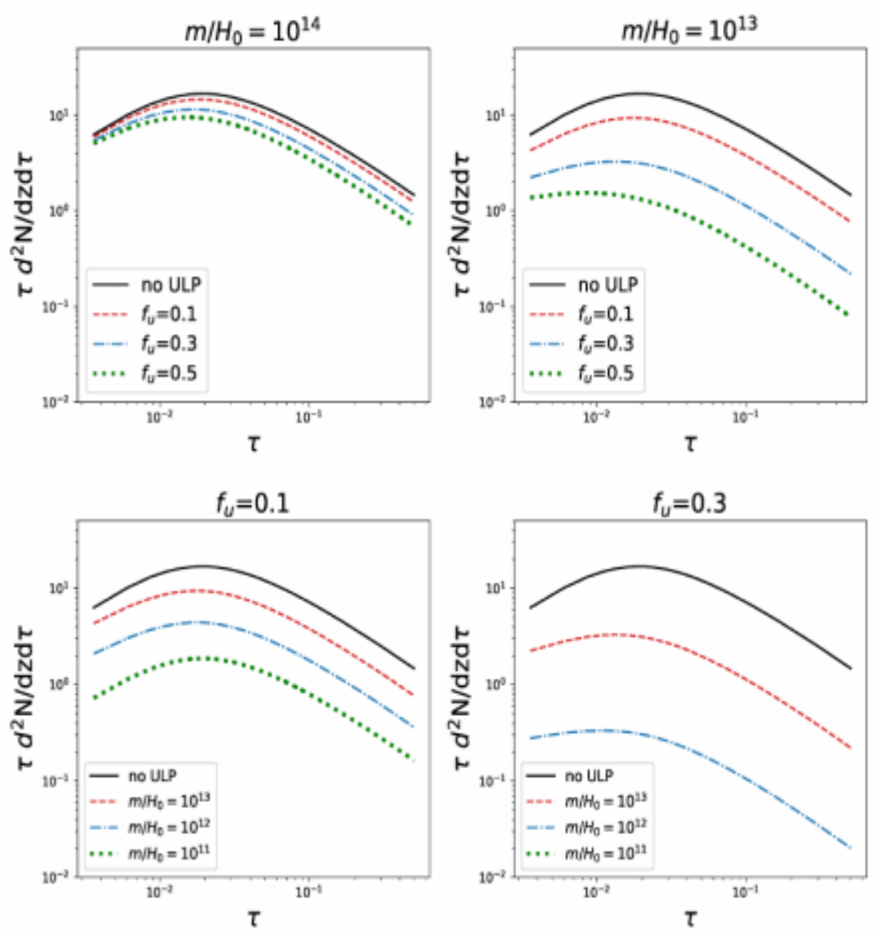
With this new method, the joint analysis combined with the data of eBOSS, CMB constrain the growth index:

$$\gamma = 0.58^{+0.17}_{-0.16} \quad (68\ \%\ \mathrm{CL})$$

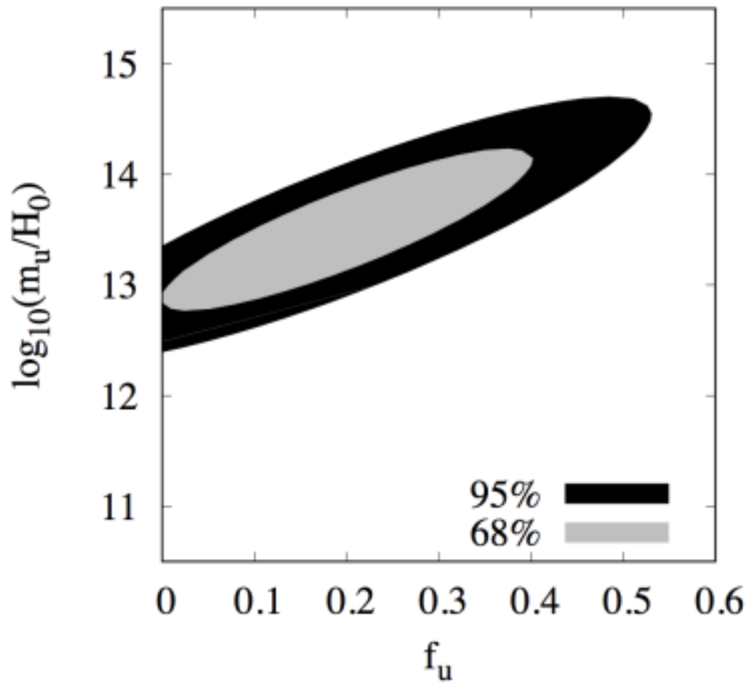
Constraints on nature of ultra light dark matter particles (ULP) with 21cm forest

H. Shimabukuro, K. Ichiki and K. Kadota,
arXiv:1910.06011 (PRD in press)

Abundance of 21 cm absorption line



m: ULP mass, f_u: ULP fraction



ULP reduces the number of absorption lines of 21cm forest compared to the standard CDM case.

21cm forest can reach the mass scale of ULP up to

$$m \simeq 10^{14} H_0 \simeq 10^{-19}\ \mathrm{eV}$$

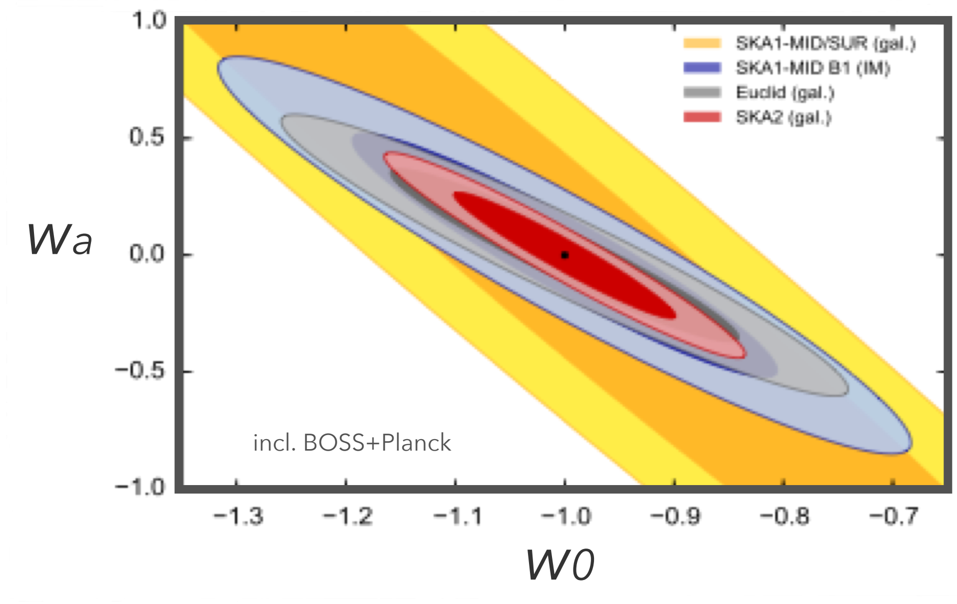
Neutral hydrogen (HI) gas clustering with the RSD of 21 cm line

R. Ando, A.J. Nishizawa+ (arXiv:1808.01116)

Exploring the properties of HI clustering with cosmological dynamical simulations

This is particularly useful for the 21 cm intensity mapping of SKA measurements (wide range, high-redshift).

→ It will be possible to use it for probing the physics of dark energy.



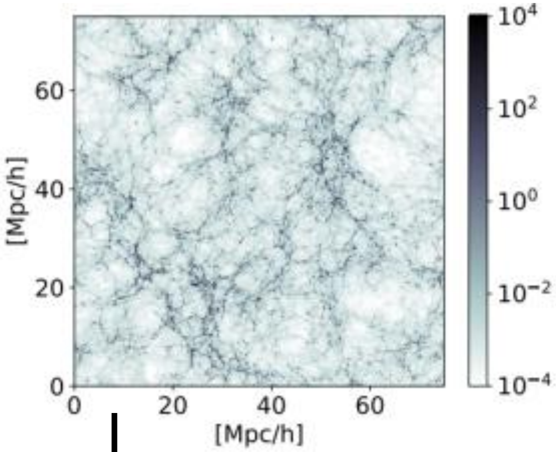
Dynamical dark energy equation of state

$$w = w_0 + (1-a)w_a$$

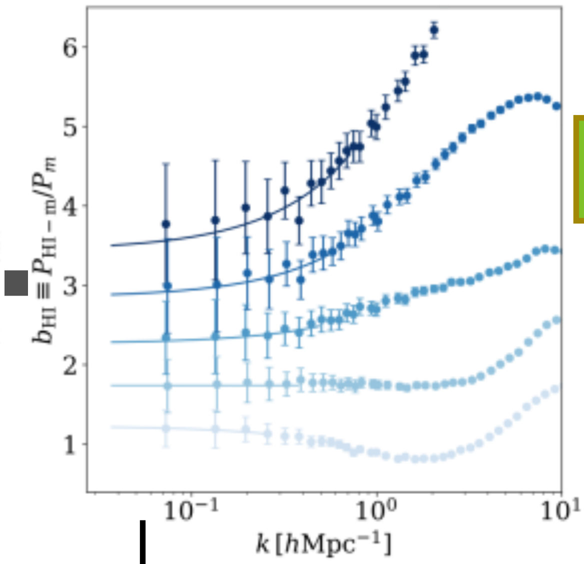
Modeling of HI P(k) toward BAO measurement for SKA

R. Ando, A.J. Nishizawa+ (arXiv:1808.01116)
R. Ando, A.J. Nishizawa+ in prep.

Illustris TNG @ z=3



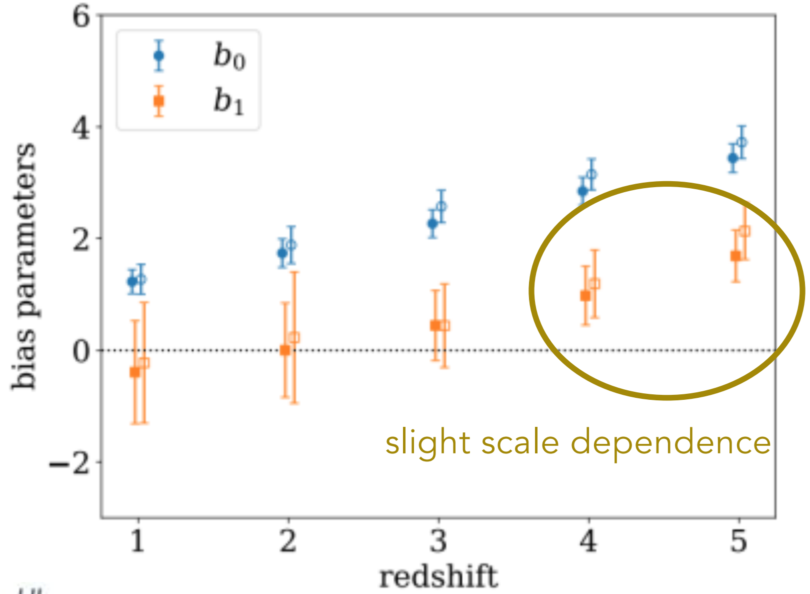
measure P(k)



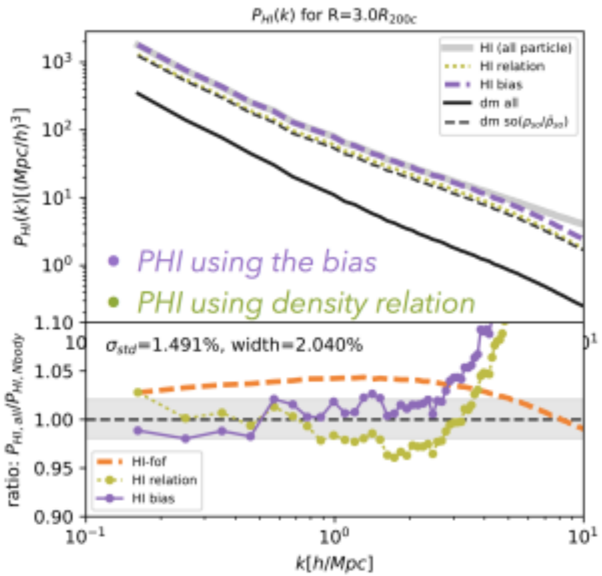
measure bias(k,z)

Ando (D1@Nagoya)

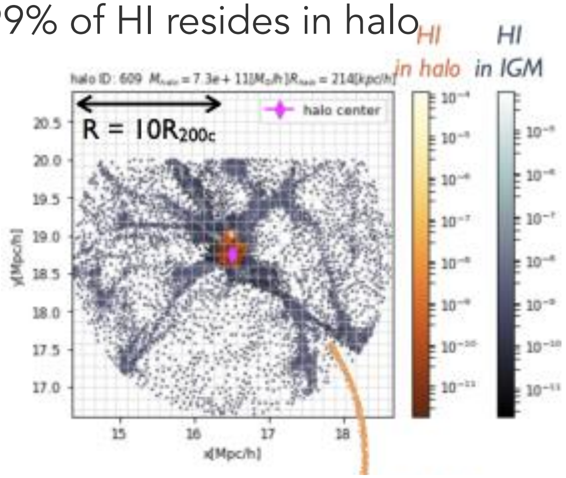
no difference btwn. w/wo SN/AGN feedback



semi-modeling of $P_{\rm HI}(k)$



99% of HI resides in halo



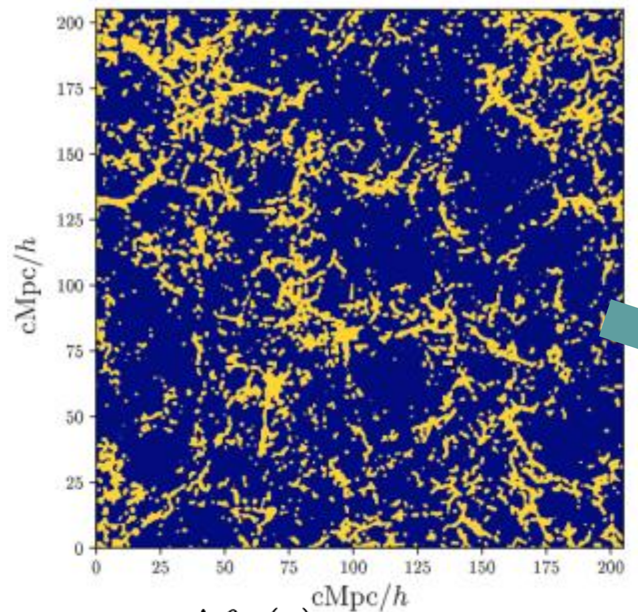
$$\delta_{\rm HI}(\boldsymbol{x}) = b\,\delta_{\rm DM}(\boldsymbol{x}) \left(\sum_i W_{3R}^{\rm TH}(\boldsymbol{x} - \boldsymbol{x}_i) \right)$$

DM Halo catalog -> constant bias can reproduce HI P(k)

Alcock-Paczynski (AP) test on 21cm intensity map

T. Endo, H. Tashiro A.J. Nishizawa (arXiv:2002.00348)

Illustris TNG simulation

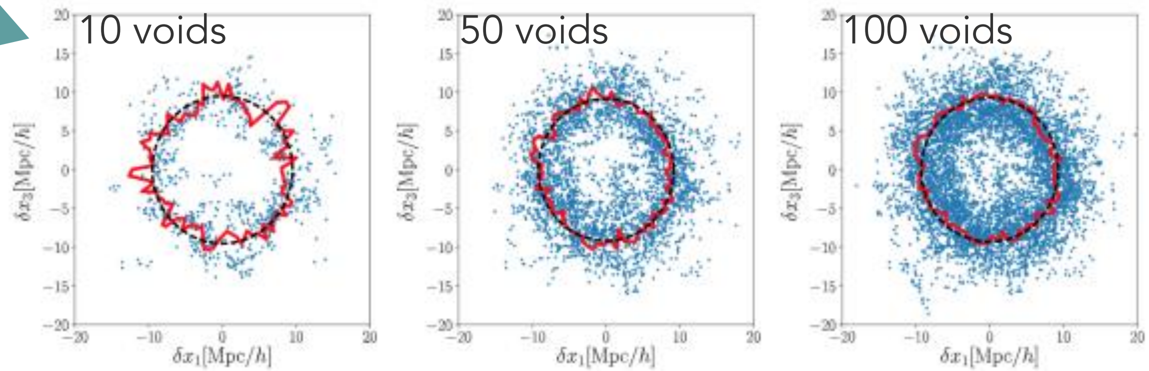


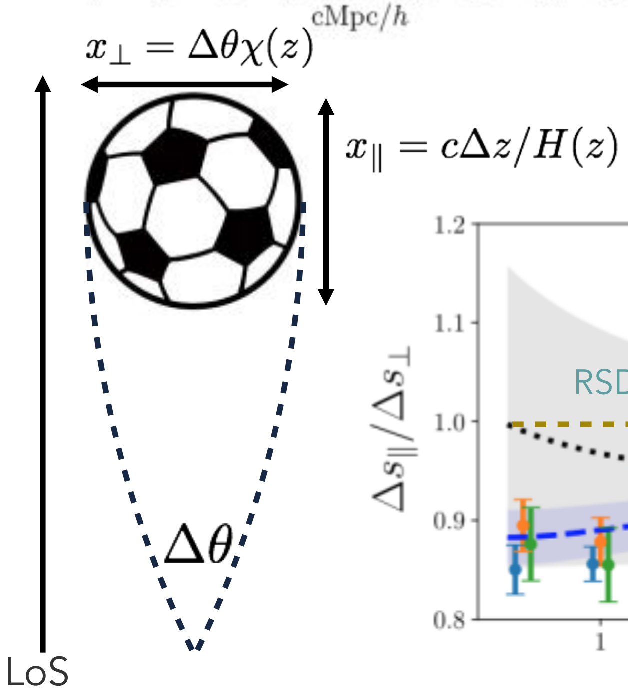
Brightness temperature higher than "threshold"

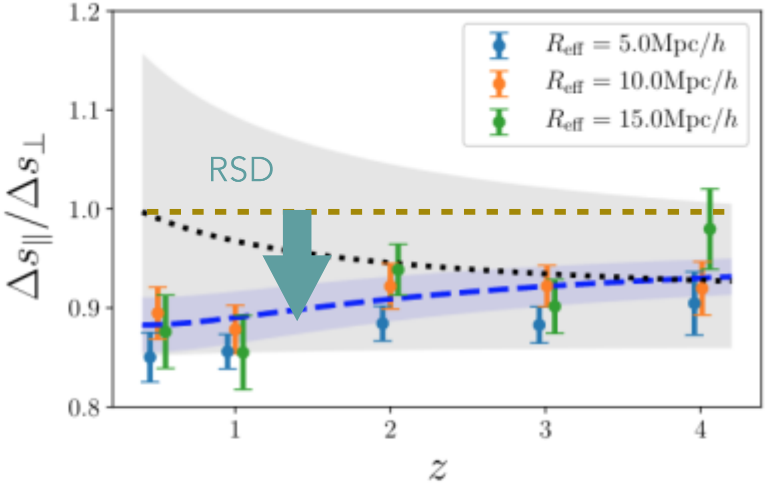
$$\delta T_b \propto x_{\rm HI}\rho_b \left(1 - \frac{T_{\rm CMB}}{T_S}\right)$$

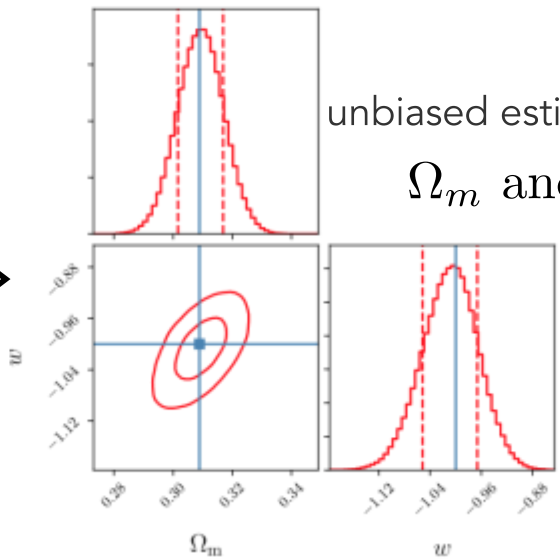
Endo (D3@Nagoya)

void finder (VIDE)









unbiased estimate of

Ω_m and w

Summary

1. In the theoretical side many dark energy models were proposed, but allowed models are now quite restricted from the observations of GW etc.

2. There are some models in scalar-tensor and vector-tensor theories showing the observational compatibility better than the ΛCDM.

3. The coupled DE/DM model with momentum transfer can alleviate the σ_8 tension problem of ΛCDM. Hopefully it will be possible to construct coupled DE/DM model alleviating the H_0 tension.

4. In the observational side, we will obtain a wealthy of observational data including GWs, 21 cm forest, weak lensing, and RSD which can be used to constrain DE models further.

We believe that the A03 group contributed to the progress of DE research over the past 5 years, but we will also continue to do it in the future.