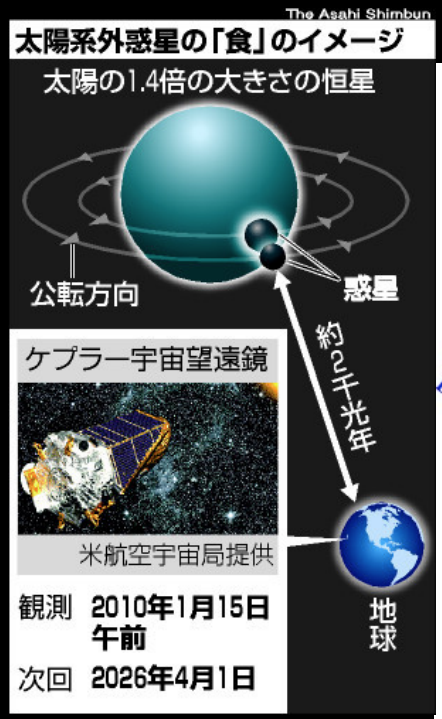
Summary of Research Activity 2005-2012



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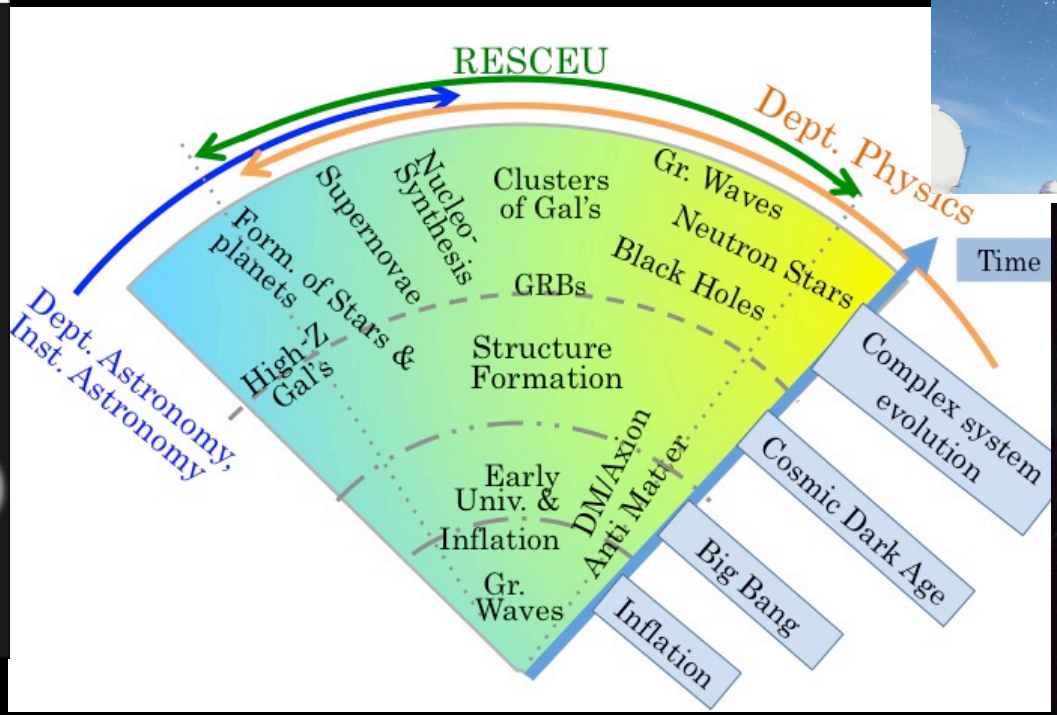

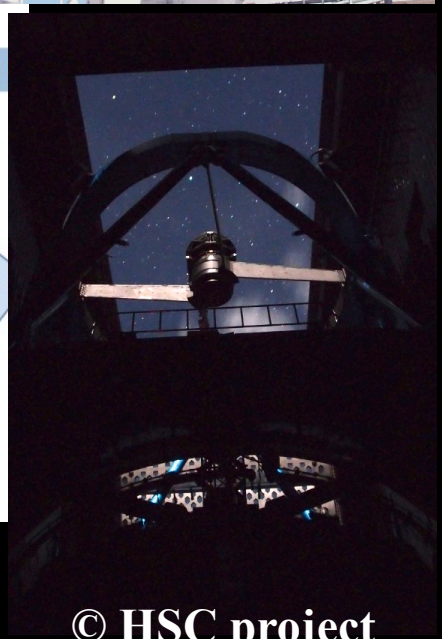

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Yasushi Suto, Atsushi Taruya

Visiting review committee @room #1320

16:30-16:50 January 9, 2013

Theoretical astrophysics group in brief

- Organized jointly between Physics Dept. and RESCEU
  - Y.Suto + A.Taruya + 8 grad. students
  - N.Yoshida + T.Hosokawa
  - J.Yokoyama + T.Suyama
- Weekly joint seminars, journal clubs, archive paper reading (undergraduate reading class)
- International collaboration with Princeton, MIT, Institut d'astrophysique de Paris, etc.

Major research projects

- Observational cosmology
  - Founding of SuMIRe (=HSC+PFS; Subaru Measurement of Images and Redshits of the universe)
  - Improved perturbation theory for accurate modeling of nonlinear galaxy power spectrum (led by Atsushi Taruya)
  - Discovery of FIR emission signatures from galaxies on the Galactic extinction map
- Extrasolar planet
  - Analytic expression for the Rossiter – McLaughlin effect for transiting planets
  - Discovery of a planet-planet eclipse in a multiple transiting planetary system
  - Towards a remote-sensing of exo-Earths: beyond a pale blue dot

Titles of Ph.D thesis 2005-2012

取得年	学位論文題名	現職
2012	An Improved Method for CMB Lensing Reconstruction and Its Cosmological Applications	未定
2012	Measurements of Spin-Orbit Angles for Transiting Systems: Toward an Understanding of the Migration History of Exoplanets	東工大学振研究員 (4月以降)
2012	Exploring the landscape of habitable exoplanets via their disk-integrated colors and spectra: Indications for future direct imaging observations	東大地惑学振研究員 (4月以降)
2010	Toward a precise measurement of neutrino mass through nonlinear galaxy power spectrum based on perturbation theory	バークレー学振研究員
2010	(The central engine of gamma-ray bursts and core-collapse supernovae probed with neutrino and gravitational wave emissions)	京大基研特任准教授
2010	Numerical Studies on Galaxy Clustering for Upcoming Wide and Deep Surveys: Baryon Acoustic Oscillations and Primordial Non-Gaussianity	IPMU学振研究員 IAP学振研究員(4月以降)
2009	Inhomogeneity in Intracluster Medium and Its Cosmological Implications	東大地惑助教
2008	太陽系外トランジット惑星系のロシター効果 -摂動論的アプローチと惑星リング検出への応用 -	民間企業
2008	Galaxy clustering constraints on departure from Newton's law of gravitation at cosmological scales	高校教員
2008	Spectroscopic Studies of Transiting Planetary Systems	国立天文台特任助教
2008	The relation of the Galactic extinction map to the surface number density of galaxies	民間企業
2007	Numerical studies on cosmological perturbations in braneworld	京大基研特任助教

http://www-utap.phys.s.u-tokyo.ac.jp/~suto/former_members.htm

Awards (2005-2012)

表彰年月日	氏名	受賞名	受賞対象題目
2012年1月19日	河原創	Martin and Beate Block Award (Aspen winter school, best poster)	Global Mapping of Earth-like Planets toward Exo-habitat Research
2010年3月24日	平野照幸	平成21年度東京大学大学院理学系研究科 研究奨励賞(修士課程)	太陽系外トランジット惑星系の公転軸の決定
2009年3月29日	大栗真宗	第3回(平成20年度) 日本物理学会若手奨励賞	非球対称性を取り込んだ銀河団重力レンズモデルの構築
2009年3月26日	稲田直久	第20回(2008年度) 日本天文学会研究奨励賞	可視光広域サーベイデータを用いた重力レンズクエーサーの探索
2006年2月3日	大栗真宗	第22回(平成17年度) 井上研究奨励賞	冷たい暗黒物質宇宙における強い重力レンズ現象
2005年3月29日	須藤靖	第9回(2004年度) 日本天文学会林忠四郎賞	銀河および銀河団を用いた観測的宇宙論の研究
2005年3月24日	大栗真宗	平成16年度第2回学生表彰 「東京大学総長賞」	重力レンズ現象を用いた宇宙の構造進化の解明

http://www-utap.phys.s.u-tokyo.ac.jp/~suto/award_list.htm

International Research Network for Dark Energy (JSPS, core-to-core program 2007-2012)

DENET

Princeton U. Dept. of Astrophys. Sci.
coordinator

Institut d'Astrophysique de Paris
coordinator
Jerome Martin

Univ. of Tokyo Res. Center for the Early Universe
coordinator
Yasushi Suto

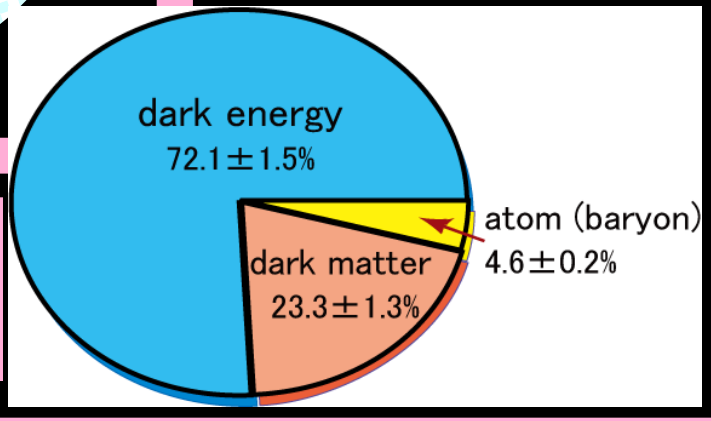
Tohoku Univ.
NAOJ
Hiroshima Univ.
Kyoto Univ.
Nagoya Univ.

CMB
Gravitational lens
Baryon oscillation

Modified gravity
Extra-dimension
backreaction

Edinburgh U. Royal Obs.
coordinator
John Peacock

Theoretical model
Baryon oscillation
Weak lens



Yasushi Suto

Decrypting the Universe

Large Surveys for Cosmology

Invited Speakers
D. Spergel
S. Cole
E. Copeland
M. Doi
A. Helmi
O. Lahav
R. Maartens
Y. Mellier
S. Miyazaki
A. Murphy
M. Takada
T. Yamada

24th-26th October 2007
Edinburgh, Scotland

Joint Royal Observatory Edinburgh / JSPS
Core-to-Core Program Workshop
www.roe.ac.uk/roe/workshop/2007

Royal Observatory Edinburgh Scotland

Local Organising Committee
A. Heavens
R. Ivison
A. Nicol
P. Norberg (Chair)
P. Simon
F. Simpson
A. Taylor

THE UNIVERSITY OF EDINBURGH

Science & Technology Facilities Council
UK Astronomy Technology Centre

JSPS 日本学術振興会
Core-to-Core Program
DENET
International Research
Network for Dark Energy

JAPAN SOCIETY FOR THE PROMOTION OF SCIENCE · FOUNDED 1932 ·

Cosmology Near & Far: Science With WFMOS

May 19-21, 2008 @Marriot, Kona, Hawaii

GEMINI OBSERVATORY

NOAO

Astronomy Australia Ltd.

SUBARU

Science & Technology Facilities Council

Yasushi Suto

DENET and Princeton joint conference:

Science Opportunities with Wide-Field Imaging and Spectroscopy of the Distant Universe

November 9-11, 2009@Princeton Univ.

Yasushi Suto


DENET-Caltech conference:
The Observational Pursuit of Dark Energy after Astro2010
October 7-9, 2010@Cahill Center for Astronomy and Astrophysics, Caltech
JSPS 日本学術振興会
Core-to-Core Program
DENET
International Research
Network for Dark Energy

IAP-DENET International Conference
"The Accelerating Universe"
October 24-26, 2011
Institut d'Astrophysique de Paris

Todai Forum
Aux frontières de la connaissance
28 Sep ▷ 26 Oct 2011
Paris/Lyon en France

Yasushi Suto

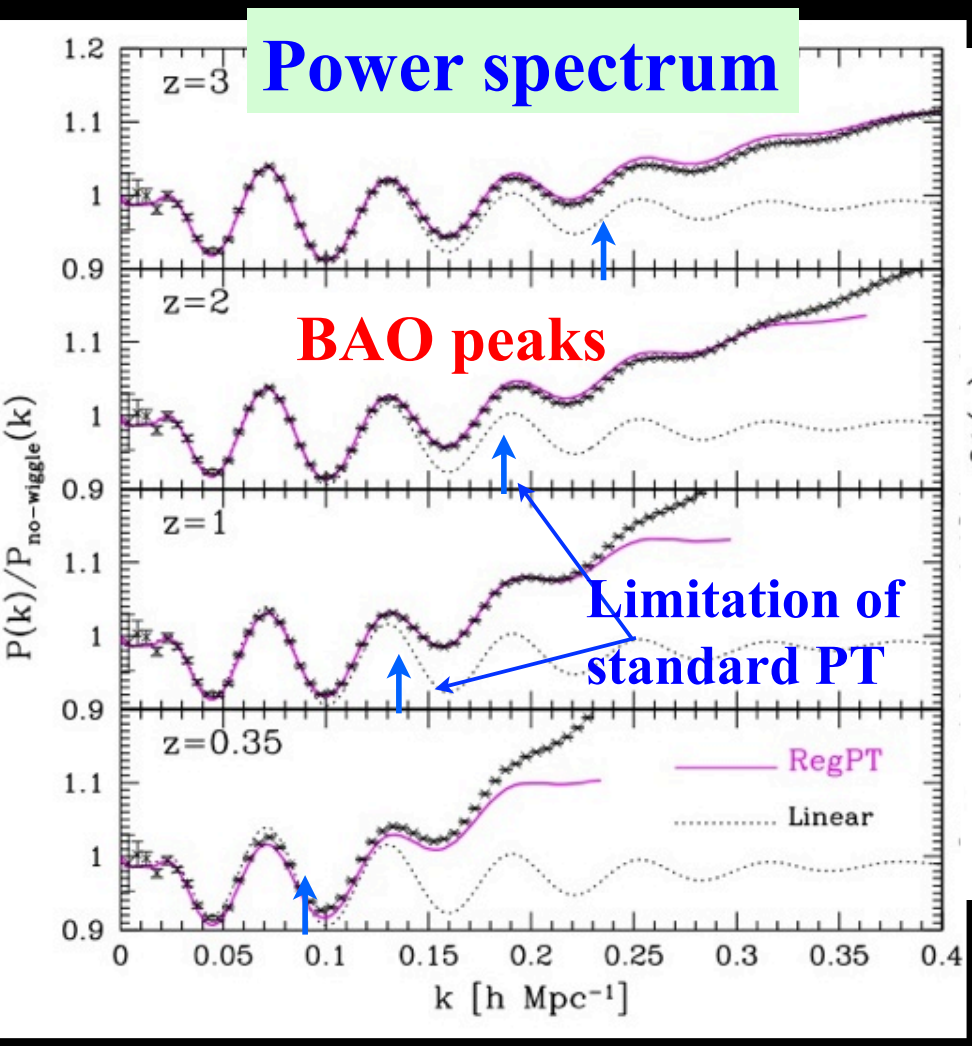
[1] Improved perturbation theory for accurate modeling of nonlinear galaxy power spectrum

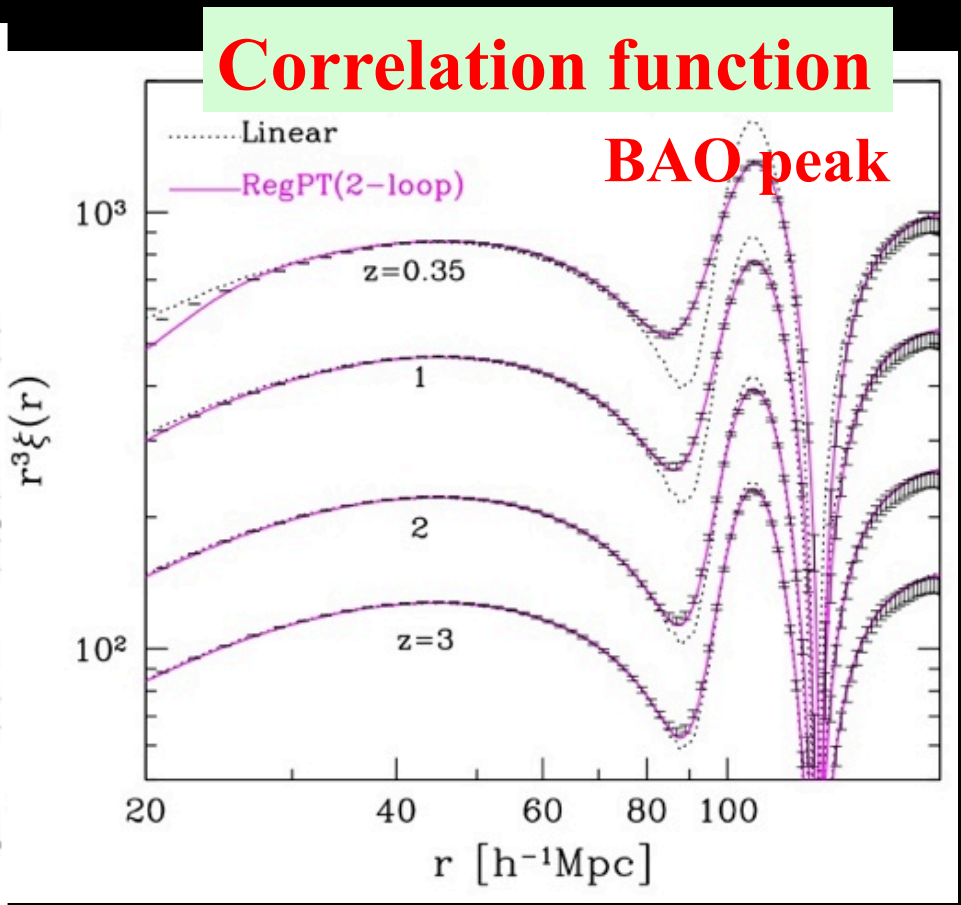
Precision theoretical model for next-generation large-scale galaxy surveys (e.g., SuMIRe project)

- Nonlinear gravitational evolution
  - Taruya & Hiramatsu (2008), Taruya et al. (2009)
- Redshift-space distortion
  - Taruya, Nishimichi & Saito (2010),Nishimichi & Taruya (2011)
- Neutrino mass
  - Saito, Takada & Taruya (2008, 2009, 2011)

Public code: RegPT-fast

Public release of numerical package based on regularized perturbation theory *(5-10min. → few sec.)*

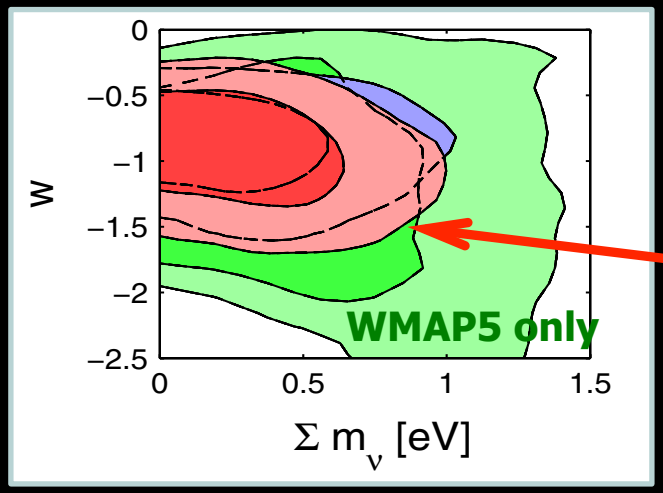




Taruya, Bernardeau, Nishimichi & Codis (2012)

Neutrino mass from SDSS galaxies

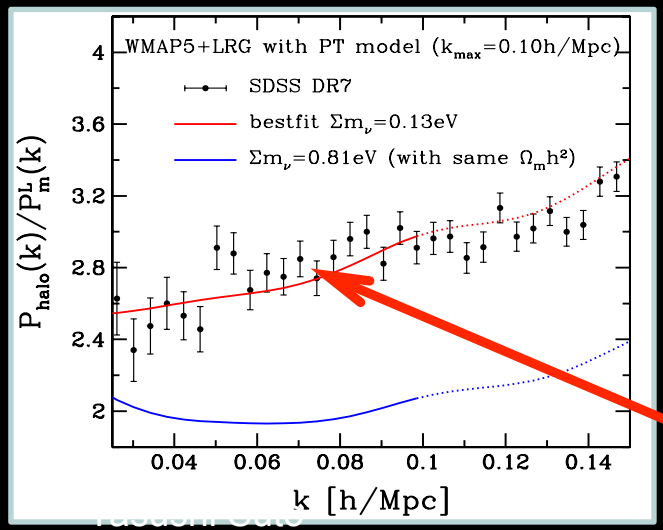
theoretical template for galaxy power spectrum placed a *robust* and strong constraint on neutrino mass



WMAP5+SDSS LRG

$$\sum_\nu m_\nu \leq 0.81 \text{ eV}(95\%\text{C.L.})$$

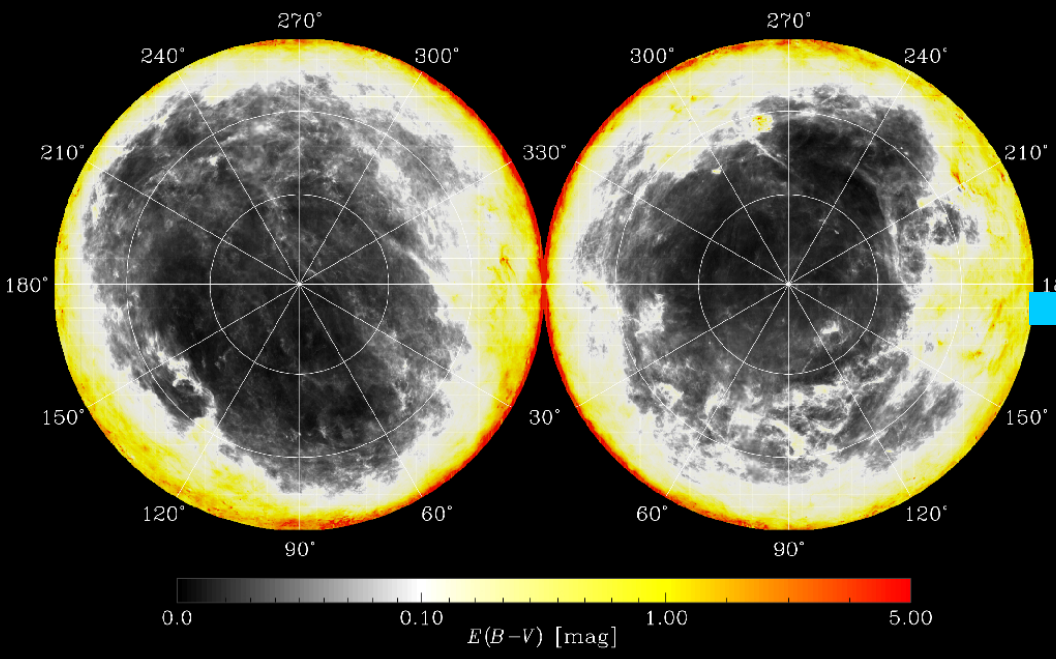
Saito, Takada & Taruya (2011)



Quoted in The Review of Particle Physics (2012) *as a reliable cosmological constraint*

Best-fit PT-based template

[2] Discovery of FIR emission signatures from galaxies on the Galactic extinction map



Galactic extinction E(B-V) map (Schlegel, Finkbeiner & Davis 1998; SFD)

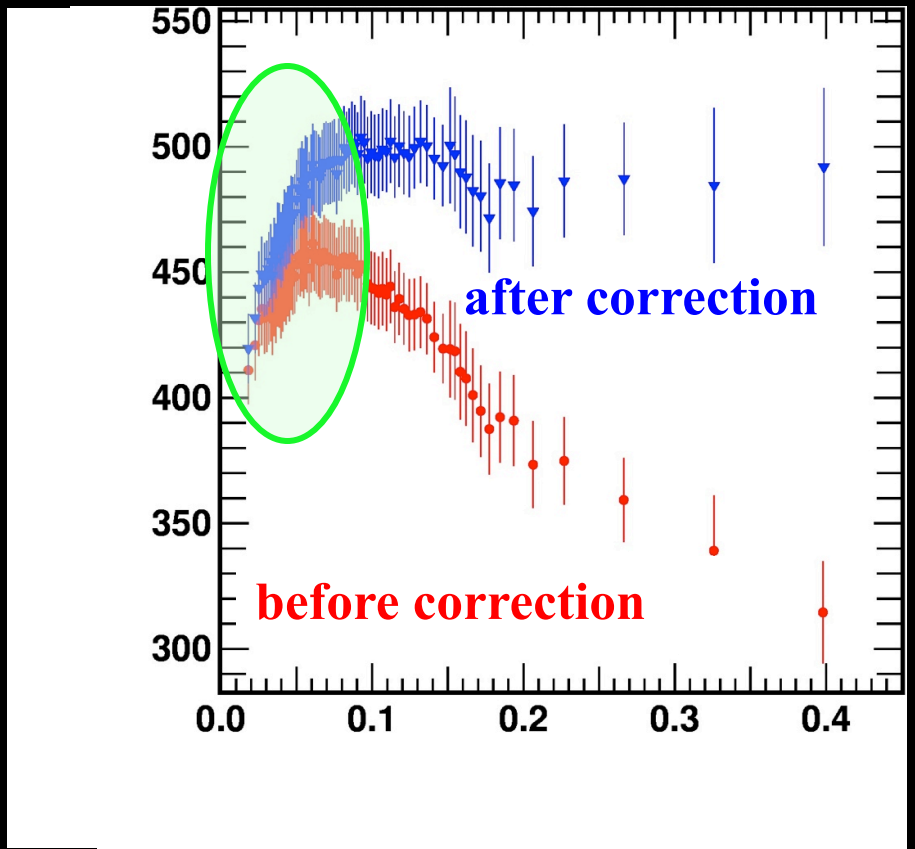
- The most fundamental dataset for any astronomical observation
- True large-scale structures revealed only after the extinction correction
- Its reliability is of vital importance in precision cosmology

Top 5 cited papers in astrophysics (as of November 2012)

	authors	citation	title
1	Schlegel, Finkbeiner & Davis (1998)	7647	Maps of Dust Infrared Emission for Use in Estimation of Reddening and Cosmic Microwave Background Radiation Foregrounds
2	Spergel et al. (2003)	6991	First-Year Wilkinson Microwave Anisotropy Probe (WMAP) Observations: Determination of Cosmological Parameters
3	Perdew & Zunger (1981)	6872	Self-interaction correction to density-functional approximations for many-electron systems
4	Perlmutter et al. (1999)	6671	Measurements of Omega and Lambda from 42 High-Redshift Supernovae
5	Riess et al. (1998)	6564	Observational Evidence from Supernovae for an Accelerating Universe and a Cosmological Constant

Anomalous behavior of SDSS galaxy surface density S_{gal} as a function of A_{SFD}

- ***If A_{SFD} is perfect, we expect that***
  - Before correction: S_{gal} should monotonically decrease as a function of A_{SFD}
  - After correction: S_{gal} should be constant



- OK for A_{SFD} >0.1, but ***quite the opposite for A_{SFD} <0.1***
  - ~70% of the SDSS survey area has A_{SFD} <0.1 !
- First pointed out by Yahata et al. (2007) for DR4, and confirmed by Kashiwagi (2011) for DR7

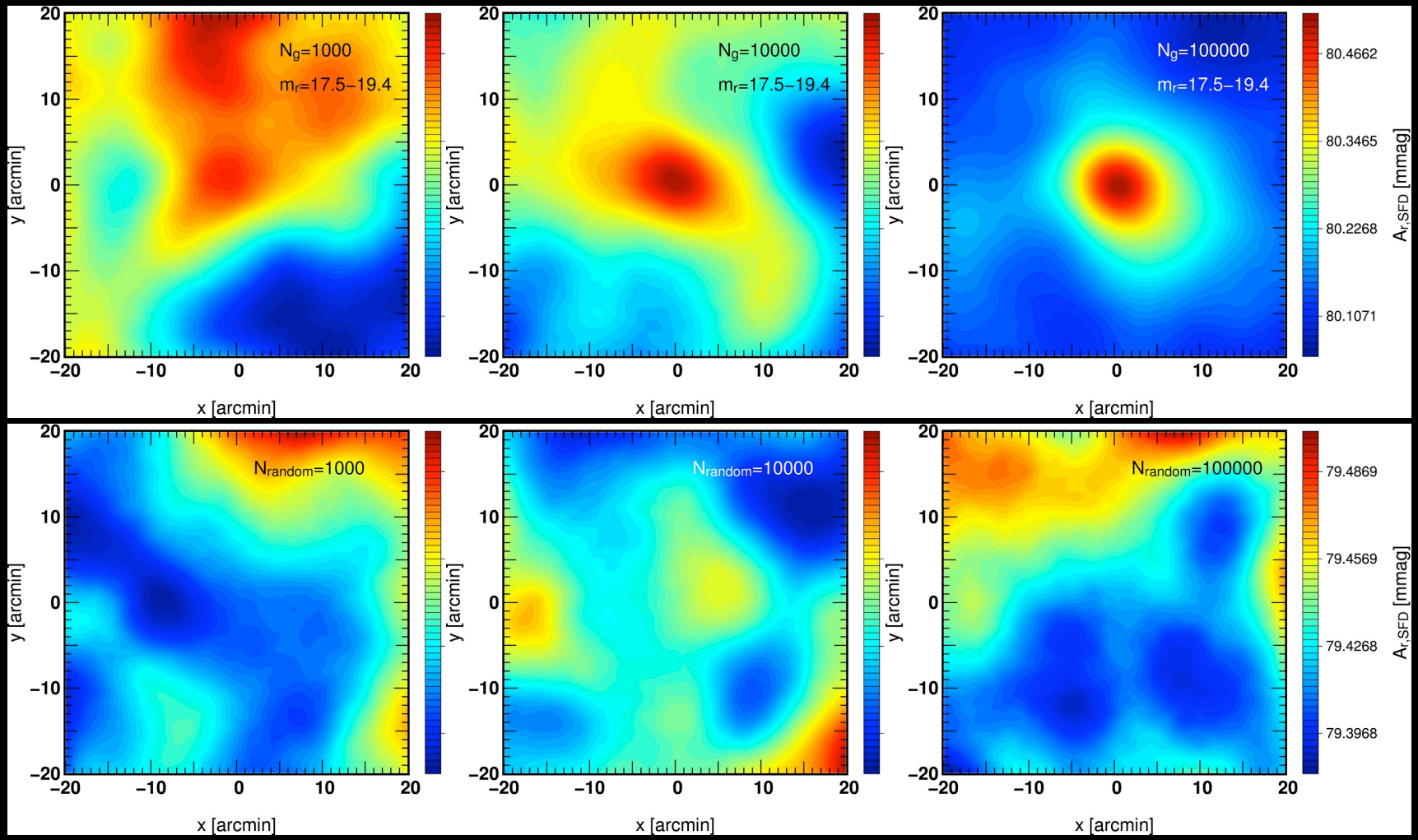
Origin of the anomaly

- A_{SFD} is estimated assuming that the reddening is proportional to the FIR emission flux (100 μ m)
  - the anomaly indicates the positive correlation between galaxy surface density and the FIR flux at least where the real extinction is small
- 100 μ m flux = Galactic dust + galaxies
  - contamination by the FIR emission from galaxies proposed by Yahata et al. (2007)

Stacking analysis of SDSS galaxies on the SFD map

galaxy

random

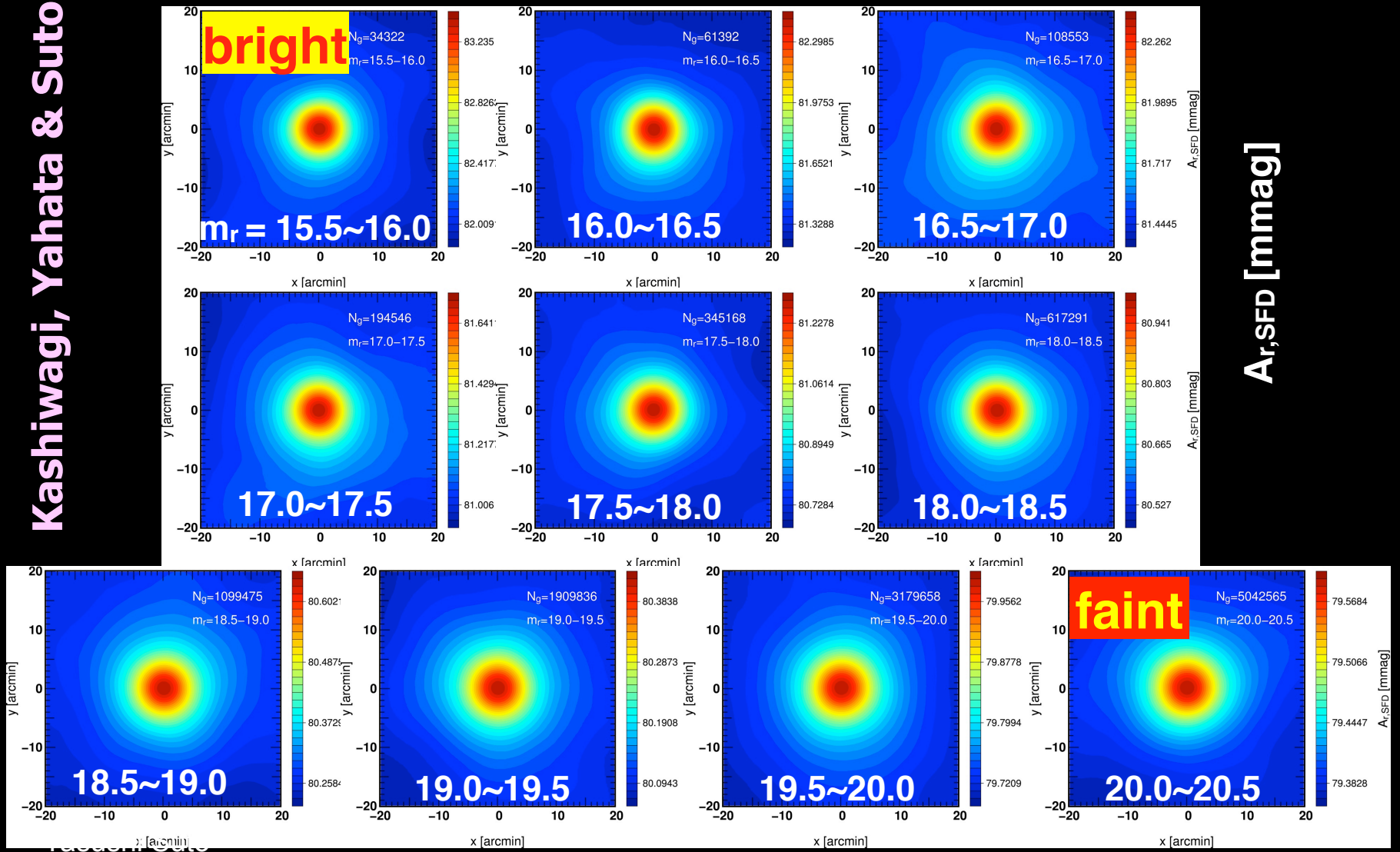


$N = 10^3$ $N = 10^4$ $N = 10^5$

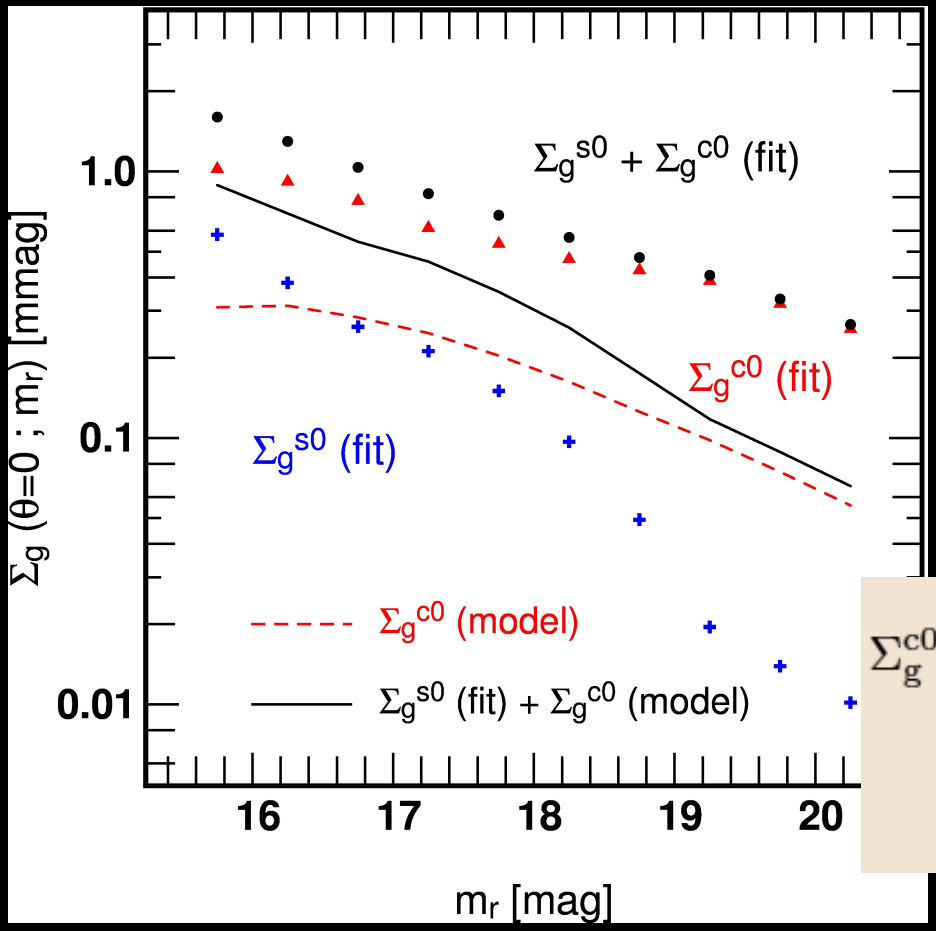
Magnitude dependence

Stacking SDSS galaxies ($15.5 < m_r < 20.5$) over SFD map according to their r-band magnitude ($\Delta m_r = 0.5$)

Kashiwagi, Yahata & Suto (2013)



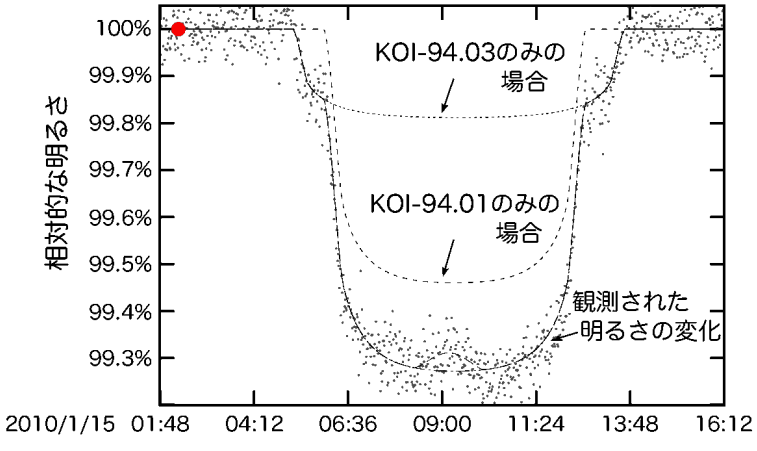
Extended dust emission around the halo hosting the central galaxy and/or contribution from unresolved galaxies ?



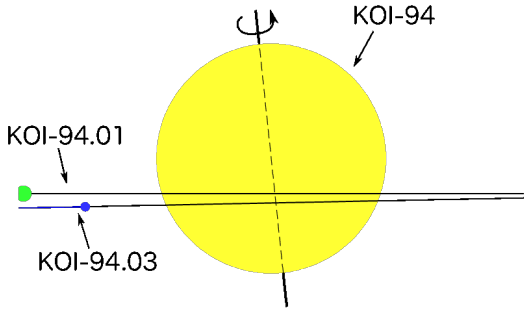
- The fitted clustering term is a factor of 2-3 larger than that expected from the measured angular correlation functions of resolved SDSS galaxies

$$\Sigma_g^{c0}(m_r) = 2\pi\sigma^2 \left(\frac{\varphi_0}{\sqrt{2}\sigma}\right)^{\gamma} \Gamma\left(1-\frac{\gamma}{2}\right) \times \int dm' \Sigma_g^{s0}(m') K(m', m_r) \frac{dN_g(m')}{dm'}$$

[3] Discovery of a planet-planet eclipse in a multiple transiting planetary system KOI-94



2010/1/15 02:16:48



Miraculous alignment !

Next planet-planet eclipse event is predicted in 2026 !

Hirano et al. ApJL 759(2012)L36

Kepler archive photometry + Subaru radial velocity

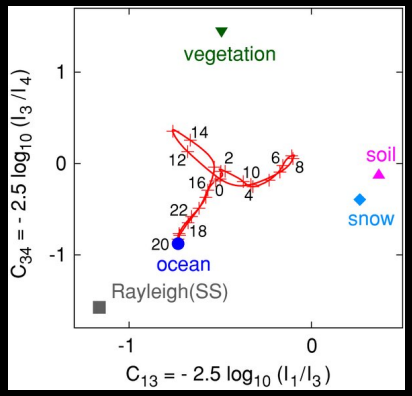
featured by Asahi and Yomiuri on Nov 14 2012

[4] Towards a remote-sensing of exo-Earths: beyond a pale blue dot

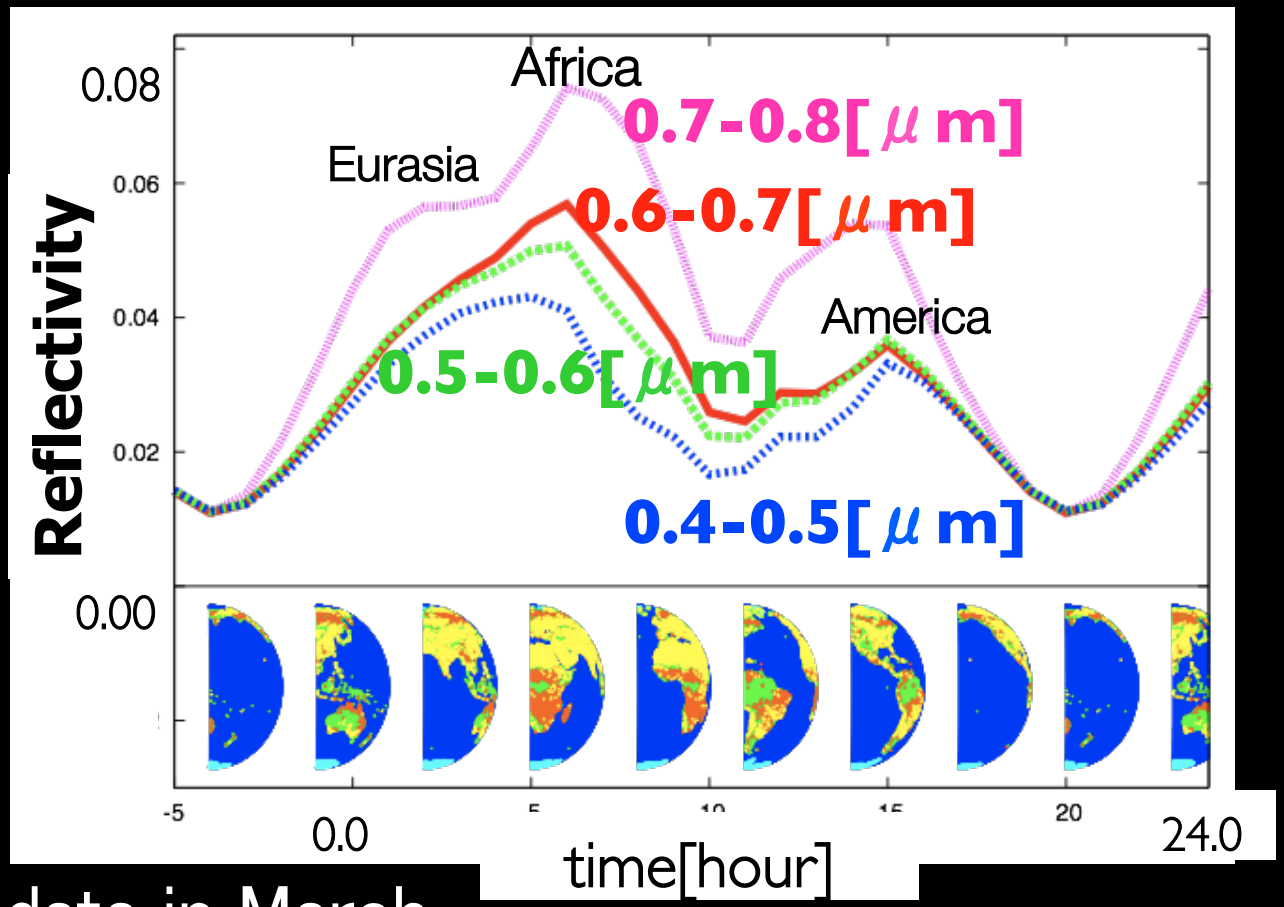
- Colors of a Second Earth: estimating the fractional areas of ocean, land and vegetation of Earth-like exoplanets
  - Y.Fujii et al., ApJ. 715(2010)866, arXiv:0911.5621
- Colors of a Second Earth. II: Effects of Clouds on Photometric Characterization of Earth-like Exoplanets
  - Y.Fujii et al. ApJ. 738(2011)184, arXiv:1102.3625
- Yuka Fujii, H.Kawahara, A.Taruya, Y.Suto (Dept. of Phys., Univ. of Tokyo), S.Fukuda, T.Nakajima (Univ. of Tokyo, Center of climate system research), Edwin Turner (Princeton Univ.)

http://www.space.com/scienceastronomy/color-changing-planets-alien-life-100513.html

A pale blue dot ? Not really



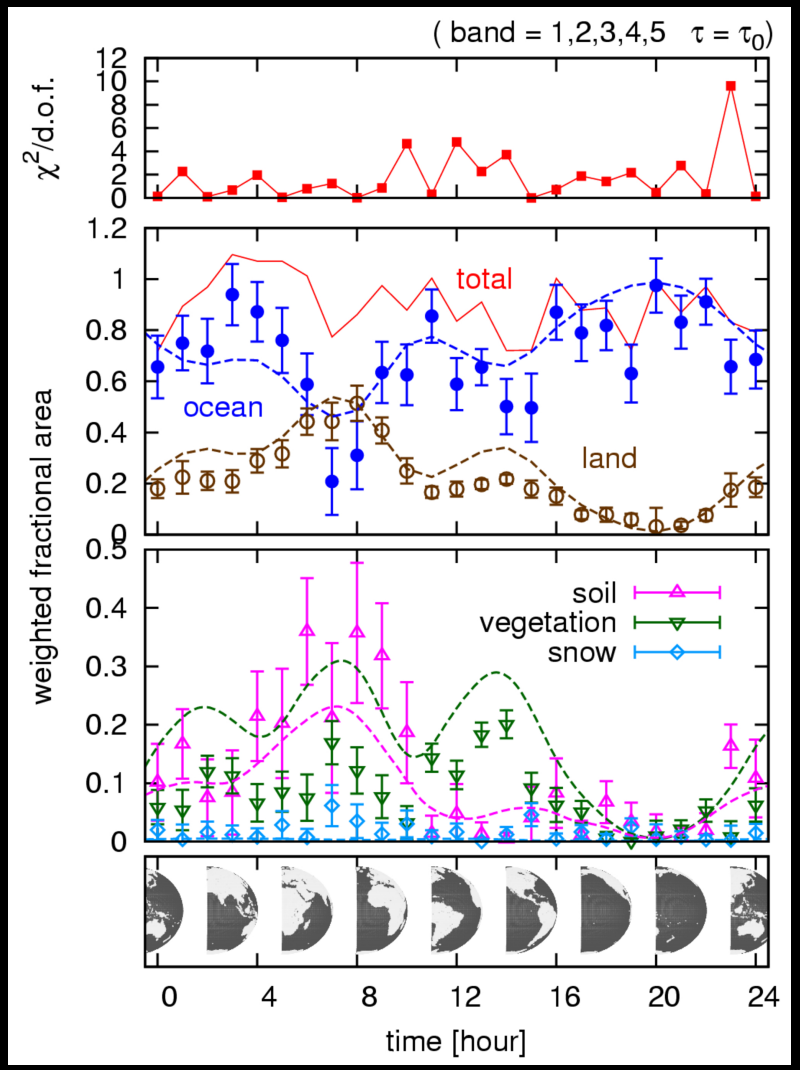
Simulated photometric light-curves of Earth



- Adopted Earth data in March
- Spin inclination = 0 (vernal equinox)
- cloudless

Fujii et al. (2010)

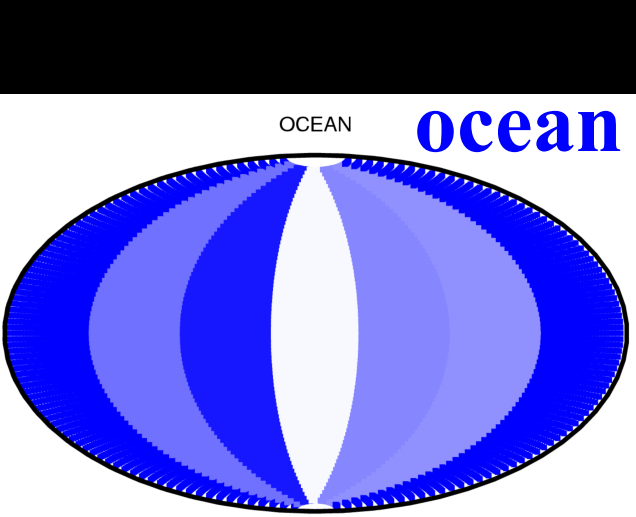
Idealized cloudless earth



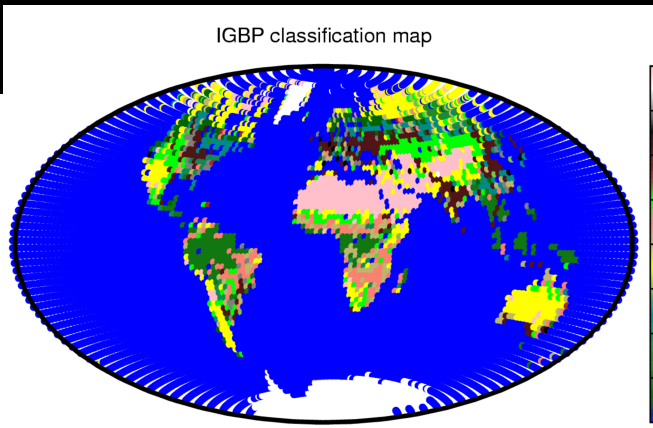
Fujii et al.（2010）

- Input data
  - 5 light-curves using anisotropic scattering (BRDF) model
  - 2 week observation of a cloudless Earth at 10 pc away
- Inversion assumptions
  - Ocean, soil, vegetation and snow only (with atmosphere)
  - Isotropic scattering assumed
- Results
  - Estimated areas (symbols) vs Surface classification data (dashed line)
  - Reasonably well reproduced.
  - Can identify vegetation !

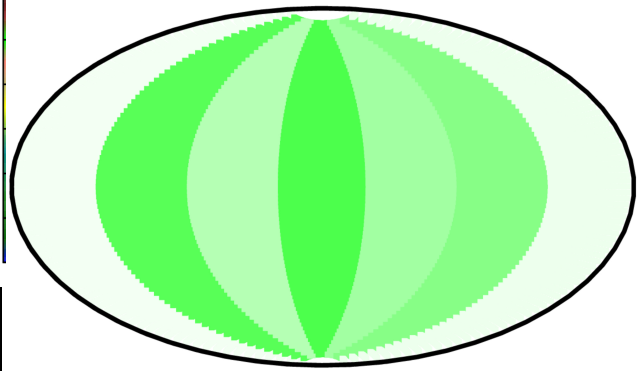
Surface latitude map estimated from EPOXI data: towards astrobiology?

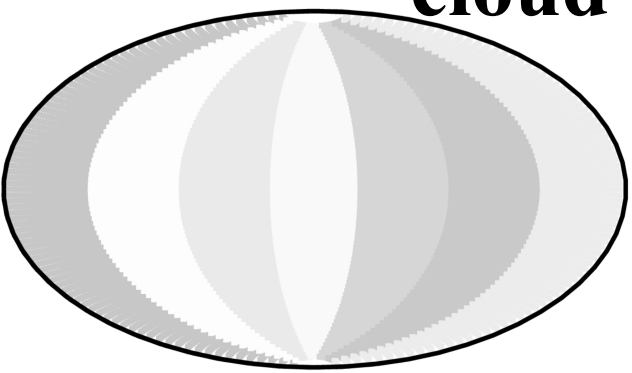


ocean

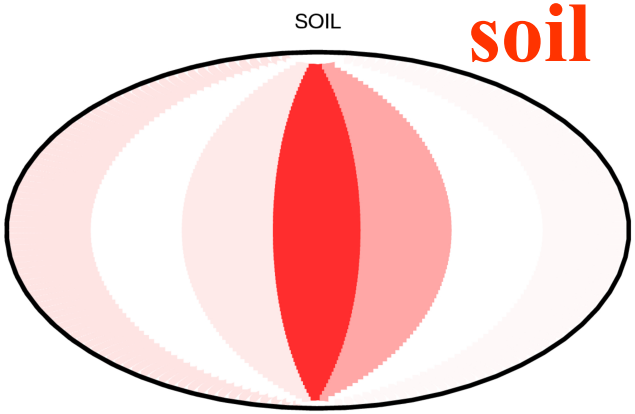


vegetation



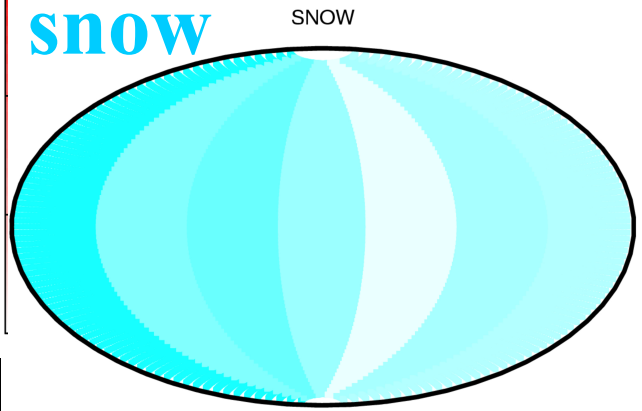


cloud



soil

snow



Fujii et al.（2011）

参考解説記事： 河原創、藤井友香 “太陽系外惑星をCTスキャンする”
日本物理学会誌2012年1月号 4–10ページ

Summary and Prospect

- **From Big-bang to Life in the universe**
  - Birth of the universe (Yokoyama in RESCEU)
  - Cosmology with gravitational radiation (Yokoyama, Taruya)
  - Cosmological parameters (SuMIRe project, Taruya)
  - Formation of the first objects (Yoshida)
  - Evolution of galaxy clusters (Makishima, Nakazawa)
  - Dust in the universe
  - Formation and evolution of planets (Kawahara in Earth Planetary Sci. Dept.)
  - Discovery and characterization of planets (a new professor in Astron Dept.)
  - Search for biomakers in other worlds (Kawahara)