Observational Cosmology Group

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Outline

1) Science goals
2) Instruments and status
3) Scientific results
4) Size of Group, manpower, and budget
5) Relation with other universities/community
6) Education and mentoring young scientists
7) Future prospect

Goals and Projects

- Understanding the origin and evolution of the universe including
  - Energy density distribution,
  - Expansion history,
  - Structure/Galaxy formation, and
  - Cosmic reionization

Instruments and Status

- Projects
  1. Sloan Digital Sky Survey (SDSS)
  - Instrumentation untill ~2000.
  - Survey observations completed in 2008.
  - Analysis and paper preparation up to 2012

  2. Subaru Hyper Suprime-Cam (HSC)
    +complementary/preparatory observations w HST/ALMA
  - ICRR started HSC-NB since 2010 (arrival of M. Ouchi)
  - HSC instrument first-light (2012)
 - HSC survey planned to start from FY 2013

Scientific Resutls
(Refereed Papers)

- The project papers
  - A total of 66 refereed papers
  - A total of 8622 citations

- ICRR-led papers
  - SDSS 8 papers, 234 citations (2006-2012)
  - HSC 4 papers, 237 citations (2010-2012)

  - SDSS: Fukugita et al. 2007, "
    A Catalog of Morphologically Classified Galaxies from the Sloan Digital Sky Survey: North Equatorial Region" (64 citations)

  - HSC: Ouchi et al. 2010, "Statistics of 207 Lyα Emitters at a Redshift Near 7: Constraints on Reionization and Galaxy Formation Models" (114 citations)
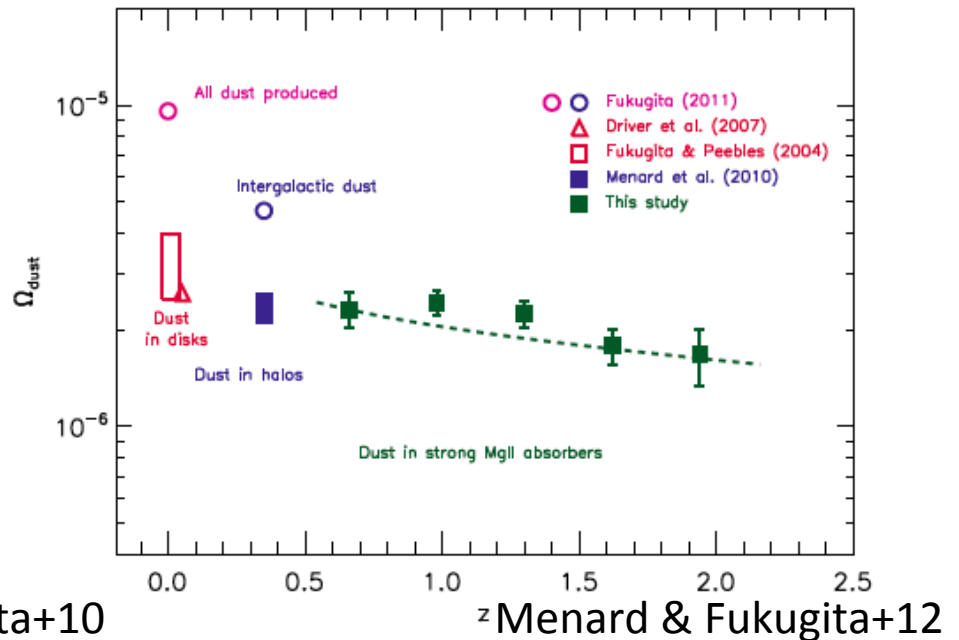
Citation counts as of Jan 2013

Highlights of Scientific Results (1)
First Identification of 'Cosmic' Dust
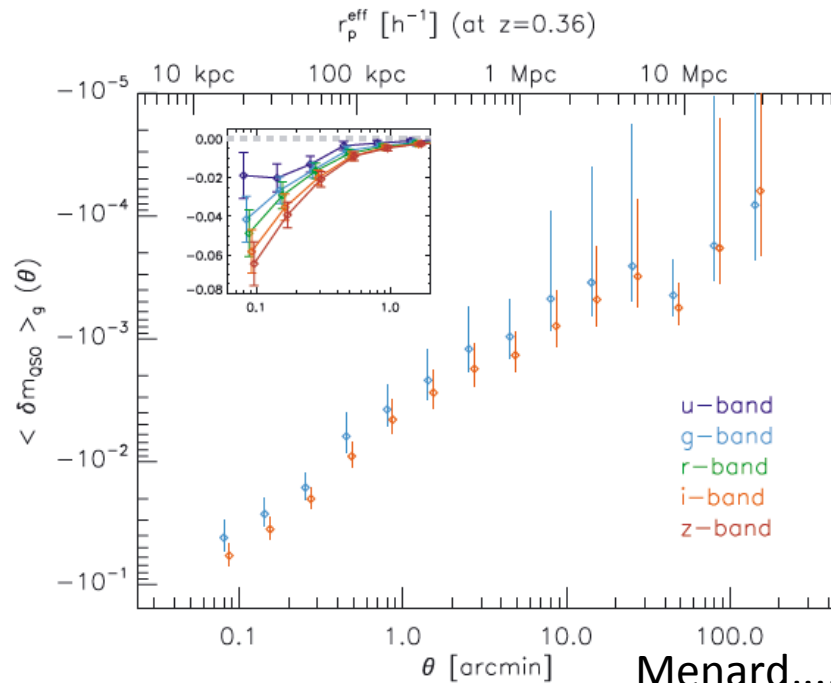
Menard,..,Fukugita+10   Menard & Fukugita+12

- Missing baryon problem: all the stars, gas, and dust within galaxies constitute at most 40% of the baryons predicted by the Big Bang. Where are the rest? → Baryon energy density dist?

- Statistics of QSO brightness (m) as a function of galaxy angular distance (θ). Color dependence→ Dust in halo+IGM (Menard,..,Fukugita+10)

- Energy density of dust: $\Omega_{dust} \sim 5 \times 10^{-6}{}_{\circ}$. About twice large as those in galactic disks.
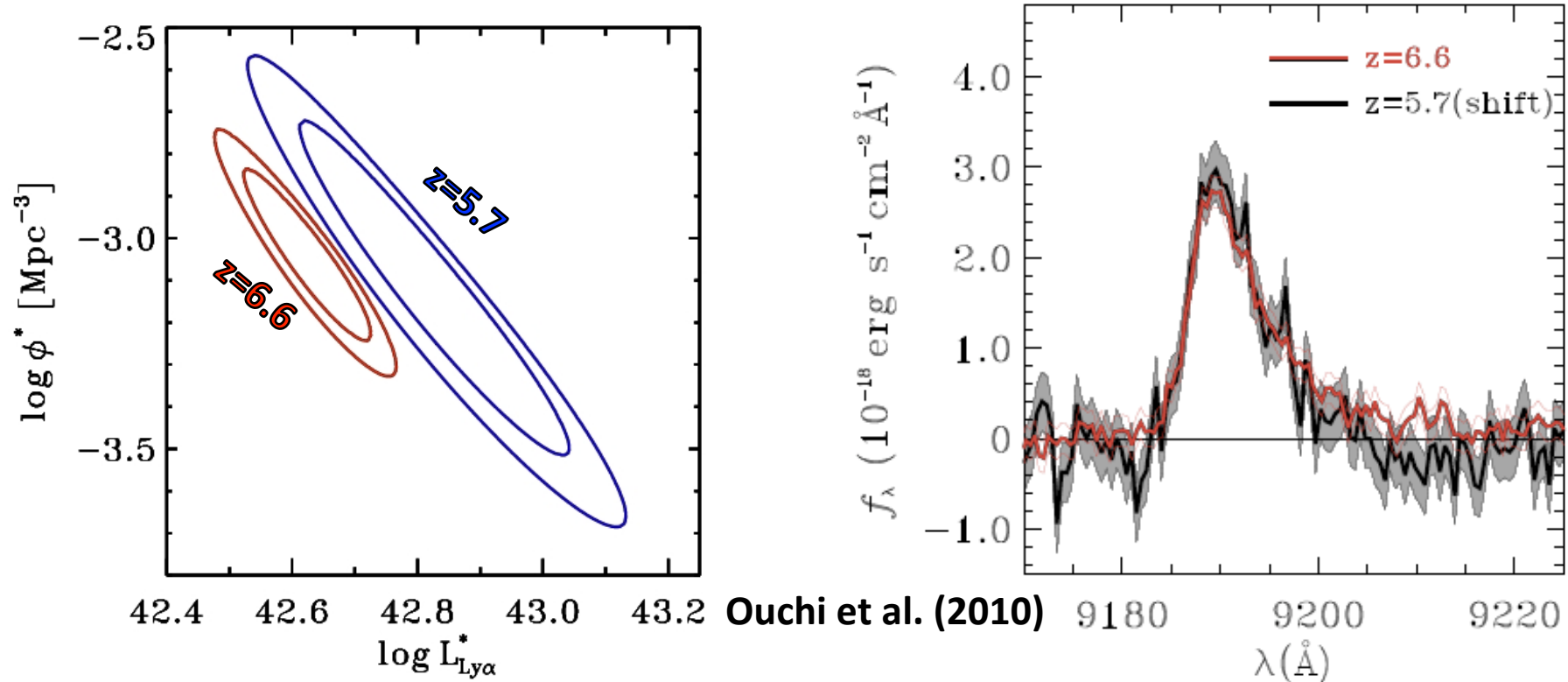
Highlights of Scientific Results (2)
Cosmic Reionization Completion

Fan,..,Fukugita+06
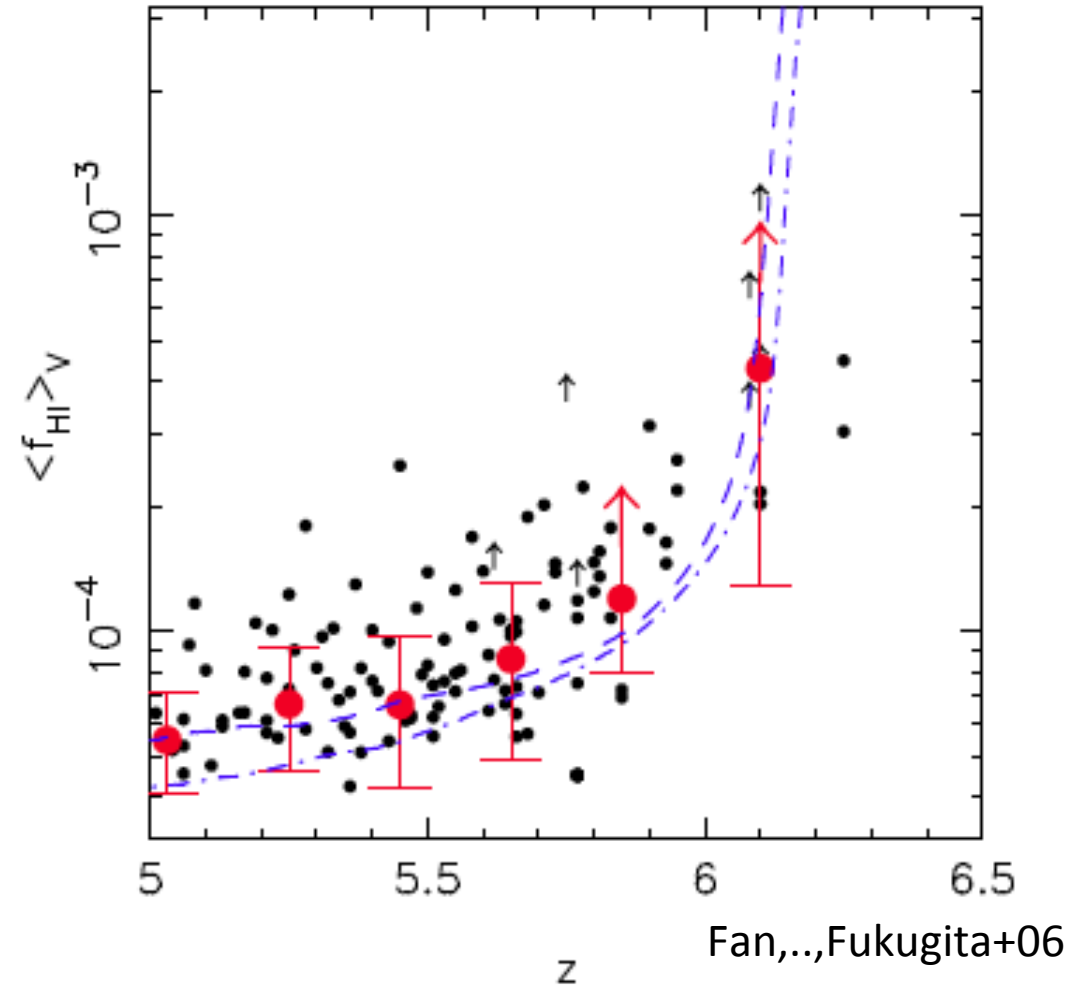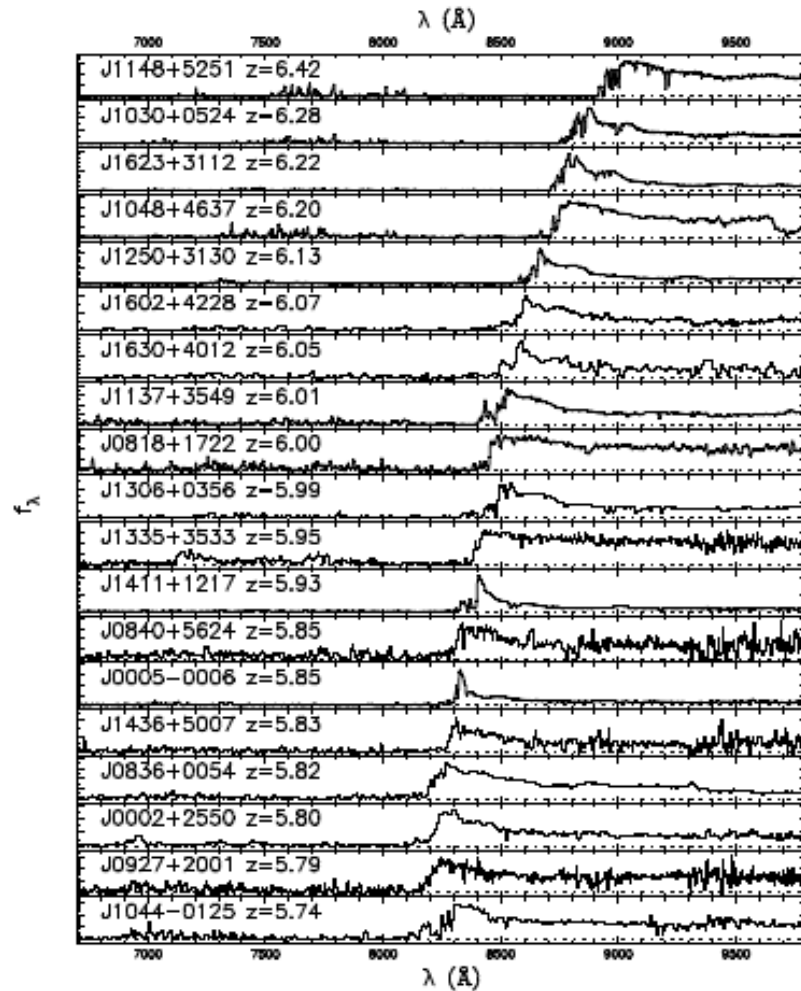
- SDSS QSOs→Lya optical depth(τ) of IGM (HI indicator)
- Rapid change of τ at z~6→completion of reionization

Highlights of Scientific Results (3)
Cosmic Reionization Completion


Ouchi et al. (2010)

- First precise measurement (incl. cosmic variance errors; cf. Malhotra&Rhoads+04, Kashikawa+06) of Lya luminosity function at z~6. Definitive identification of Lya luminosity decrease (90% CL) from z~5.7 to 6.6 that is likely made by IGM HI damping wing abs. (Ouchi et al. 2010). Moderately early cosmic reionization.

- xHI~0.2±0.2 at z=6.6. large statistical error → next generation HSC survey with a size larger by x 30

Highlights of Scientific Results (4)
Cosmic Reionization Completion

Ono, MO et al. (2012
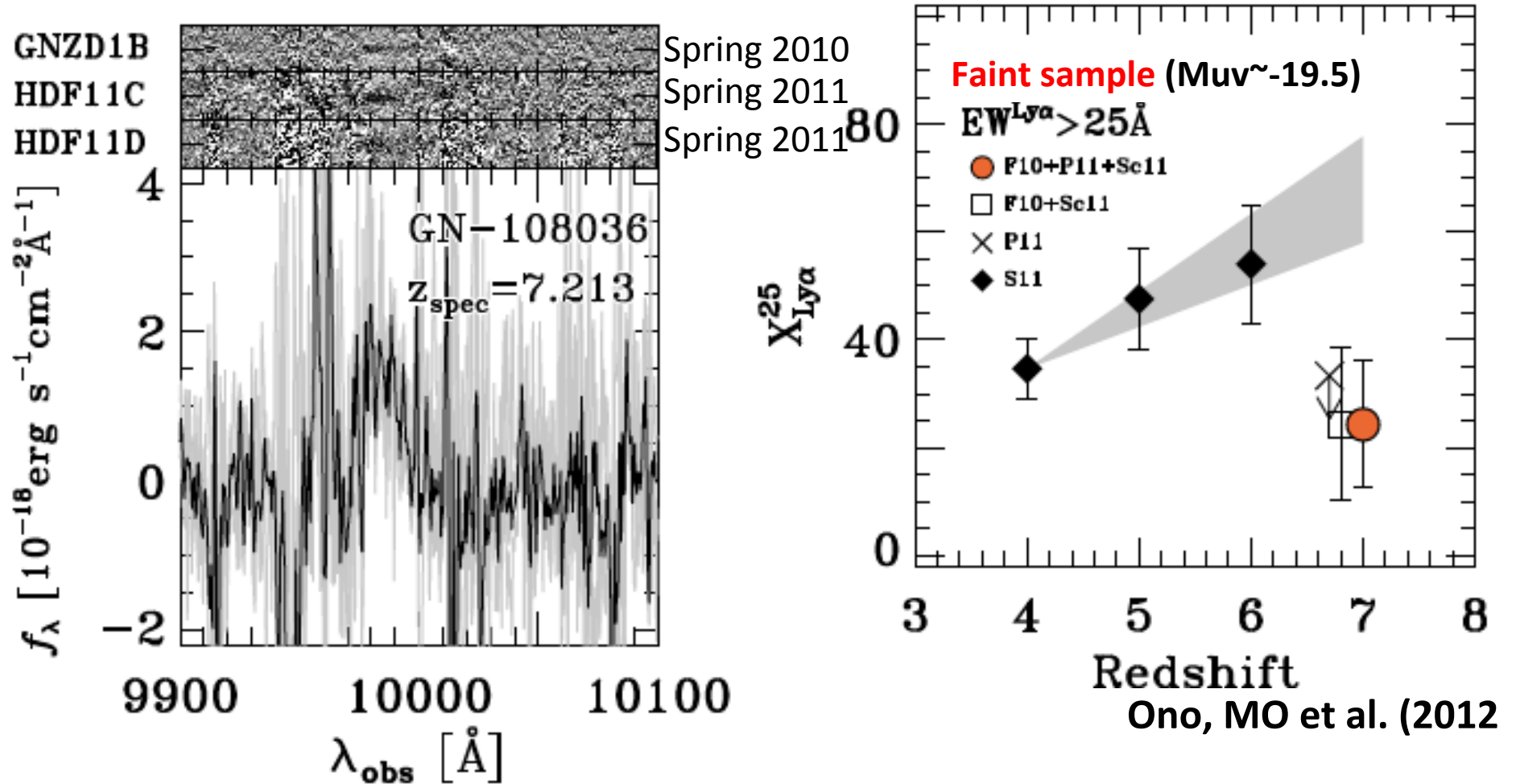
- Identification of z~7 galaxies including the most distant z=7.213 galaxy.
- The fraction of Lya emitting galaxies is low, ~20% → Signature of reionization? The amplitude of drop is larger in faint galaxies than in bright galaxies→ suggestive of inside-out reionization (Ono, MO et al. 2011).

Size of Group, Manpower, and Budget

- Faculty
  - Masataka Fukugita, Professor, 1996 to 2012
  - Naoki Yasuda, Assoc. Professor, 2003 to 2009
  - Masami Ouchi, Assoc. Professor, 2010 to the present
  - Yoshiaki Ono, Research Associate, 2012 to the present

- Postdoctoral Fellows
  - Rieko Momose, 2012 to the present
  - Suraphong Yuma, 2012 to the present

Budget and Machine time

- SDSS
  - Grants-in-Aid for Scientific Research (A) for 2003-2006
- HSC
  The basic design and tests for HSC narrow-band
  - Grants-in-Aid for Scientific Research (A) (Ouchi et al. 2011-2014) for
  - Grants-in-Aid for Scientific Research (start-up: Ono 2012-2014)

- Machine time (2010-2012)
  - Subaru: 14 nights (PI Ouchi)
  - Hubble Space Telescope:
    - Cycle 18: 18 orbits (PI Ouchi),
    - Cycle 19: 128 orbits (PI Ellis in collaboration)
    - Cycle 20: 16 orbits (PI Ono),
  - ALMA:
    - Cycle 0: 5 hours (PI Ouchi),
    - Cycle 1: 4+6 hours (PI Ouchi), 5 hours (PI Momose)
  - Keck: 5 nights (PI Ouchi) + VLT/Magellan etc.

Relation with other universities/community

- SDSS
  - Large international collaboration (US, Japan, German)
- Subaru Hyper Suprime-Cam (HSC) program
  - HSC survey consortium (Opt-NIR society in Japan, Princeton, Taiwanese institutes)
  - Narrow-band development w K. Shimasaku et al. from Tokyo, NAOJ, Ehime, Osaka-sangyo, Tsukuba etc.
  - ALMA Collaborations with NAOJ/Tokyo researchers (e.g. Nakanishi, K. Kohno). Accepting post-docs from ALMA community (e.g. R. Momose)

Education and mentoring young scientists

- A master and Ph.D degree for one student under N. Yasuda (-2009)
- No more students were accepted. No post-docs.
- Resuming education activities after the arrival of Ouchi
  - 2 students (2012) + 2 more students (2013)

    from Physics/Astronomy departments
  - Spring school in 2012

    In ICRR, one of the most popular research group for which students apply.
- Resuming accepting post-docs
  - 2 post-docs (2012) + 1-2 post-docs (2013)
  - The 2 post-docs (2012) have submitted new papers in the past few months. One out of 2 won a JSPS fellowship.
- Young post-docs and students are gathering. (0→5 in 2012)
- Strong demands on this study subject from young people.

Future prospects

- HSC survey from FY 2013 (2013-2017)
- Synergistic observations with Hubble, ALMA etc.

- Preparation activities for 2020s programs
  - Subaru Prime Focus Spectrograph (PFS; ~2018-)
  - Thirty Meter Telescope; Infrared Imaging Spectrograph (IRIS; ~2020) TBA

Addressing Three Major Questions of Early Universe


Ouchi et al. (2010)

Robertson et al. (2010)
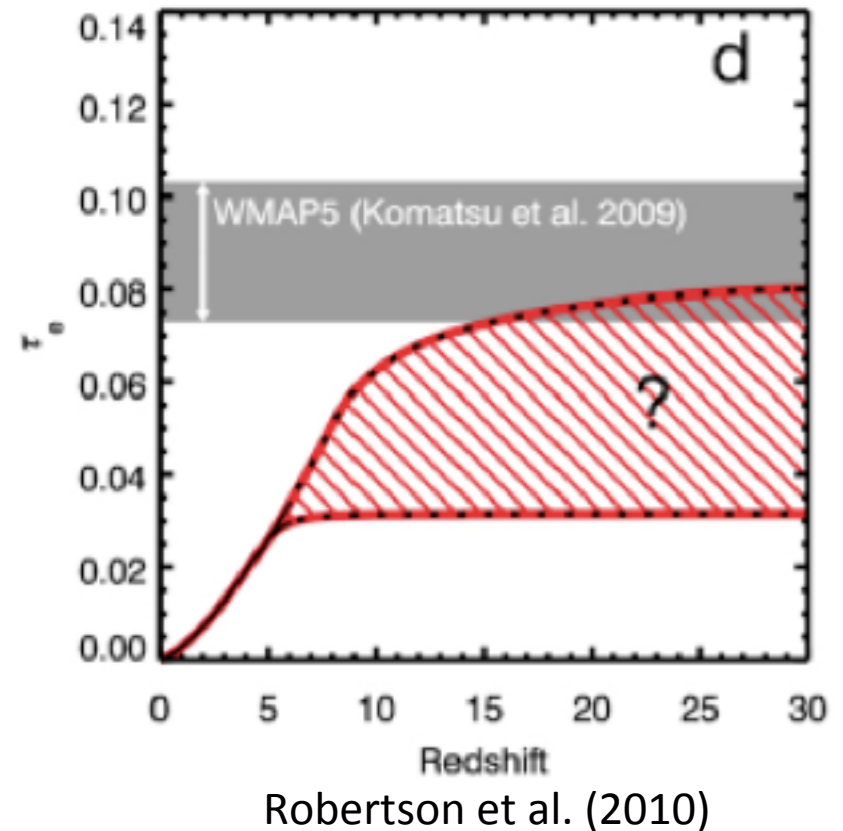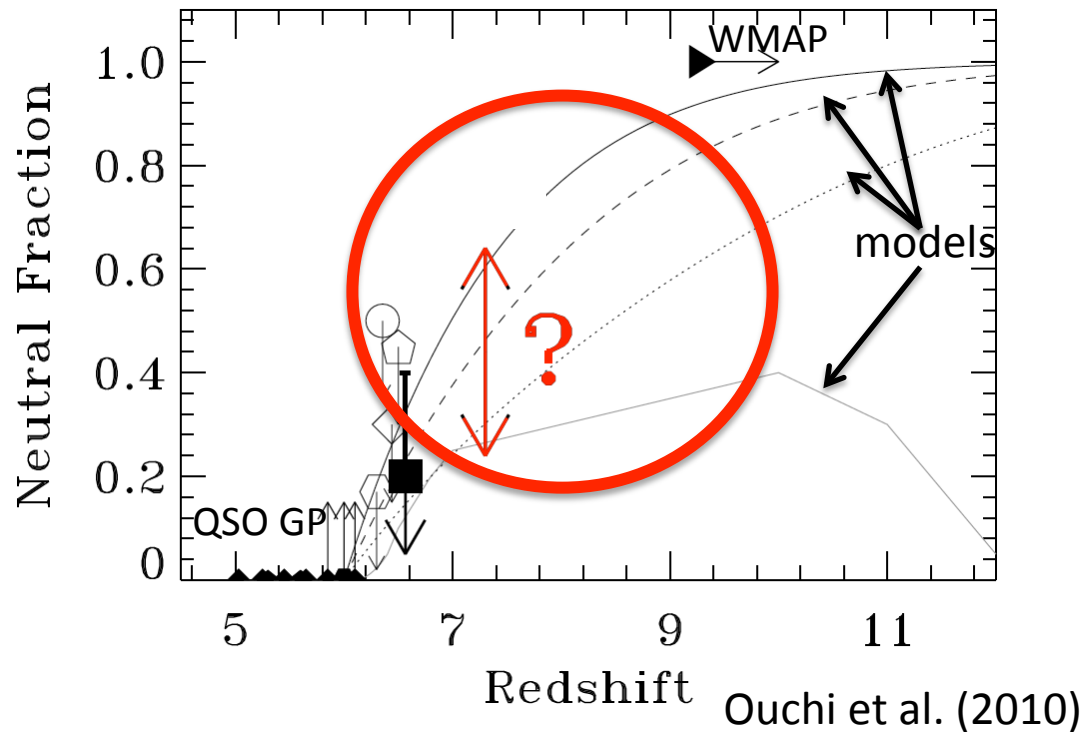
1. Uncovering the cosmic reionization history (determination of reionization scenario)

2. Missing ionizing photons: Inconsistency of ionizing photon budget and τ

3. First-generation galaxy formation strongly related to cosmic reionization

→interesting coincidence with the one of the priority sciences selected by US decadal survey Astro2010 (2012-2021)
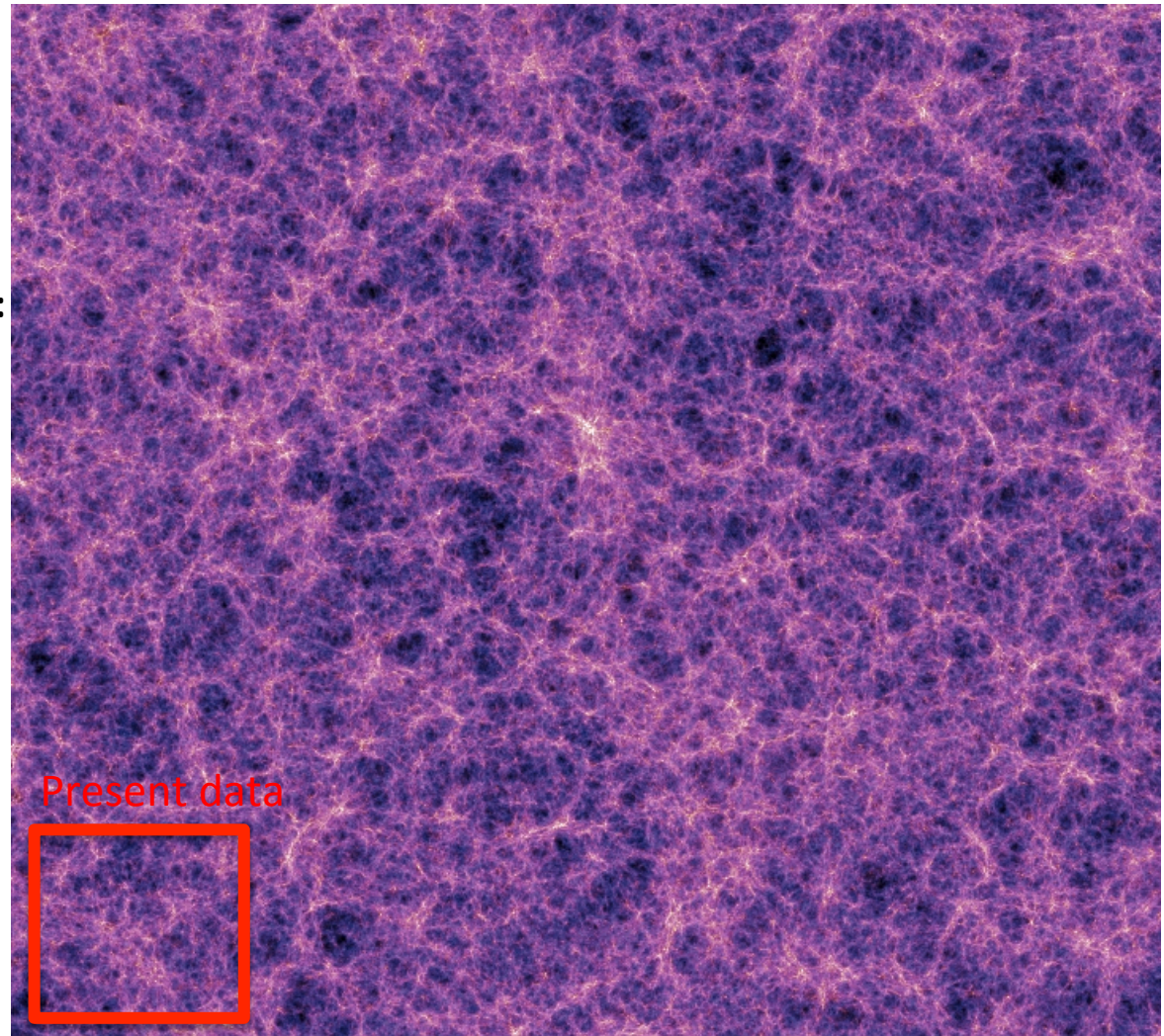
Hyper Suprime-Cam Survey (2013-2017)

Hyper Suprime-Cam(HSC; 2012-) PFU

HSC NB filter(test piece: 2012 Mar.)
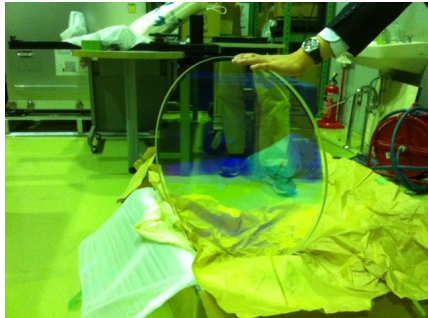
- Developing HSC narrow-band filters in ICRR

- HSC survey plans to be conducted in 2013-2017

Size of HSC survey for reionization (z~6-7)

Present data

Summary

- **Science goals**
  - Origin/Evolution of the universe (Ω, galaxy formation, and reionization etc.)
- **Instruments and status**
  - SDSS (-2012). HSC+related studies (2010-)
- **Scientific results**
  - 66 refereed papers, 12 out of which are led by ICRR
- **Size of Group, manpower, and budget**
  - 2 faculty and 2 post-doc (2012-). JSPS grant, Subaru/HST/ALMA time
- **Relation with other universities/community**
  - Belonging to large international collaborations, SDSS and HSC survey.
- **Education and mentoring young scientists**
  - Education activities resumed in 2011→2 students, 2 PDs (more in 2013)
- **Future prospect**
  - Addressing 3 questions of early universe with HSC etc.