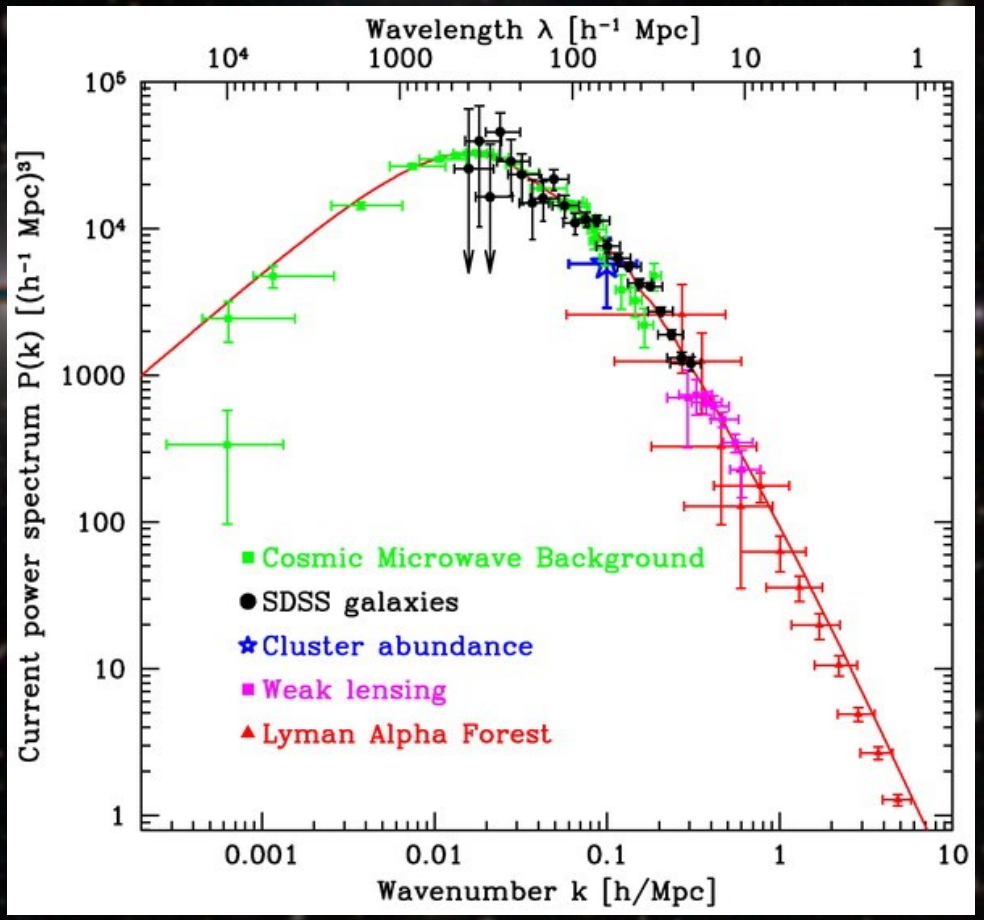
HSC – Huntsman:

A search for dwarf galaxies around nearby galaxies

Masayuki Tanaka (NAOJ)
Lee Spitler (Macquarie, AAO)

LCDM has been extensively tested on large scales



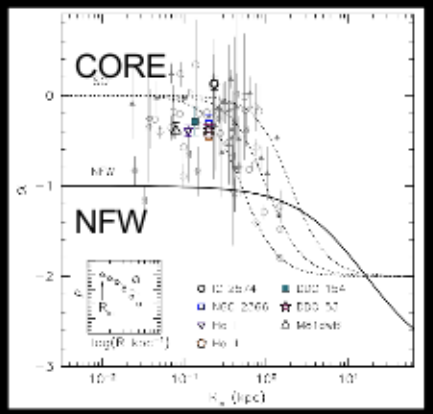
Tegmark et al 2004 ApJ

Current small scale problems in ΛCDM

- ❖ Core-cusp problem
  - Too steep dark matter density profiles of ΛCDM subhalos.
- ❖ Missing satellites problem
  - Overabundance of ΛCDM subhalos.
- ❖ Too-big-to-fail problem
  - Too concentrated most massive ΛCDM subhalos.
- ❖ Satellite plane problem
  - Anisotropic distribution & coherent motion of dwarf satellites

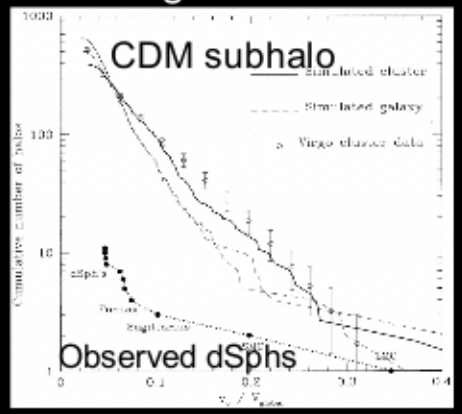
Solutions:
- Baryonic feedbacks?
- Alternative DM models?
- Incomplete observational data?

Core-cusp



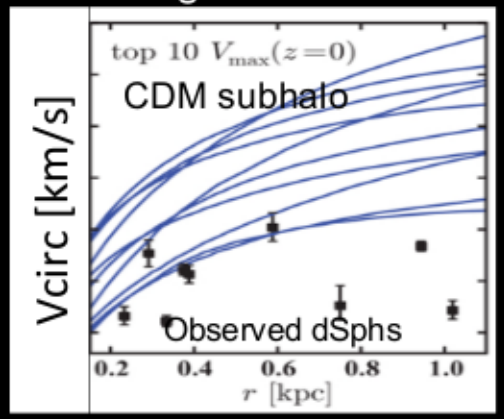
(Oh+ 2011)

Missing satellites



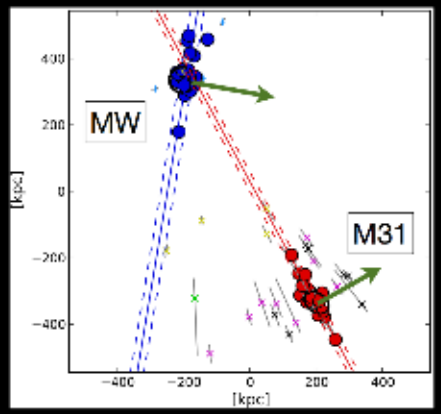
(Moore+ 1999)

Too-big-to-fail



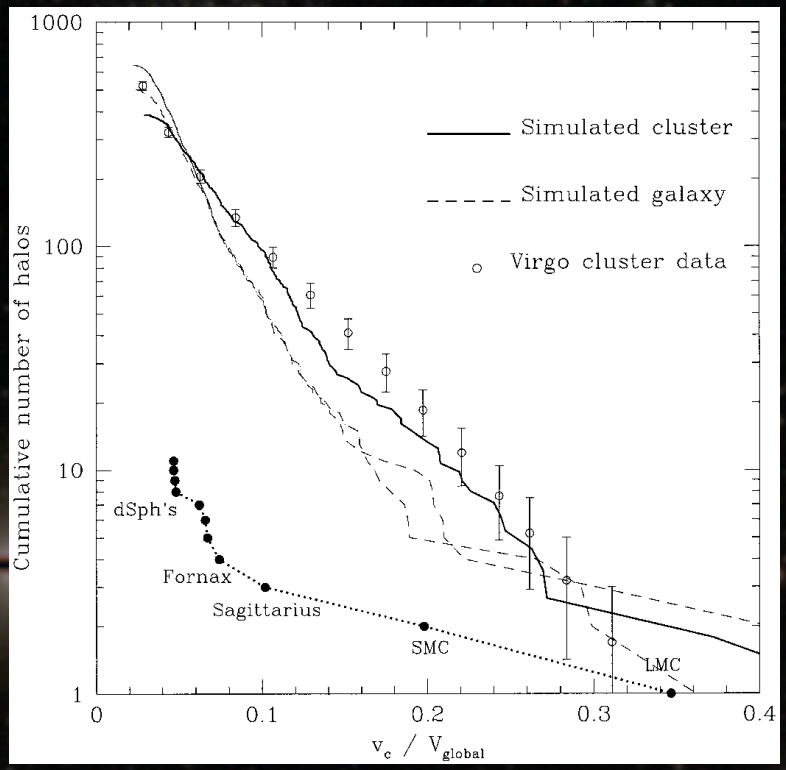
(Boylan-Kolchin+ 2012)

Satellite plane

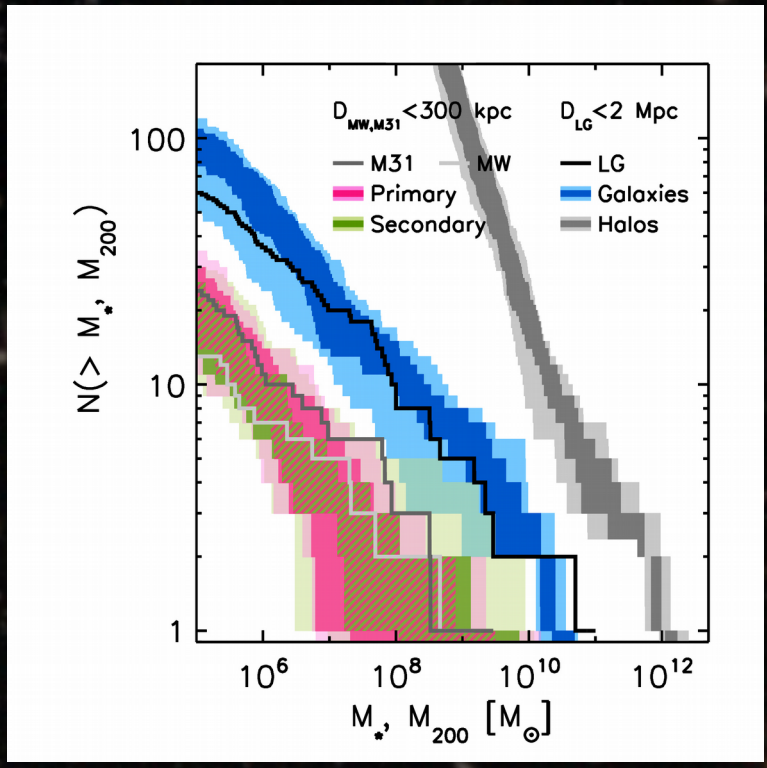


(Pawlowski+ 2013)

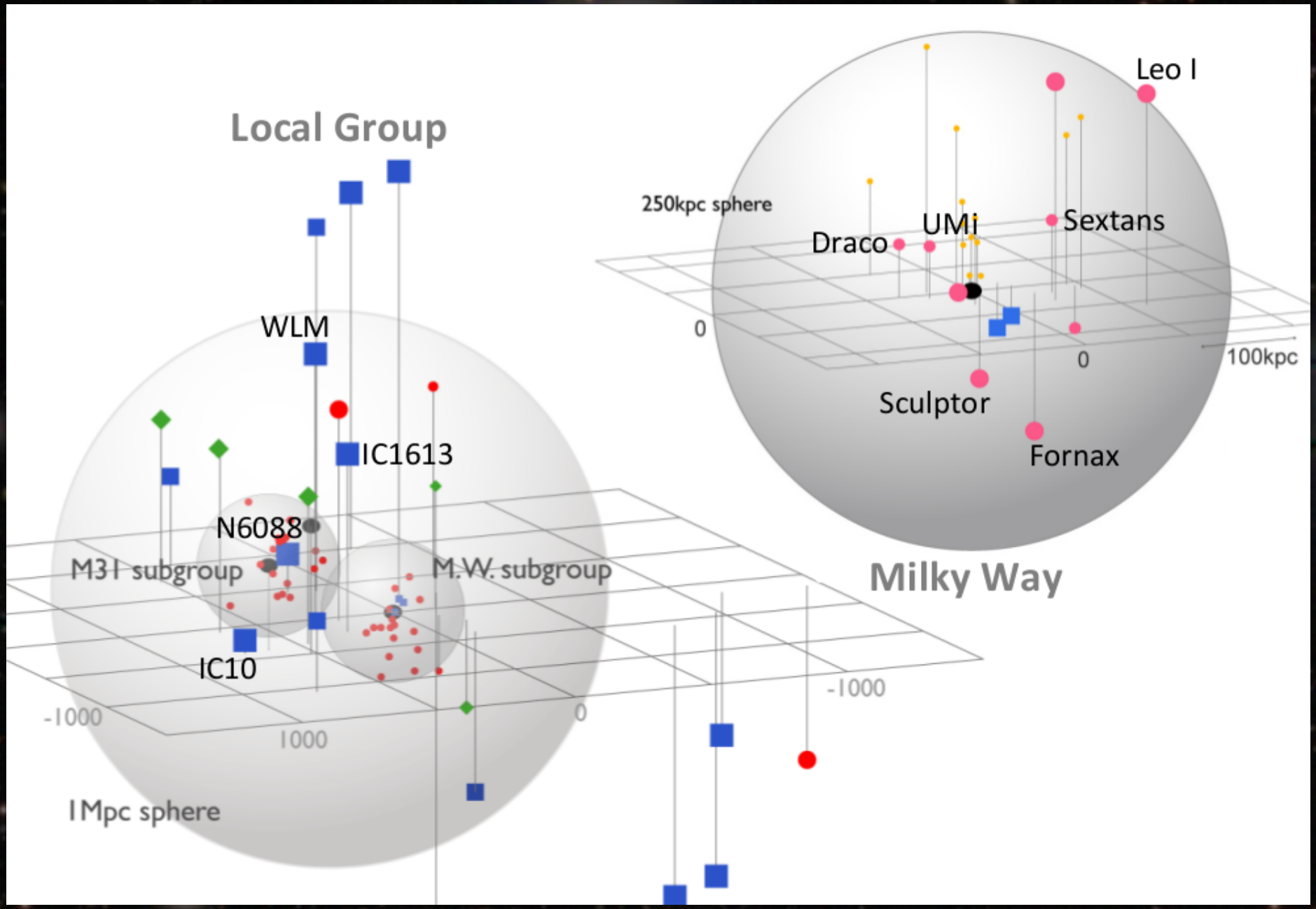
The missing satellite problem



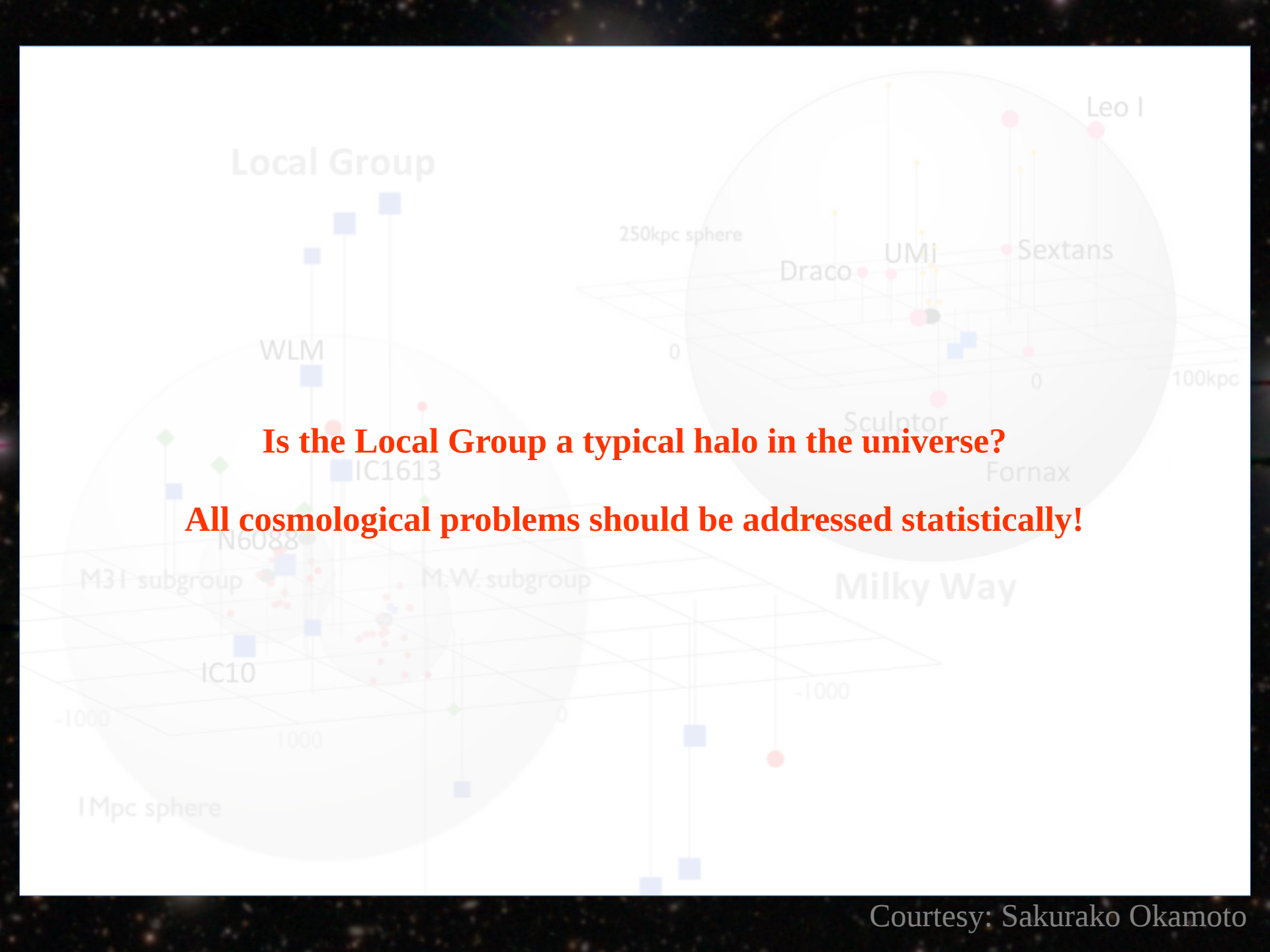
Moore et al. 1999
DM only simulation



Sawala et al. 2014
DM + Baryon simulation



Courtesy: Sakurako Okamoto



Is the Local Group a typical halo in the universe?

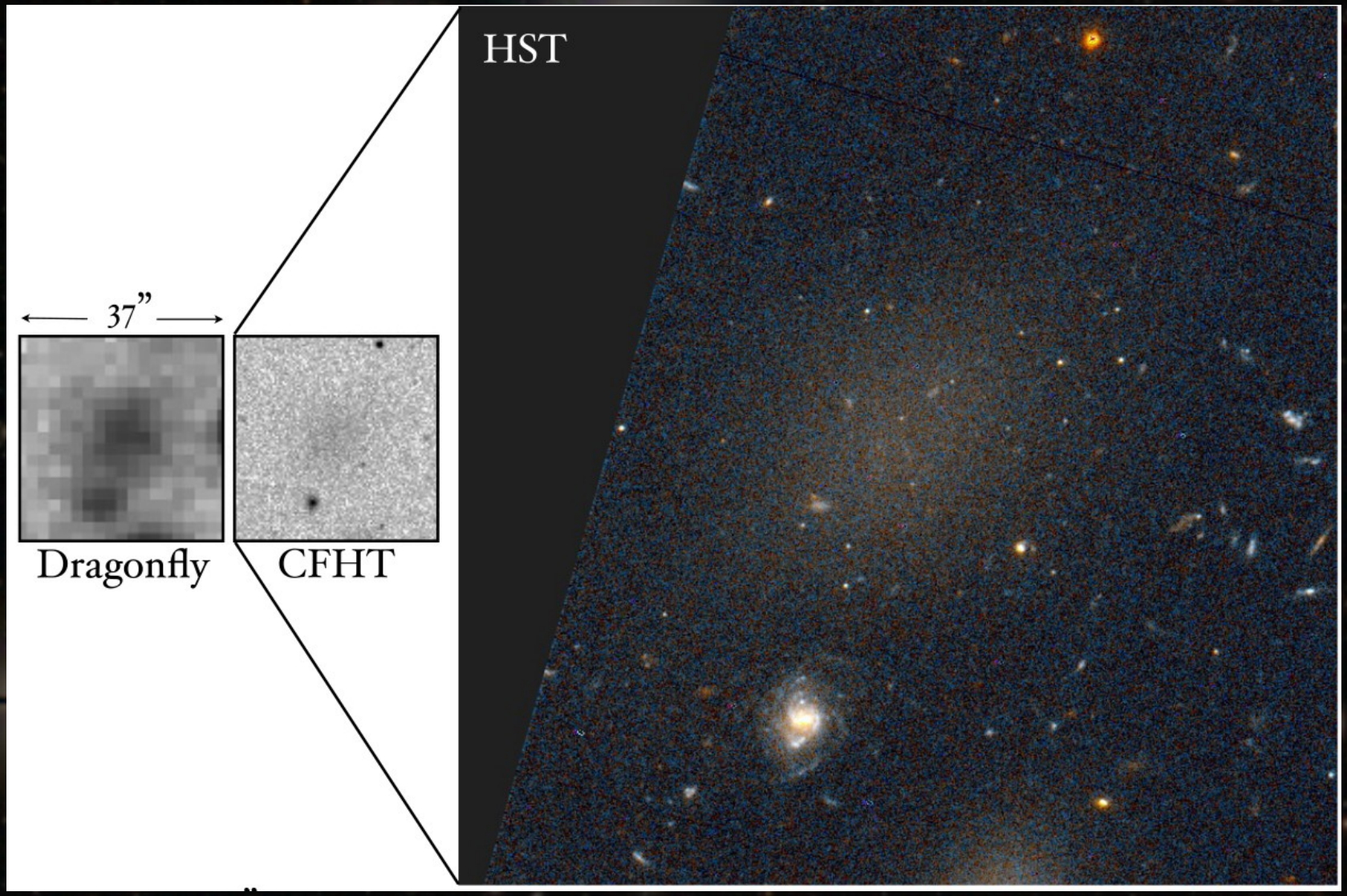
All cosmological problems should be addressed statistically!

Courtesy: Sakurako Okamoto

But, HSC is not without problems...

(1) optical artifacts

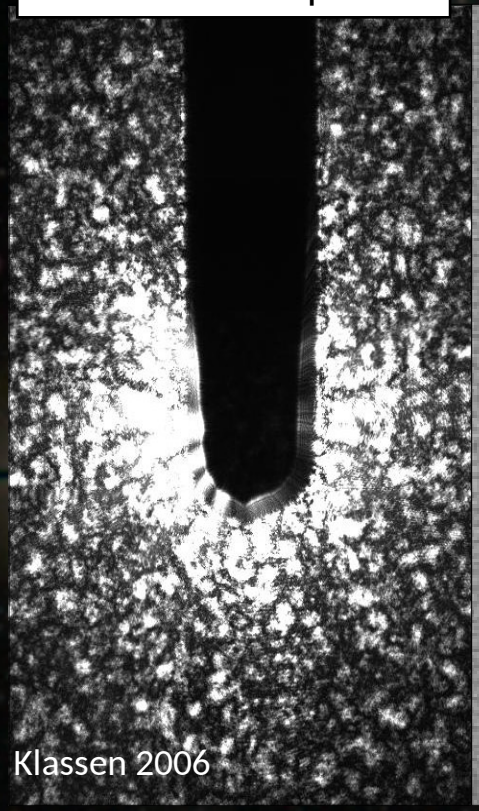
(2) over-subtracted sky



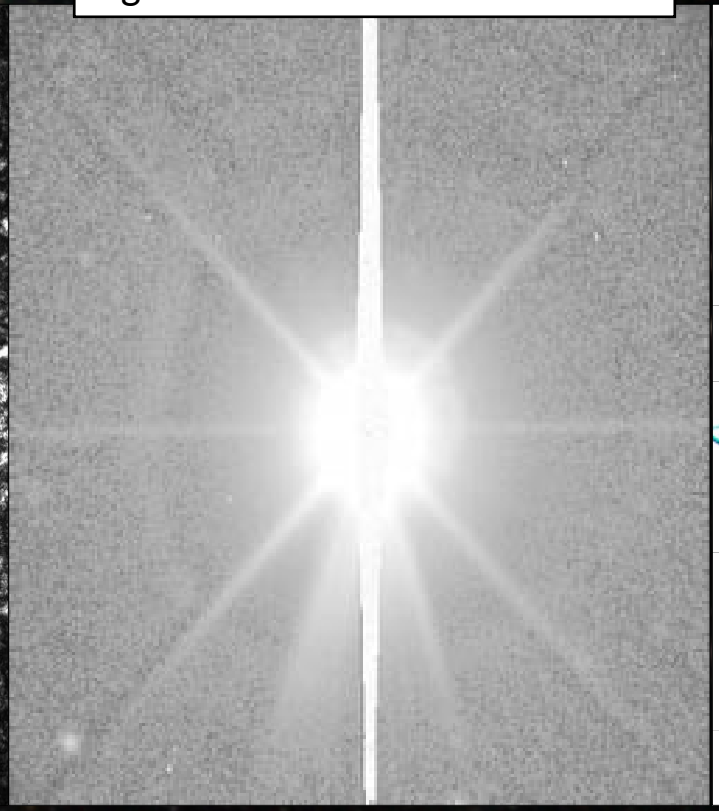
“Ultra Diffuse Galaxies” (van Dokkum et al. 2015 ApJ)

Reflecting telescopes leave artifacts on images that are difficult to remove

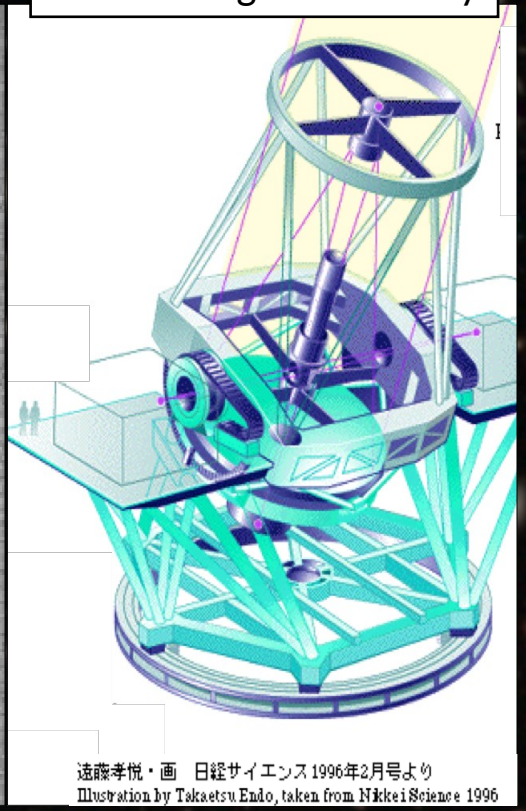
Mirrors are not perfect

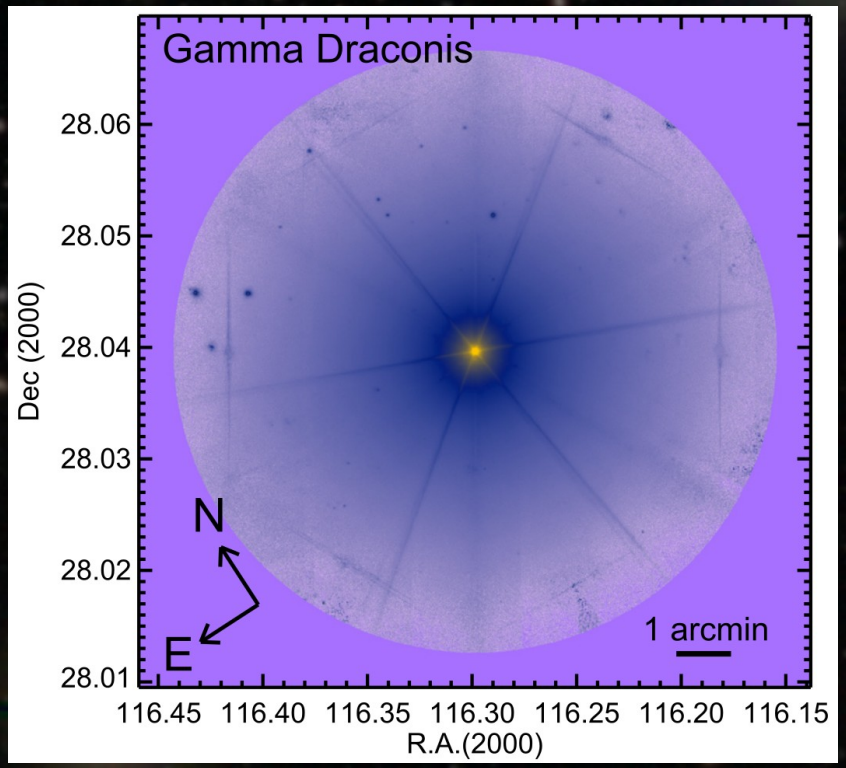


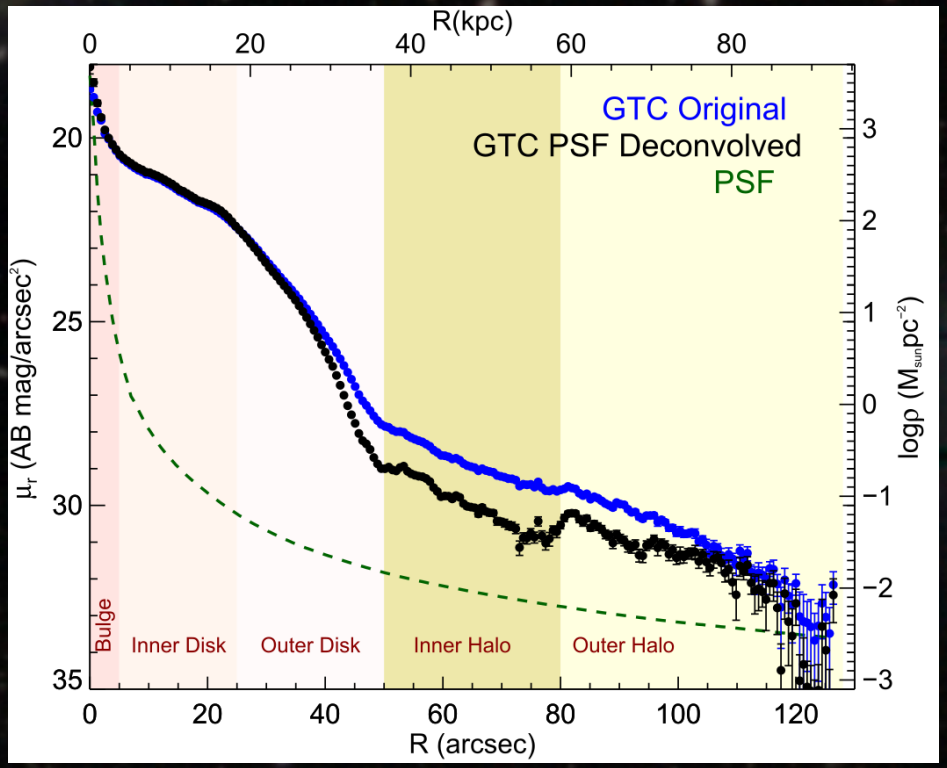
Light is scattered far from source



Structures get in the way







2nd mag star with GTC (Trujillo et all 2016, ApJ).
Lots of interesting features on the large scale!

Development of Subwavelength Structure Coating (SWC) and its Application to Imaging Lenses

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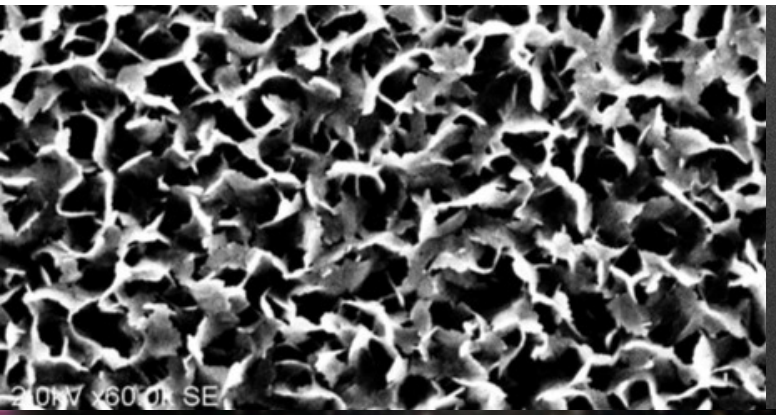
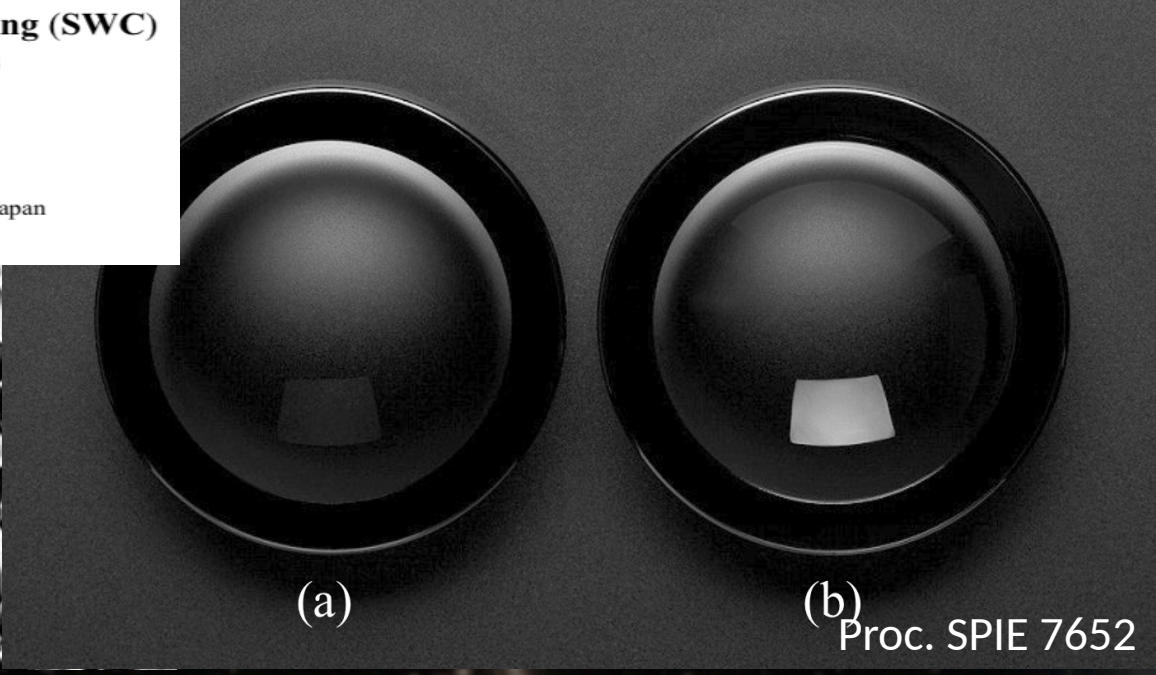




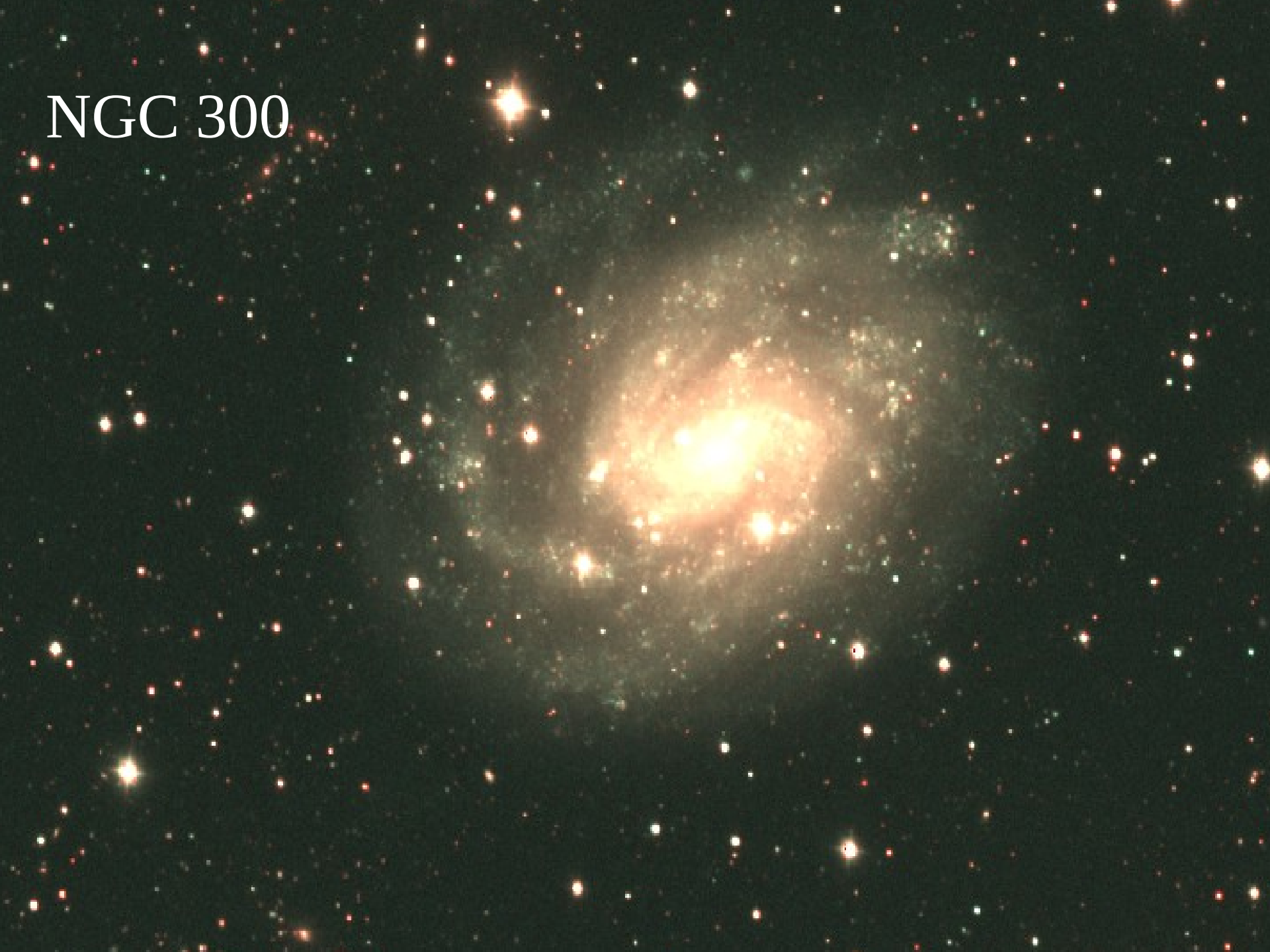
Proc. SPIE 7652

‘old’ coating

‘new’ coating

Huntsman

- Located at Siding Spring Observatory
- Number of Canon lenses: 10
- Field of view: 2x3 deg^2
- Filters: g, r, Halpha
- Pixel scale: 3”/pixel
- 5-sigma sensitivity 3.5 nights
  - g = 32 ABmag/arcsec^2 (plus r-band)
  - Halpha = 2e22 W/m^2/arcsec^2 ~9e6 M_{sun}/yr/kpc^2


NGC 300

Stellar-HI assembly information

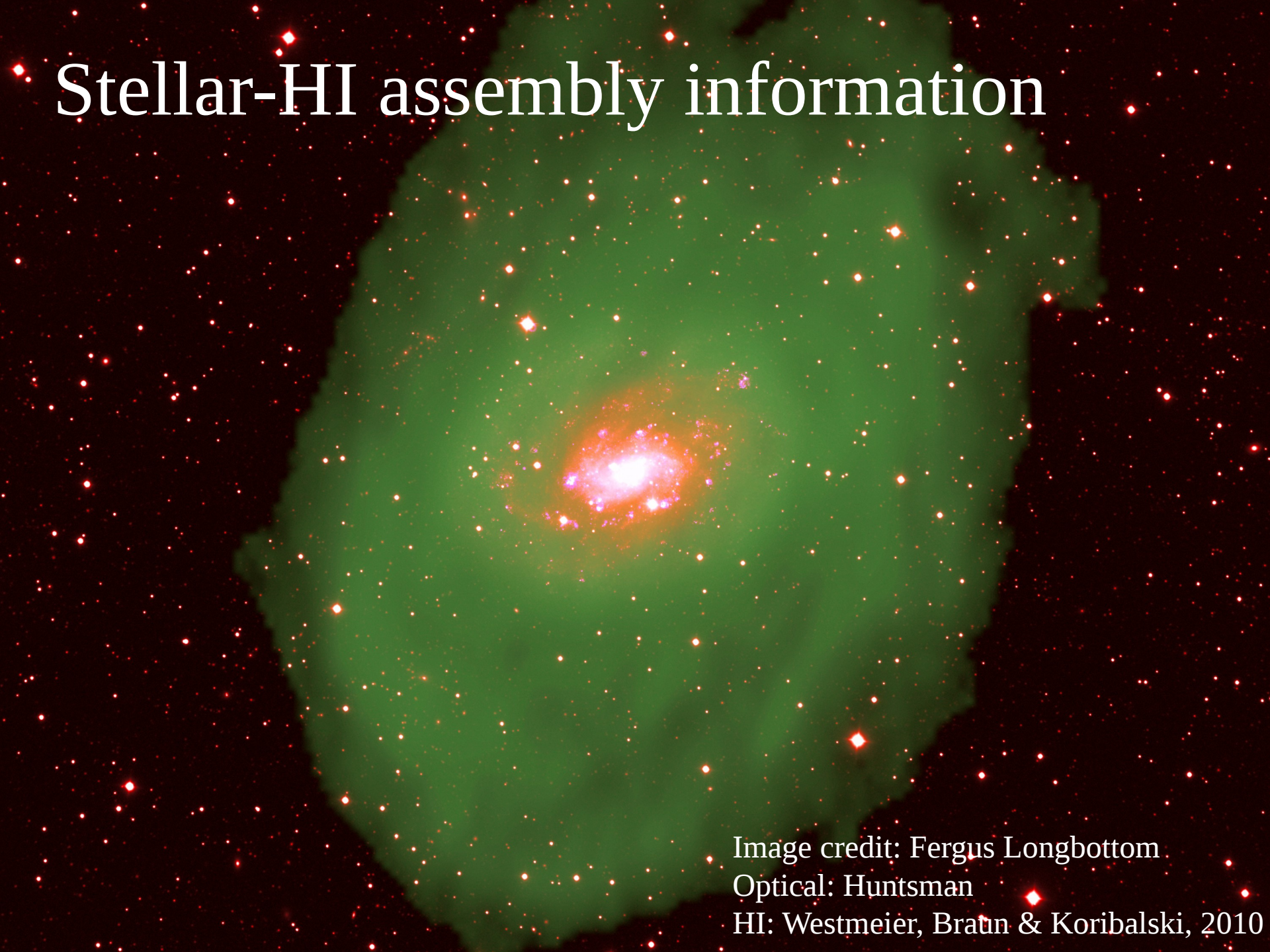


Image credit: Fergus Longbottom
Optical: Huntsman
HI: Westmeier, Braun & Koribalski, 2010

Science Goals

Advantages of each instrument:

- **HSC**: Sensitive to faint sources. High angular resolution.
- **Huntsman**: Sensitive to diffuse sources. Can probe outer parts of the stellar halo of massive galaxies.

Our science goals include:

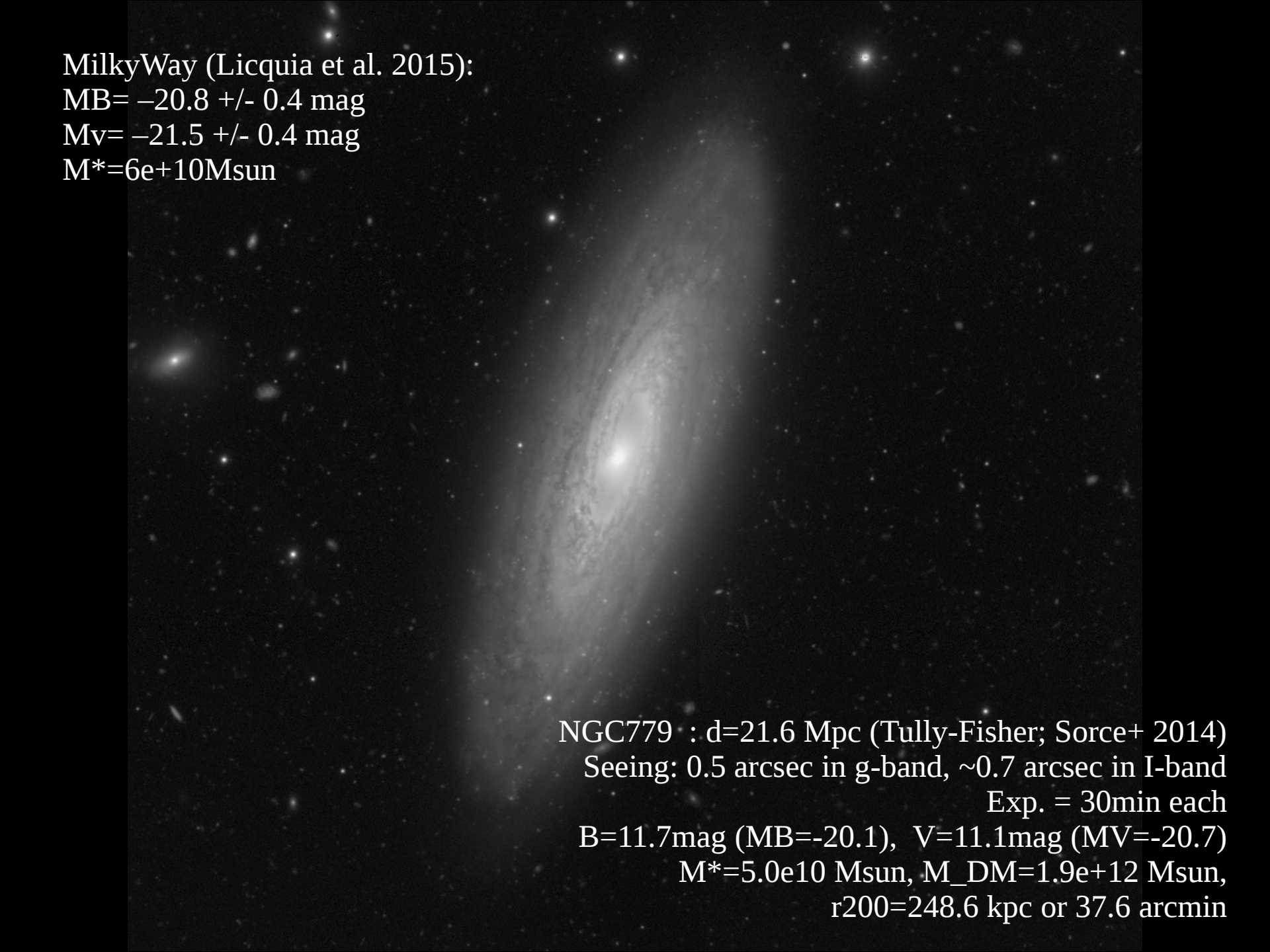
– constructing a complete sample of dwarf galaxies (both diffuse and compact) to address the missing satellite problem

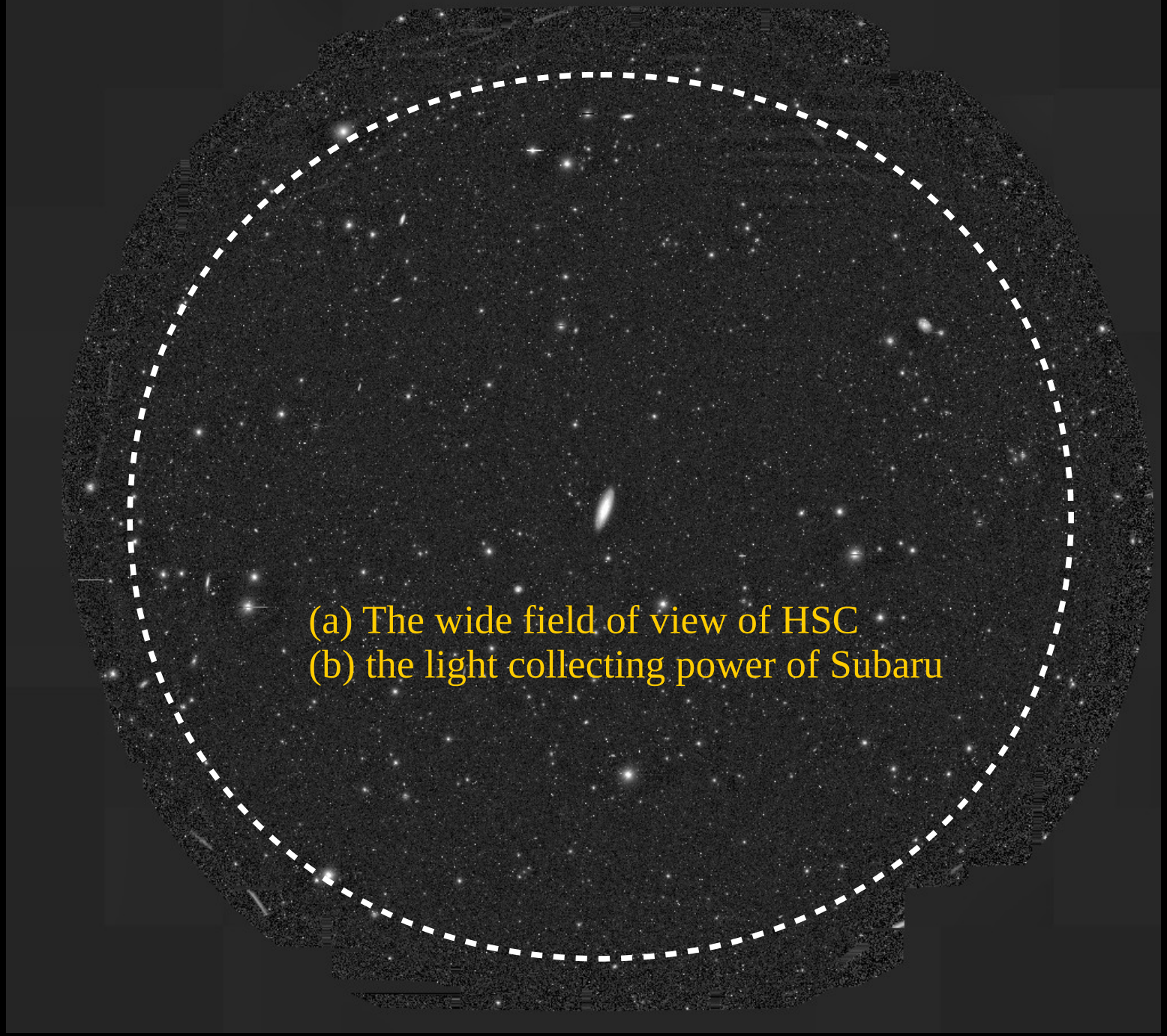
– explore outer stellar halos as well as globular clusters

– cross-correlation between stars and gas

– and more!

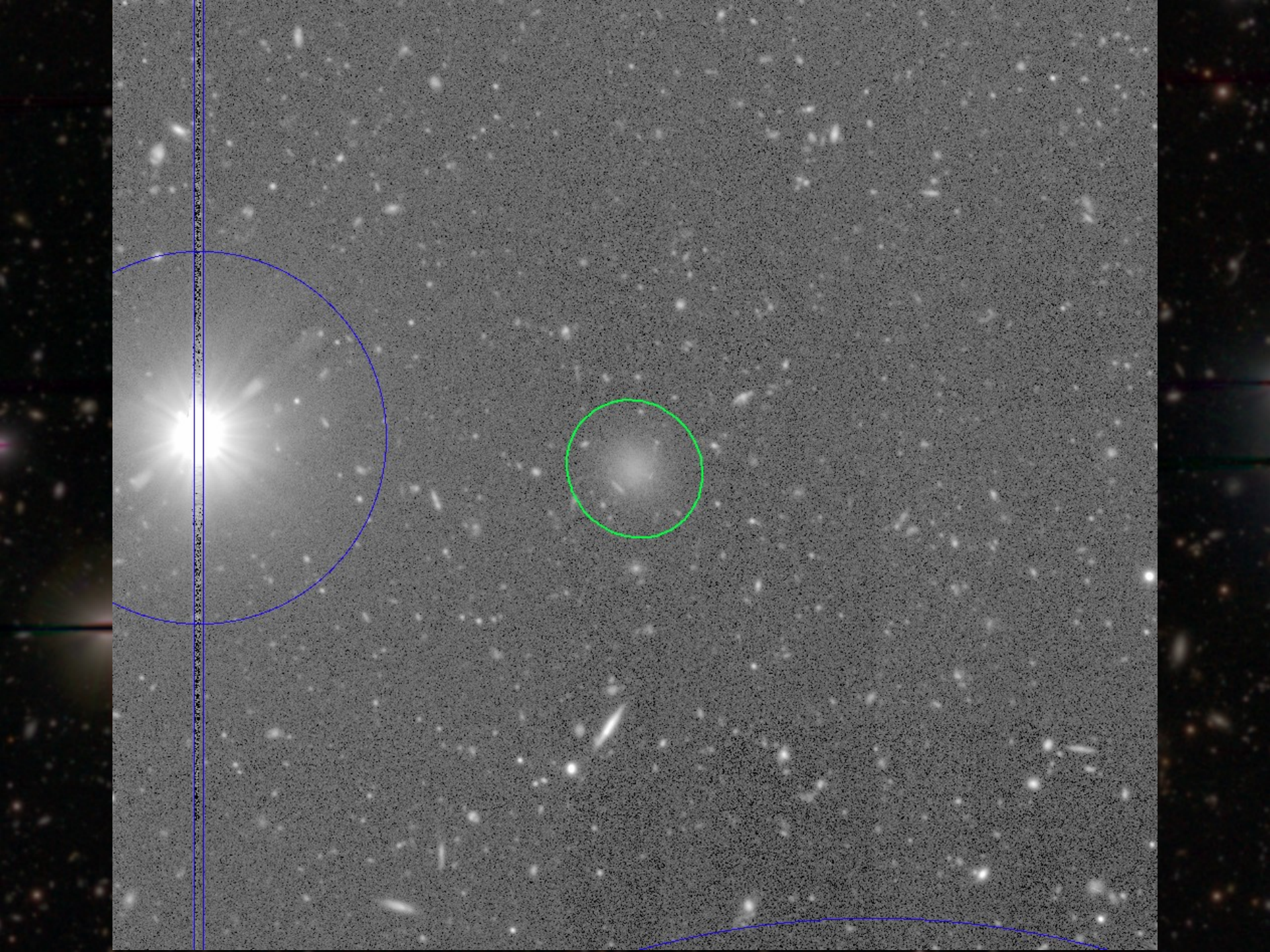
Some HSC results...

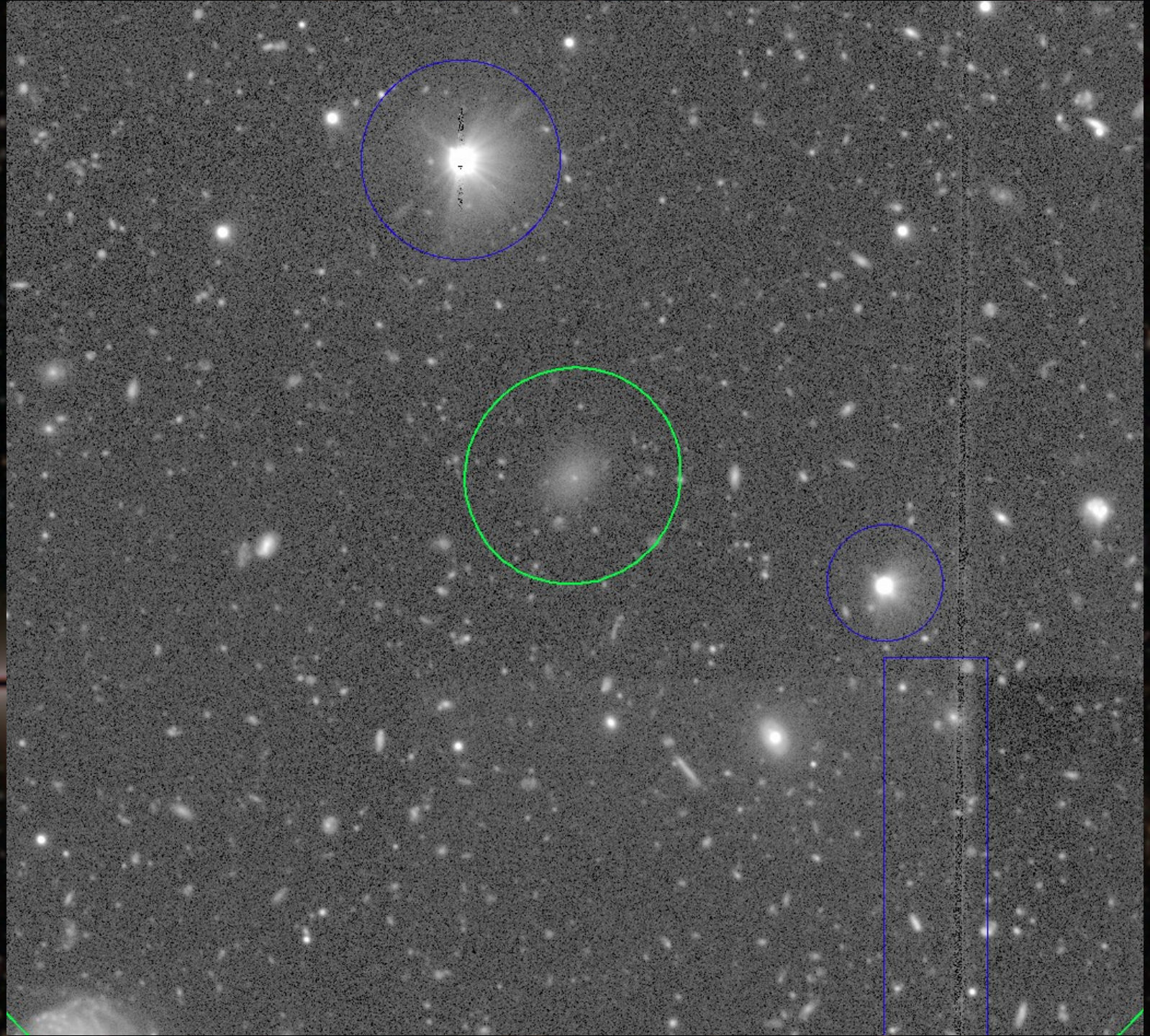

MilkyWay (Licquia et al. 2015):
MB= –20.8 +/- 0.4 mag
Mv= –21.5 +/- 0.4 mag
M*=6e+10Msun
NGC779 : d=21.6 Mpc (Tully-Fisher; Sorce+ 2014)
Seeing: 0.5 arcsec in g-band, ~0.7 arcsec in I-band
Exp. = 30min each
B=11.7mag (MB=-20.1), V=11.1mag (MV=-20.7)
M*=5.0e10 Msun, M_DM=1.9e+12 Msun,
r200=248.6 kpc or 37.6 arcmin

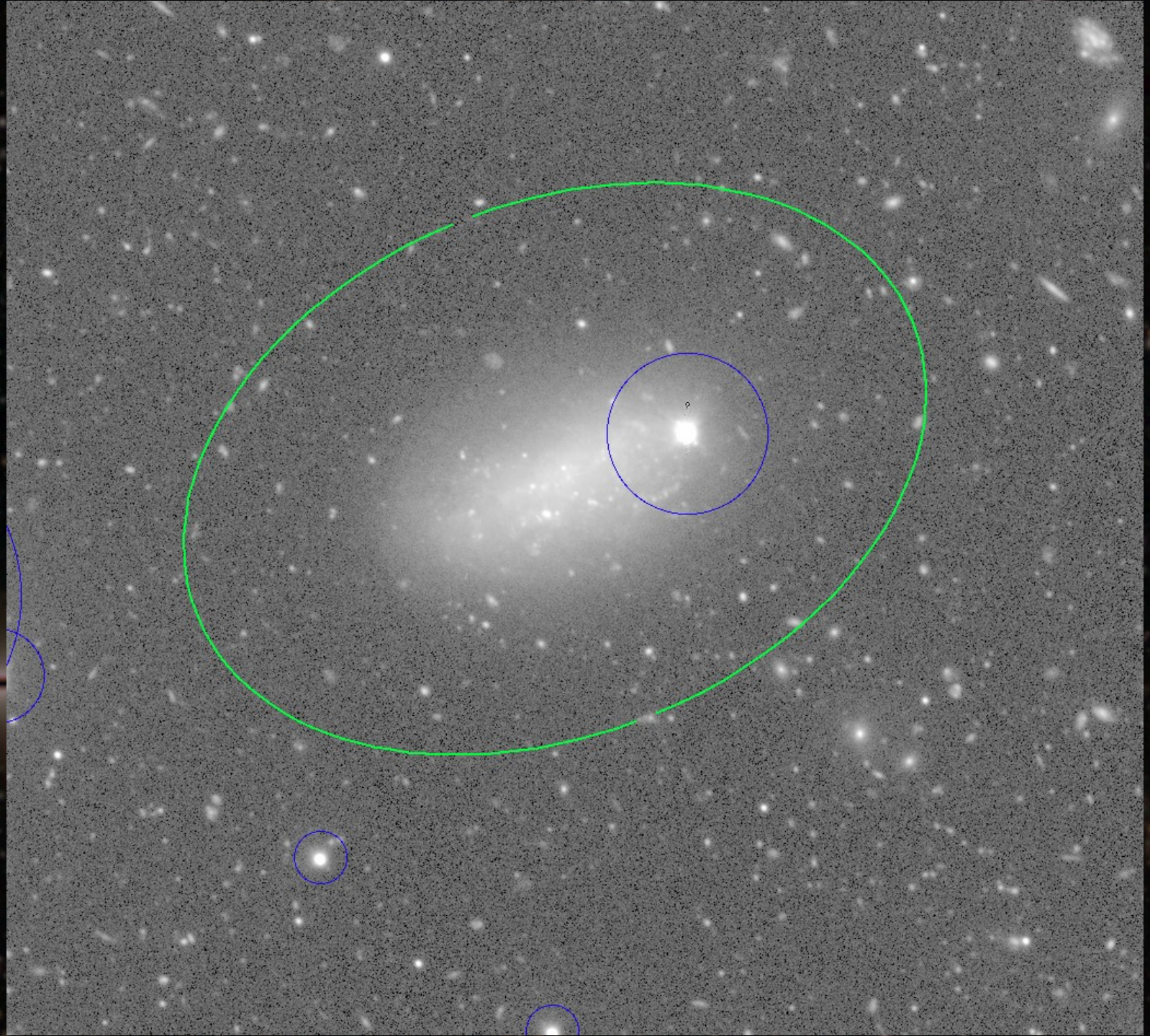

(a) The wide field of view of HSC
(b) the light collecting power of Subaru

Not just missing satellite problems, but more...

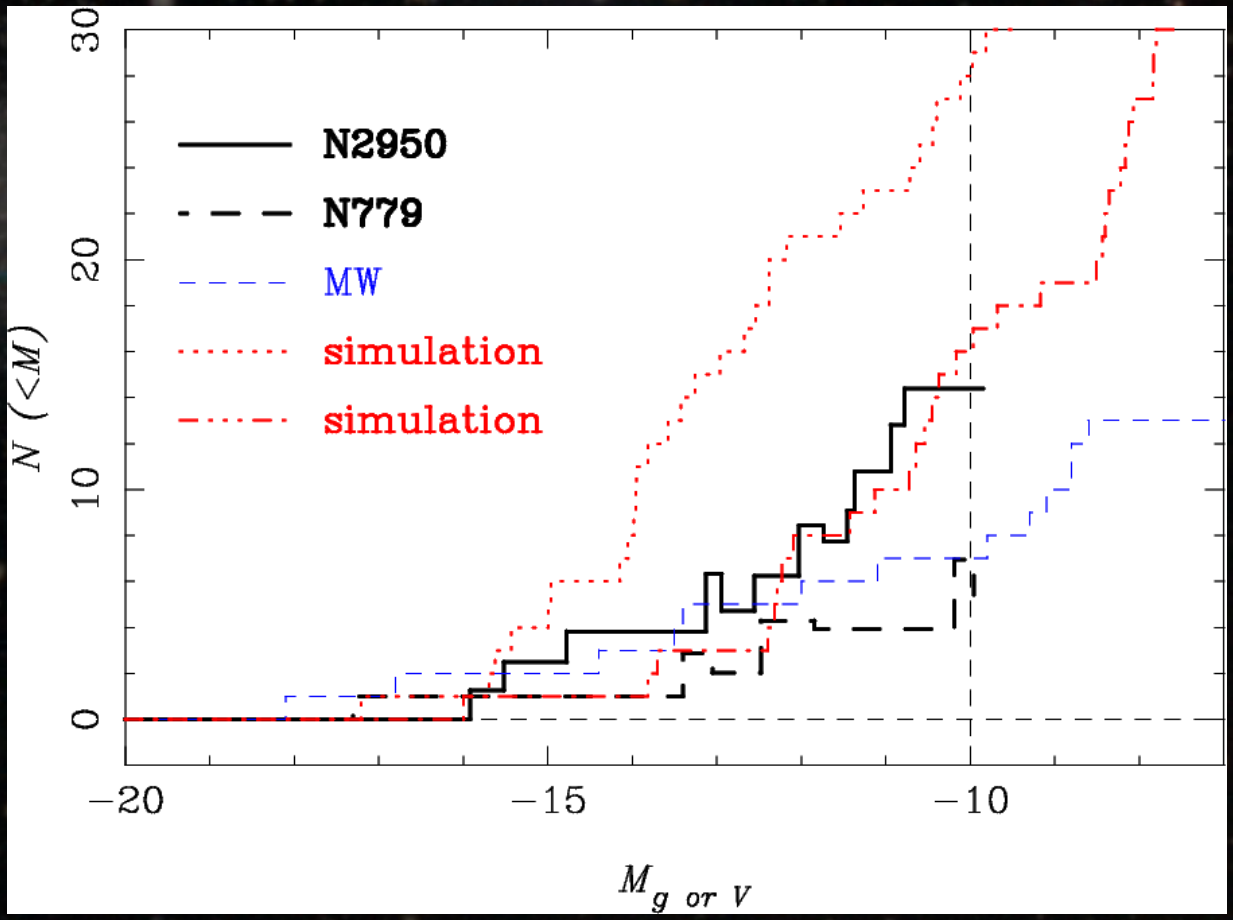
- Stellar tidal streams: a probe of galaxy-scale assembly
  (Duc et al. 2015, MNRAS)
- Spatial alignment of dwarf galaxies: another potential challenge to LCDM
  (Ibata et al. 2013, Nature)
- Gaps in stellar streams: potential probe of subhalo mass function
  (Carlberg 2012, ApJ)







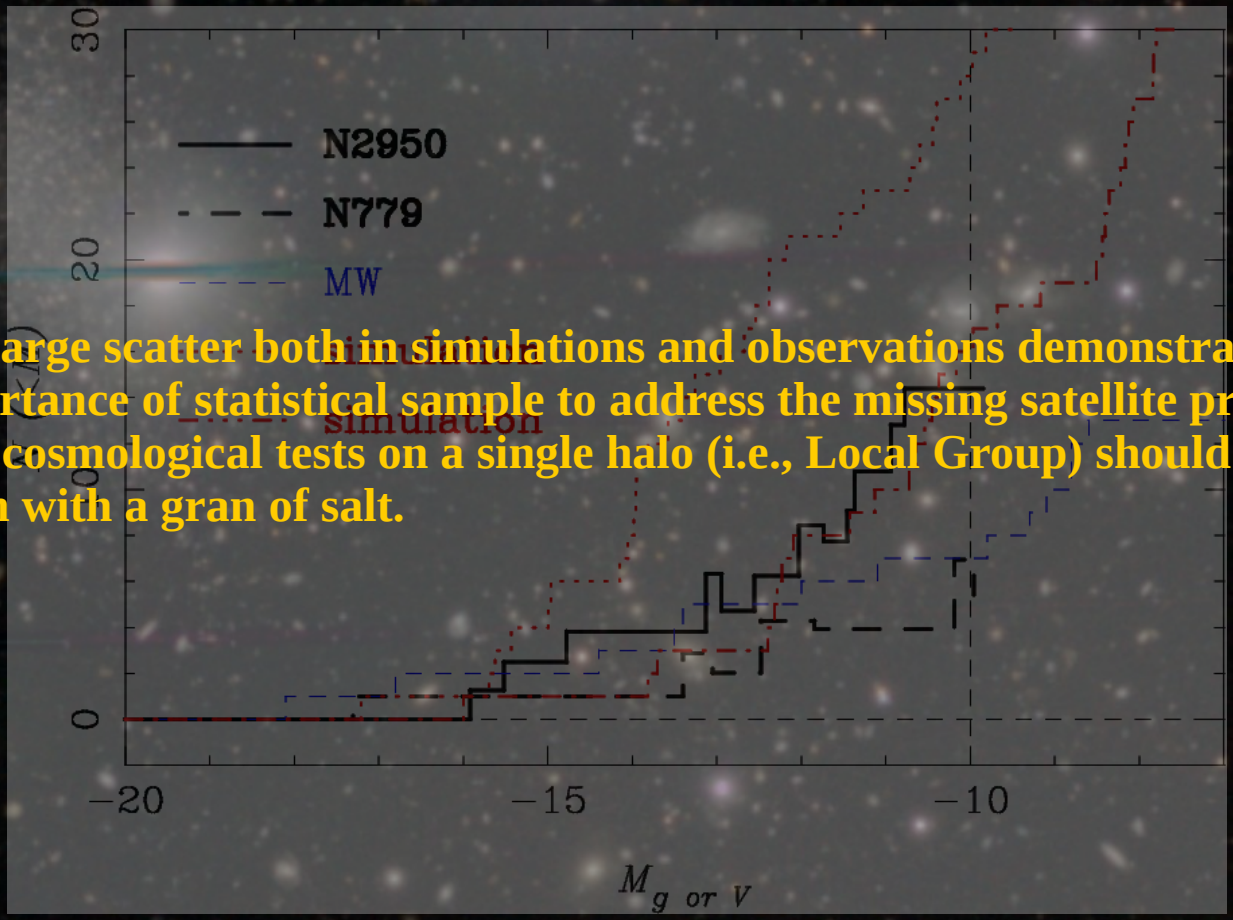
Main results – cumulative luminosity function



Simulations are from Okamoto (2013, MNRAS, 428, 718).

Tanaka et al in prep

Main results – cumulative luminosity function



The large scatter both in simulations and observations demonstrates the importance of statistical sample to address the missing satellite problem. Any cosmological tests on a single halo (i.e., Local Group) should be taken with a gran of salt.

Simulations are from Okamoto (2013, MNRAS, 428, 718).

Tanaka et al in prep

Summary

Let me know if you are interested in joining the HSC-Huntsman project!

Hyper Suprime-Cam Subaru Strategic Program

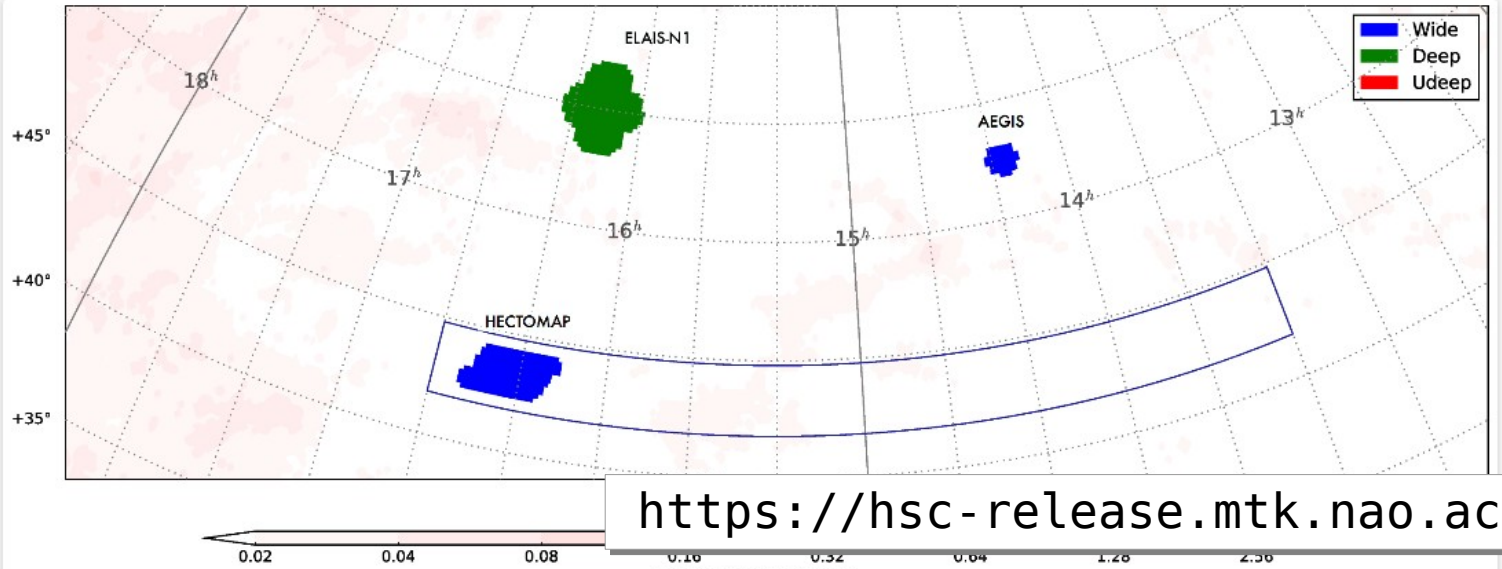
Data Release 1

Home | Survey | Processing | Release Data | Database | Data Access | FAQ

We peer deep into the Universe to unveil the nature of dark matter and dark energy.

Public Data Release 1

Welcome to the Hyper Suprime-Cam Subaru Strategic Program Data Release Site!
The first public release of HSC-SSP occurred on 28 February 2017. The release includes over 100 square degrees of deep multi-color data served through dedicated databases and user interfaces. The figures below shows the area covered in this release and the table gives an overview of the data in the three survey layers. Refer to our survey website for details of the survey design.



https://hsc-release.mtk.nao.ac.jp/

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doi: 10.1093/pasj/xxx000

First Data Release of the Hyper Suprime-Cam Subaru Strategic Program

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Data release paper with more than 100 authors!

arXiv: 1702.08449