Large-IFU for CAHA
&
LUCA: Local Universe from Calar Alto

IAA (CSIC)

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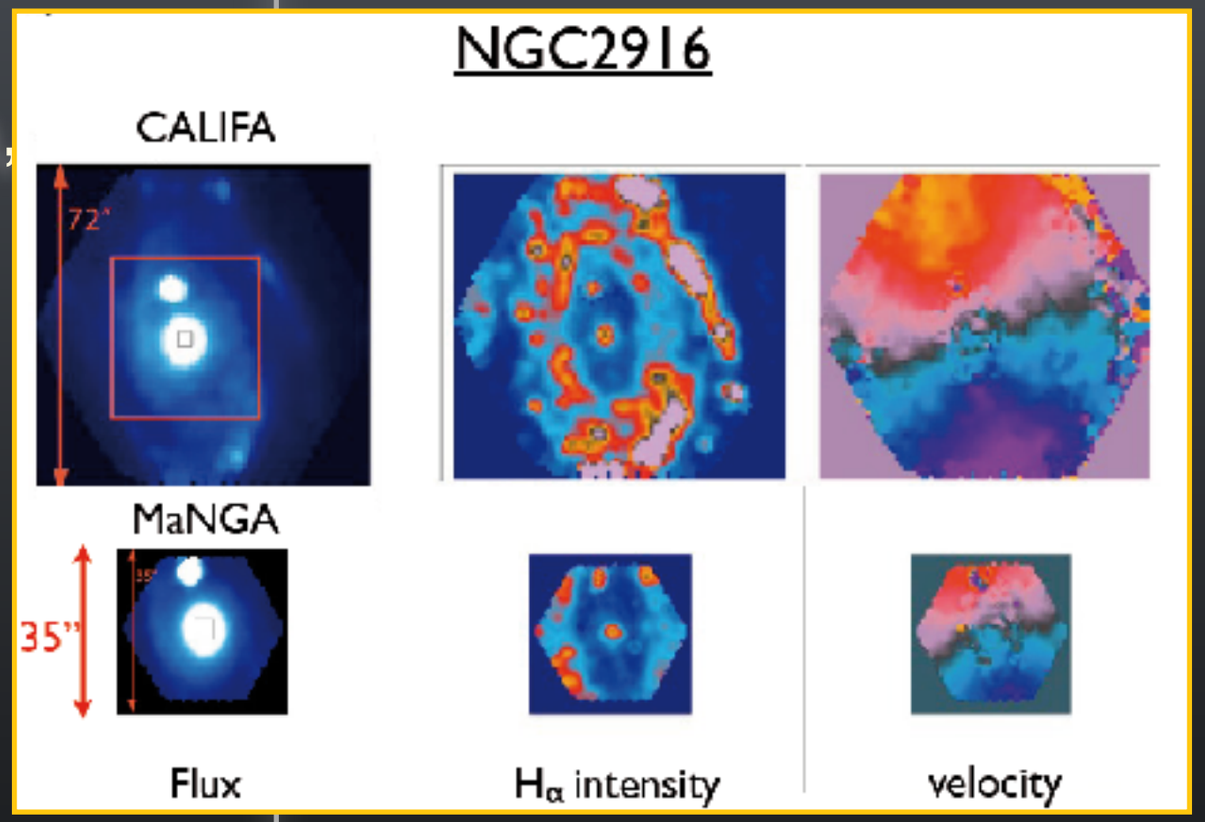
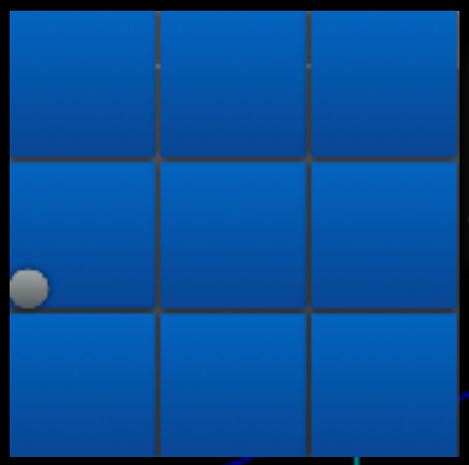
Niche for a Large-IFU at 3.5m CAHA

IFU characteristics

- PPaK@CAHA: 1.2 arcmin x 1 arcmin,
  - R ~ 500 : 3700 —7000 A
  - 2.6 arcsec/spaxel
- MUSE@VLT: 1.2 arcmin x 1 arcmin,
  - R ~2000: 4650 — 9300 A
  - 0.2 arcsec/spaxel
- MaNGA: diameter ~12 to 32 arcsec
  - R ~2000: 3600 — 10000 A
  - 2 arcsec/spaxel
- LIFU(WEAVE)@WHT: 1.5 x 1.3 arcmin
  - LR 2500: 3360 — 9840 A
  - 2.6 arcsec/spaxel



Local Universe: sphere of 15 Mpc center at the local group
Local Volumen distribution of galaxies (~10 Mpc) + Virgo cluster



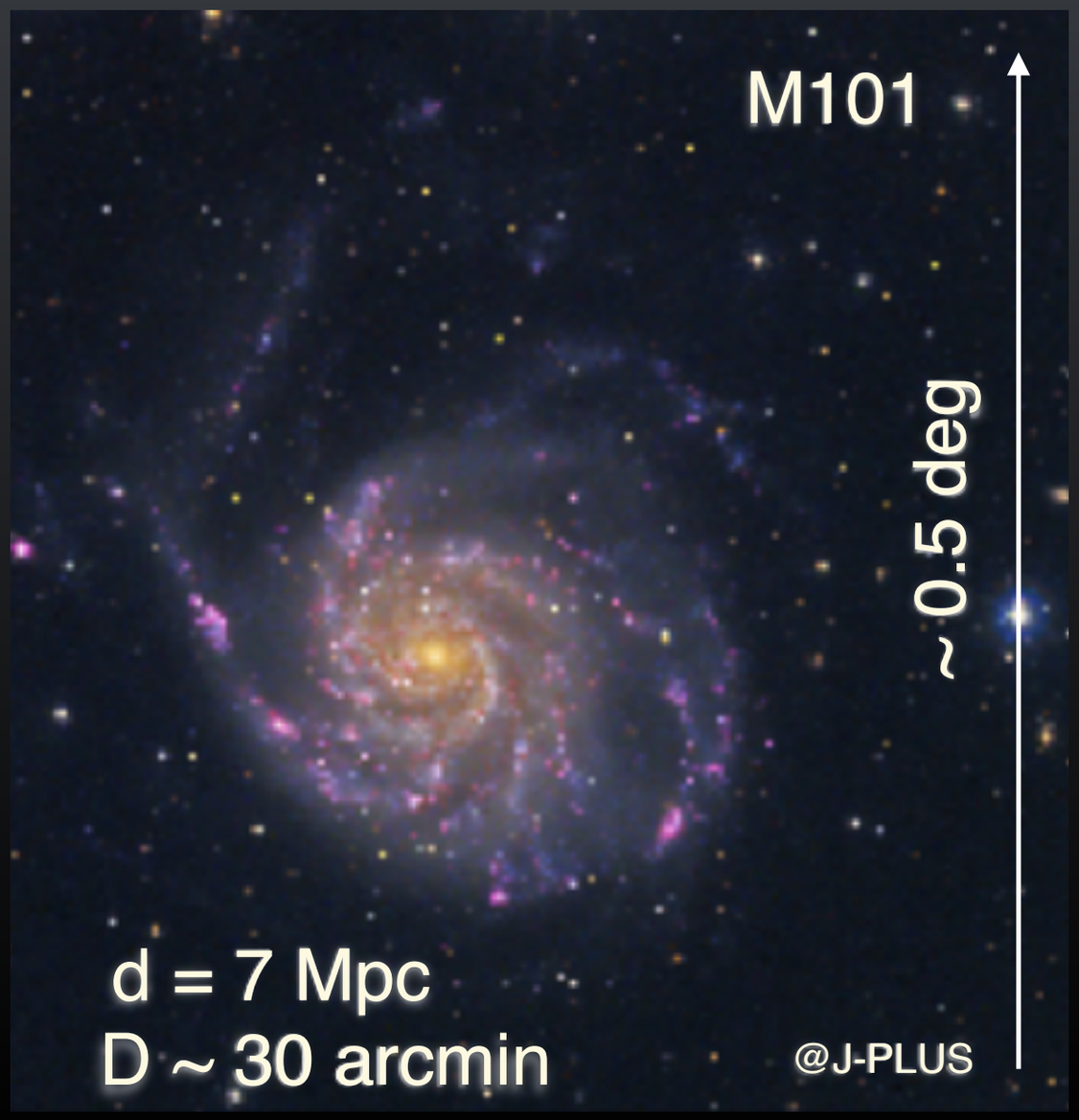
Large-IFU

- FoV: 3 arcmin x 3 arcmin

scale < 80 pc/arcsec
Constrains to the sub grid physics for simulations of galaxy formation

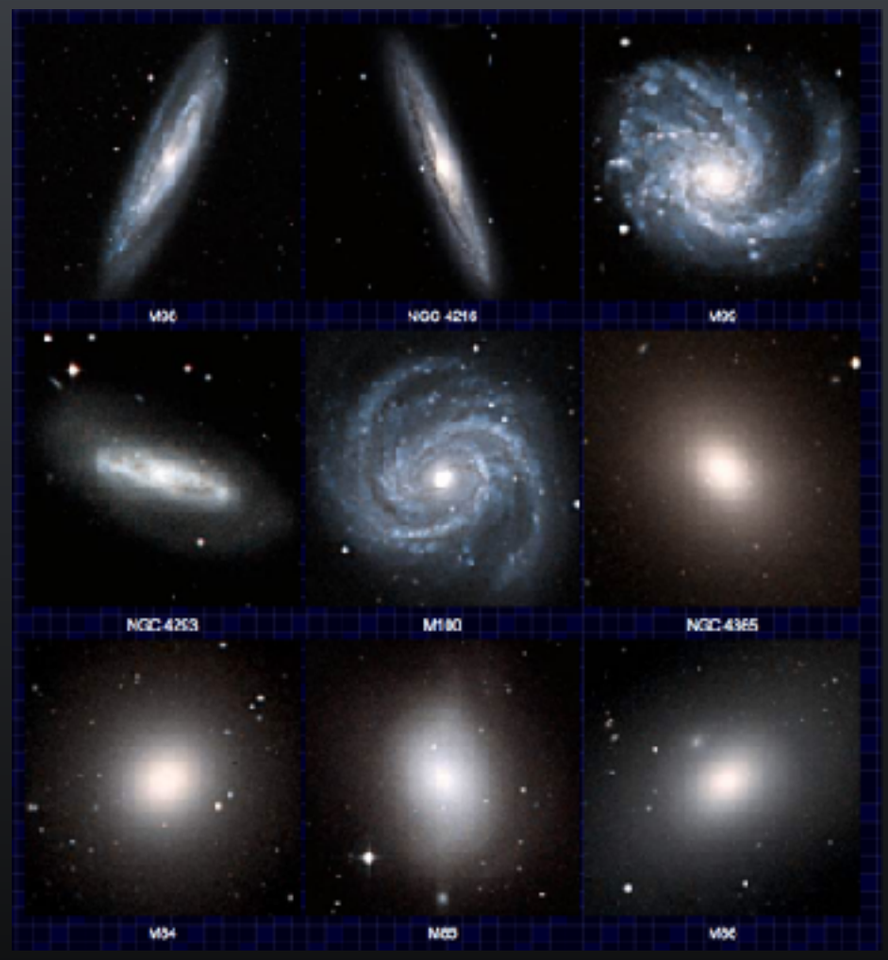
Local Universe: Niche for a Large-IFU at 3.5m CAHA

IAU: Local Universe: sphere of 15 Mpc
center at the local group
Local Volume distribution of galaxies
(d< 11 Mpc) + Virgo cluster



Galaxies of Local Universe
1 arcmin < D < 30 arcmin

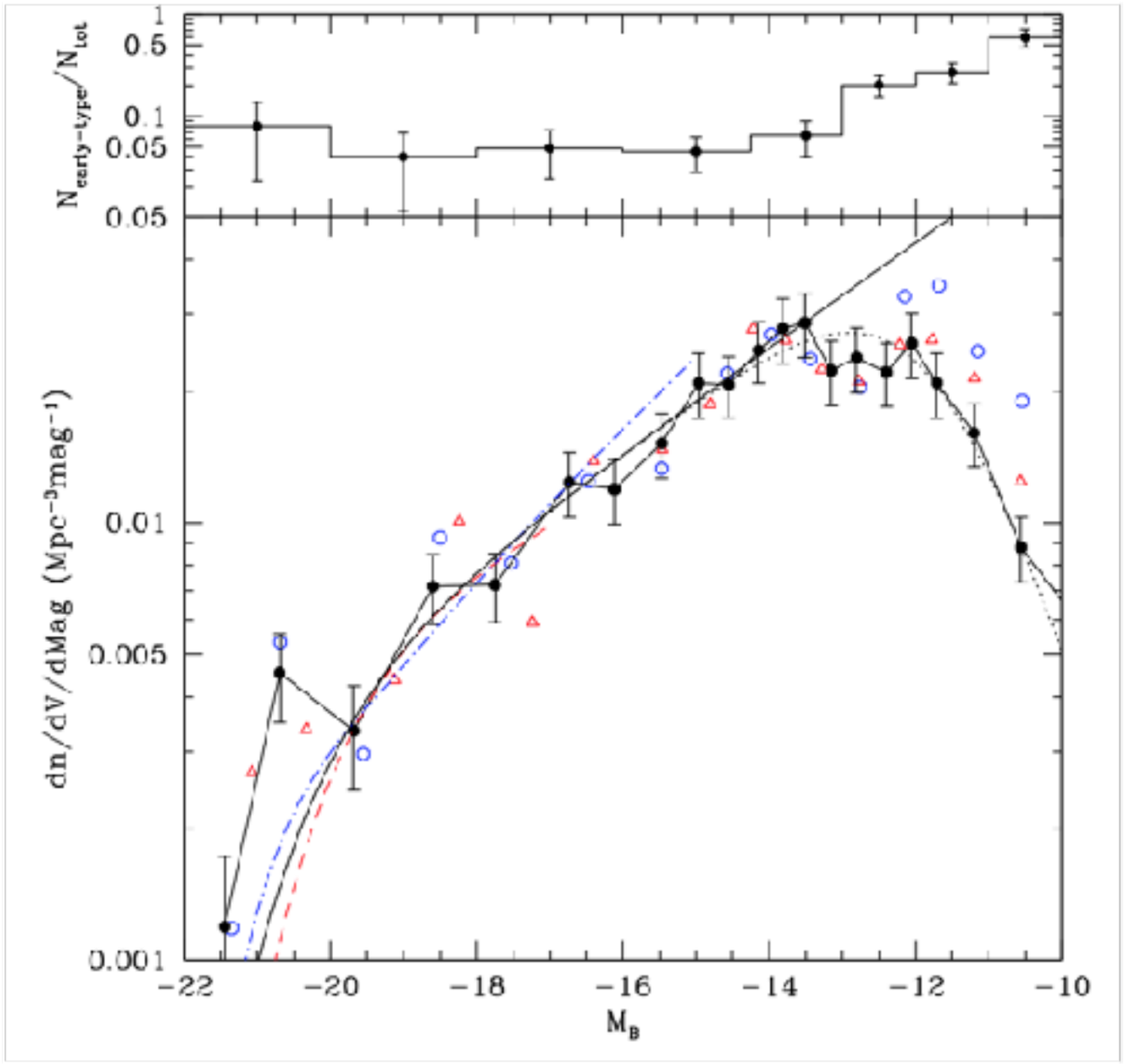
Galaxies in Virgo



- M86 (E3): 10 arcmin
- M84 (E1): 6 arcmin
- NGC4435 (S0): 3 arcmin
- NGC4438 (Sa): 9 arcmin
- M100 (Sbc): 7 arcmin

LUCA: Local Universe from Calar Alto

Selection from the LV sample: complete up to $M_B < -14$



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Abstract of field galaxies

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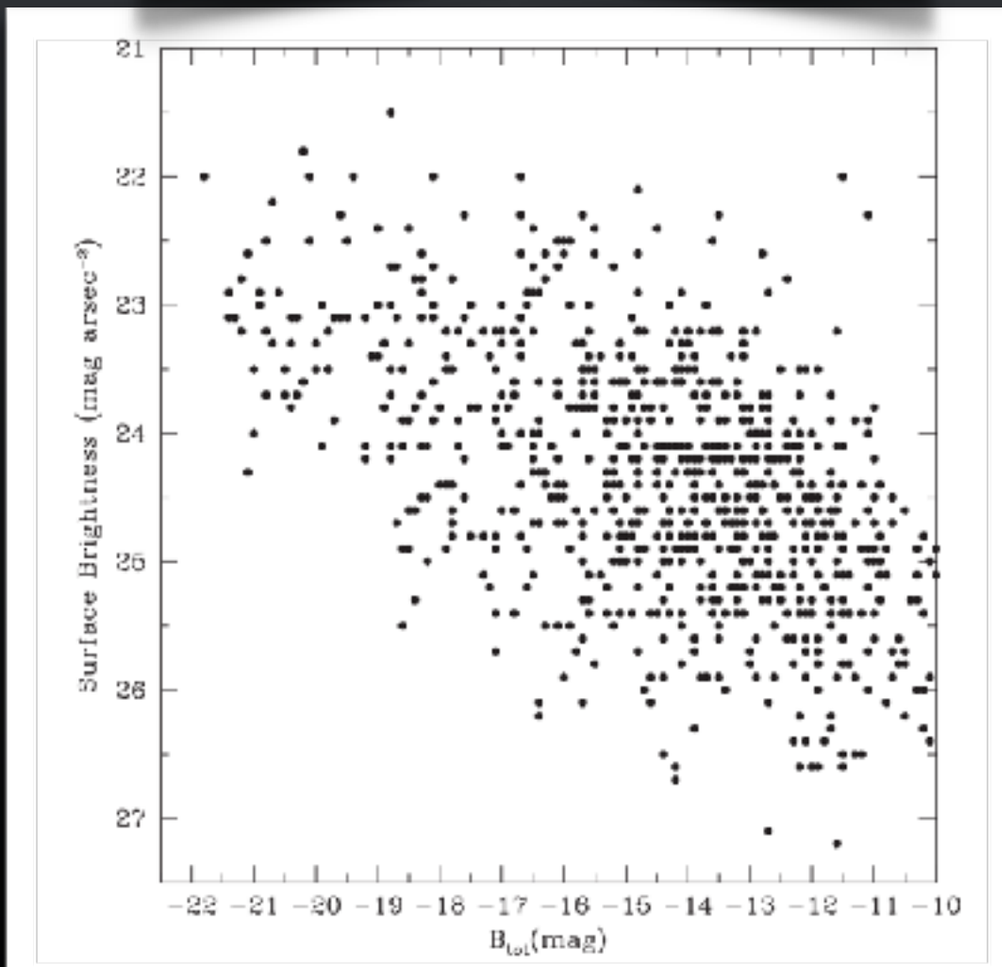
ABSTRACT

We present new measurements of the abundance of galaxies with a given circular velocity in the Local Volume: a region centred on the Milky Way Galaxy and extending to distance ~10 Mpc. The sample of ~750 mostly dwarf galaxies provides a unique opportunity to study the abundance and properties of galaxies down to absolute magnitudes $M_B \approx -10$ and virial masses $M_{vir} = 10^8 M_\odot$. We find that the standard Λ cold dark matter (ΛCDM) model gives remarkably accurate estimates for the velocity function of galaxies with circular velocities $V \gtrsim 10 km s^{-1}$ and corresponding virial masses $M_{vir} \gtrsim 5 \times 10^{10} M_\odot$, but it badly fails by overpredicting ~5 times the abundance of large dwarfs with velocities $V = 30–40 km s^{-1}$. The warm dark matter (WDM) models cannot explain the data either, regardless of mass of WDM particle. Just as in previous observational studies, we find a shallow asymptotic slope $dN/dog\, V \propto V^\alpha$, $\alpha \approx -1$ of the velocity function, which is inconsistent with the standard ΛCDM model that predicts the slope $\alpha = -3$. Though reminiscent to the known overabundance of satellite problem, the overabundance of field galaxies is a much more difficult problem. For the standard ΛCDM model to survive in the 10 Mpc radius of the Milky Way there should be 1000 not yet detected galaxies with virial mass $M_{vir} \approx 10^{10} M_\odot$, extremely low surface brightness and no detectable H I gas. So far none of this type of galaxies have been discovered.

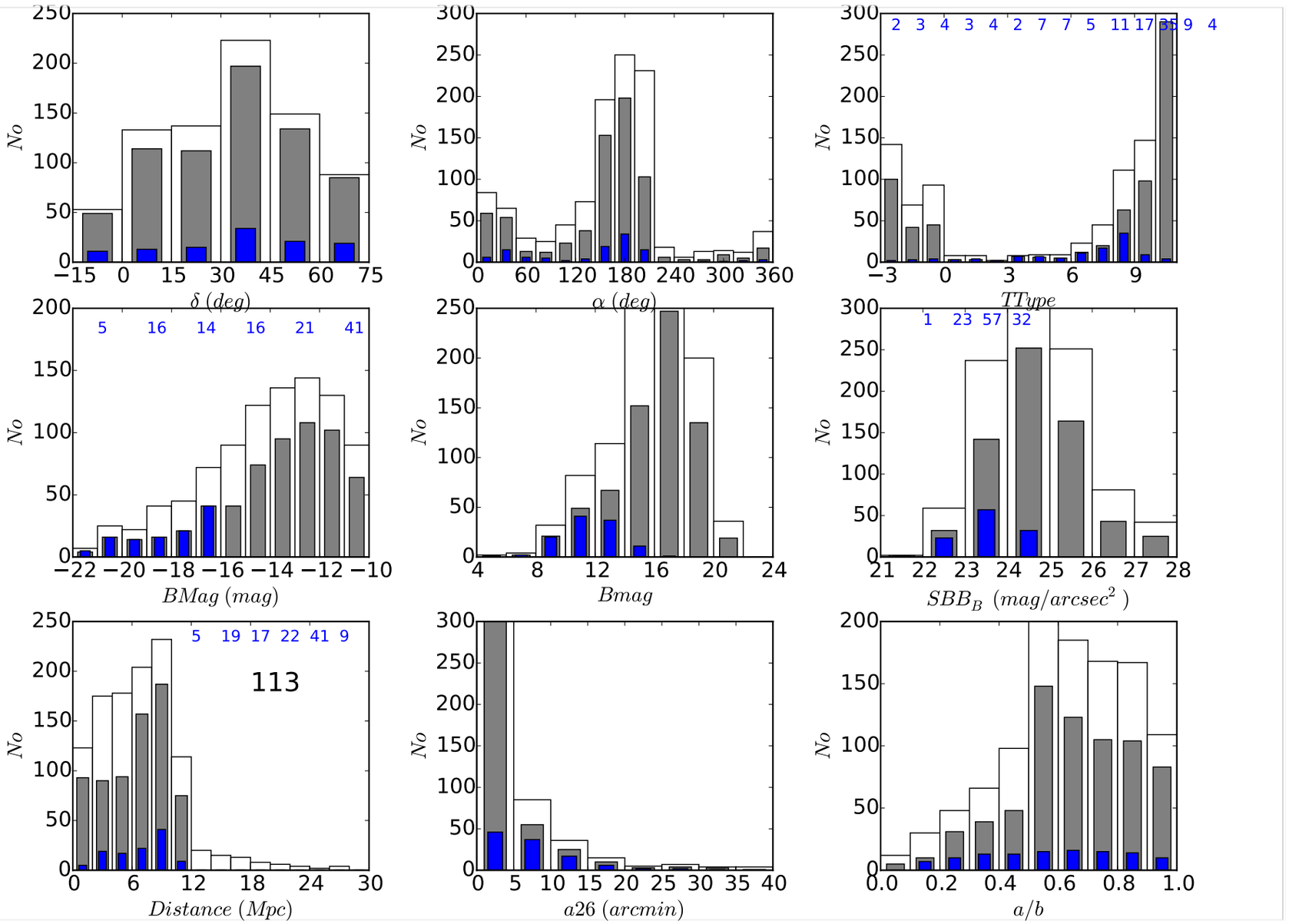
Key words: galaxies: haloes – cosmology: theory – dark matter.

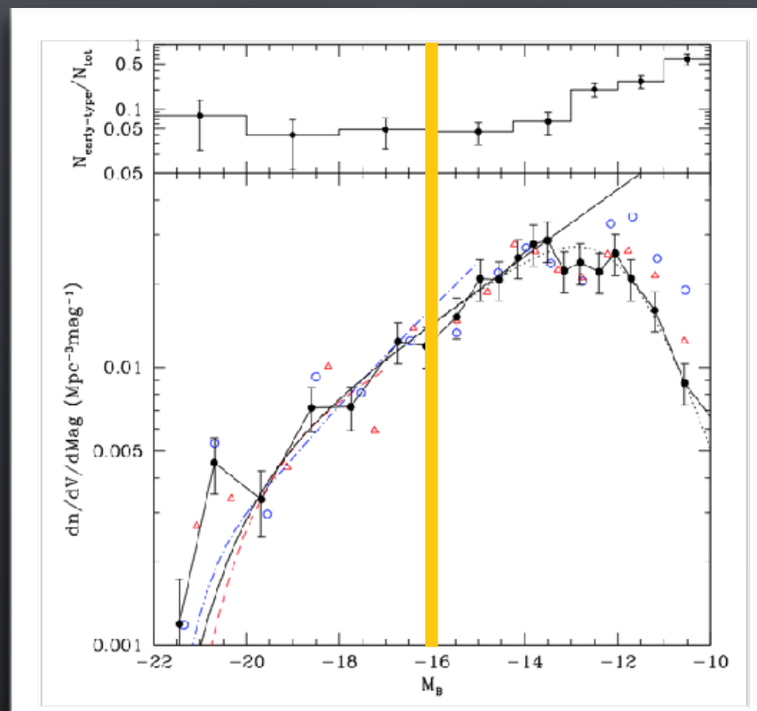


LUCA: Local Universe from Calar Alto

sample selection

- M_B <= -16
- a_{26_B} > 1 arcmin



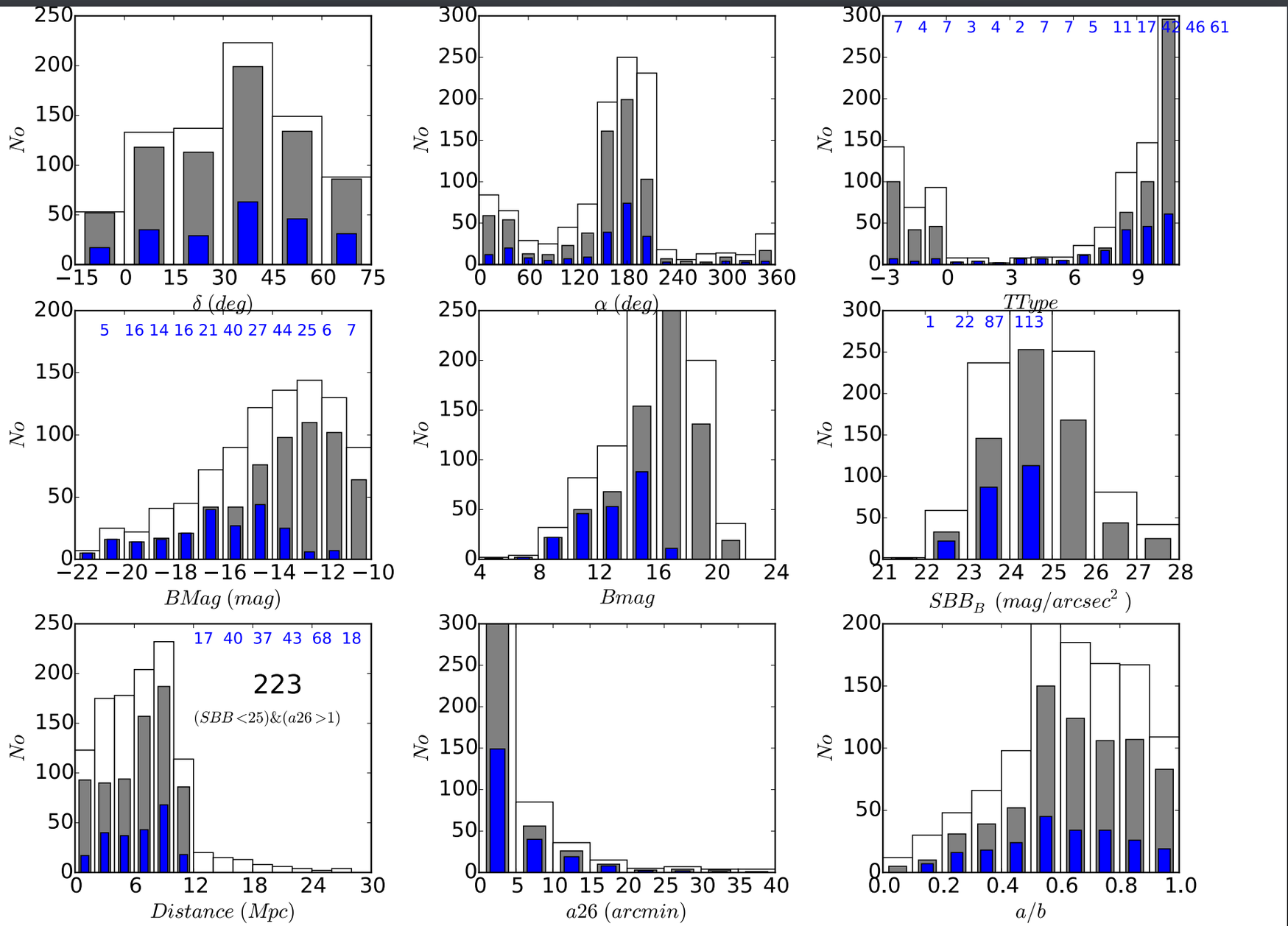


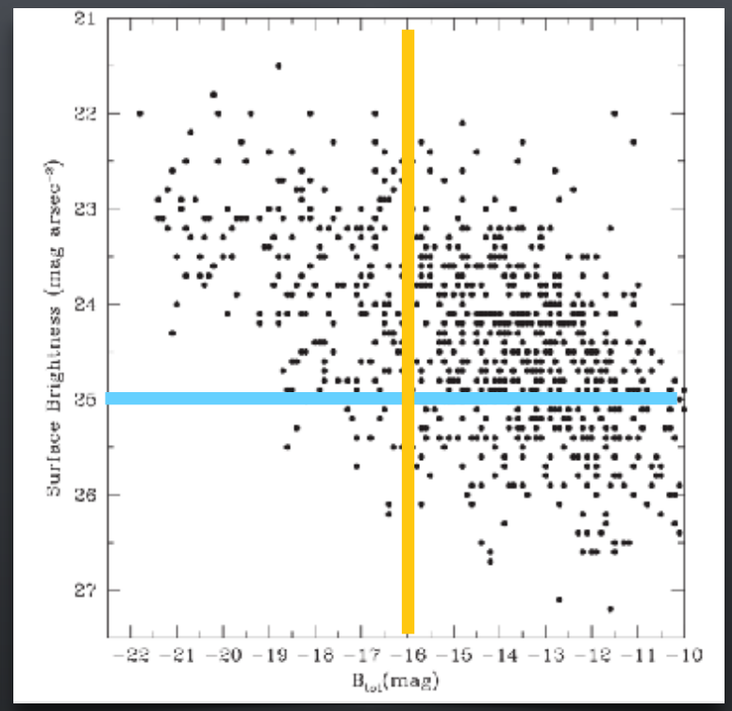
- complete sample
- log Mass > 9 Msun
- mean Distance = 7 Mpc
- spatial scale: 34 pc/arcsec
- dwE + Spirals

LUCA: Local Universe from Calar Alto

Sample selection

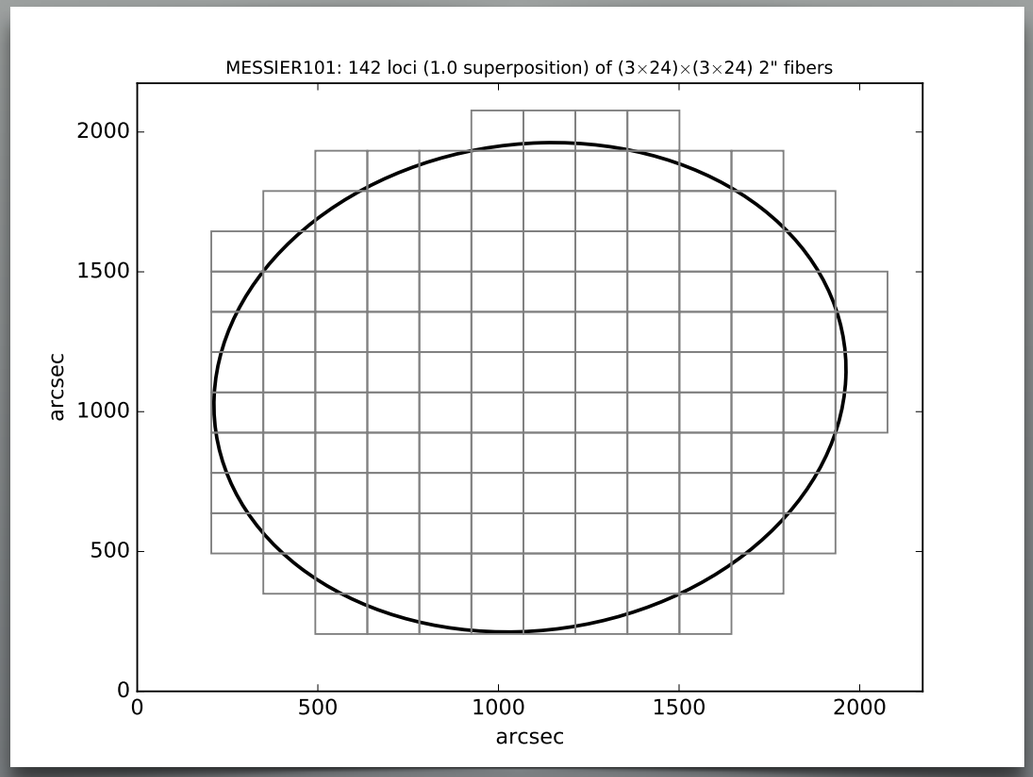
- S_B <= 25 mag/arcsec^2
- a_{26_B} > 1 arcmin

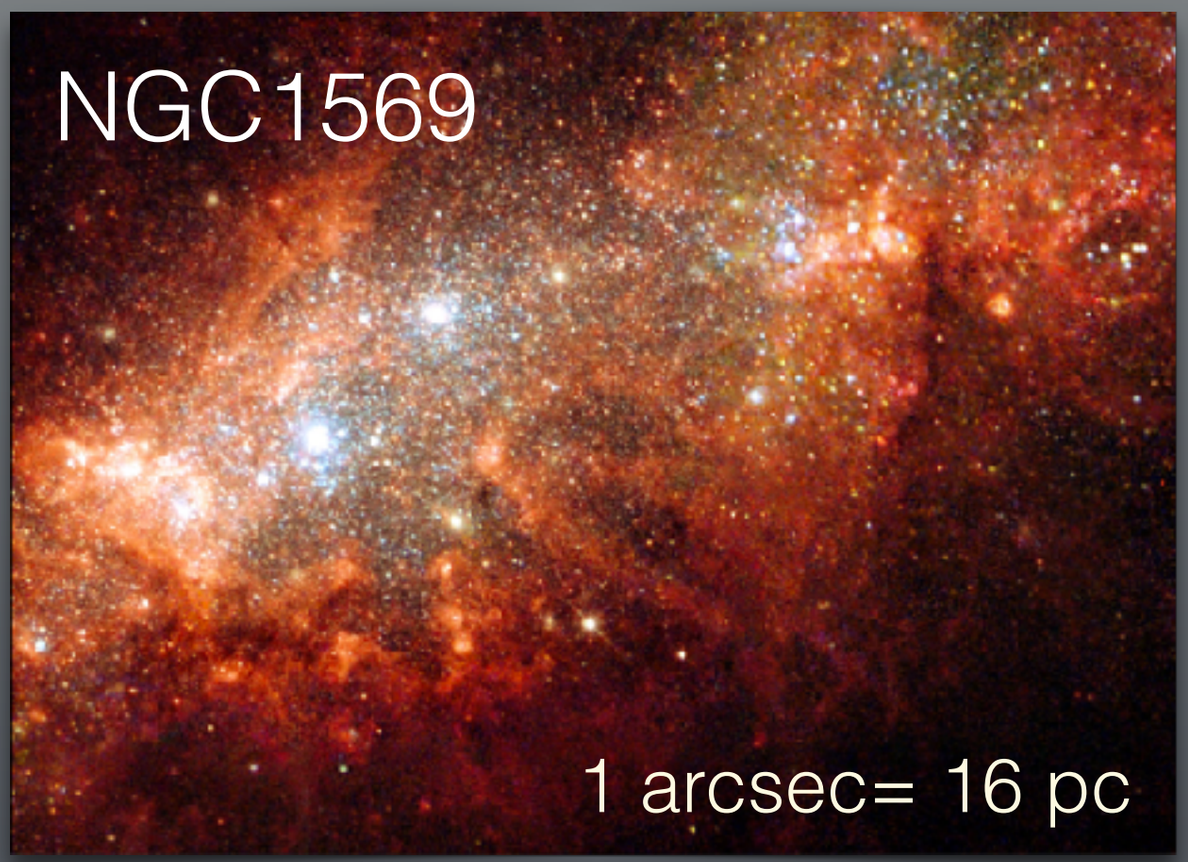


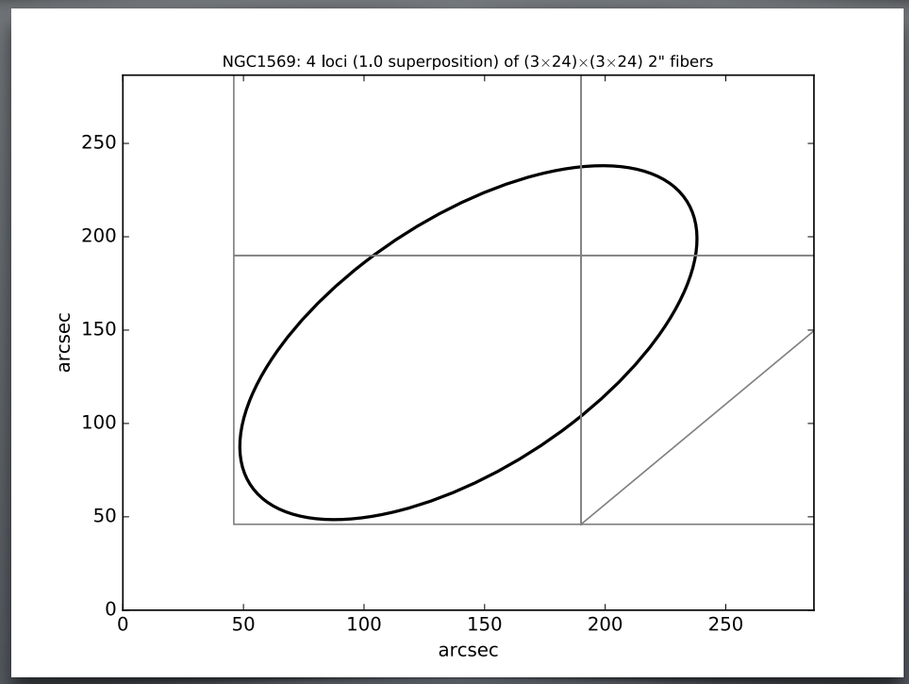


- complete sample
- dwE, Spirals and
- Irr with a26_B < 5 arcmin

Examples of galaxies and number of pointings

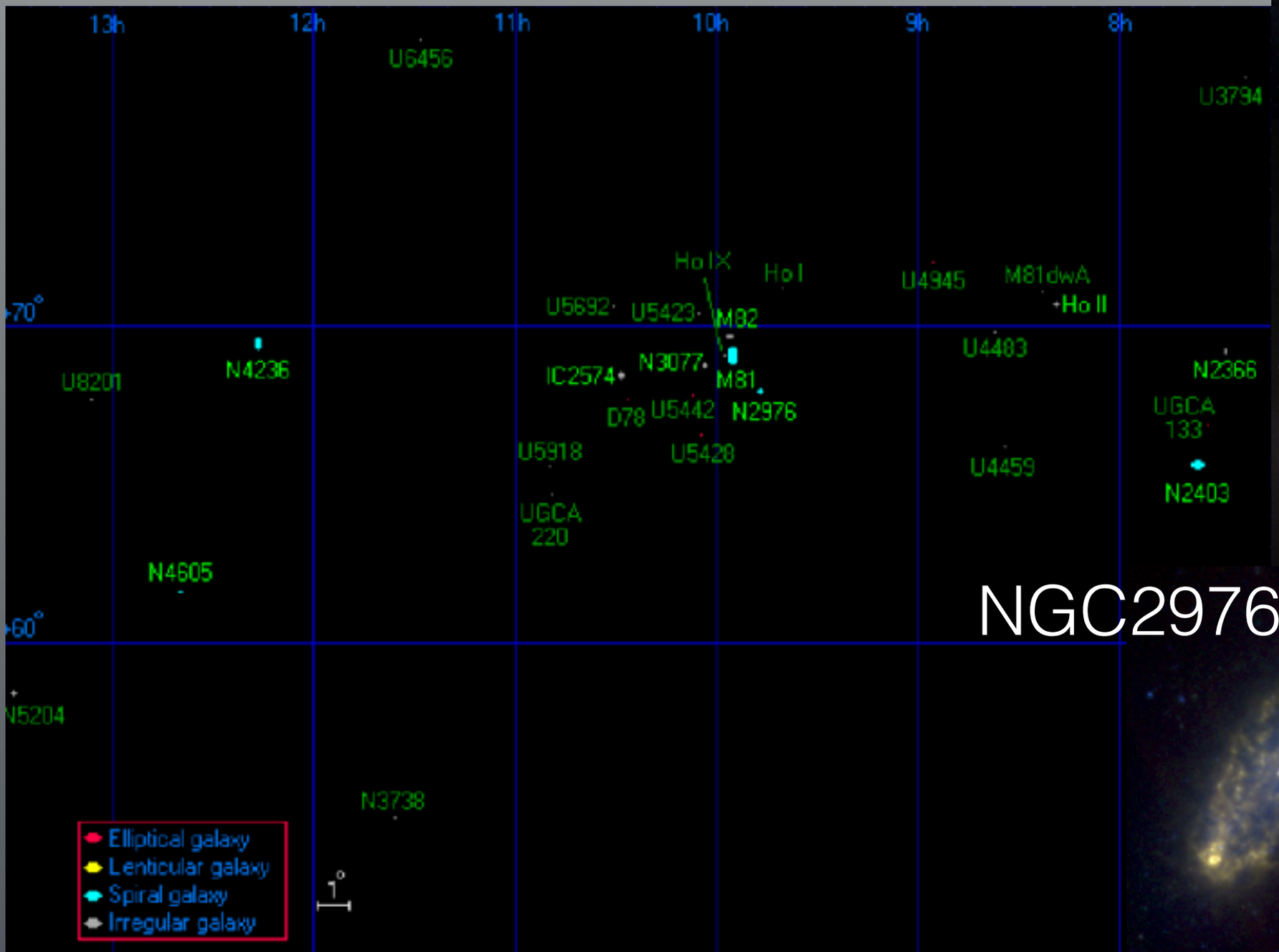






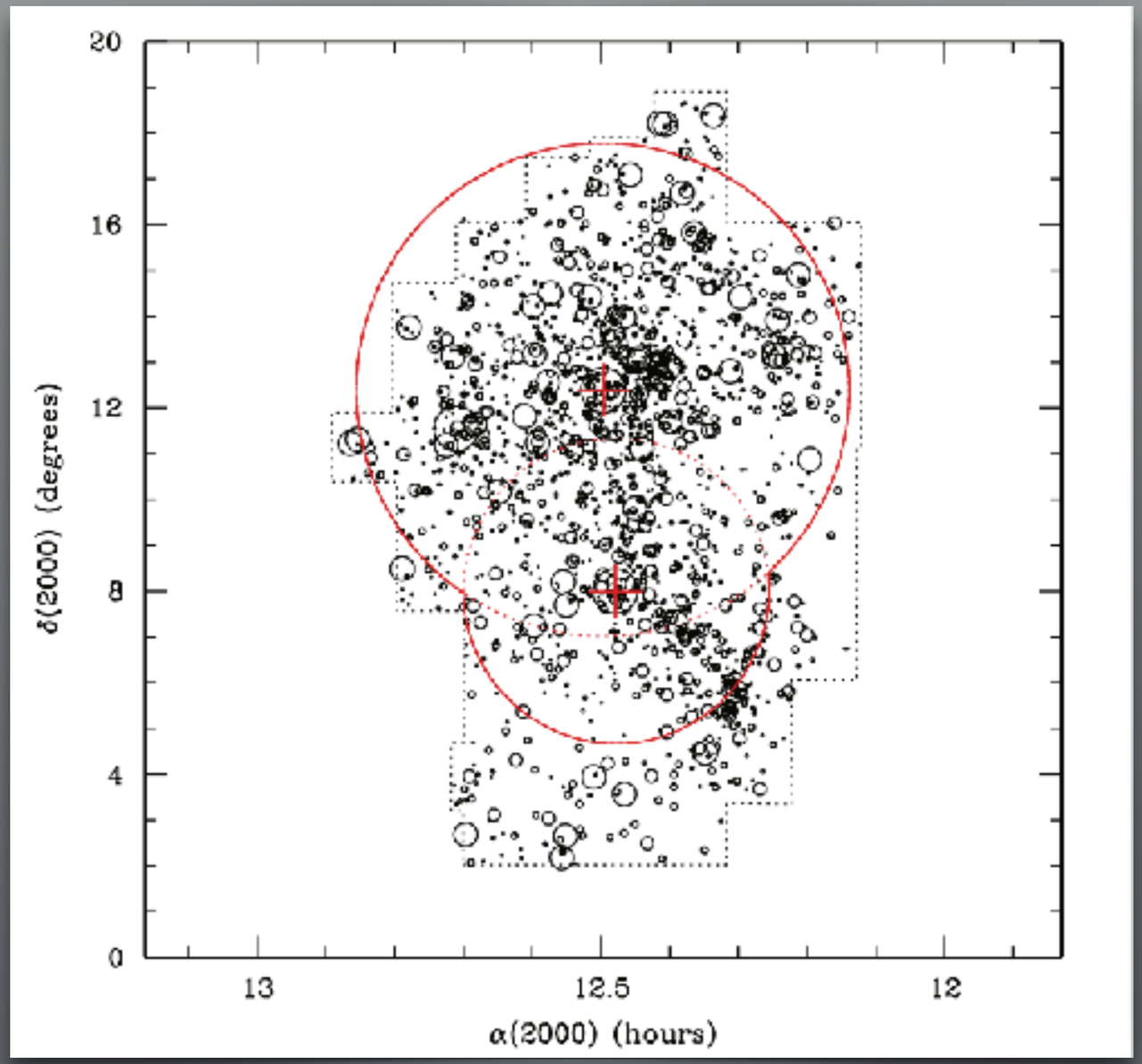
Local groups (d < 11 Mpc)
M81,Maffei,NGC2403, CanesI, M101, NGC672, NGC5194, NGC3115

M81 group: HolmII, IC2574, M82, NGC2976,
NGC3077, NGC3738, NGC4236



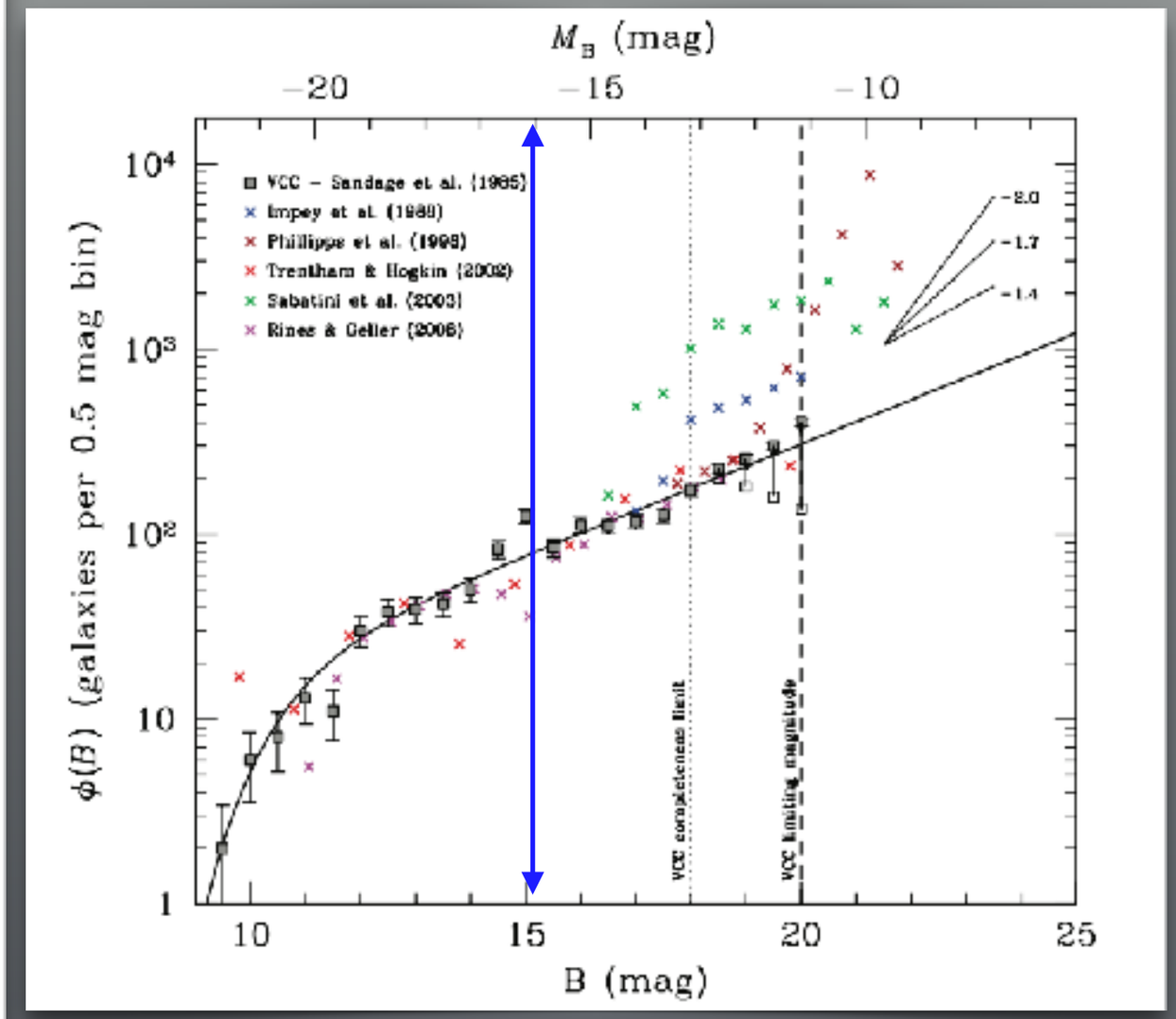
Selection from VCC (Binggeli, Sandage & Tammann 1985)

VCC: 2095 galaxies
complete to M_B < -13



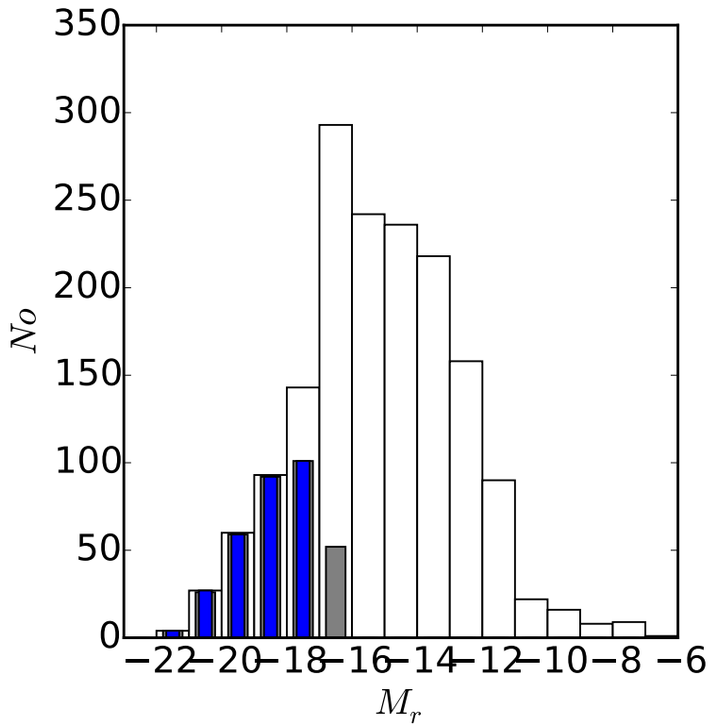
Next Generation of Virgo Cluster survey
SDSS-bands (u, g, r, i, z)

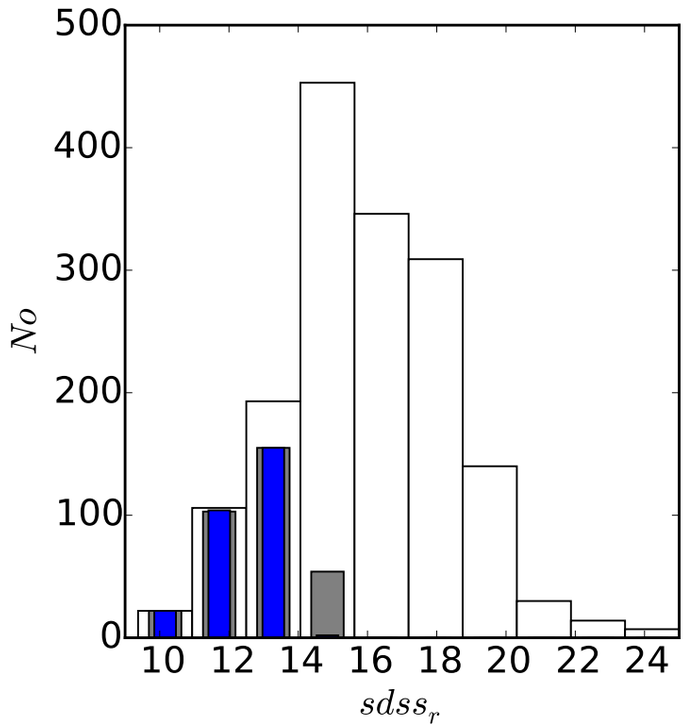
$$\mu_g \sim 29 \text{ mag arcsec}^{-2}$$

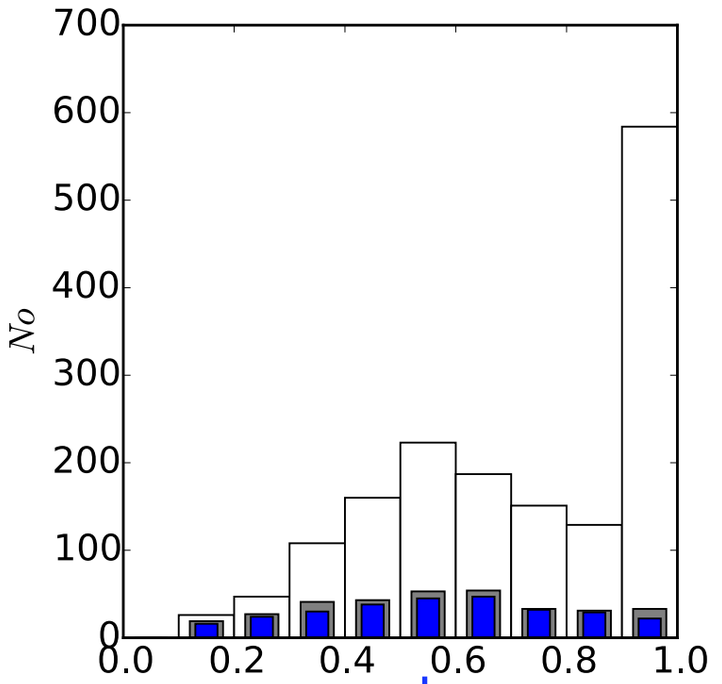


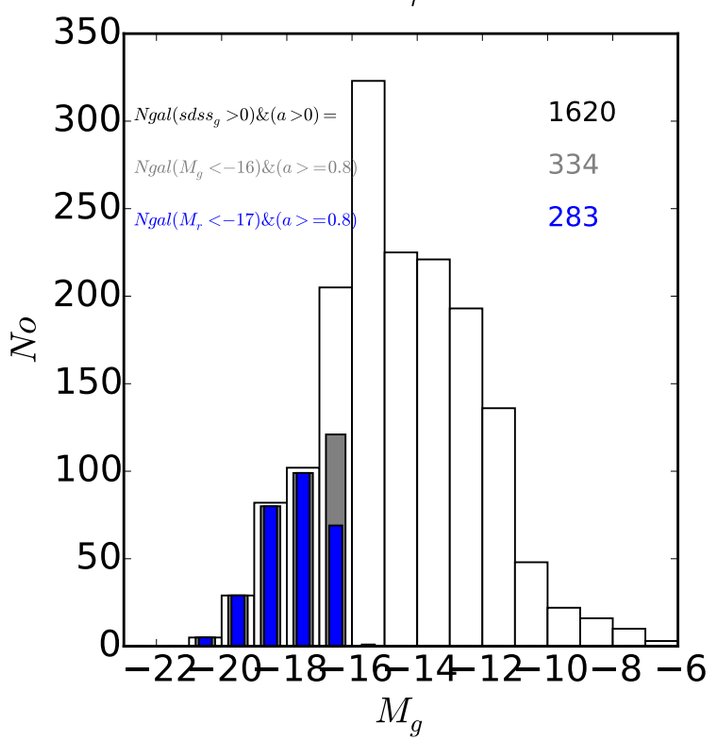
Ferrarese et al. 2012, ApJS, 200

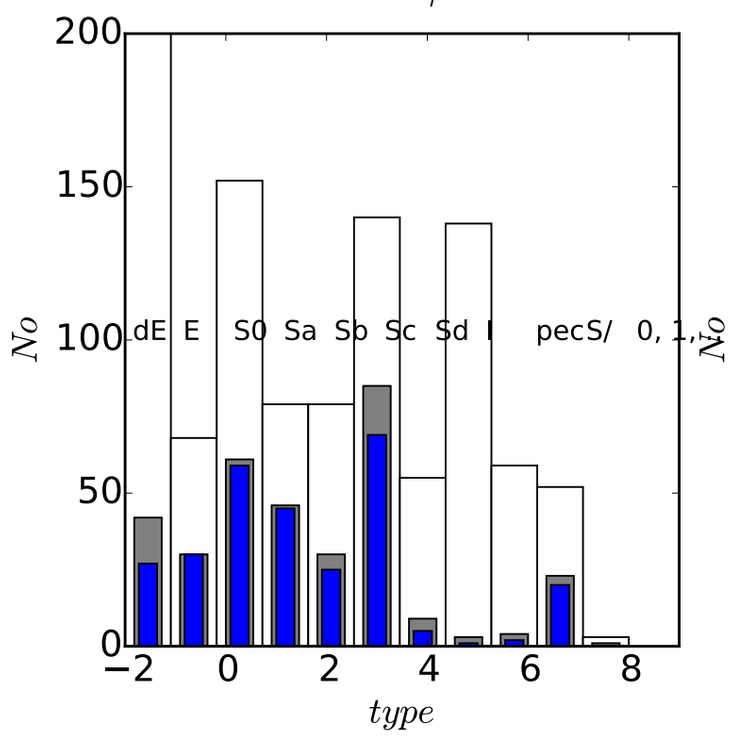
Selection criteria

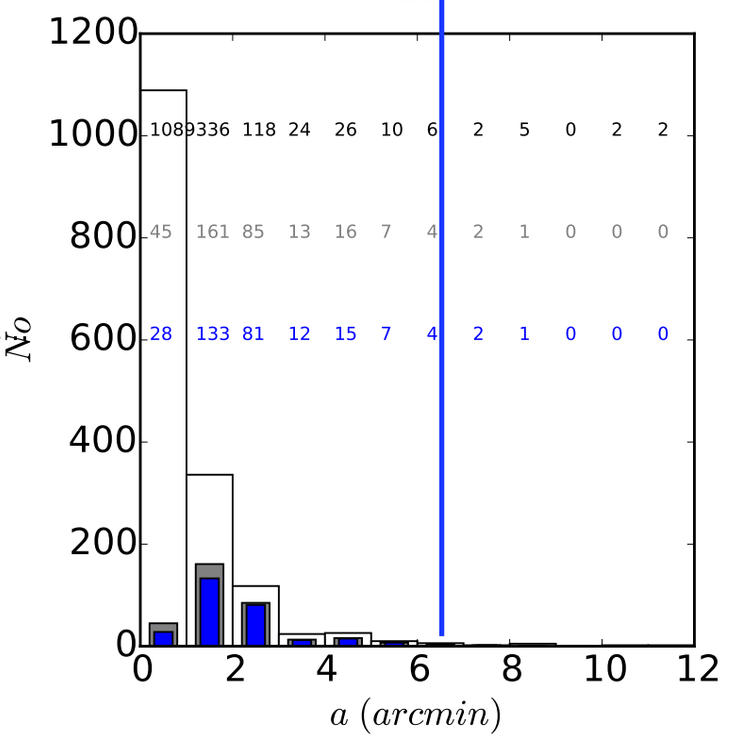








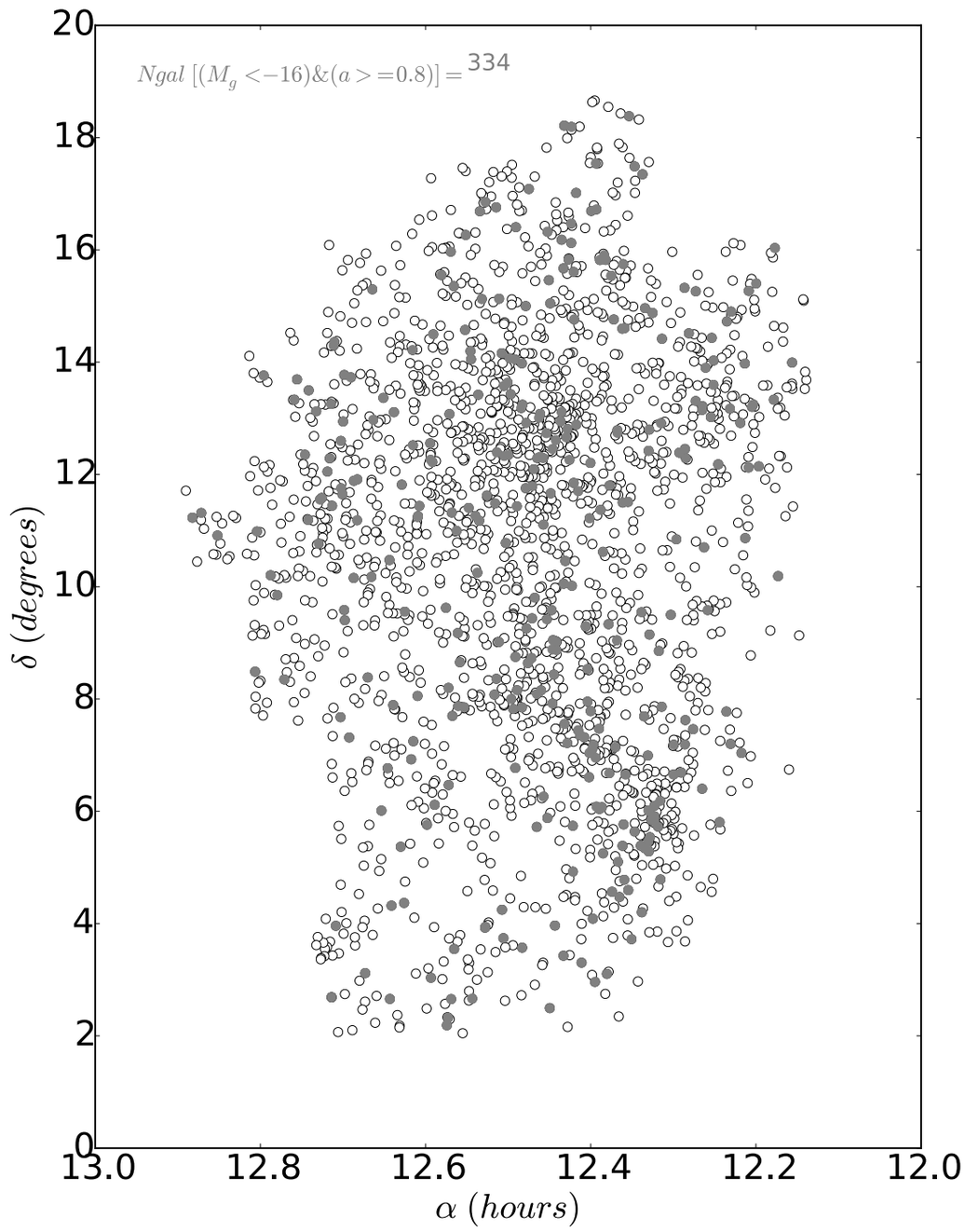


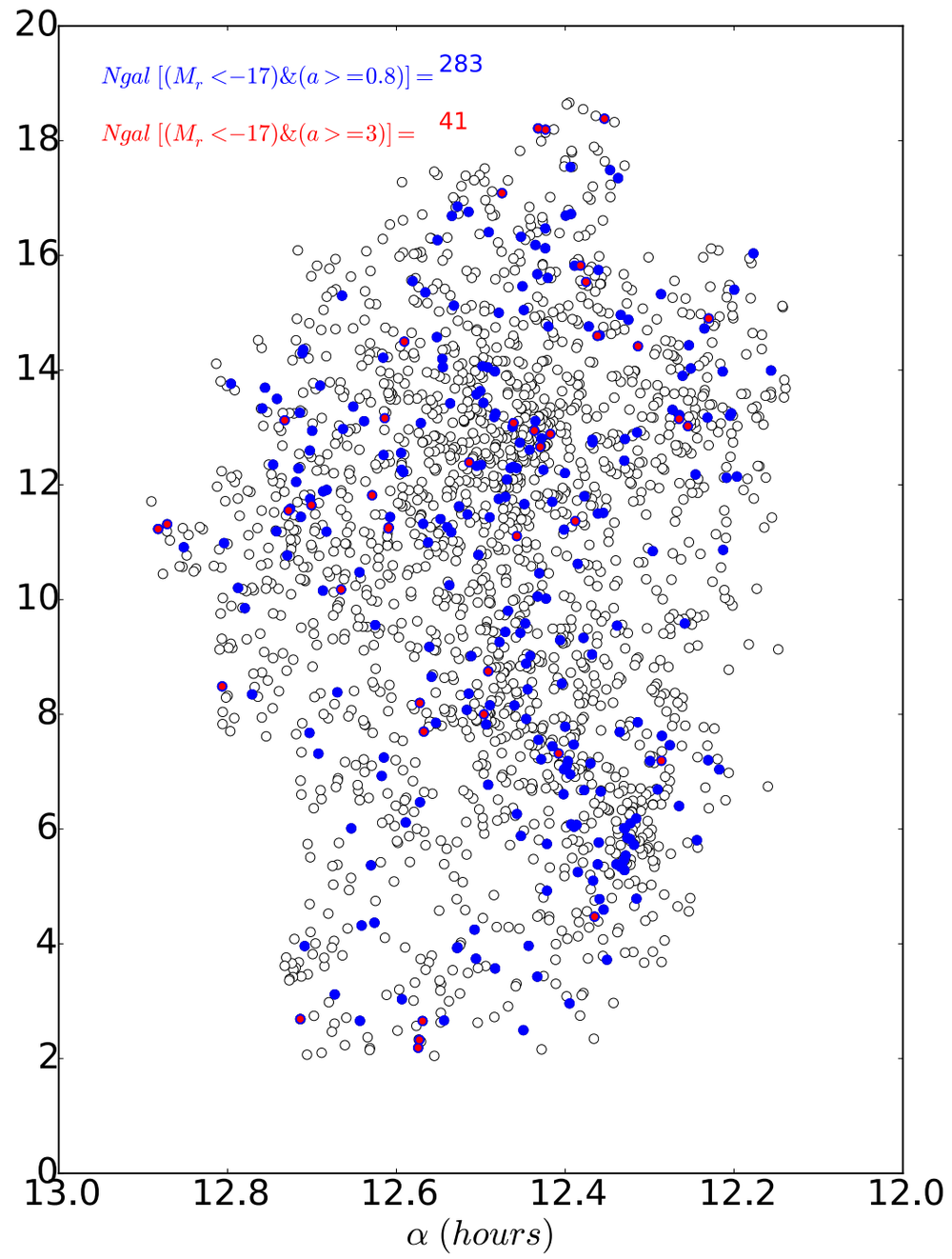


Selection criteria

- M_g < -16 & a > 0.8 arcmin
- Ngal = 334

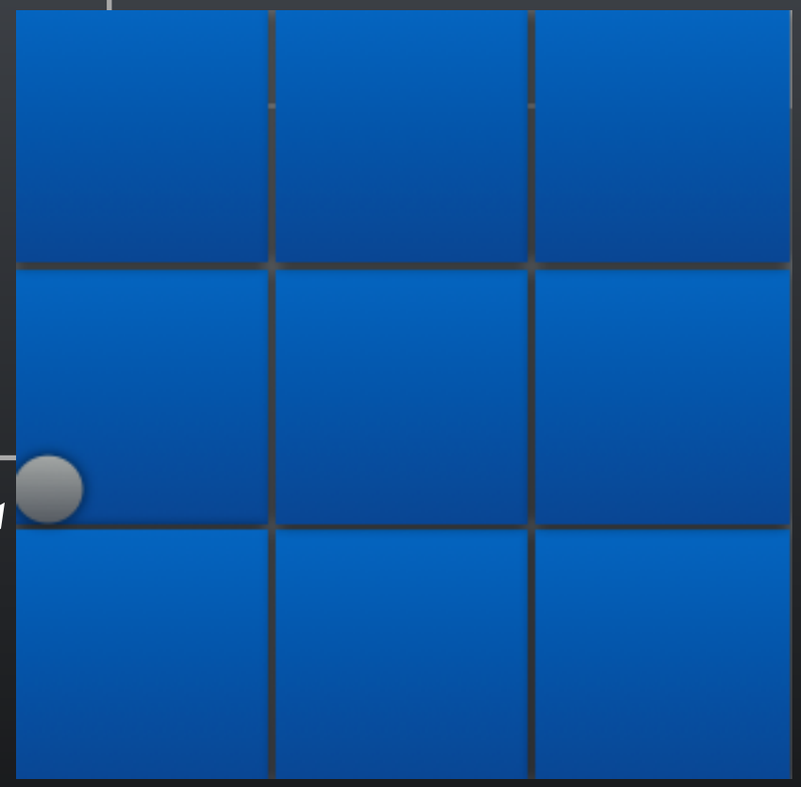
- M_r < -17 & a > 0.8 arcmin
- Ngal = 283





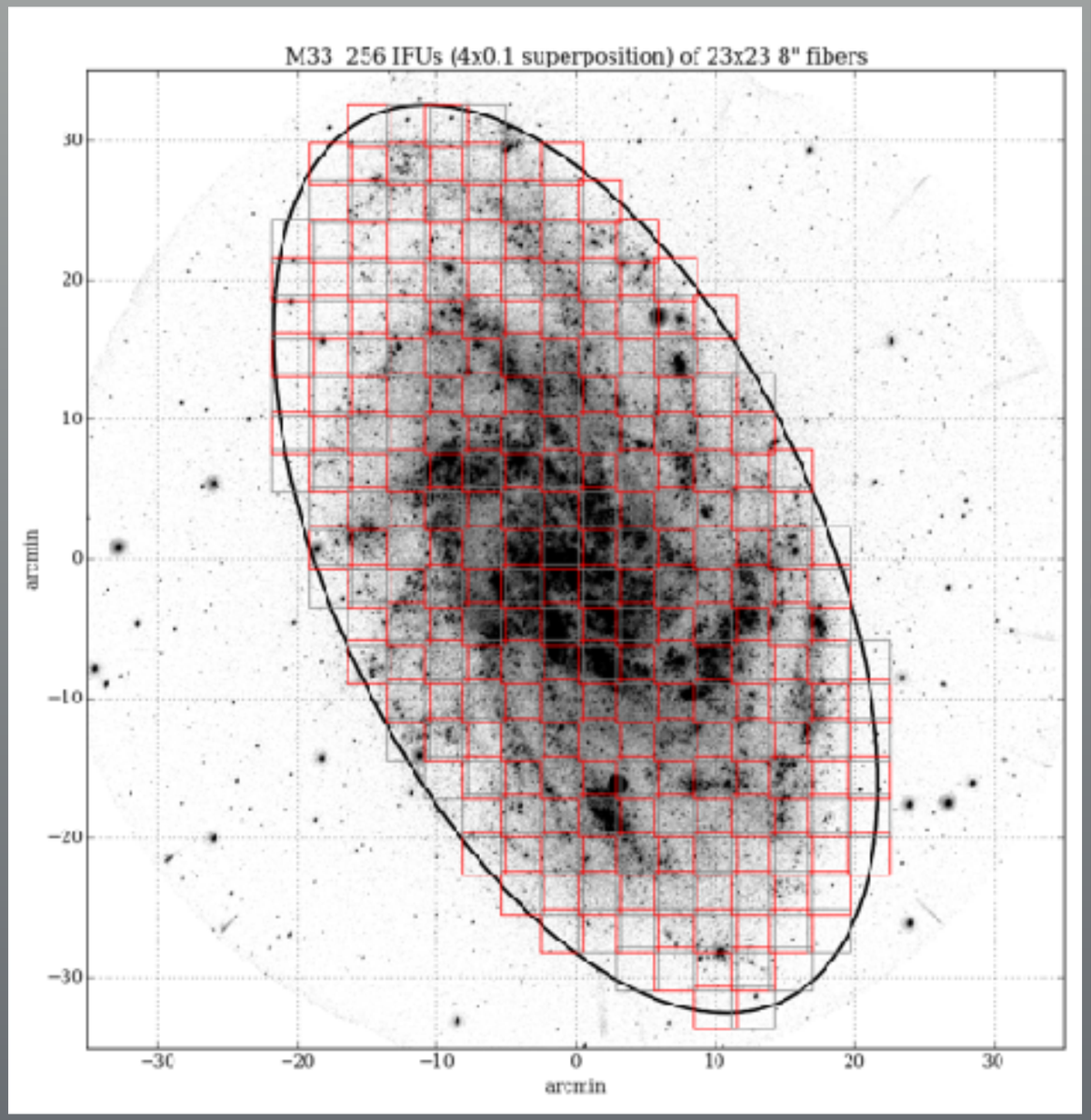
LUCA

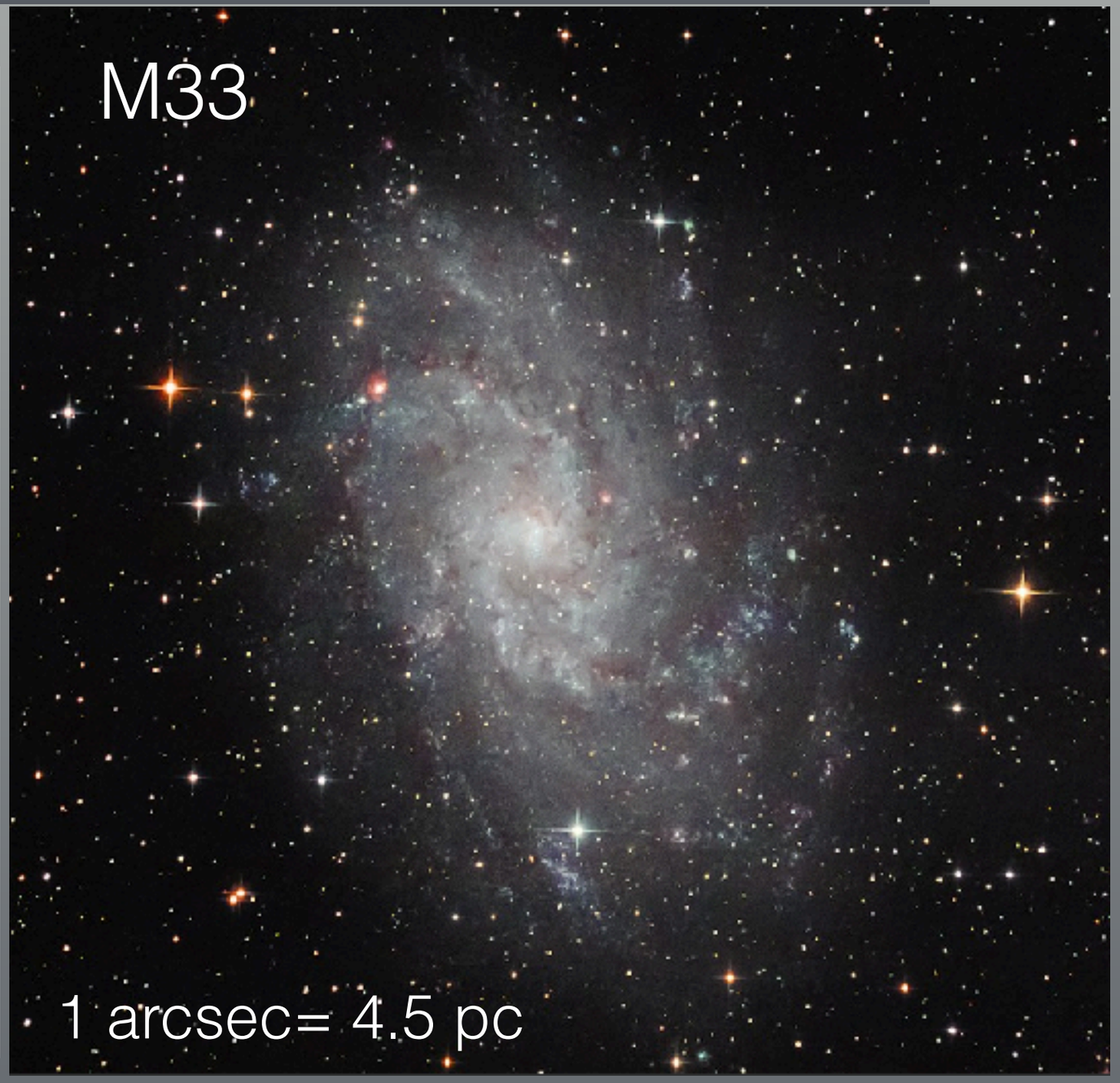
- Local Volume Sample (d < 11 Mpc) + Virgo Cluster
- Ngal ~ 300-500 galx
- 3600 to 7000 A
- R ~2000
- FoV ~3x3 arcmin (continuous)
- fiber size ~2.5 arcsec
- mean distance 7 Mpc (LV): 85 pc
- Virgo: 190 pc



9 cloned spectrographs
FoV = 3x3 arcmin
600 fibers of 2.5 arcsec

Examples of galaxies and numbers of pointings





M33 and M31 can be done with small telescopes, a large FoV, and with fiber of size 8 arcsec
(20-40 pc)
(more than 400 pointings with 2.5x2.5 arcmin FoV)

Local Group

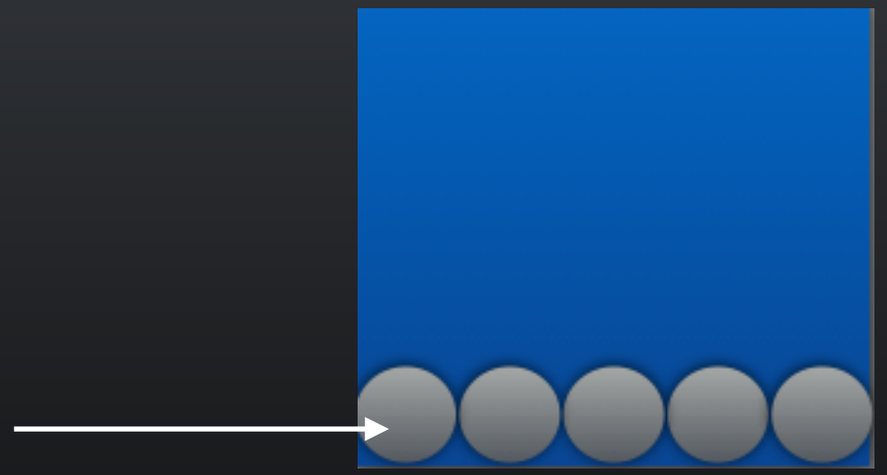
M31 (a_{26} = 190 arcmin)

Leo I
Leo II
Ursa Minor Dwarf
Draco Dwarf
Sextans Dwarf
Milky Way
Carina Dwarf
LMC
SMC
Sagittarius Dwarf
Sculptor Dwarf
Fornax Dwarf
IC 10
And VII
NGC 185
NGC 147
EGB 0427+63
And V
Andromeda Galaxy (M31)
NGC 205
And III
And I
M32
NGC 6822
And II
M33 (a_{26} = 69 arcmin)
Pinwheel
NGC205
(a_{26} = 20 arcmin)
Phoenix Dwarf
Sagittarius Dwarf Irregular
And VI
LGS 3
Aquarius Dwarf
M32 (a_{26} = 9 arcmin)

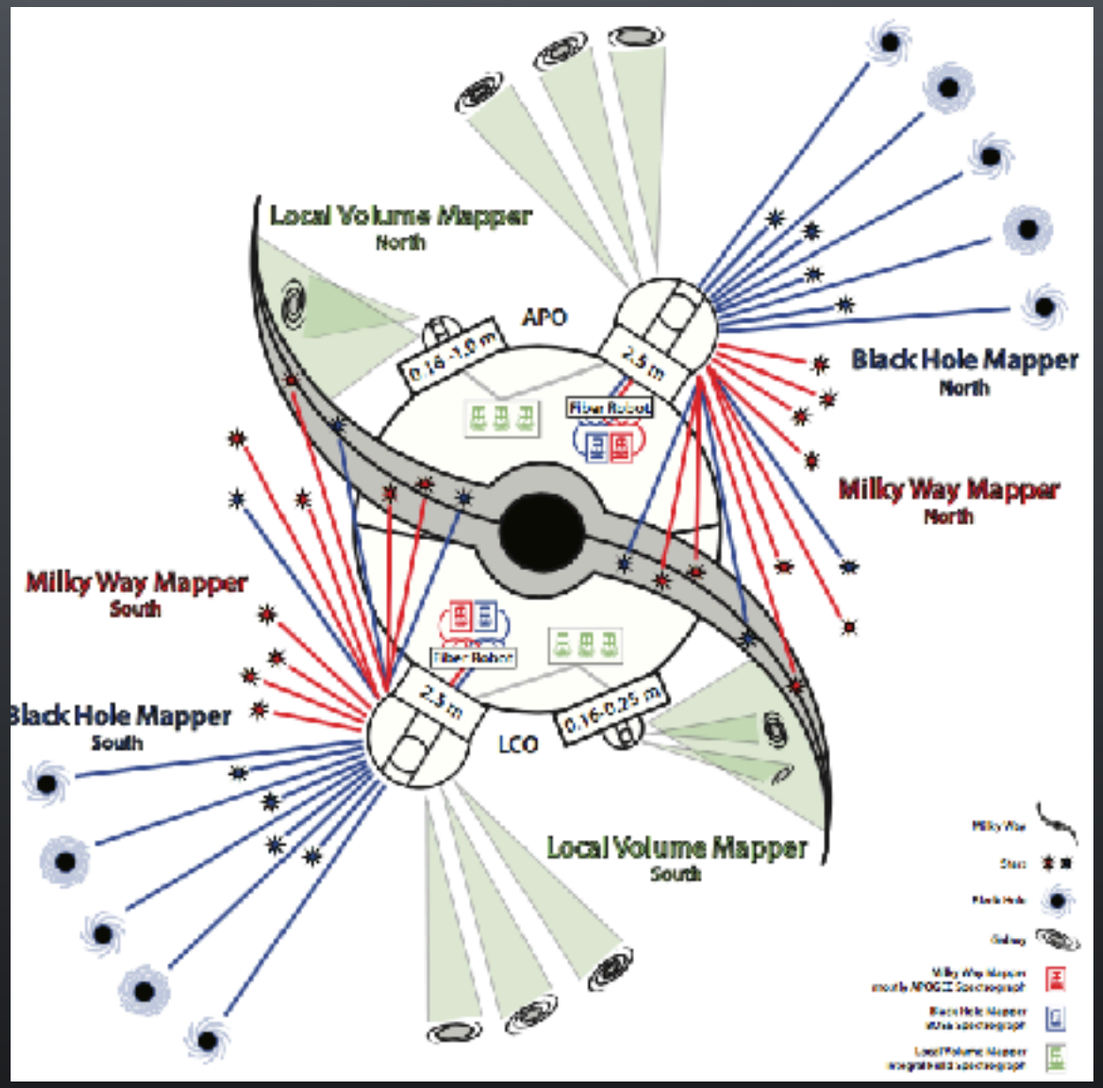
LUCA

- Local group (M33, M31) can be done with Schmidt telescope
- 1 CCD + 1 spectrograph
- resolution : 38 pc (fiber size = 8.5 arcsec)

1 spectrograph
FoV = 3.5x3.5 arcmin
600 fibers of 8.5 arcsec

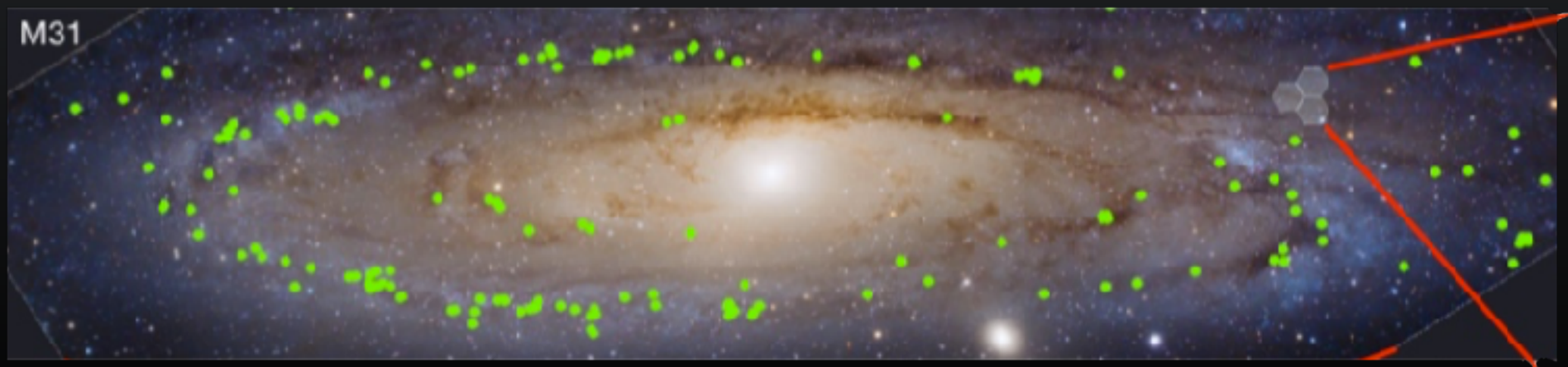


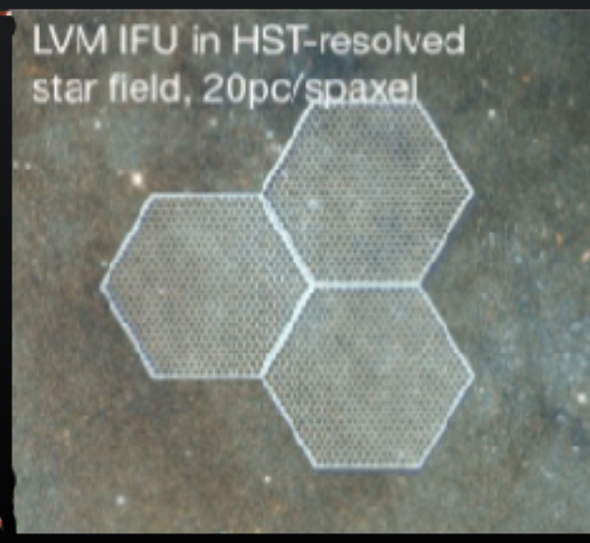
The closest competitor beyond 2020: SDSS-V



Local Volume mapper:

- MW, LMC, SMC
- M31, M33 and other galaxies out to 5Mpc:
  - sparse IFS sampling
  - statistical samples of HII regions at 20 pc resolution in M31 and ~50pc in other galaxies
- At each hemisphere: ~2000 fibers feed 3 spectrographs at R~4000, 3600-10000Å





Niche for a Large-IFS at 3.5m CAHA

Niche for a Large-IFS at 3.5m CAHA

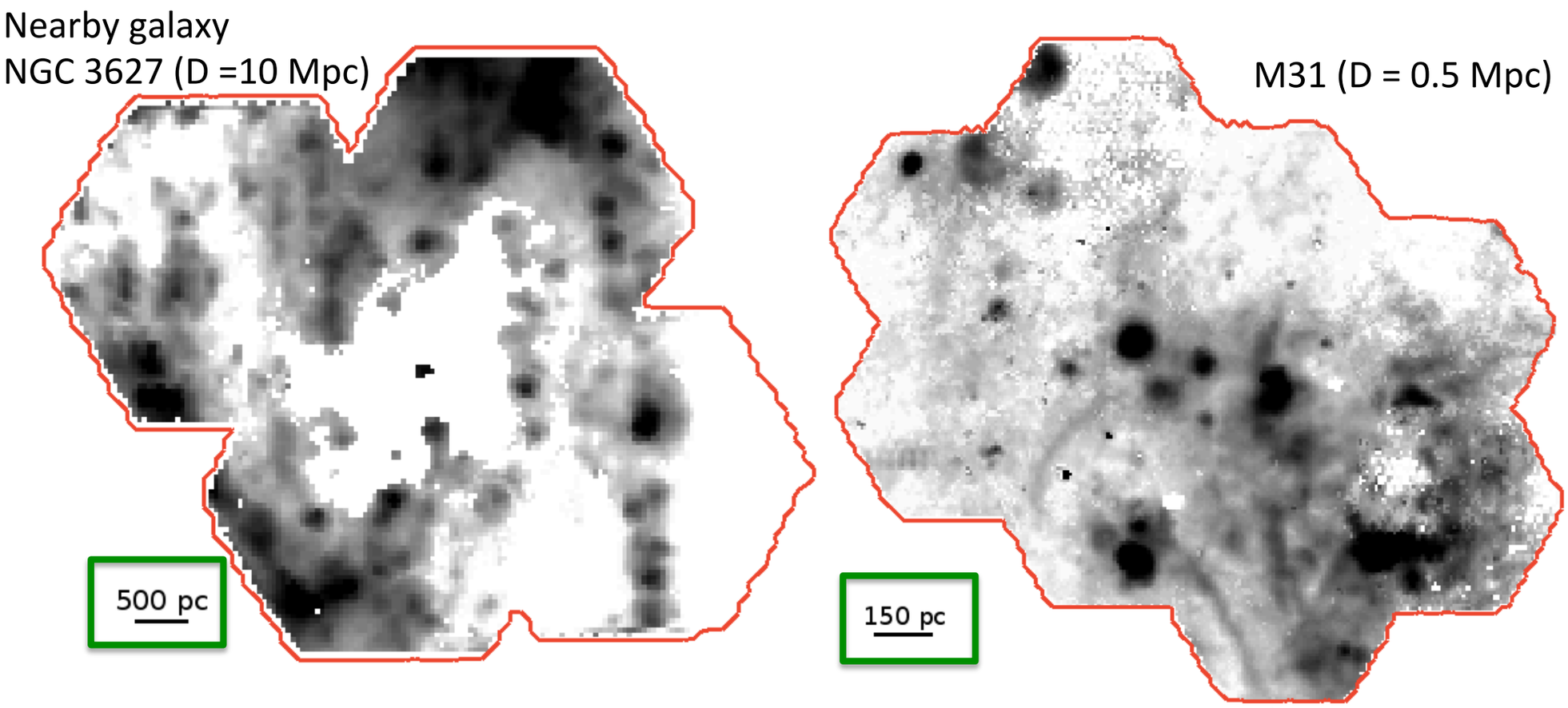
Develop:

- Additional scientific cases with the survey data
- Additional scientific cases with additional data

Kathryn Kreckel (MPIA)

Optical IFU maps of nearby galaxies enable us to

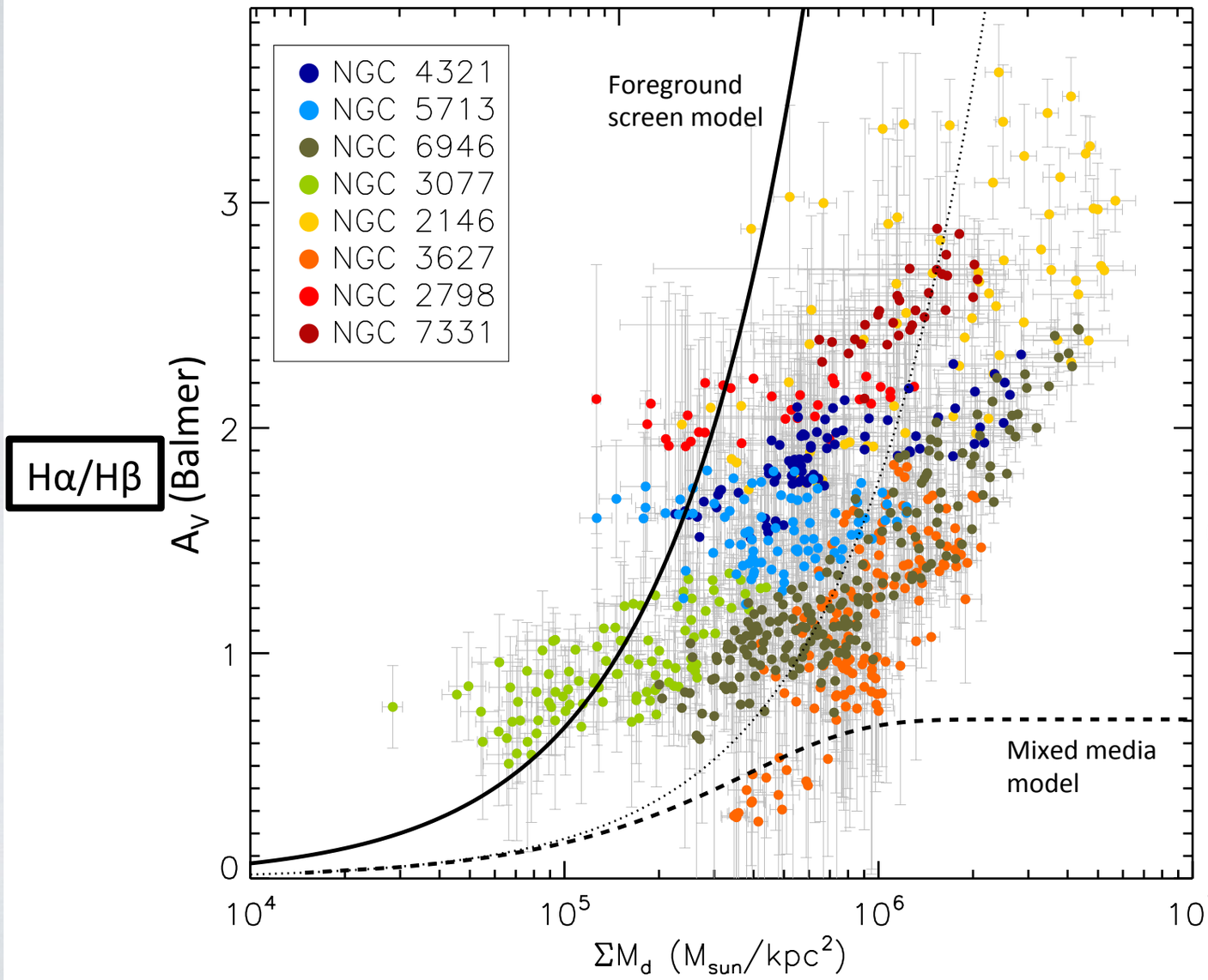
- resolve HII regions
- reveal & resolve the diffuse ionized gas
- map dust within galaxies



Observed using PMAS/PPAK at Calar Alto

Balmer line reddening as a dust tracer

Kreckel et al. 2013



Nearby galaxies
200-700 pc scales

Dust geometry on 500pc scales complicates modeling

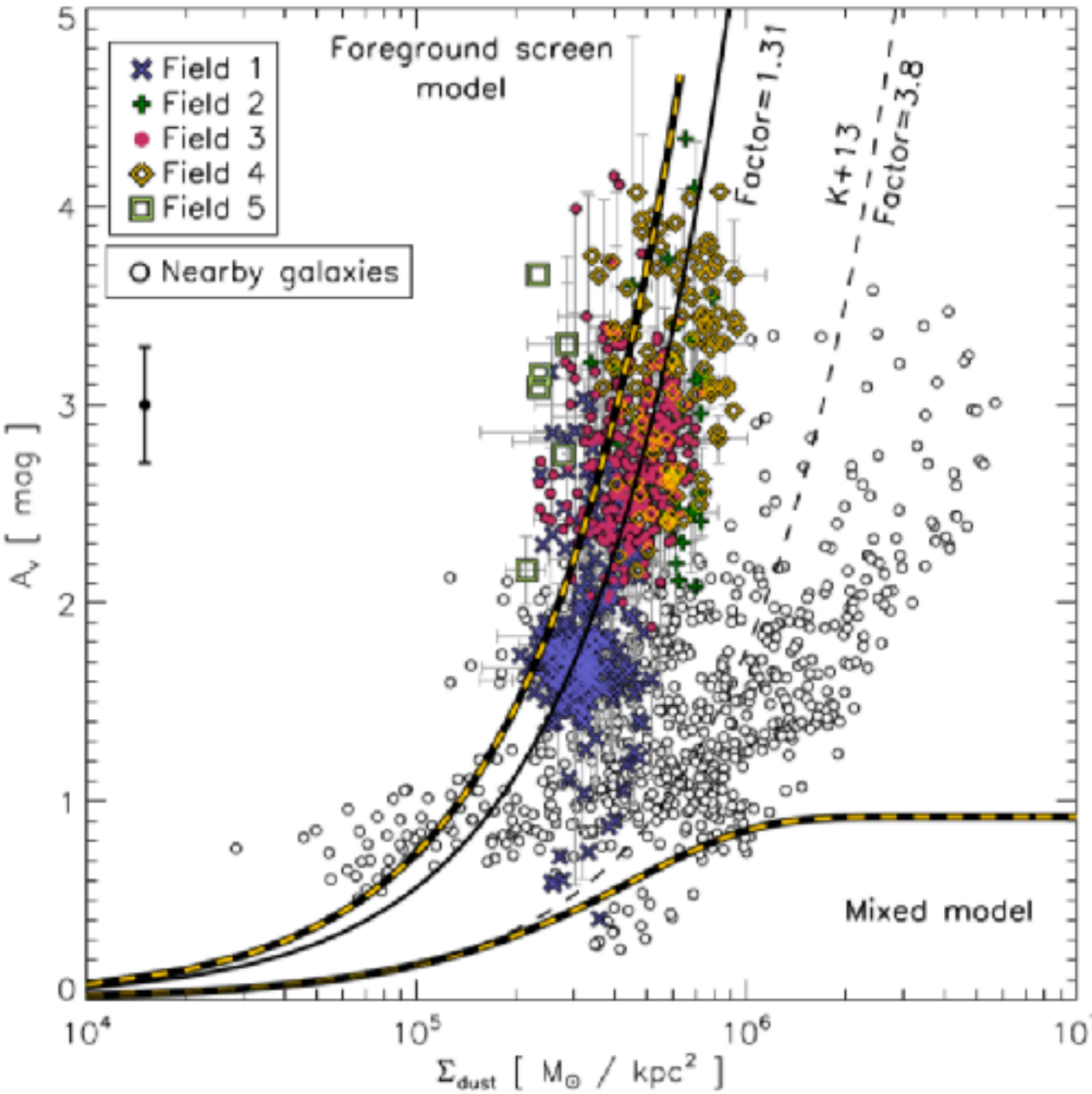
Far-IR SED modeled dust mass (KINGFISH, Aniano et al. 2012)

FIR Herschel

Balmer line reddening as a dust tracer

Tomicic+2017

M31
100pc scales

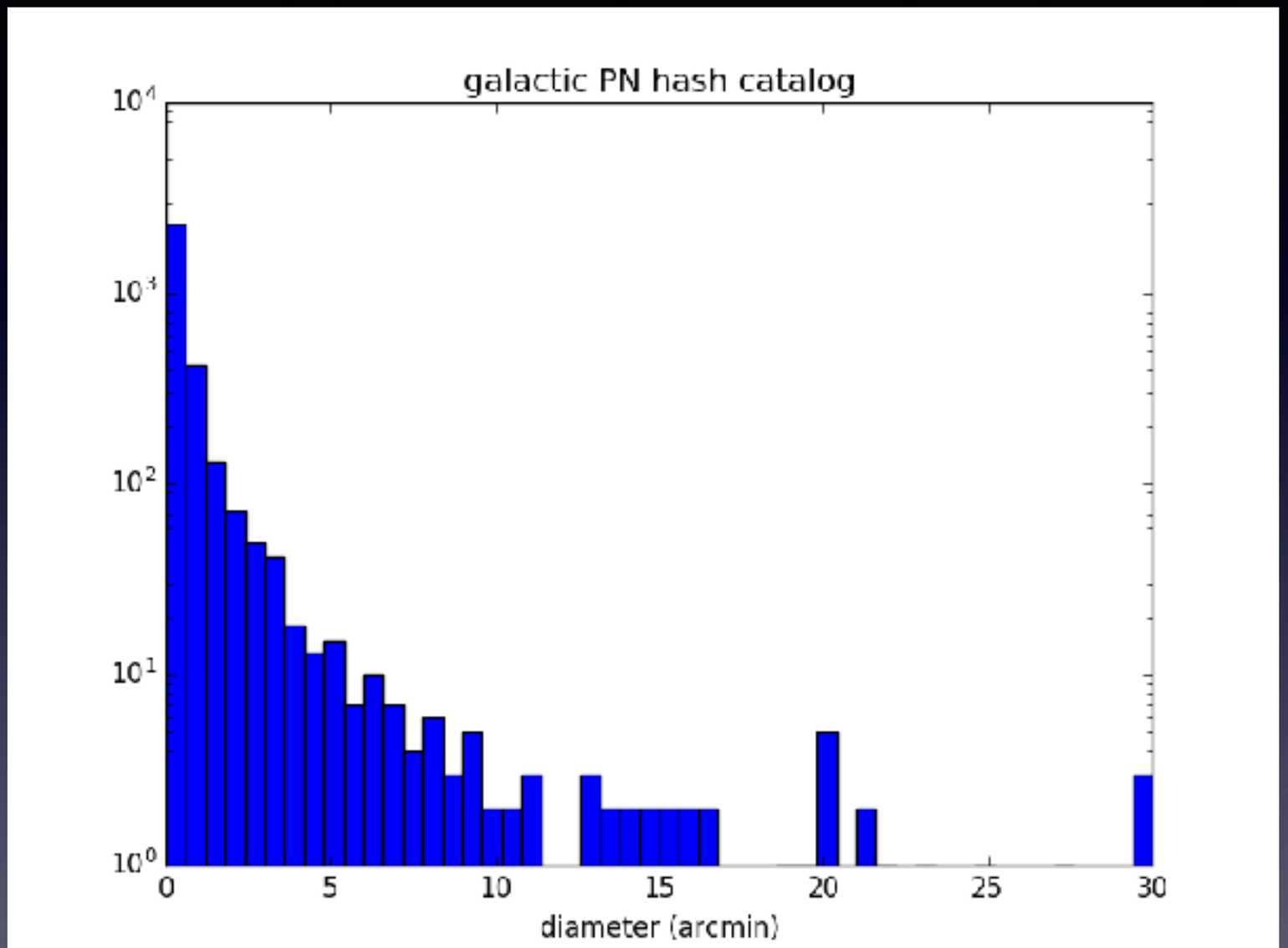


Dust **well modeled** by a foreground screen at 100pc spatial scales

Kathryn Kreckel (MPIA)

M33 is ideal:
-high (32 pc) spatial scales
-low metallicity environment
-existing extensive multi-wavelength coverage
-high (50 pc) resolution CO maps (Rosolowsky et al. 2007)

Enables studies of **HII regions** and **dust** at the spatial scales relevant for understanding the **physics** of star formation


galactic PN hash catalog
10^4
10^3
10^2
10^1
10^0
0
5
10
15
20
25
30
diameter (arcmin)

www.apc.univ-paris7.fr/~semikoz/ASTRONET/ASTRONET_talk/Devriendt.pdf

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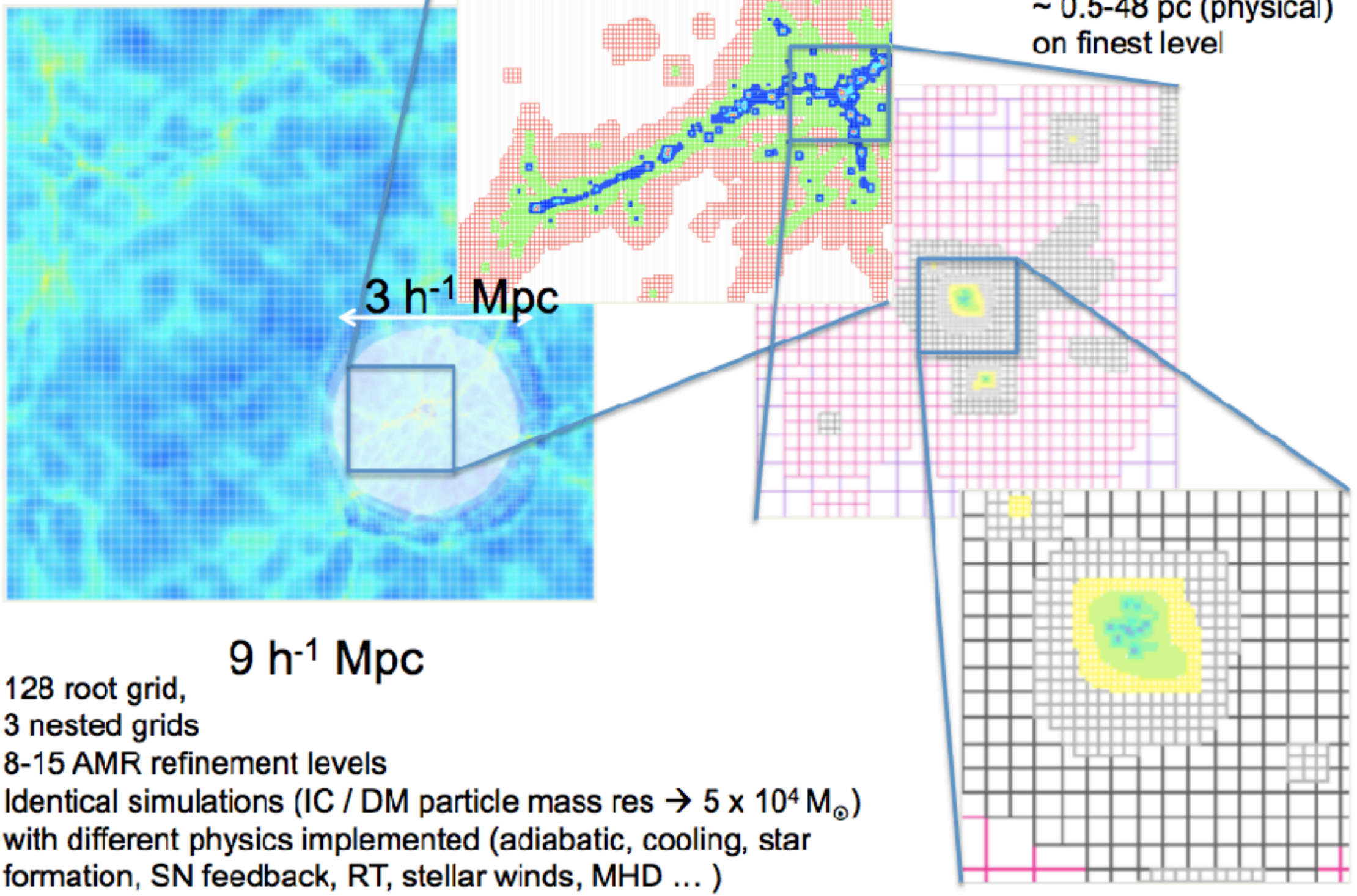
AMR NUT ( )

« re-simulations »

spatial resolution
~ 0.5-48 pc (physical)
on finest level



128 root grid,
3 nested grids
8-15 AMR refinement levels
Identical simulations (IC / DM particle mass res → 5 x 10^4 $M_\odot$)
with different physics implemented (adiabatic, cooling, star formation, SN feedback, RT, stellar winds, MHD …)