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TAIPAN
PLANS AND PROGRESS

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www.taipan-survey.org

A COMPLETE REFURBISHMENT OF THE UK SCHMIDT TELESCOPE

- 1.2m telescope at Siding Spring Observatory (SSO): originally built c1973 and operated by the UK; reverted to Australian Astronomical Obs. (AAO) in 2010; known for Southern Sky Survey, 6dFGS, and RAVE.
- A new, fixed-format, dual-arm spectrograph providing continuous 3700–8700 Å coverage at $R > 2100$
- 6 deg FOV; rapidly reconfigurable (design goal: 5 min) with up to 300 autonomous ‘starbug’ fibre positioners.
- Set up for remote and/or fully automated operations.

HEADLINE SCIENCE GOALS FOR THE TAIPAN GALAXY SURVEY

- a 1% measurement of the Hubble parameter at $z < 0.3$ from BAO (i.e. independent of other experiments).
- a 5% measurement of the growth rate parameter from redshift space distortions and peculiar velocities.
- in combination with SkyMapper, VHS, WISE, and Wallaby: a unique laboratory for exploring the lifecycle of baryons within galaxies as a function of mass and environment.
- ~10 % of time allocated/earmarked for ancillary science.

Taipan white paper: da Cunha et al. (2017)

TECHNICAL GOALS FOR THE TAIPAN GALAXY SURVEY

- SDSS-like: an optically-selected ($i < 17$) legacy sample
- >1.5M galaxy redshifts across the Southern hemisphere (2π steradians; dec < 15°; excluding low Galactic latitudes)
- Different S:N requirements for different samples
- mean target density ~100/sq.deg. means ~25 pass survey
  - enables revisits of selected targets to build signal:noise
  - near-total spectroscopic completeness (significant!)

Taipan white paper: da Cunha et al. (2017)

PRIORITY SCIENCE GOALS FOR THE TAIPAN GALAXY SURVEY

- *In first 12-18 months of science operations:*
- a 2% measurement of the Hubble parameter at $z < \sim 0.3$ (2MASS selected bright and red galaxies).
- peculiar velocities for ~25000 early type galaxies at $z < 0.1$ (selected based on 6dFGRS redshifts).
- full completeness over >1500 sq. deg., including WAVES regions and SDSS-Taipan overlap.
- ~10 % of time allocated/earmarked for ancillary science.

Taipan white paper: da Cunha et al. (2017)

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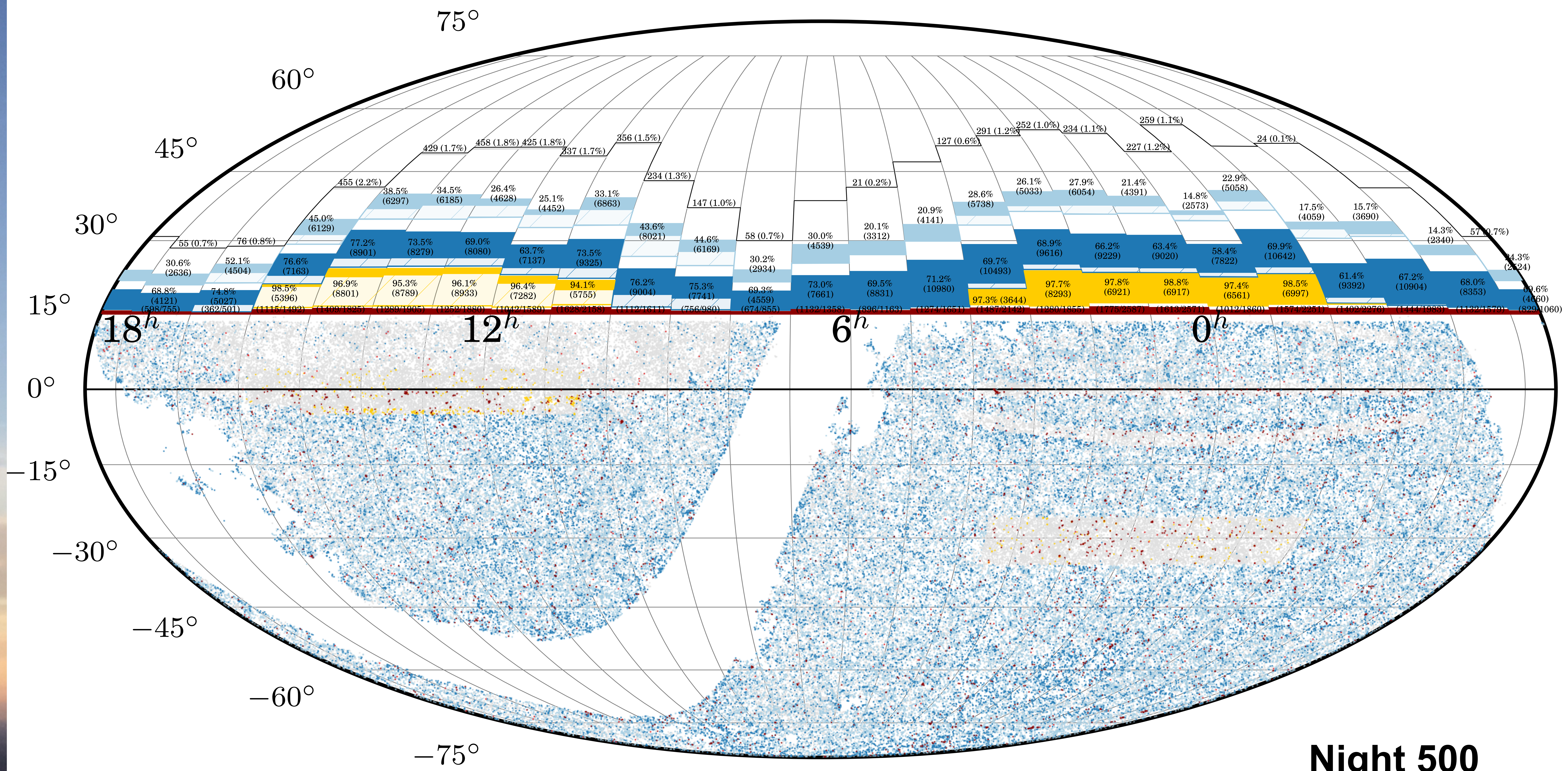

Night 500

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TAIPAN GALAXY SURVEY EXECUTION

- Comprehensive survey logic, including nightly (if not hourly) updated target priorities, and per-object success criteria
  - e.g. BAO targets prioritised by (J-K) colour; vpec targets by z;
  - always revisit a low S:N spec target, but never revisit a BAO redshift failure;
  - S:N ~ 10 for $z < 0.1$ vpec targets; S:N ~ 3 for $z < 0.05$ galaxies.
- Natural balance of sparse sampling and high completeness science.
- Staged survey execution, with clear annual/seasonal milestones.
- Scheduling naturally leads to ~optimal observing (i.e. near zenith).

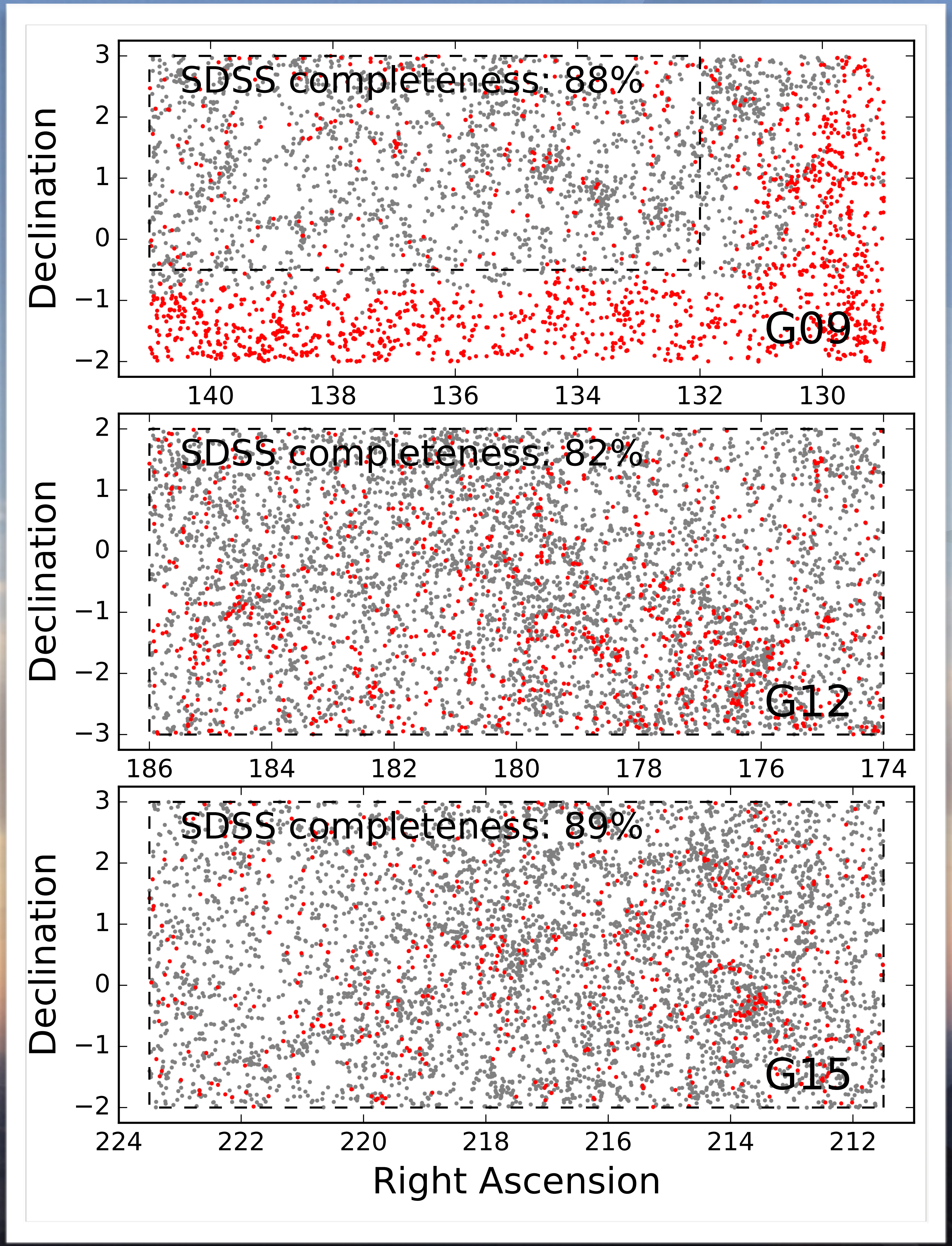
TAIPAN AS A LABORATORY TO STUDY THE BARYON CYCLE AS A FUNCTION OF MASS AND ENVIRONMENT

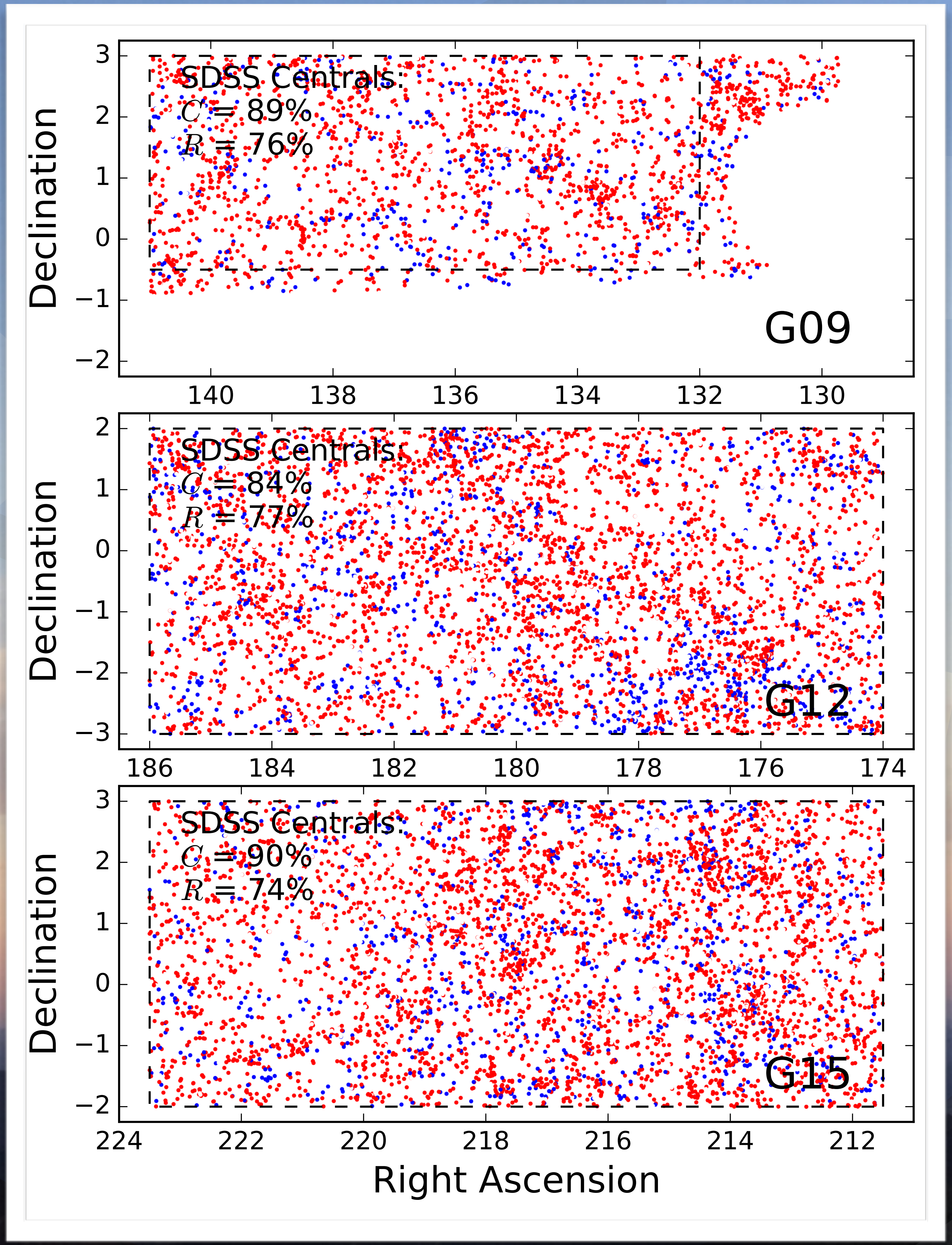
- *Taipan spectra*: redshifts, group/env. metrics, halo masses
- *SkyMapper optical*: stellar populations and stellar masses
- *VHS near infrared*: stellar masses, sizes, morphology
- *WISE mid infrared*: stellar masses, star formation rates, AGN
- *EMU radio continuum*: star formation rates, AGN luminosities
- *WALLABY 21cm*: total HI mass, plus resolved intragroup HI

THE VALUE OF NEAR-TOTAL REDSHIFT COMPLETENESS

gray:
has SDSS spec-z

red:
no SDSS spec-z
(fibre collisions)





red:
SDSS centrals
(Yang+05)

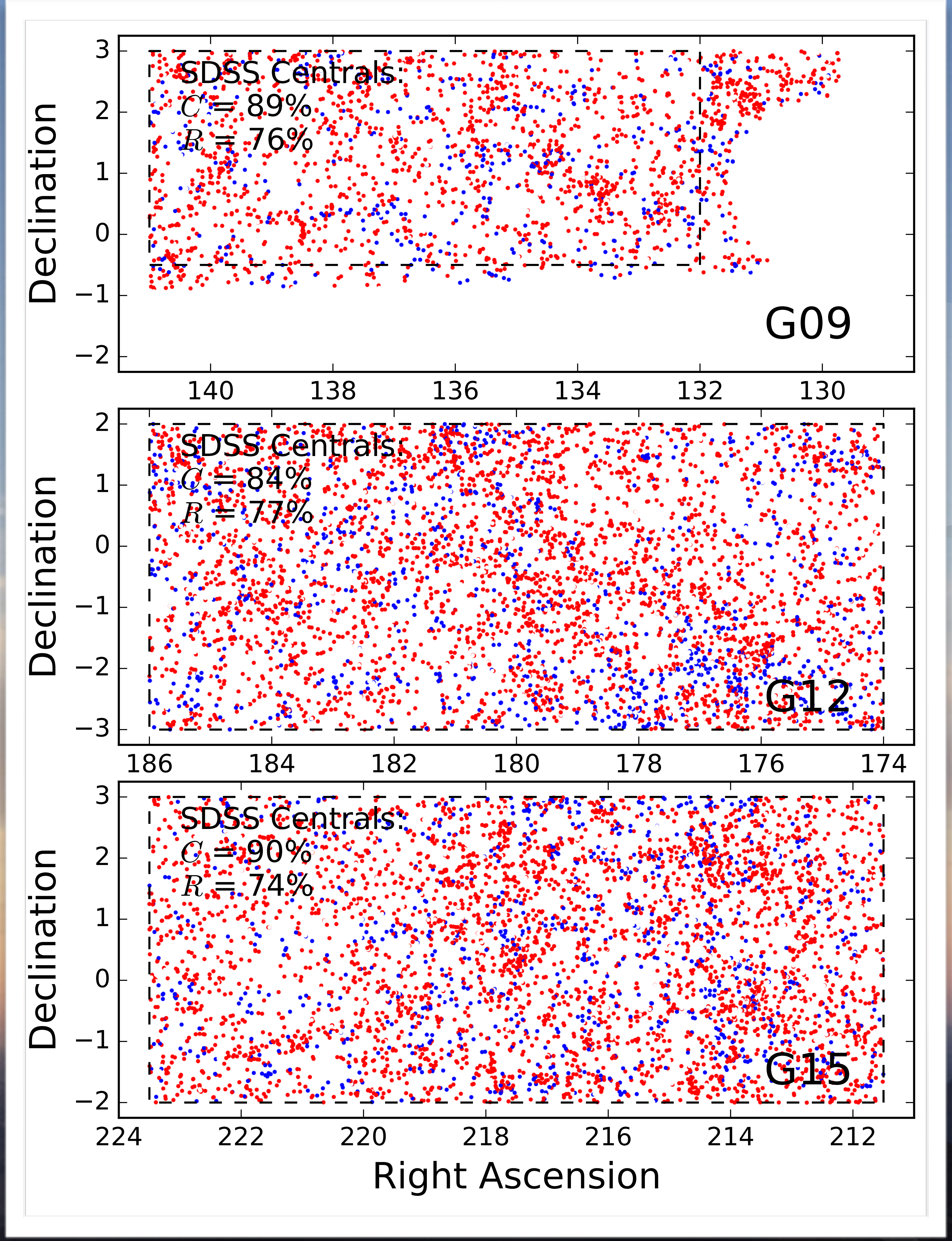
blue:
has SDSS spec-z

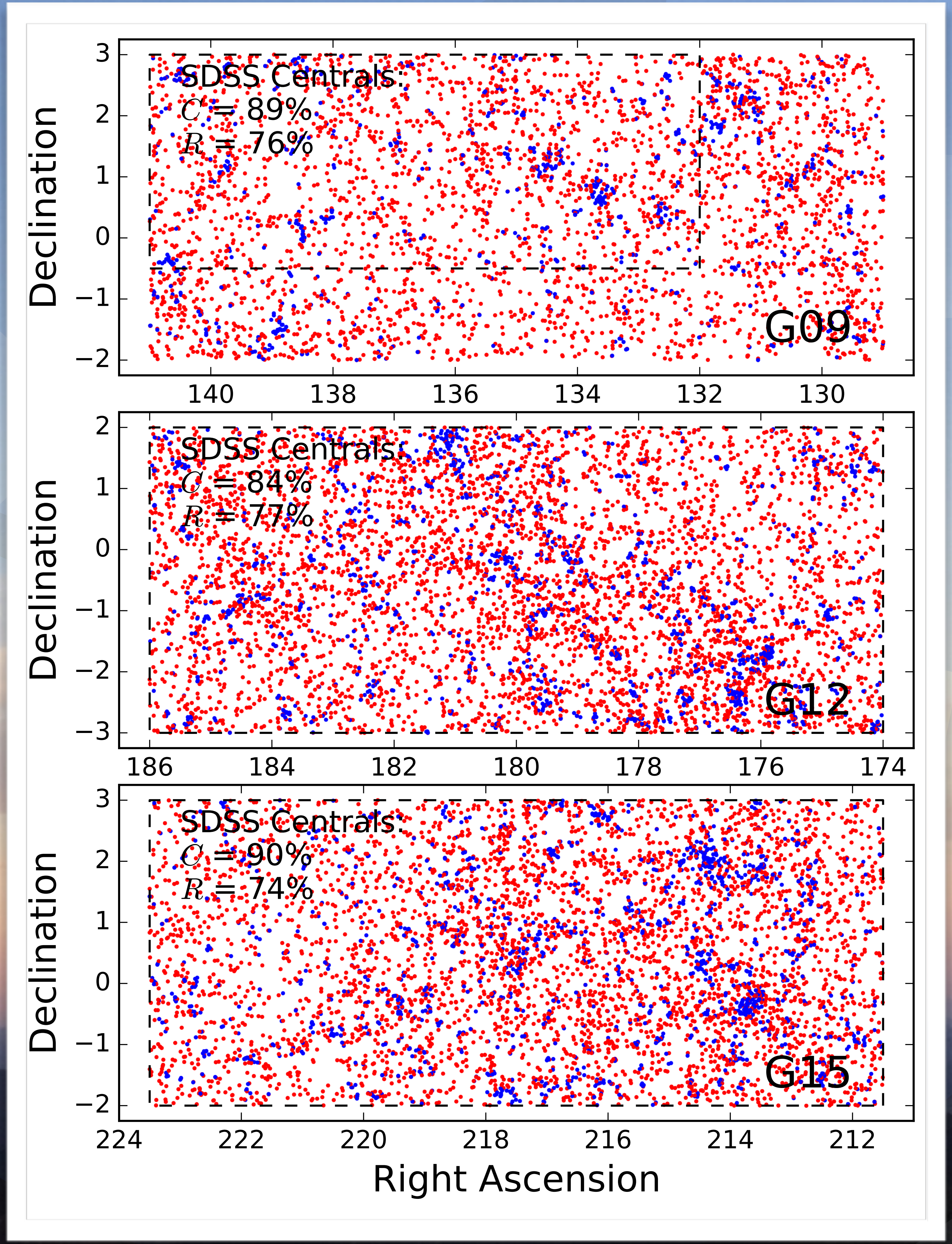
THE VALUE OF NEAR-TOTAL REDSHIFT COMPLETENESS

red:
SDSS centrals
(Yang+05)

blue:
has SDSS spec-z

r < 17.8;
z < 0.2





red:
GAMA centrals
(Robotham+10)

blue:
GAMA satellites

r < 17.8;
z < 0.2

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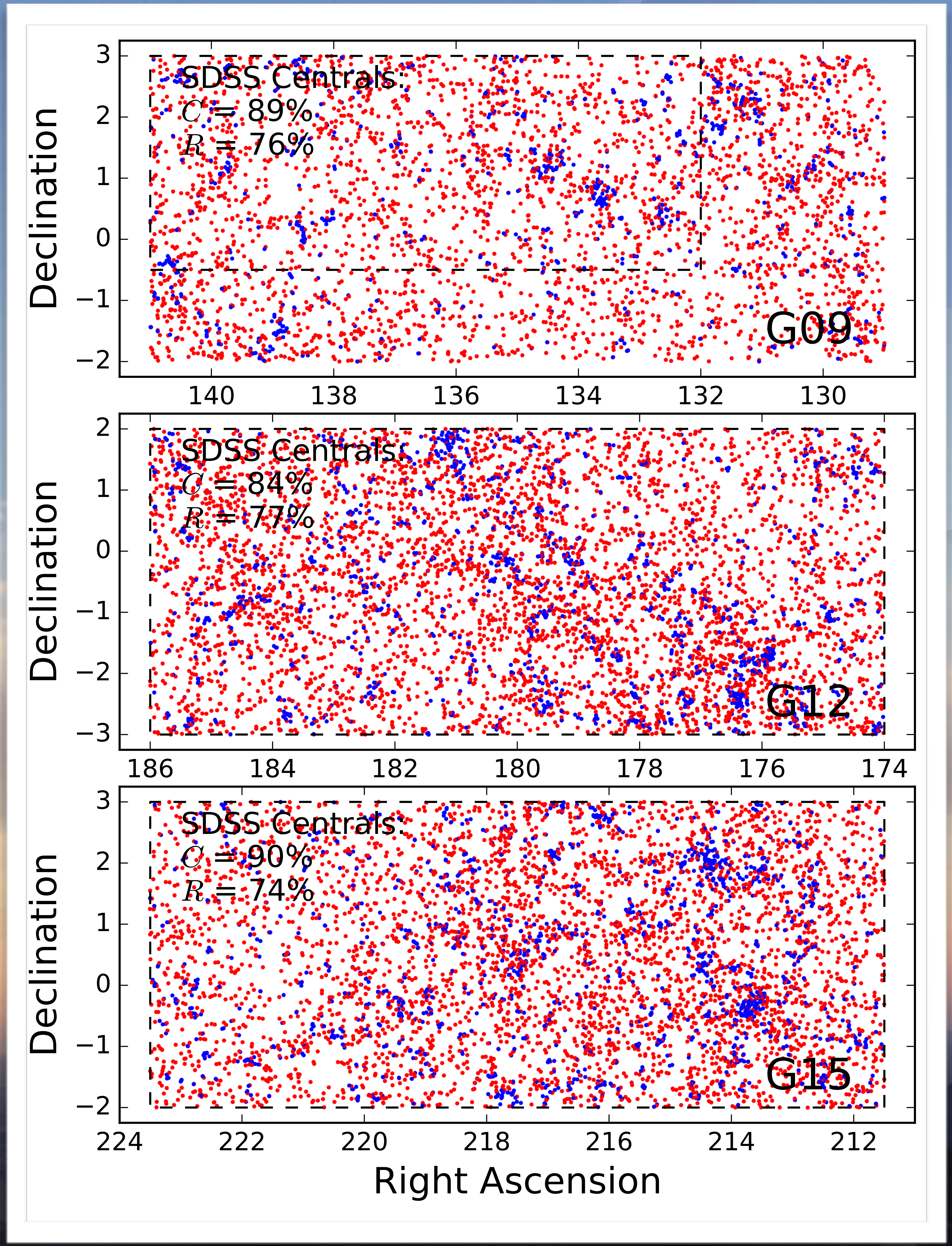
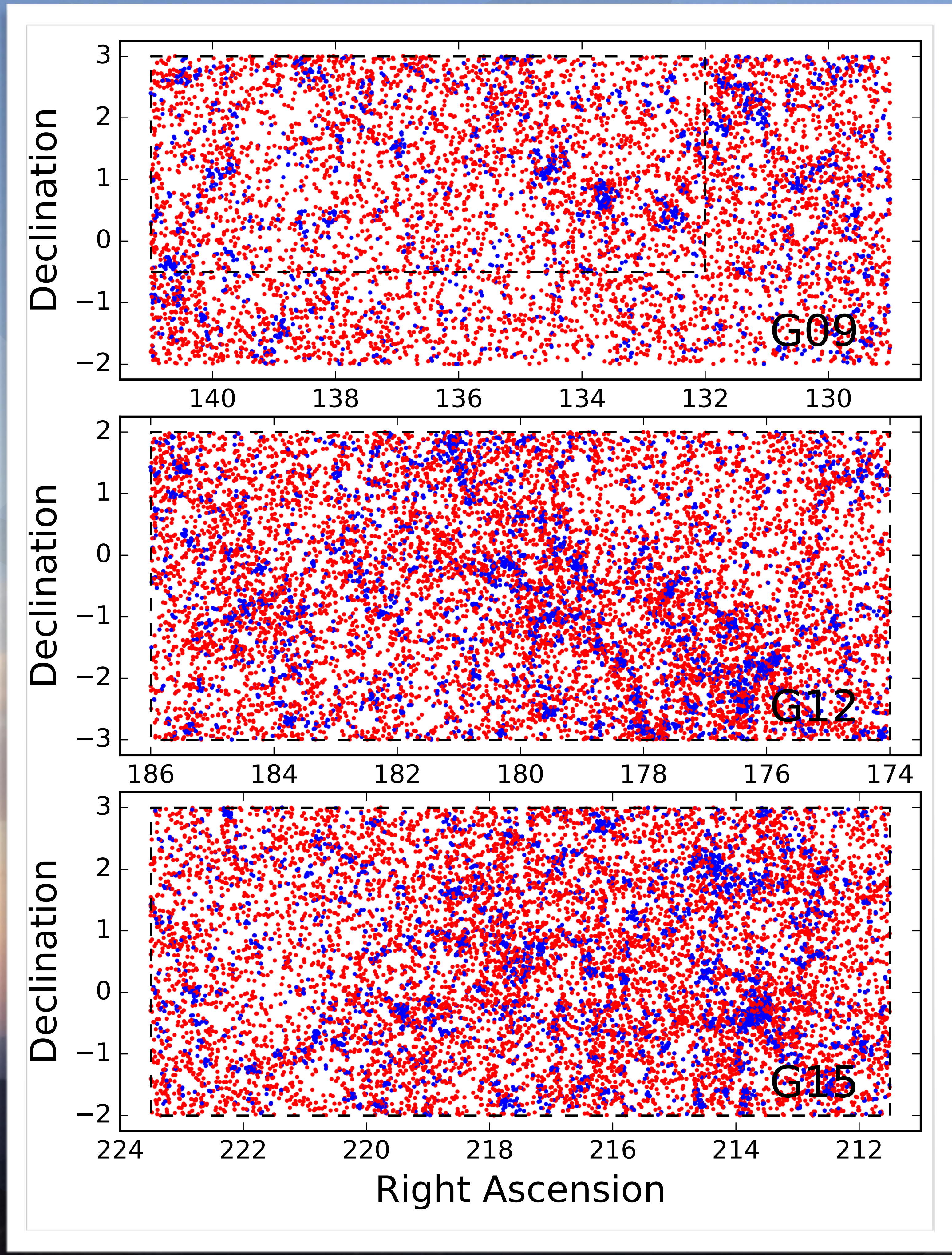
THE VALUE OF DEEP SPECTROSCOPY FOR ENVIRONMENTS

red:
GAMA centrals
(Robotham+10)

blue:
GAMA satellites

$r < 17.8$;
$z < 0.2$





red:
GAMA centrals
(Robotham+10)

blue:
GAMA satellites

$r < 19.8$;
$z < 0.2$

To study environmental effects and processes (eg. ram pressure stripping, interactions, mergers, cold accretion, hot shocked accretion, AGN feedback, strangulation, outflows, galactic fountains, headstart bias, etc): it is necessary to go: ***wide, complete, and low redshift***.

4HS:

THE 4MOST HEMISPHERIC SURVEY

PIs: ENT & Michelle Cluver

Seed Team:

Chris Blake
Jarle Brinchmann
Alyson Brooks
Matthew Colless
Luke Davies
Simon Driver
Henk Hoekstra
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4HS: THE 4MOST HEMISPHERIC SURVEY

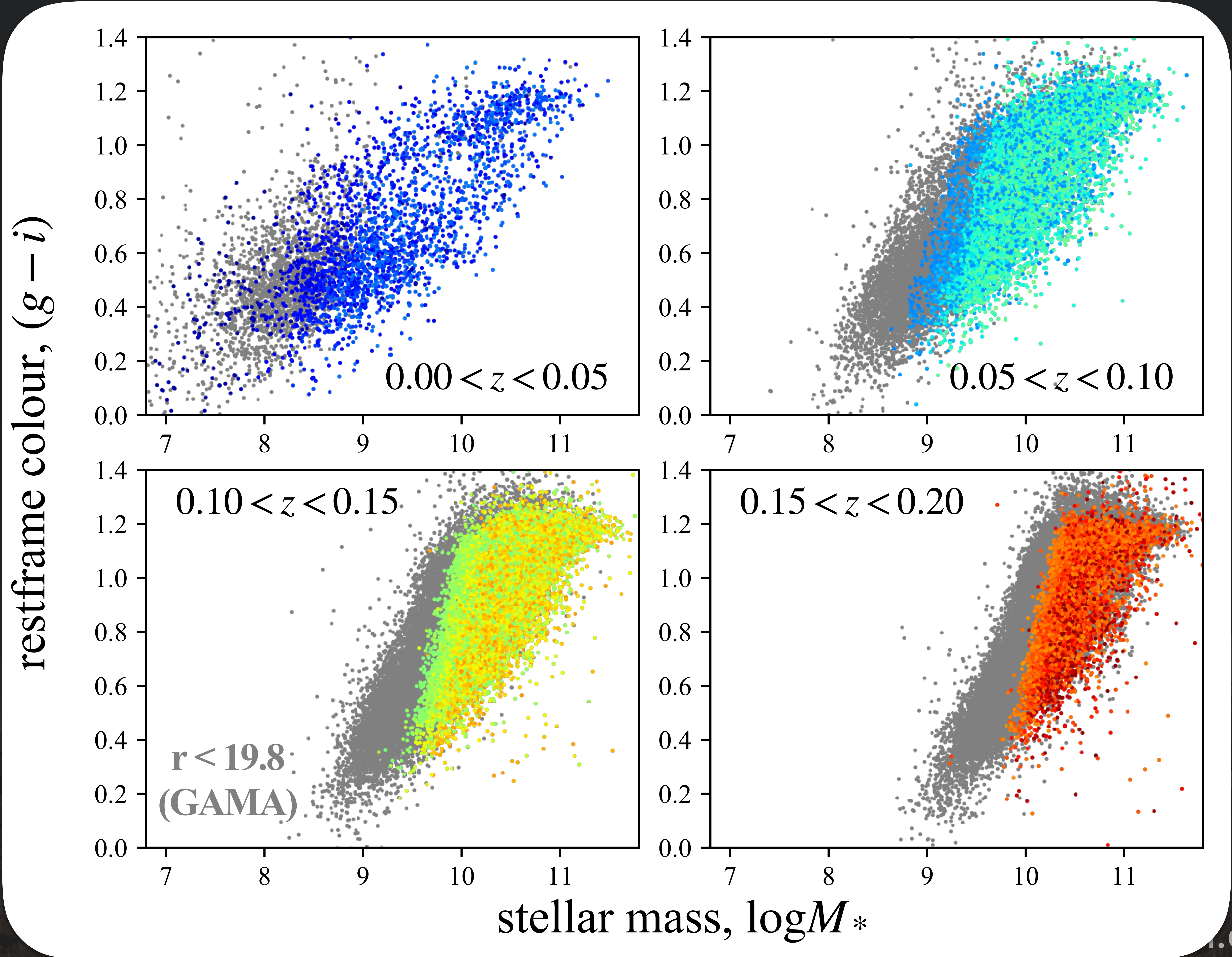
- *A galaxy redshift survey covering the Southern hemisphere, targeting $z <$ ~0.1, with near total spectroscopic completeness.*

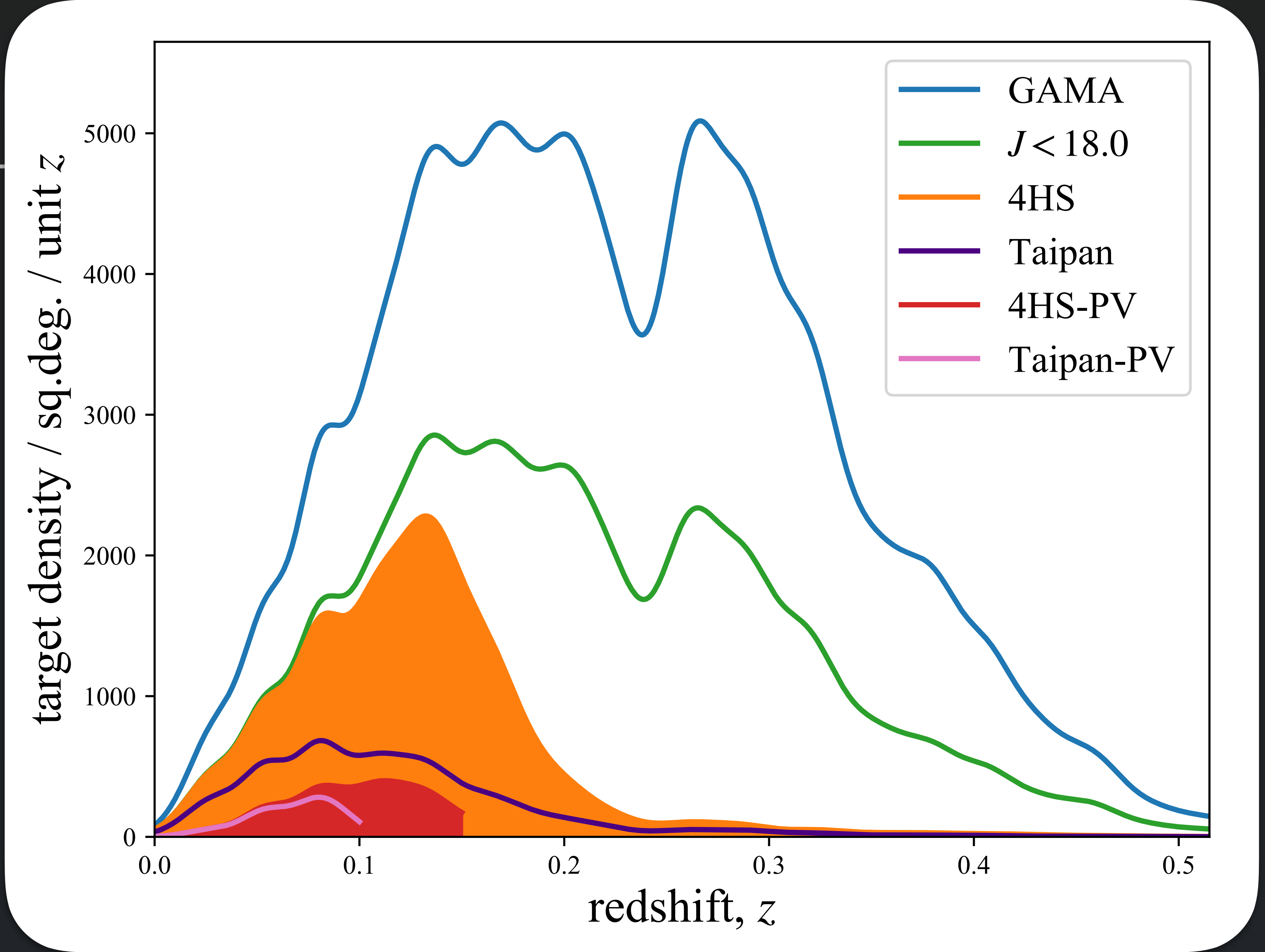
- VHS selected: $J < 18$ and $(J–K) > 0.3$ –> ~275 / sq.deg.
  5.5 Million galaxies over 2π steradians ~ 20,000 sq. deg.

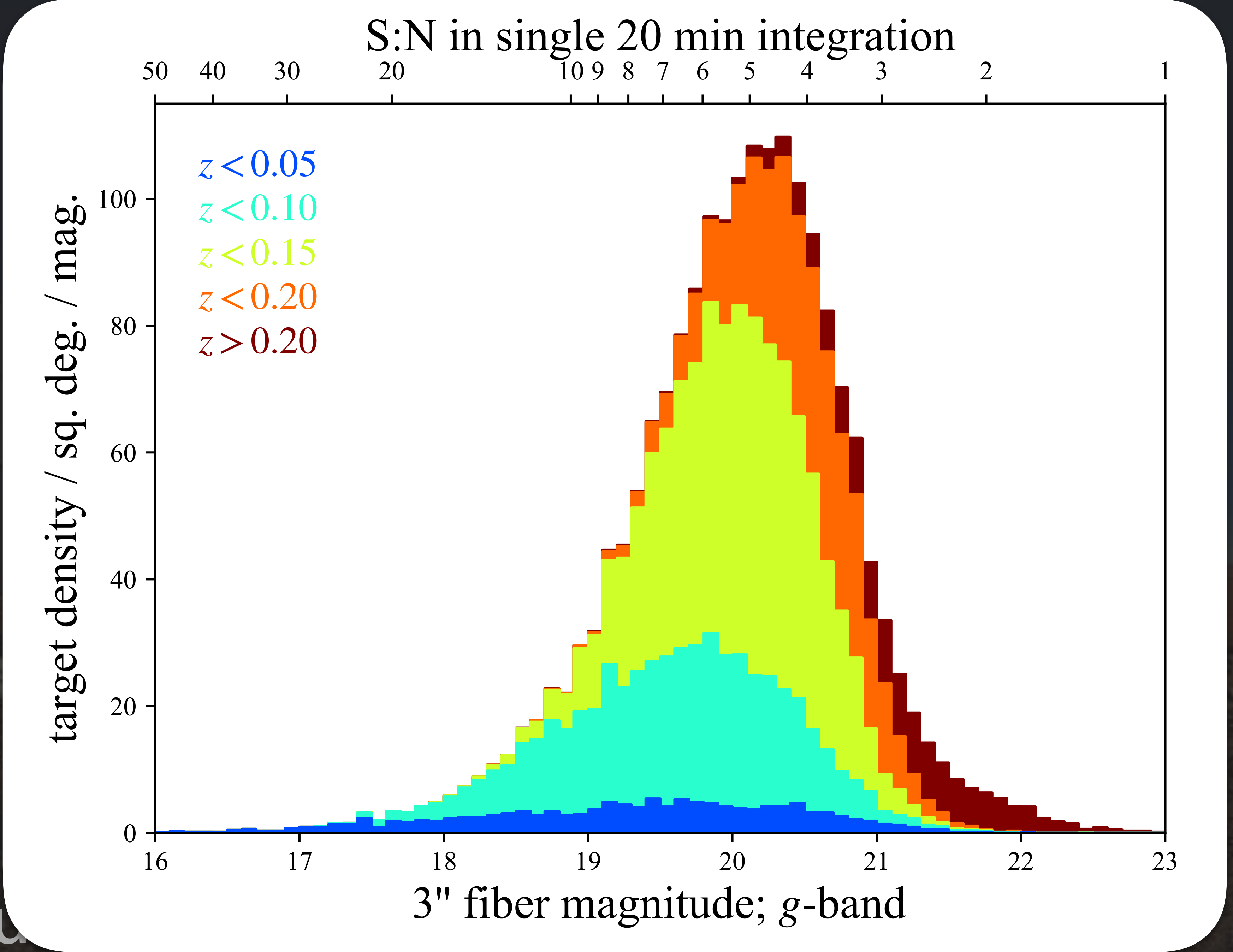
- Southern hemisphere: ALMA, LSST, SKA; Euclid, WISE, eRosita

- *A transformative laboratory for studying the baryon lifecycle in and around galaxies as a function of mass and environment.*

4HS: THE 4MOST HEMISPHERIC SURVEY







4HS HAS NO COMPETITION

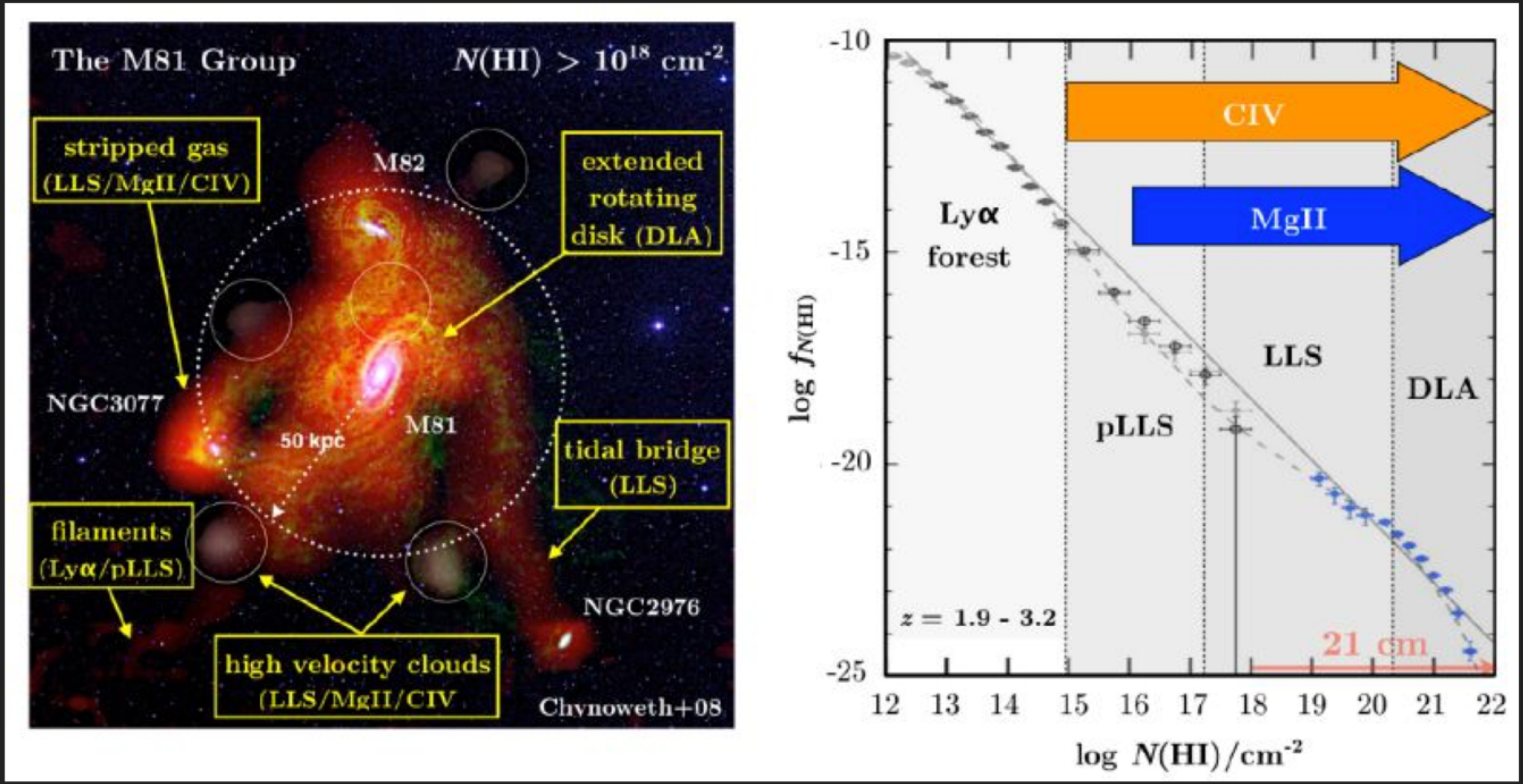
- *cf. SDSS/Taipan:* ~2 mag deeper; ~1 dex deeper in halo mass.
- *cf. GAMA*: similar $z \sim 0.1$ group fidelity, over ~100 times the area (617 $z < 0.1$ groups in GAMA –> 60000 in 4HS).
- *cf. WAVES-Wide*: ~2.5ish mag shallower, but 15 times area; 4HS does at $0 < z < 0.1$ what WAVES-Wide does at $0.1 < z < 0.2$.
- *cf. DESI-BGS*: near-total completeness (cf. ~90% for DESI); necessary for environments… and also in the right hemisphere!

A TRANSFORMATIVE LABORATORY TO PROBE THE BARYON LIFECYCLE AS A FUNCTION OF MASS AND ENVIRONMENT

- ***4HS spectra:*** redshifts, group/env. metrics, halo masses
- ***PS/SM –> LSST:*** stellar masses and pops, sizes, morphologies, lensing
- ***VHS –> Euclid:*** stellar masses, sizes, morphology, lensing
- ***WISE:*** stellar masses, star formation, AGN diagnostics
- ***ASKAP –> SKA 21cm:*** integrated, resolved, and intragroup HI
- ***ASKAP –> SKA continuum:*** star formation, AGN power
- ***eRosita Xray:*** AGN, intragroup filaments, hot cluster gas

A TRANSFORMATIVE LABORATORY TO PROBE THE BARYON LIFECYCLE AS A FUNCTION OF MASS AND ENVIRONMENT

Lyα absorbers from Kim et al. (2013)



https://ned.ipac.caltech.edu/level5/Sept17/Chen/Chen1.html

4HS: A CRUCIAL COMPLEMENT TO SKA SURVEY SCIENCE

- HI surveys need redshifts, too! Group finding and halo masses …
- … and stacking, obviously; but at least as valuable is …
- … targeted HI mass measurements of marginal detections: loads and loads of 1–10σ measurements (cf. 10+ σ detections).
- Resolved galaxy and intragroup HI science with ASKAP –> SKA is the next frontier (after SAMI, Hector, MaNGa, SDSS-V, etc).

4HS FOR COSMOLOGY

- Where 4HS shines is peculiar velocity science and GRoS: *i.e.*, mapping the large scale density and velocity fields, enabling tests of gravity on the very largest scales (>> 10 Mpc).
- 4HS complements BAO and RSD cosmology by DESI and CRS.
- Goal: S:N ~ 10 for ~800,000 Early Type/Fund. Plane galaxies at $z < 0.15$; ~2 % measurement of growth rate of structure parameter, *f;* marginal cost is ~5% compared to pure redshift survey.
- A comprehensive legacy catalogue of galaxy properties *and halo masses* for low-z transients, including supernovae, gravitational wave sources, etc.

4HS: COMPLEMENTARITY WITH CONSORTIUM SURVEYS

- highly complementary with all 5 extragalactic consortium surveys: (WAVES, Clusters, AGN, CRS, and TiDES).
- 4HS does at $0 < z < 0.1$ what WAVES-Wide does at $0.1 < z < 0.2$. HMF, HOD, low-redshift weak lensing (with LSST/Euclid).
- naturally commensal with 4/5 Galactic consortium surveys.
- spreads/relieves hour angle pressure.

4HS SURVEY DESIGN AND FORECASTING

- Expect ~100% redshift success with ~20 min integration.
  (Maybe ~1% percent hit from cosmic rays; live-with-able.)
- 5.5 M targets –> 2.0 M LR fibre hours
- Three natural levers: area, redshift, mass limits.
- No attempts yet to optimise sample definition.
  Efficiency is ~40% (or ~75%) for $z < 0.10$ (or 0.15).
  (But remember that there is value in $z < \sim 0.15$ 'contaminants',
  and that ~40% efficiency is good cf. SDSS/GAMA.)
- No attempt yet to account for overlap between 4HS and others,
  including Taipan, DESI BGS, WAVES, CRS, …

Can you imagine a Universe in which we have:

eRosita

LSST

Euclid

WISE

SKA

LISA

… but lack local Universe redshifts?