The Merian Survey: characterizing dark matter and feedback in star-forming dwarf galaxies with medium-band filters on DECam

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The Merian Survey

- Two medium-band filters (N708/N540) for Hα and OIII in order to find ~100,000 dwarf galaxies ($10^8 - 10^9 M_{\odot}$) at $z \sim 0.1$

- 64 full nights on the CTIO-4m Dark Energy Camera (DECam) to cover 800 deg$^2$ in HSC-SSP field

- Core science goals: constrain dark matter and feedback in star-forming dwarf galaxies
Weak gravitational lensing

- Constrain dark matter halo out to Rvir
- Need large sample of lenses

Leauthaud et al. 2020
Simulations shows HSC can already detect enough low-mass galaxies down to $10^8$ Msun with high completeness to get a decent lensing signal.
Improve photo-z’s at z<0.2

• Optical broad-band photo-z’s are not optimal for dwarf galaxies at z<0.2

• Quenched fraction for galaxies in mass range $10^8 - 10^9 \, M_\odot$ is low (~5%)

• Emission lines from HII regions can provide additional information to improve the photo-z precision

Mao et al. 2024
Danieli et al. submitted to ApJ
Tradeoffs in the central wavelength & filter width

- longer central wavelength & wider filter width = larger volume = higher lensing S/N
- longer central wavelength = fainter dwarf galaxies = longer exposure time = less volume with fixed survey time
- wider filter width = weaker S/N of emission line detection = fewer dwarfs detected
Optimize lensing S/N for different filter design

Luo+2024
Merian filter transmission across the DECam focal plane

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![Graph showing filter transmission across different wavelengths with corresponding redshift for Hα.]
Merian Wide (~800 deg^2):

- 4x10 min for N708 (Halpha)
- 4x15 min for N540 (OIII)

Merian Deep (~2 deg^2):

- 40x10 min for N708 (Halpha)
- 40x15 min for N540 (OIII)

Danieli et al. submitted to ApJ
Merian has finished $>500 \, \text{deg}^2$ with decent depth

Danieli et al. submitted to ApJ
Merian data reduction pipeline: LSSTpipe

- Merian DR1: 230 deg^2: full depth full color region
- Photometry on HSC broad-bands based on Merian footprint
- Gaussian-aperture-and-PSF (GAAP) photometry
- One of the first survey reduced with LSSTpipe

Danieli et al. submitted to ApJ
Merian spec-z calibration sample

• Collecting spec-z’s with Keck/DEIMOS, Magellan/IMACS and DESI down to $i \sim 23$ mag

• >6000 spectra for Merian objects have been collected (and increasing)

• Combining redshifts from previous surveys (COSMOS, GAMA, SDSS, etc.)
Merian template fitting photo-z’s achieve a precision of ~0.015

Luo et al. in prep
Medium-band flux excess for spec-z confirmed galaxies

Mintz et al., submitted to ApJ (go see her poster #25!)
Satellite properties around MW analogs

Pan et al. in prep (go see her poster #30!)
Beyond photo-z point estimation

Credit: Yue Pan
First Merian dwarf lensing signal

- ~30% of the Merian final footprint - lensing S/N > 10
- More modeling is underway

Luo et al. in prep
• LSST can constrain dwarf lensing with much higher lensing S/N
• Medium-band surveys for LSST should be considered
Merian filters N708/N540 + DESI-2 filters
Summary

- Merian is a new medium-band imaging survey with 64 nights on DECam to cover 800 square deg in the HSC SSP wide field
- Two new medium-band filters N708 and N540 will find $\sim 100,000$ dwarf galaxies ($10^8 - 10^9 M_\odot$) at $0.05 < z < 0.1$
- Merian photo-z’s provide a precision of $\sim 0.015$, could be improved with $p(z)$
- We have detected weak lensing signal around dwarf galaxies within 30% of Merian total footprint
- More Merian early science papers will be out soon!