China-VO 2020

Completion of BASS/DESI Imaging Surveys and Latest Data

邹虎（NAOC）&

BASS collaboration team

Xiamen, 2020.11.26

BATC and China-VO

- . chmidt telescope（巡天）
  - . multi-color survey: > . papers
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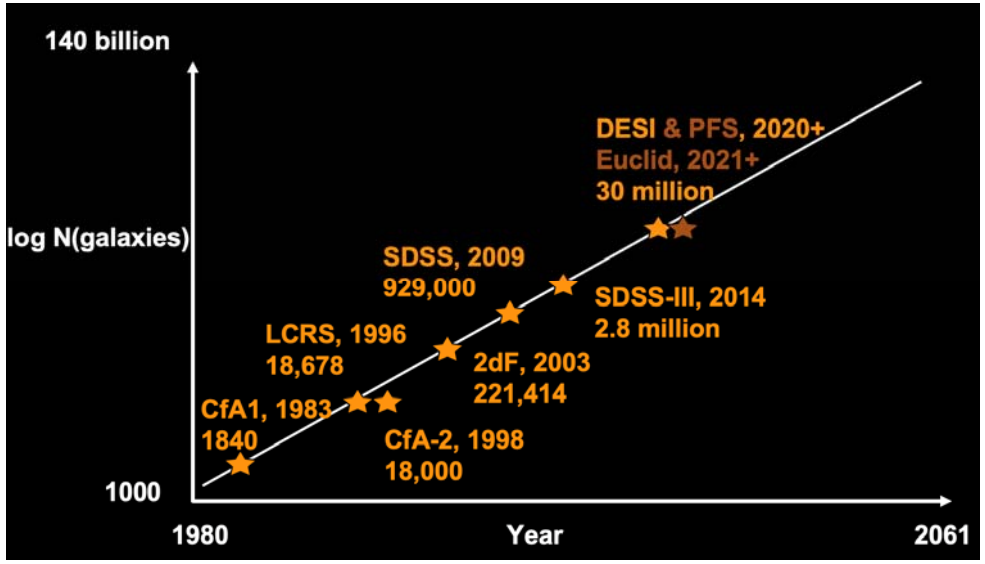
China-VO

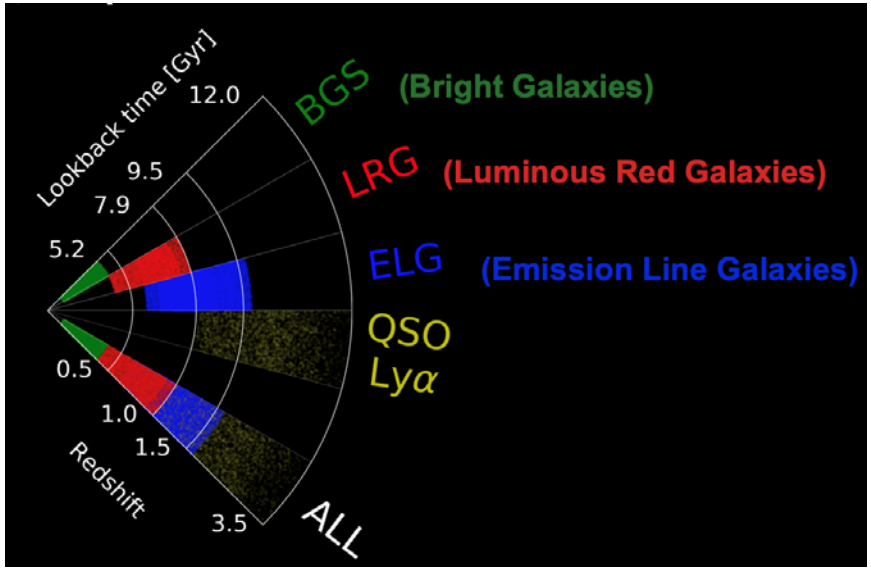
- 数据库
- 数据检索
- 计算资源
- 可视化

BASS Motivation

Dark Energy Spectroscopic Instrument

- Stage-IV dark energy exploring experiment
- Supported by DOE/US
- Measuring redshift of 35 millions galaxies
- Mapping the 3D universe
- exploring the effect of dark energy on the expansion of the Universe

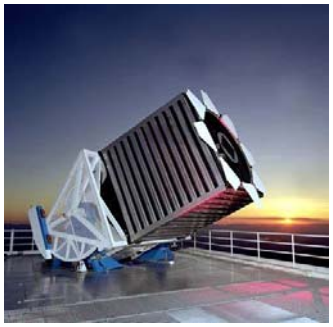
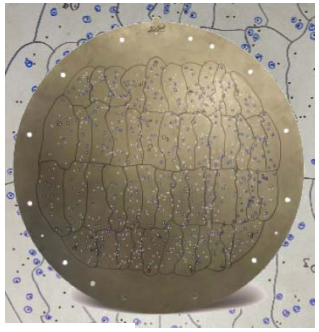




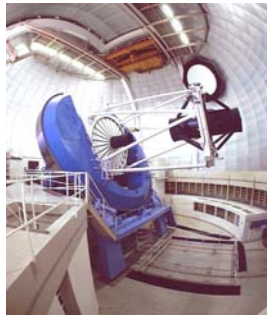
Motivation: DESI targeting

SDSS imaging → SDSS spectroscopy

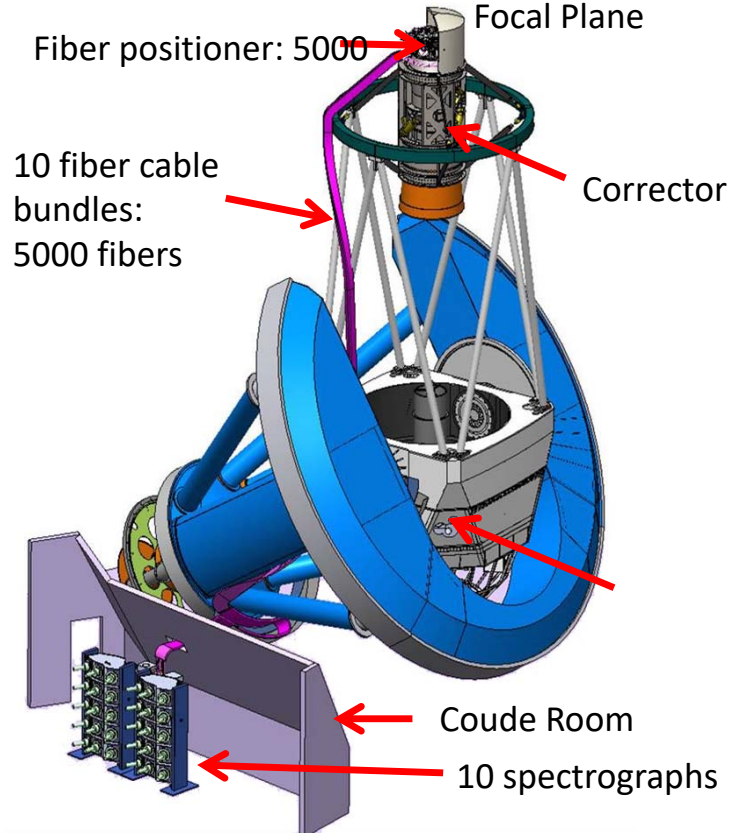
DESI imaging → DESI spectroscopy

BOSS and eBOSS



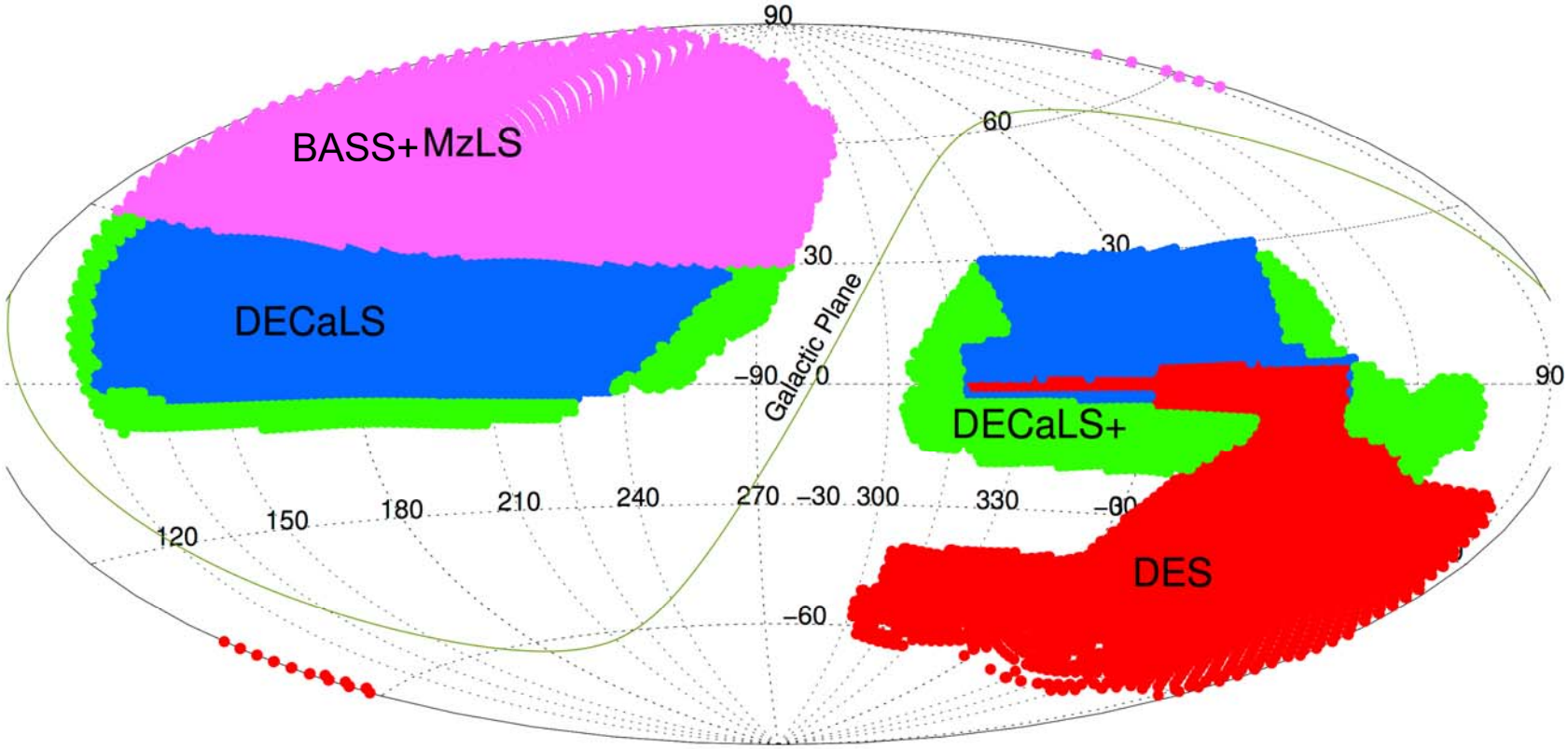

DESI



Mayall 4m Telescope, Kitt Peak, Tucson, AZ

DESI imaging surveys

- Baseline footprint: 14000 deg2
- Photometric bands: g,r, and z bands
- Depths: g>24.0, r>23.4, z>22.5



DESI imaging surveys: collaborations

NAOC 中国科学院国家天文台 NATIONAL ASTRONOMICAL OBSERVATORIES, CAS

THE UNIVERSITY OF ARIZONA

NOAO

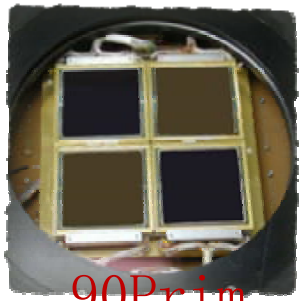
BERKELEY LAB

BASS

MzLS

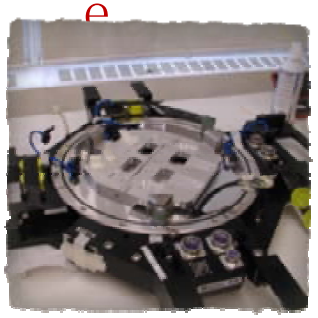
DECaLS

Bok



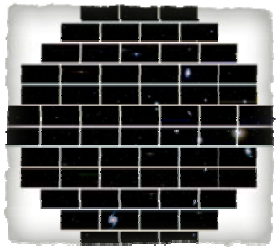
90Prime

Mayall



MOSAIC-3

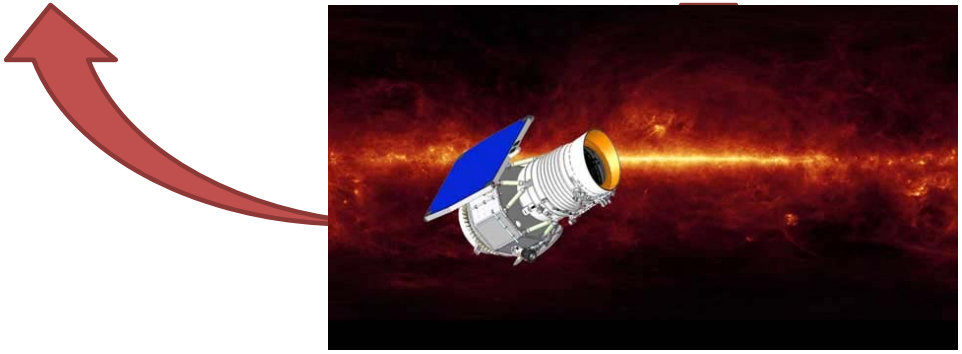
Blanco



DECam

Survey features

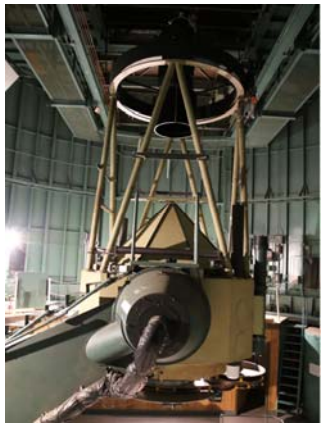
- 2-3 magnitude deeper than SDSS
- “Open collaboration” includes non-DESI participants
- “Public surveys” — no proprietary period on the data
- Pilot surveys in 2013, last photons in March 2019
- Adding infrared data of W1+W2 from WISE satellite (7-year stacks), 1.5 mag deeper than official WISE data



Survey observation and strategy

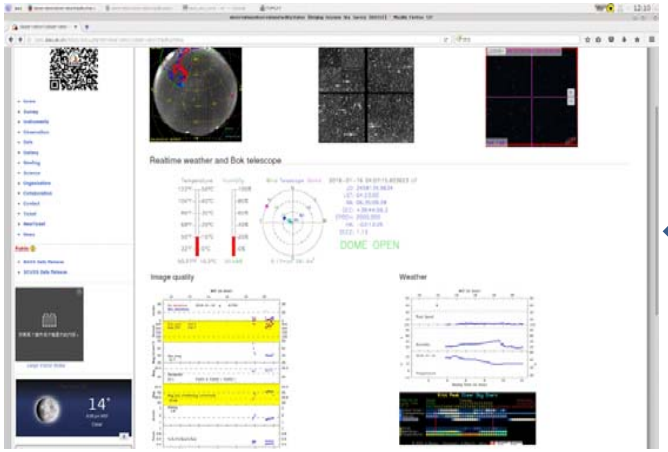
- Consistent survey strategy
- Automatic real-time check of the imaging quality
- Dynamical Exposure time calculator
- Making the imaging depths uniform across the full footprint

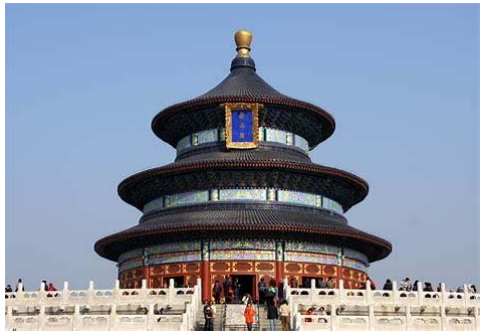
Tucson, US

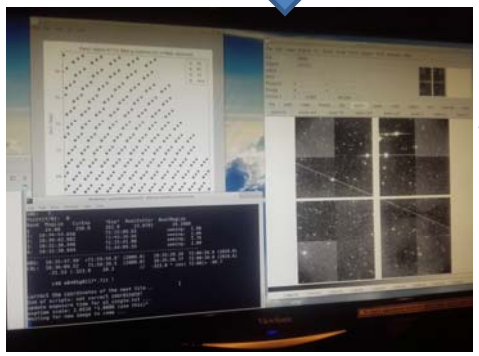


Automatic survey plan

Beijing, CN



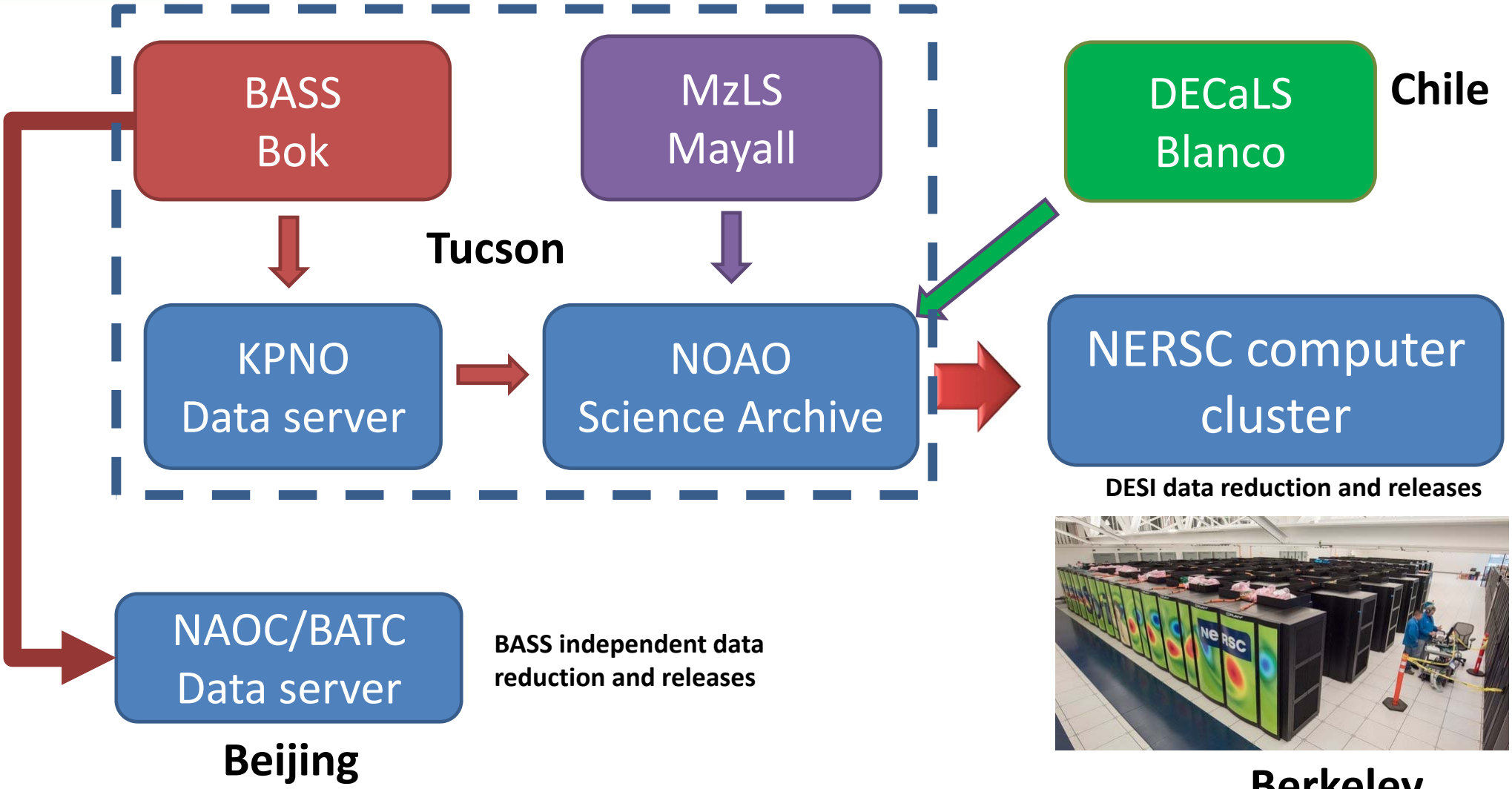




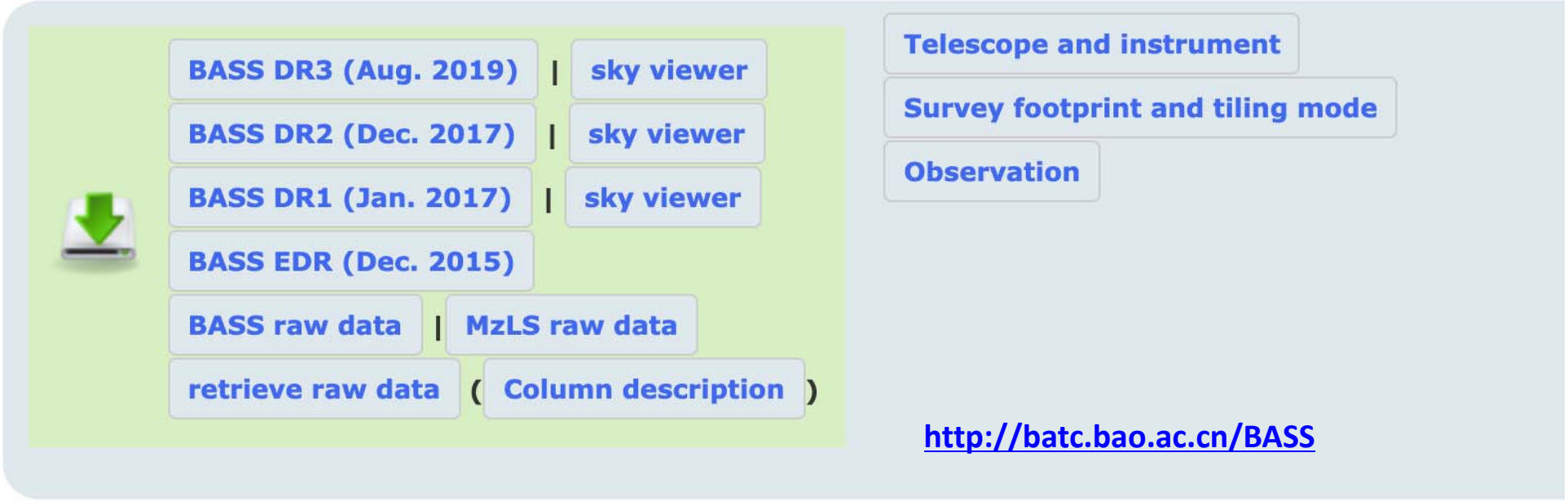
Updating strategy and exposure time

Image qualities, statistics

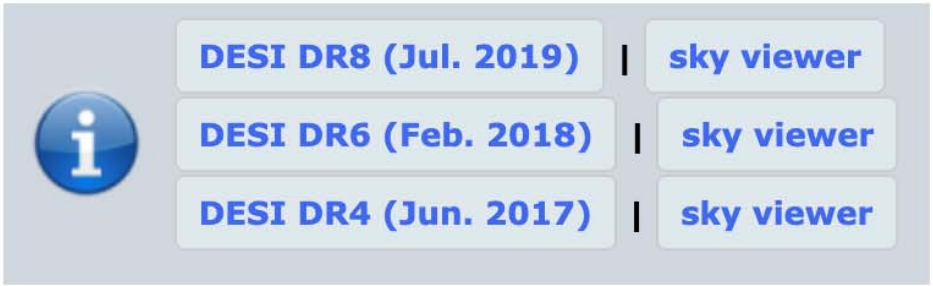
Data transferring



Data releases



Other data releases for DESI legacy surveys, which also include the BASS data.

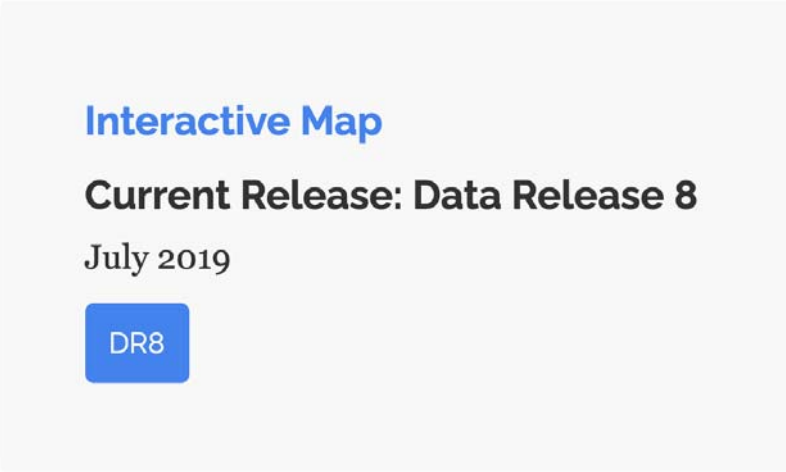


2020.12: DESI DR9, final targeting release

https://www.legacysurvey.org/

Updates from DR8 to DR9

- Re-reductions of all data from raw imaging pixels
- Updated calibrations — astrometry, flat-fields, PSFs, sky modeling
- Careful + consistent treatment faint sources near large galaxies + bright stars
- Includes 7 years of WISE infrared data (also reprocessed from raw pixels)
- Iterative detection of sources to recover faint targets near bright objects
- Improved morphologies for resolved galaxies (using Sersic profiles)



This was another 16 months work since DR8
Lots of testing wither interim releases dr9a, dr9b, dr9c,…, dr9m

Data

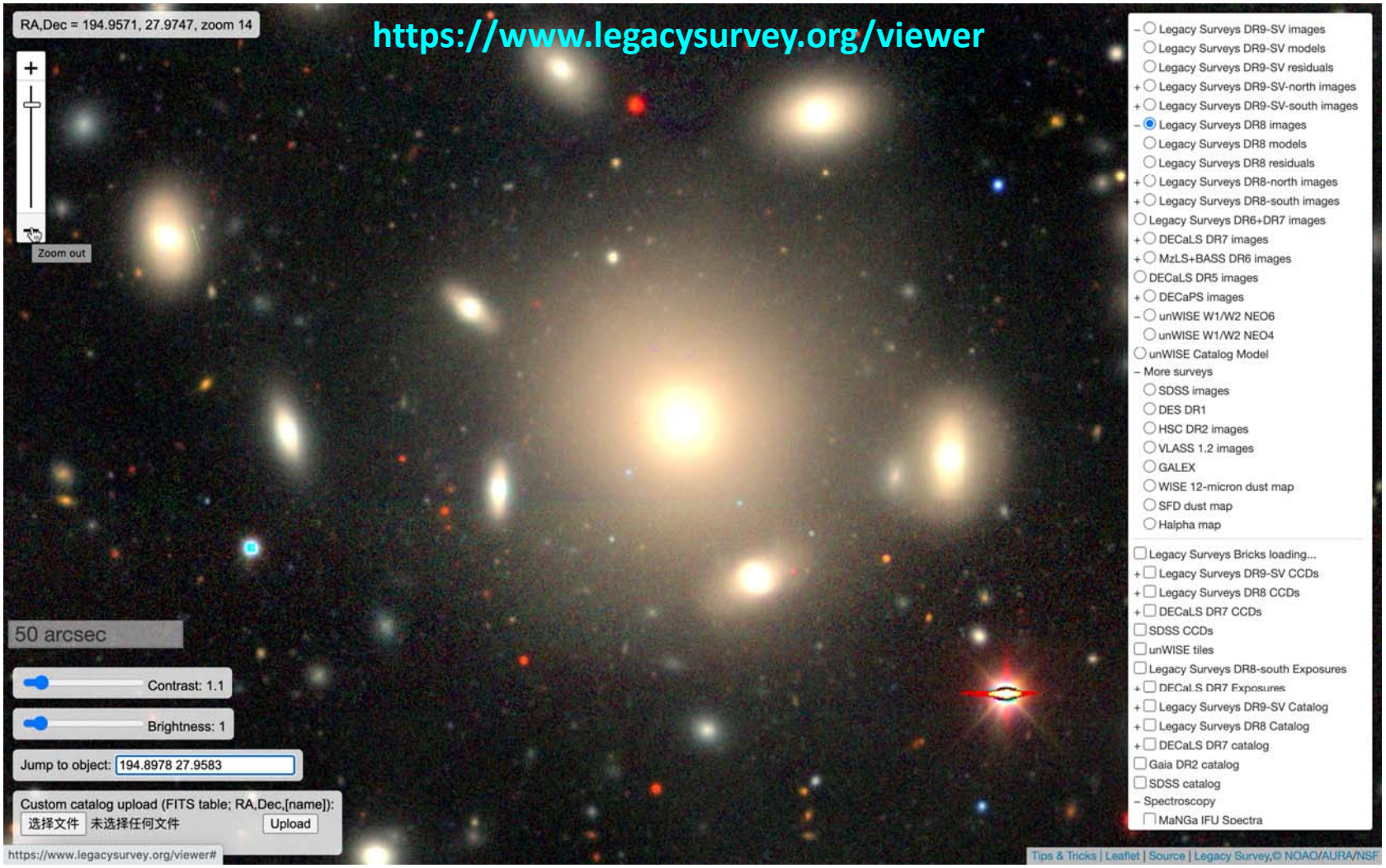
- 20000 squared degrees, g,r,z,W1,W2
- 2-3 mag deeper than SDSS, 1.5 mag deeper than AllWISE

- Raw Data at NAOC and NOAO Archive
- Calibrated single-epoch images
- Stacked images

- Co-added catalogs
- Force single-epoch catalogs
- Cross-matching with SDSS spec data
- Integrating Gaia data

- Attractive sky viewer

Sky viewer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Zoom out
50 arcsec
Contrast: 1.1
Brightness: 1
Jump to object: 194.8978 27.9583
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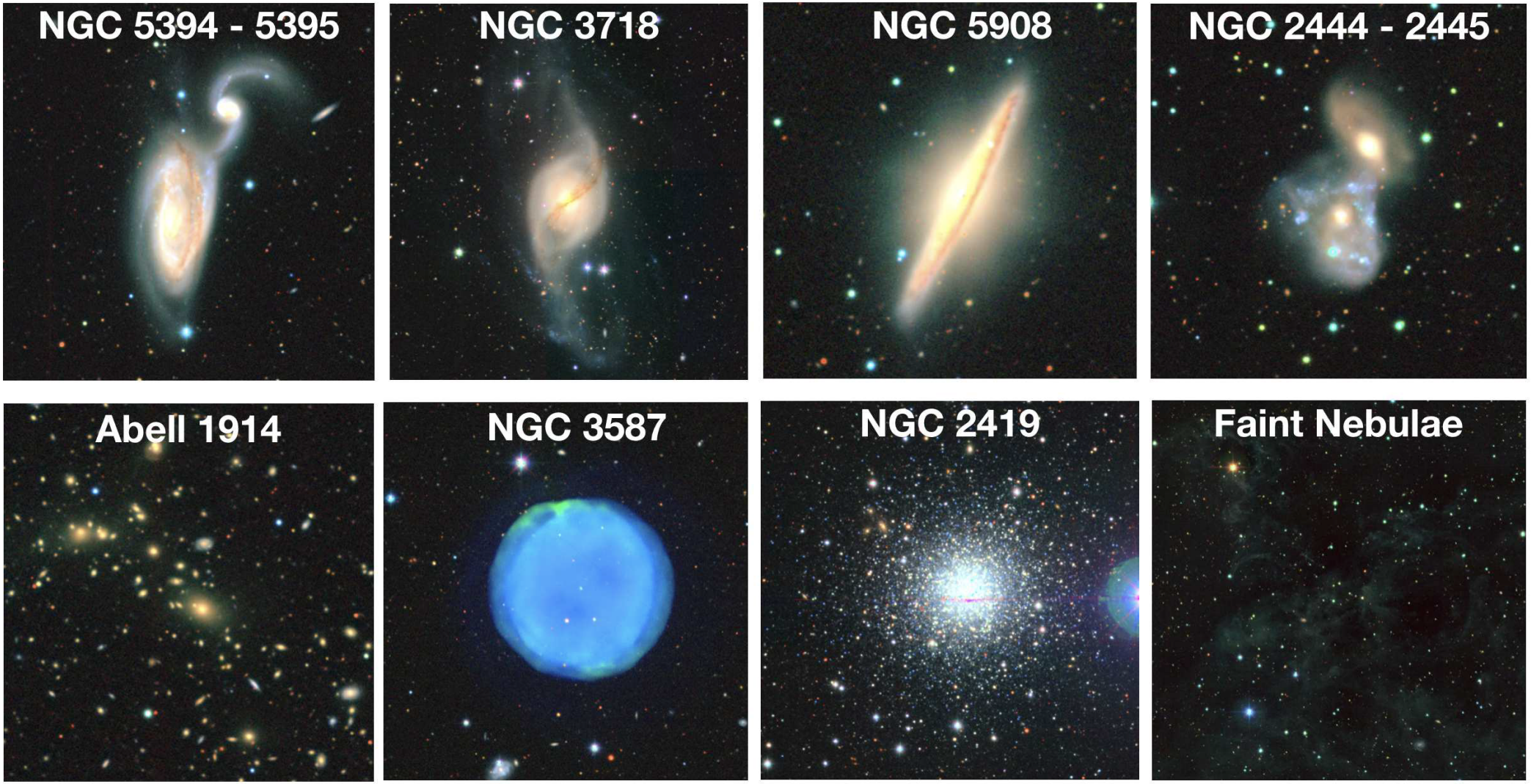
https://www.legacysurvey.org/viewer#
Legacy Surveys DR9-SV images
Legacy Surveys DR9-SV models
Legacy Surveys DR9-SV residuals
Legacy Surveys DR9-SV-north images
Legacy Surveys DR9-SV-south images
Legacy Surveys DR8 images
Legacy Surveys DR8 models
Legacy Surveys DR8 residuals
Legacy Surveys DR8-north images
Legacy Surveys DR8-south images
Legacy Surveys DR6+DR7 images
DECaLS DR7 images
MzLS+BASS DR6 images
DECaLS DR5 images
DECaPS images
unWISE W1/W2 NEO6
unWISE W1/W2 NEO4
unWISE Catalog Model
More surveys
SDSS images
DES DR1
HSC DR2 images
VLASS 1.2 images
GALEX
WISE 12-micron dust map
SFD dust map
Halpha map
Legacy Surveys Bricks loading...
Legacy Surveys DR9-SV CCDs
Legacy Surveys DR8 CCDs
DECaLS DR7 CCDs
SDSS CCDs
unWISE tiles
Legacy Surveys DR8-south Exposures
DECaLS DR7 Exposures
Legacy Surveys DR9-SV Catalog
Legacy Surveys DR8 Catalog
DECaLS DR7 catalog
Gaia DR2 catalog
SDSS catalog
Spectroscopy
MaNGa IFU Spectra
Tips & Tricks | Leaflet | Source | Legacy Survey,© NOAO/AURA/NSF

Color images

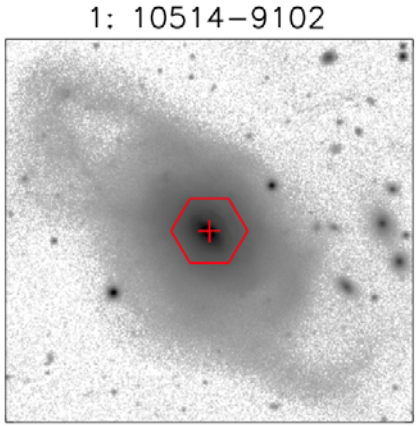


DESI spectroscopic targets

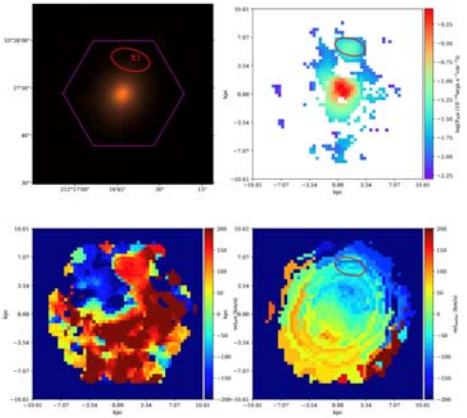
Galaxy type	Redshift range	Bands used	Targets per deg^2	Exposures per deg^2	Good z's per deg^2	Baseline sample
LRG	0.4–1.0	r,z,$W1$	350	580	285	4.0 M
ELG	0.6–1.6	g,r,z	2400	1870	1220	17.1 M
QSO (tracers)	< 2.1	g,r,z,$W1$,$W2$	170	170	120	1.7 M
QSO (Ly-α)	> 2.1	g,r,z,$W1$,$W2$	90	250	50	0.7 M
Total in dark time			**3010**	**2870**	**1675**	**23.6 M**
BGS	0.05–0.4	r	700	700	700	9.8 M
Total in bright time			**700**	**700**	**700**	**9.8 M**

- Luminous Red galaxy (LRG)
- Emission line galaxies (ELG)
- Quasars (QSO)
- Bright Galaxy Sample (BGS)

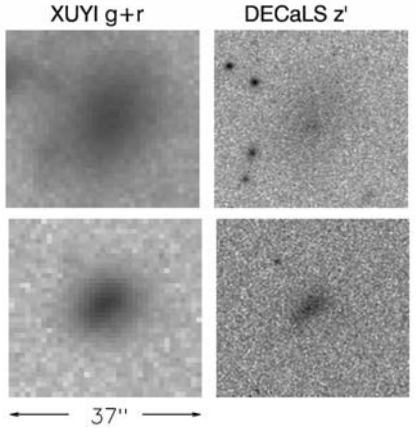
Optical images of special objects and candidates



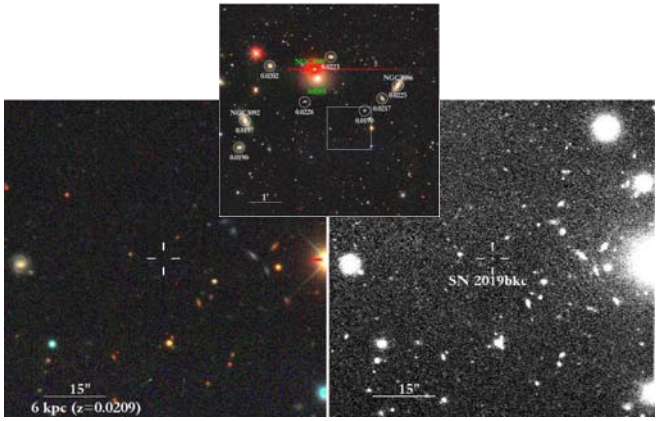
Find merging galaxies in MaNGA samples
Song-lin Li, et al. 2019



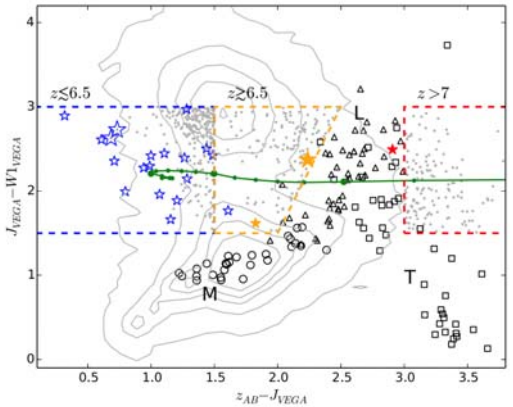
Outlying Hα emitters in MaNGA
Bait Omkar et al. 2019

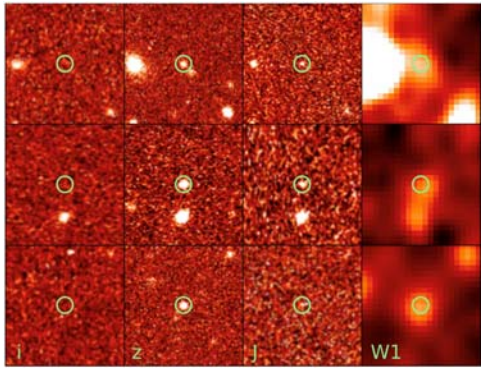


Confirming ultra-diffuse galaxies
Dongdong Shi, et al. 2017



Optical images of supernova
Ping Chen et al. 2020

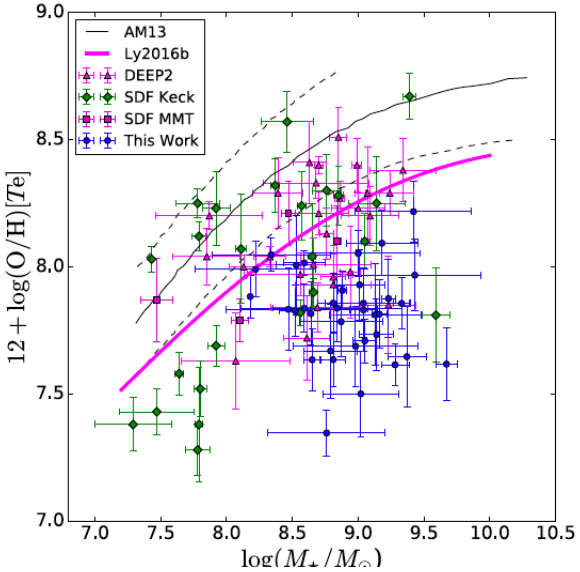




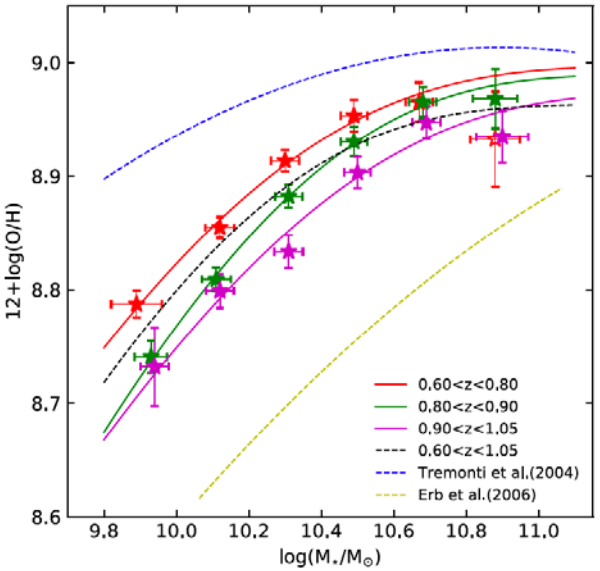
discover high-z quasars:
Feige Wang et al. 2017,2018,2019

Scaling relations for galaxies

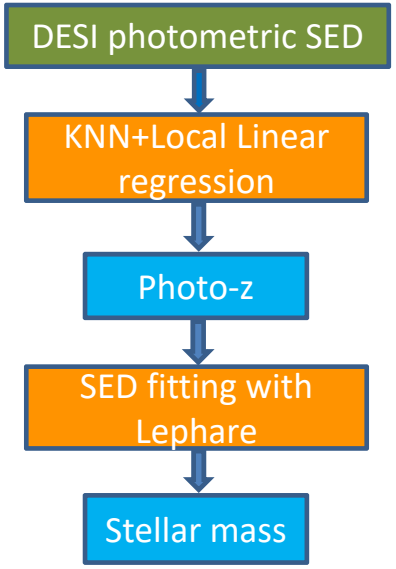
- Mass-Metallicity Relation and Fundamental Metallicity Relation of Metal-poor Star-forming Galaxies at 0.6 < Z < 0.9 (Gao et al. 2018)
- The Mass-Metallicity Relation at z ~ 0.8: Redshift Evolution and Parameter Dependency (Huang et al. 2019)
- Photometric Redshifts and Stellar Masses for Galaxies from the DESI Legacy Imaging Surveys (Zou et al. 2019): for DR6+DR7 and DR8
- Stellar mass measurements based on grz+WISE



Gao et al. 2018



Huang et al. 2019

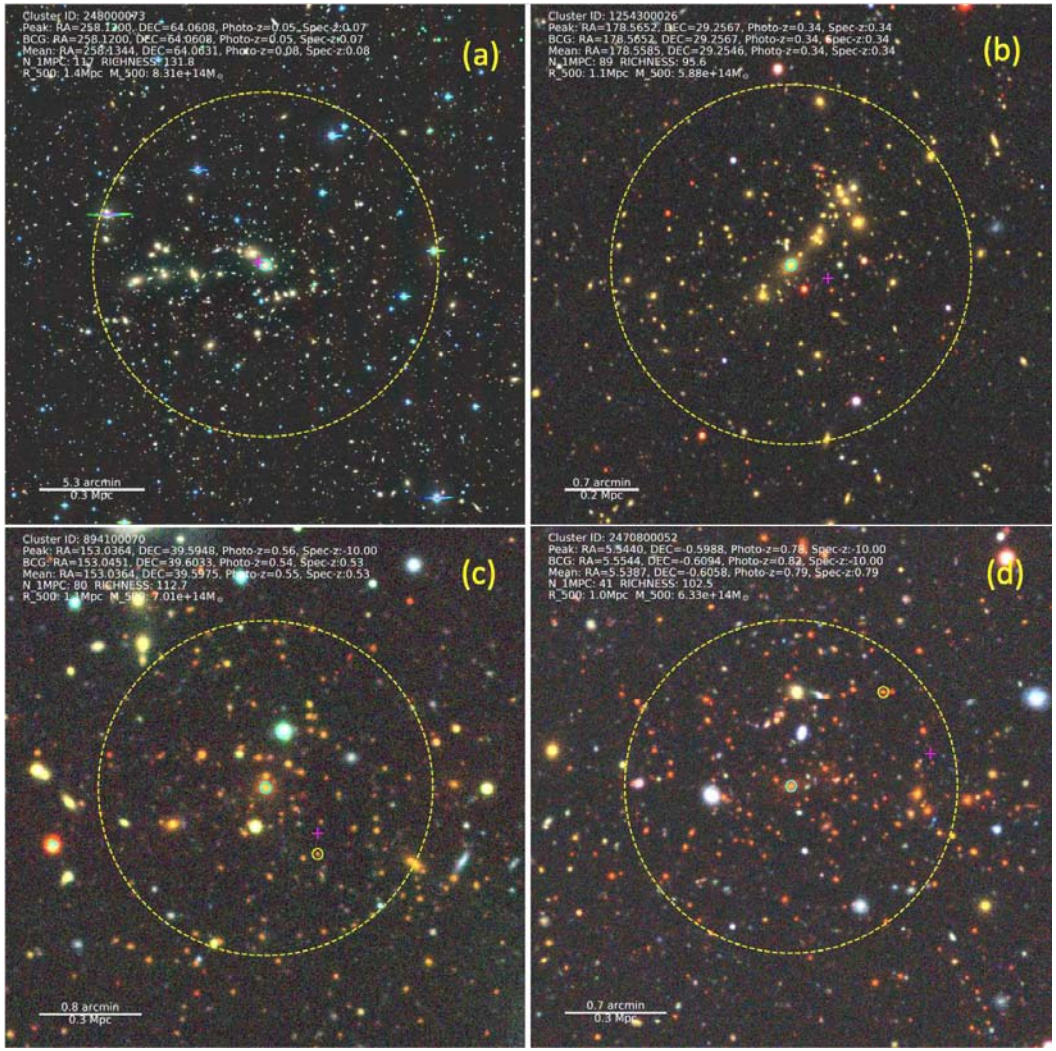


Zou et al. 2019

Photometric cluster detections

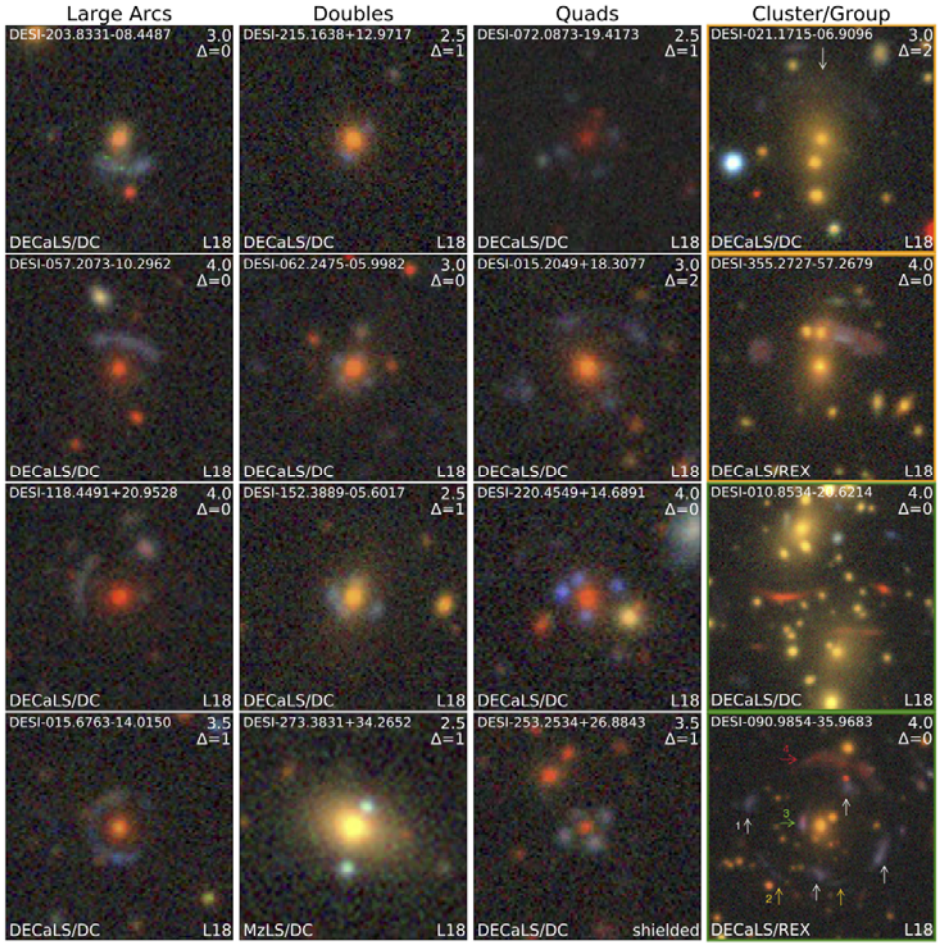
Halo-based group/cluster finders: Xiaohu Yang et al. 2020

A fast clustering algorithm to detect clusters: Hu Zou et al. 2020



Strong lenses

Strong lensing systems => dark matter



RESIDUAL NEURAL NETWORKS:

- **X. Huang et al. 2020 (submitted)**
- **X. Huang et all. 2020, ApJ (335 candidatets)**
- **C.X. Wang et al. in preparation (in BASS region)**

1210 new strong lens candidates

Lensed quasars

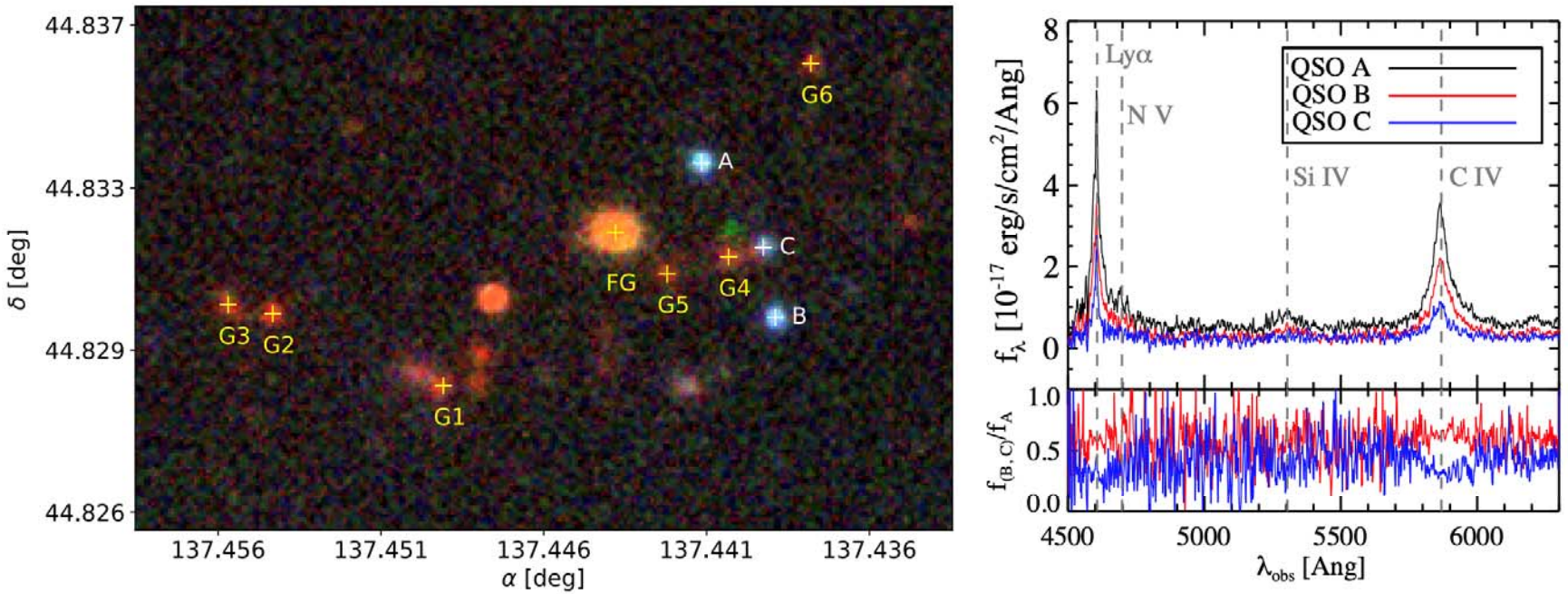
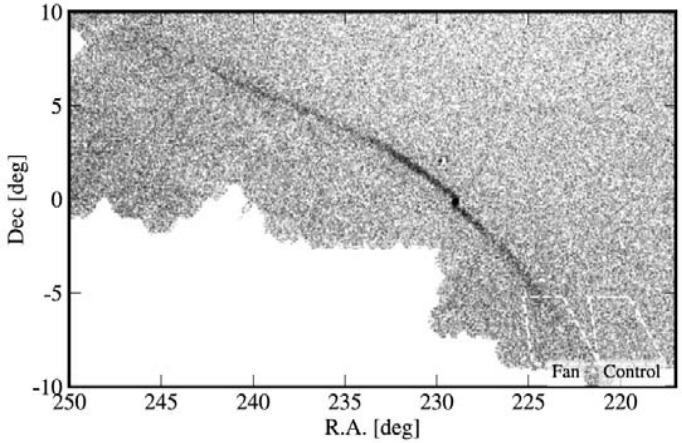


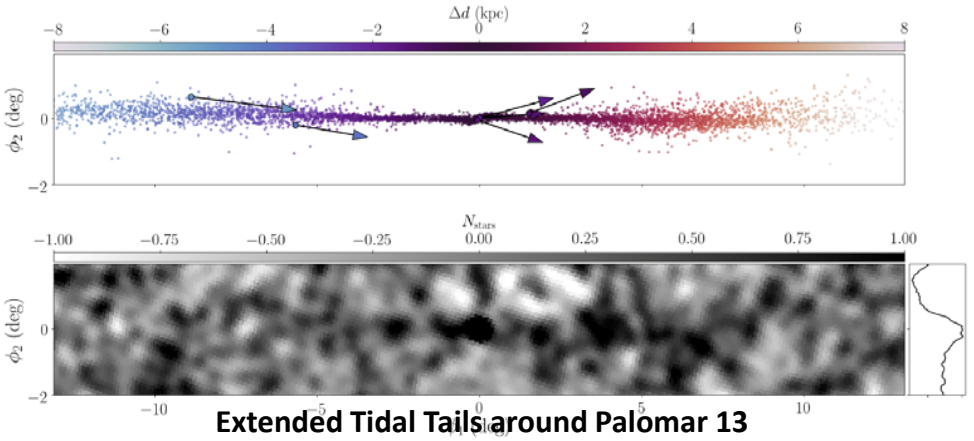
Figure 1. *Left*: BASS+MzLS colour cutout of SDSS J0909+4449. Three spectroscopically confirmed lensed quasar images are labelled as A, B, and C. Nearby galaxies that are potentially related to the lens are labelled accordingly. *Top right*: Gemini GMOS spectra of the three quasar images A (black), B (red), and C (blue). *Bottom right*: Ratios of B and C spectra with respect to A. (The green object north of G4 is a known asteroid 2015 TO103.)

A large-separation strongly lensed quasar at z ~ 2.8 with three images
Yiping Shu et al. 2018

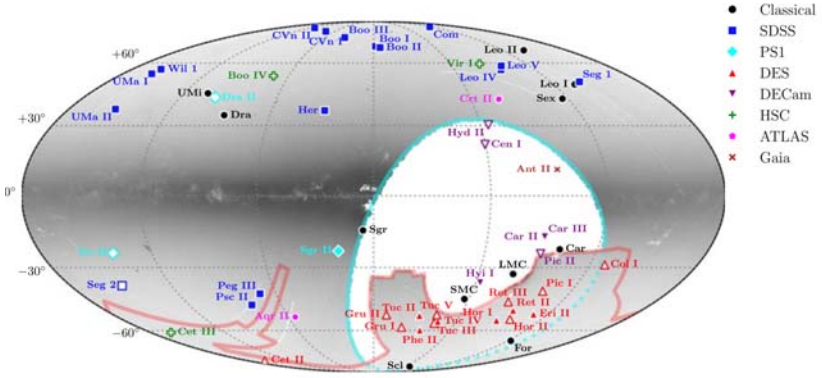
Tidal streams, MW satellites, low surface brightness objects



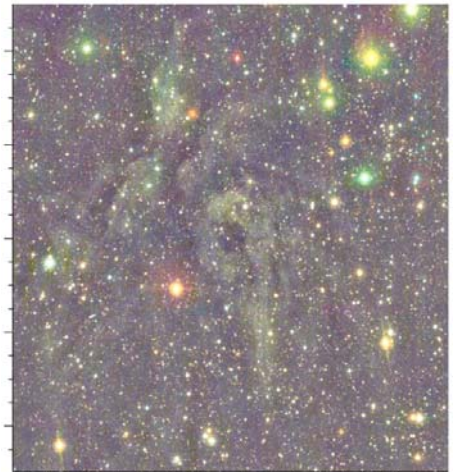
Investigating Palomar 5 Tidal Tails
Ana Bonaca et al. 2020



Extended Tidal Tails around Palomar 13
Nora Shipp et al. 2020



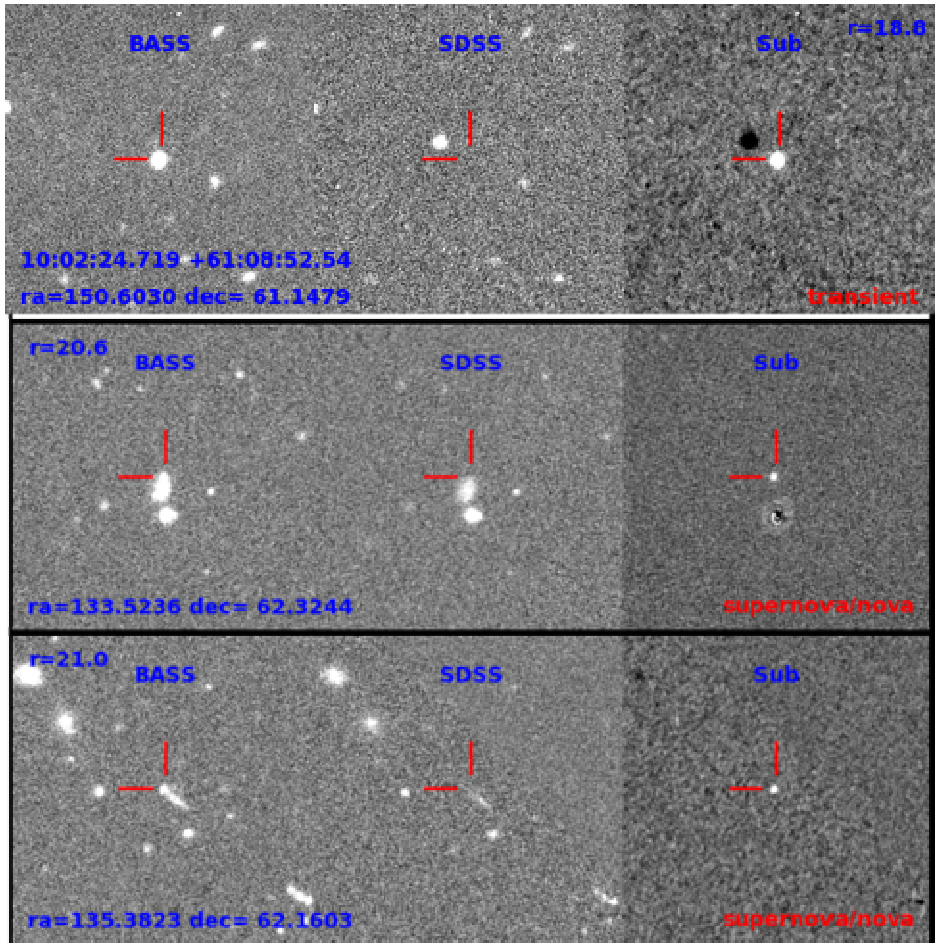
Milky Way Satellite Census
A. Drlica-Wagner et al. 2020

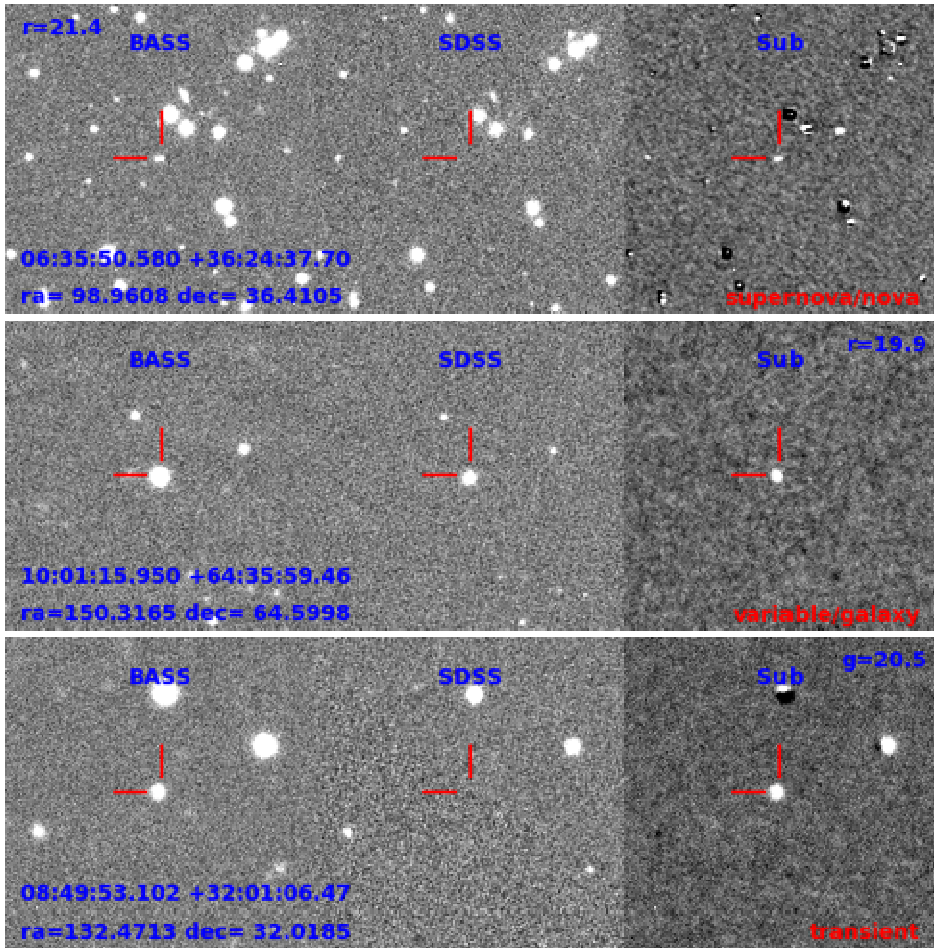


MW nebulae
Wei Zhang et al. 2020

Time domain

- supernova/nova, proper motion, moving objects, and variable stars





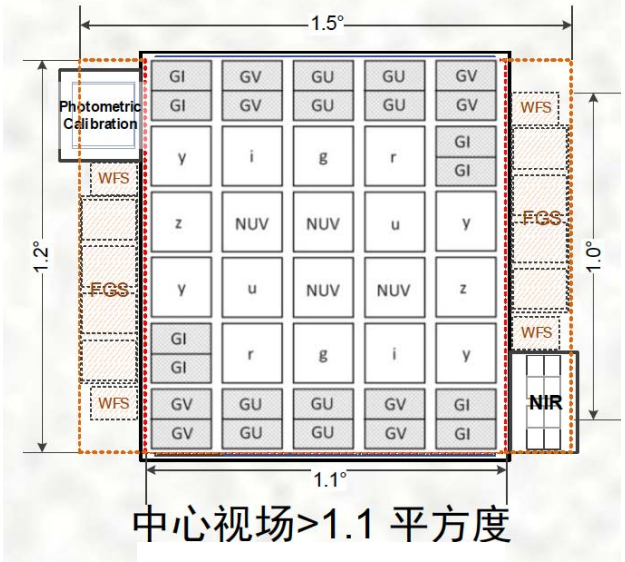
DARK ENERGY SPECTROSCOPIC INSTRUMENT

U.S. Department of Energy Office of Science

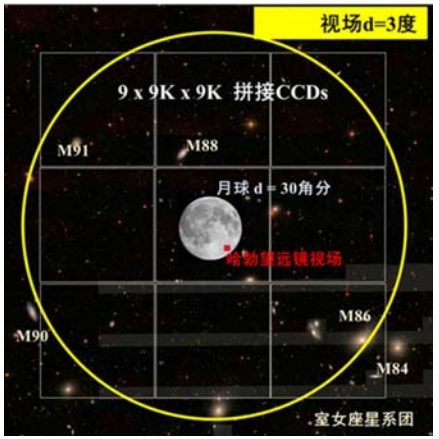
BASS, MzLS, DECaLS collaborators

- CEA/Saclay (France) — Christophe Yeche, Nathalie Palanque-Delabrouille
- Lawrence Livermore National Lab — Eddie Schlafly
- Lawrence Berkeley National Lab — David Schlegel, Michael Levi, Martin Landriau, Rongpu Zhou, Peter Nugent, Armin Karcher, Chris Bebek, Kaylan Burleigh, Mark Zhang
- **NAOC/CAS Beijing — Hu Zou, Xu Zhou, Tianmeng Zheng, Zhimin Zhou, Junden Nie, Xiyan Peng, Dongwei Fan, Boliang He, Zhaoji Jiang, Jun Ma, Jiali Wang**
- NOIRLab - Arjun Dey, Frank Valdes, David Herrera, Stephanie Juneau, Aaron Meisner, Ben Weaver, Alistair Walker, Robert Blum, David Sprayberry, Behzad Abareshi
- Ohio State University — Klaus Honscheid, Hui Kong
- **Peking University — Linhua Jiang**
- Perimeter Institute — Dustin Lang
- Siena College — John Moustakas
- **Tsinghua University — Shude Mao**
- **University of Arizona — Xiaohui Fan, Michael Lesser, Dennis Zaritsky, Jinyi Yang, Ian McGreer**
- University of Toronto — Ray Carlberg
- University of Wyoming — Adam Myers, Joe Findlay
- Yale University — Charles Baltay, David Rabinowitz
- **All observers and other collaborators**

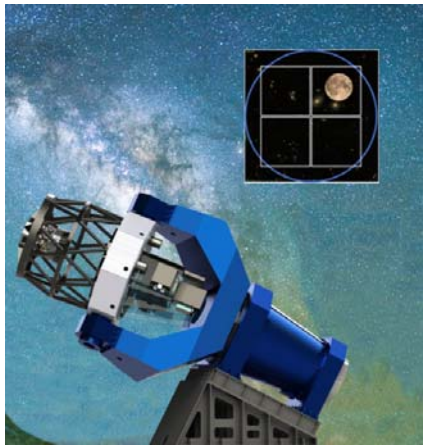
Upcoming Chinese Surveys



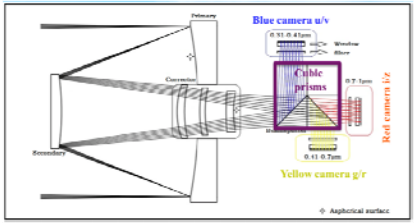
CSST



WFST
USTC+PMO



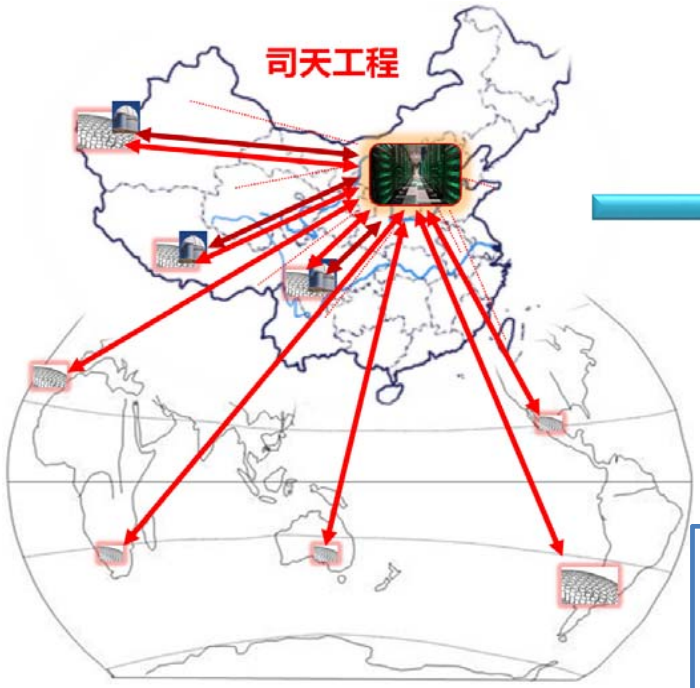
others …



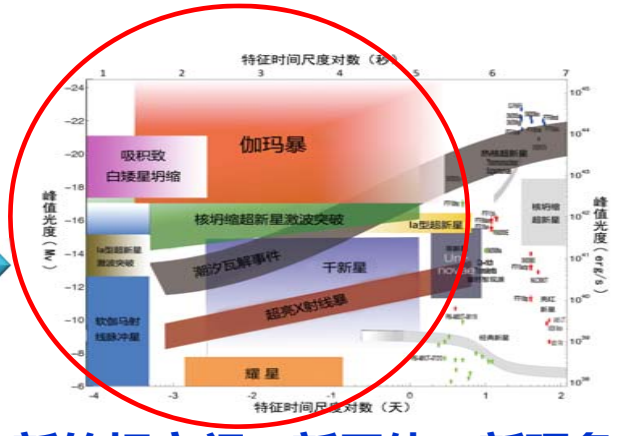
Mephisto
SWIFAR, YNU

From Static to Dynamic

Ambitious Sitian Project (司天工程)



高精度宇宙摄像机
时域天文学
终极观测网络



新的相空间→新天体、新现象

核心概念：现准全天区、高频率、高精度采样

- 72台1米5x5平方度望远镜
- 10000平方度，三色同时观测
- 30分钟采样间隔
- 单次曝光探测极限21等，可后随观测
- 时域观测模式的变革：“巡视”→“深度凝视”

核心科学：

- 宇宙极端高能爆发
- 太阳系天体和系外行星
- 深场静态宇宙

挑战：

- 大视场望远镜和拼接相机研制和工业化生产
- 大规模望远镜智能化集成控制
- 自动化科学优化策略
- 海量数据精确处理和分析
- 海量数据管理
- 科学+技术+科普+教育

谢谢