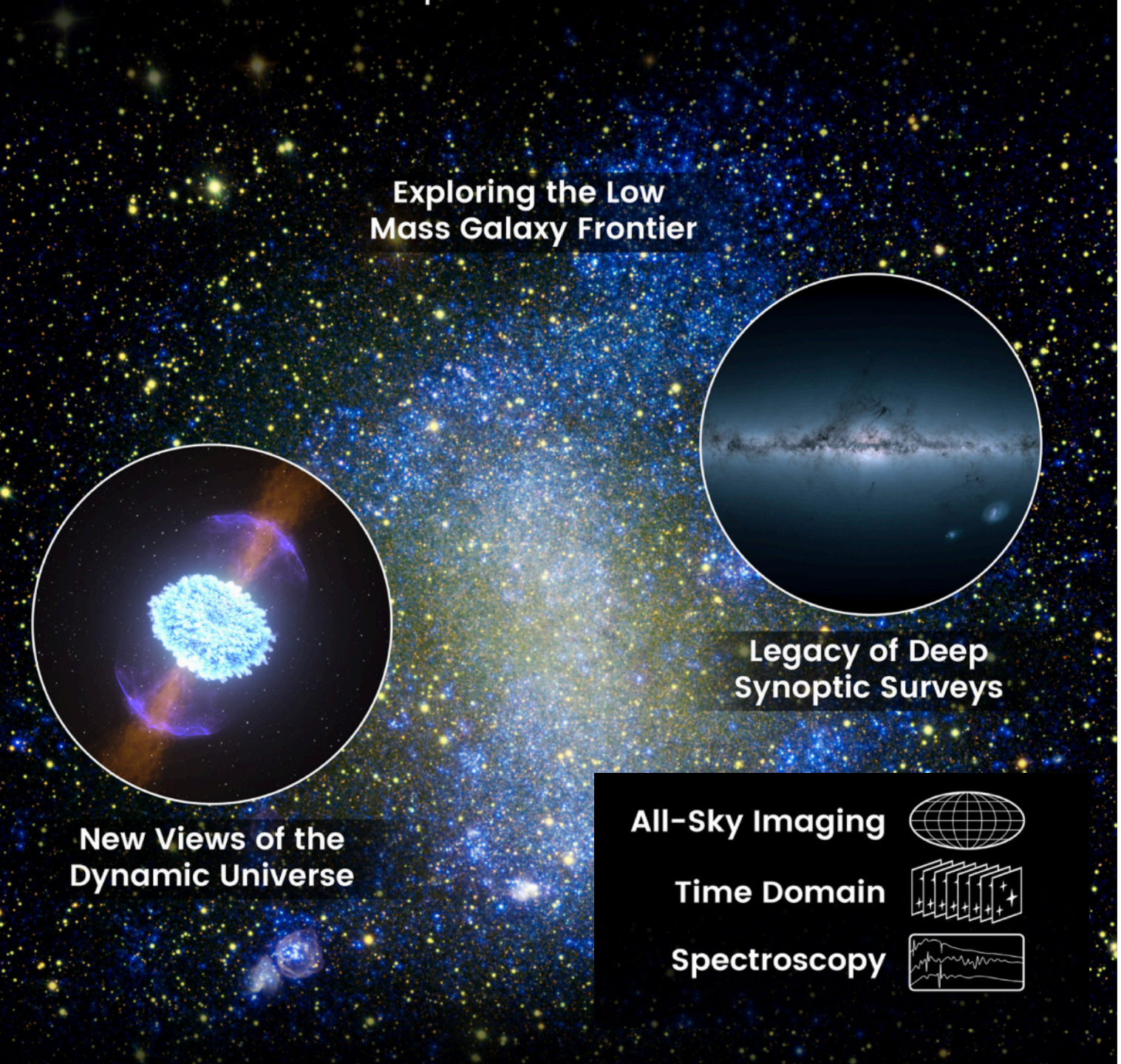
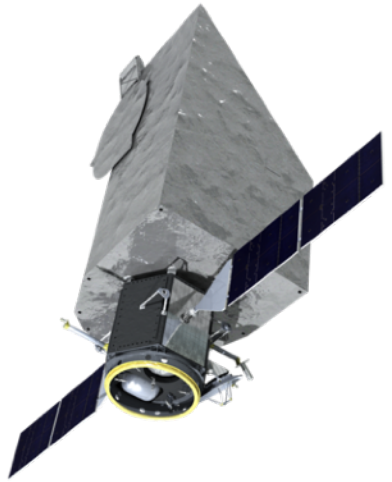


UVEX



The Ultraviolet Explorer

NASA MIDEX Mission
Launch in 2030
PI Fiona Harrison (Caltech)

Dan Weisz

on behalf of the UVEX Team

Dwarfs, Streams, & Clusters

in the LSST Era

July 8, 2024

UVEX Science

The Low-Mass, Low-Metallicity Galaxy (LMLZ) Frontier Lead: Dan Weisz

UVEX will uncover the lowest mass, most pristine local galaxies and diagnose their unique cosmic ecosystems

2020 Decadal priority area: Drivers of Galaxy Growth

New Views of the Dynamic Universe

Lead: Suvi Gezari

UVEX will follow-up multi-messenger and community triggers to probe the early UV emission of transients

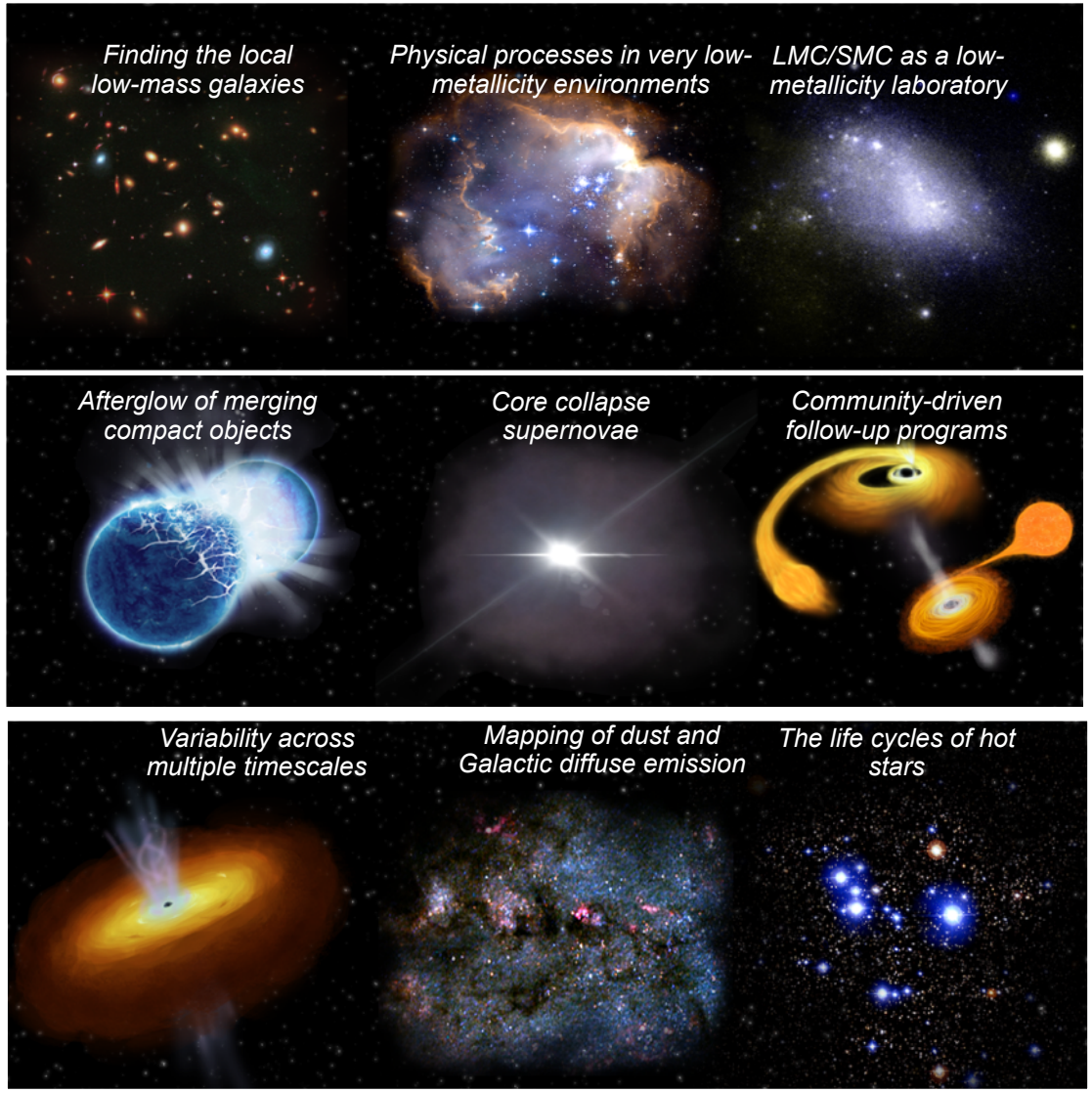
2020 Decadal priority area: New Windows on the Dynamic Universe

A Legacy of Deep, Synoptic All-Sky Surveys

Lead: Kevin Staussun

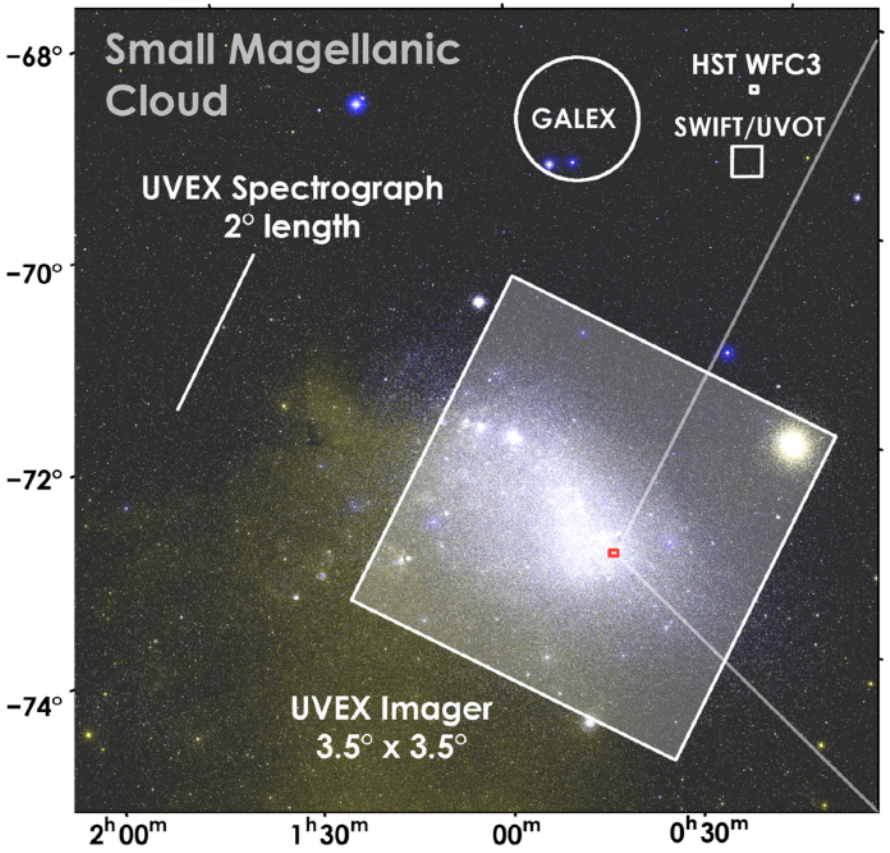
UVEX cadenced all-sky imaging leaves a legacy dataset for the entire community.

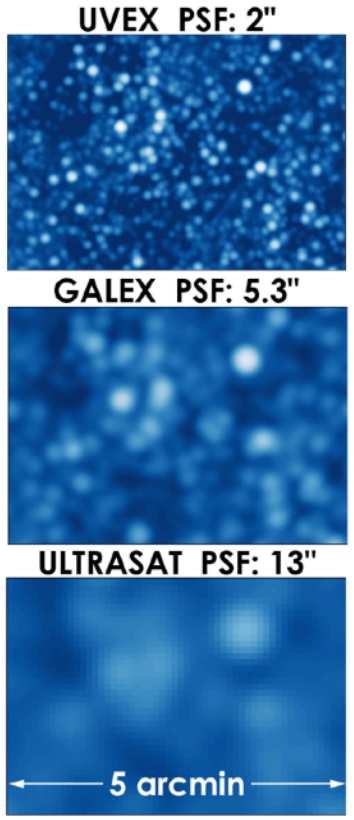
2020 Decadal priority areas: Drivers of Galaxy Growth, New Windows on the Dynamic Universe

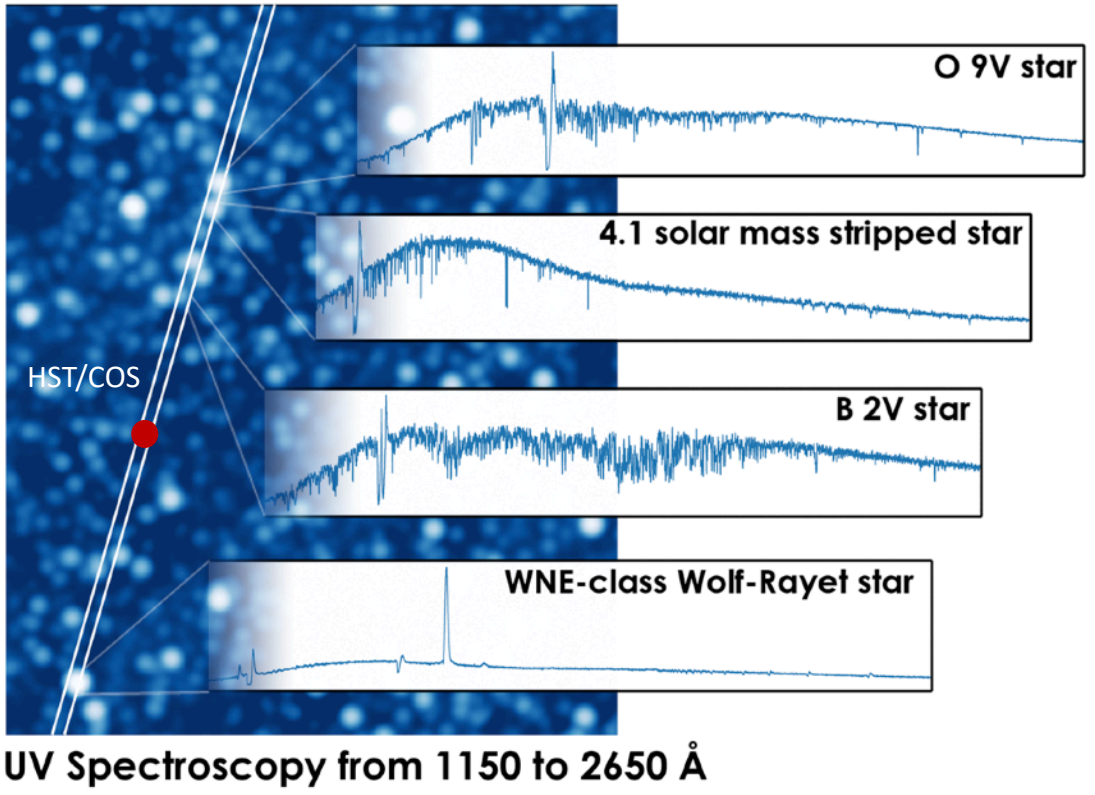


UVEX Capabilities

- *Sensitive wide-field imaging in two ultraviolet bands (FUV & NUV)*
- *High angular resolution across large field of view (<2”/12 deg²)*
- *Broadband ultraviolet spectroscopy (*1150 – 2650 Å; R~1000-3000)
- *Simultaneously acquires imaging and spectra*

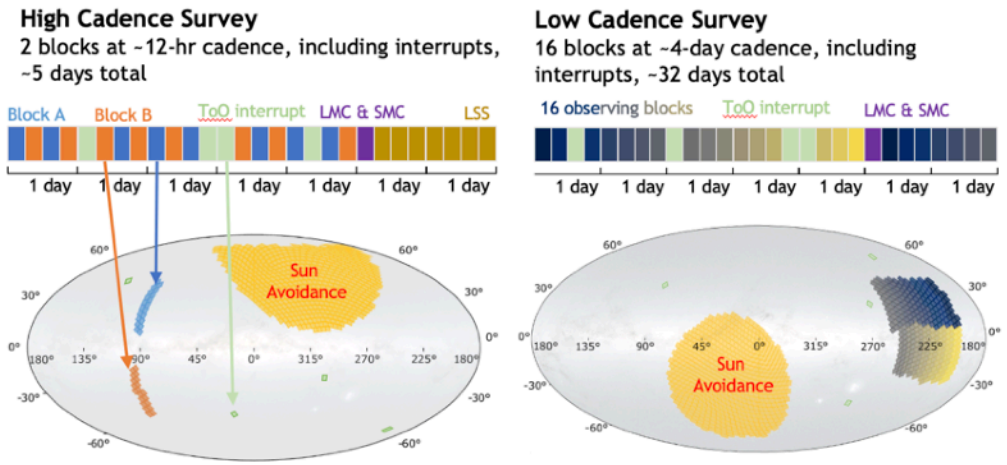






Deep Synoptic Surveys – All-Sky, Cadenced Imaging

Explore the UV time domain by performing imaging surveys of the entire sky in two UV bands with cadences spanning hours to months



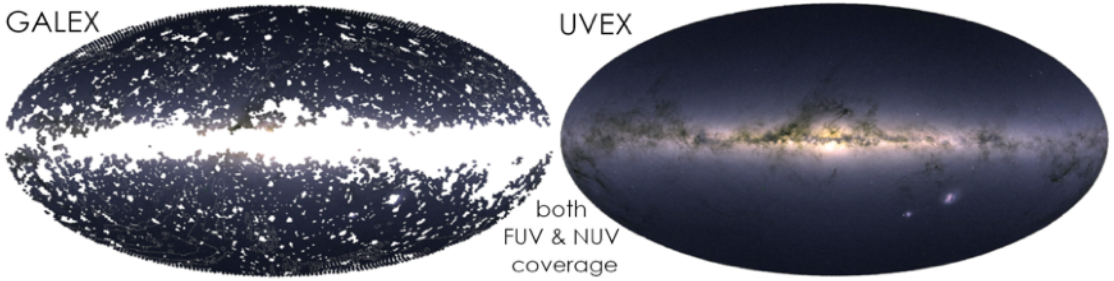
UVEX will discover variable and transient UV phenomena and alert the community for follow-up

A variety of cadences will probe fast transients, tidal disruption events, and monitor variability

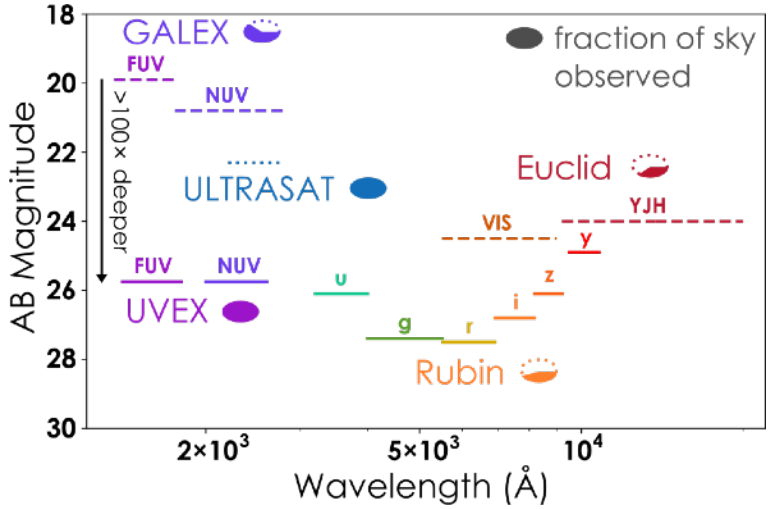
UVEX provides a modern UV time-domain survey

Deep Synoptic Surveys – All-Sky, Cadenced Imaging

Provide deep all-sky maps in two UV bands with sensitivity and resolution complementing modern wide-field surveys in the optical and infrared



The UVEX all-sky survey is >100x deeper than GALEX, and will be the first deep UV survey of the Galactic plane.

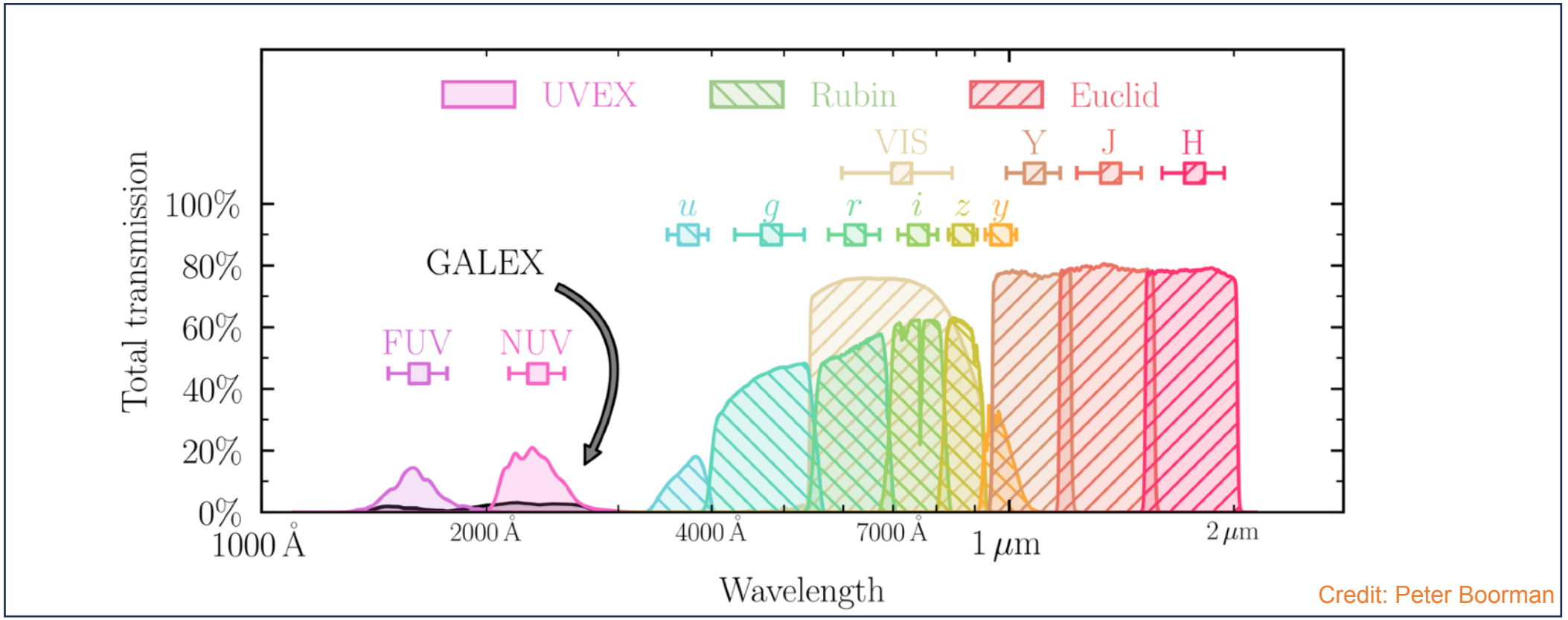


UVEX matches the deep cosmological surveys from Euclid, Rubin, and Roman

UVEX covers the entire sky, and achieves depth and resolution matching modern optical and IR facilities

Deep Synoptic Surveys – All-Sky, Cadenced Imaging

Provide deep all-sky maps in two UV bands with sensitivity and resolution complementing modern wide-field surveys in the optical and infrared

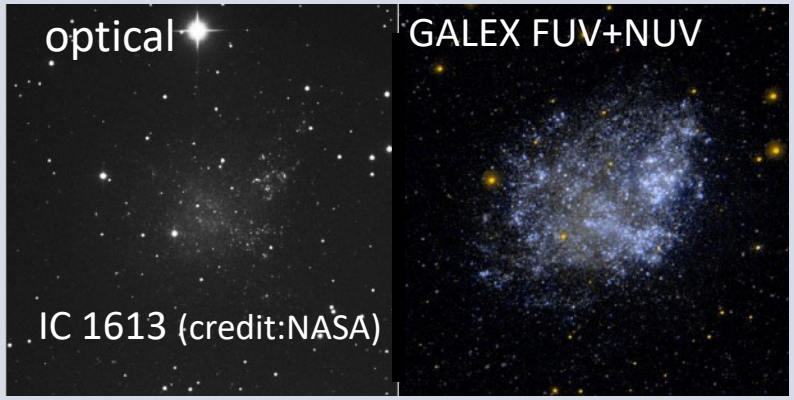


Credit: Peter Boorman

A modern UV / optical / near-IR filter set for most of the sky (Euclid -> Roman in the Galactic Plane).

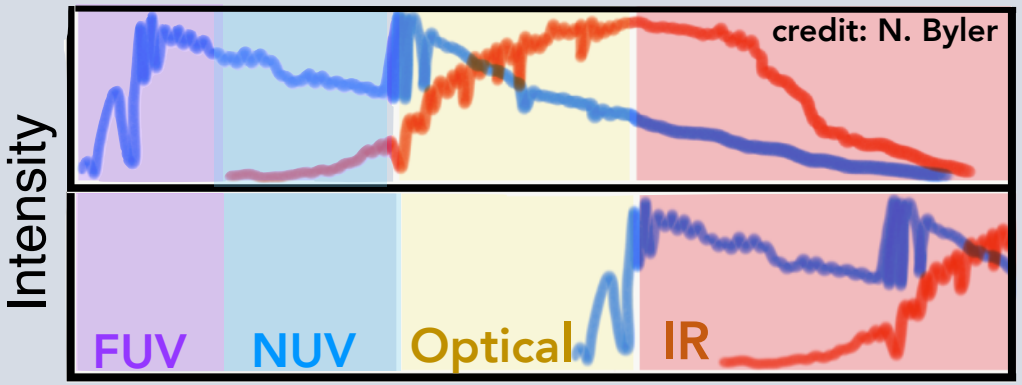
Why UV?

Drivers of galaxy growth



Star-forming galaxies are UV bright

Rest-frame UV spectra characterize galaxy evolution across redshift



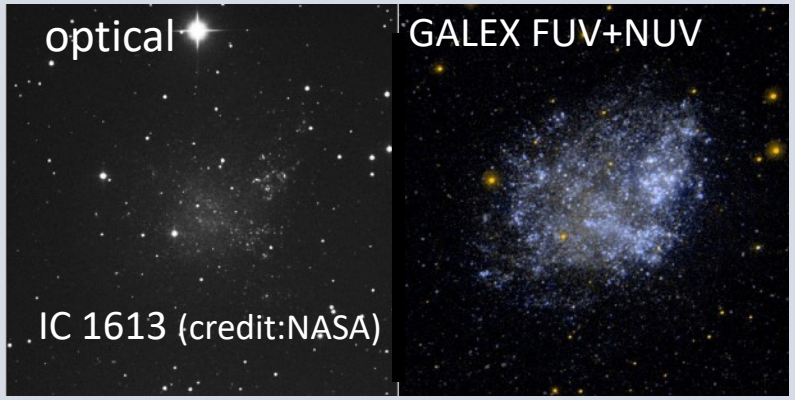
z~0.1 - UVEX (local universe)

z>6 - JWST (distant universe)

Why UV?

Drivers of galaxy growth

Rest-frame UV spectra characterize galaxy evolution across redshift



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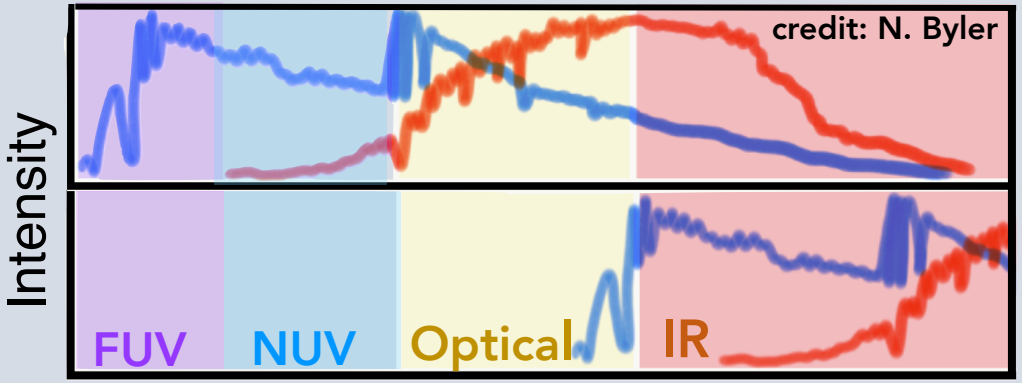

z~0.1 - UVEX (local universe)

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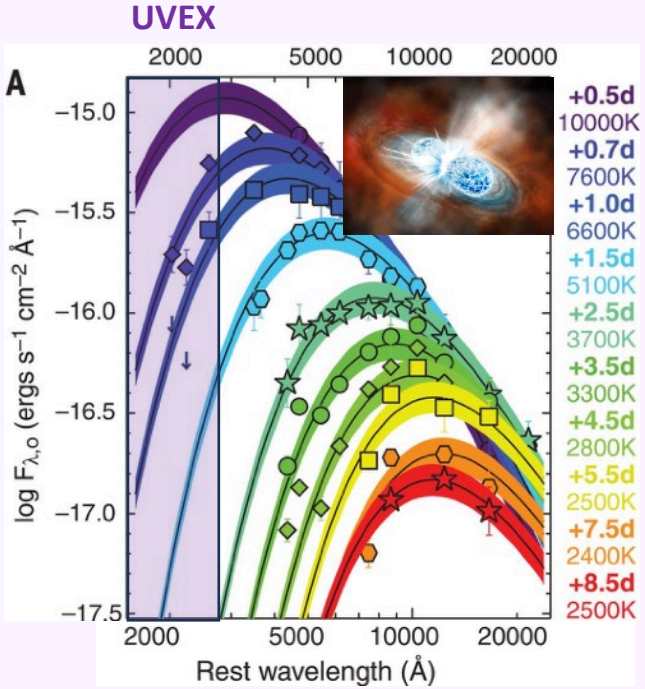
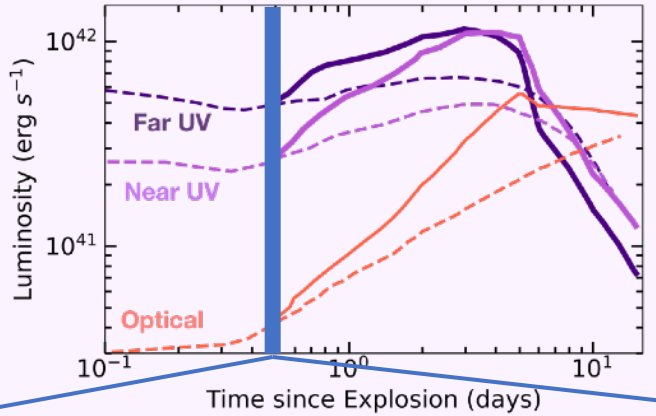
Dynamic Universe



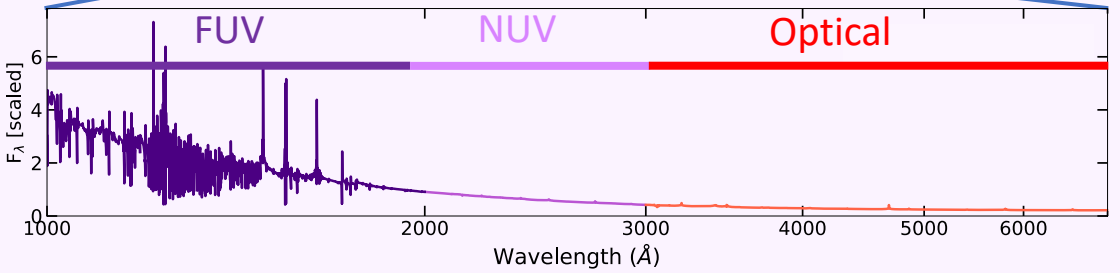
GW-discovered neutron star mergers emit first in UV light



Massive star explosions evolve UV-optical

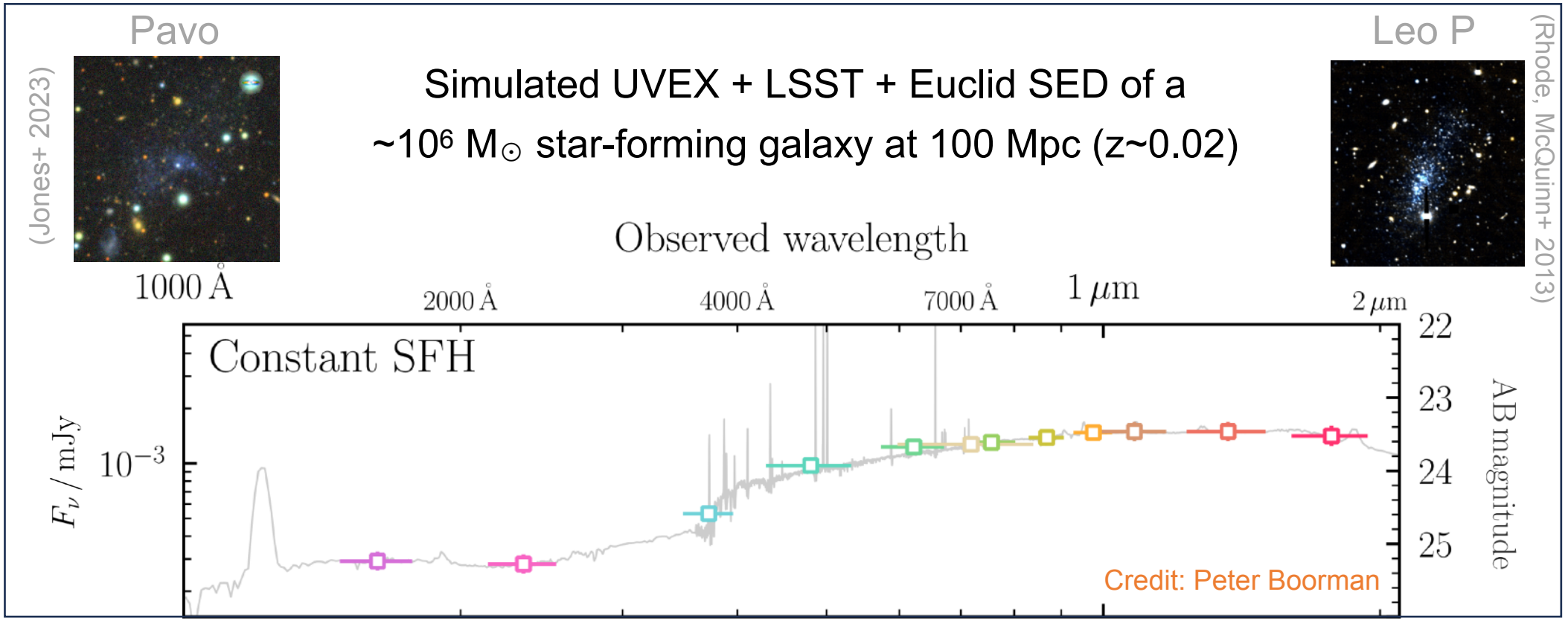
UVEX can follow up within hours

Key diagnostic lines lie in UV



Low-Mass Galaxy Frontier - Mapping Local LMLZ Galaxies

Find the local (z<0.3; d~1.5 Gpc) low-mass (<10^9 $M_\odot$) star-forming galaxies through wide-field imaging surveys (e.g., UVEX+LSST+Euclid) and compare them with known cosmic structures



A modern UV / optical / near-IR dataset set for the extragalactic sky

Lead: Dan Weisz (Berkeley)

Low-Mass Galaxy Frontier - Mapping Local LMLZ Galaxies

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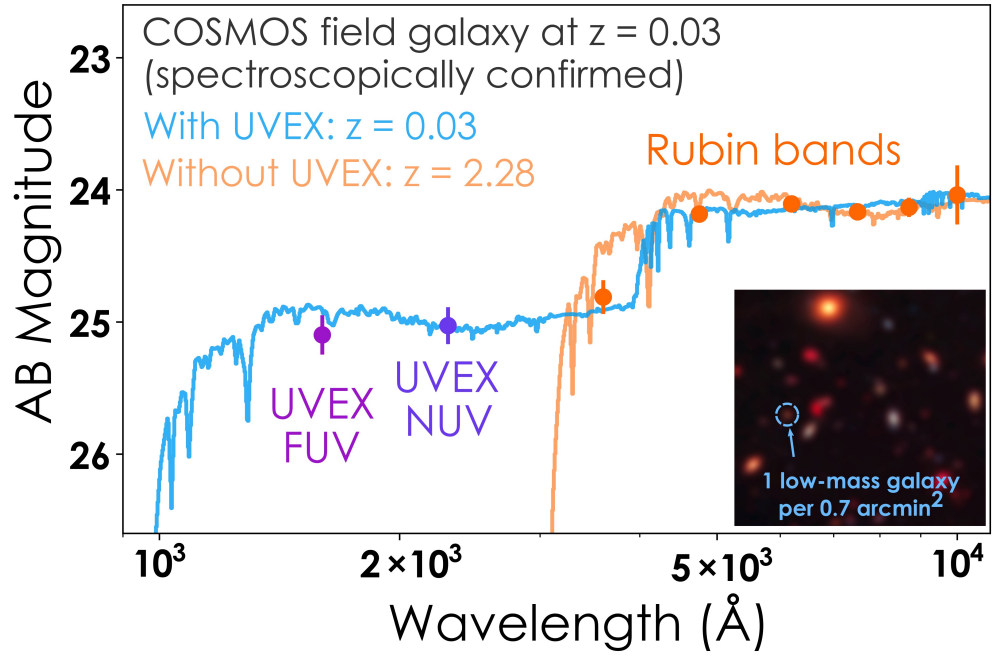
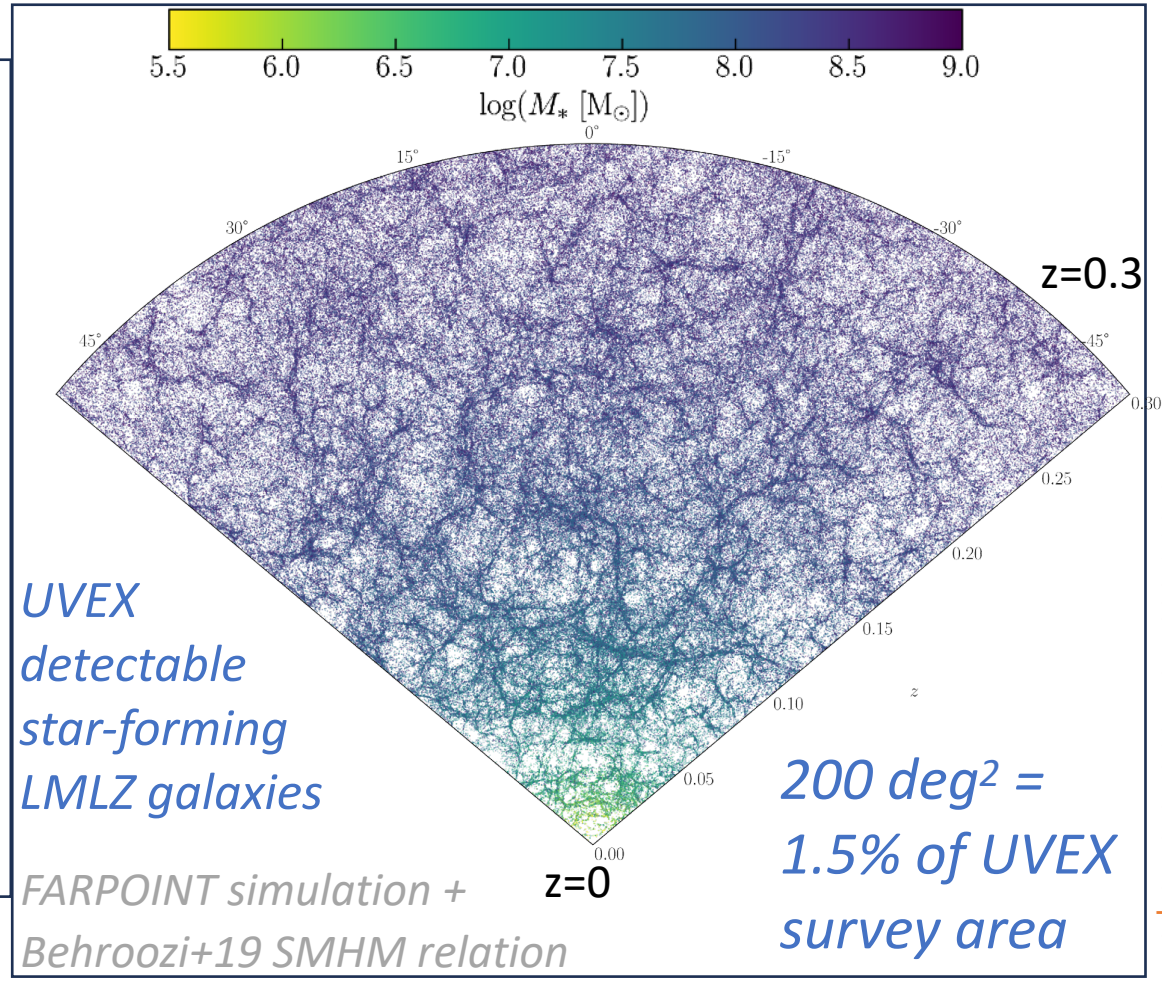
UV imagining critical for separating local low-mass and higher-z more massive star-forming galaxies



Science: field stellar-halo mass connection, star formation, effects of environment, large-scale structure, …



Credit: Joanna Piotrowska-Karpov

Frontiere+ 2022

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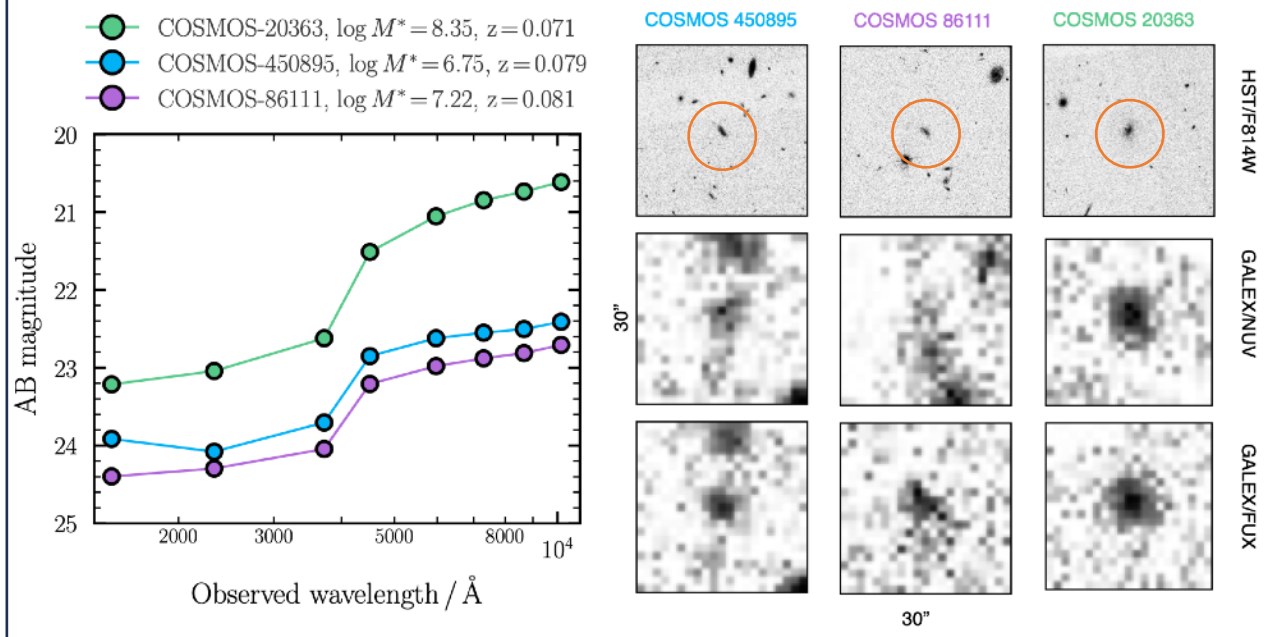
Examples of LMLZ galaxies in COSMOS (~2 deg²)

Wright+ 2017, Weaver+ 2022



Science builds on GAMA, ELVES, SAGA, DESI, Merian, …

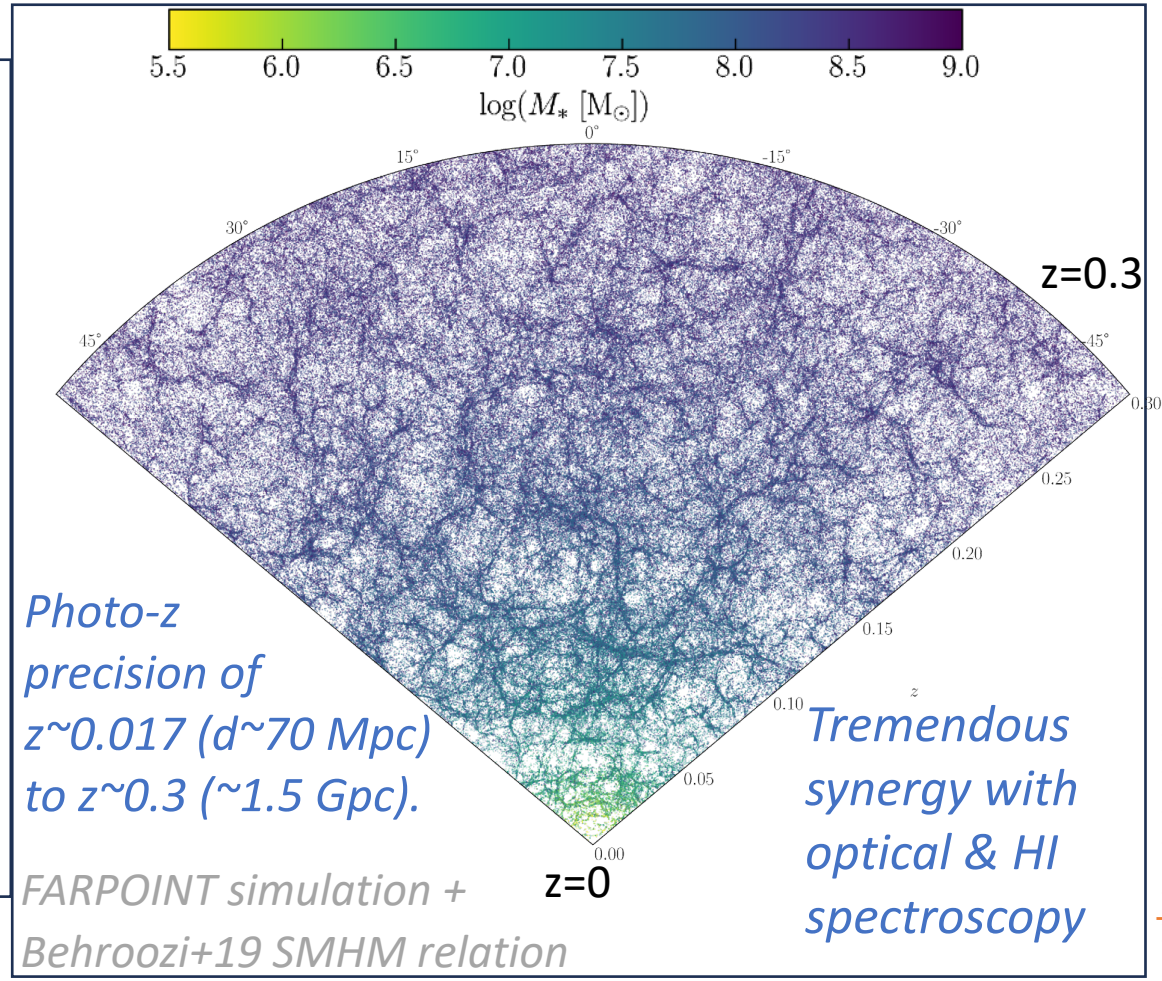


Photo-z precision of z~0.017 (d~70 Mpc) to z~0.3 (~1.5 Gpc).

FARPOINT simulation + Behroozi+19 SMHM relation

Tremendous synergy with optical & HI spectroscopy

Credit: Joanna Piotrowska-Karpov

Frontiere+ 2022

Low-Mass Galaxy Frontier - Mapping Local LMLZ Galaxies

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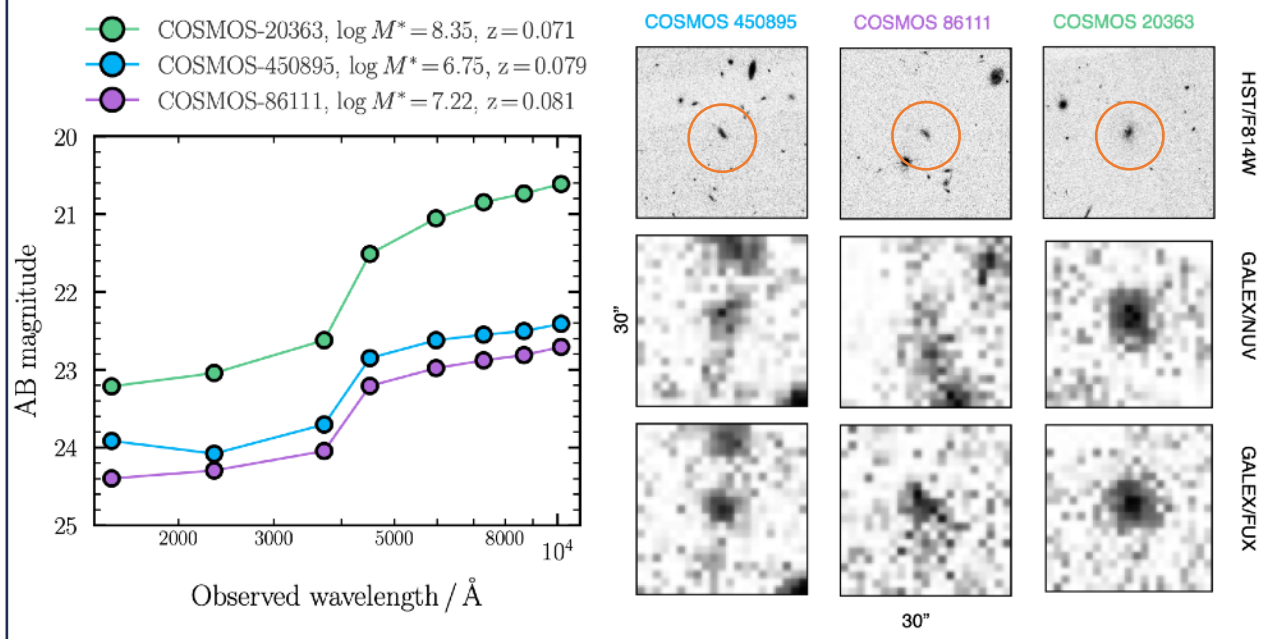

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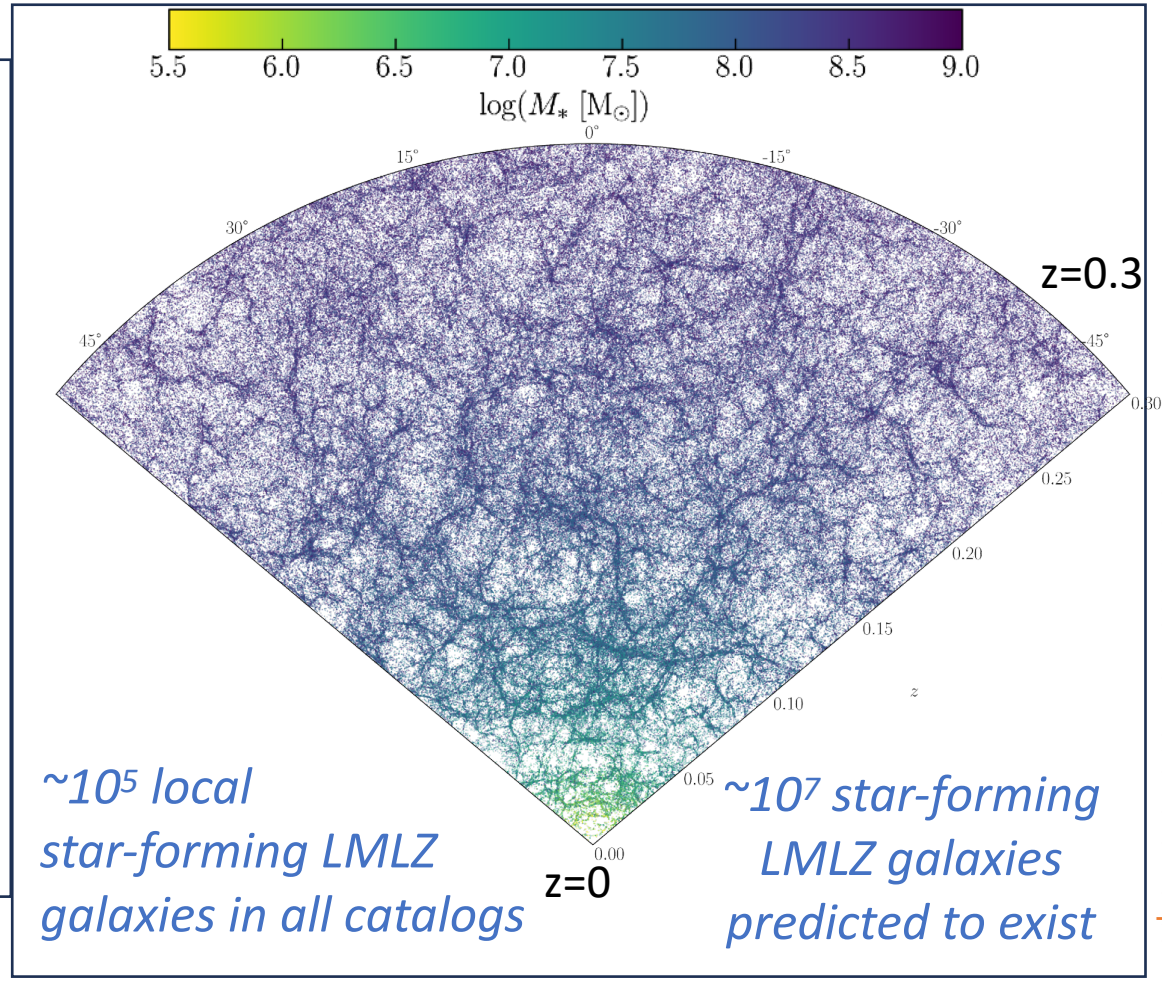


~10^5 local star-forming LMLZ galaxies in all catalogs

~10^7 star-forming LMLZ galaxies predicted to exist

Credit: Joanna Piotrowska-Karpov

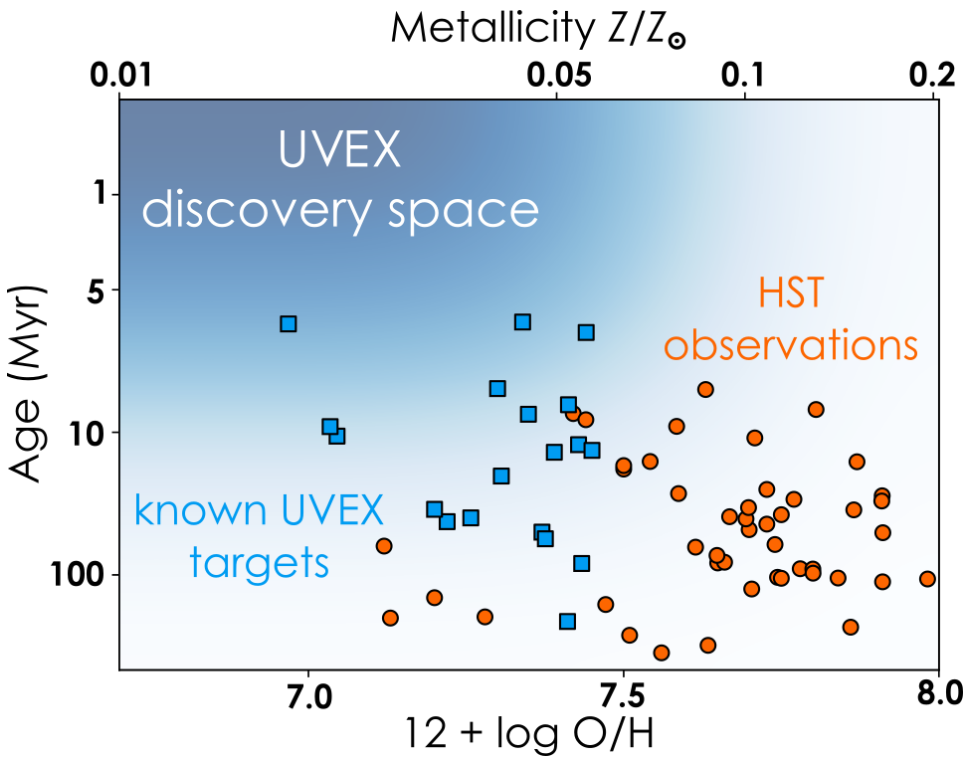
Frontiere+ 2022

Low-Mass Galaxy Frontier - Extreme LMLZ Galaxies

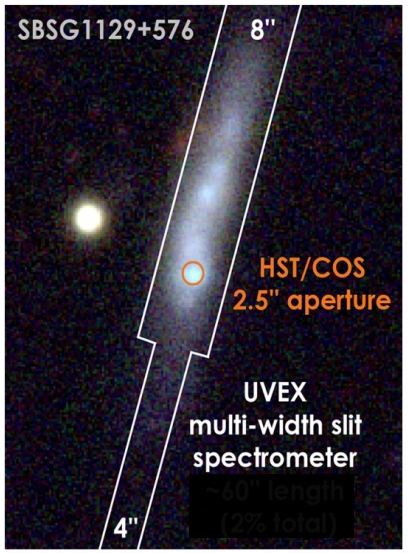
Diagnose the physical processes that drive

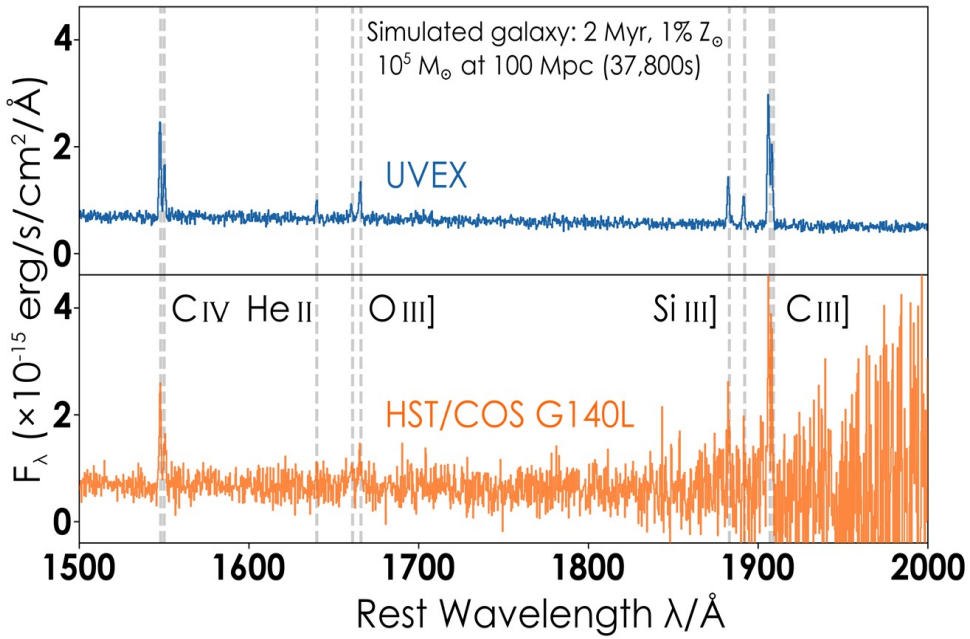
LMLZ galaxy formation through UV spectroscopy

UVEX imaging will help discover local extreme star-forming LMLZ galaxies



UVEX will obtain deep spectroscopy for dozens of local extreme LMLZ galaxies



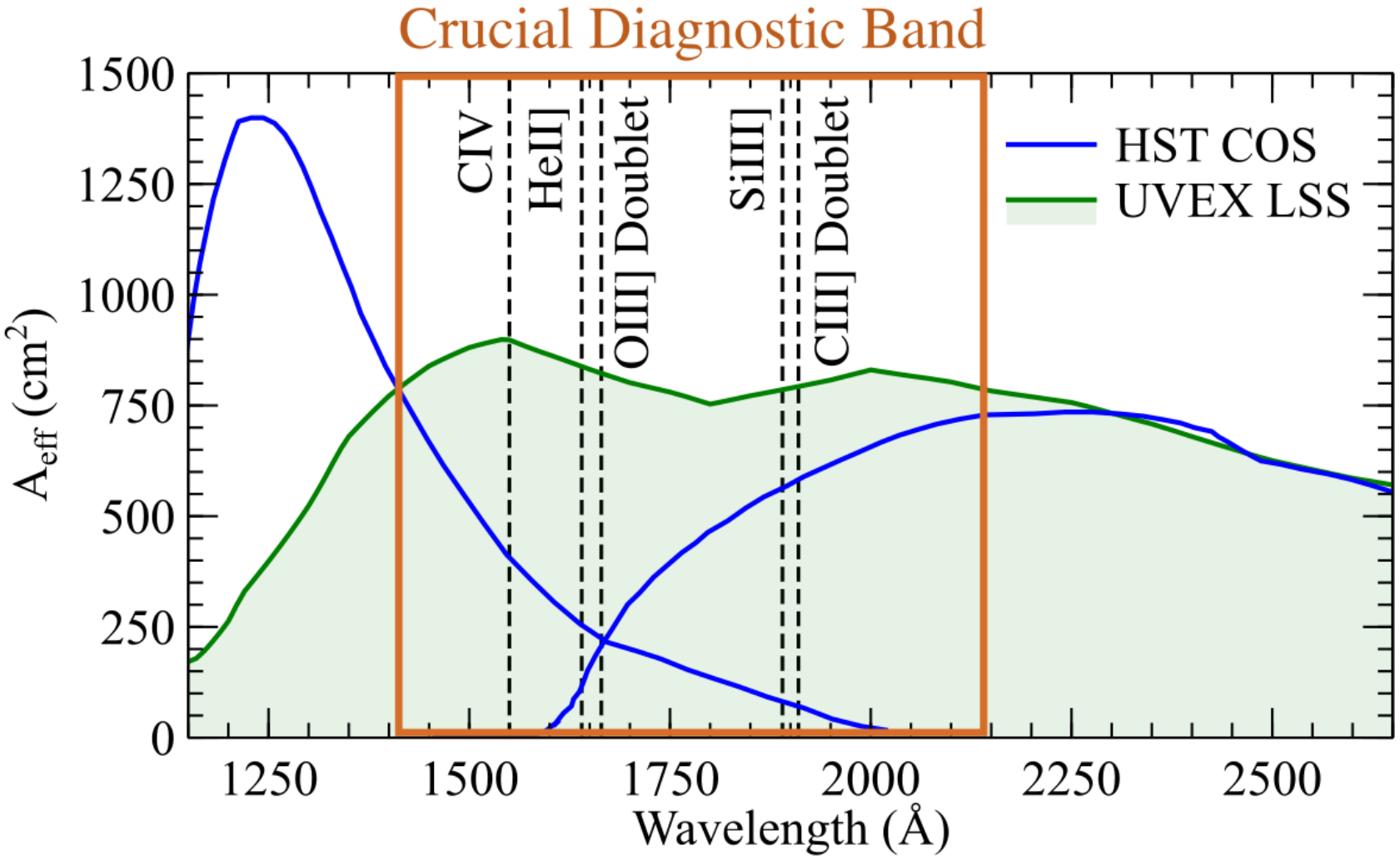


Science builds on HST CLASSY survey: stellar winds, gas-phase high ionization abundances, carbon production mechanisms, feedback, outflows, …

Credit: Danielle Berg, Peter Senchyna

Lead: Danielle Berg (Texas)

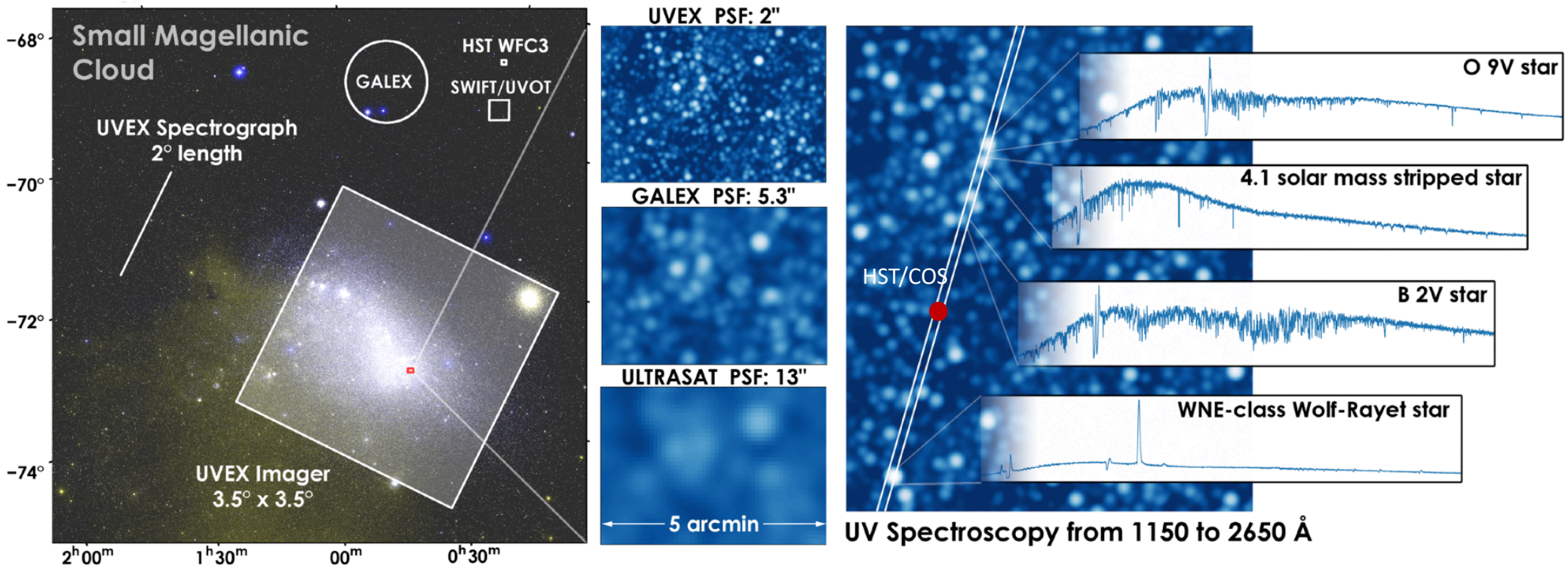
UVEX Spectroscopy — leverages improvements in UV technology



UVEX designed for sensitivity across crucial UV band

Galaxy Frontier Science - Hot Stars in the LMC/SMC

Determine the evolution of hot single and binary stars in the Magellanic clouds



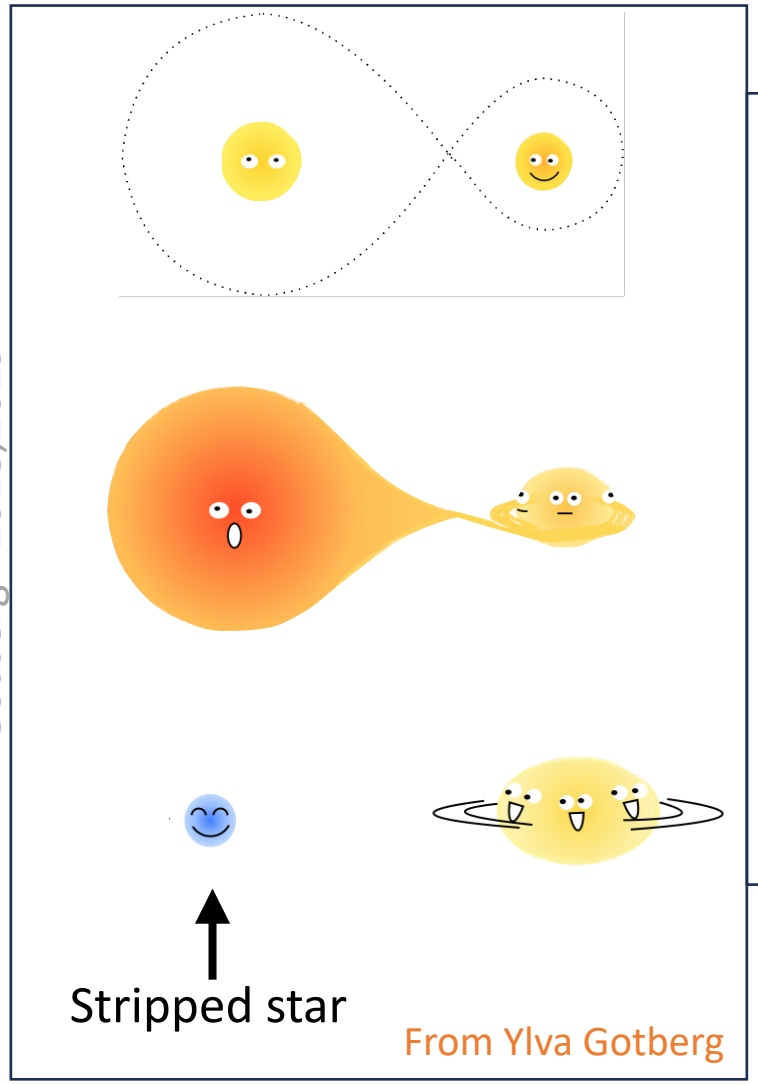
- *UVEX time series imaging identifies hot stars, rare binaries, and eclipsing systems*
- *Stacked LMC/SMC imaging reaches SNR>=30 at m_{UV}=25 to find stripped stars*
- *UV spectroscopy of ~1000 hot stars/binaries to measure stellar winds*

Lead: Hugues Sana (Lueven)

Galaxy Frontier Science - Hot Stars in the LMC/SMC

Identifying Stripped Star Candidates in the LMC and SMC

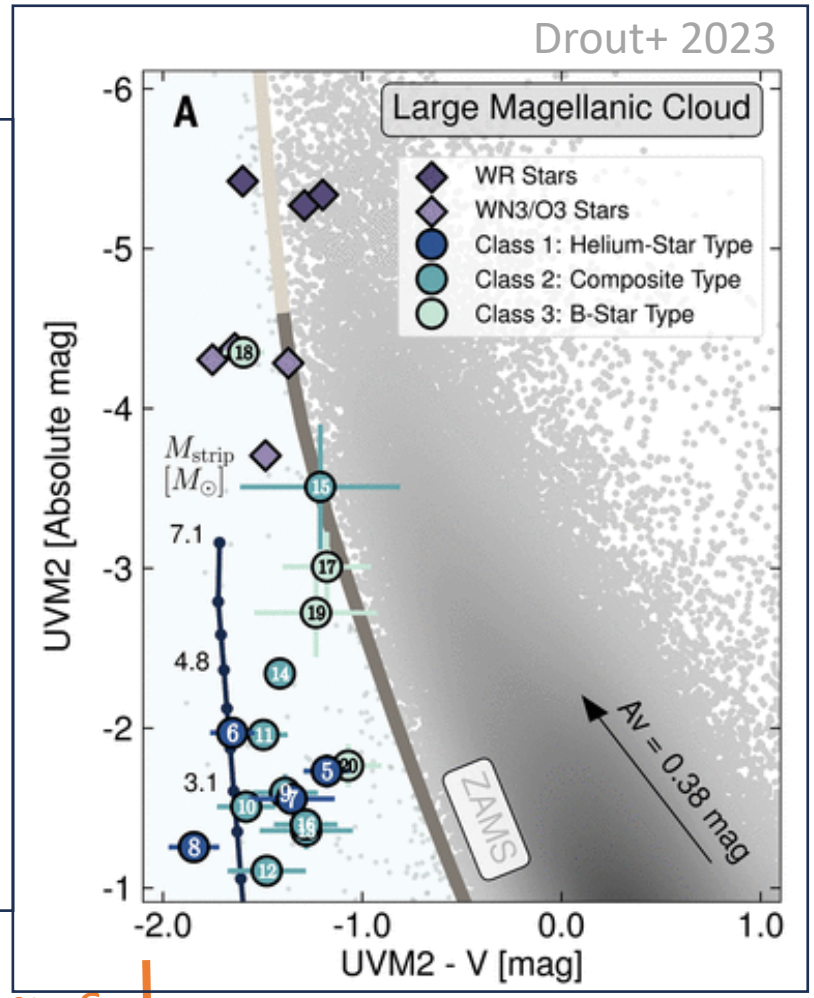
Making of a stripped star



Gotberg+ 2018,2019

- *Unambiguous signpost of binary mass transfer*
- *Most clearly identified through UV color excess*
- *Very few observed to date*
- *UVEX should detect ~10^4 stripped star candidates in LMC and SMC*

Drout+ 2023

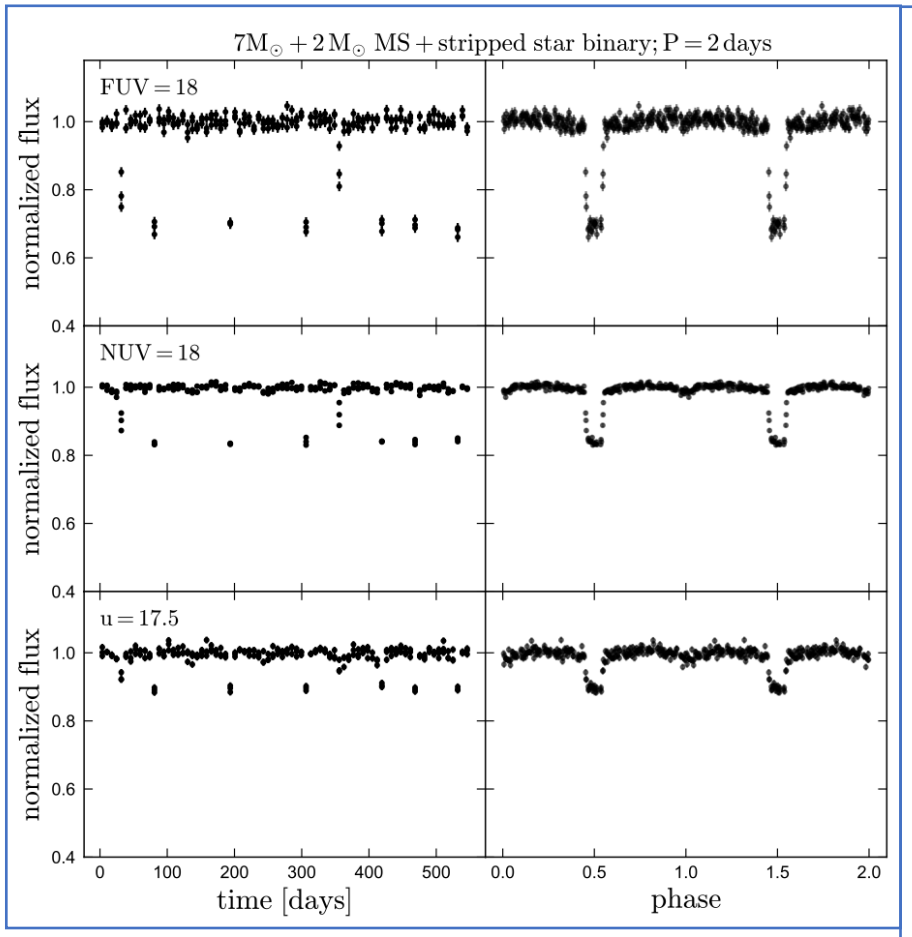


UVEX depth: M_{UV} ~ +6
LSST depth: M_g ~ +8

Galaxy Frontier Science - Hot Stars in the LMC/SMC

Time series imaging and targeted spectroscopy to characterize hot single and binary stars

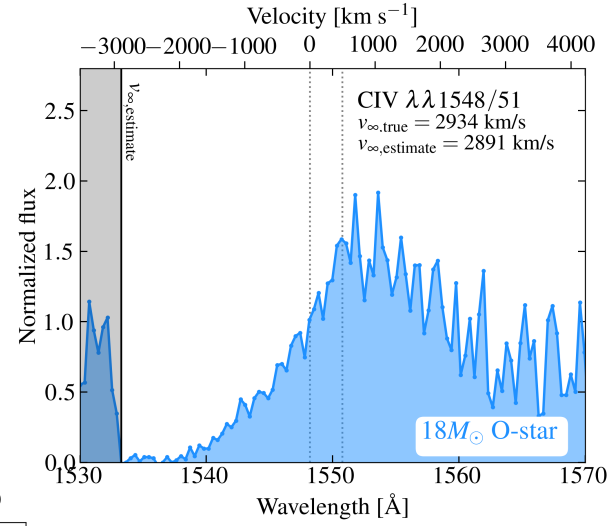
Eclipsing MS + stripped star binary

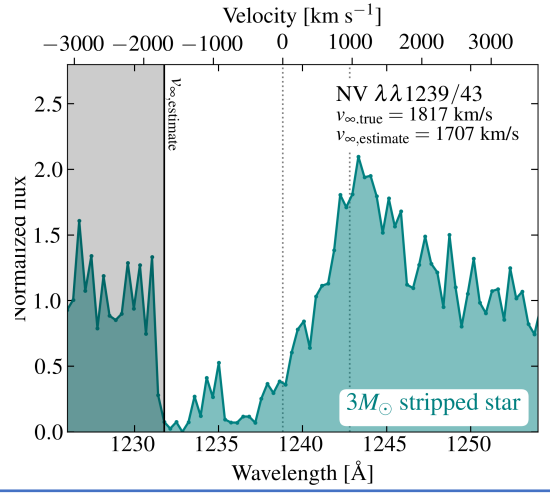


Credit: Kareem El-Badry

Wind velocities for OB and stripped stars

CIV line in LMC O-type star



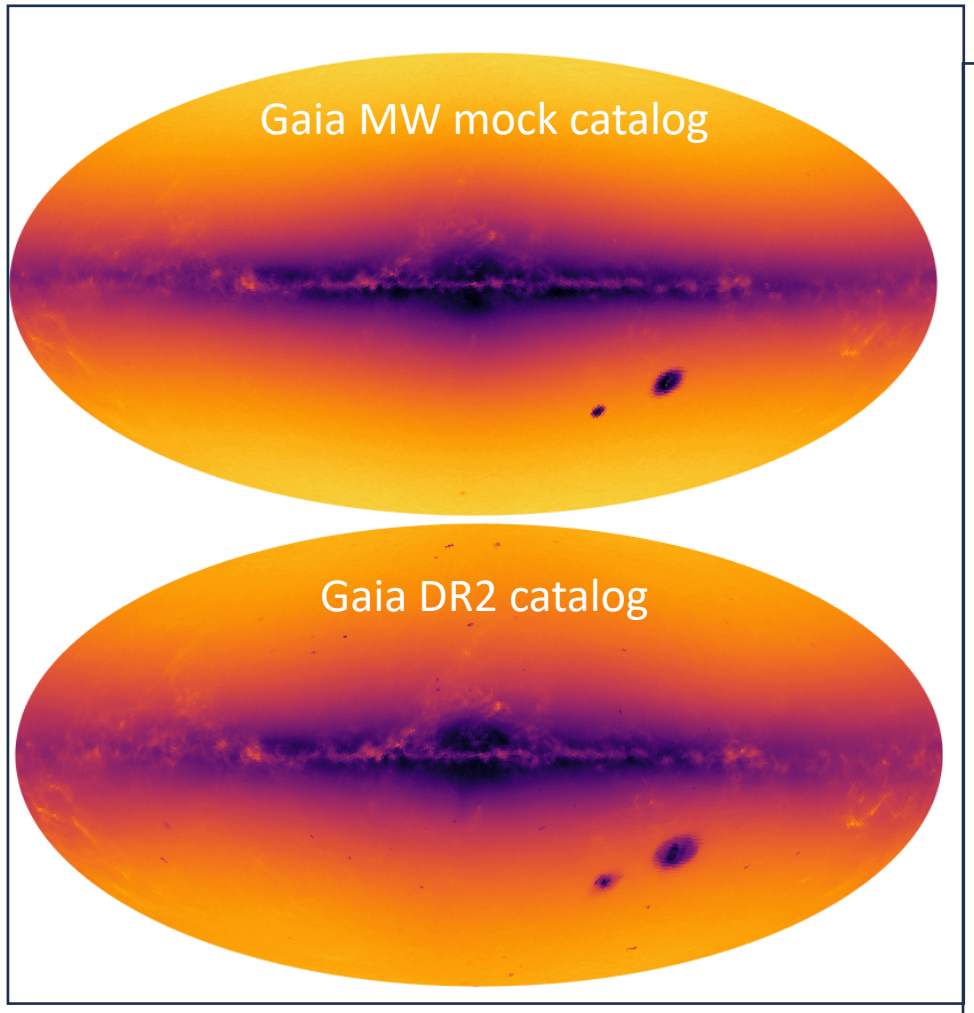


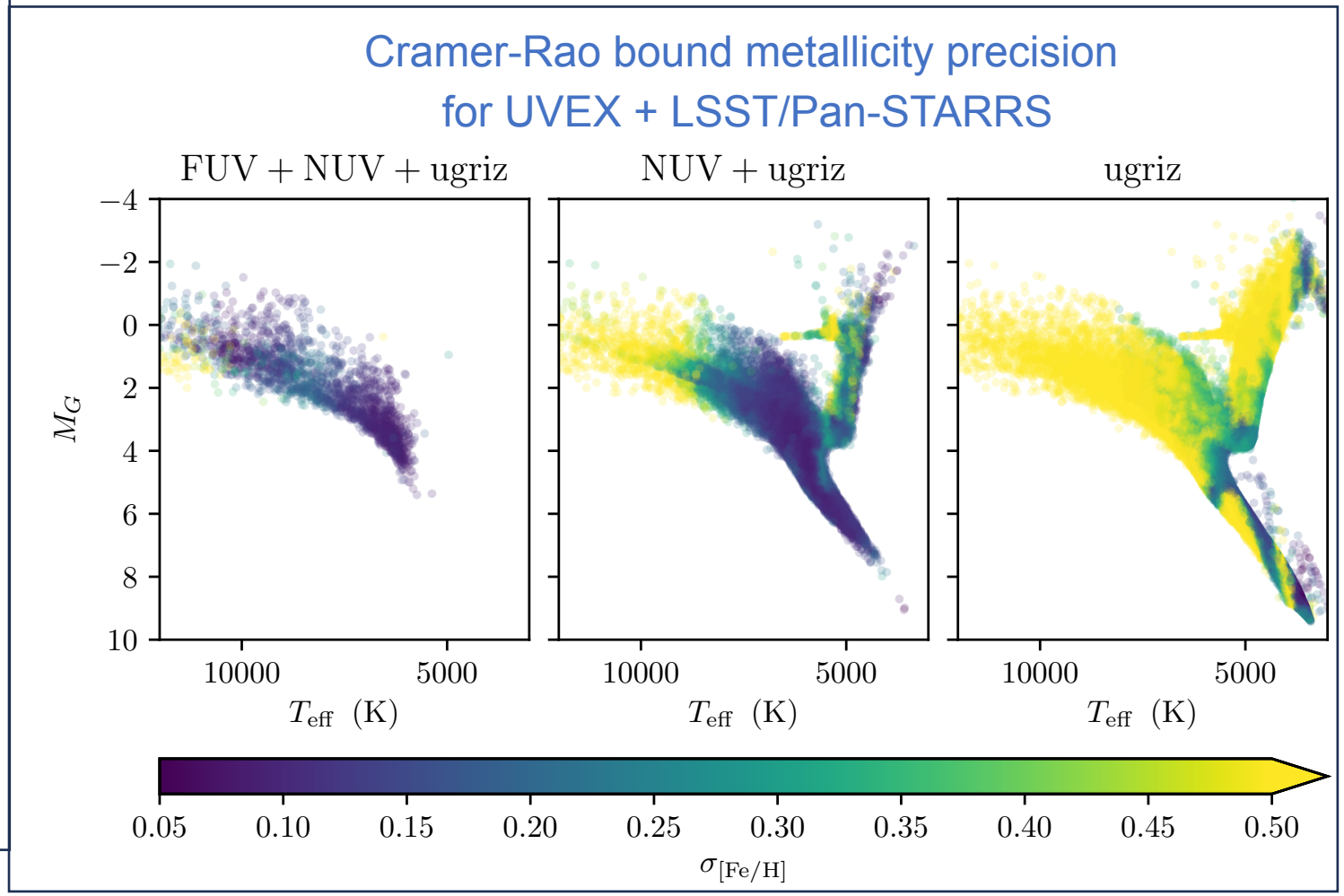
NV line in LMC stripped star

Credit: Ylva Gotberg

Deep Synoptic Surveys – Milky Way Stellar Metallicites

Ancillary Science: UVEX photometric metallicities of 300 millions stars in MW



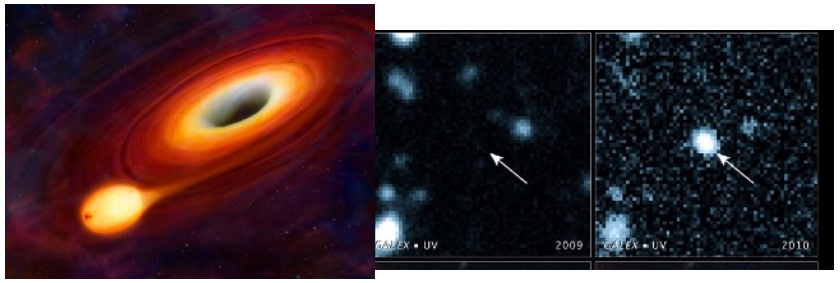


Rybizki+ 2020

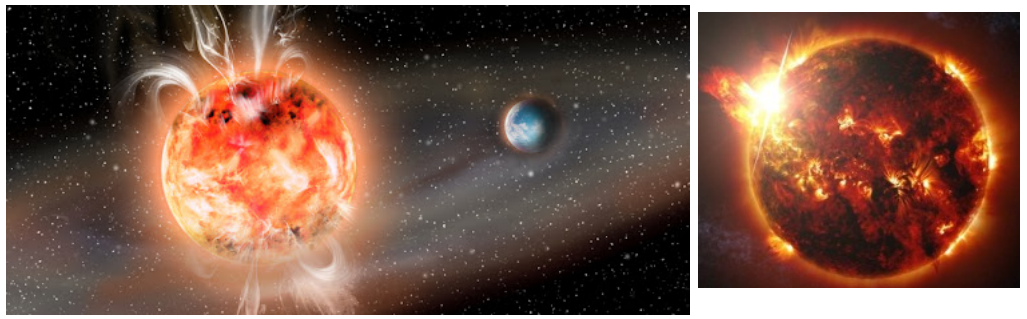
Credit: Greg Green

Dynamic Universe - Community triggered ToOs

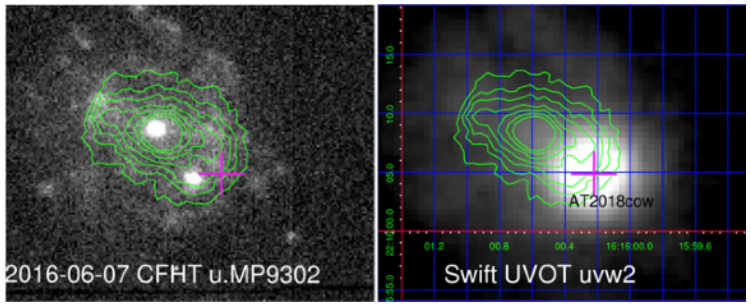
Provide a resource for the community to explore the dynamic sky through rapid UV spectroscopic follow-up — ~60 days of UVEX is community ToO time



Broad absorption lines in stars being eaten by supermassive black holes



Energetic flares on active stars



Relativistic supernovae - UV-bright fast blue optical transients

Accretion physics at the end of the stellar lifecycle – novae, low-mass X-ray binaries

By providing the first rapid spectroscopic UV follow-up capability UVEX enables a broad range of time-domain science and opens tremendous discovery space

UVEX — 2030 launch, 2 year prime mission

uvex.caltech.edu

Kulkarni+ 2021

- **Modern, all-sky, cadenced FUV+NUV imaging (and UV spectra)**
  - >100x deeper than GALEX
  - ~60 days of community ToO time
  - Transient alerts in real time
  - All data public via IPAC
  - Strong synergy with LSST, Euclid, Roman, UNIONS, SPHEREx, PFS, DESI, …
- **Low-mass, Low-Metallicity Galaxy Science**
  - Find and map millions of LMLZ galaxies to ~1.5 Gpc (z~0.3)
  - Targeted UV spectroscopy of extreme LMLZ galaxies
  - LMC/SMC: deep, cadenced imaging and targeted spectroscopy of hot stars
- **Collaboration with the broader community** (e.g., spectroscopic follow up, large volume simulations, HI surveys, Magellanic Cloud science, LMLZ galaxy searches, …)
- **Looking for postdocs and/or grad students in the upcoming year**