Science

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Team

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Megan Kokoris(grad student)

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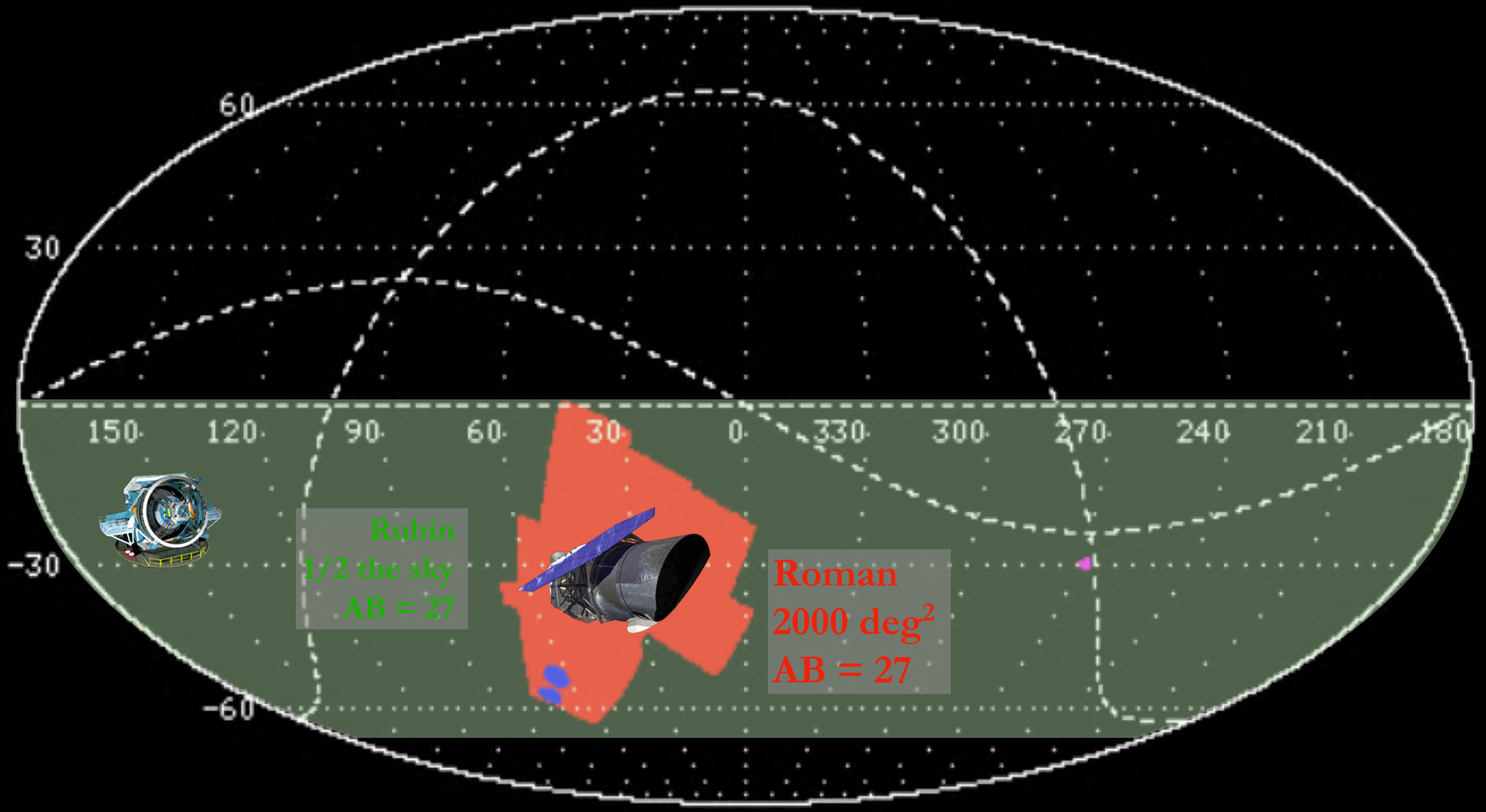
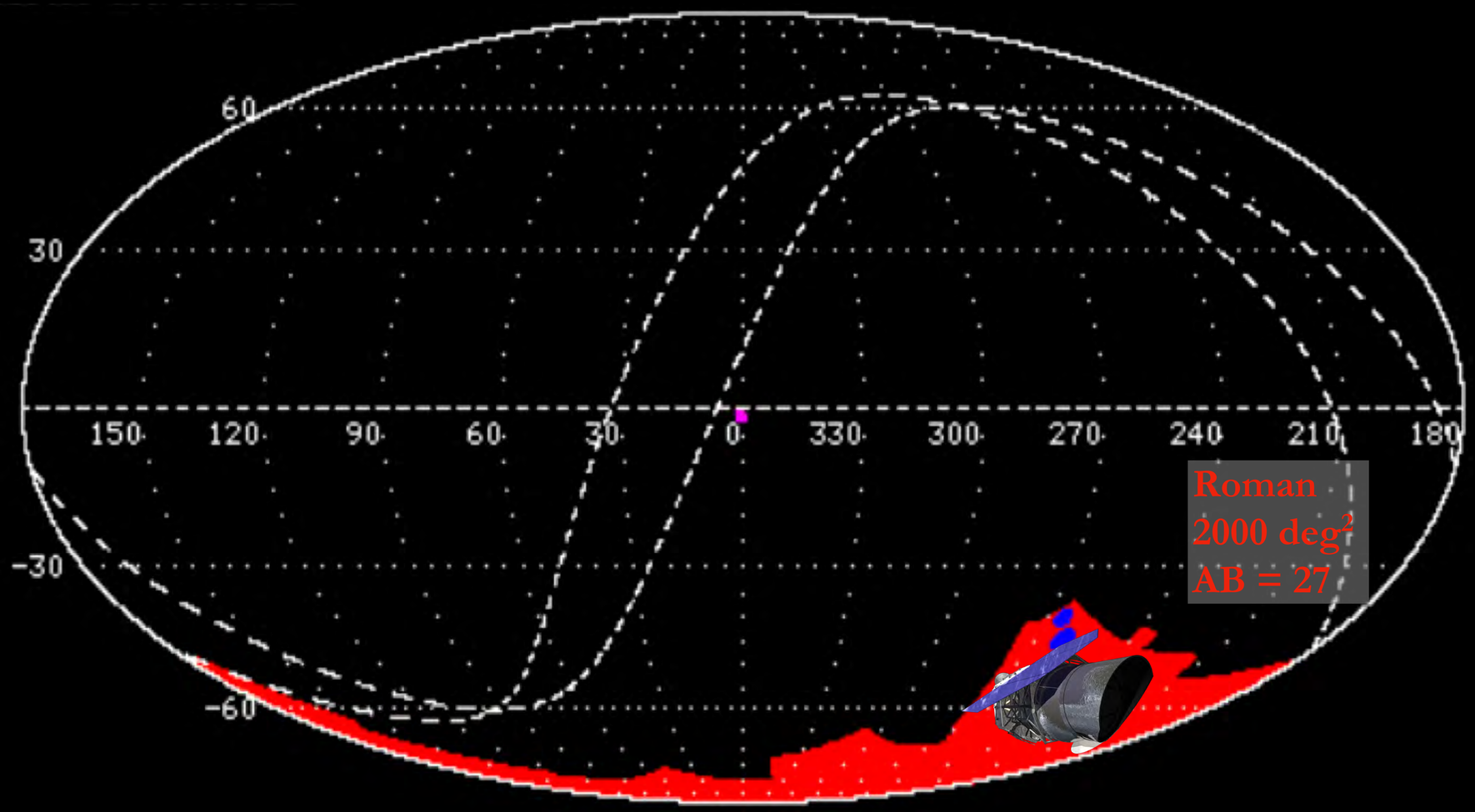
Roman HLS - Equatorial Coordinates



Roman HLS - Galactic Coordinates



Inner Milky Way studies require
infrared wavelengths to minimize extinction.

courtesy Jessica Lu

Milky Way Science Themes

structure of the inner Milky Way

isolated black holes

star formation and IMF near the Galactic Center

fundamental evolution and binarity of post-MS stars

mass loss from evolved stars in coronagraphic imaging

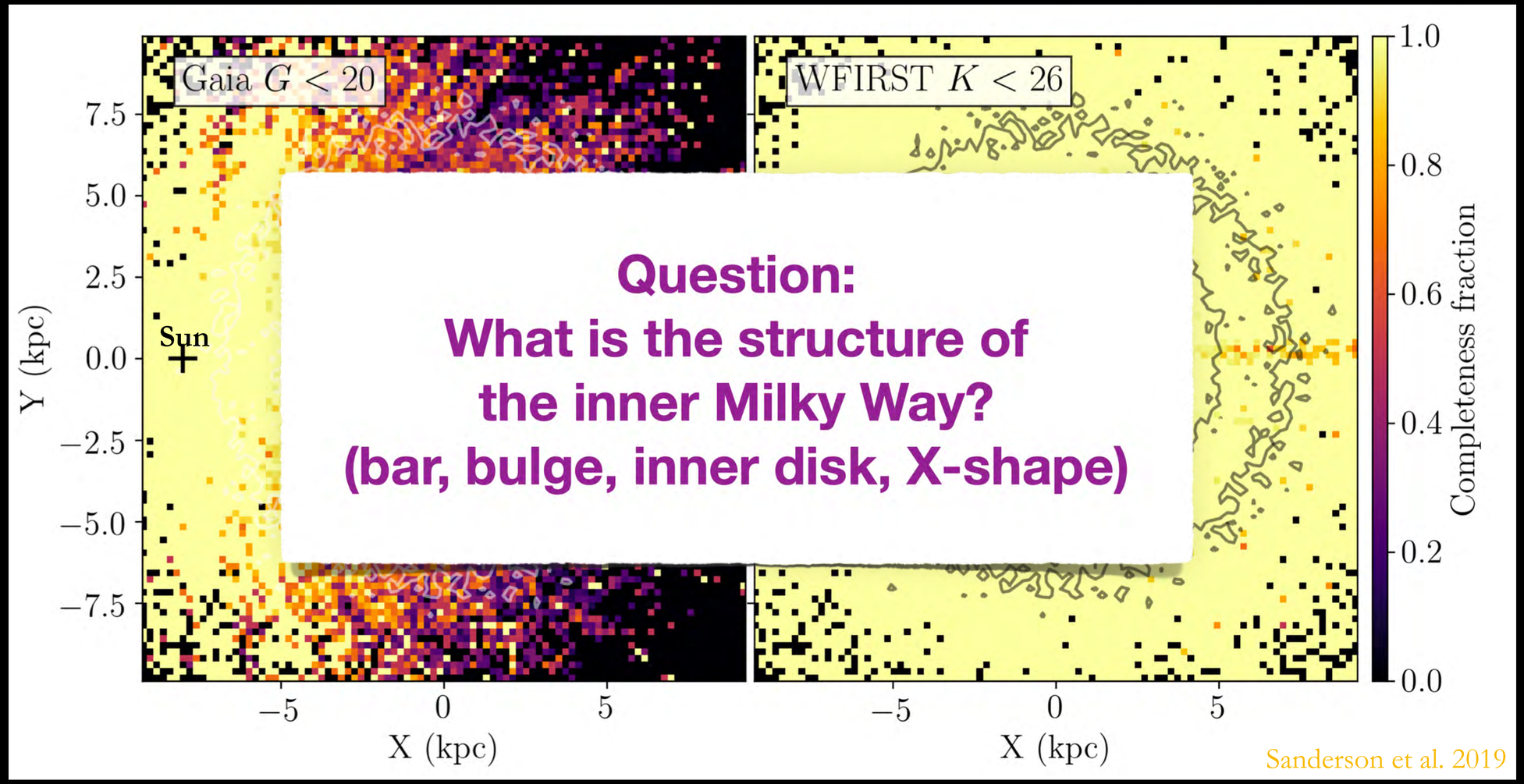
fundamental models

hierarchical galaxy formation via satellites

streams and faint dwarfs

Structure of the inner Milky Way

Roman sees where Gaia cannot



Caption: Red clump stars visible in Gaia (left) and Roman (right) color coded by "completeness".

Need proper motions and parallaxes.

"a mission-long astrometric accuracy of 10 μas or better (with a stretch goal of 3 μas) should be achieved at H_{AB} = 21.6. (9% relative parallax at 8 kpc)."

Lu

Black holes discovered so far are all in binaries.

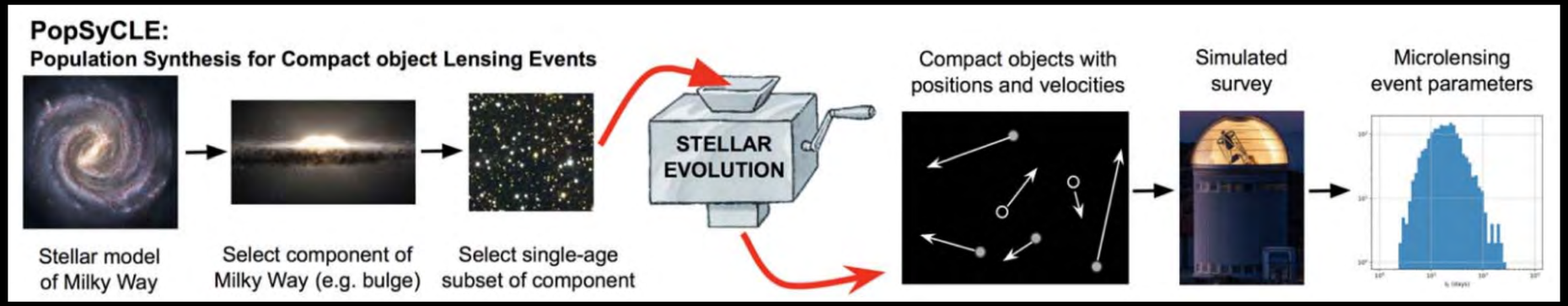
Unanswered questions remain.

- What is the total number of BHs in the Milky Way?
- What stars turn into black holes?
- What is the true black hole mass distribution?
- How many BHs are in binaries and when will they merge?
- Do BHs get kicked during a supernova?
- Do primordial black holes exist?

Roman microlensing survey: not just exoplanets!

Lu

PopSyCLE (**Pop**ulation **Sy**nthesis for **C**ompact object **L**ensing **E**vents)



- Microlensing simulation with realistic modeling of Galactic black hole population
- Provide survey parameters, returns list of observable microlensing events and their properties

Lam+ 2020, Rose+ in prep, Abrams+ in prep

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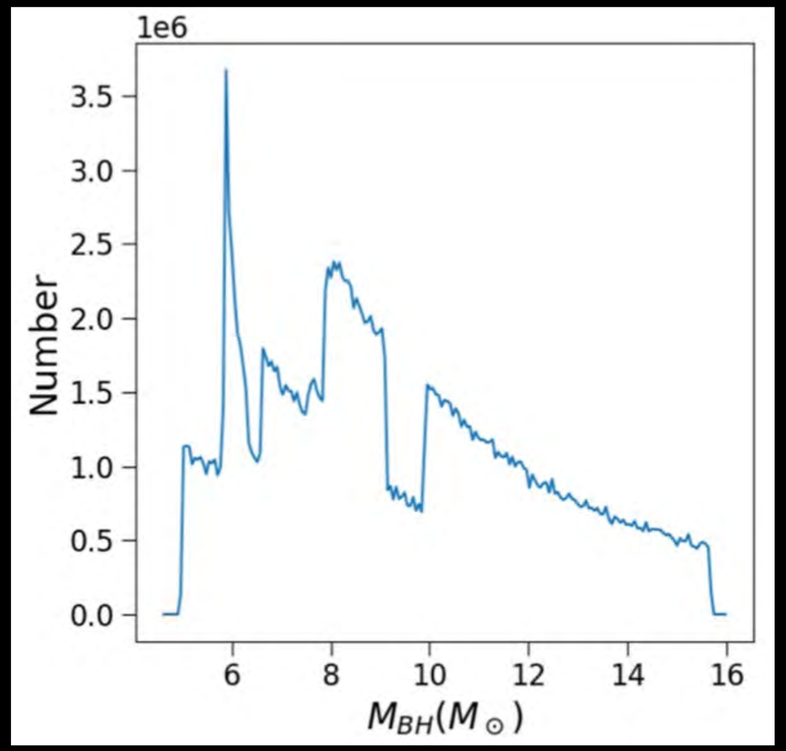
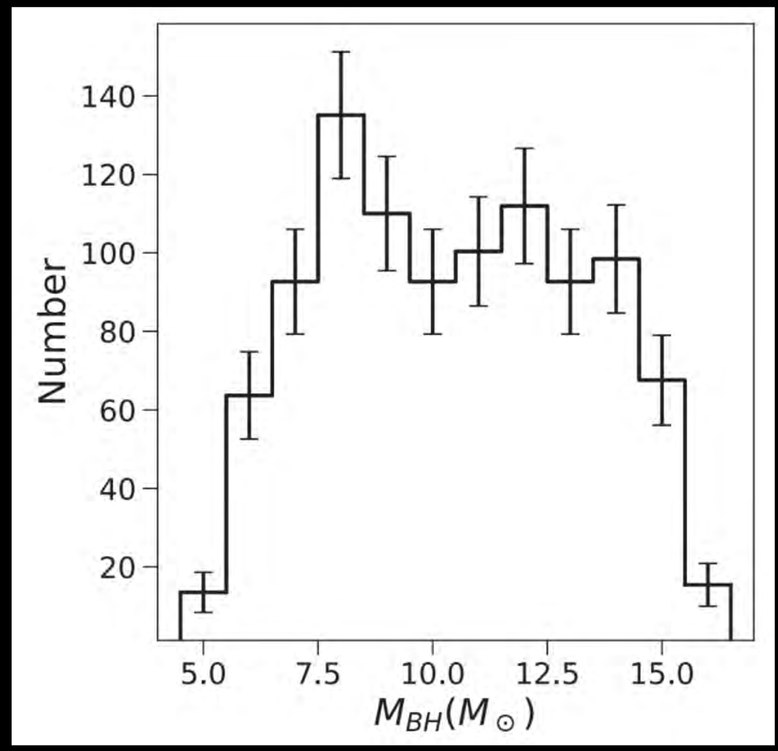
Expected black hole masses (via the Roman exoplanet survey).

Simulated Milky Way BH population
(SFH + IMF + IFMR)



Detect O(100-1000)
black holes with microlensing:
probe Milky Way's
BH mass function



Lam+ 2020

Roman and the Central Molecular Zone

r~100 - 200 pc
~10^8 M_{sun} in H_2
High T, B, ρ, σ_{turb}

Morris & Serabyn 1996
Molinari+ 2011
Kruijssen & Longmore 2013
Henshaw+ 2016

Question:
Do these initial conditions impact the outcome of the star formation process?

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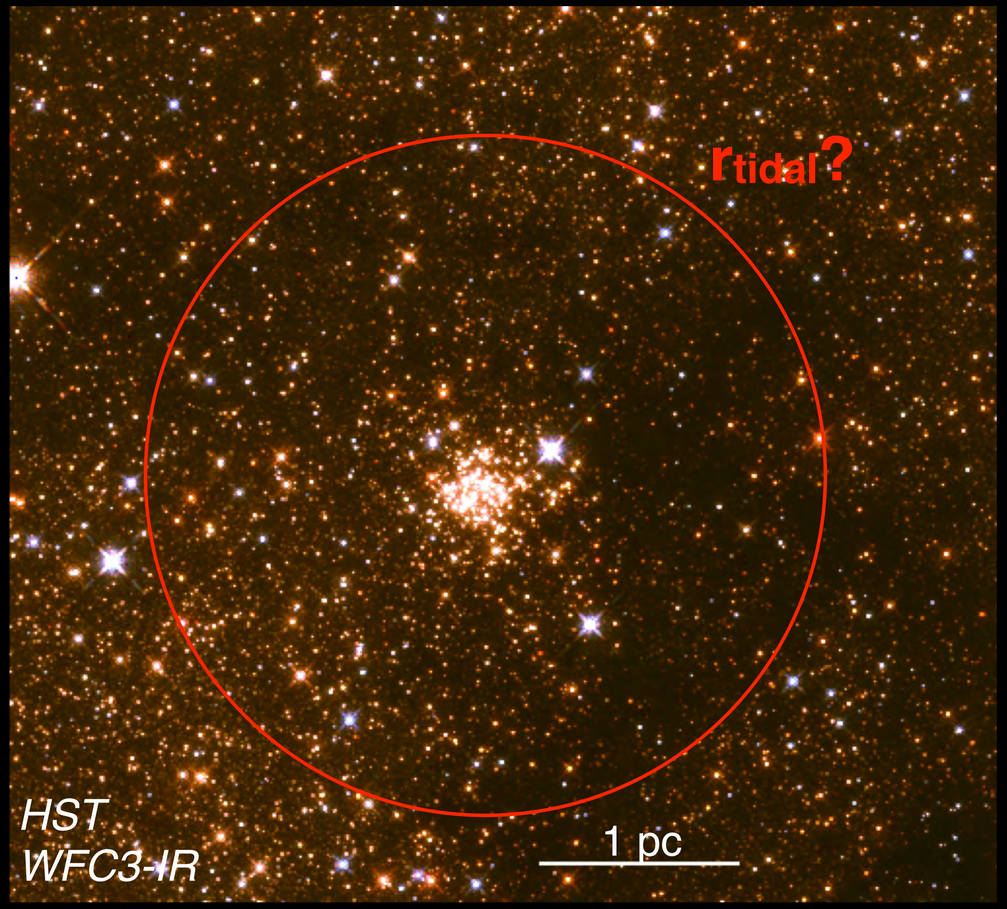
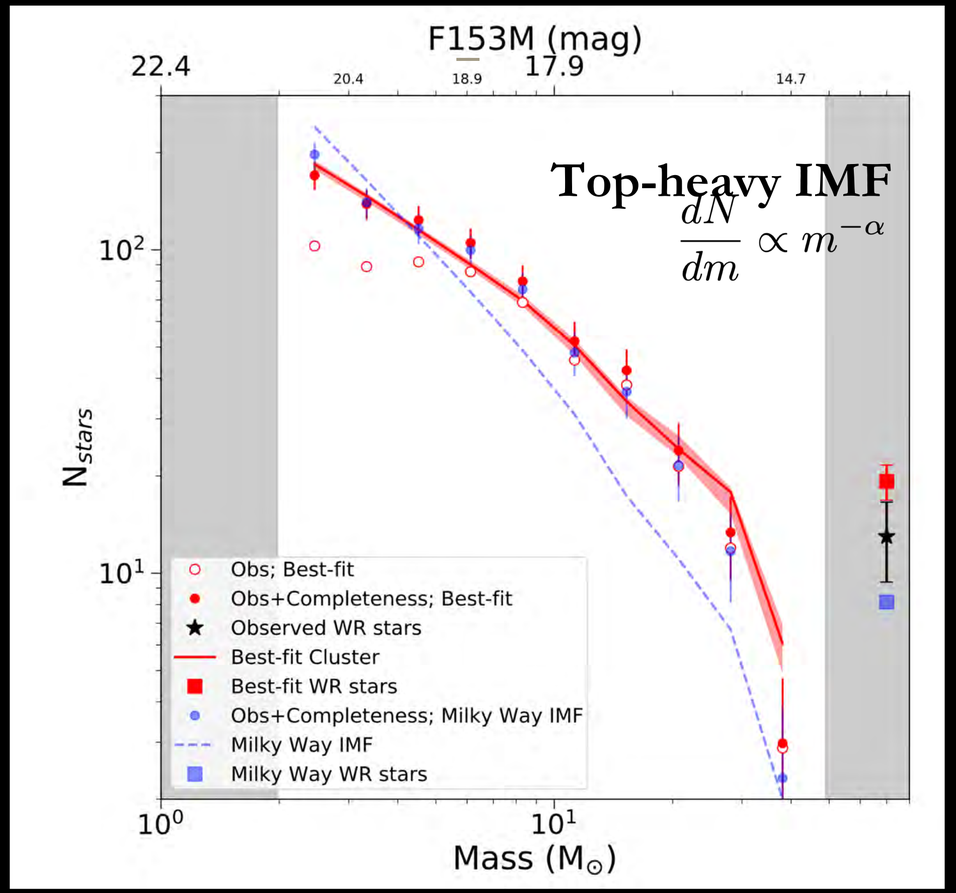
How does the strong tidal field effect the Arches cluster structure, dynamics, evolution, and mass function? Why is it's IMF "top heavy"





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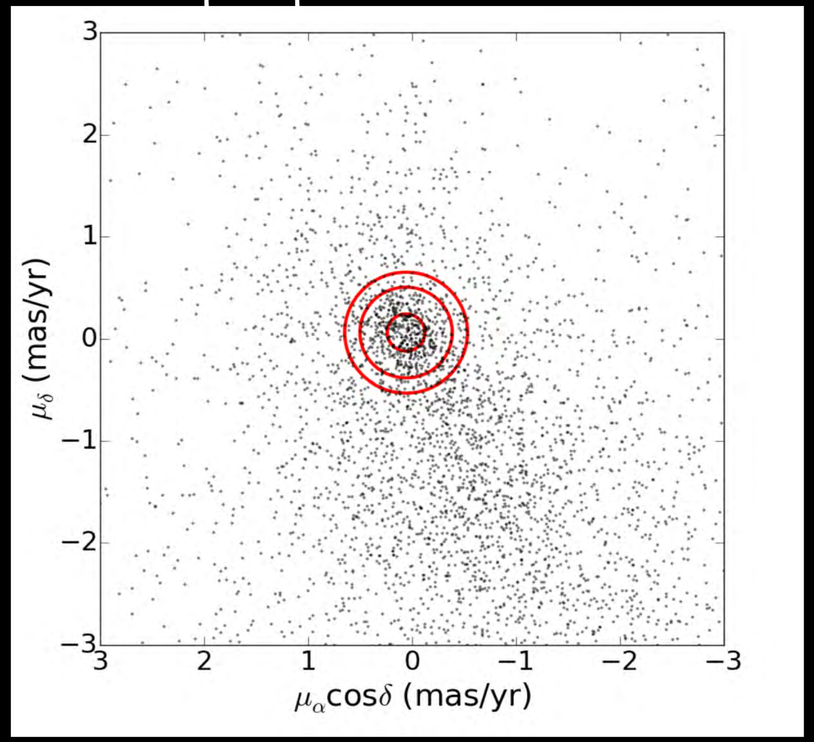
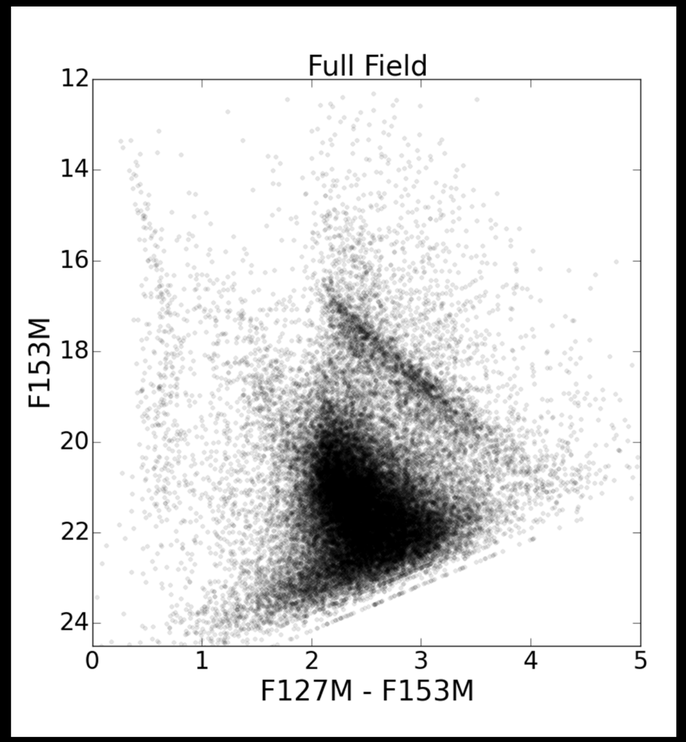
HST (eventually Roman) astrometry on the Arches cluster selects cluster members and gives precise proper motions.

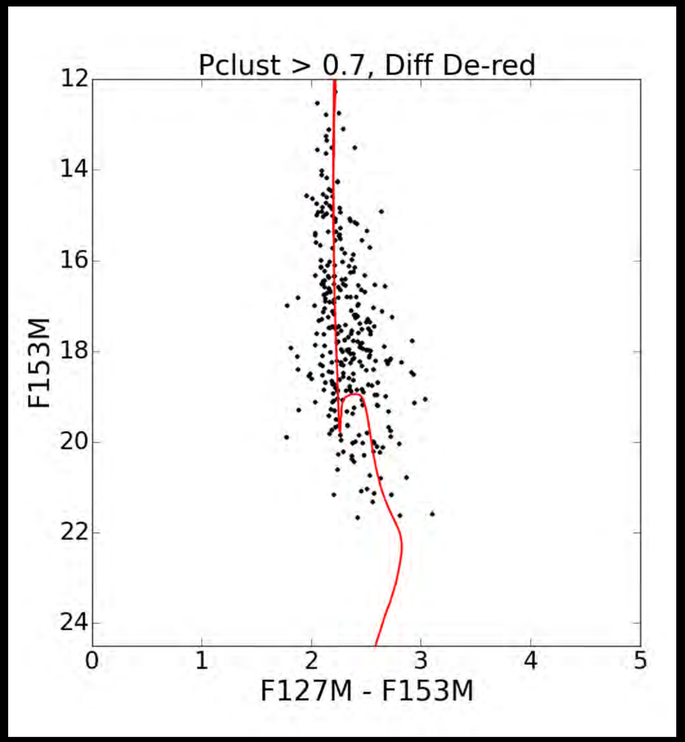
proper motions



full CMD

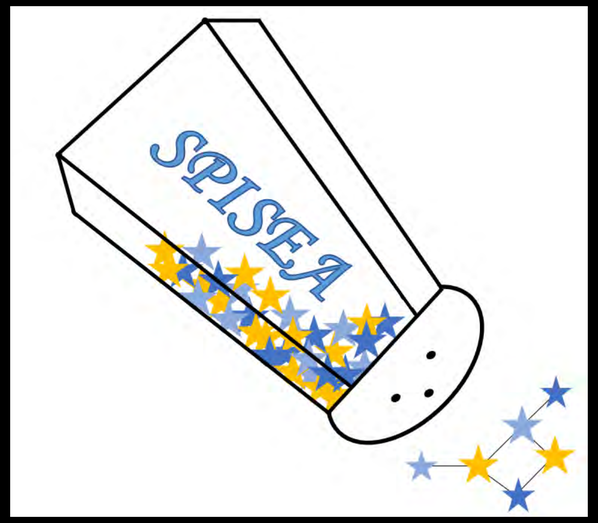


PM-cleaned CMD



Roman can also derive the field IMF in the Galactic Center regions from microlensing (e.g. Wegg et al. 2017 for OGLE)

Figure from Hosek+ 2015



Tools for Roman:

SPISEA: Stellar Population Interface for Stellar Evolution and Atmospheres

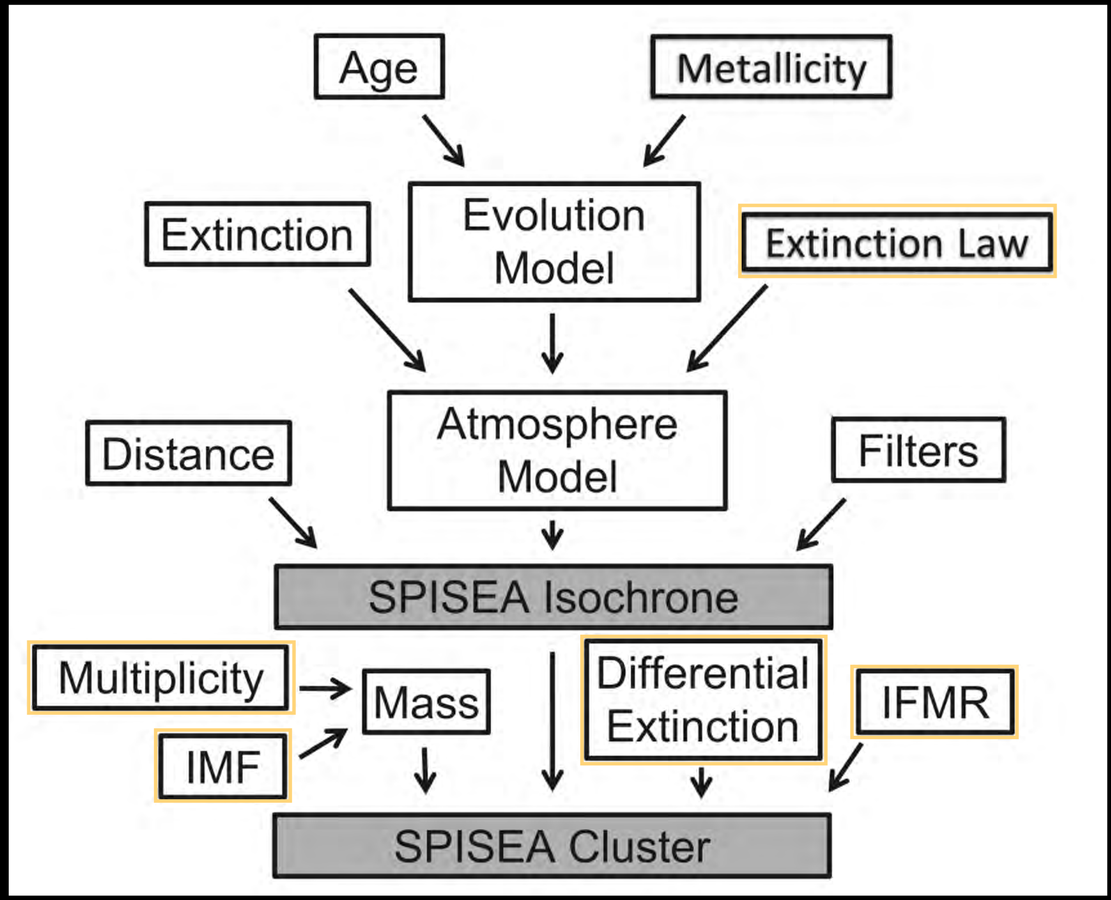
is fast, flexible, usable, and extensible:

- Make isochrones, clusters from many established model grids
  - (e.g. Geneva, MIST, Parsec, Pisa, BPASS; ATLAS, Phoenix, BT Settl, etc.)
- Python, easy to use
- add your own model grids
- add your own filters
- fast enough for inference

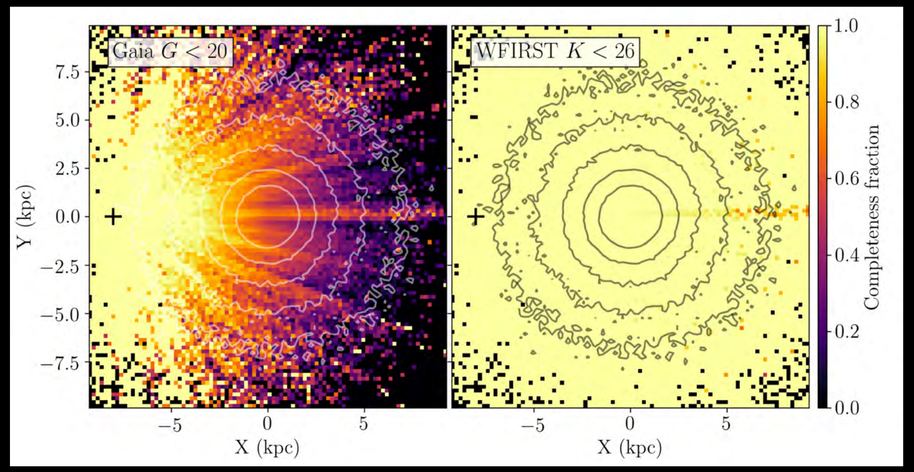
https://spisea.readthedocs.io/
https://github.com/astropy/SPISEA

not found in many SSP codes.

Hosek+ 2020, Rose+ in prep.



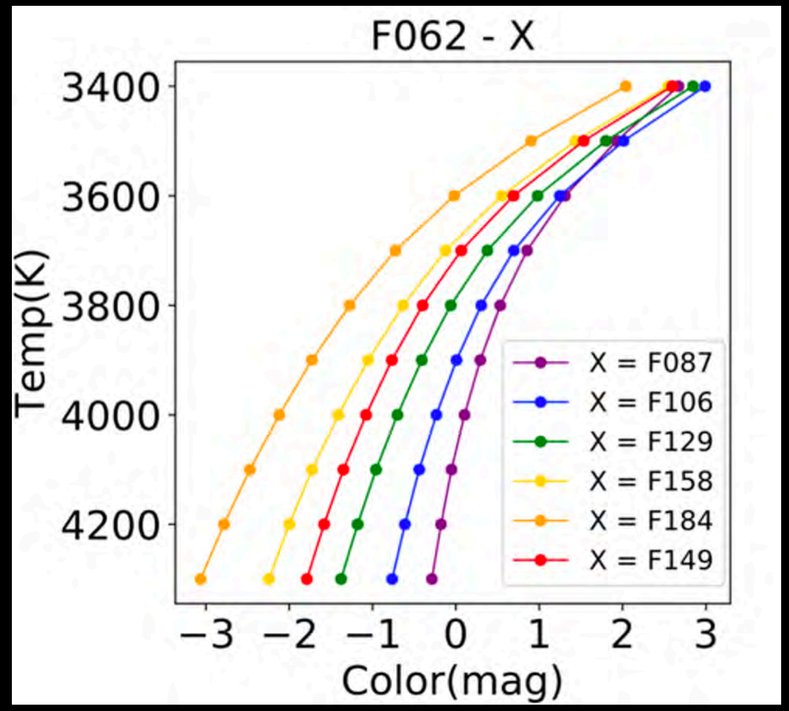
Identifying evolved massive star populations in the Galactic plane



The IR capabilities of *Roman* will allow us to carry out a **complete census of the evolved massive star population "hidden" in the Galactic disk**

With a complete sample of evolved massive stars in the Milky Way we can:

Roman **F062−F184** colors will be ideal for estimating effective temperatures in red supergiants, spanning a 5 mag change in color over the 3400-4300 K temperature range.



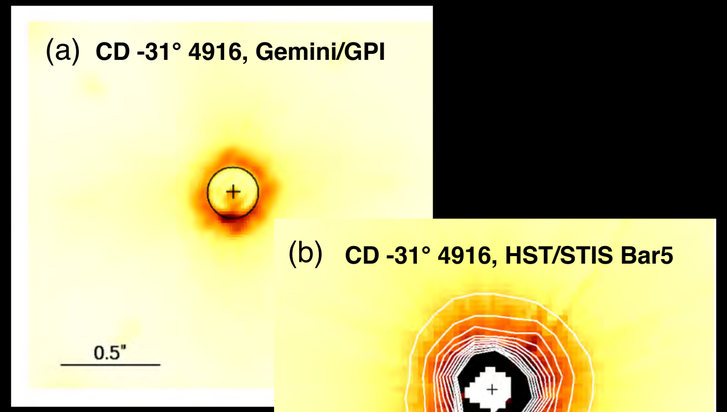
—constrain models of post-main-sequence stellar evolution using accurate BSG/RSG, WR/RSG, and WC/WN ratios

—probe star formation and young stellar clusters on the far side of the Milky Way

—test predictions of binary evolution and the binary fraction of massive stars

Kokoris & Levesque (2019) Levesque

Coronagraphic imaging of the circumstellar environments of evolved massive stars



Lomax et al., in prep

With *Roman*'s coronagraph **we can isolate and observe the circumstellar environments of Galactic supergiants in unprecedented detail.**

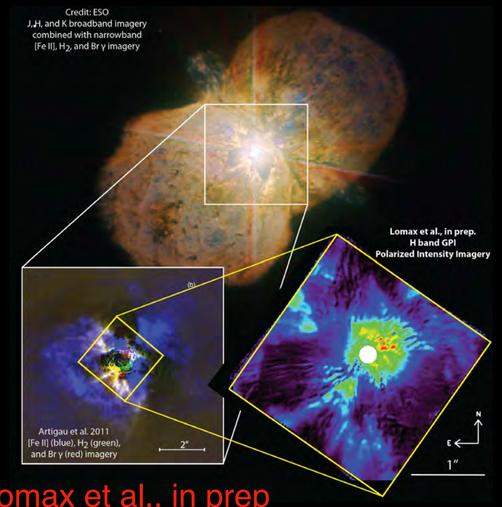
—place constraints on mass loss mechanisms, rates, and evolutionary stages in RSGs, YSGs, LBVs, and WR stars

—directly compare circumstellar morphologies of different evolutionary stages and supernova remnants to probe eruption and supernova kinematics

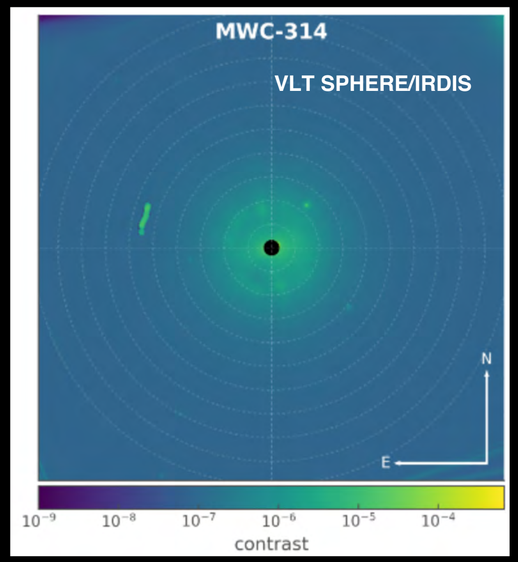
—identify close binary companions to these stars that could impact their late-time evolution

Levesque's group has observed RSGs and LBVs with a suite of multi-wavelength coronagraphs at Apache Point, Gemini, the VLT, and Hubble. These observations lay key groundwork for *Roman*.

η Car, Gemini/GPI



Lomax et al., in prep



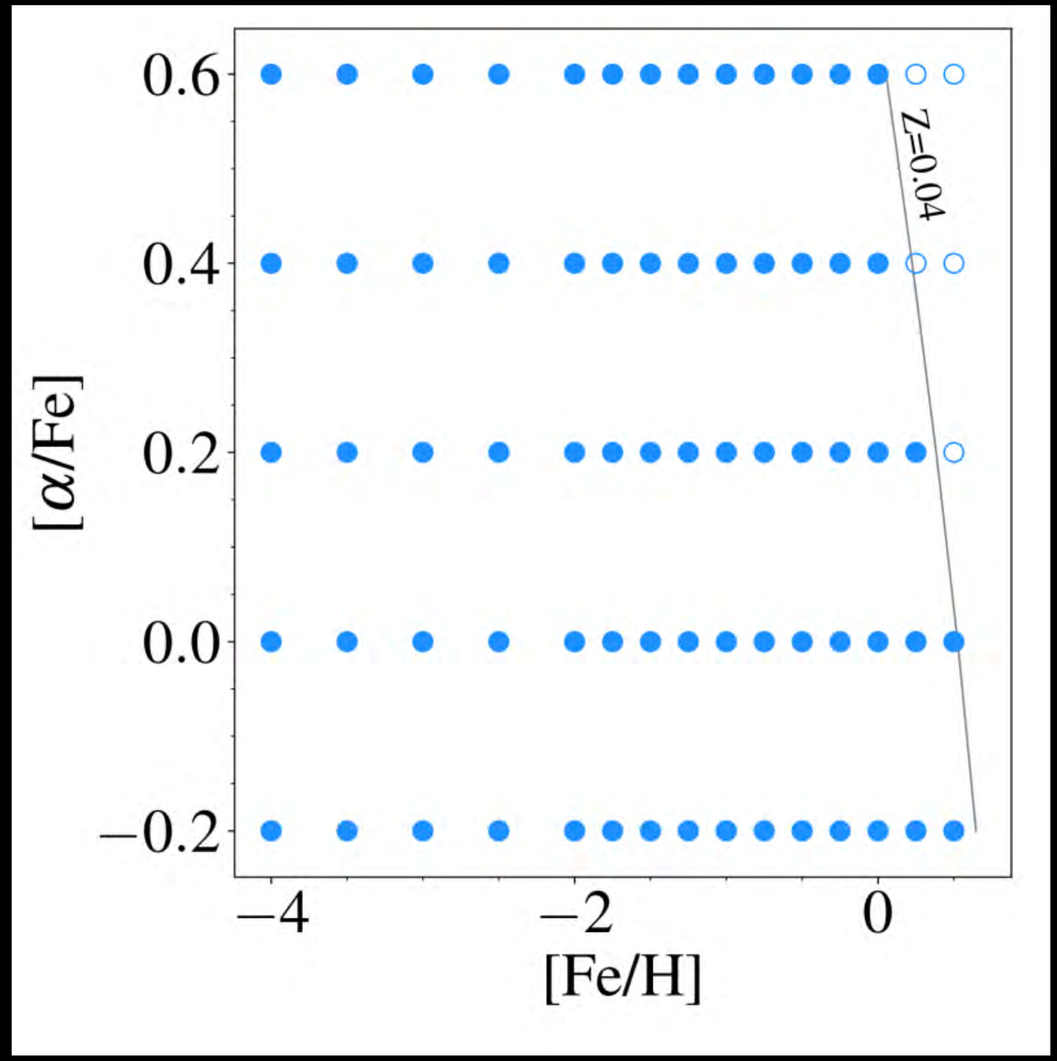
Gootkin et al., in prep

MIST2 Development for WFIRST

Computing grids of stellar evolution models for a wide range of [Fe/H] and [alpha/Fe] using the MESA code, demonstrated at left.

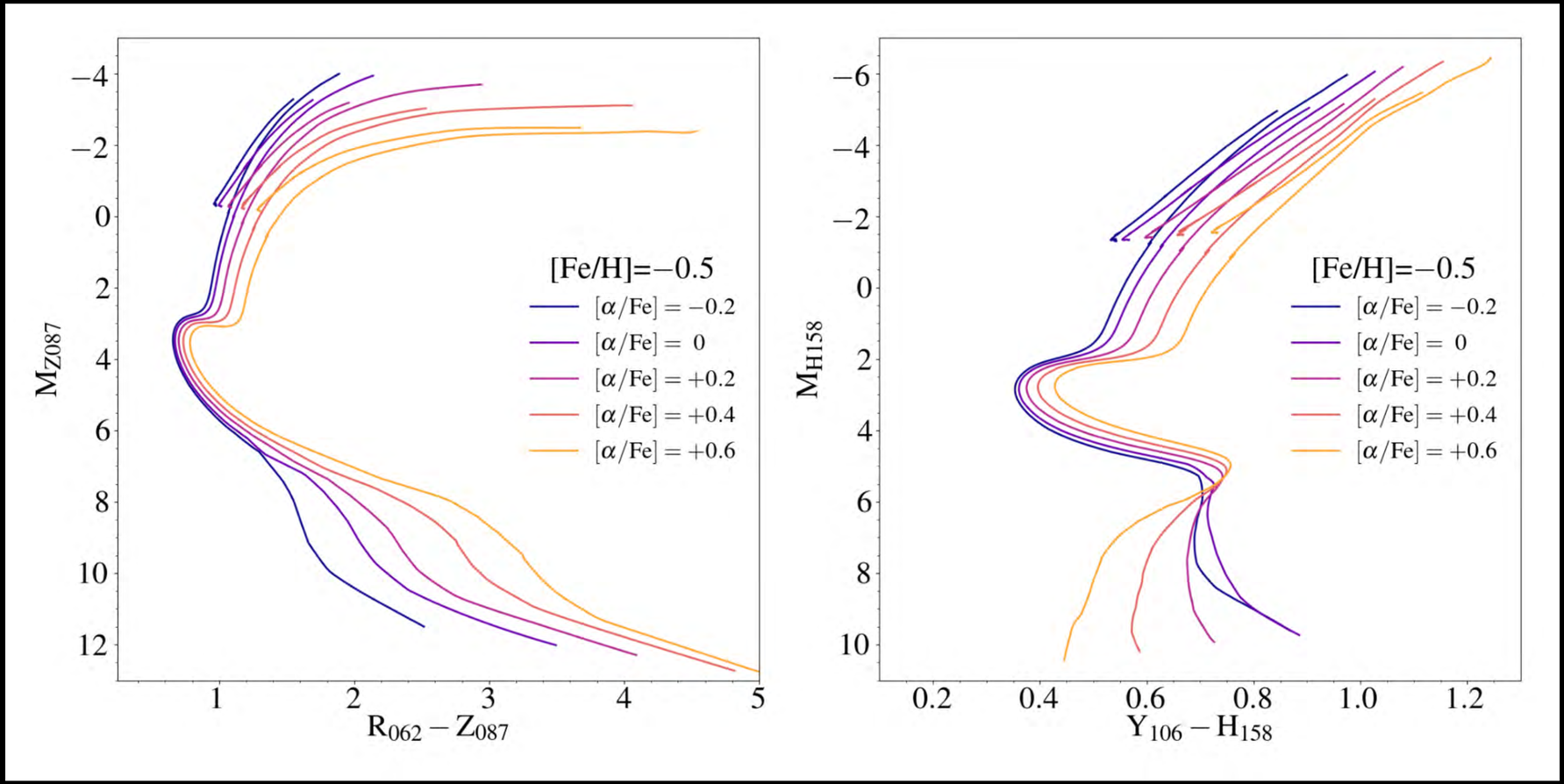
Creating tracks and isochrones for ages between 10^5 and $2x10^{10}$ years for all with masses between 0.1 and 300 solar masses.

http://waps.cfa.harvard.edu/MIST/

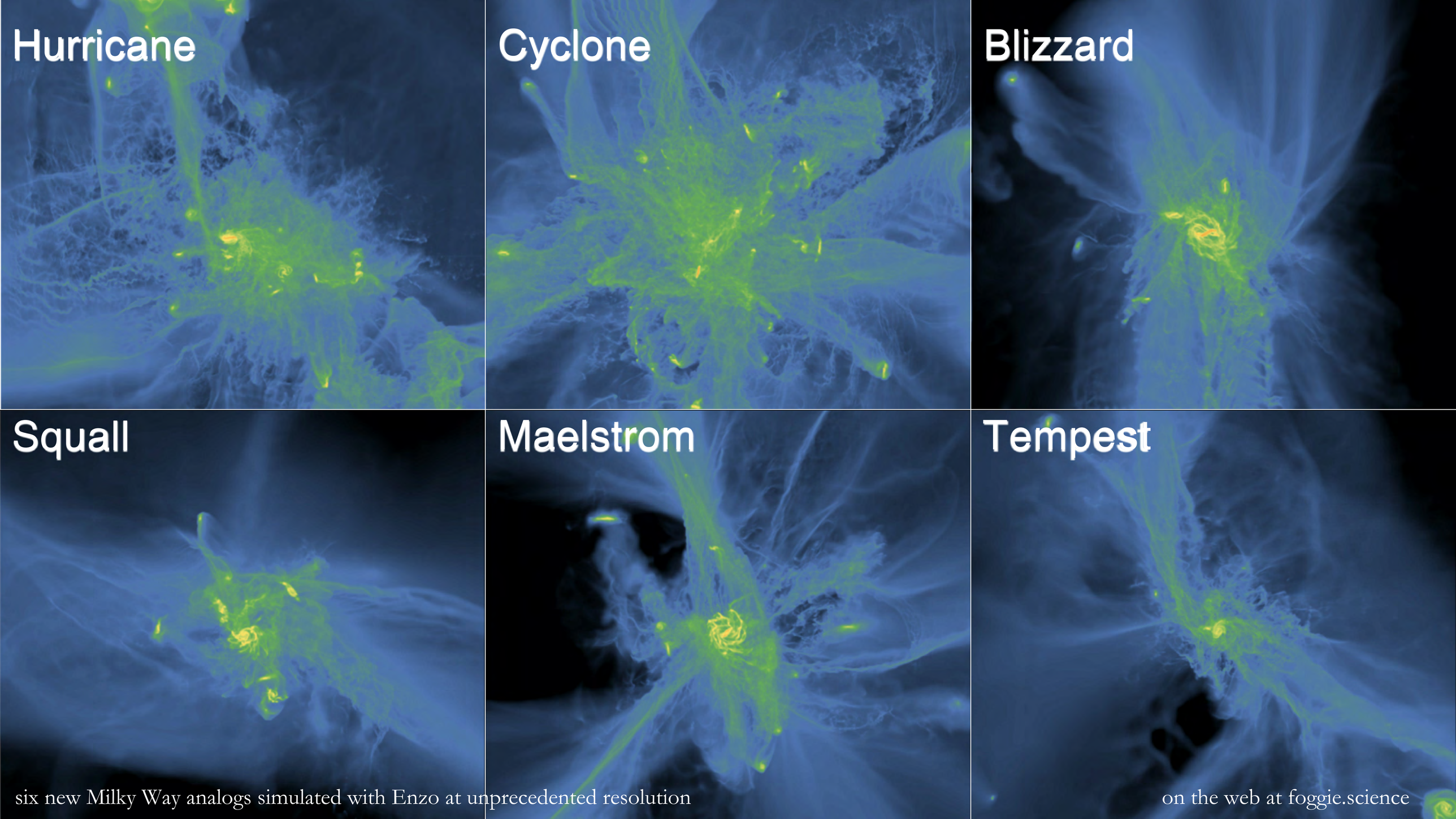


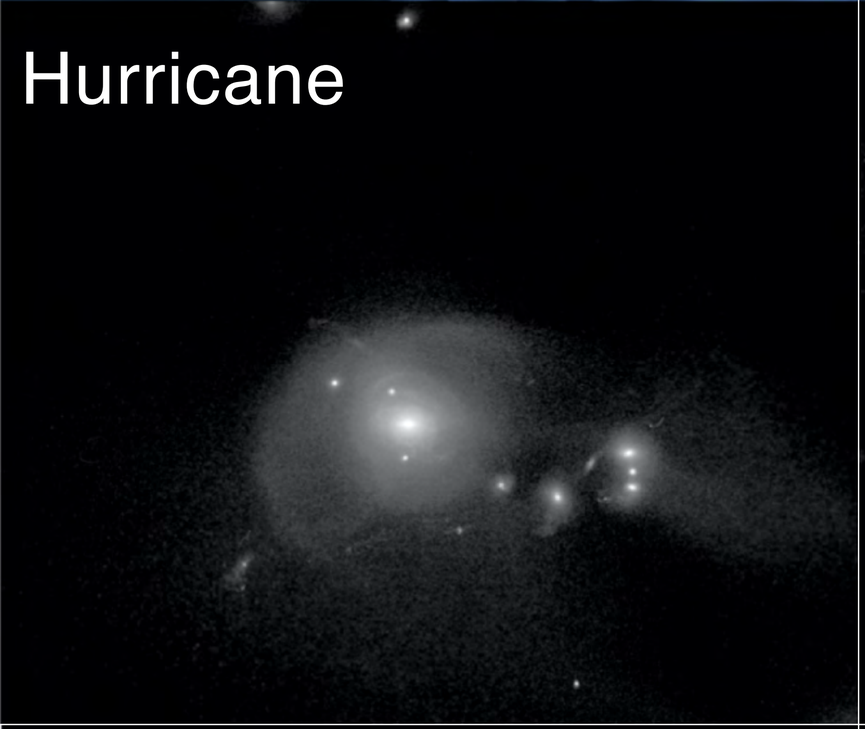
The upper right region of the plot is excluded due to limitations in the input physics.

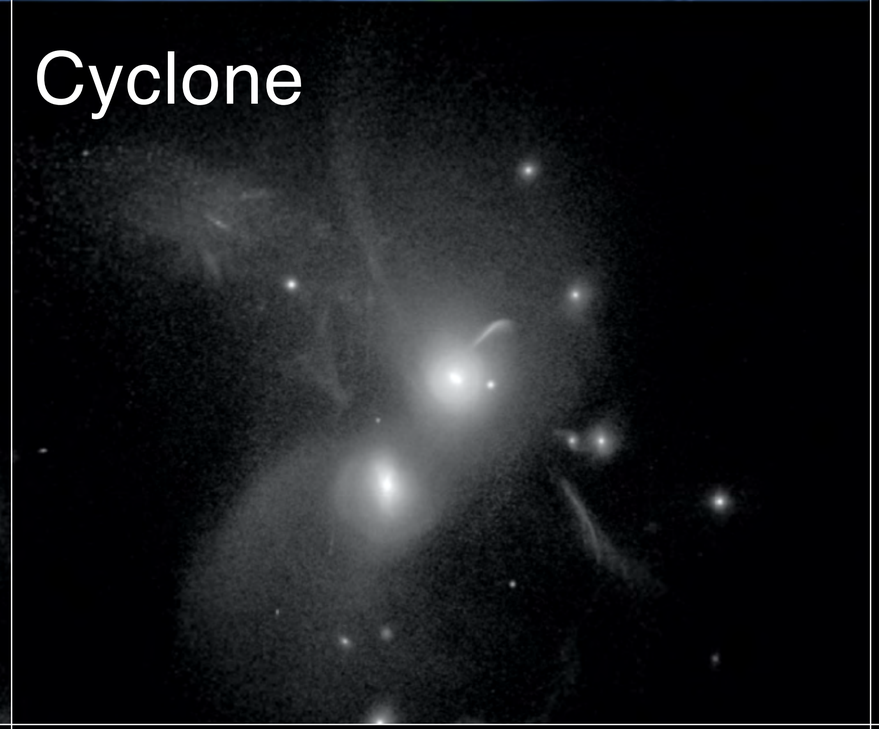
MIST2 Development for WFIRST



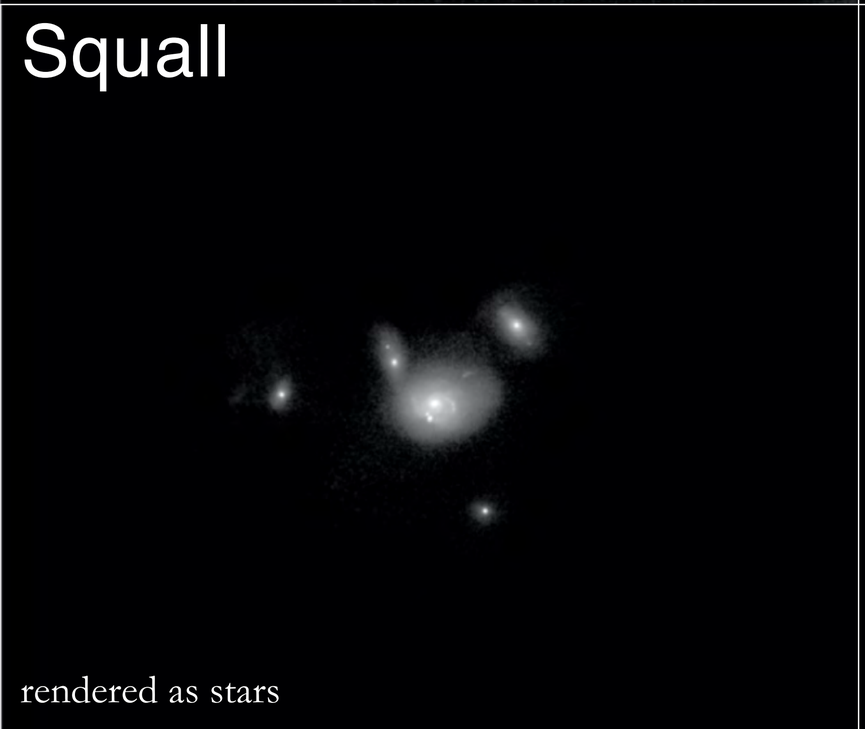
MIST2 has the potential to inform WFIRST science before the telescope reaches orbit, by showing the value of different filter combinations. Here we show an example of the 2018 vintage filter set for isochrones with [Fe/H]=-0.5 and the full range of [alpha/Fe].

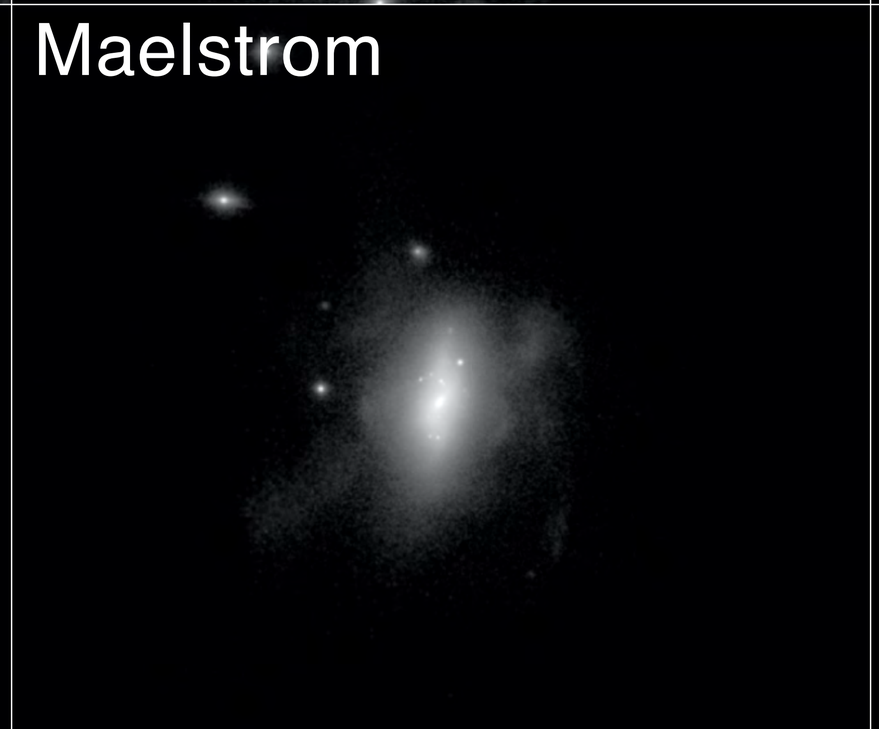

Hurricane
Cyclone
Blizzard
Squall
Maelstrom
Tempest
six new Milky Way analogs simulated with Enzo at unprecedented resolution
on the web at foggie.science


Hurricane


Cyclone


Blizzard


Squall
rendered as stars


Maelstrom


Tempest

Coming Soon:

-fully rendered Roman images over time

- views from “inside” and "outside”

- mock stream and dwarf satellite mock catalogs

thanks for listening!

please contact me

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for more information