Supernova science with the HWO

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Introduction

Scope of the talk

Supernova science is not only based on target-of-opportunity (ToO) observations

What can be done with HWO proposed instrumentation?

Potential ToO breakthrough science

Science cases driving the proposal for a fourth instrument

Unveiling SN progenitors

Non-ToO Science

Direct detection of SN progenitors (core-collapse)

Search for failed-SN events

Search for PISNe and/or analog-Pop III SNe

Environments and host galaxies of supernovae-related phenomena

SN progenitors

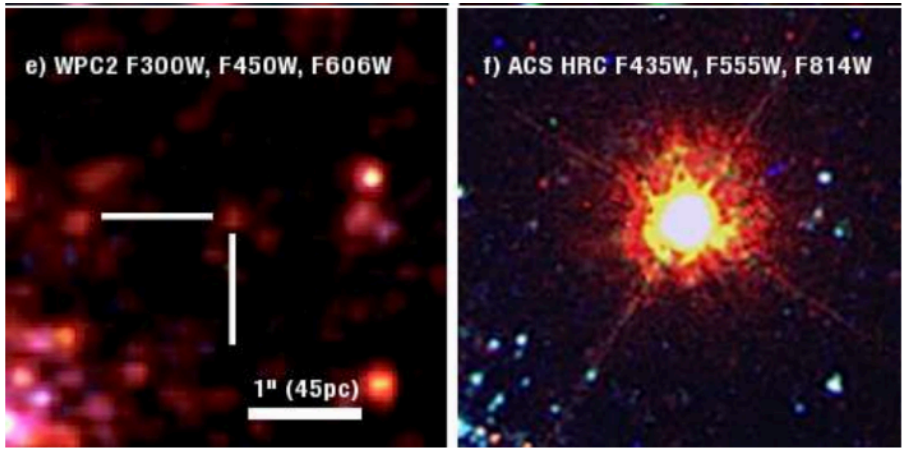
Direct detection of SN progenitor

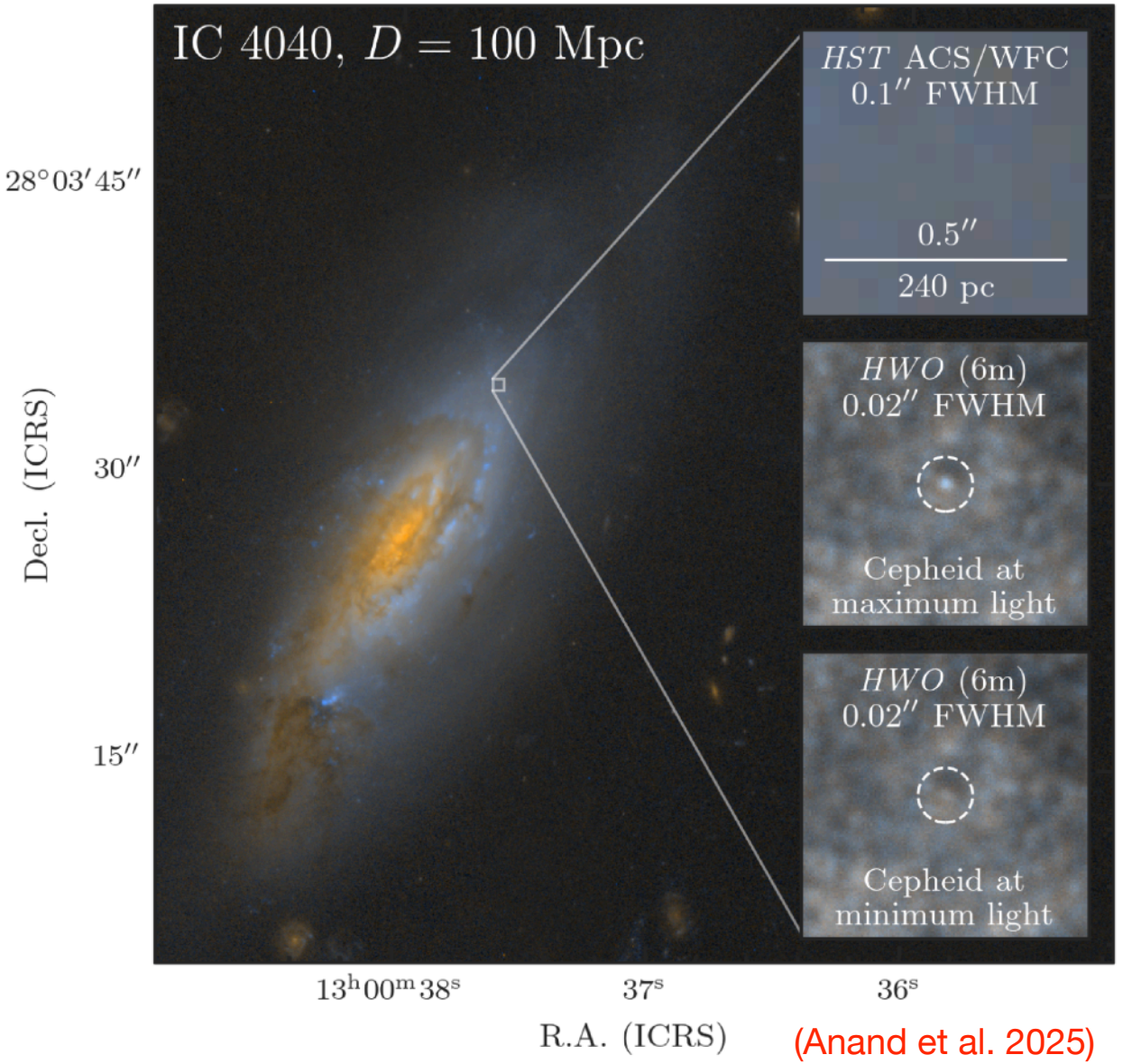
Diffraction limit of HWO

=> 10 pc at distance of Coma cluster

M_V = -4 mag => SNR ~ 10, t_{exp} = 2 hrs

(SN 2003gd case - Smartt 2009)





(Anand et al. 2025)

SN progenitors

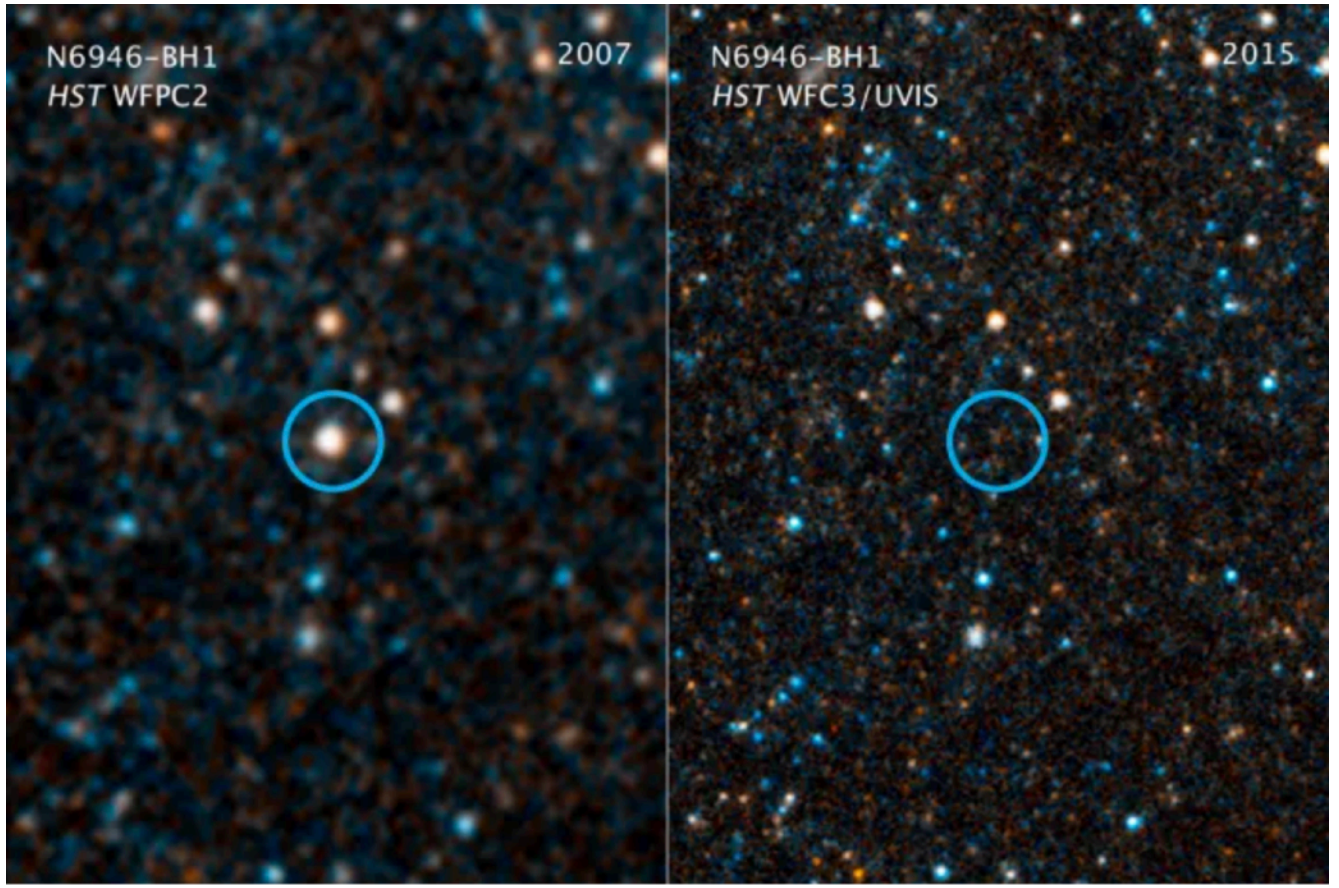
Failed SNe

Direct collapse to a black hole

- High-res spatially-resolved observations of nearby galaxies

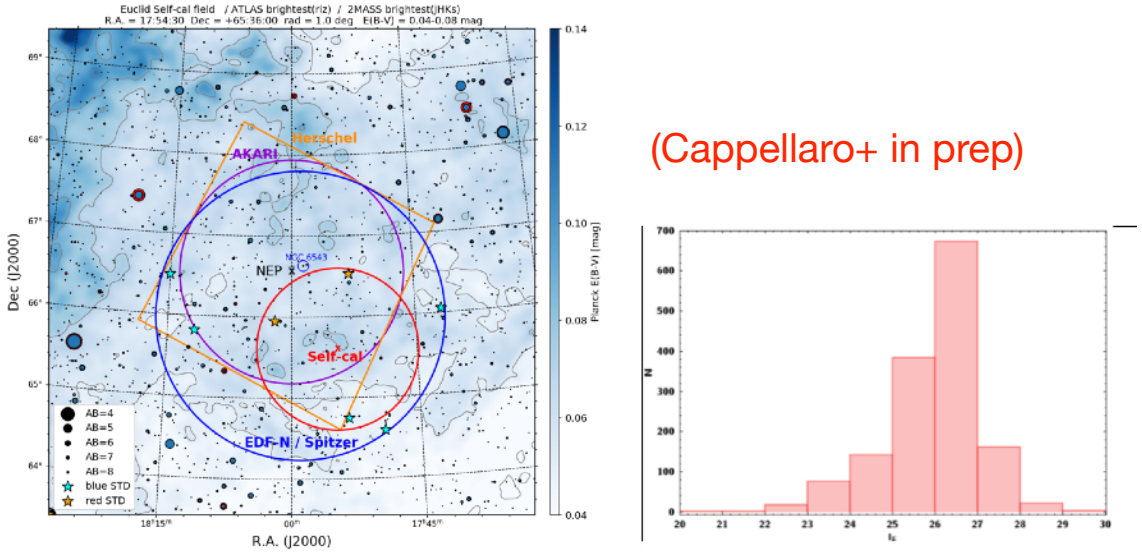
- Synergy with previous observations by space telescopes (HST, JWST, Roman, Euclid)

- Take advantage of exceptional characteristics of the HWO/HRI

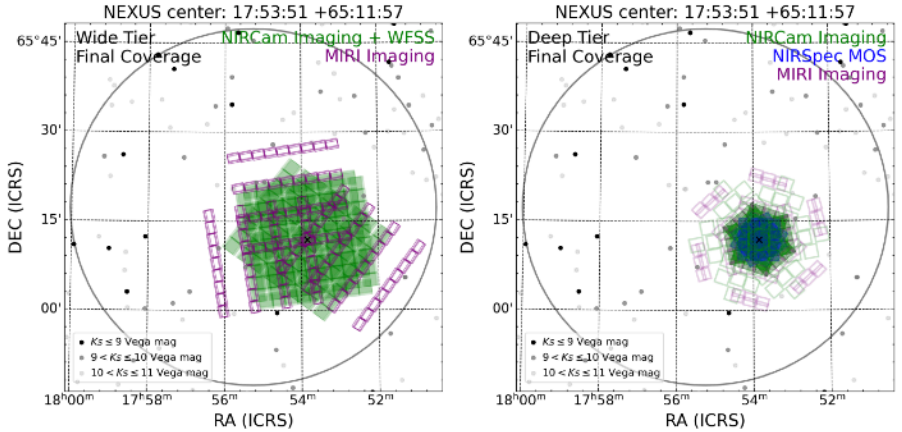


(Kochanek et al. 2017)

Deep high-z surveys



(Cappellaro+ in prep)



Deep survey of cosmological field(s)

Based on the **JADES-JWST & Euclid** experience

Inspired by the **NEXUS-JWST**

=> Systematic search of SNe at z > 2-3

=> Identify SLSNe & **PISNe**

=> SN rates at high-redshift

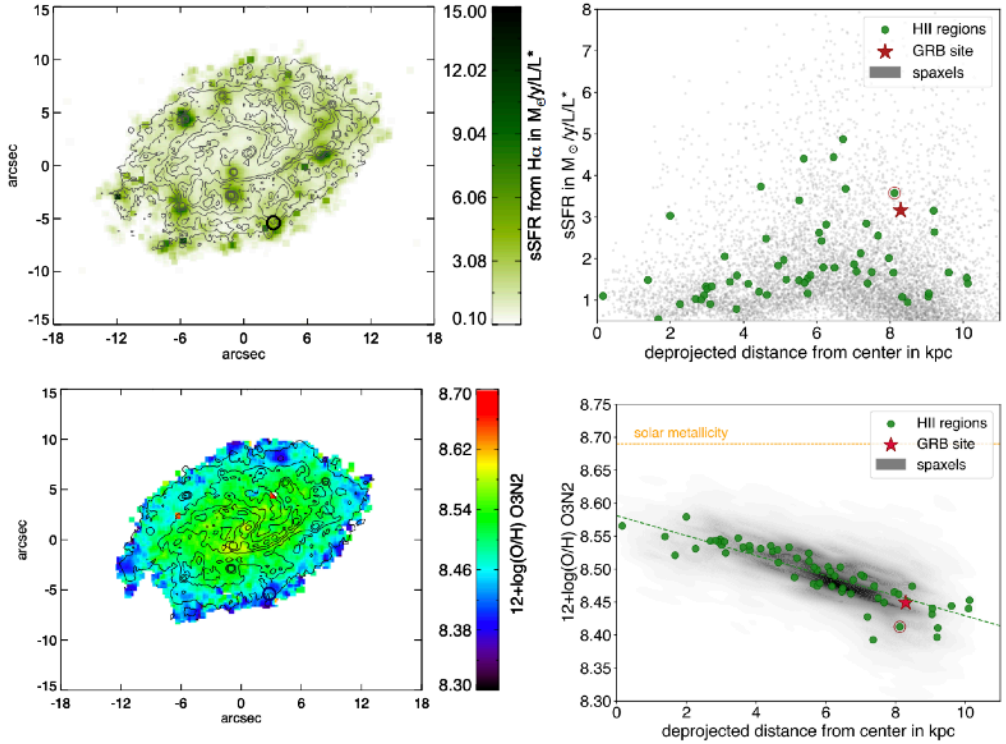
=> Extending SN-Ia cosmology

Usage of NIR filters + HRI (lambda > 2000 nm)

(Shen+ 2025, DeCoursey+ 2024))

Immediate environments and host galaxies

GRB 171205A host (Thone+ 2025)



IFU/MOS NUV/FUV observations

Exploiting the UV-MOS instrument

Unprecedented **HR** study of transients host galaxies

IFU => immediate environments observations

- metallicity estimates

(abs. lines and direct method - if 436.3 nm)

- (s)SFR

- accurate extinction measurement

- young stellar populations

ToO SN science

UV/MOS — two main science cases

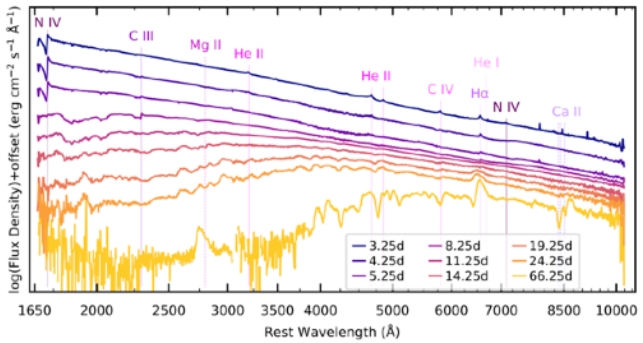
RAPID ToO - Disruptive

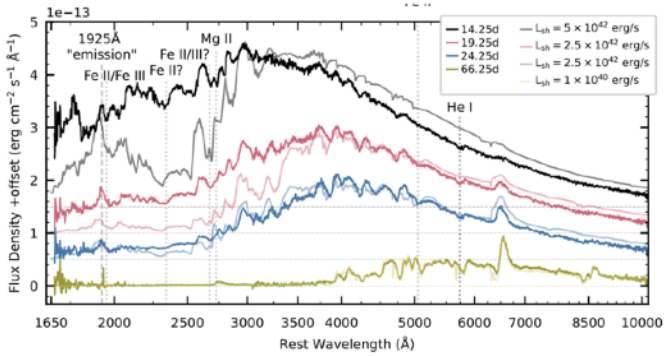
UV is dominant in very young SNe (<5 dd) and GRBs

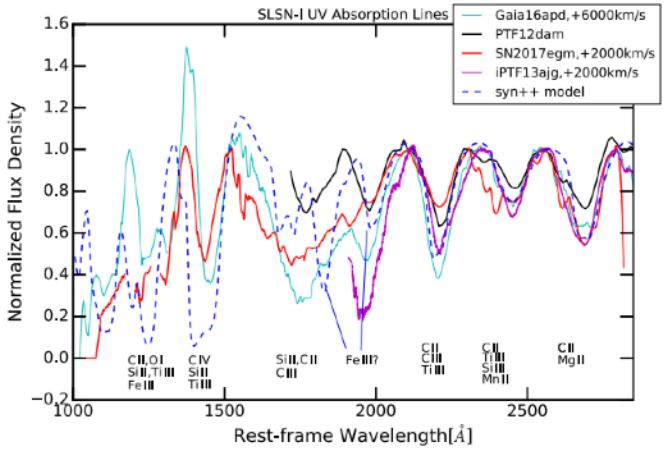
=> flash-ionization lines from surrounding CSM

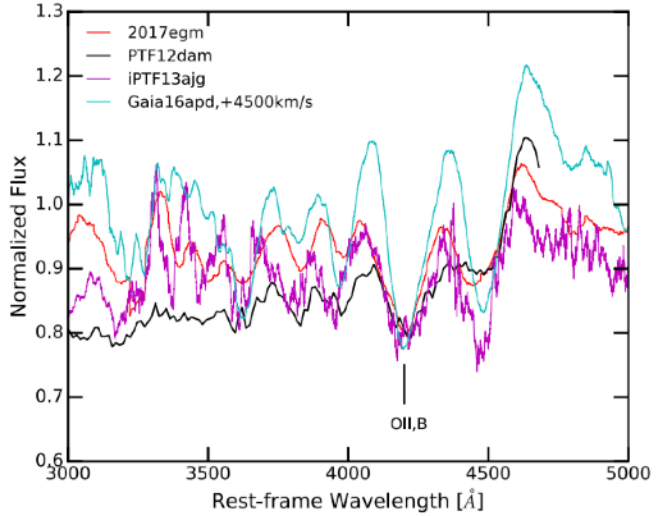
=> metallicity from abs lines in immediate medium

Important for FBOT, GRB-SNe, SLSNe









(Azalee Boestroem+ 2024 ,Lin+ 2018)

ToO SN science

UV/MOS — two main science cases

Non-Disruptive ToO / survey mode

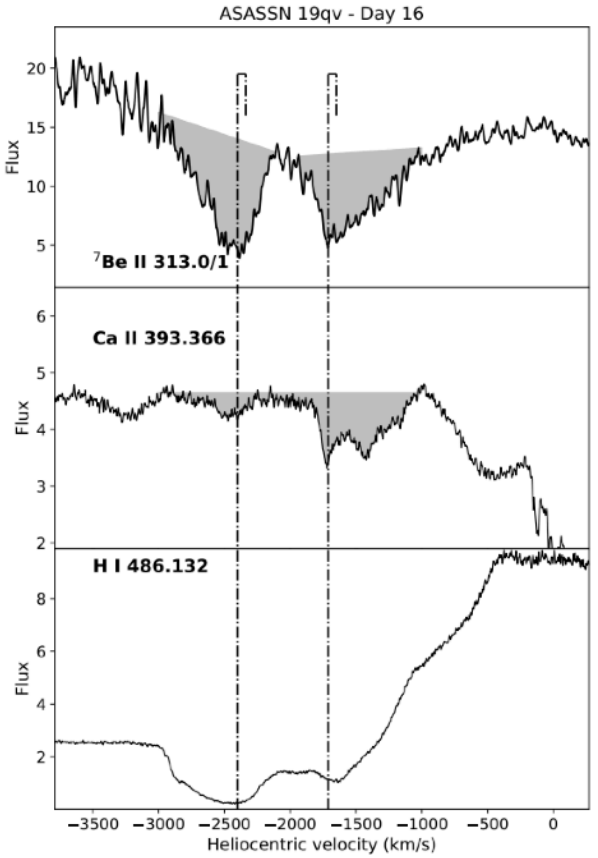
Lithium abundances from novae

=> identify ^{7}Be 313 nm

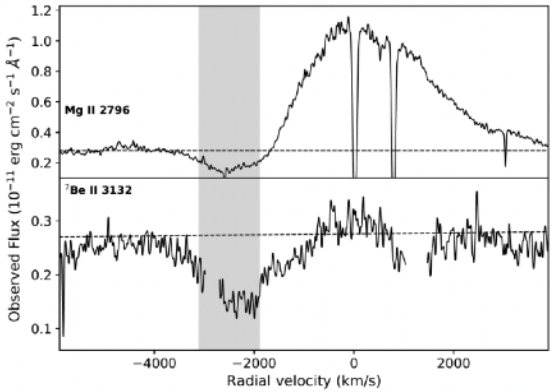
=> check with Mg II 280 nm

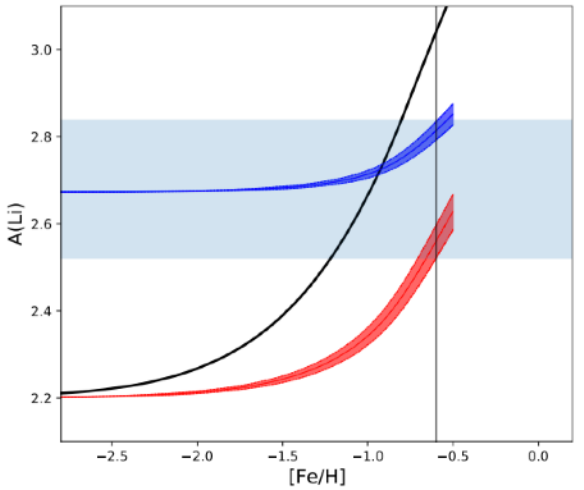
=> targets from LSST/ZTF/

Li enrichment in nearby galaxies



(Izzo+ 2022)



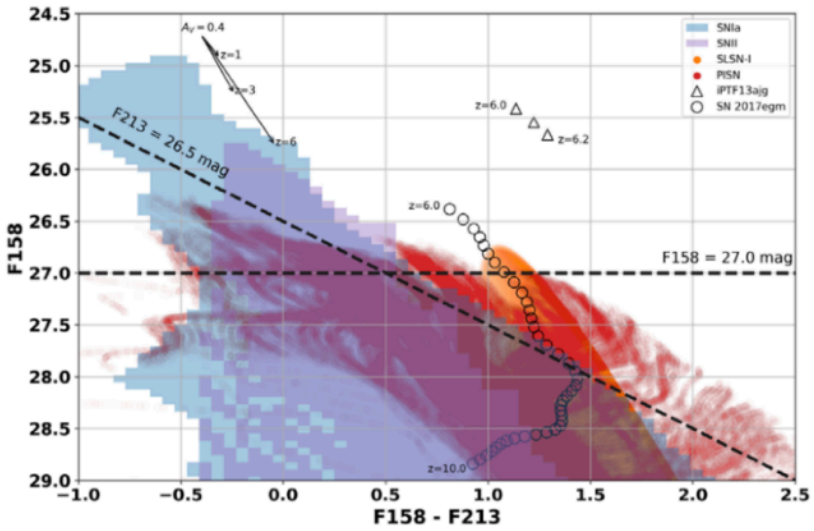


A science case for a potential 4th HWO instrument

The first stellar explosions

(Moriya+ 2023)

Unveiling the nature of first stars



Identify the first Pair-Instability SNE and very high-z GRB

Common at very high-redshifts (z > 3)

Efficient identification in color (optical-NIR) analyses

=> Need of HRI optical/NIR surveys for their ID

NIR filters are needed to distinguish PISNe from low-z SNe

=> medium-resolution NIR/MIR spectrograph (NIRSPEC-JWST/SHARP) to characterize the rest-frame spectral emission of these events - useful also for planetary science

Thank you !!!