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**DUNLAP INSTITUTE** for **ASTRONOMY** & **ASTROPHYSICS** 

Photometric redshifts and supernova cosmology

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#### In general we need to model



#### In general we need to model/control for contamination (uncertain type)







# and redshift uncertainty





Ruhlmann-Kleider, Lidman Möller 2022





# What does a preliminary analysis with photo-z yield? (Mitra++ 2023)

Simulated Type Ia only sample from Rubin LSST DDF (PLAsTiCC simulations)

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### Photo-z treatment following Graham et al. 2018



Mitra++ 2023

# Incorporating photo-z "as usual" in standard analysis



No type contamination from non-la objects  $\rightarrow$  significantly more objects with only photo-z at z> 0.8



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#### Take home message: using all the supernovae gives 1.5x the FoM



While still controlling for various systematic errors (including extinction, calibration and wavelength offsets)

Bias in mu from redshift error mostly self-corrects since  $z_{phot}$  and SALT2 color are anticorrelated  $\rightarrow$  larger (smaller)  $z_{phot}$  results in bluer (redder) color.

This will be harder to do given type/classification uncertainty.



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# Still considering a multi-stage approach $\rightarrow$ can we fit for things simultaneously and forward model uncertainties?







# What is the way forward?

- Template generation early is going to be critical for supernova cosmology → light curve fitting will be more important to early cosmology with supernova before photo-z become the bottle neck
- Most supernova hosts will have spec-z from telescopes like 4MOST, DESI will cover z < 0.5-0.6; for higher redshifts, spec-z from other telescopes will supplement individual objects (see e.g., Mandelbaum++2019, Newmann++ 2019, Hlozek++ 2019)

Facility	Supernova single-object follow-up requirements
4 m spectroscopy	60–180 nights total
8 m spectroscopy	180-540 nights total
> 20m spectroscopy	180-540 nights total
Facility	Strong Lensing single-object follow-up requirements
2–4 m non-AO imaging	< 8000 hours total
> 8m AO imaging	$\sim 30$ hours, split amongst 8 m+ and 30 m+ telescopes
> 8m spectroscopy	$\sim 100$ hours, split amongst 8 m+ and 30 m+ telescopes

- Two analysis modes can exist: including separately-generated p(z) into cosmology likelihood and multi-fit for photo-z and lc/cosmology in hierarchical model
- Lots of exciting work to develop our photometric cosmology