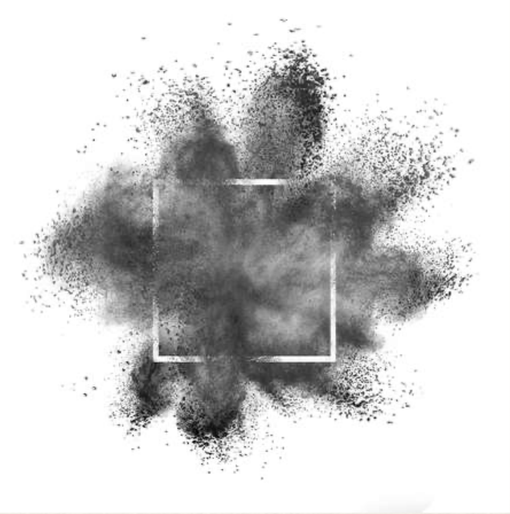


Working Group Reviews:

SNIa Cosmology

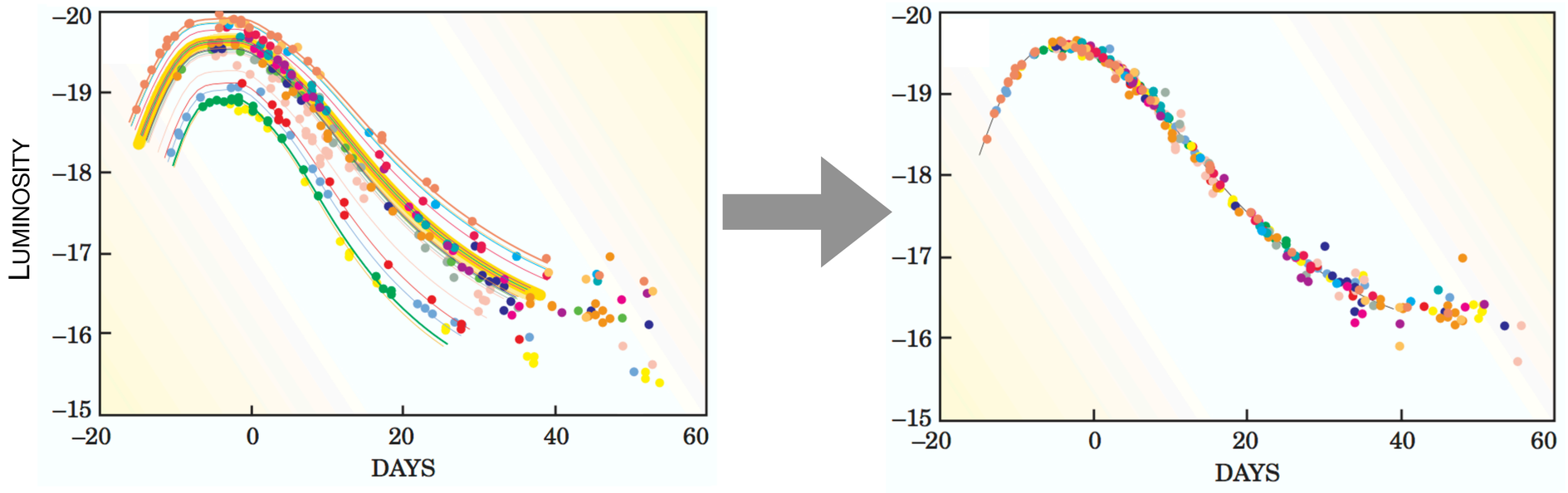
Mathew Smith *on behalf of the* **SNIa WG**

ZWICKY TRANSIENT FACILITY

erc USNAC

SNIa Cosmology: Principals

Bright and Standardisable Transients



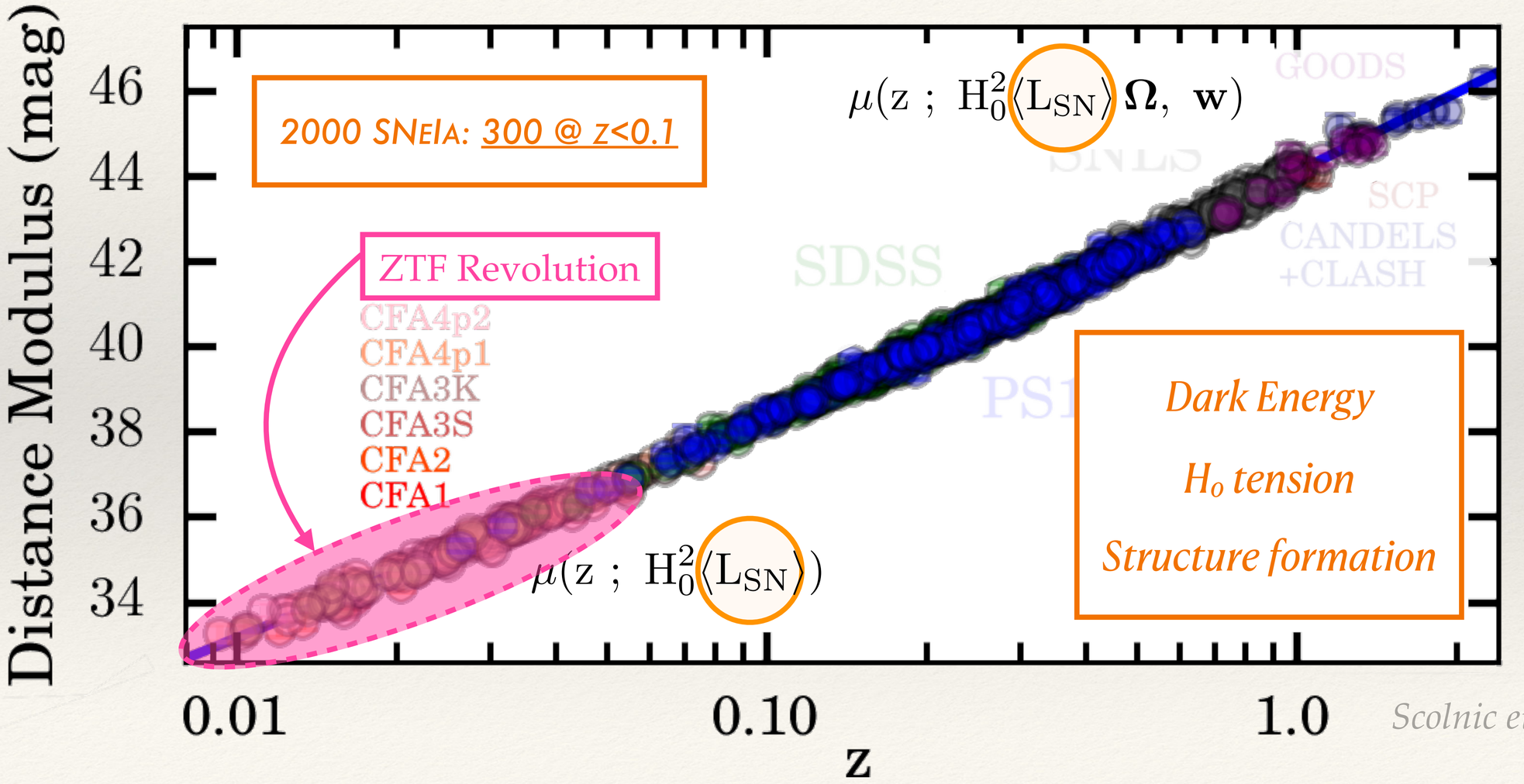
$$\mu(z, \boldsymbol{H_0}, \boldsymbol{\Omega_x}) = m_{obs} - (\boldsymbol{M_{abs}} - \boldsymbol{\alpha} \times s + \boldsymbol{\beta} \times c)$$

Empirical corrections:

Light-curve: **brightness** **width** **colour**

SNIa Cosmology: Today

Key concept | L_{SN} is constant with time



Scolnic et al. 2018

SNIa Cosmology: Caveats

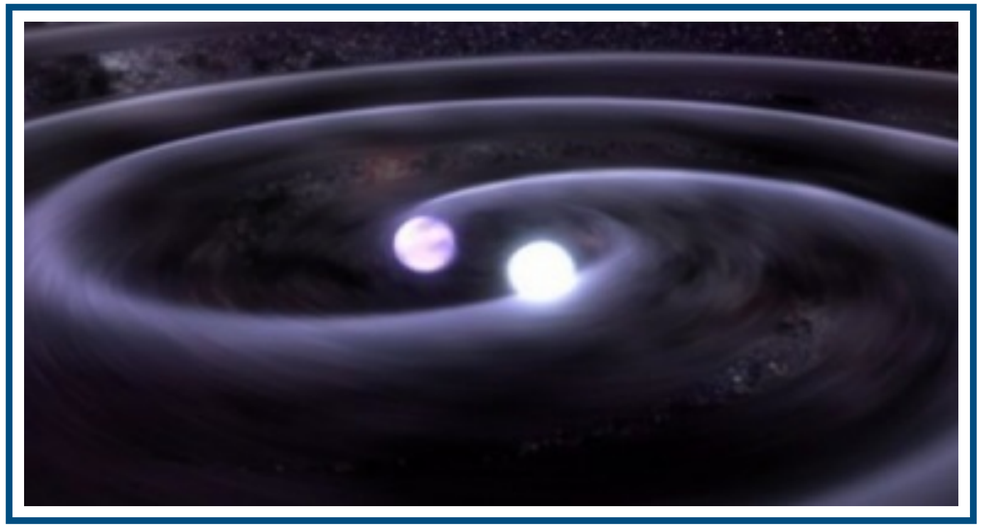
Unknown Origin

Systematics Dominated

Environmental dependence

Uncertain physics

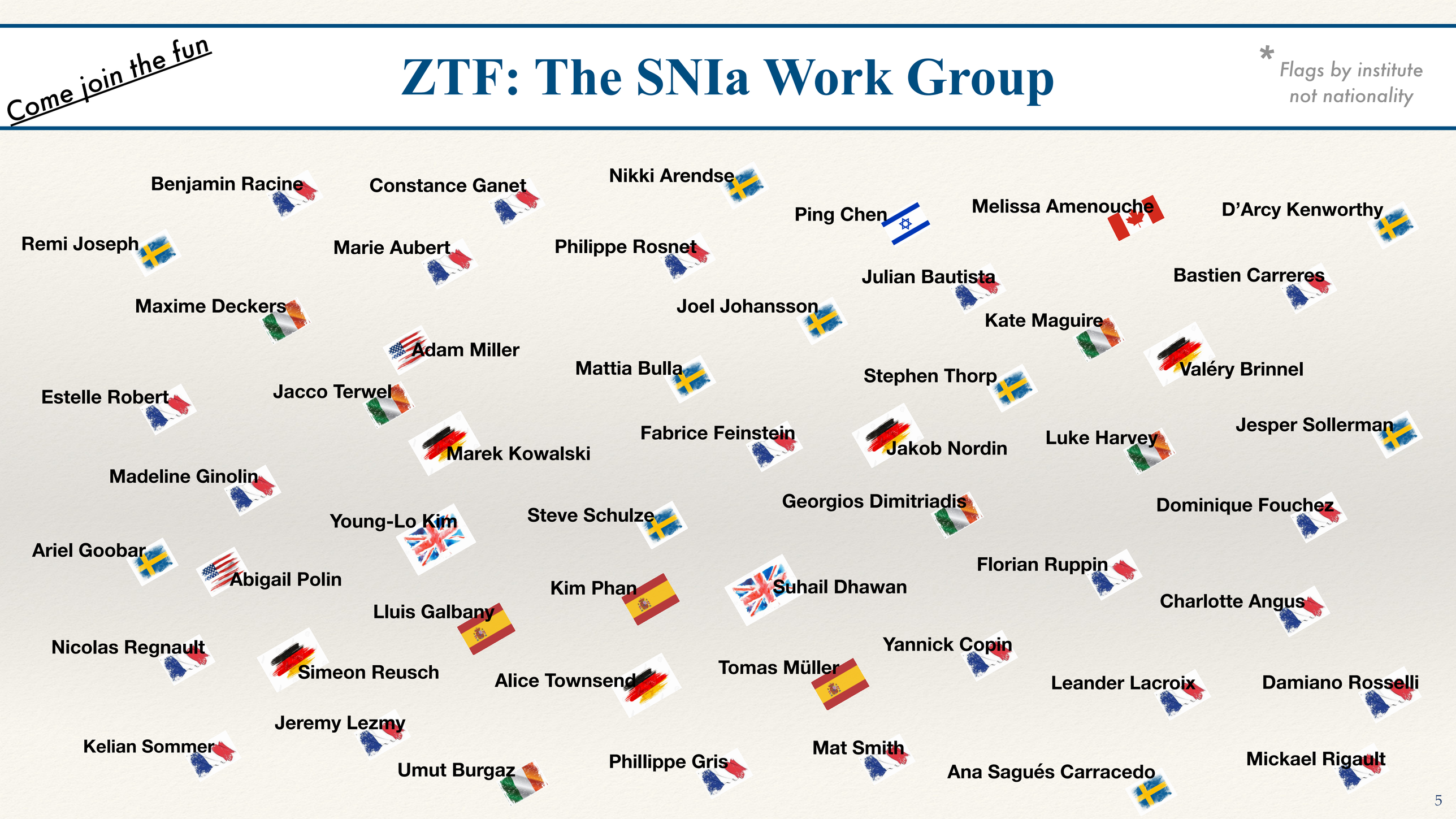
0.12mag unexplained scatter



Come join the fun

ZTF: The SNIa Work Group

* Flags by institute not nationality



ZTF-DR2 | *Changing the scale of SN Cosmology*

3000+ SNe Ia

10x more than state-of-the-art

Requirements:

Classification

LC properties

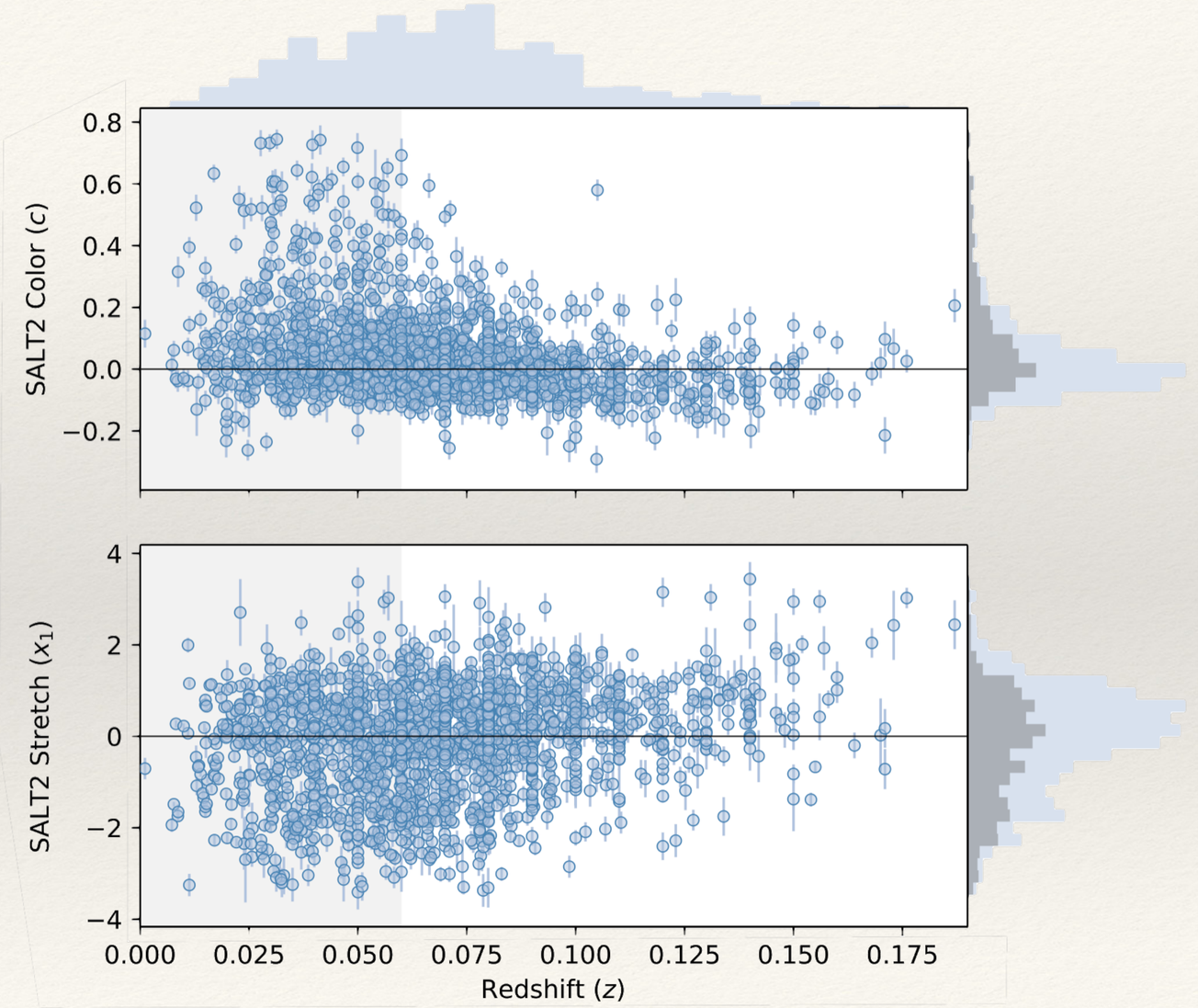
Spectral properties

Redshifts

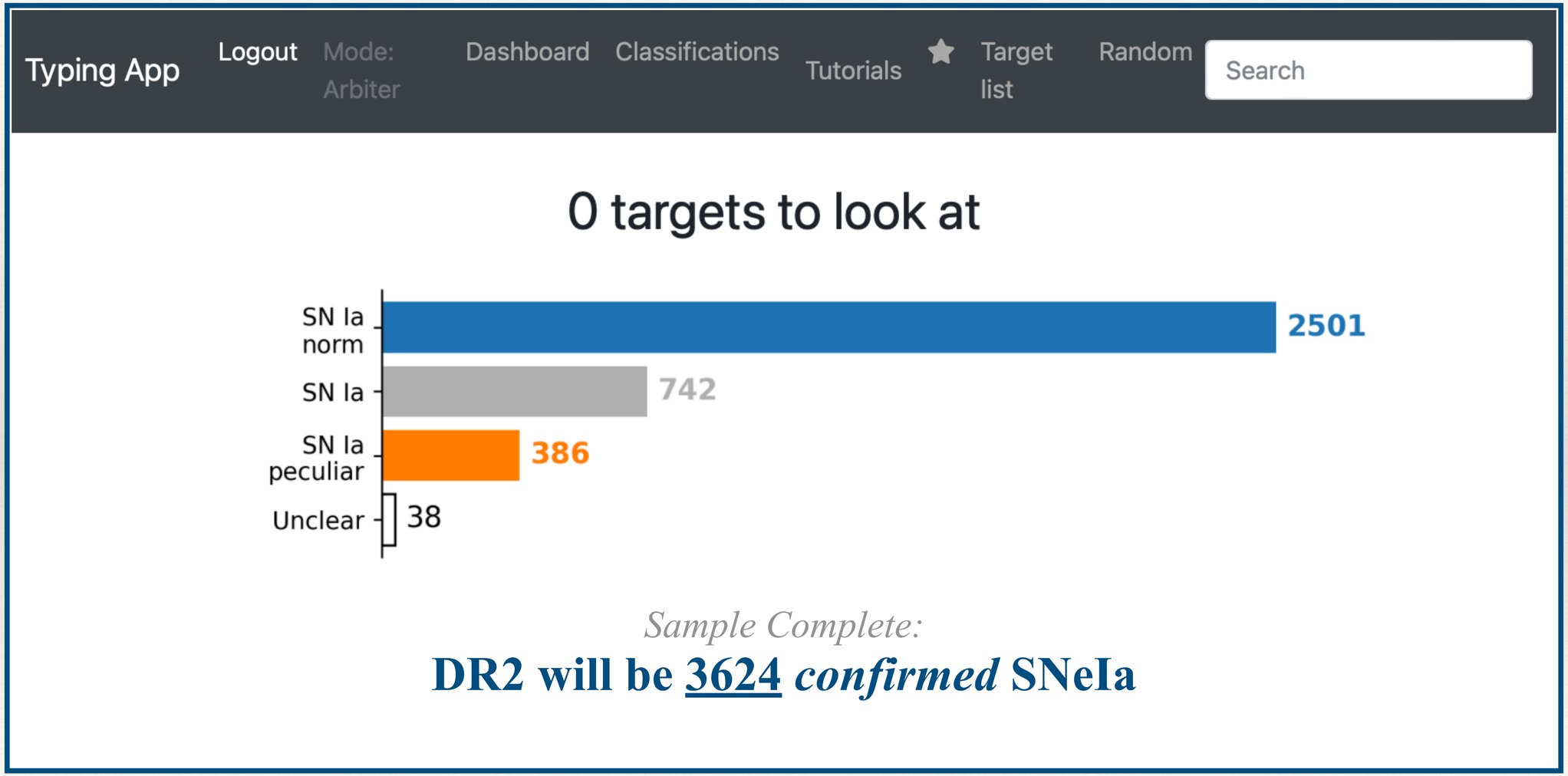
Host Properties

Sub-typing

Selection



Classification: Defining a SNeIa



Sample Complete:

DR2 will be <u>3624</u> *confirmed* SNeIa

TODAY: *Tested* Light-Curves

Force Photometry

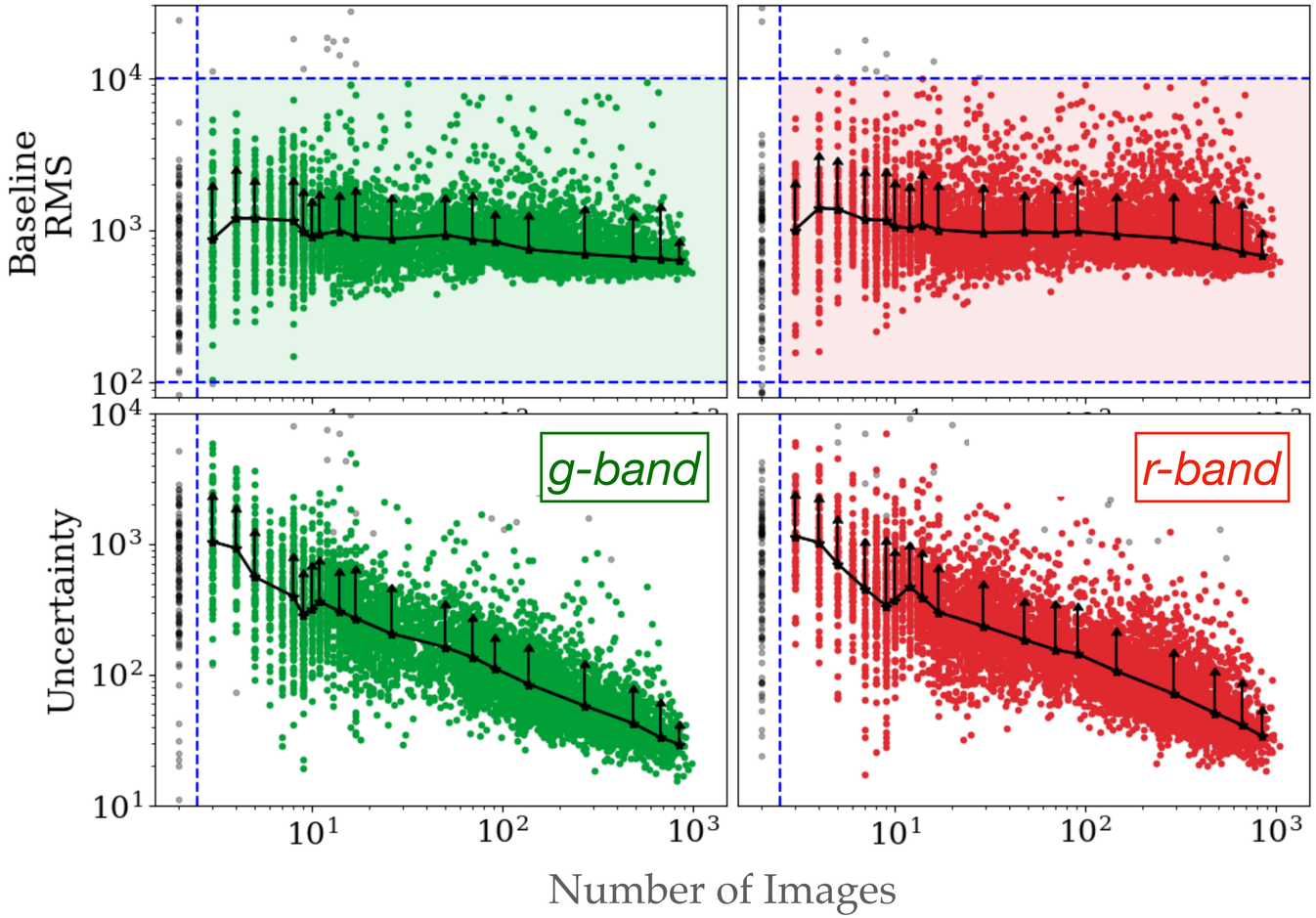
automated baseline corrections

understood uncertainties

$$\sigma^2_{mag} = \sigma^2_{stat} + 0.03^2$$

'unknown' systematics

See Leander on Scene Modelling



TODAY: *Tested* Light-Curves

Force Photometry

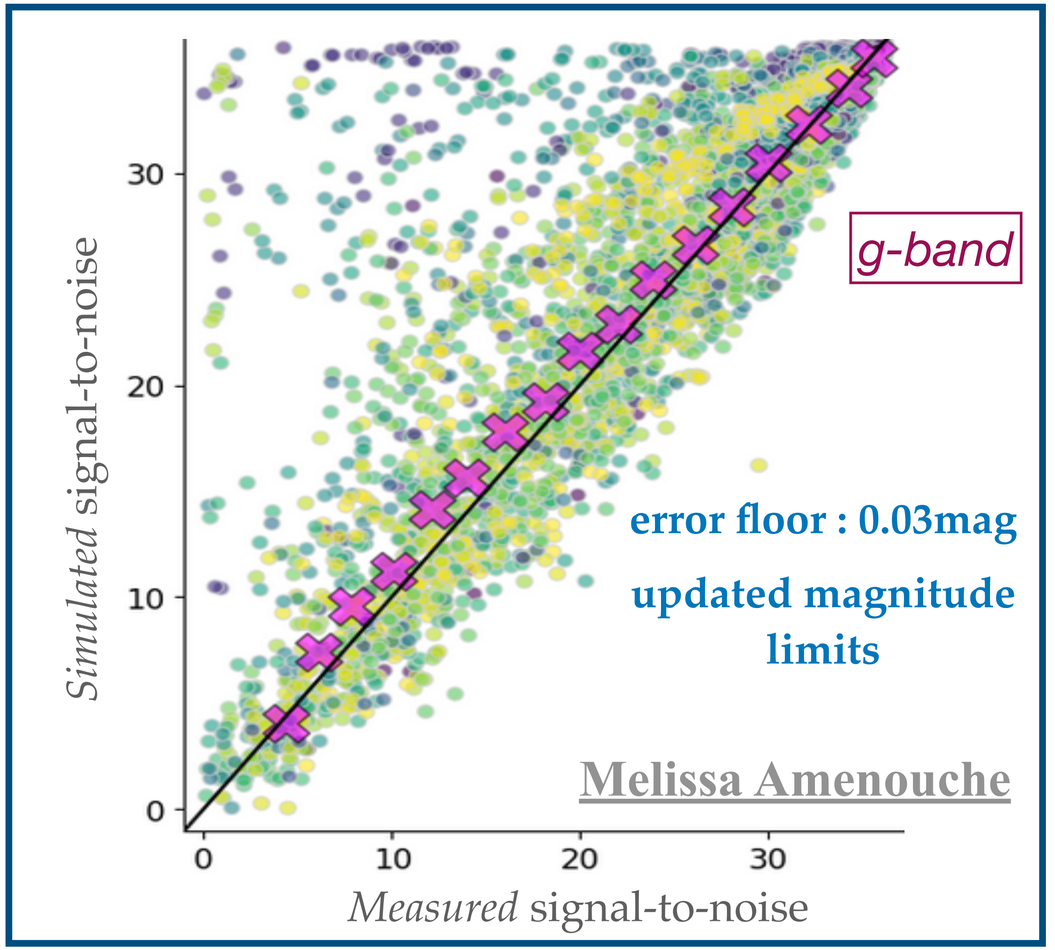
automated baseline corrections

understood uncertainties

$$\sigma^2_{mag} = \sigma^2_{stat} + 0.03^2$$

'unknown' systematics

See Leander on Scene Modelling



TODAY: *Secure* Galaxy Associations

Automated: *Galaxies and Redshifts*

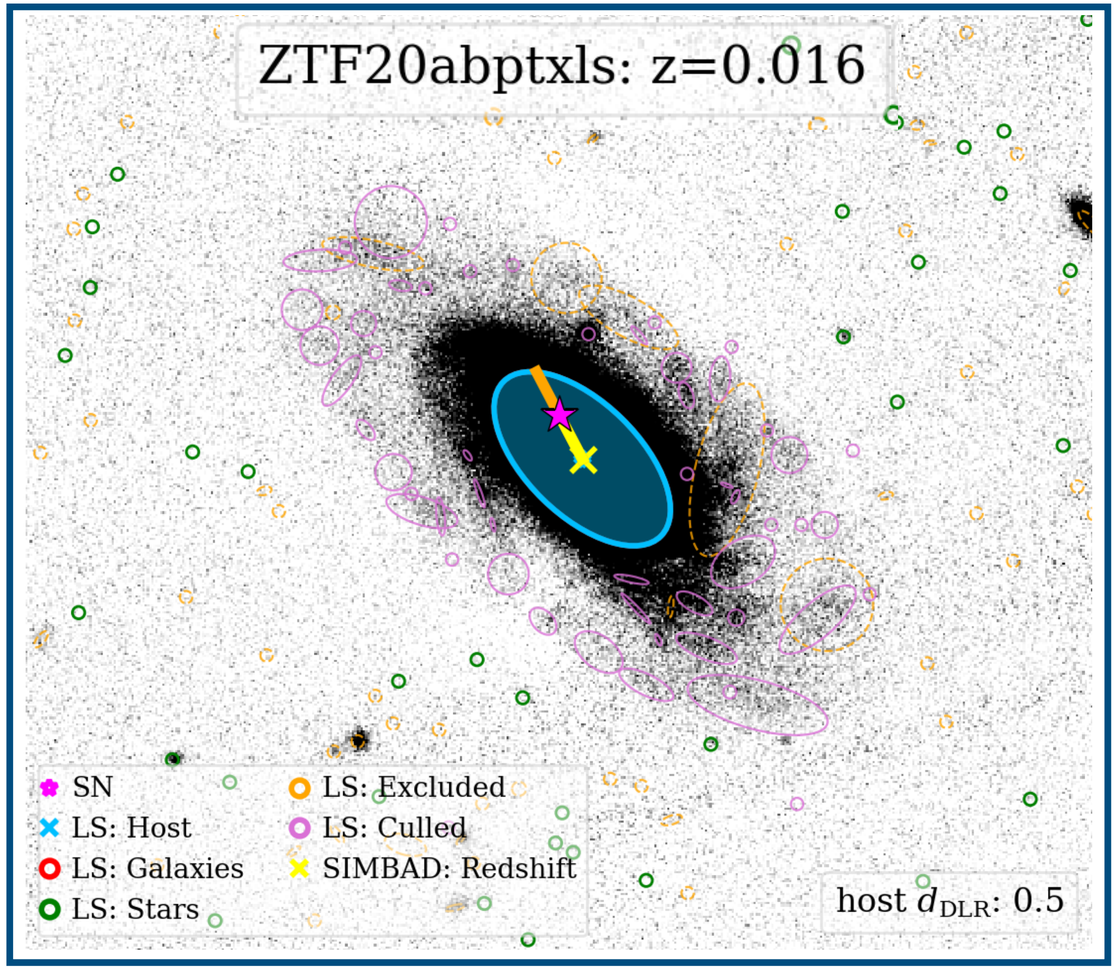
See Mat this afternoon

51% of SNeIa with z_{gal}

58% of SNeIa with z_{spec}

DESI discussions ongoing

Derived properties ongoing



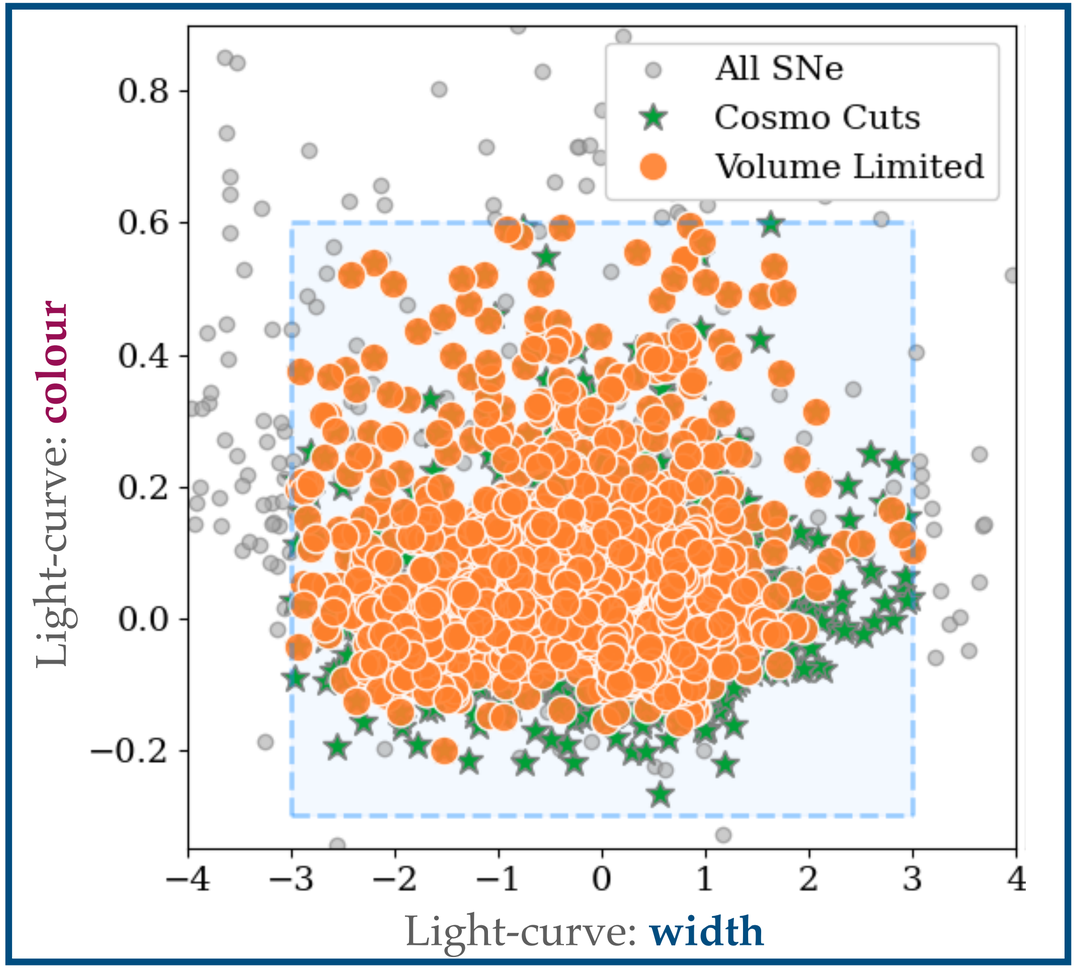
TODAY: *light-curve fits with systematics*

2665 cosmological SNeIa

State-of-the-art : 300

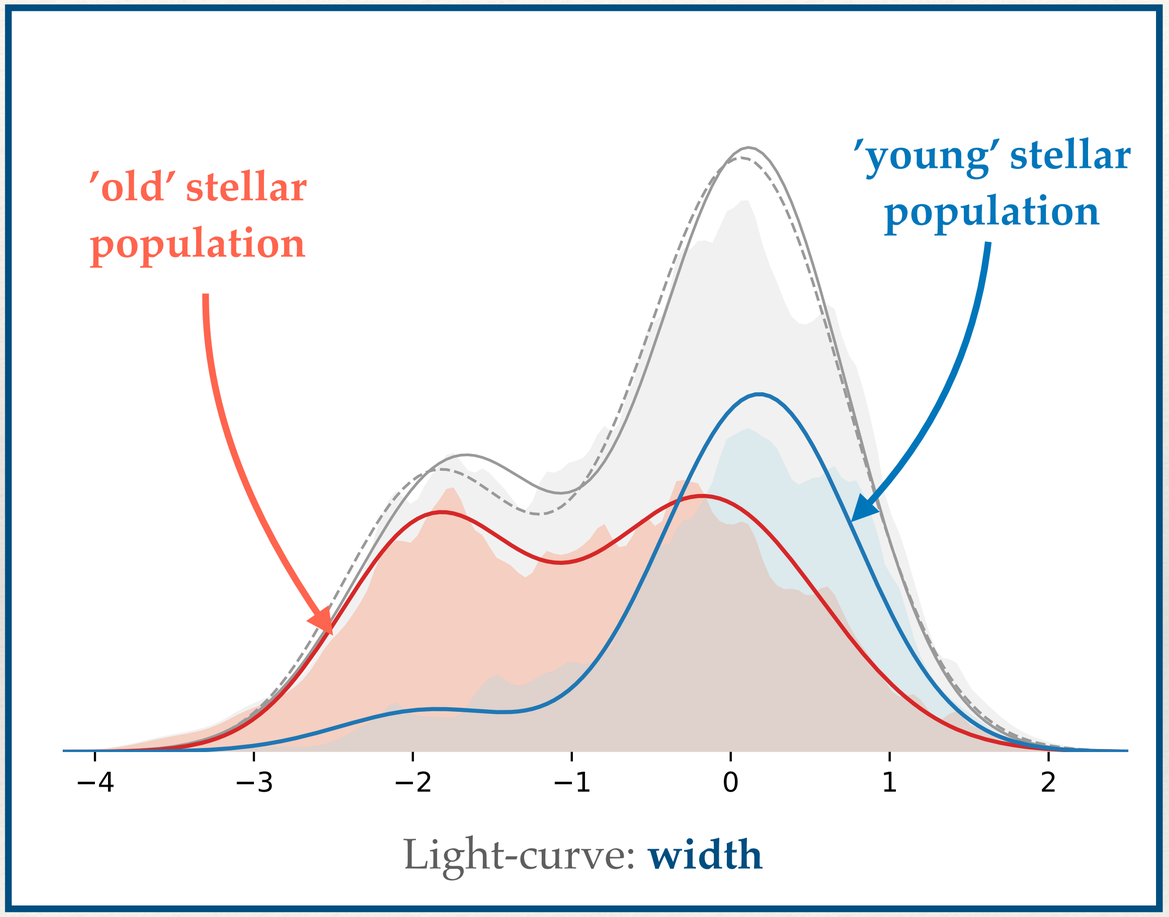
900 SNeIa with z<0.06

650 normal SNeIa

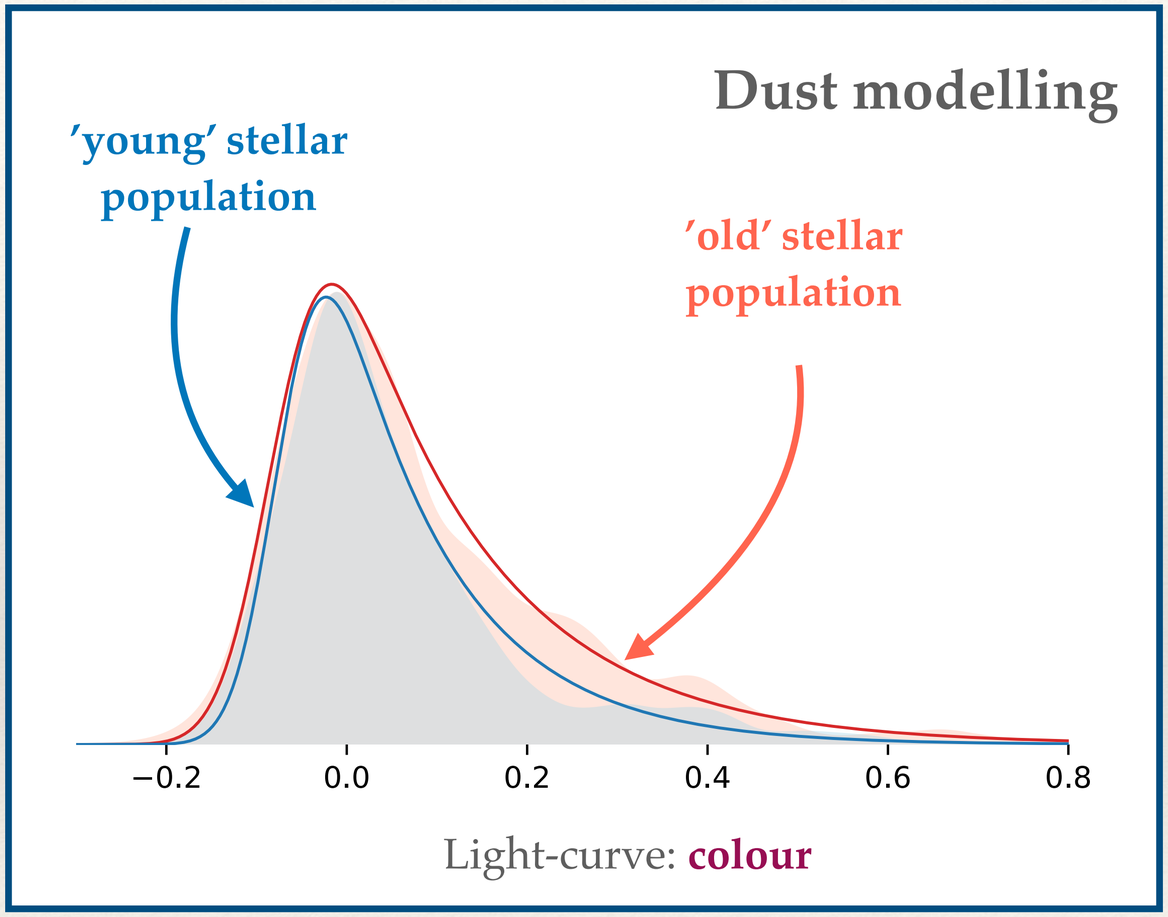


ZTF-DR2: SCIENCE

MADELINE GINOLIN: Modelling observables

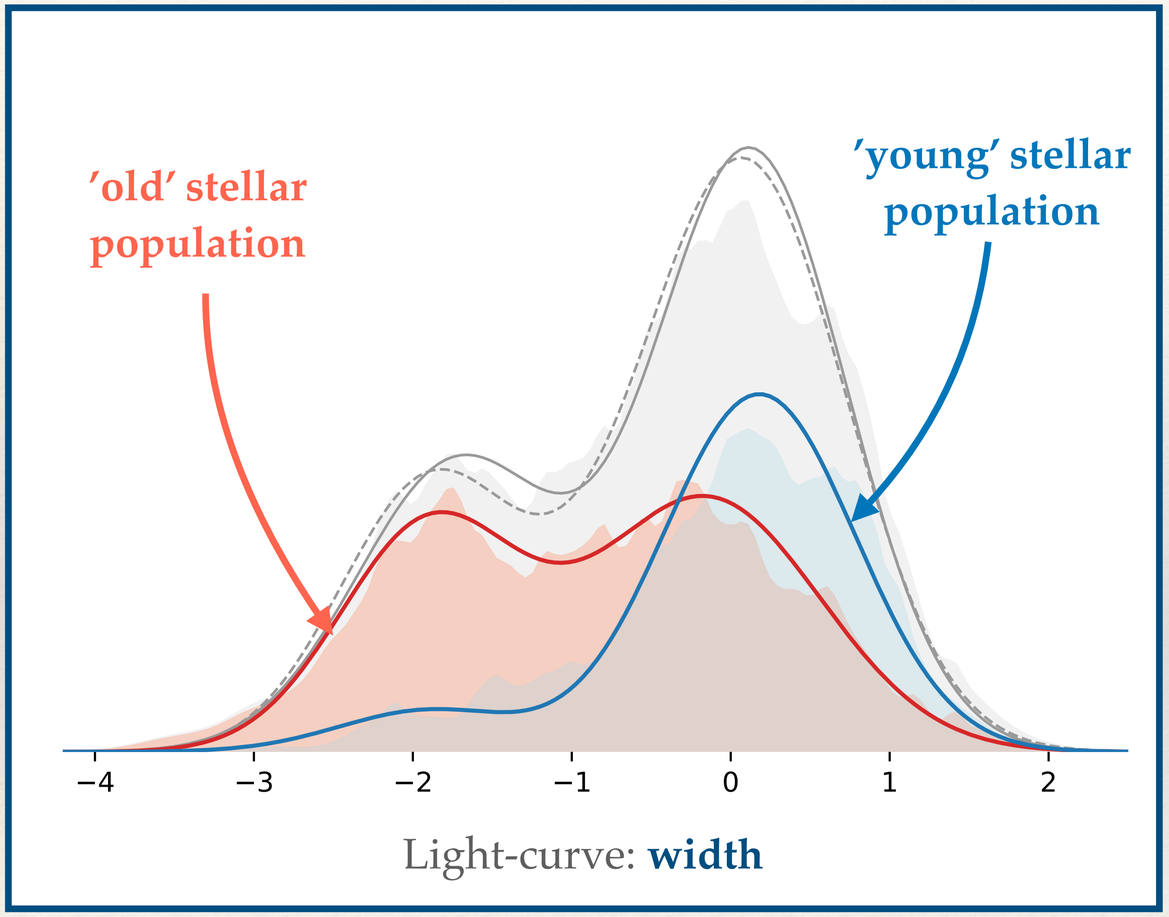


Light-curve: **width**

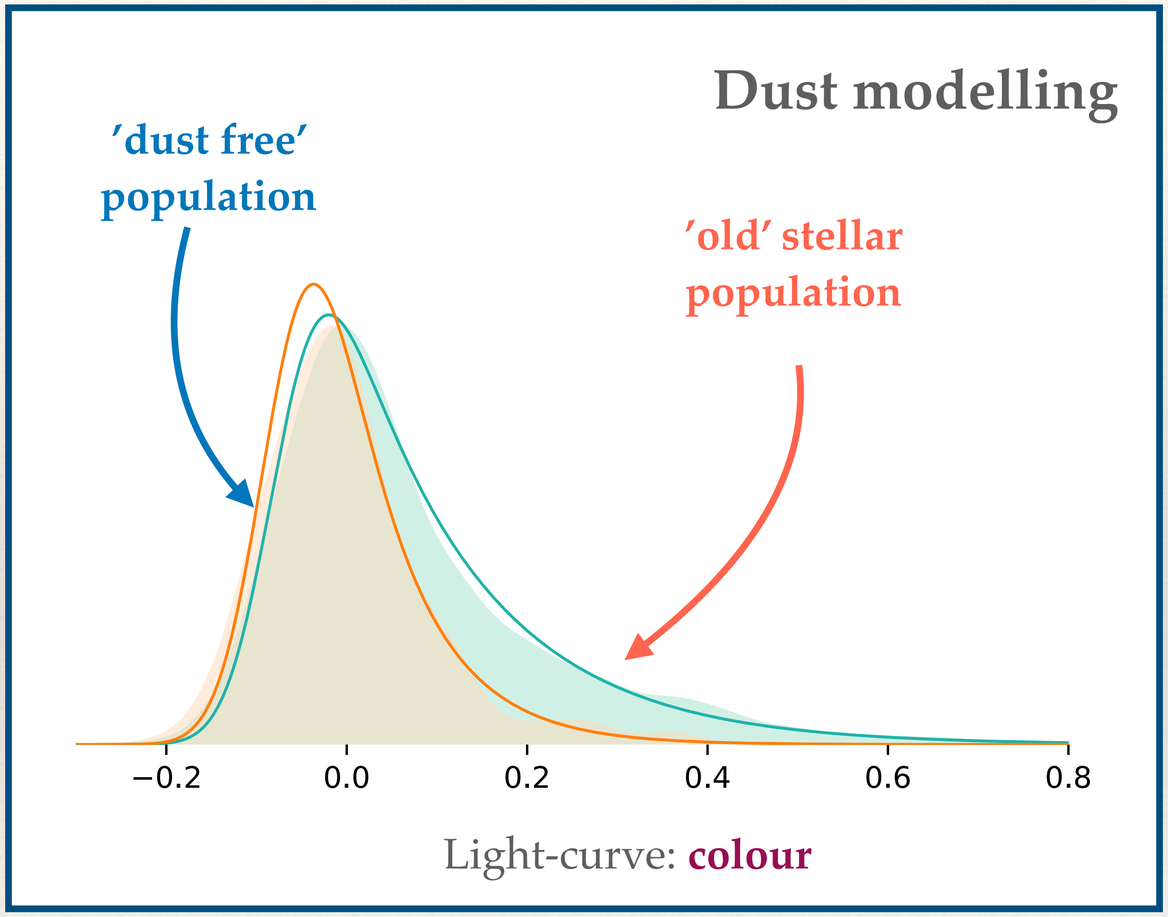


Light-curve: **colour**

MADELINE GINOLIN: Modelling observables

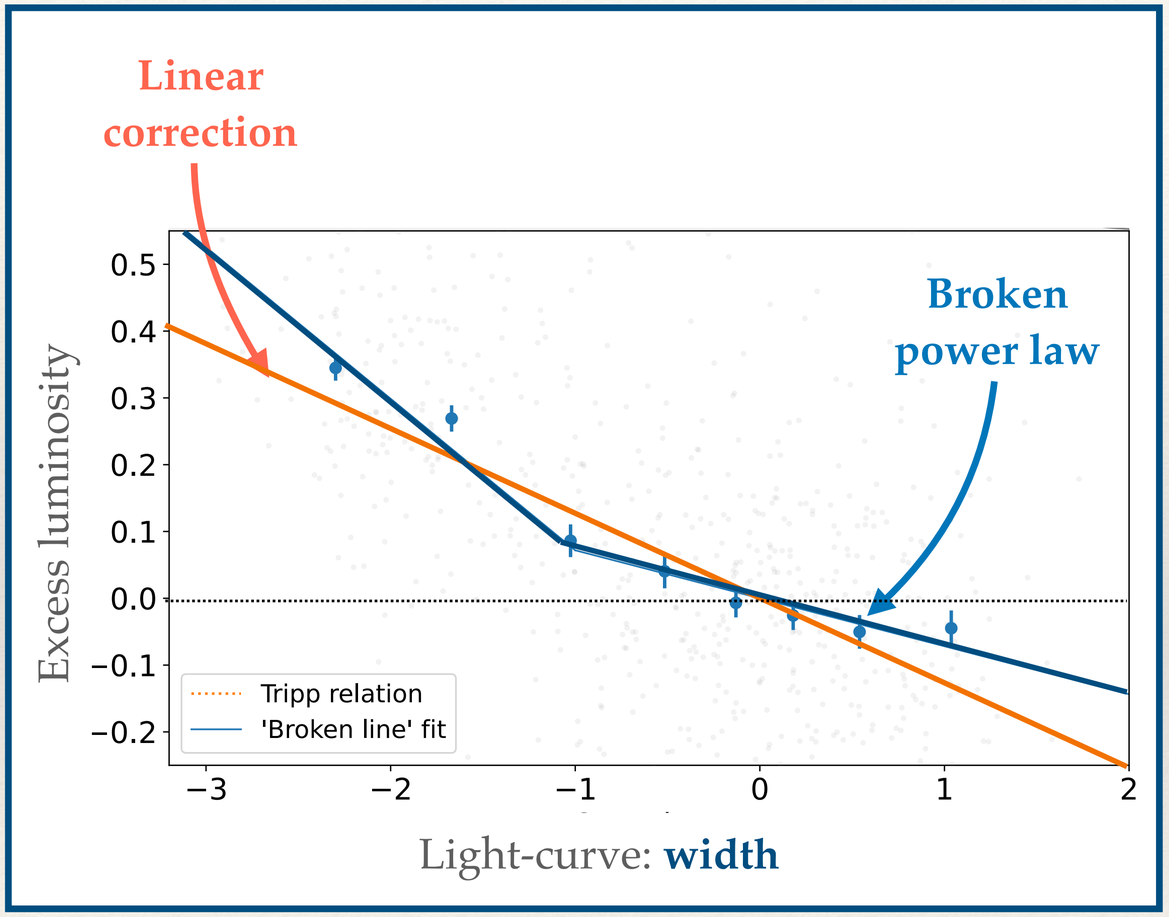


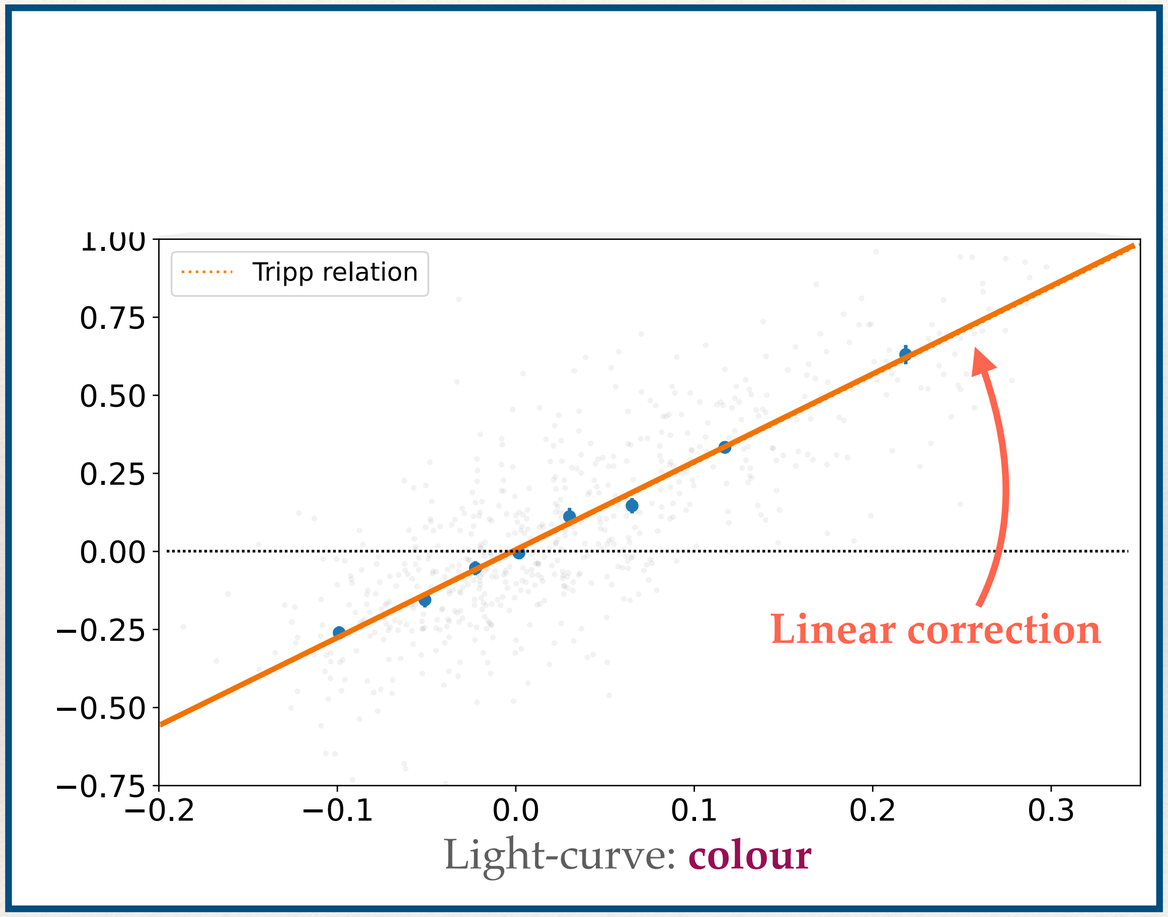
Light-curve: **width**



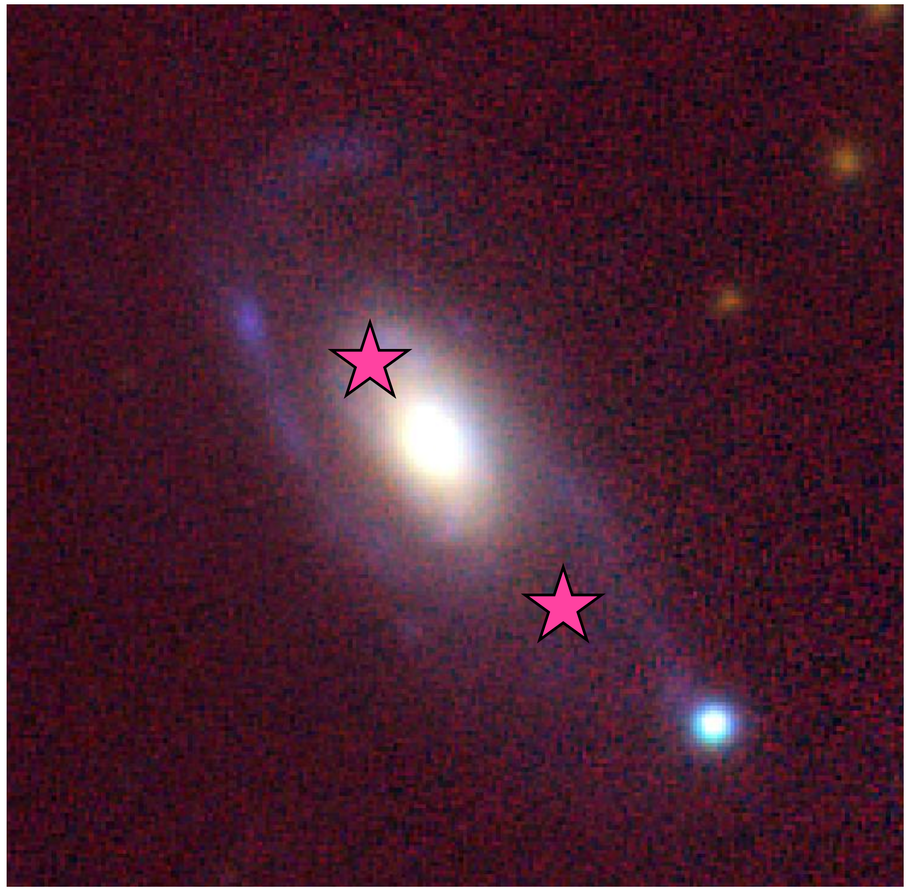
Light-curve: **colour**

MADELINE GINOLIN: Testing Standardisation

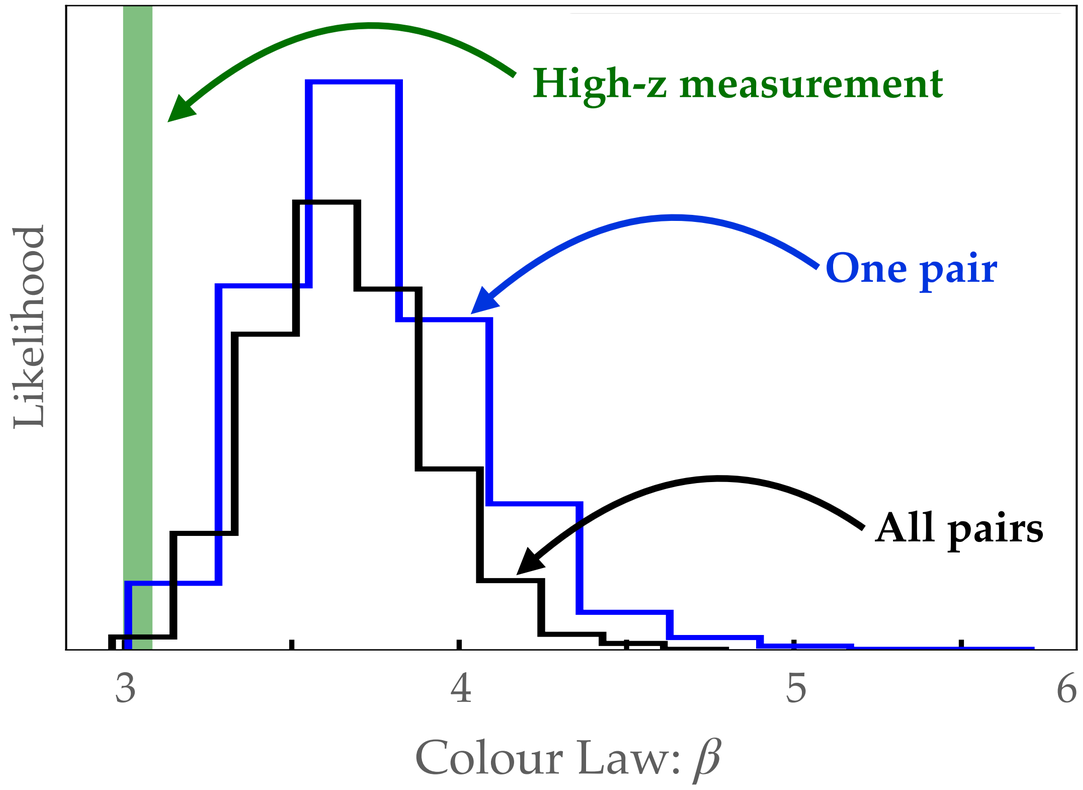




Suhail Dhawan: Sibling SNe

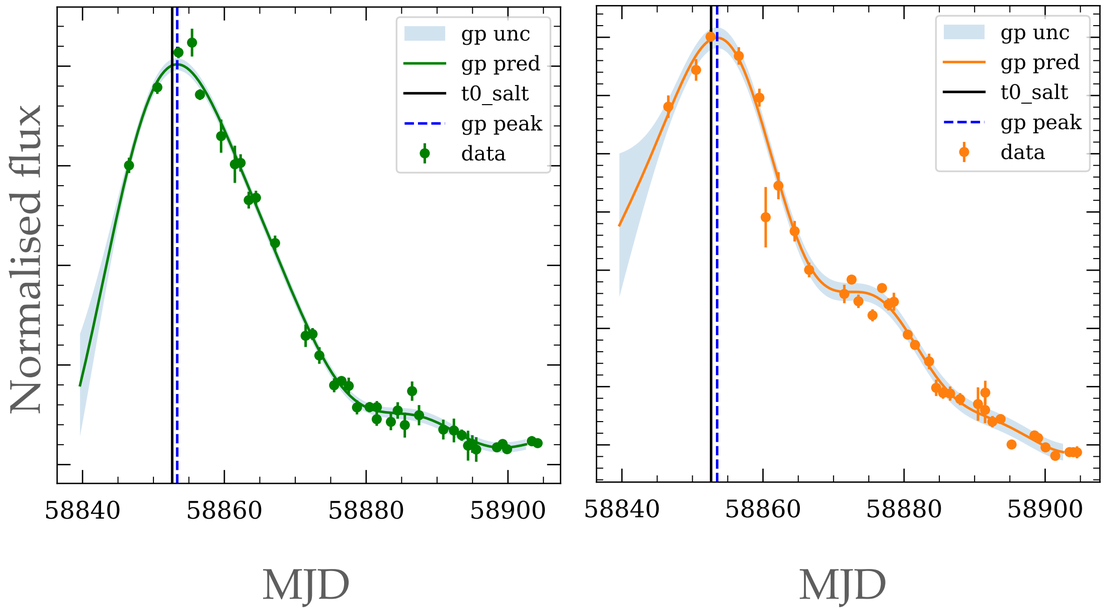


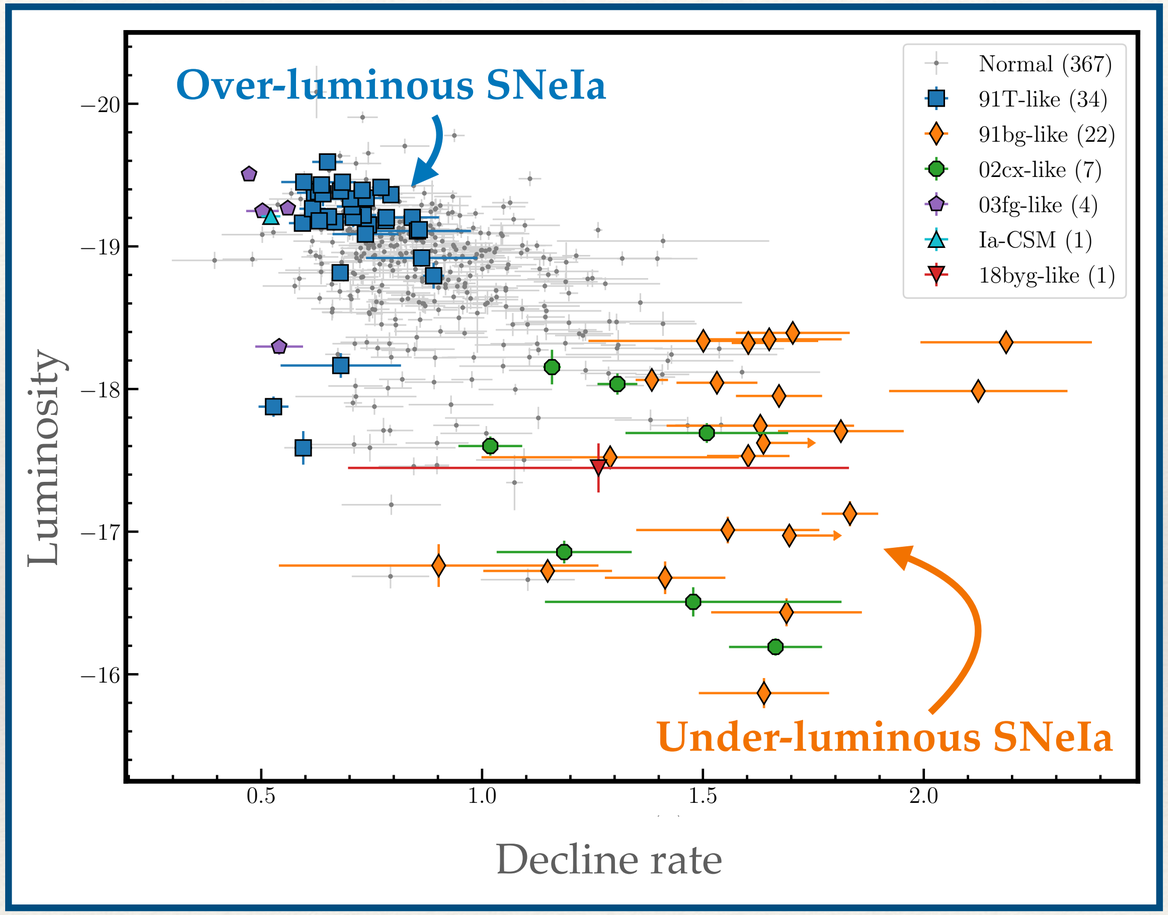
$$\mu(z) = m_{obs} - (M_{abs} - \alpha \times s + \beta \times c)$$



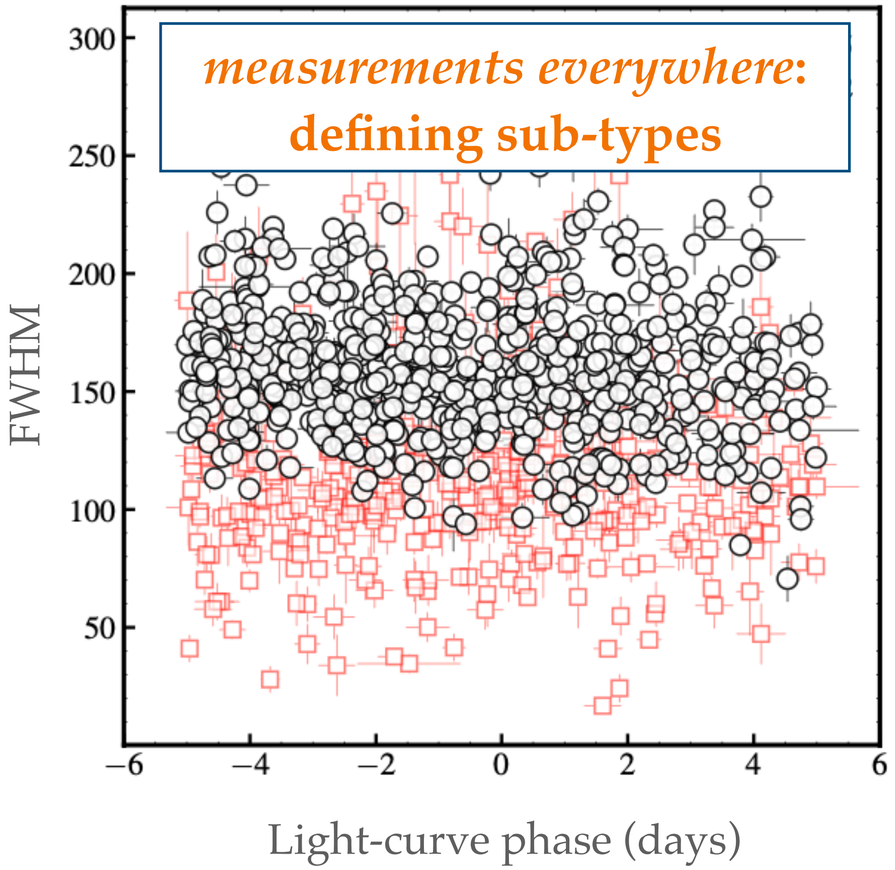
GEORGIOS DIMITRIADIS: Photometric diversity

Model Independent Fits

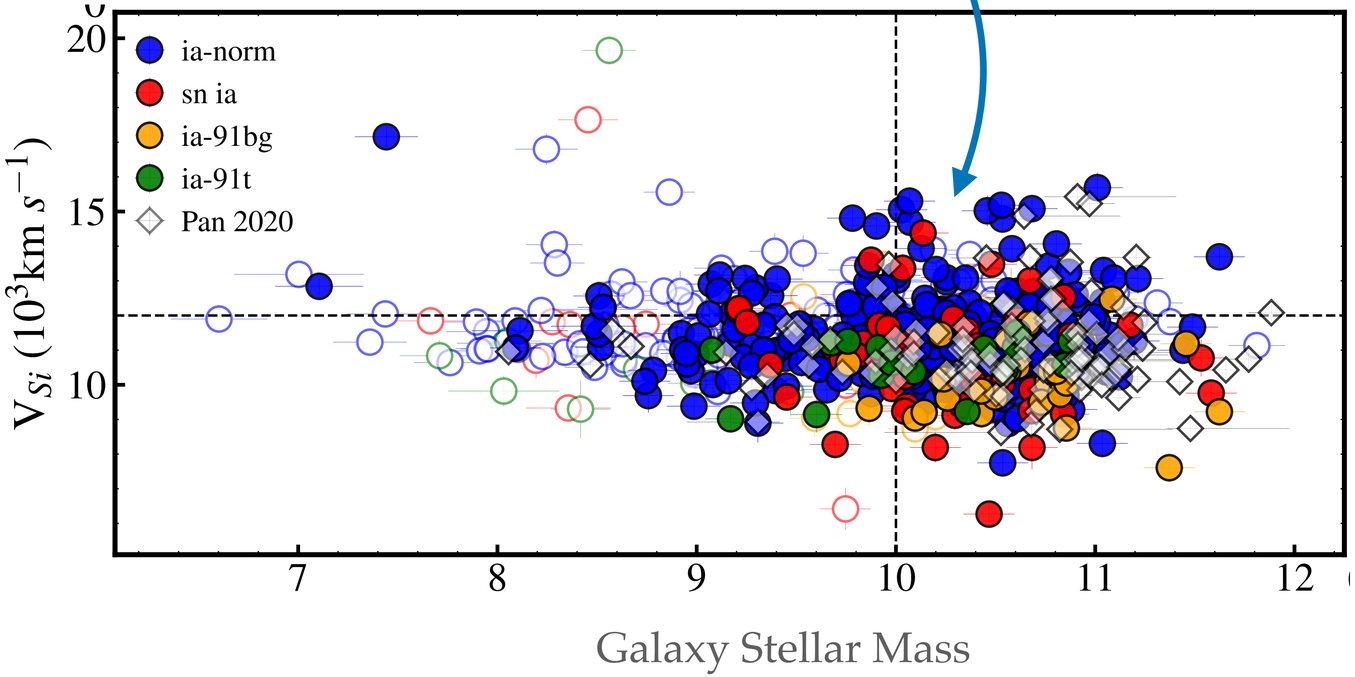




UMUT BURGAZ: Spectral diversity

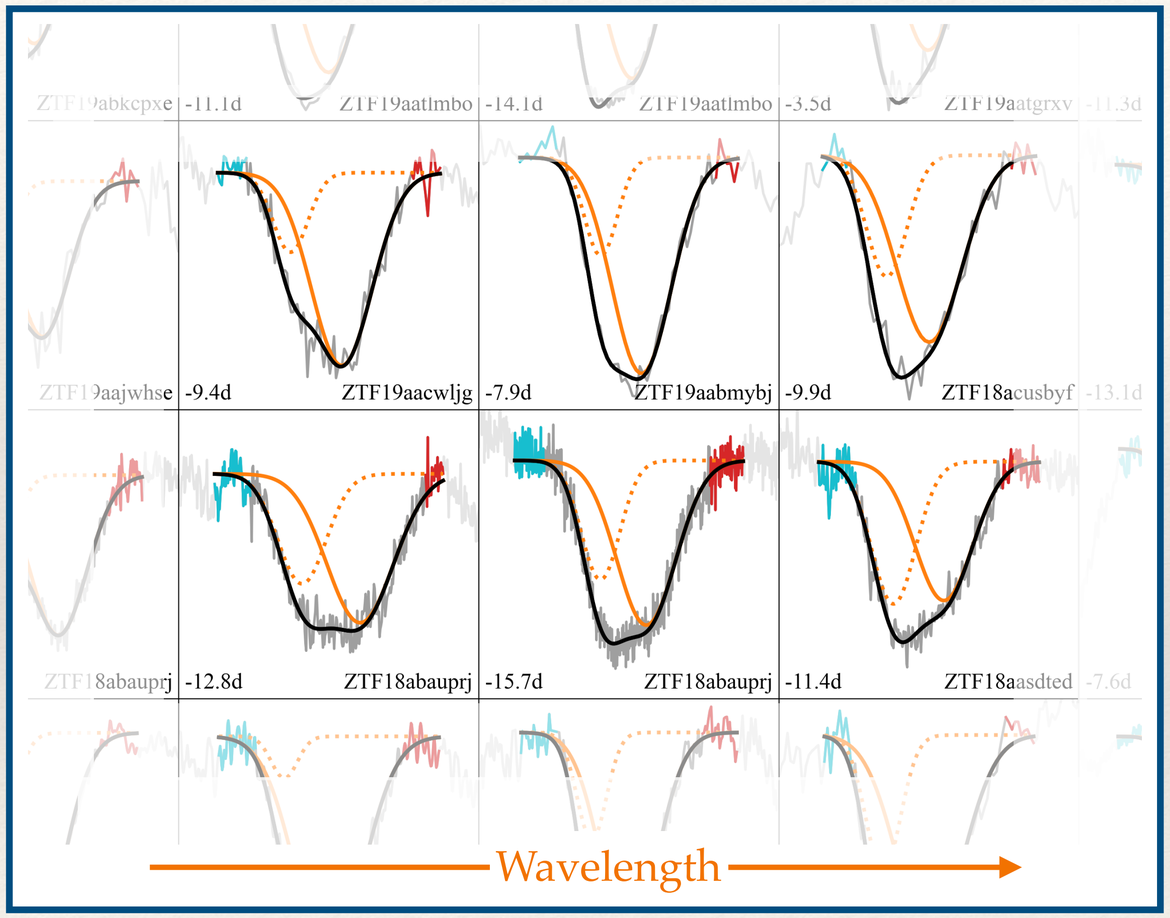


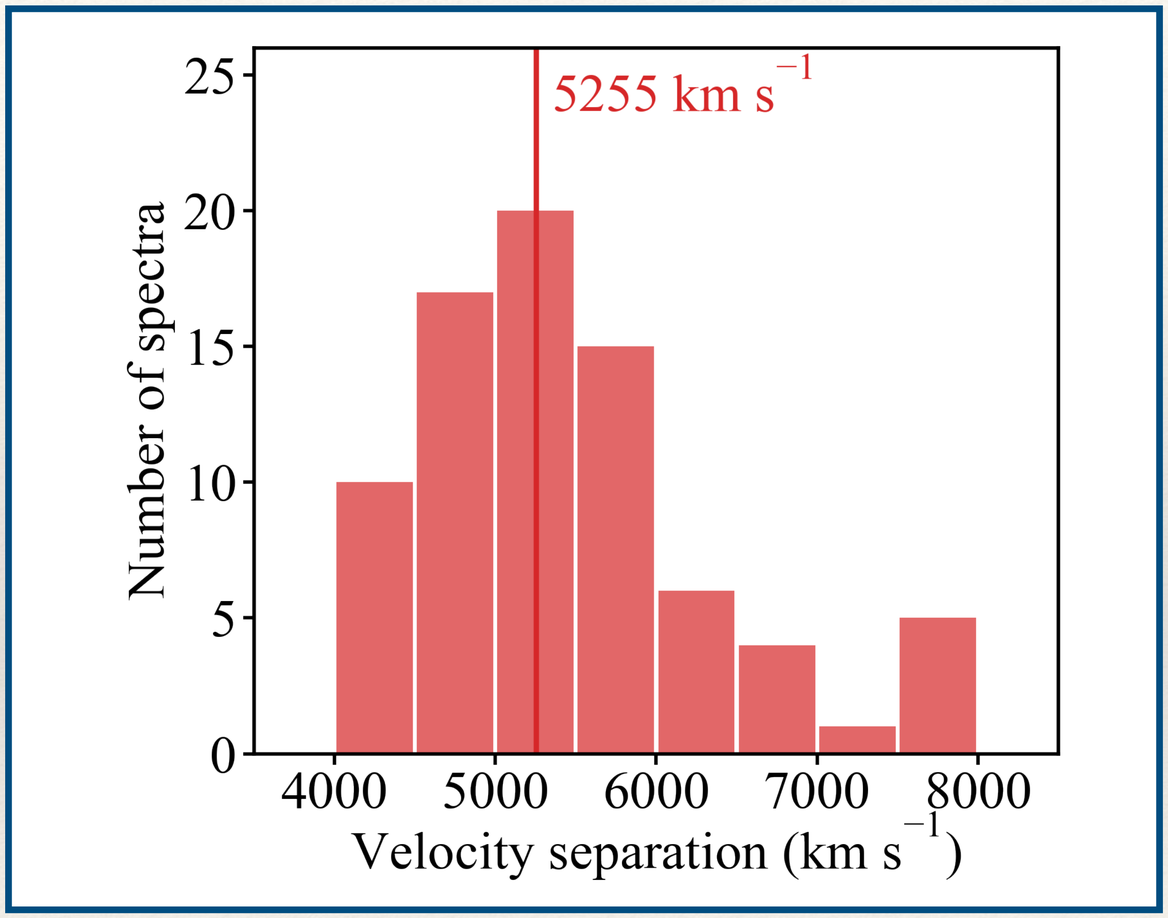
High velocity SNeIa seen everywhere



Metallicity correlations to come

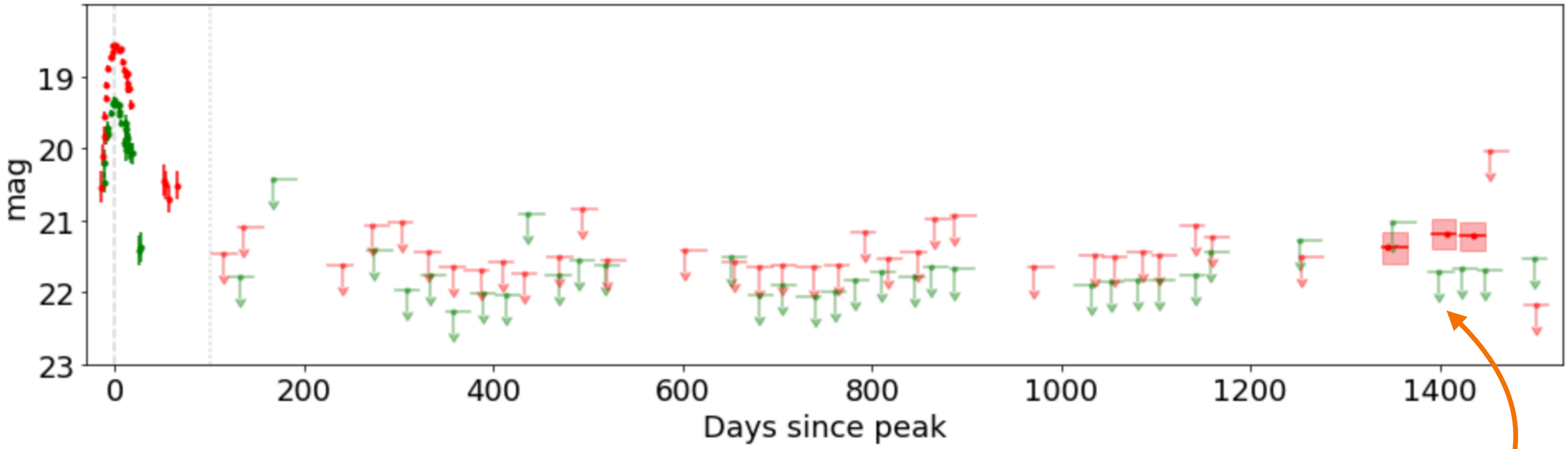
LUKE HARVEY: Early time signatures





JACCO TERWEL: Progenitor signals

Searching for late-time interaction



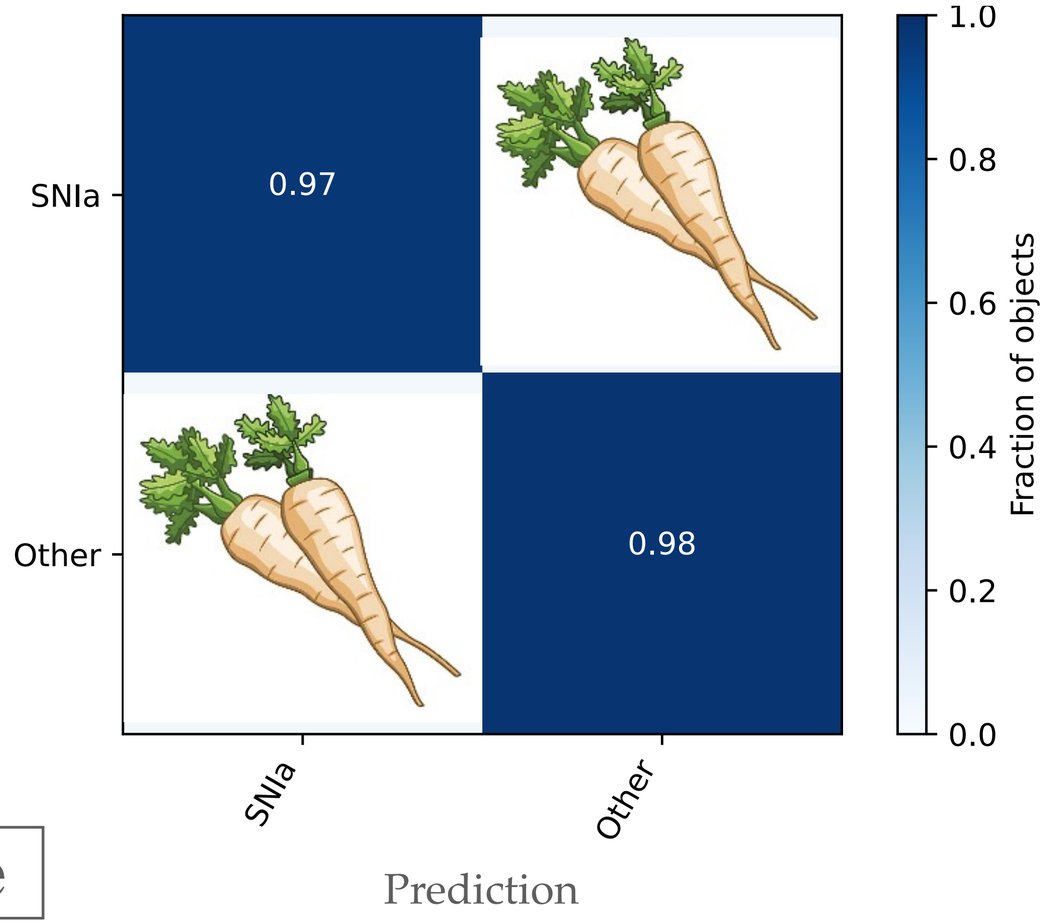
Late time excess

ALICE TOWNSEND: Photometric SNe

ZTF-DR2 : 3500 SNeIa

ZTF : ??? SNeIa

at *least* 30,000



Critical to:

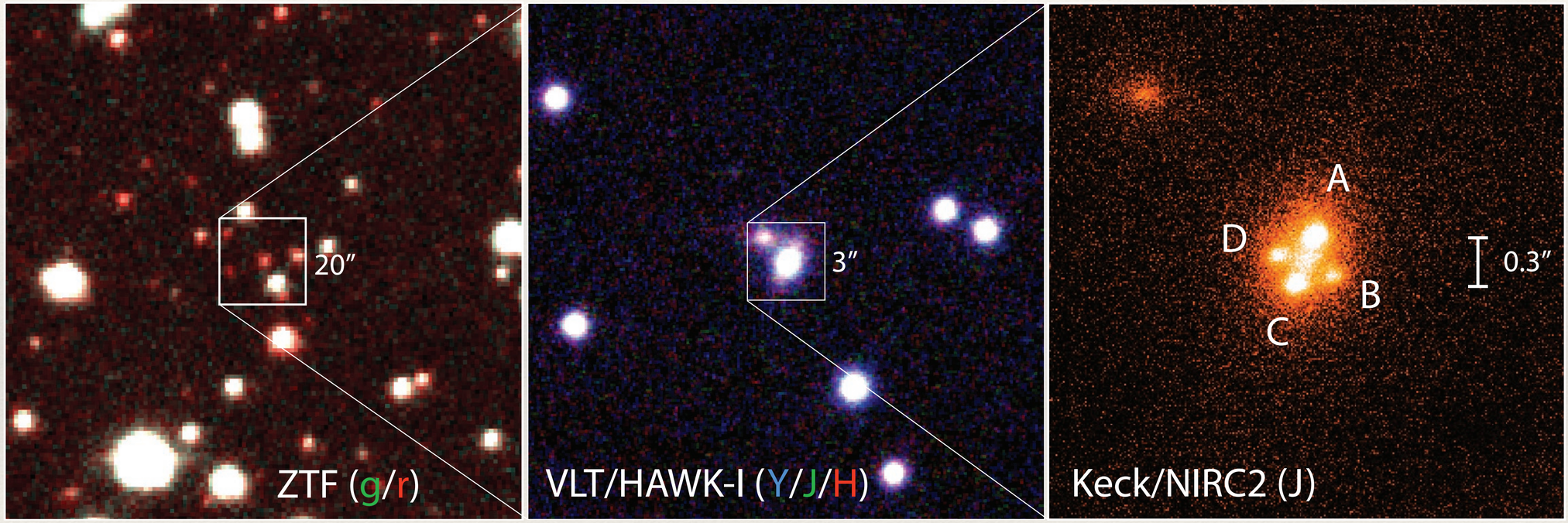
Understand selection (any cosmology)

ZTF-DR3 (legacy science)

***Coming soon* : real-time and archive**

The Lensing team (Ariel, Joel, Ana, Nikki, Alice, Suhail, Steve, Jakob, Edvard, …)

SN Zwicky



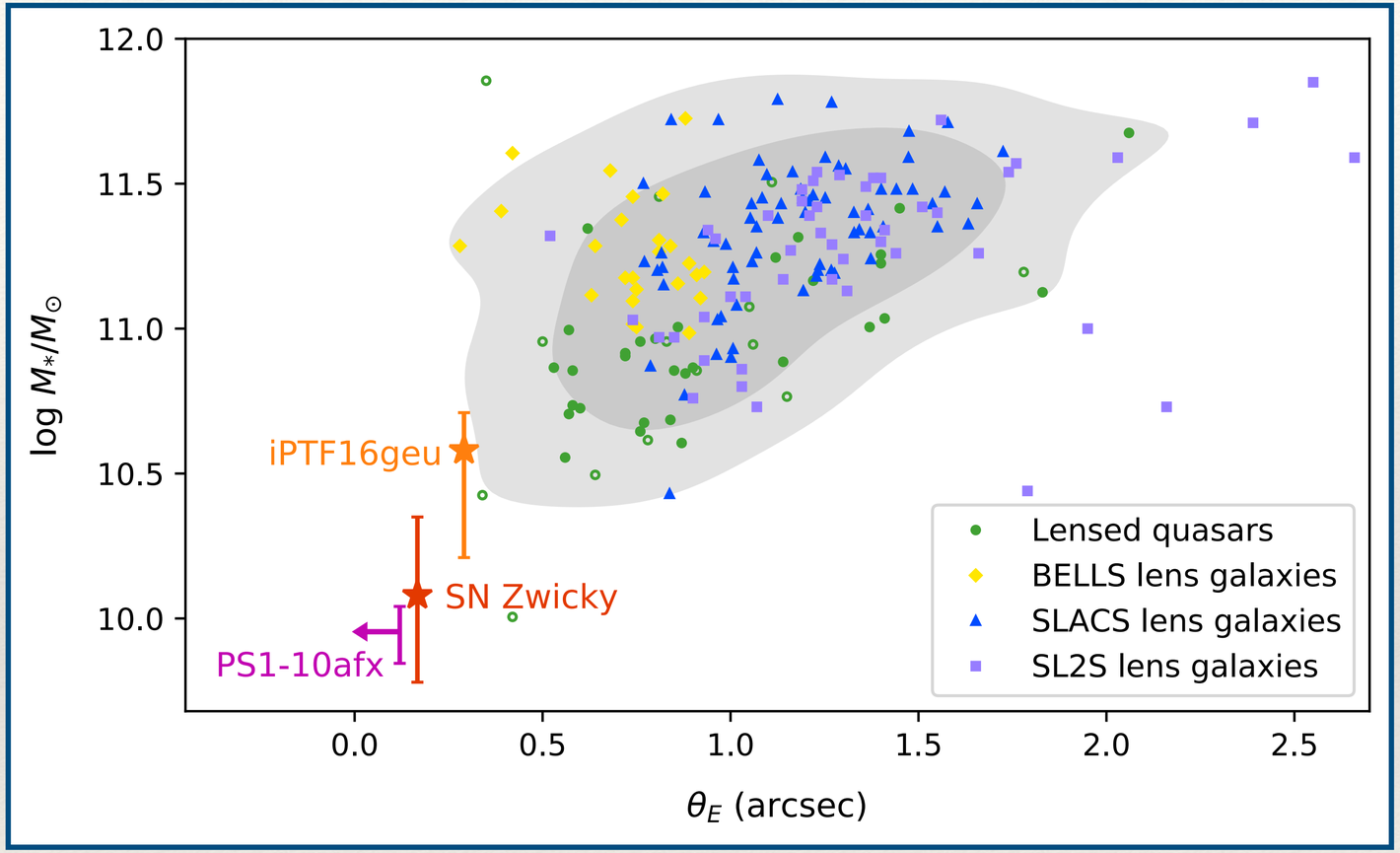
Goobar et al.;
Nature Astronomy

THE LENSING TEAM (ARIEL, JOEL, ANA, NIKKI, ALICE, SUHAIL, STEVE, JAKOB, EDVARD, …)

Lessons:

SN lenses:
high magnification
small angular separation
small time-delays
milli/micro-lensing

Constraints on:
stellar populations
black holes
substructures



Conclusions

low magnification events missed : *many more to come*
Spectroscopy is critical : *teamed with DESI*
Space-based followup : *JWST C2 + HST C30 & C31*

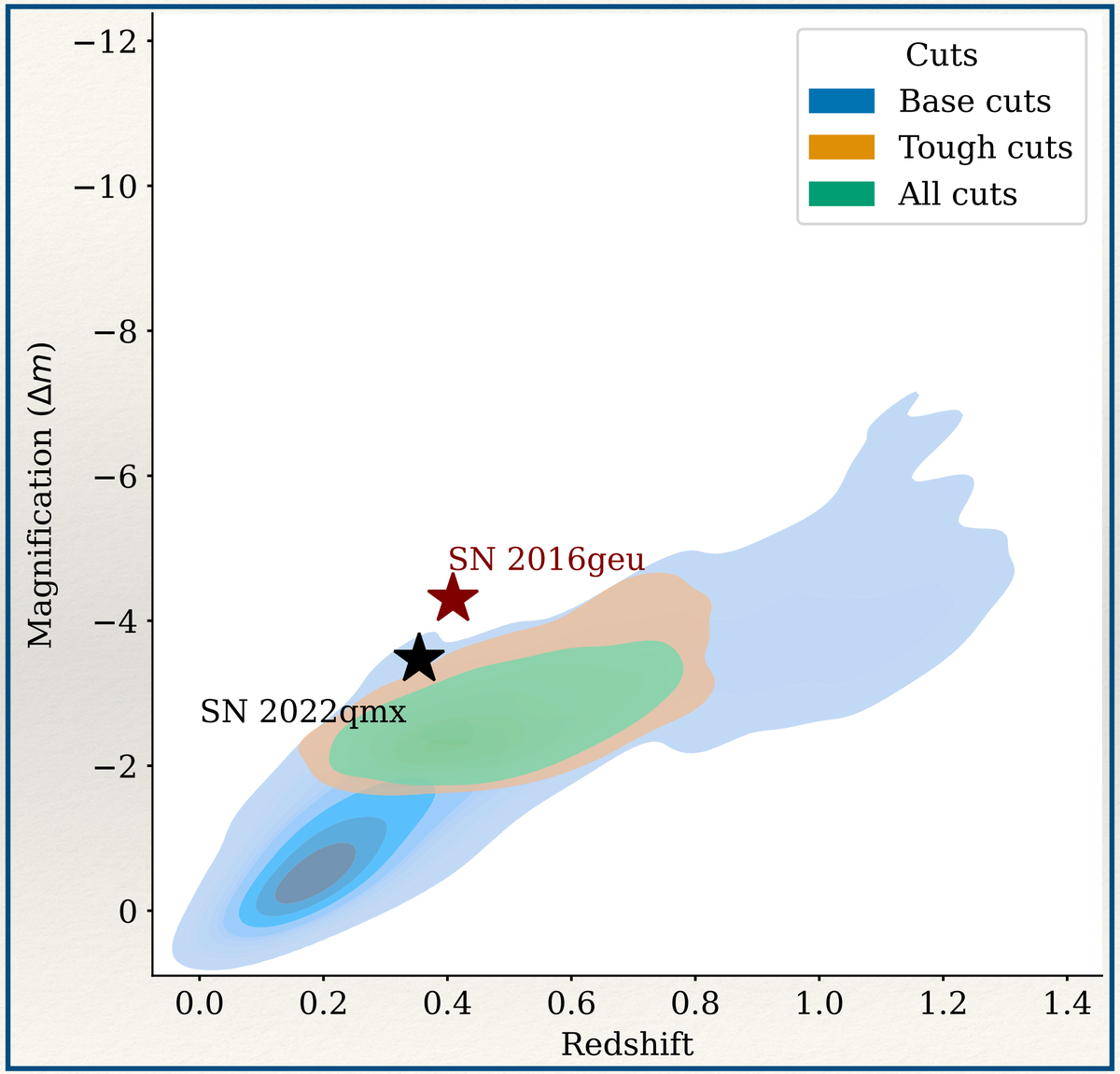
THE LENSING TEAM (ARIEL, JOEL, ANA, NIKKI, ALICE, SUHAIL, STEVE, JAKOB, EDVARD, …)

Archival Search

- AMPEL Pipeline
  - Optimised based on simulations

200+ viable candidates

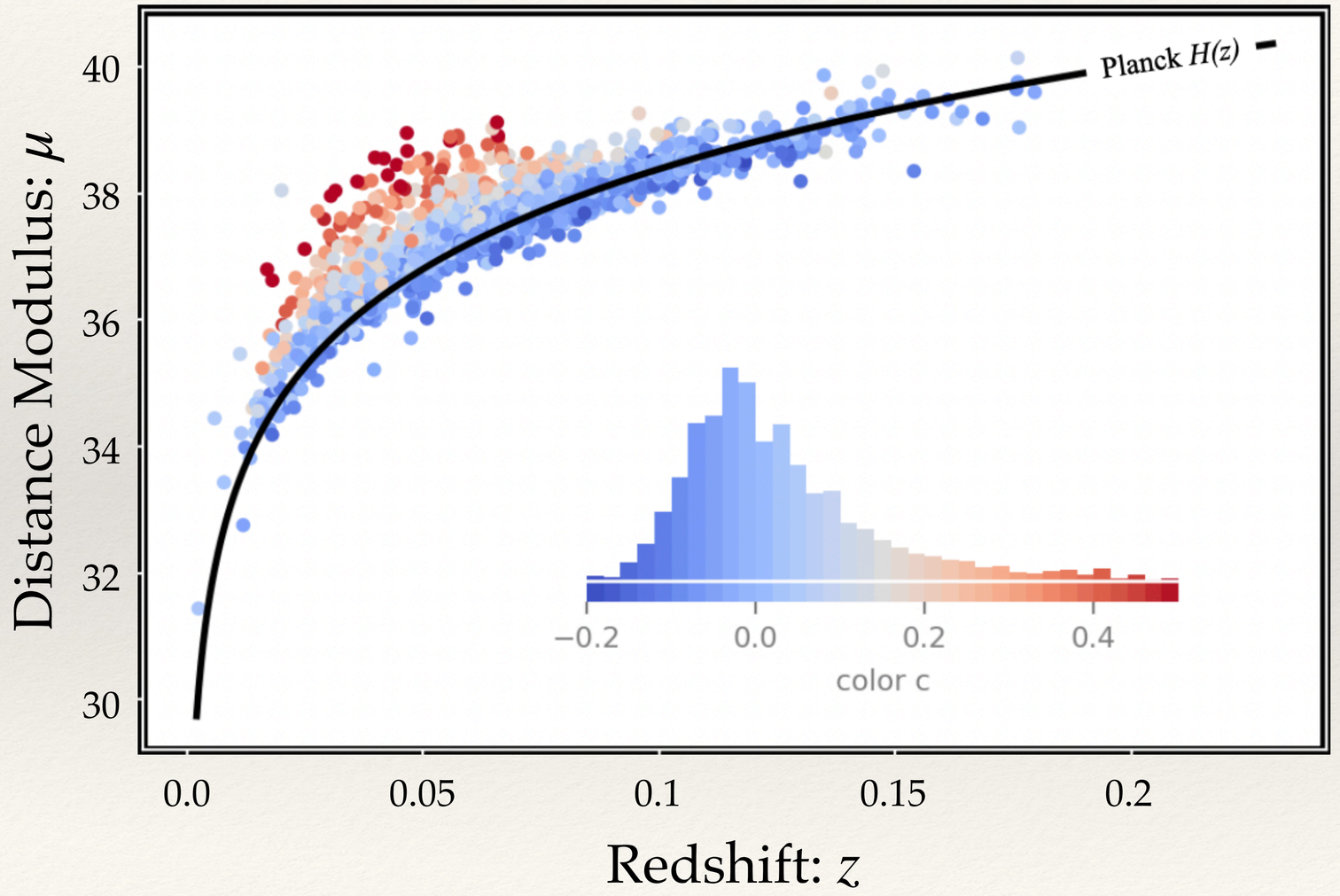
Spectroscopy needed!



Alice Townsend + Ana Sagues-Carrecedo

SUMMARY

ZTF-DR2 : OUT THIS SUMMER



3624 SNeIa

2665 Distances

State-of-the-art today : 300

Short term goal: **20 papers**

2024: **Cosmology**

(see re-calibration)

THANK YOU :-)