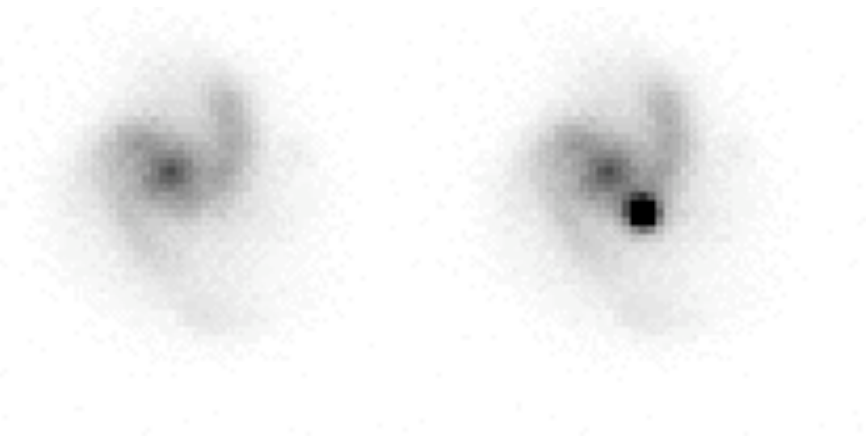
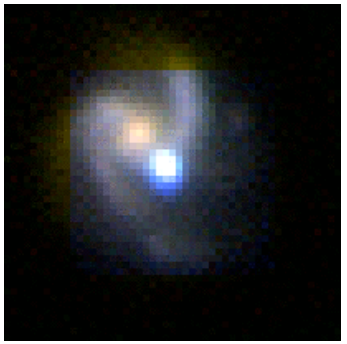
Paris-Berkeley DE workshop

SN session 1: Issues for Future Progress

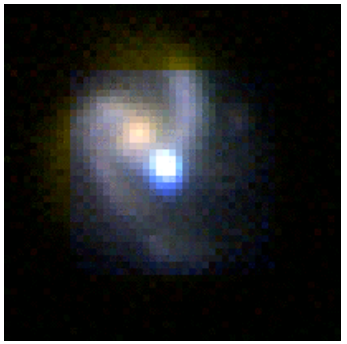


Issues for Future Progress



- What is the question ?
- Issues raised in today contributed talks
- Other issues (from the working session)
- Issues for progress

What is the question ?



Wokshop program: « discuss insights into the nature of Dark Energy … from current and future experiments »

With the SN probe, « nature of DE » means :

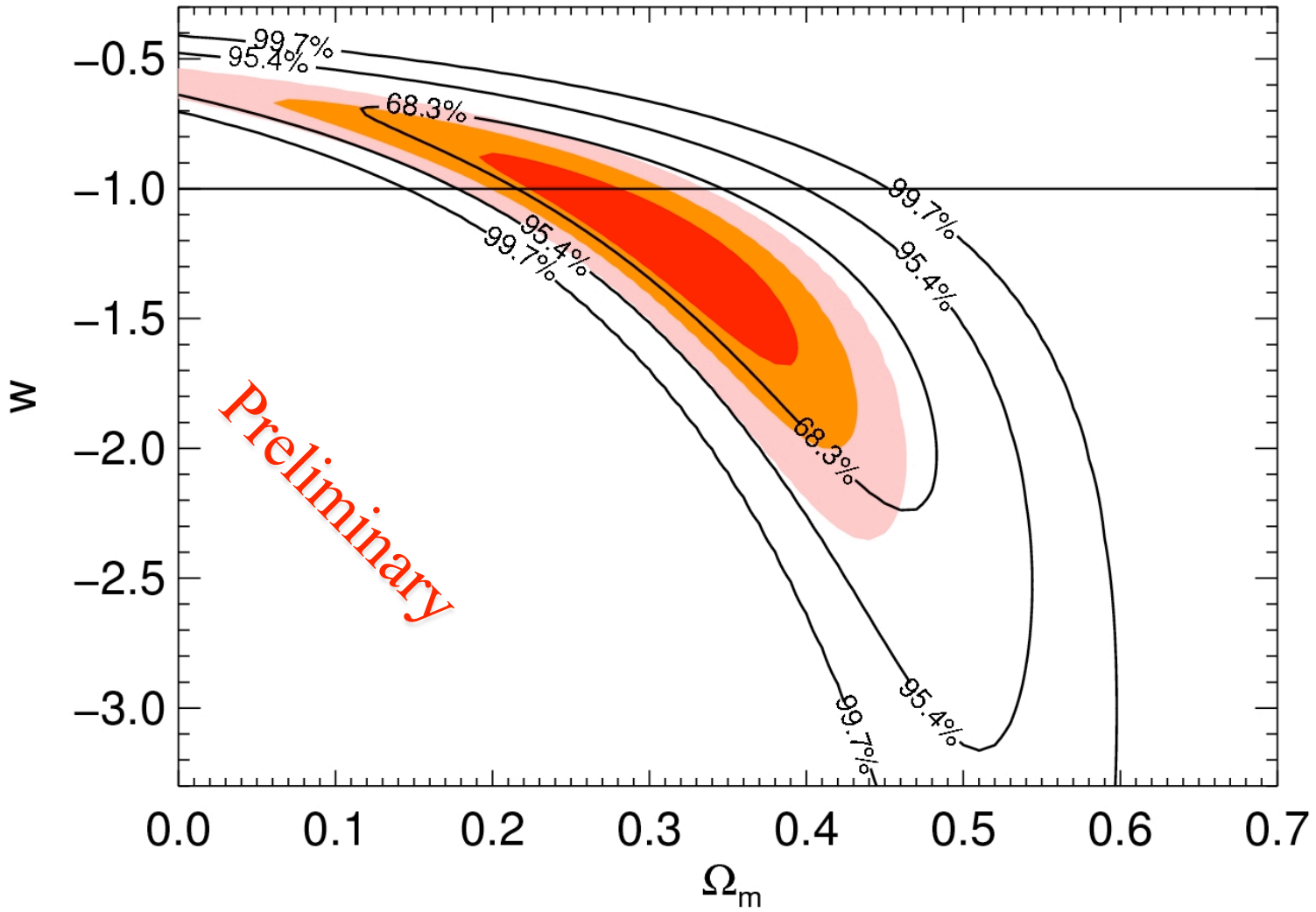
measuring w (combined with other probes for precision)

is it DE or modified gravity (require other probes) ?

=>

do the best possible job on measuring (constant) w

+ test the w=constant hypothesis



Systematic errors included in the error contours. Filled are statistical only.

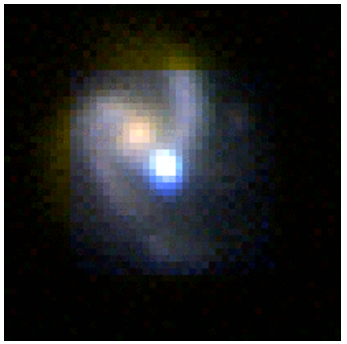
Is dark energy the same in every direction?

- SNLS observes 4 different fields distributed in RA
- Each gives independent cosmological results

SNLS Field	Ω_M (SNe only)	<w> (with BAO+WMAP5)
D1	0.23±0.04	-1.06±0.07
D2	0.26±0.05	-1.03±0.08
D3	0.23±0.03	-1.07±0.07
D4	0.25±0.04	-0.99±0.07

Preliminary

Improving precision on <w> 1/3



A 3 step process

1- Take today most precise measurements

statistical uncertainties are reaching the level of systematics

=> No need to get more SN unless systematics are reduced

2 - Ask what are the dominant systematics:

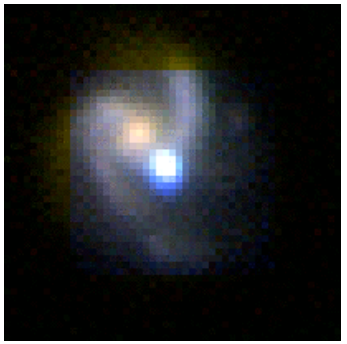
answer:

1) (Photometric) calibration

where part of the uncertainty has nothing to do with SN:

color (B-R flux ratio) of the primary standard

Improving precision on <w> 2/3



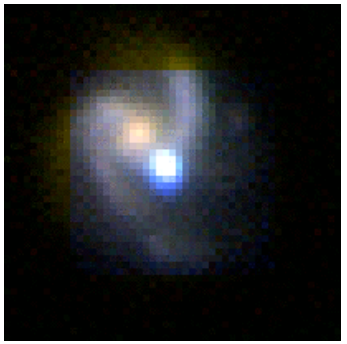
2) (empirical) SN LC modeling in the visible

[including the « color law » (relation between filter band passes)]

3) Malmquist bias in the nearby sample

…..

Improving precision on <w> 3/3



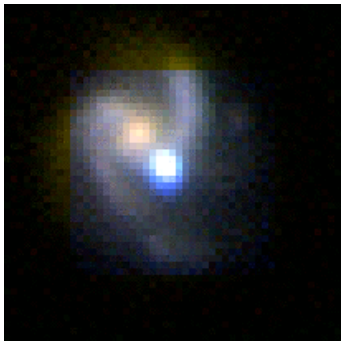
3) Design your experiment to improve with:

- improve calibration to 0.1% (~1% today)
  -> instrumentally challenging

- improve SN modeling/understanding
  -> more statistics + redundant information, theory, …

- get new nearby sample (possibly from same instrument)
  minimize malmquist bias (go deep)

Probing (time) varying w



But what if w varies with time/redshift ?

look for a deviation from -1. To what level ? 10^{-3}, 10^{-6}

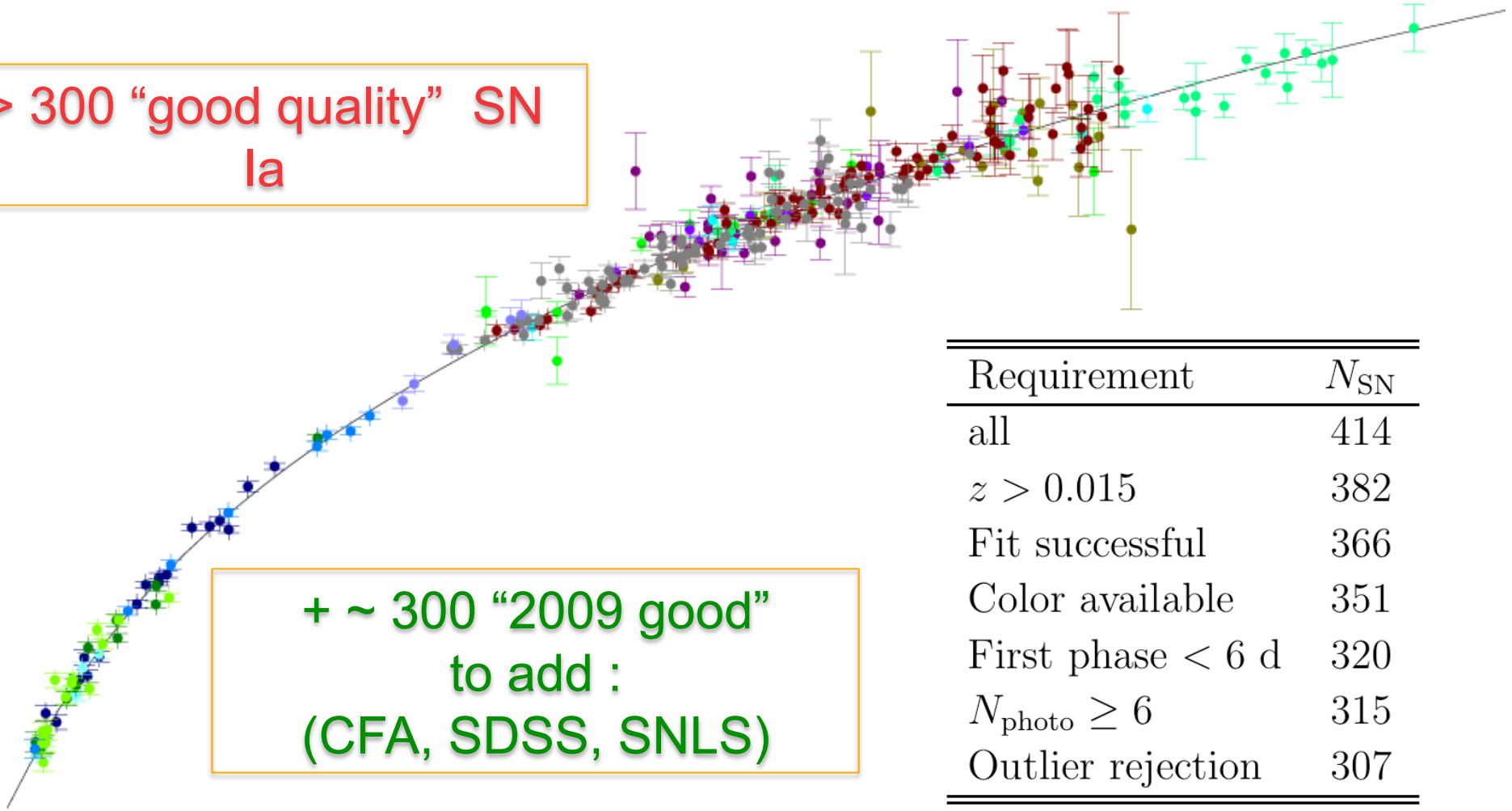
no guidance from (DE) theory

=> go to higher z to test if DE behaves like Λ

constraint wa

2008 status : The “Union” Supernova Ia Compilation

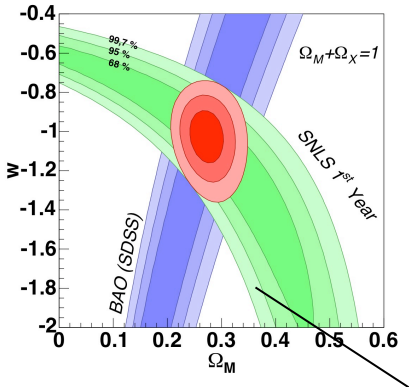
> 300 “good quality” SN Ia



+ ~ 300 “2009 good” to add : (CFA, SDSS, SNLS)

Requirement	$N_{\rm SN}$
all	414
$z > 0.015$	382
Fit successful	366
Color available	351
First phase < 6 d	320
$N_{\rm photo} \geq 6$	315
Outlier rejection	307

Expected near term precision on w (~2010)



Expected « realistic » statistical improvements on Ω_M and w

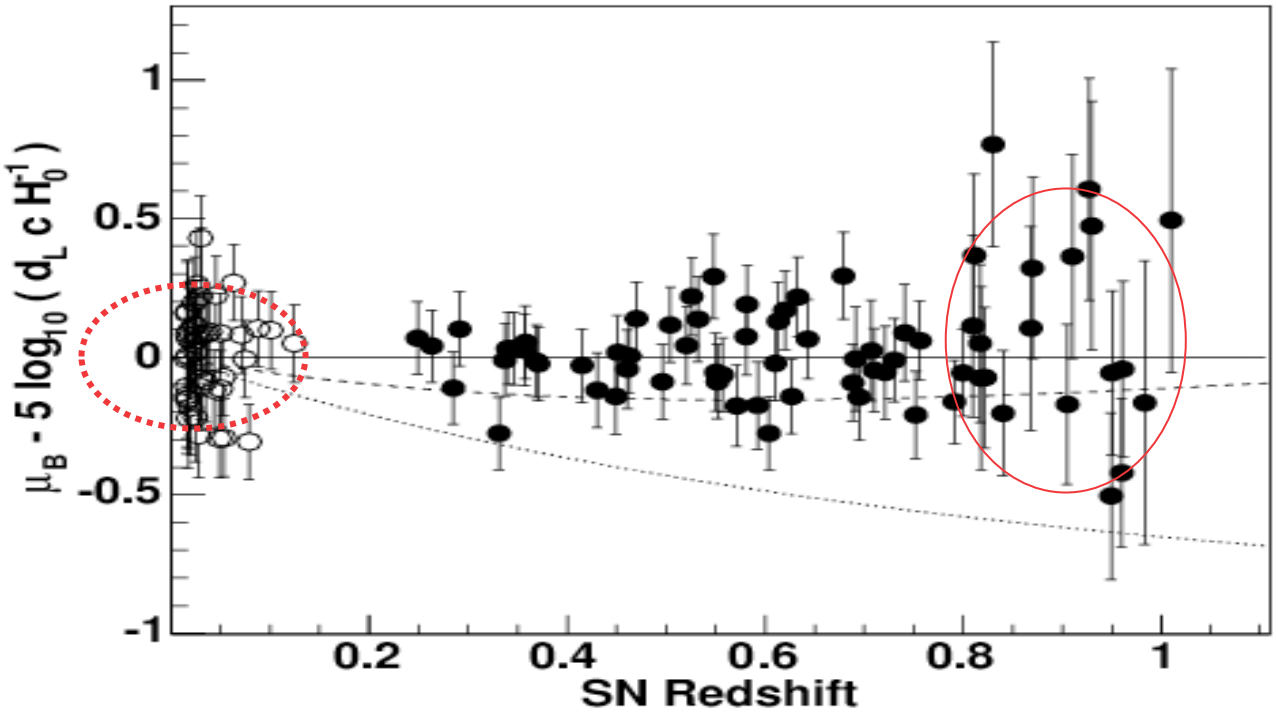
+CFA+SNF+SDSS+SNLS

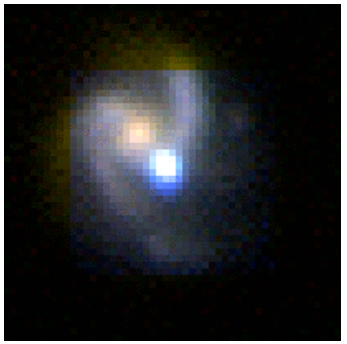
# nearby SNe	44	44	132
# distant SNe	71	213	500
$\sigma\Omega_M$ (current BAO)	0.023	0.019	0.018
σw (current BAO)	0.088	0.064	0.055
$\sigma\Omega_M$ (BAOx2)	0.016	0.014	0.013
σw (BAOx2)	0.081	0.054	0.044

+ systematics : ~+/-0.05

Improving on stage II

Improving on 2nd generation SN survey results will very difficult



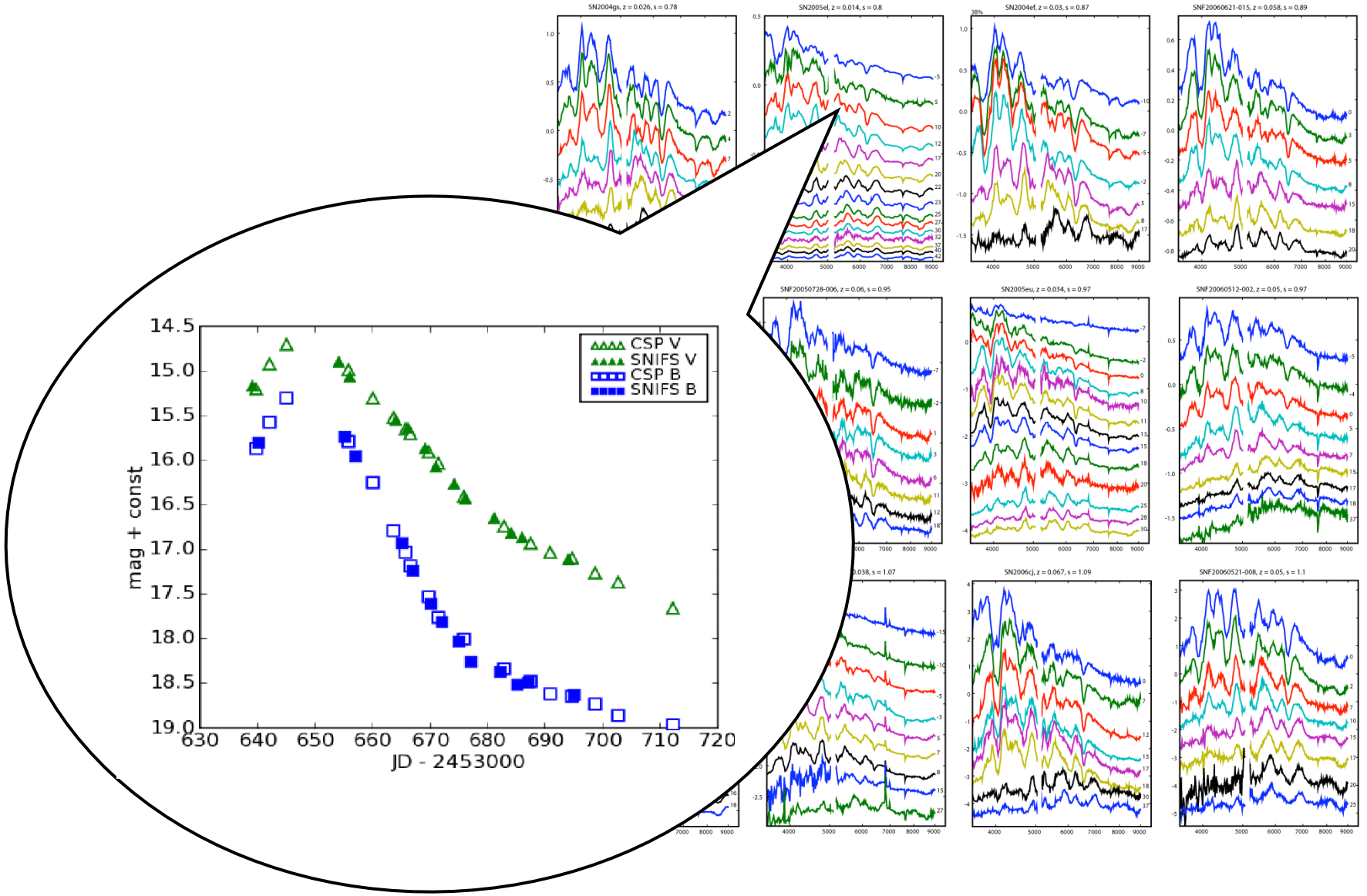


Contributed talks

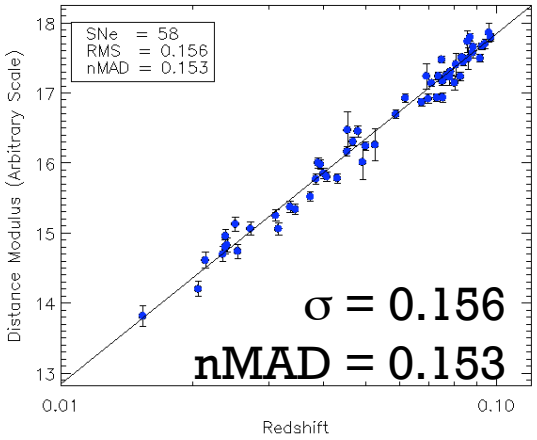
- The role of spectro-photometry (G. Aldering)
  need for spectro-photometry
- Cosmology bias from population drift (A. Amblard)
  need for host id
- Circumstellar/SN dust (Goobar)
  need for IR observations
- Account for systematics (Linder)

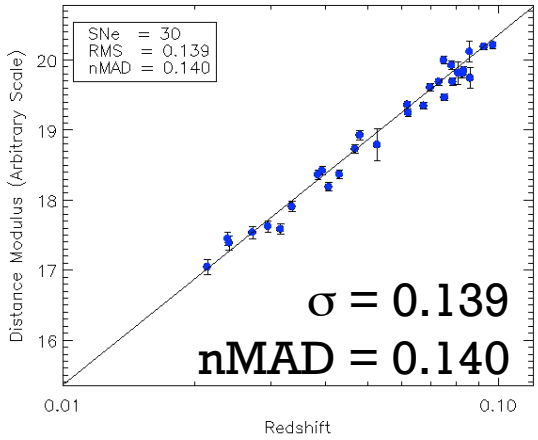
- Using SN photo-z (Palanque-Delabrouille)

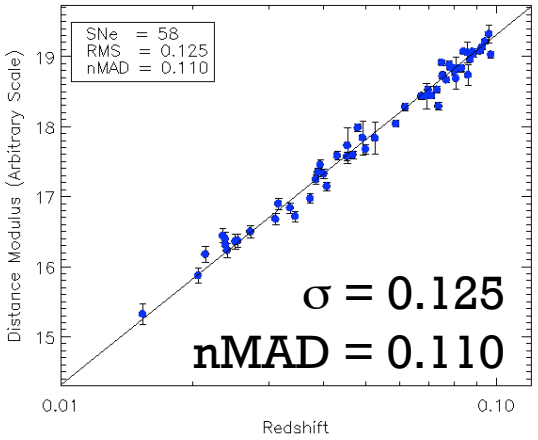
Library of Spectral Time Series



Now Several Paths to SN Hubble Diagram



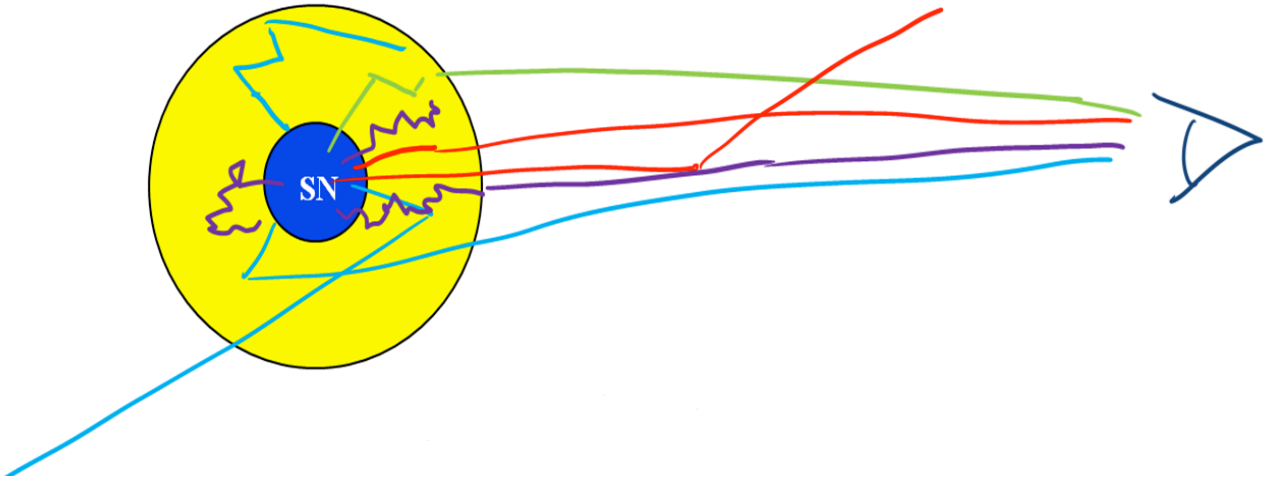




Multiple scattering in CS *dusty* medium

Observed colors after the semi-diffusive shell will depend on:

- **Wavelength dependent cross-sections, albedo and scattering angles**
- **Dust density and shell volume**



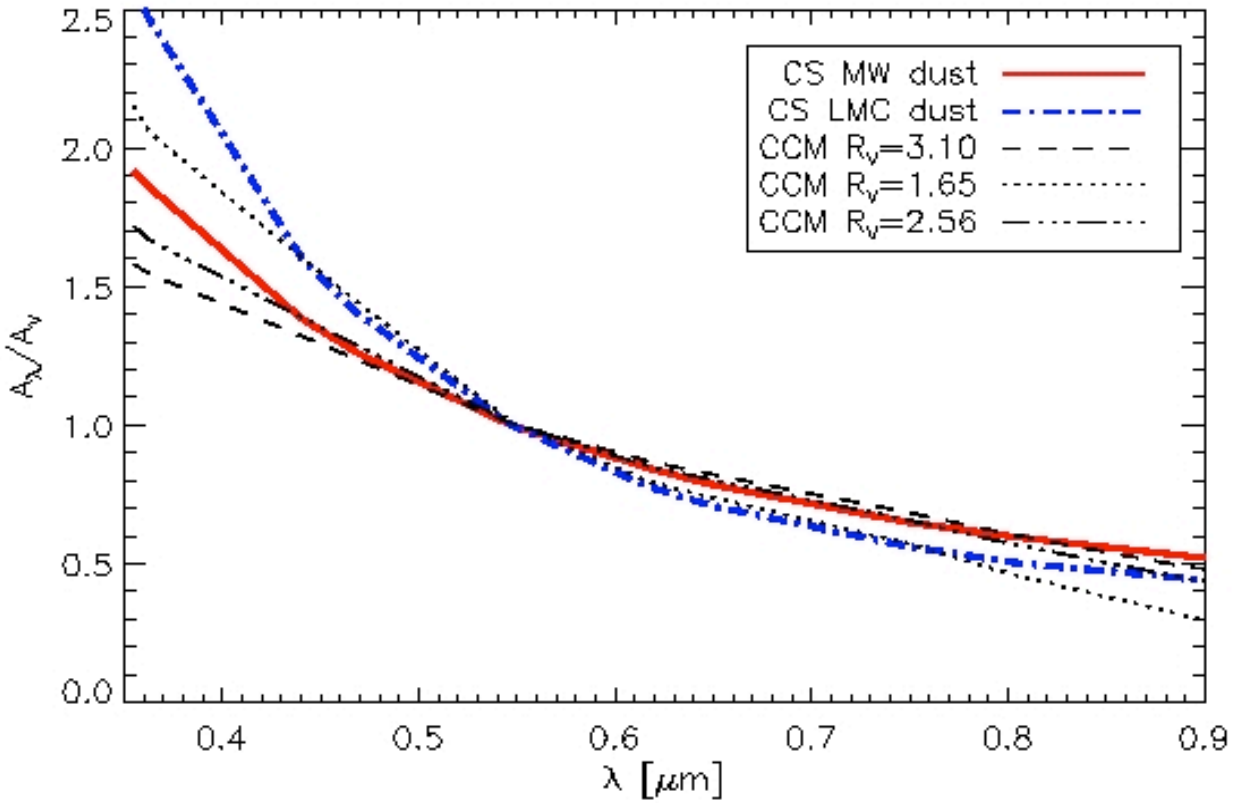
Run a Monte Carlo!

Use dust parameters for MW and LMC by:
Draine ApJ 2003, *Weingartner & Draine ApJ 2001*
(also SMC dust , but mostly absorption (not scattering) at optical wavelengths)

AG, ApJ 2008

see also Wang 05

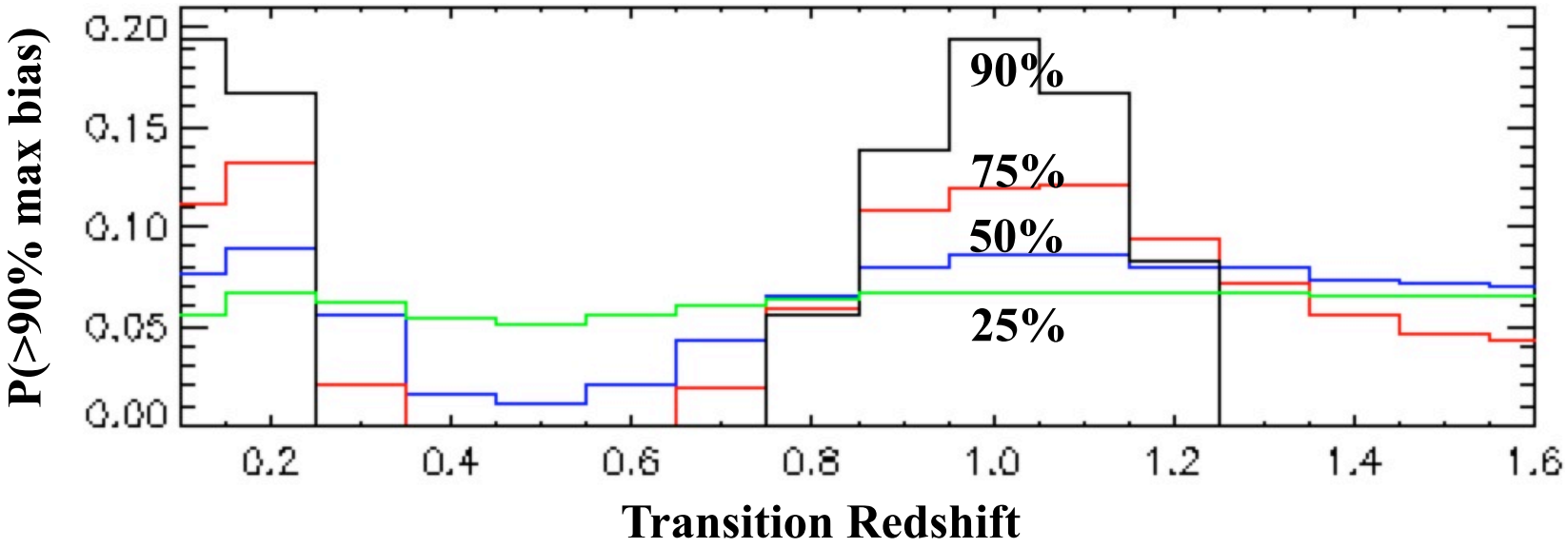
Differential extinction function differs, especially towards UV



Cardelli law does not fit entire optical windows, for any R_v

Redshift Focus

The worst biases come from population drift at localized redshifts: z~0.1 and z~1.0.

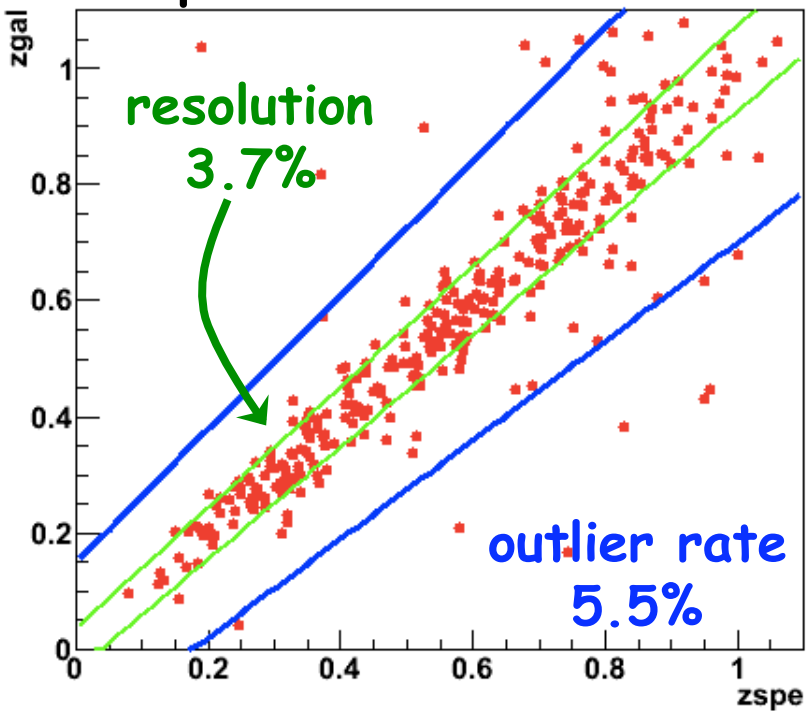


Observations to control systematics should be most comprehensive at these critical redshifts. Greatest danger from mixing samples at these z's, e.g. ground-space.

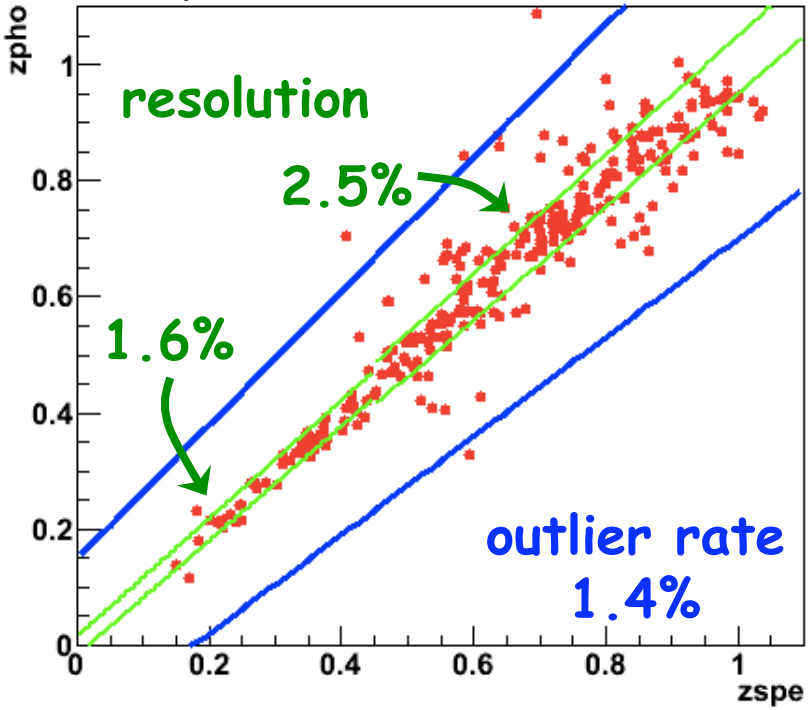
ongoing work

Cosmology without spectra?

host galaxy
photometric redshift



SN
photometric redshift



N. Palanque-Delabrouille et al. submitted to A&A

➡ A first step towards SN cosmology without spectroscopy

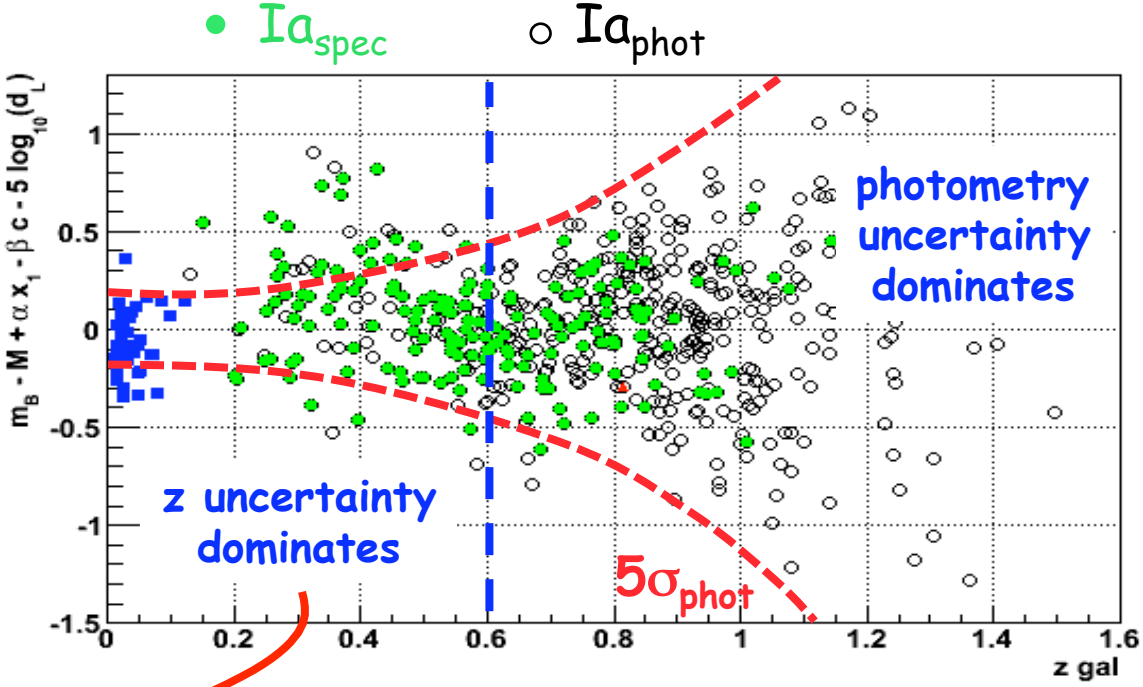
ongoing work

Cosmology without spectra?

Fit of (Ω_M, Ω_Λ)

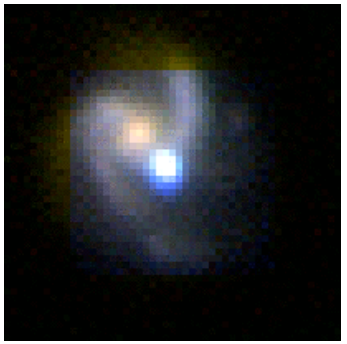
bias of ~0.05 on Ω_M due to use of z_{gal}

no bias if $5\sigma_{phot}$ clipping



need improved σ_z for z < 0.6

Some other issues (from the working session)



- Overlapping filters?
- Optimal number of colors

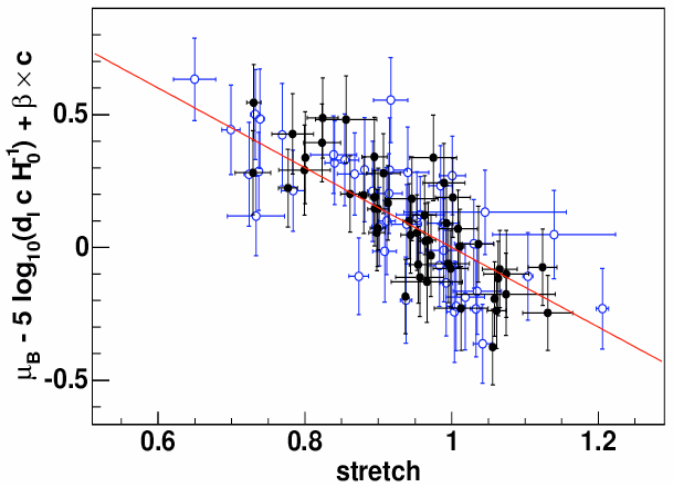
  UBVR at all z
- Calibration

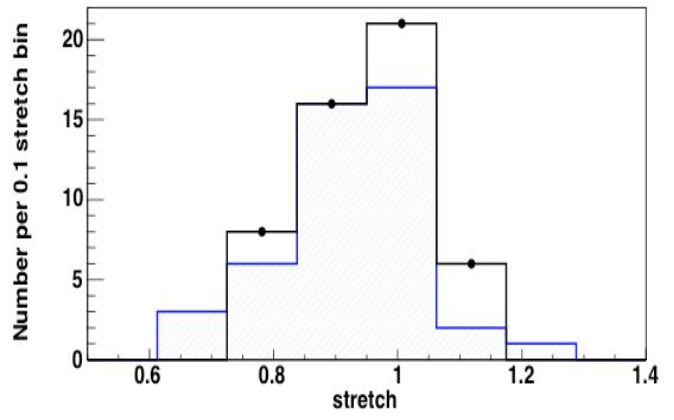
  Absolute color + Color dependent Instrumental effects
- Evolution/Environment

- More nearby SNe

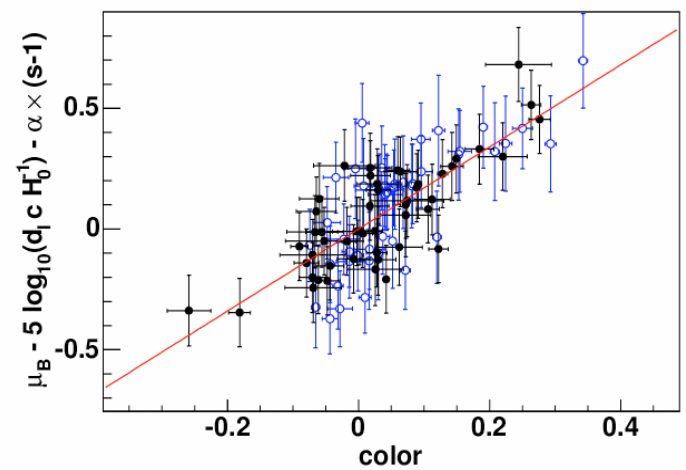
Are local and distant SN Ia alike ?

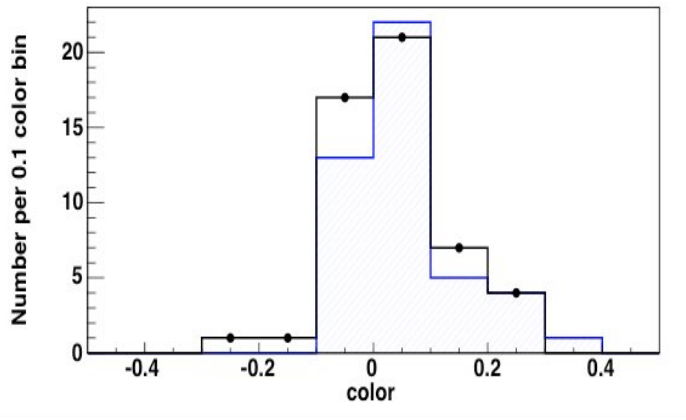
Brighter- Slower





Brighter-Bluer





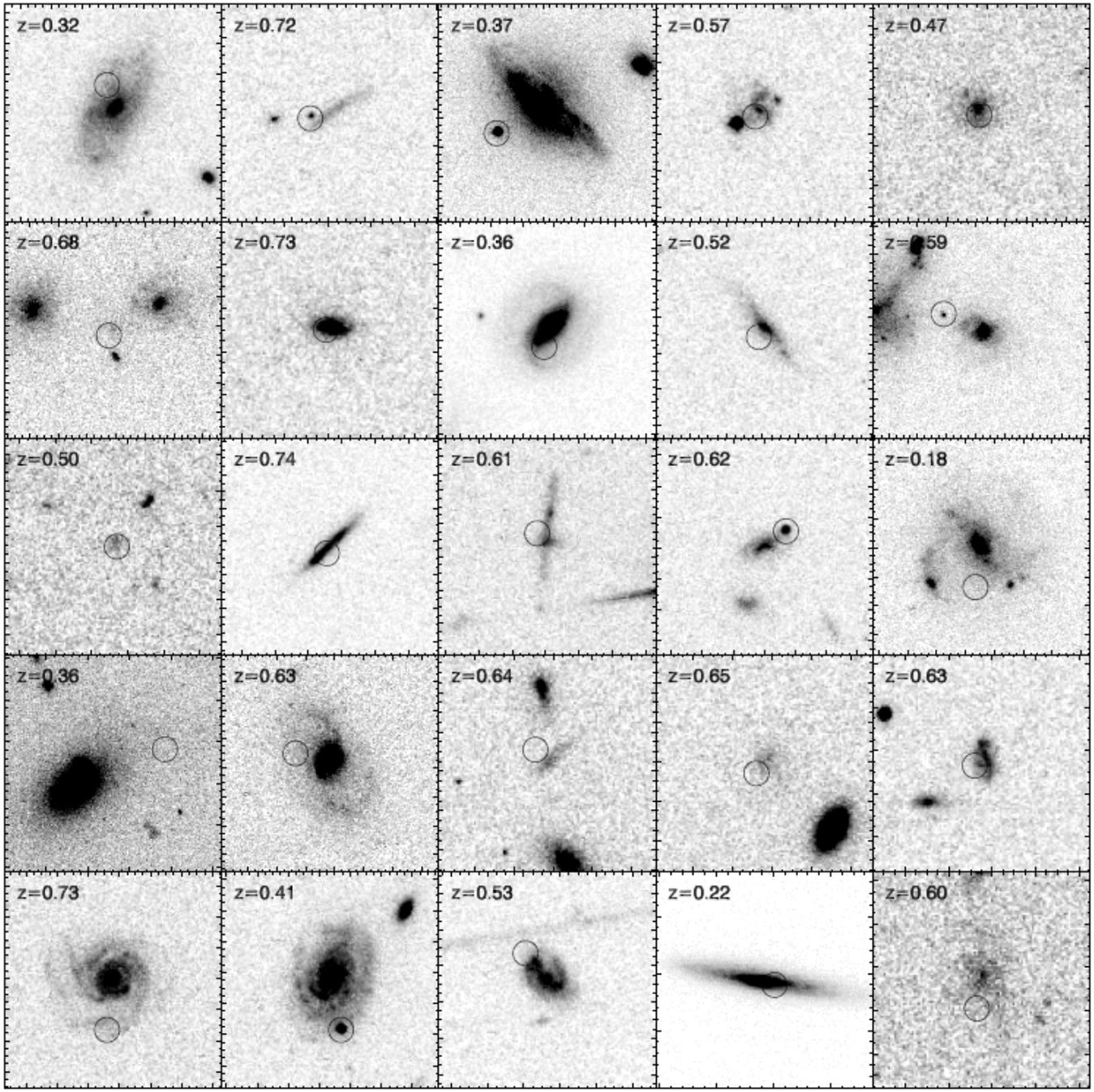
black: SNLS
blue: Nearby

Environment

SNLS D2 field ACS imaging

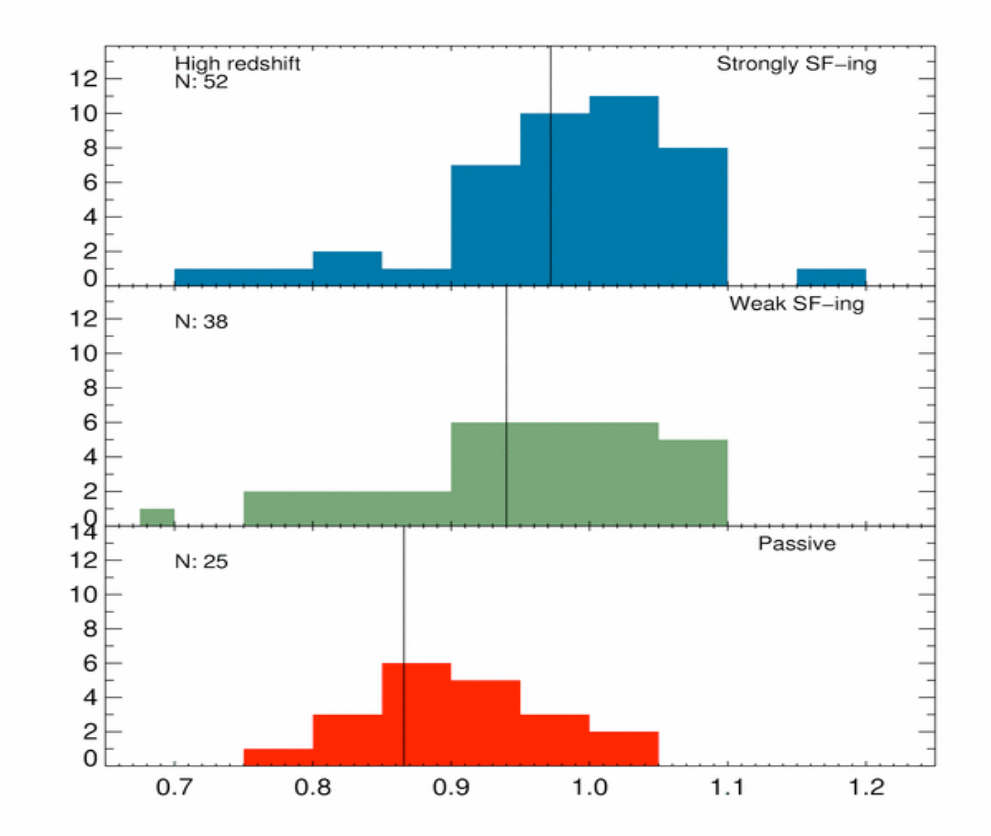
Plenty of irregular/late-type systems

Few genuine ellipiticals



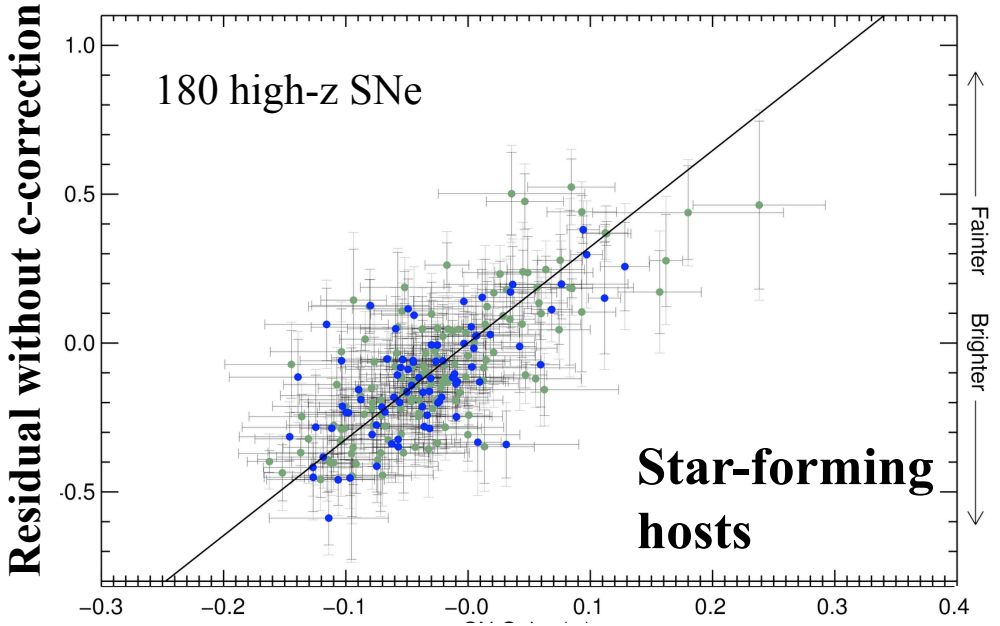
R. Pain

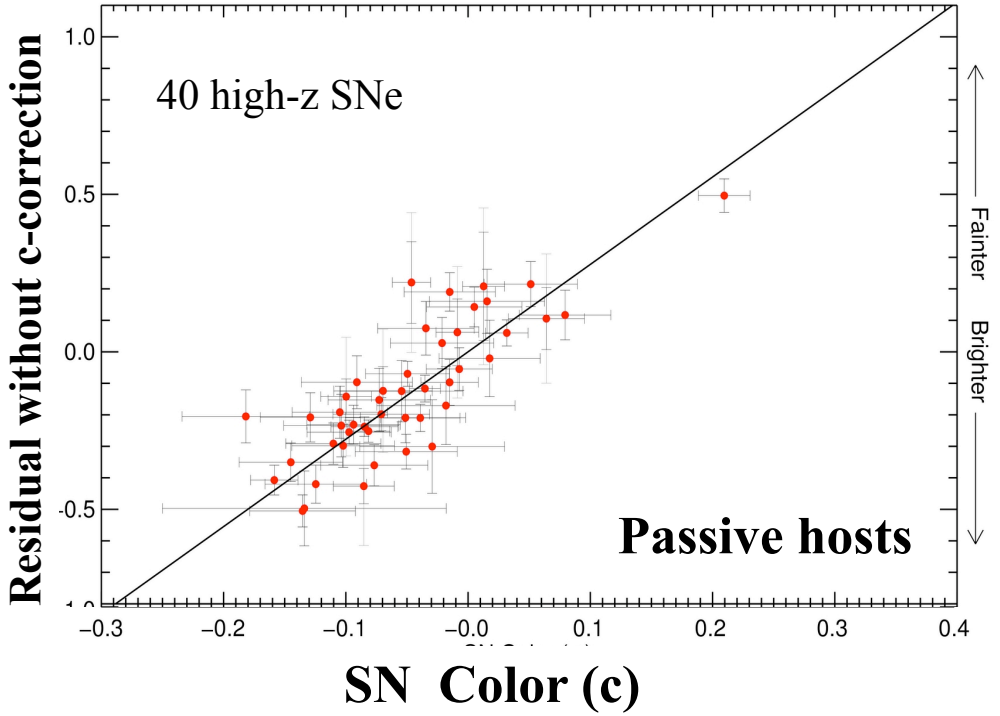
Stretch vs environment



Stretch

←Fainter SNe Brighter SNe →





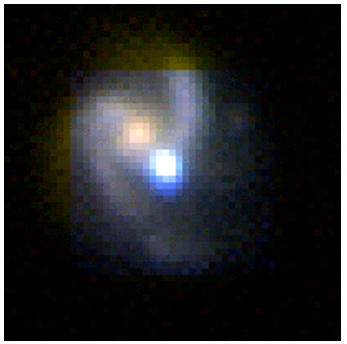
Color correction required in all host types

Either:

Passive hosts have dust?

An intrinsic relation dominates over dust?

Issues for Future Progress

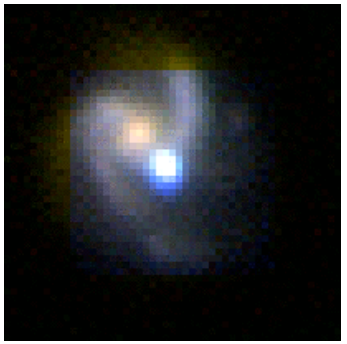


To precisely measure <w>

- Photometric calibration ~ 0.1 % (or better)
  Primary standard,
  Instrument efficiency, stability, detector linearity, stray light,
  Flatfielding, PSF modeling, software, …

- (Empirical) SN LC modeling
  More and better sampled LC (rise/fall time)
  understand SN color law (“dust”)
  Ability to test evolution (in the z range probed)

Issues for Future Progress



- Improve SN modeling/understanding

  make SN better standard candle : spectro-photometry and/or NIR measurements

  Theoretical modeling?
- Improved Nearby sample

To test the constant w hypothesis (measure wa)

- Go to higher z (up to z=2 ?)

  (not necessarily with the same precision)