

Using Type Ia Supernovae in Distant Galaxy Clusters as a Dark Energy Probe

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“Future Fellow”
AAO

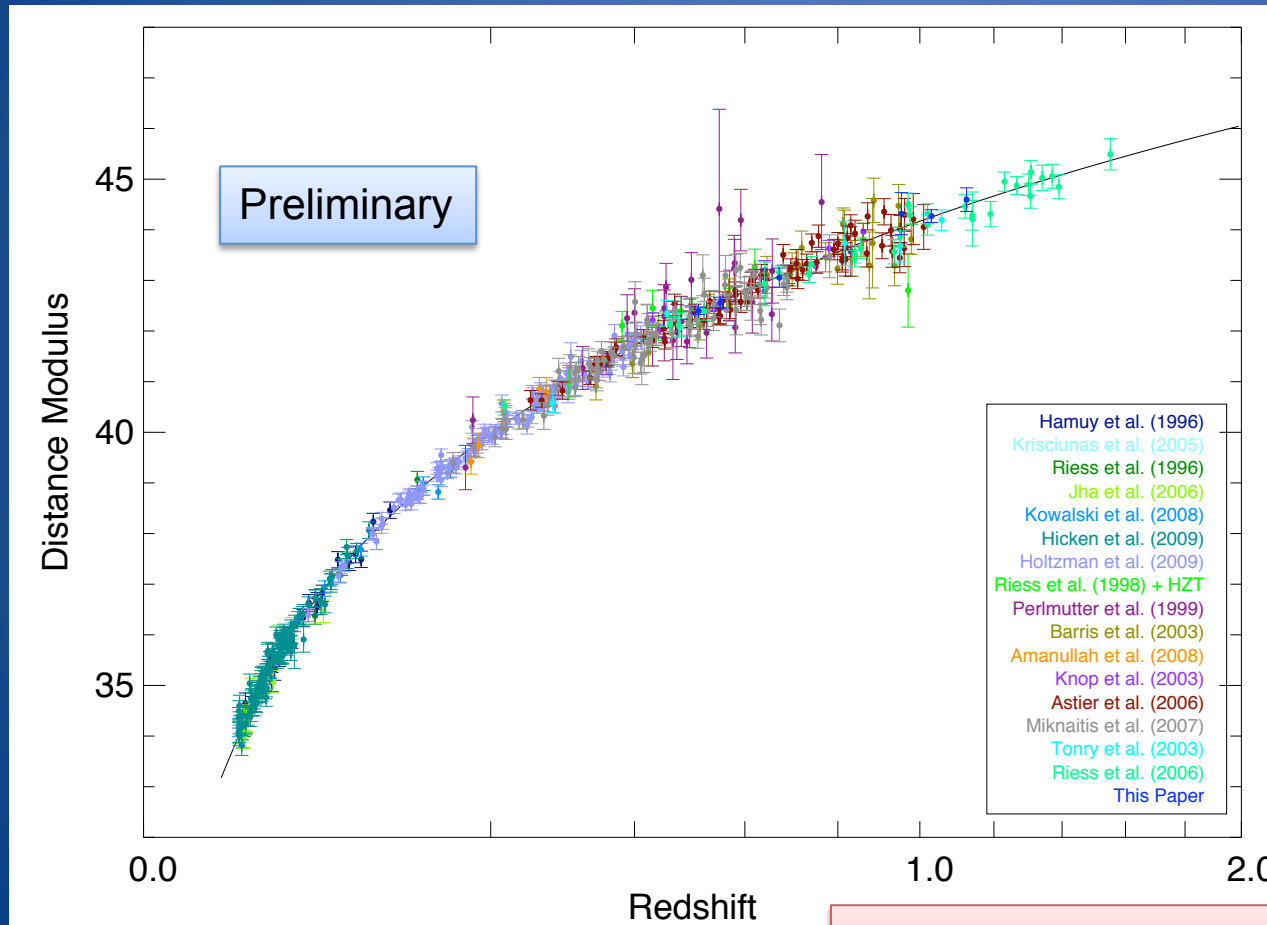


- Supernova Ia cosmology 2009
- The challenges for supernova Ia cosmology
- SN Type Ia in distant galaxy clusters

SNe Ia Cosmology 2009



555 SNe Ia



Many more to add during the next couple of years

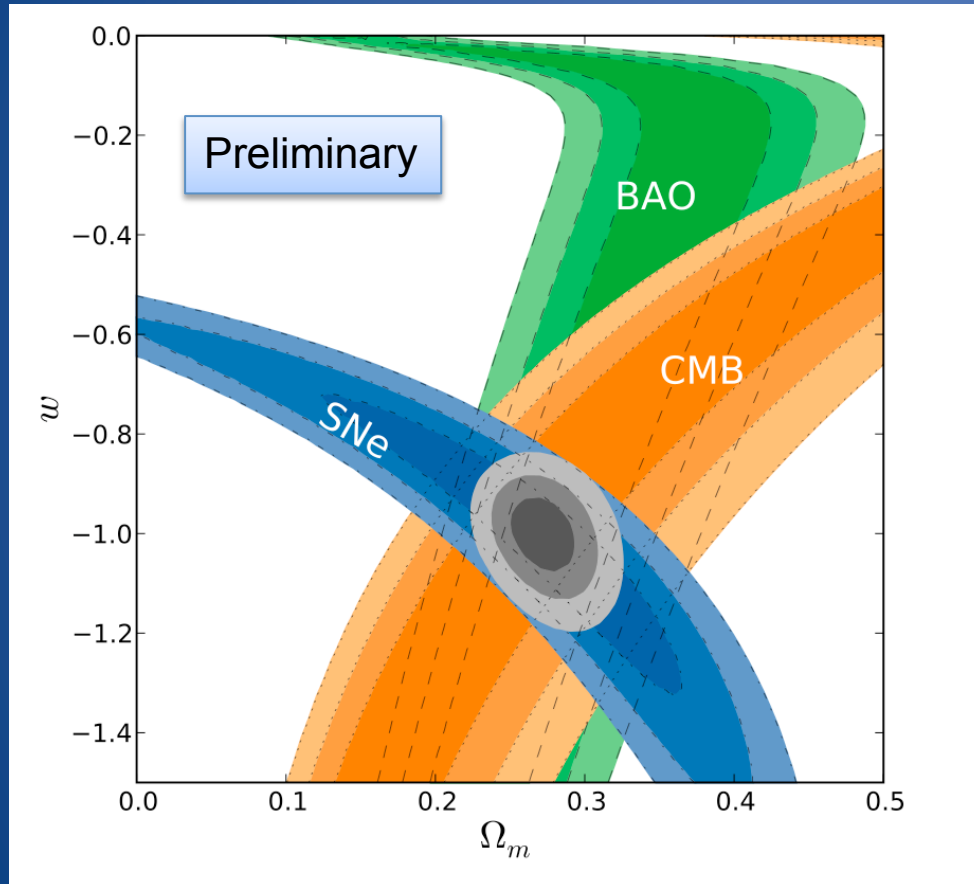
- SCP surveys 02-06
- SNLS 3yr sample
- SDSS 3yr sample
- SN factory
- ~ 1000 SNe Ia by next year

Union2 sample – R. Amanullah and the SCP

Latest constraints



The cosmological constant - Λ



Union2 sample – R. Amanullah and the SCP

$$p_w = w\rho_w$$

For the cosmological constant

$$w \equiv -1$$

Combining SNe + BAO + CMB gives

$$w = -0.974^{+0.050 (+0.075)}_{-0.053 (-0.080)}$$

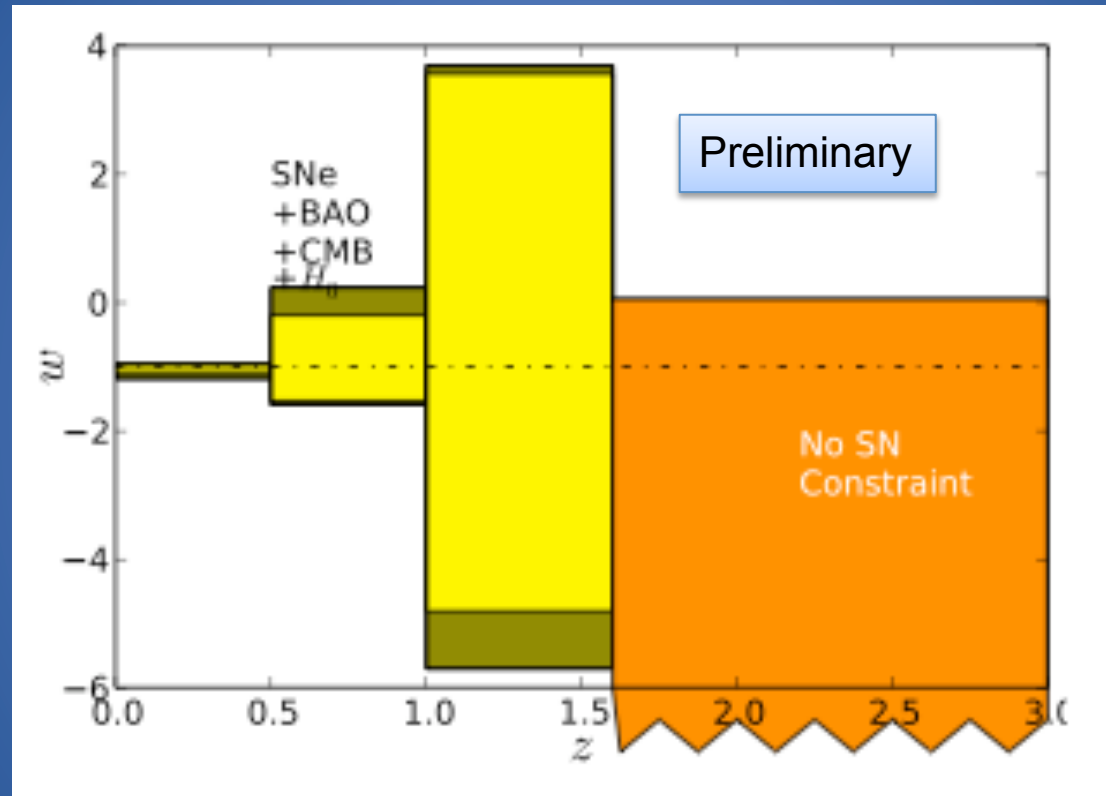
Consistent with Λ

But, look at the impact of including systematic errors!

Latest constraints

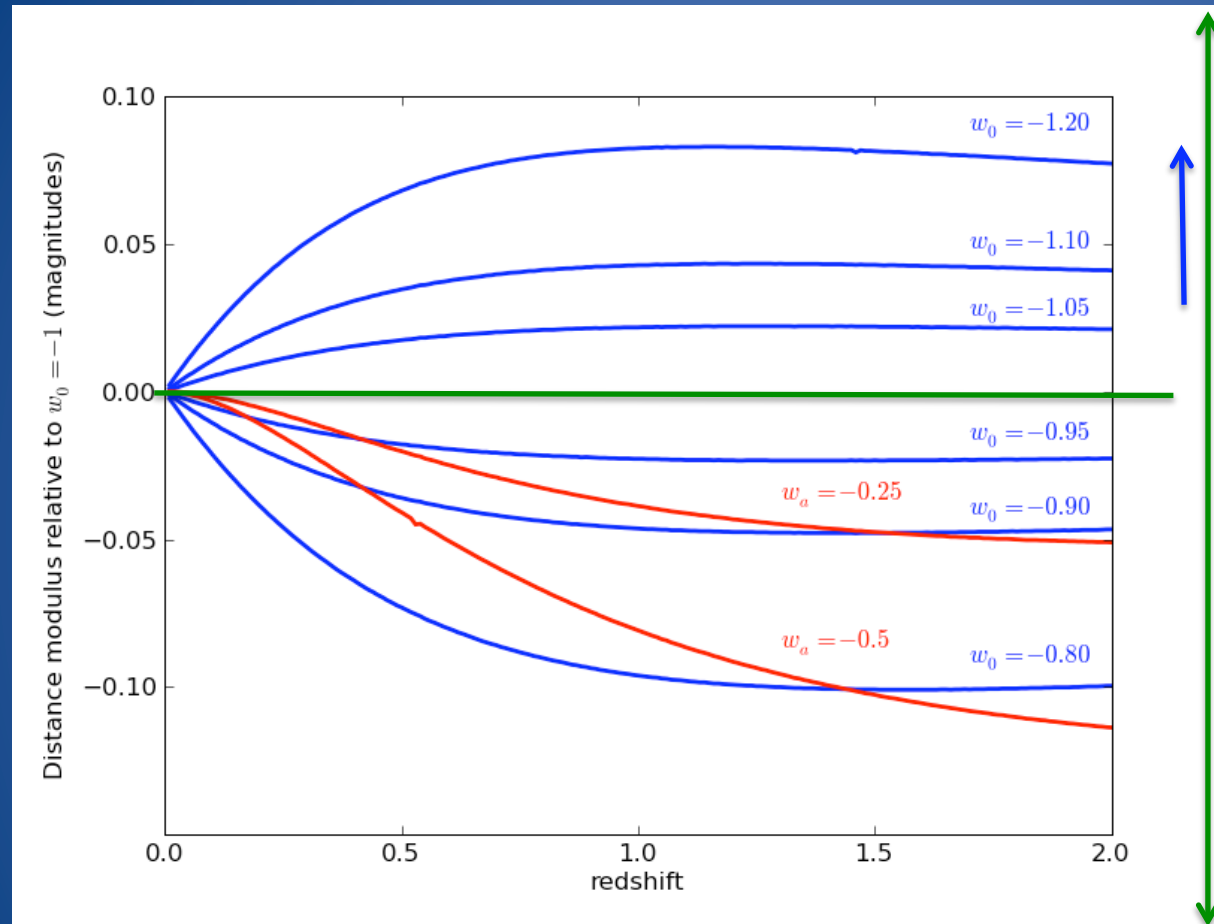


Evolving dark energy



Union 2 sample – R. Amanullah and the SCP

The challenge for SNe Ia cosmology



HST NICMOS
recalibration
2007-2009

Intrinsic dispersion after
standardisation

- A 5% change in w corresponds to a 1% change in distances out to $z=1$.

The Challenge for SNe Ia Cosmology

- The challenges
 - Reduce systematic errors
 - Improve Type Ia SNe as standard candles
- Two approaches
 - Use SNe Ia in elliptical galaxies
 - *Use the rest frame near IR (H-band, in particular)*

Early type galaxies



- Only SNe Ia occur in early type galaxies
- Type Ia in early type galaxies are better standard candles (this is true for $z < 0.8$)
- Early type galaxies generally have relatively little dust (?)
- Galaxy clusters are rich in early type galaxies
- Rich galaxy clusters up to $z \sim 1.5$ are known

Search in clusters!

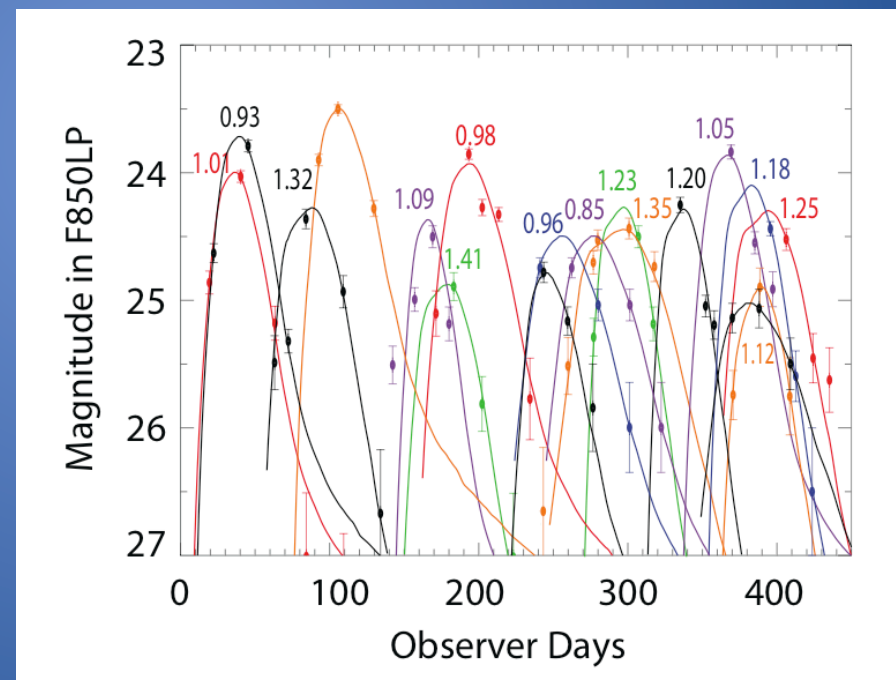
RDCS 1252.9 @ $z=1.23$
ISAAC and ACS



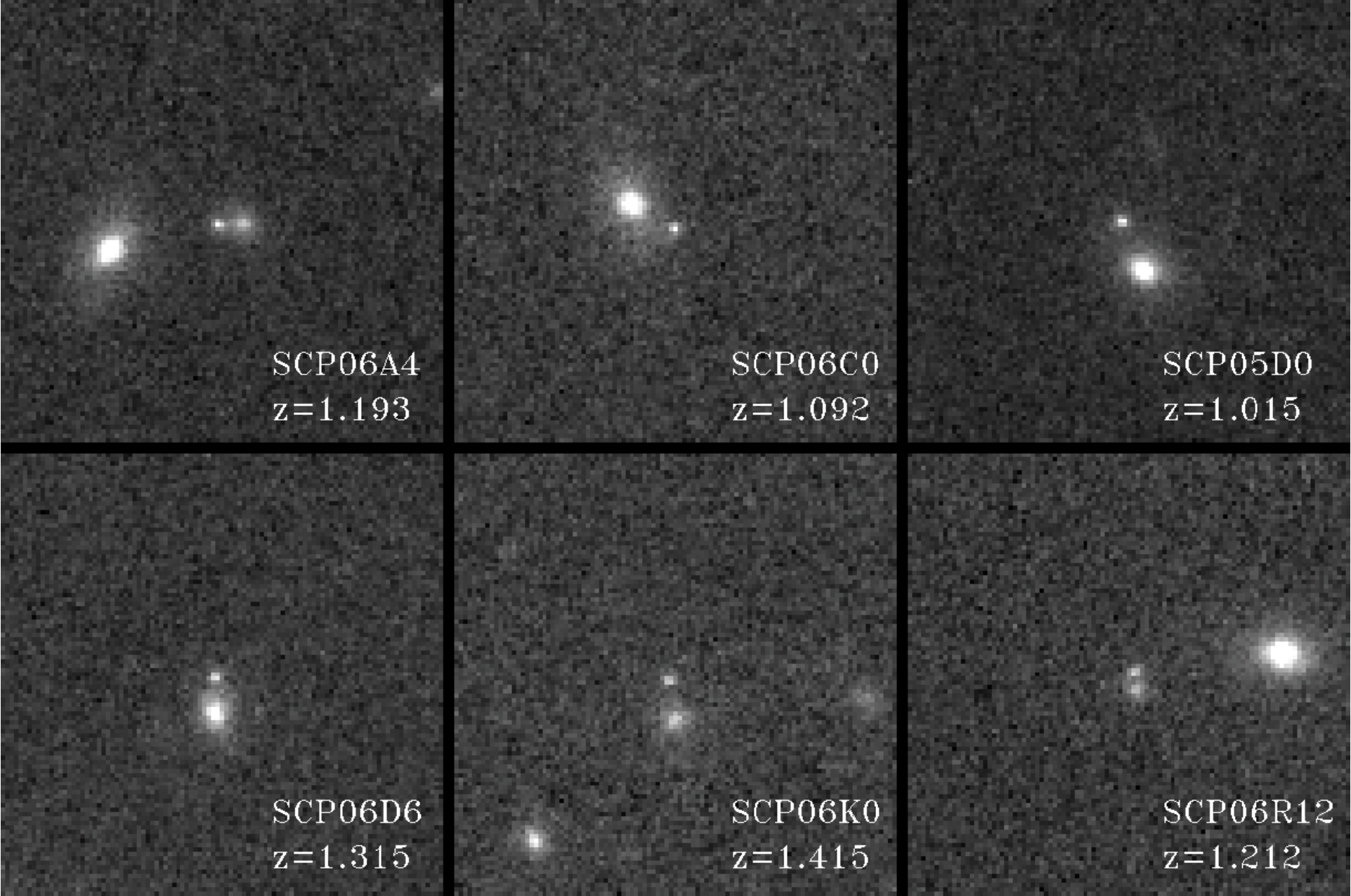
HST Cluster SN project



- Twenty-five $0.9 < z < 1.5$ galaxy clusters
- Collaboration involving SCP, ISCS, XMMXDS, RCS, RDCS, XMMDCS, PDCS
- Rolling search with ACS



Dawson et al. 2009



SCP06A4
 $z=1.193$

SCP06C0
 $z=1.092$

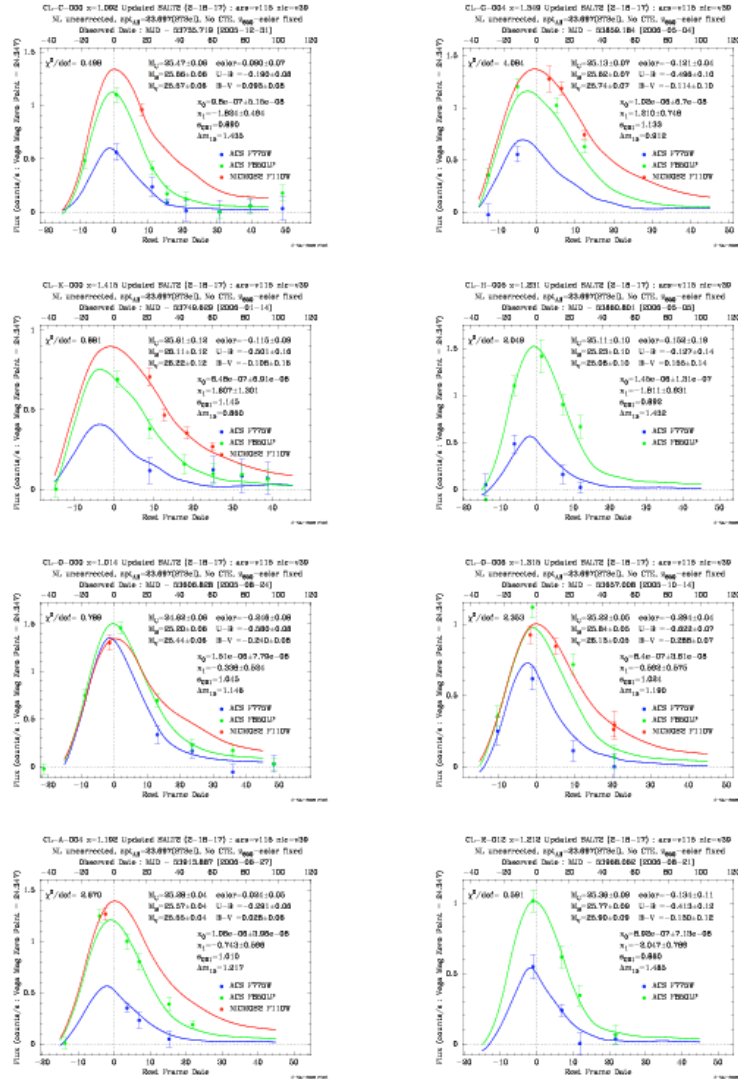
SCP05D0
 $z=1.015$

SCP06D6
 $z=1.315$

SCP06K0
 $z=1.415$

SCP06R12
 $z=1.212$

SCP SNe Ia Cluster Survey

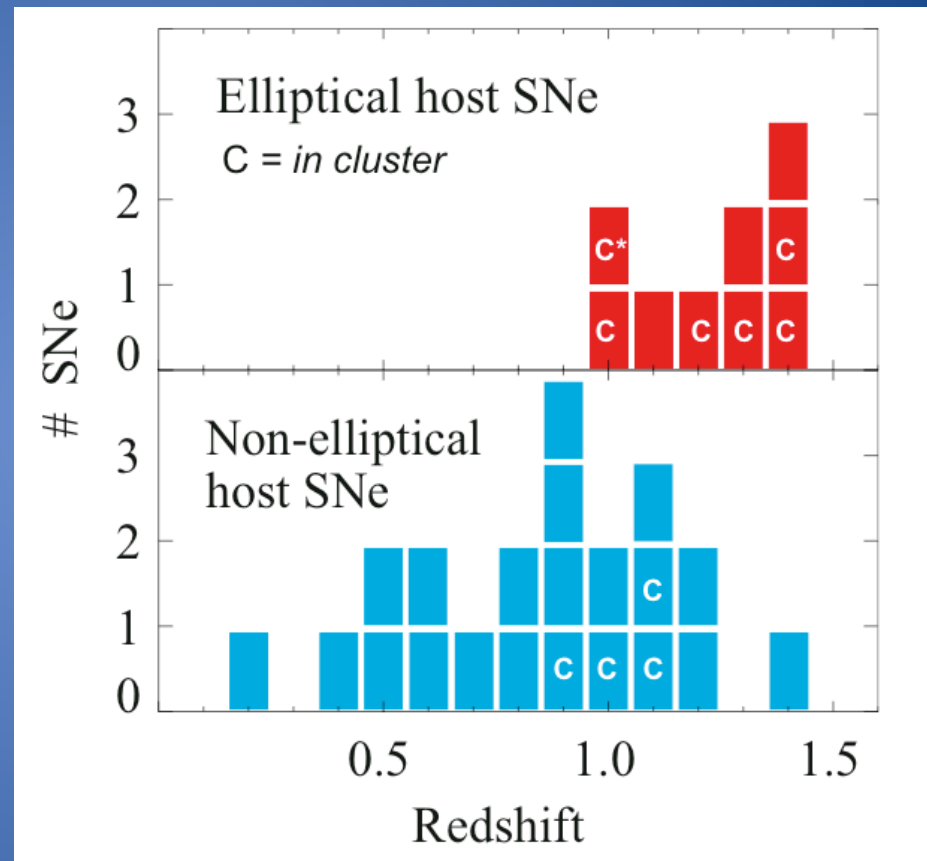


SCP SNe Ia Cluster Survey

Very efficient way of finding SNe Ia ...

... at a specific redshift

Expensive real time spectroscopy is not needed

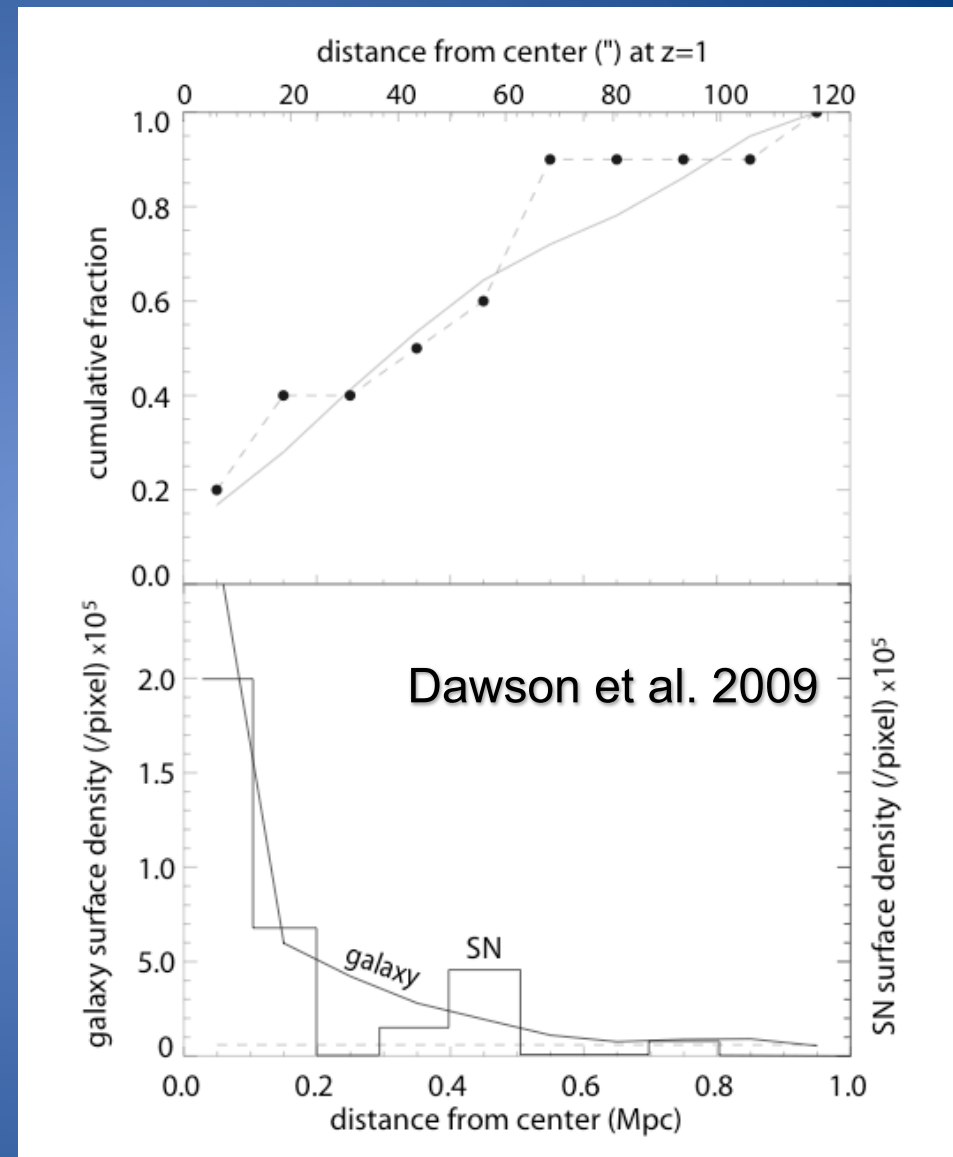


Dawson et al. 2009

SCP SNe Ia Cluster Survey

Results

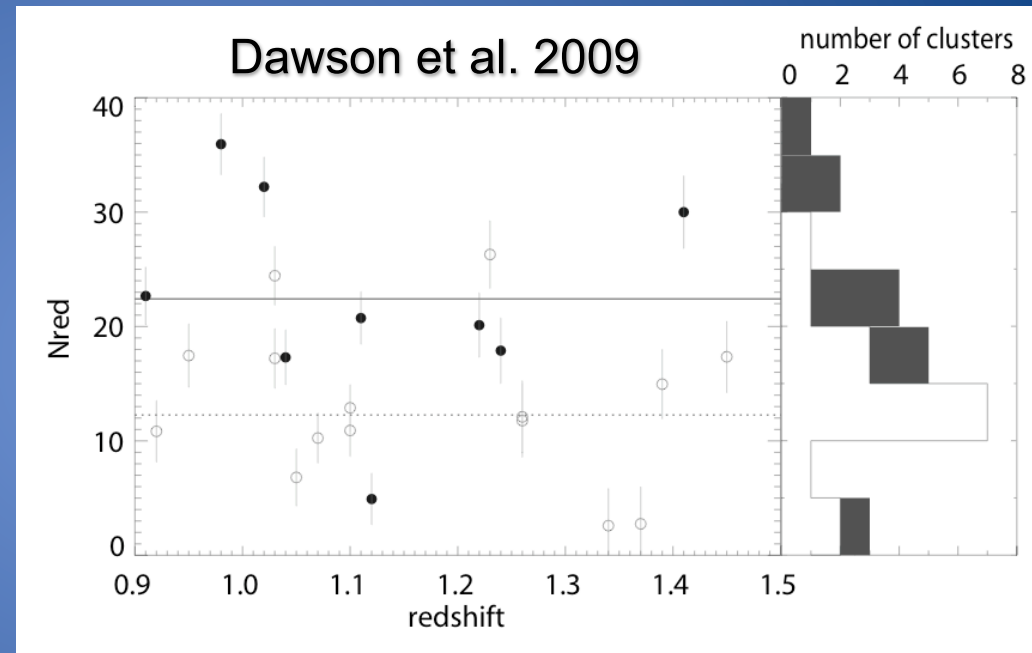
1. SNe Ia follow the galaxies



SCP SNe Ia Cluster Survey

Results

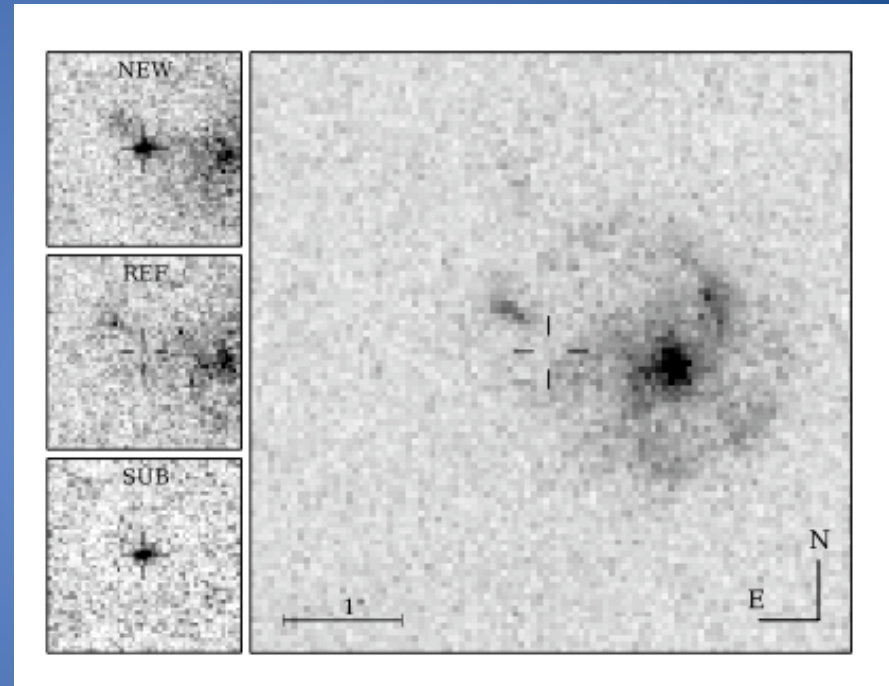
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2. More SNe Ia in the richer clusters



SCP SNe Ia Cluster Survey

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5. Hubble diagram is in the works (NICMOS calibration is problematic)
6. Should work very well with WFC3. A factor of four (six) increase in efficiency over a blank field survey

Conclusion



Distant clusters are good places to find distant SNe Ia