Limitations in Determining w_{de} at High Redshift

Q.P. Su and R.G. Cai, arXiv:1204.3393

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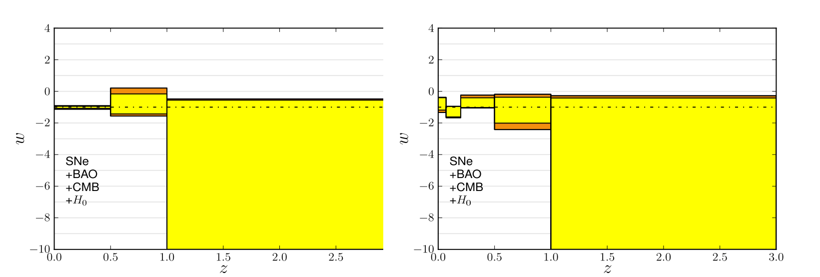
Outline of Contents

In higher redshift bins, errors of w_{de} from observational data are much larger



N. Suzuki, D. Rubin, *et al.*, Astrophys. J. **746**, 85 (2012) [arXiv:1105.3470 [astro-ph.CO]].

Main reasons:

- There are less related data points at higher redshift.

z→	0.2	0.4	0.6	0.8	1.0	1.2	1.4
N_{bin}	173	77	71	78	60	8	5

Table: the redshift distribution of 472 supernovae data from 3 years Supernova Legacy Survey (SNLS3).

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- In higher redshift bins, the role played by DE in the luminosity distance

$$D_l(z) = (1+z)\int_0^z dx/H(x) \qquad (1)$$

is weaker, since $\Omega_{de} = \rho_{de}/3H^2$ will be smaller.

Methology:

- Divide the redshift region under consideration into 2 bins,

$$w_{de}(z) = \begin{cases} w_1 \ , & 0 \leq z \leq z_1 \\ w_2 \ , & z_1 < z \leq 1.4 \end{cases} \ , \tag{2}$$

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  where w_1 and w_2 are constant.
- Errors of w_{de} in the second bin indicate the limitations in determining w_{de} at high redshift (beyond $z = z_1$).

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- 12 Observational Hubble Data with $z < 1.4$.

z	0	0.1	0.17	0.27	0.4	0.48	0.88	0.9	1.3	0.24	0.34	0.43
h	0.738	0.69	0.83	0.77	0.95	0.97	0.9	1.17	1.68	0.7969	0.838	0.8645
σ_h	0.024	0.12	0.08	0.14	0.17	0.6	0.4	0.23	0.17	0.0232	0.0296	0.0327

Results

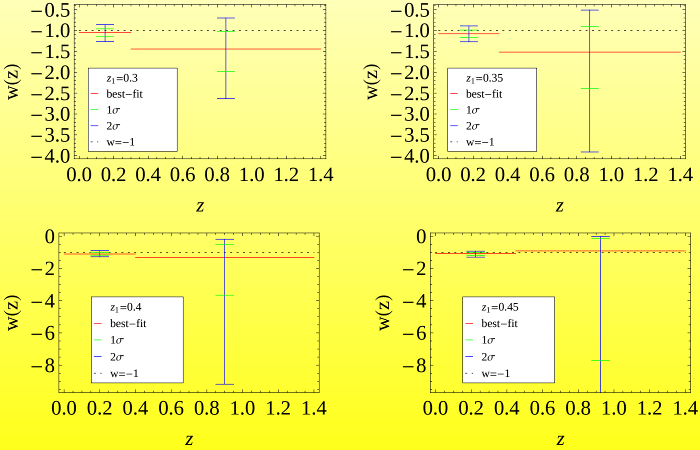


Figure of merit can be used to compare the goodness of constraints of w_{de} at high redshift

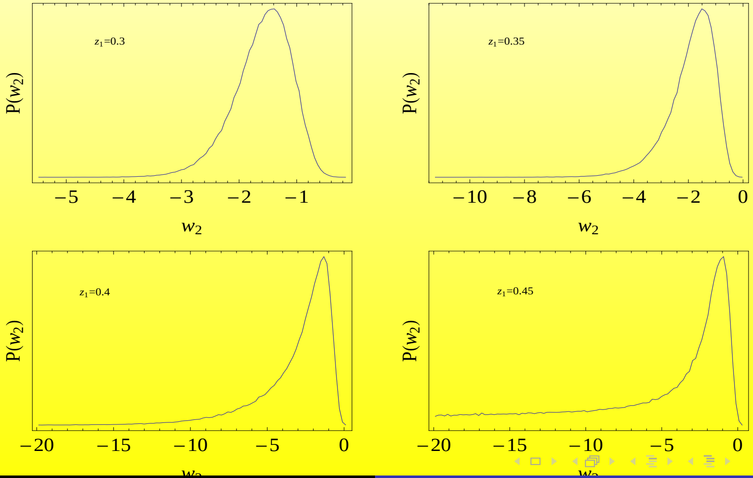
$$\mathrm{FoM} = [\det C(w_1, w_2)]^{-1/2} \ ,$$

where $C(w_0, w_1)$ is the covariance matrix of w_1 and w_2.

z_1	Ω_{m0}	w_1	w_2	χ^2_{min}	FoM
0.30	$0.279^{+0.023+0.047}_{-0.020-0.040}$	$-1.05^{+0.09+0.19}_{-0.10-0.21}$	$-1.44^{+0.42+0.74}_{-0.54-1.19}$	423.988	19.346
0.35	$0.277^{+0.031+0.055}_{-0.016-0.038}$	$-1.08^{+0.09+0.19}_{-0.09-0.19}$	$-1.52^{+0.62+1.01}_{-0.87-2.39}$	424.323	11.525
0.40	$0.272^{+0.042+0.067}_{-0.010-0.033}$	$-1.11^{+0.11+0.21}_{-0.07-0.17}$	$-1.31^{+0.78+1.12}_{-2.35-7.87}$	424.614	4.115
0.45	$0.269^{+0.045+0.067}_{-0.006-0.029}$	$-1.09^{+0.07+0.16}_{-0.12-0.21}$	$-0.92^{+0.79+0.90}_{-6.80-19.07}$	424.764	1.981

Table: The best-fitted values and their 68.3% and 95.4% C.L. errors from present observational data.

At high redshift, the likelihood of w_{de} is flat on its downward side.



The simulated 2298 supernovae data

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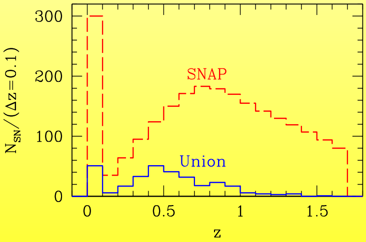
- 

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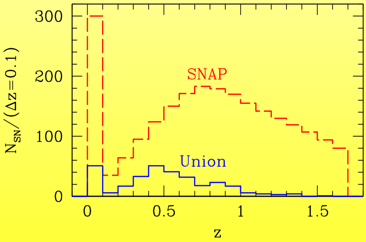
- 

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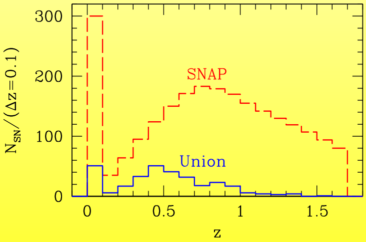
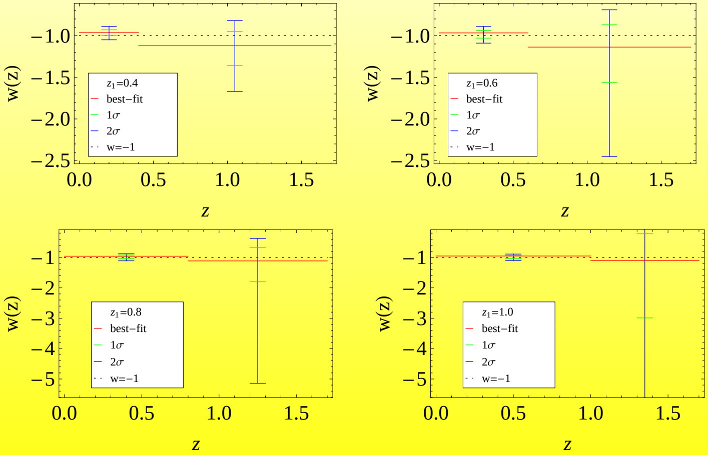
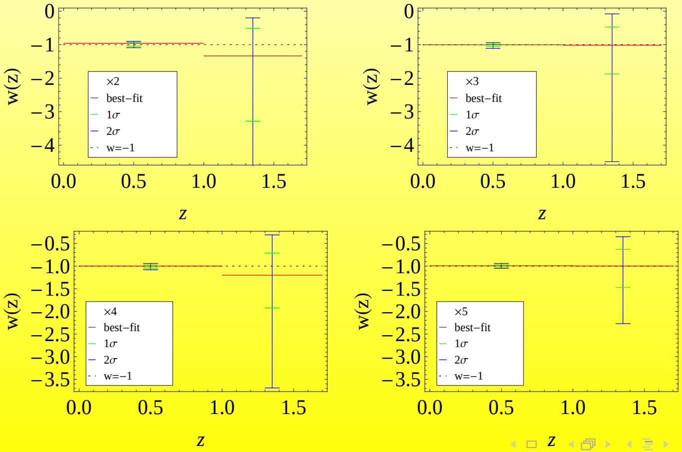
- 

- The fiducial model: $w_{de}(z) = -1$
- The error in distance modulus: $\sigma = 0.13$

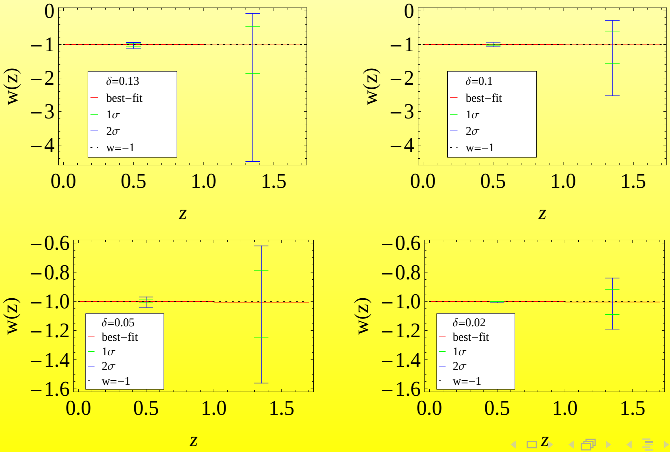
Set z_1 as 0.4, 0.6, 0.8 and 1.0, respectively



With 2, 3, 4 and 5 times of the 2298 elementary data; $z_1 = 1$.



Set $\sigma = 0.13$, 0.1, 0.05, and 0.02, respectively; $z_1 = 1$. Number of supernovae data: 3×2298.



Thank You!