The SDSS 1st-year Supernova data in combination with growth, ISW & BAO

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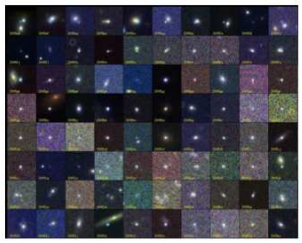

We combine constraints on the equation of state (EoS) of Dark Energy *w* from the 1st year SDSS Supernova Survey[1,2,6] with measurements from growth of structure (GS)[4], the integrated Sachs-Wolfe effect (ISW)[3] and Baryon Acoustic Oscillations (BAO)[5]. The above mentioned measurements are taken at comparable redshifts between 0.1-0.35 and therefore allows one to derive *w* independent of systematic uncertainties potentially acquired by combining measurements over a wide range of redshifts or, in case of SN Ia, from a variety of different instruments and surveys.

By fitting a second order Hubble law to the SN data we find that the SDSS SNe[2] on their own show a indication for an accelerated universe on the 2σ level. If we fit a *w*CDM model assuming a flat universe and combine the data with constraints from GS or the ISW effect we calculate values of *w* consistent with -1 and a statistical error of order 0.15 and a comparable systematic error attributed to uncertainties in the light curve fitting procedure.

In the case of BAO taken from Percival et al. (2007) – without using the distance to the last surface of scattering – we note that the BAO prefers larger distances compared to the SN data[Fig.1]. This could potentially point to a not yet understood systematic in either the SN data or the BAO. Alternatively, by interpreting the BAO measurement as angular diameter distance (D_A)and the SN measurement as luminosity distance (D_L) we interpret the discrepancy as a violation of *distance duality* which should hold in all metric theories of gravity. Parameterising the relation between D_L and D_A as

$$D_L = (1+z)^{2+2\alpha} D_A \qquad (1)$$

we find that *distance duality,* indicated by α=0 (see lower panel of Fig.4), is compatible with the data on the 1.5σ level.

References:

(1) Frieman et al., 2008, AJ, 135, 338
http://sdssdp47.fnal.gov/sdsssn/sdsssn.html
(2) Kessler et al. 2008 (in preparation)
(3) Giannantonio, 2008, PhRvD, 77, 123520,
(4) Hawkins et al. 2003, MNRAS, 346, 78
(5) Percival et al., 2007 MNRAS, 381, 1053
(6) Sako et al., 2008, AJ, 135, 348
(7) Wang et al., 2007, PhRvD, 76, 103533

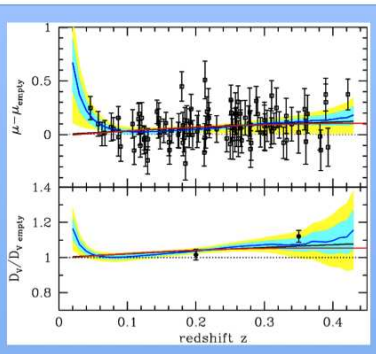

Fig. 1:Residual Hubble diagram for the SDSS 1st-year supernova data. The red line indicates the concordanceΛCDM model, whereas the colored contours show results derived by a local fitting technique using a variable window size. Lower panel: Same as above but now converted to a distance ratio with:

$$D_V(z) = [D_M(z)\frac{cz}{H(z)}]^{1/3}$$

The points Indicate the BAO measurements taken from (5)

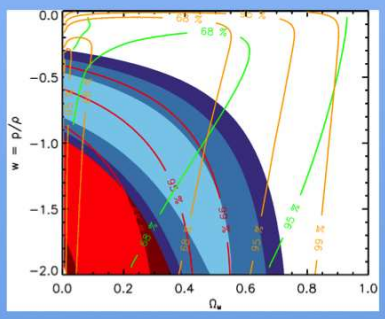

Fig. 2: Confidence levels in the w-Ω_M plane under the assumption of a flat universe and a wCDM model. The blue contours are derived from the supernova data, the red from the BAO, green ISW and orange from GS. Note that GS and ISW provide primarily a constraint on Ω_M whereas the BAO contours seem to be in tension with the SN data.

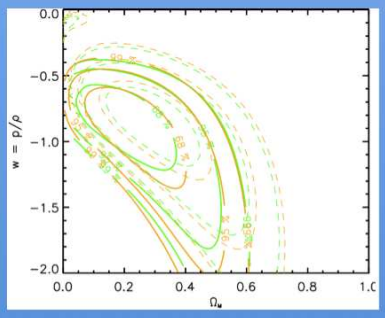

Fig. 3: Combination of contours for growth of structure (orange) and ISW effect (green). The solid lines are under the assumption of a flat universe, whereas the dashed lines are calculated if one allows for curvature constrained by the CMB R-parameter[7]. We note that there is only a little change in w if curvature is taken into account.

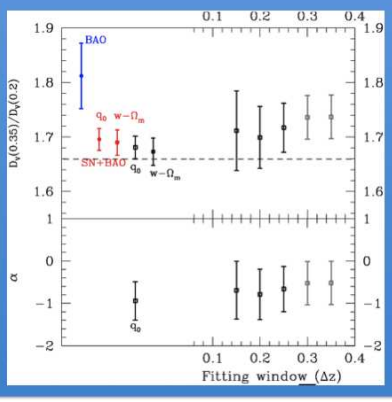

Fig. 4: Ratio of $D_V(0.35)/D_V(0.2)$ as measured by the BAO (blue) and interfered by different methods. From the SN data. The value labeled q_0 indicates a second order Hubble law, w-Ω_M derived for a wCDM parametrization in a flat universe. Data points to the right are derived by a local fit with window size indicated on the abscissa. The lower panel indicates the best fit value on α (Eq. 1) given that we allow for a redshift dependent scaling between luminosity and angular diameter distance. α=0 indicates distance duality.

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