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NCBJ
Closing Year
Seminar

05 December 2024

Cosmological Parameters from the Newest Baryon Acoustic Oscillation Measurements

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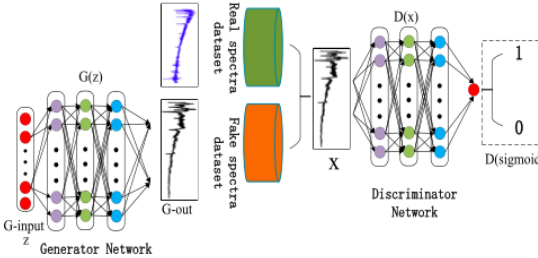
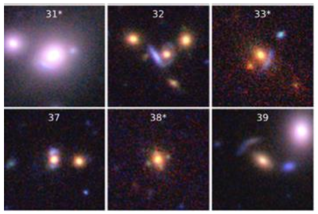
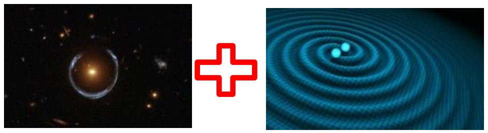
2024 achievements



Liu W., Cao S., Yu X.-C., Zhu M., Biesiada M., Yao J., Du Minghao, "StellarGAN: Classifying Stellar Spectra with Generative Adversarial Networks in SDSS and APOGEE Sky Surveys", *Astrophys. J. Supp. Ser.* (2024), **271**:53

Grespan M., Thuruthipilly H., Pollo A., Lochner M., Biesiada M., Etsebeth V., "TEGLIE: Transformer encoders as strong gravitational lens finders in KiDS – From simulations to surveys" *Astron. Astrophys*, **688**, A34 (2024)

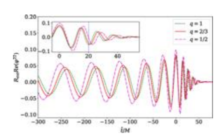




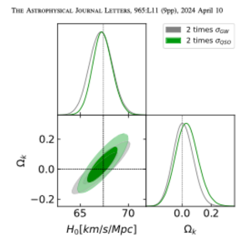
Liu T., Biesiada M., Tian S., Liao K., „Robust test of general relativity at the galactic scales by combining strong lensing systems and gravitational wave standard sirens" *Phys. Rev. D* **109**, 084074 (2024)

Liu Y., Cao S., Zheng X., Biesiada M., Jiang J., Liu T. "Distinguishing LCDM from Evolving Dark Energy with Om Two-point Statistics: Implications from the Space-borne Gravitational-wave Detector" *Astrophys. J* (2024) **966**:19

Liu T., Cao S., Biesiada M., Zhang Y., Wang J., „Model-independent Way to Determine the Hubble Constant and Curvature from the Phase Shift of Gravitational Waves with DECIGO", *Astrophys. J. Lett.* (2024) **965**:L11

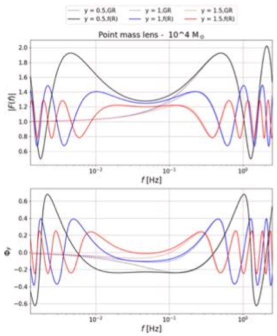


$$X(z) \equiv \frac{H_0}{2}\left(1 - \frac{H(z)}{(1+z)H_0}\right).$$



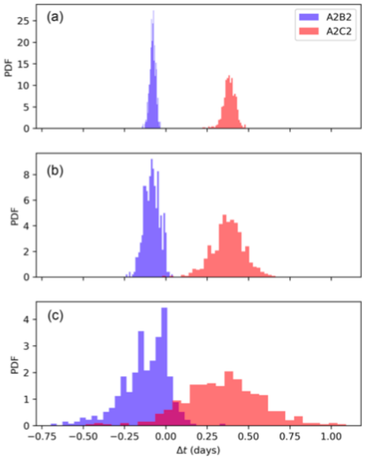
Sharma V.K., Harikumar S., Grespan M., Biesiada M., Verma M.M. "Probing massive gravitons in f(R) with lensed gravitational waves" *Phys. Lett. B* **859**, 139093 (2024)

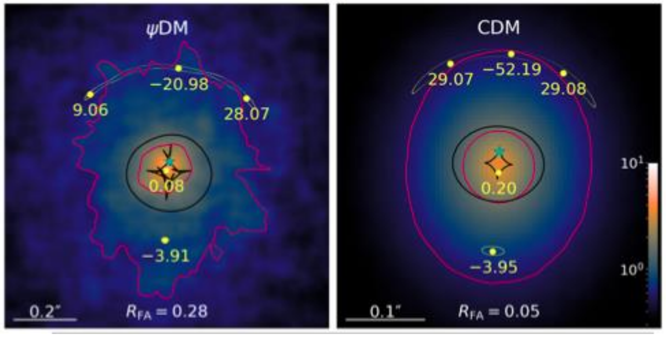
Harikumar S., Jarv L., Saal M., Wojnar A., Biesiada M., „Propagation and lensing of gravitational waves in Palatini f(R) gravity" *Phys. Rev. D* **109**, 124014 (2024)



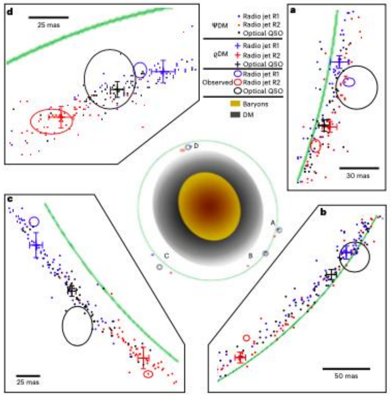
2024 achievements

Liu J., Gao Z., Biesiada M., Liao K., "Time delay anomalies of fuzzy gravitational lenses", *Phys. Rev. D* **110**, 083536 (2024)





Credit: J.H.H. Chan et al. PRL 2020



Credit: A. Amruth et al. Nature Astr. 2023

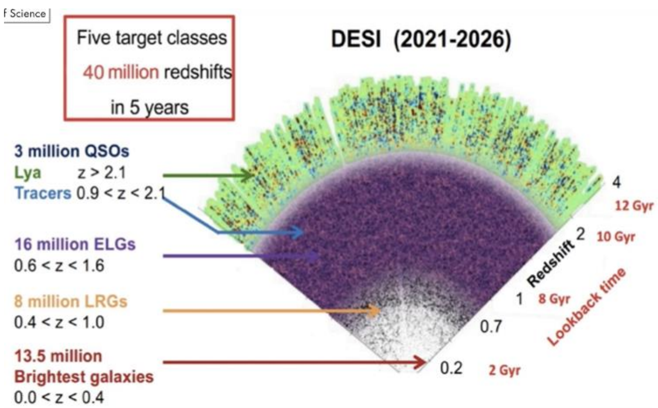
Liu T., Zhong X., Biesiada M., „Model-independent Calibration for Sound Horizon: Combining Observations of Supernovae and Baryon Acoustic Oscillation Measurements" ***Astrophys. J*** **976:208 (2024)**

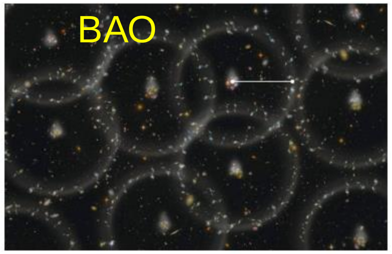
Yang Y., Liu T., Huang J., Cheng X., Biesiada M., Wu S.-M., "Simultaneous measurements on cosmic curvature and opacity using latest HII regions and H(z) observations." *Eur. Phys. J. C* (2024) **84**:3,

Guo W., Wang Q., Cao S., Biesiada M., Liu T., Lian Y., Jiang X., Mu C., Cheng D., „Newest measurements of the Hubble constant from DESI 2024 BAO measurements" ***Astrophys. J .Lett.*** **(2024) accepted**

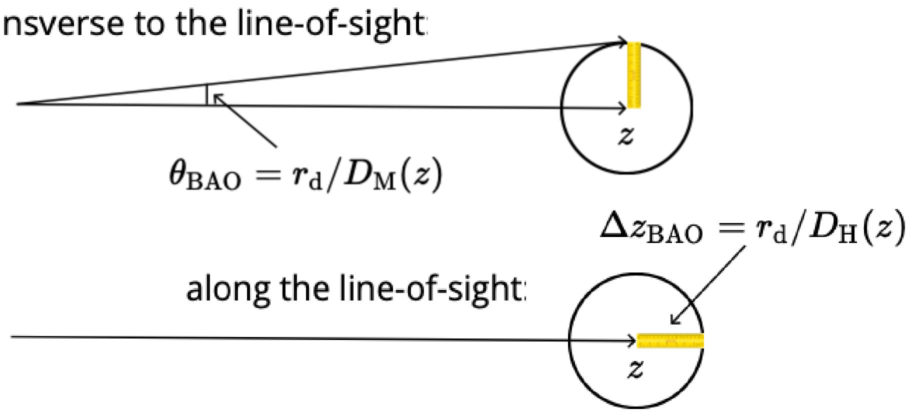
Dark Energy Spectroscopic Instrument DESI

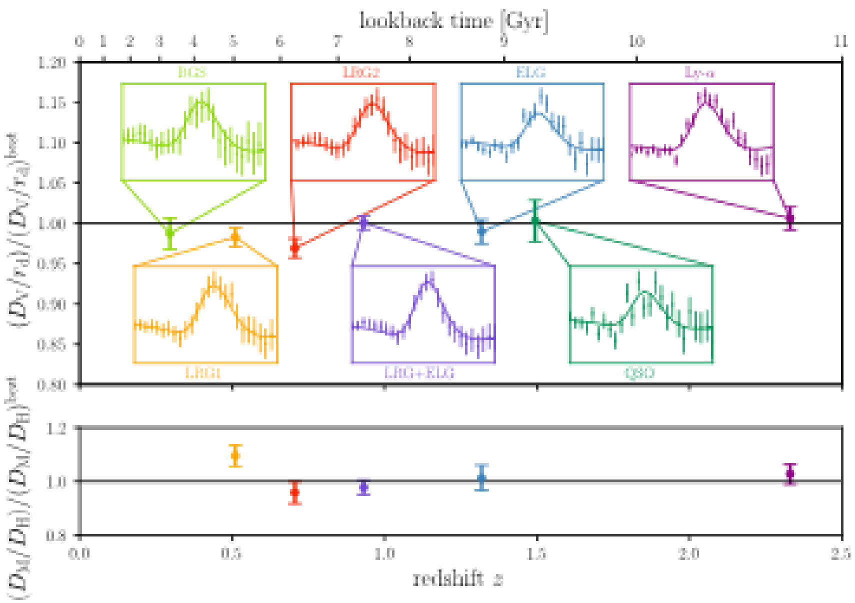
Credit: E. Burtin *Moriond 2024*





BAO measures ratios of distances over the sound horizon scale at the drag epoch ["standard ruler"] $r_{\rm d}$





- transverse to the line-of-sight: $D_{\rm M}(z)/r_{\rm d}$
- along the line-of-sight: $D_{\rm H}(z)/r_{\rm d} = c/(H(z)r_{\rm d})$
- isotropic average: $D_{\rm V}(z)/r_{\rm d} = (zD^2_{\rm M}(z)D_{\rm H}(z))^{1/3}/r_{\rm d}$

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Model-independent Calibration for Sound Horizon: Combining Observations of Supernovae and Baryon Acoustic Oscillation Measurements

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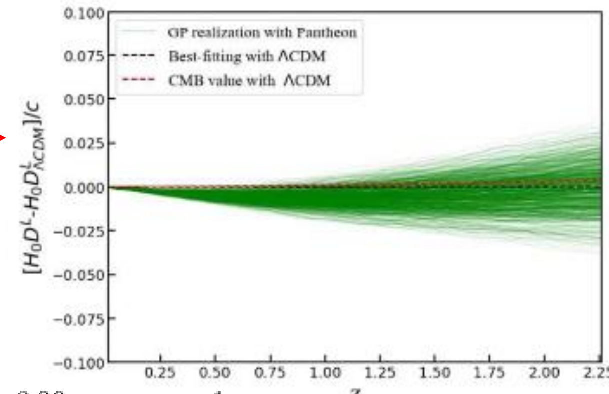
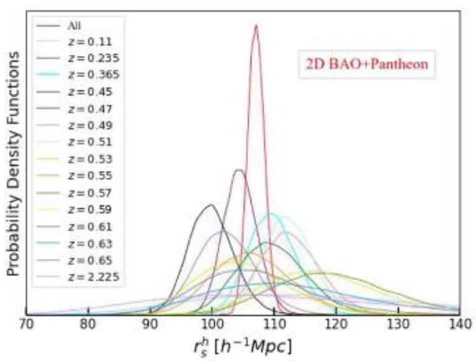
$$r_s^h = \frac{(1+z_{\rm BAO})\theta_{\rm BAO}}{100}\cdot[H_0D^A]^{\rm SNe}.$$

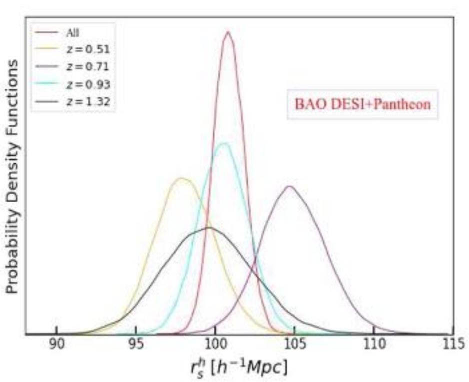
SN Ia Pantheon



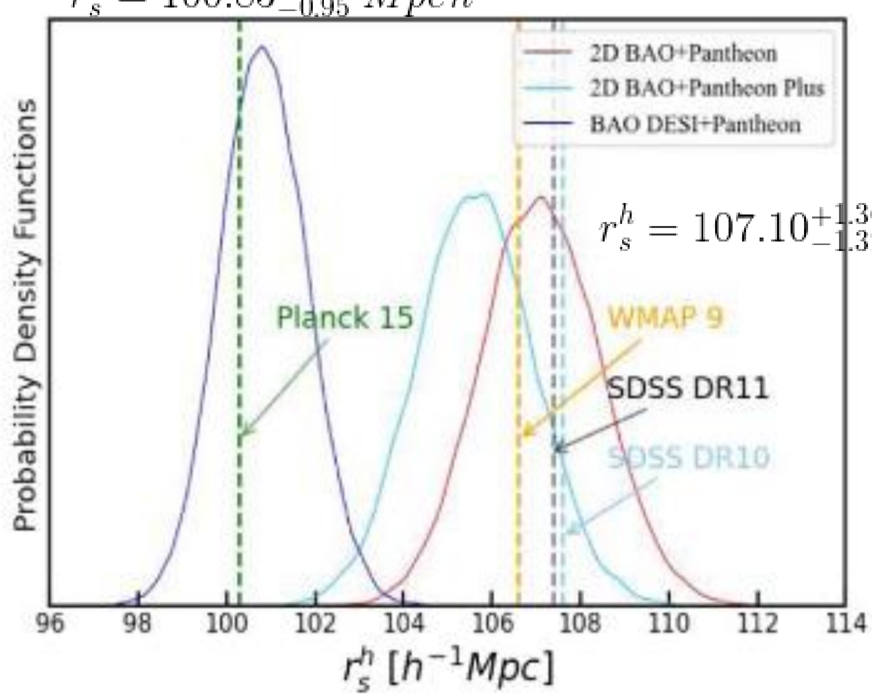


BAO data
Nunes et al.
MNRAS 2020

$$r_s^h = 100.83^{+0.99}_{-0.95}\ Mpc\,h^{-1}$$



BAO data
DESI 2024



$$r_s^h = 107.10^{+1.36}_{-1.32}\ Mpc\,h^{-1}$$

Newest measurements of Hubble constant from DESI 2024 BAO observations

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[1] Institute for Frontiers in Astronomy and Astrophysics, Beijing Normal University, Beijing 102206, China;
[2] School of Physics and Astronomy, Beijing Normal University, Beijing 100875, China;
[3] National Centre for Nuclear Research, Pasteura 7, PL-02-093 Warsaw, Poland;
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$$\frac{d_L(z)}{(1+z)^2 d_A(z)} = 1.$$

Etherington relation

SN Ia Pantheon+

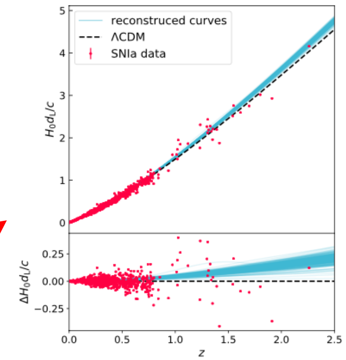


Figure 1. Reconstructed $H_0 d_L$ from SN Ia data using Gaussian regression. The black dashed line shows the best-fitted ΛCDM model. The residuals between reconstructed $H_0 d_L$ and the best-fit ΛCDM are also shown in the bottom panel.

$$H_0 = \frac{1}{(1+z)^2} \frac{H_0 d_L(z)}{H(z) d_A(z)} H(z).$$

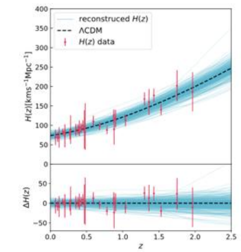
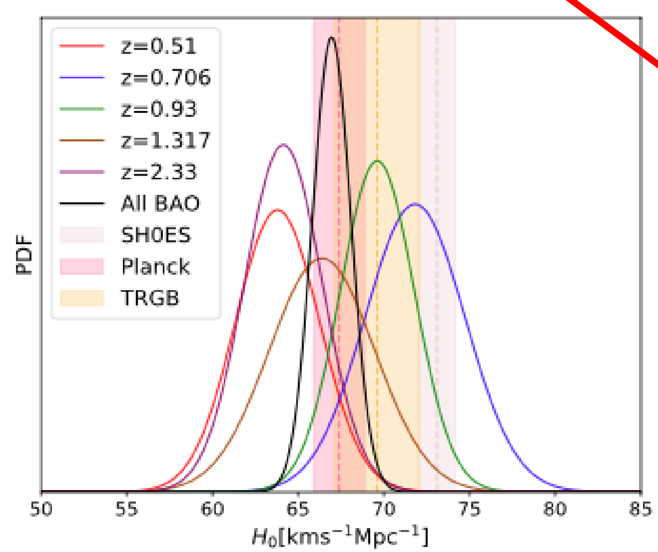


Figure 2. Reconstructed $H(z)$ from CC data using Gaussian regression. The black dashed line shows the best-fit ΛCDM model. The residuals between reconstructed $H(z)$ and the best-fit ΛCDM are also shown in the bottom panel.

Cosmic Chronometers

Results

z	H_0(km s^{-1} Mpc^{-1})
total	$66.9^{+1.1}_{-1.0}$
0.51	$63.8^{+2.9}_{-2.4}$
0.706	$71.8^{+3.2}_{-2.9}$
0.93	$69.6^{+2.4}_{-2.2}$
1.317	66.8 ± 3.1
2.33	$64.1^{+2.8}_{-2.3}$



$$\frac{D_M}{D_H} = \frac{(1+z)d_A(z)}{cH(z)^{-1}} = \frac{1+z}{c} H(z) d_A(z).$$

DESI 2024
7 BAO data points

Thank you !