Newsletter of *A Cosmology Group* - October 2023

In this Newsletter: $H_0 = 76.9$ km/s/Mpc from "an individual baryon acoustic oscillation," evolution of radio sources mimic a nonexpanding universe, carbon-rich early universe, galaxy overdensity at $z = 7.88$, and more tensions with ΛCDM expectations.

Thanks to Pierre-Réal Gosselin and all who contributed references to interesting papers.

Louis Marmet, October 15, 2023
redshift@marmet.org

Reviewed Publications[1]

- Redshift, Hubble parameter, Expansion

"Peculiar velocity effects on the Hubble constant from time-delay cosmography" C. Dalang, M. Millon, and T. Baker, Phys. Rev. D **107**, 12, p. 123528 (2023-6). doi: 10.1103/PhysRevD.107.123528. "Two major challenges of contemporary cosmology are the Hubble tension and the cosmic dipole tension. At the crossroads of these, we investigate the impact of peculiar velocities on estimations of the Hubble constant from time-delay cosmography. [...] Any time-delay cosmography program which aims for percent precision on the Hubble constant may need to take this source of systematic bias into account. This is especially so for future ground-based surveys which cover a fraction of the celestial sphere that is well aligned with the observer's peculiar velocity."

"Ho'oleilana: An Individual Baryon Acoustic Oscillation?" R.B. Tully, C. Howlett, and D. Pomarède, ApJ **954**, 2, p. 169 (2023-9) doi: 10.3847/1538-4357/aceaf3. "Evidence is presented here for the discovery of a remarkably strong individual contribution to the baryon acoustic oscillations (BAO) signal at z = 0.068, an entity that is given the name Ho'oleilana. The radius of the 3D structure is $155\,h_{75}^{-1}$ Mpc. At its core is the Boötes supercluster. The Sloan Great Wall, Center for Astrophysics Great Wall, and Hercules complex all lie within the BAO shell. The interpretation of Ho'oleilana as a BAO structure with our preferred analysis implies a value of the Hubble constant of $76.9^{+8.2}_{-4.8}\,\mathrm{km\,s^{-1}\,Mpc^{-1}}$."

"Seven hints that early-time new physics alone is not sufficient to solve the Hubble tension" S. Vagnozzi, Universe **9**(9), 393 (2023) https://doi.org/10.3390/universe9090393 Submitted on (31 Aug 2023). "The Hubble tension has now grown to a level of significance which can no longer be ignored and calls for a solution which, despite a huge number of attempts, has so far eluded us. Significant efforts in the literature have focused on early-time modifications of ΛCDM, introducing new physics operating prior to recombination and reducing the sound horizon. In this opinion paper I argue that early-time new physics alone will always fall short of fully solving the Hubble tension [and] that a promising way forward should ultimately involve a combination of early- and late-time (but non-local – in a cosmological sense, i.e. at high redshift) new physics, as well as local (i.e. at $z \sim 0$) new physics.

"Objects in JWST's mirrors are closer than they appear" S. Serjeant and T. J. L. C. Bakx, arXiv:2308.13347 doi: 10.48550/arXiv.2308.13347 (2023-8-25). "The James Webb Space Telescope (JWST) has revealed extremely

[1]For all reviews, quoted text is adapted from the original, underlined text is my emphasis, and *italicized text are my comments.*

distant galaxies at unprecedentedly early cosmic epochs from its deep imaging using the technique of photometric redshift estimation, with its subsequent spectroscopy confirming their redshifts unambiguously. However, as larger samples continue to be followed up spectroscopically, it has become apparent that nearly all photometric redshifts at these epochs are biased high with confidence >> 99%, for as yet unclear reasons. Here we show that this is the same statistical effect that was predicted in different contexts by Sir Arthur Eddington in 1913, in that there exist more lower redshift galaxies to be scattered upwards than the reverse."

"Distance Duality Test: The Evolution of Radio Sources Mimics a Nonexpanding Universe" P. Li, The Astrophysical Journal Letters **950** (2) L14 (2023) https://iopscience.iop.org/article/10.3847/2041-8213/acdb49 "Interestingly, the luminosity density and the source size conspire to fine-tune their evolution to make them indistinguishable from a nonexpanding universe." *Perhaps the universe does not expand after all!*

- Nucleosynthesis

"Carbonaceous dust grains within galaxies seen in the first billion years of cosmic time" J. Witstok *et al.* arXiv:2302.05468 [Submitted (2023-2-10)] "Here we report observations of the 2175 Å dust attenuation feature, well known in the Milky Way (MW) and galaxies at $z \leq 3$, in the near-infrared spectra of galaxies up to $z \sim 7$, corresponding to the first billion years of cosmic time. The relatively short timescale implied for the formation of carbonaceous grains giving rise to this feature suggests a rapid production process, likely in Wolf-Rayet stars or SN ejecta."
See also "Webb sees carbon-rich dust grains in the first billion years of cosmic time" on the ESA website.

- Galaxy and Large-Scale Structure Formation

"Subaru High-z Exploration of Low-luminosity Quasars (SHELLQs). XVIII. The Dark Matter Halo Mass of Quasars at $z \sim 6$" J. Arita **et al.**, ApJ **954**, 2, p. 210 (2023-9) doi: 10.3847/1538-4357/ace43a. "We present, for the first time, dark matter halo (DMH) mass measurement of quasars at $z \sim 6$ based on a clustering analysis of 107 quasars. The DMH mass of quasars is evaluated as $5.0^{+7.4}_{-4.0} \times 10^{12}\, h^{-1} M_{\odot}$ with the bias parameter $b = 20.8 \pm 8.7$ by the projected correlation function. Our results supporting a significant increasing bias with redshift are consistent with the bias evolution model with inefficient active galactic nucleus feedback at $z \sim 6$."

"Reionization and the ISM/Stellar Origins with JWST and ALMA (RIOJA): The Core of the Highest-redshift Galaxy Overdensity at z = 7.88 Confirmed by NIRSpec/JWST" T. Hashimoto *et al.* The Astrophysical Journal Letters **955**, 1, L2 (2023-9-13) DOI 10.3847/2041-8213/acf57c. "We present the spectroscopic confirmation of the core of the most distant protocluster at $z = 7.88$, A2744-z7p9OD, with the James Webb Space Telescope NIRSpec integral field unit spectroscopy. The core region includes as many as four galaxies detected in [O iii] 4960 and 5008 Å in a small area of $\sim 11 \times 11$ kpc, after the lensing magnification correction. FirstLight cosmological simulations reproduce the physical properties of the member galaxies including the stellar mass, [O iii] luminosity, and dust-to-stellar mass ratio, and predict that the member galaxies are on the verge of merging in a few to several tens of Myr. The presence of a multiple merger and evolved galaxies in the core region of A2744-z7p9OD indicates that environmental effects are already at work 650 Myr after the Big Bang."

"Quiescent Low-mass Galaxies Observed by JWST in the Epoch of Reionization" V. Gelli *et al.* The Astrophysical Journal Letters **954**, 1, (2023-8-25) DOI 10.3847/2041-8213/acee80 "The surprising JWST discovery of a quiescent, low-mass ($M^* = 10^{8.7} M_{\odot}$) galaxy at redshift $z = 7.3$ (JADES-GS-z7-01-QU) represents a unique opportunity to study the imprint of feedback processes on early galaxy evolution. We build a sample of 130 low-mass ($M^* \leq 10^{9.5} M_{\odot}$) galaxies from the serra cosmological zoom-in simulations, which show a feedback-regulated, bursty star formation history (SFH). [...] However, none of these quiescent systems matches the spectral energy distribution of JADES-GS-z7-01-QU, unless their SFH is artificially truncated a few Myr after the main star formation peak. As supernova feedback can only act on a longer timescale (≥30 Myr), this implies that the observed abrupt quenching must be caused by a faster physical mechanism, such as radiation-driven winds from young massive stars and/or an active galactic nucleus." *See also* "Investigating a Star-Formation Shutdown in the

Early Universe" https://aasnova.org/2023/09/18/investigating-a-star-formation-shutdown-in-the-early-universe/

"Evidence for suppression of structure growth in the concordance cosmological model" N.-M. Nguyen, D. Huterer, Y. Wen, arXiv:2302.01331 [Submitted on (2023-2-2)] "We present evidence for a suppressed growth rate of large-scale structure during the dark-energy dominated era. Modeling the growth rate of perturbations with the "growth index" γ, we find that current cosmological data strongly prefer a higher growth index than the value $\gamma = 0.55$ predicted by general relativity in a flat ΛCDM cosmology. Both the cosmic microwave background data from Planck and the large-scale structure data from weak lensing, galaxy clustering, and cosmic velocities separately favor growth suppression. When combined, they yield $\gamma = 0.633^{+0.025}_{-0.024}$, excluding $\gamma = 0.55$ at a statistical significance of 3.7σ. The combination of σ_8 and Planck measurements prefers an even higher growth index of $\gamma = 0.639$, corresponding to a 4.2σ-tension with the concordance model. A higher γ leads to a higher matter fluctuation amplitude S8 inferred from galaxy clustering and weak lensing measurements, and a lower S8 from Planck data, effectively resolving the S8 tension."

"A massive quiescent galaxy in a group environment at z=4.53" T. Kakimoto *et al.* arXiv:2308.15011 [Submitted to ApJ (2023-8-29)] "We report on the spectroscopic confirmation of a massive quiescent galaxy at $z_{spec} = 4.53$ in the COSMOS field with Keck/MOSFIRE. [...] The follow-up spectroscopy with MOSFIRE in the K-band reveals a faint [OII] emission and the Balmer break, indicative of evolved stellar populations. We perform the spectral energy distribution fitting using both the photometry and spectrum to infer physical properties. Its star formation history suggests that this galaxy experienced starburst at $z \sim 5$ followed by a rapid quenching phase. [...] Interestingly, three of them have strongly overlapping virial radii with that of the central quiescent galaxy (∼70kpc), suggesting that the over-density region is likely the highest redshift candidate of a dense group with a spectroscopically confirmed quiescent galaxy at the center. The group provides us with an unique opportunity to gain insights into the role of the group environment for quenching at $z \sim 4-5$ corresponding to the formation epoch of massive elliptical galaxies in the local Universe."

"Detection of stellar light from quasar host galaxies at redshifts above 6" X. Ding *et al.*arXiv:2211.14329 [Submitted on (2022-11-25)] "The detection of starlight from the host galaxies of quasars during the reionization epoch ($z > 6$) has been elusive, even with deep HST observations. The current highest redshift quasar host detected, at $z = 4.5$, required the magnifying effect of a foreground lensing galaxy. Here we report rest-frame optical images and spectroscopy of two HSC-SSP quasars at $z > 6$ with JWST. Their location in the black hole mass - stellar mass plane is consistent with the distribution at low redshift, suggesting that the relation between black holes and their host galaxies was already in place less than a billion years after the Big Bang."

"SPT-CL J2215-3537: A Massive Starburst at the Center of the Most Distant Relaxed Galaxy Cluster" M.S. Calzadilla *et al.* The Astrophysical Journal **947**, 2, 44 (2023-4-19) DOI 10.3847/1538-4357/acc6c2 "We present the discovery of the most distant, dynamically relaxed cool core cluster, SPT-CL J2215-3537 (SPT2215), and its central brightest cluster galaxy (BCG) at $z = 1.16$. Using new X-ray observations, we demonstrate that SPT2215 harbors a strong cool core with a central cooling time of 200 Myr (at 10 kpc). This prodigious cooling may be responsible for fueling the extended, star-forming filaments observed in Hubble Space Telescope imaging. The high mass of this cluster, coupled with the fact that it is dynamically relaxed with a highly isolated BCG, suggests that it is an exceptionally rare system that must have formed very rapidly in the early universe."
See also https://phys.org/news/2023-07-unexpectedly-calm-remote-galaxy-cluster.html "It would be like finding a tidy kitchen right after the dinner rush."

"The massive relic galaxy NGC 1277 is dark matter deficient" S. Comerón *et al.* A&A **675**, A143 (2023-7-11) https://doi.org/10.1051/0004-6361/202346291 "According to the Λ cold dark matter (ΛCDM) cosmology, present-day galaxies with stellar masses $M^* > 10^{11} M_\odot$ should contain a sizable fraction of dark matter within their stellar body. The best relic galaxy candidate discovered to date is NGC 1277, in the Perseus cluster. By using Jeans anisotropic modelling, we find a negligible dark matter fraction within $5R_e$ ($f_{DM}(5R_e) < 0.05$; two-sigma confidence level), which is in tension with the ΛCDM expectation. Since the lack of an extended envelope would reduce dynamical friction and prevent the accretion of an envelope, we propose that NGC 1277 lost its dark matter very early or that it was dark matter deficient ab initio. Alternatively, NGC 1277 might have been born

in a high-velocity collision of gas-rich proto-galactic fragments, where dark matter left behind a disc of dissipative baryons. We speculate that the relative velocities of ≈ 2000 km s^{-1} required for the latter process to happen were possible in the progenitors of the present-day rich galaxy clusters."

- Cosmology

"A surprisingly high number of dual active galactic nuclei in the early Universe" M. Perna *et al.* arXiv:2310.03067 [Submitted on (2023-10-4)] "We report the serendipitous discovery of a triple AGN and four dual AGN (one considered as a candidate), with projected separations in the range 3-28 kpc. Their AGN classification is mostly based on classical optical emission line flux ratios, as observed with the Near-InfraRed Spectrograph (NIRSpec) on the James Webb Space Telescope (JWST), and is complemented with additional multi-wavelength diagnostics. The identification of these multiple AGN out of the 17 AGN systems in our GA-NIFS survey, suggests that they might be more common than expected from the most recent cosmological simulations, which predict a fraction of dual AGN at least one order of magnitude smaller."

"In spite of the small size of the GA-NIFS sample (17 AGN systems), our findings are definitely at odds with such predictions, pointing to the presence of a much larger population of dual AGN in the early Universe"

"The El Gordo Galaxy Cluster Challenges ΛCDM for Any Plausible Collision Velocity" E. Asencio, I. Banik, and P. Kroupa, The Astrophysical Journal **954**, 2, (2023-9-4) DOI 10.3847/1538-4357/ace62a "El Gordo (ACT-CL J0102-4915) is an extraordinarily large and bright galaxy cluster collision. In a previous study, we found that El Gordo is in 6.2σ tension with the ΛCDM standard model when assuming the nominal mass and infall velocity values from the hydrodynamical simulations of Zhang et al. Here we explore the level of tension between El Gordo and ΛCDM for the new mass estimate, assuming several $V_{\rm infall}$ values. [We] conclude that El Gordo still poses a significant challenge to ΛCDM cosmology."

A Cosmology Group

A Cosmology Group draws its mandate from the *Open Letter to the Scientific Community* to engage scientists in an open exchange of ideas beyond the framework of Standard Cosmology through a critical examination[2] of the methods and investigations of cosmology. The *ACG Newsletter* highlights observational results that are anomalous in terms of the Big Bang paradigm.

The *Newsletter* is published irregularly, editor's schedule permitting, and when interesting papers are available. ACG subscribers[3] receive notifications of *Newsletter* publications and a few additional announcements. You can subscribe to *ACG* by creating an account on GitHub.com and follow acg\Discussions.

If you would like to suggest a paper for review, please send a direct reference to `redshift@marmet.org`. Published work in a refereed journal and with open access (e.g. a preprint on `arXiv` or `HAL`) is preferred.

Created with TeXstudio 4.0.2

[2] When the thesis is supported by empirical evidence.
[3] ACG currently has 35 followers.