Newsletter of *A Cosmology Group* - July 2024

ACG Editorial

In this Newsletter, more papers on JWST observations that don't make sense in the ΛCDM paradigm. Many thanks to Alessandro Trinchera and all who contributed references to interesting papers.

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Reviewed Publications[1]

- Redshift, Hubble parameter, Expansion

"SN H0pe: The First Measurement of H0 from a Multiply-Imaged Type Ia Supernova, Discovered by JWST" M. Pascale *et al.* arXiv:2403.18902 "For the first time, the lens models are evaluated by their agreement with the SN absolute magnification, breaking these degeneracies and producing our best estimate, $H_0 = 75.4^{+8.1}_{-5.5}$ m/s/kpc. This is the first precision measurement of H_0 from a multiply-imaged SN Ia."

"Could the number of blue straggler stars help to determine the age of their parent globular cluster?" F. Llorente de Andrés, SCIREA 5, Issue 2 (Aug 2023) DOI: 10.54647/astronomy160048 scirea.org/journal/PaperInformation?PaperID=9747 "A special case is the cluster NGC104 whose age exceeds 13.8 Gyr (its age is in between 19.04 and 20.30 Gyr), which would have a very exotic explanation[...] On the other hand, if that age were true, it would call into question the expansion velocity for a flat Universe."

"Covariant cosmography: the observer-dependence of the Hubble parameter" R. Maartens *et al.* arXiv:2312.09875 Submitted on (15 Dec 2023) "The disagreement between low- and high-redshift measurements of the Hubble parameter is emerging as a serious challenge to the standard model of cosmology. Here our focus is on understanding the relation between the physical expansion rate and its measurement by observers."

"Candidate Galaxies at z ∼ 11.3–21.8 and beyond: results from JWST's public data taken in its first year" H. Yan *et al.*, arXiv:2311.15121 "While no models in the pre-JWST era predicted the emergence of galaxy population at a time as early as $z \sim 17.3$, it is not necessarily a crisis for the ΛCDM paradigm if our candidates are proved to be at such high redshifts. The existence of a large number of galaxies at $z \sim 17.3$ is in conflict with the determination of $z_{re} = 7.64$ based on CMB anisotrophy measurements."

- Nucleosynthesis

"Heavy Element Quandary in Stars Worsened by New Nuclear Data" https://physics.aps.org/articles/v17/ 47 "A widening gap between the cerium-140 abundance predicted by theories and that measured in observations of certain stars indicates a potential need for updated models of element formation."

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

"CERN's Latest Data Sends Shockwaves Through Nuclear Astrophysics Community" https://www.youtube.com/watch?v=4RtWRVVOIkc

"JADES: Carbon enrichment 350 Myr after the Big Bang in a gas-rich galaxy" F. D'Eugenio *et al.*, arXiv:2311.09908 [Submitted on 16 Nov 2023] "We present deep JWST/NIRSpec spectroscopy of GS-z12, a galaxy at $z = 12.5$. This is the most distant detection of a metal transition and the most distant redshift determination via emission lines. Such a high C/O in a galaxy observed 350 Myr after the Big Bang may be explained by the yields of extremely metal poor stars, and may even be the heritage of the first generation of supernovae from Population III progenitors.

- Galaxy and Large-Scale Structure Formation

Bound star clusters observed in a lensed galaxy 460 Myr after the Big Bang Adamo, A. *et al.* Nature doi:10.1038/s41586-024-07703-7 (2024) (Accelerated preview) "Here we report JWST observations of the Cosmic Gems. They exhibit minimal dust attenuation and low metallicity, ages younger than 50 Myr and intrinsic masses of $\sim 10^6$ $M_\odot$. Their lensing-corrected sizes are approximately 1 pc, resulting in stellar surface densities near 10^5 $M_\odot/pc^2$, three orders of magnitude higher than typical young star clusters in the local universe."

"The oldest stars with low neutron-capture element abundances and origins in ancient dwarf galaxies" H.D. Andales *et al.*, MNRAS **530** 4, p. 4712 (June 2024) doi: 10.1093/mnras/stae670 "Formed 12 to 13 billion years ago at around $z \sim 10$ ultra-faint dwarf satellite galaxies are ancient and thus extremely metal poor. We present a detailed chemical abundance and kinematic analysis of six extremely metal-poor ($-4.2 \leq$ [Fe/H] ≤ -2.9) halo stars with very low neutron-capture abundances ([Sr/H] and [Ba/H]) based on high-resolution Magellan/MIKE spectra. Using neutron-capture elements as a distinguishing criterion for early formation, we have access to a unique metal-poor population that consists of the oldest stars in the universe."

"Age of massive galaxies at redshift 8" M. Lopez-Corredoira, F. Melia, J.-J. Wei, C.-Y. Gao, arXiv:2405.12665 "Recent JWST data analyses have shown that massive red galaxies existed at redshifts $z > 6$, a discovery that is difficult to understand in the context of standard cosmology. We analyze these observations by fitting a stellar population model to the optical and near-infrared photometric data. [The] result conflicts with the inferred ages of these galaxies which were on average between 0.9 and 2.4 Gyr old [95% CL]. These galaxies should be even younger than 290 Myr on average, for which our analysis assigns a probability of only $< 3 \times 10^{-4}$ ($\geq 3.6\sigma$ tension)."

"A JWST investigation into the bar fraction at redshifts $1 \leq z \leq 3$**"** Z.A. Le Conte *et al.*, Monthly Notices of the Royal Astronomical Society **530**, Issue 2, May 2024, pp. 1984-2000, https://doi.org/10.1093/mnras/stae921 (23 April 2024) "The presence of a stellar bar in a disc galaxy indicates that the galaxy hosts in its main part a dynamically settled disc. We extend the studies of the bar fraction in disc galaxies to redshifts $1 \leq z \leq 3$. Our results show that bar-driven evolution might commence at early cosmic times and that dynamically settled discs are already present at a lookback time of ∼11 Gyr." Also *"Star bars show universe's early galaxies evolved much faster than previously thought"* https://phys.org/news/ 2024-04-star-bars-universe-early-galaxies.html

"A massive galaxy that formed its stars at $z \sim 11$**"** K. Glazebrook *et al.*, Nature 628, 277–281 (2024) https://doi.org/10.1038/s41586-024-07191-9 arXiv:2308.05606 "Extremely massive quiescent galaxies $> 10^{11}$ $M_\odot$ have now been observed as early as 1-2 Gyr after the Big Bang; these are extremely constraining on theoretical models as they form 300-500 Myr earlier and only some models can form massive galaxies this early. We report on the spectroscopic observations with the JWST of a massive quiescent galaxy ZF-UDS-7329 at $z = 3.205$, is significantly redder than typical and whose spectrum reveals features typical of much older stellar populations."

"Understanding the Universal Dust Attenuation Scaling Relation of Star-Forming Galaxies" J. Qin *et al.* arXiv:2312.16700 [Submitted on 27 Dec 2023] "Star-forming galaxies (SFGs) adhere to a surprisingly tight scaling relation of dust attenuation parameterized by the infrared excess (IRX=LIR/LUV), being jointly determined by the star formation rate (SFR), galaxy size, metallicity and axial ratio. A consistent picture of how

the star-dust geometry in SFGs evolves with galaxy metallicity is discussed."

"The SPT-Chandra BCG Spectroscopic Survey I: Evolution of the Entropy Threshold for Cooling and Feedback in Galaxy Clusters Over the Last 10 Gyr" M.S. Calzadilla *et al.* arXiv:2311.00396 [Submitted on 1 Nov 2023] "We present a multi-wavelength study of the brightest cluster galaxies (BCGs) in a sample of the 95 most massive galaxy clusters selected from South Pole Telescope (SPT) Sunyaev-Zeldovich (SZ) survey. At $z \sim 0$, previous studies have shown a strong correlation between the presence of a low-entropy cool core and the presence of star-formation and a radio-loud AGN in the central BCG. We show for the first time that a central entropy threshold for star formation persists out to $z \sim 1$."

"JWST CEERS and JADES Active Galaxies at $z = 4 - 7$ Violate the Local $M_o - M_*$ Relation at $> 3\sigma$: Implications for Low-mass Black Holes and Seeding Models" F. Pacucci *et al.*, The Astrophysical Journal Letters 957, Number 1, L3 (October 23 2023) DOI 10.3847/2041-8213/ad0158 "Black holes are overmassive by $\sim 10 - 100\times$ compared to their low-z counterparts in galactic hosts of the same stellar mass. This fact is not due to a selection effect in surveys."

"Unusually Large Fluctuations in the Statistics of Galaxy Formation at High Redshift", R. Barkana *et al.*, arXiv:astro-ph/0310338 [Submitted on 14 Oct 2003] "We show that various milestones of high-redshift galaxy formation, such as the formation of the first stars or the complete reionization of the intergalactic medium, occurred at different times in different regions of the universe. The predicted spread in redshift, caused by large-scale fluctuations in the number density of galaxies, is at least an order of magnitude larger than previous expectations that argued for a sharp end to reionization."

"JWST Reveals a Surprisingly High Fraction of Galaxies Being Spiral-like at $0.5 \leq z \leq 4$" V. Kuhn *et al.*, arXiv:2312.12389 [Submitted on 19 Dec 2023] "We used JWST images from the Cosmic Evolution Early Release Science Survey to visually identify spiral galaxies with redshift $0.5 \leq z \leq 4$ and stellar mass $\geq 10^{10}\mathrm{M}_{\odot}$. Out of 873 galaxies, 216 were found to have a spiral structure. We found the observed spiral fraction decreases from 48% to 8% at $z \sim 0.75 - 2.75$. This fraction is surprisingly high and implies that the formation of spiral arms, as well as disks, was earlier in the universe."

- Cosmology

ΛCDM is alive and well A. Blanchard *et al.*, arXiv:2205.05017 [Submitted on 10 May 2022] Open Journal of Astrophysics Volume 7, (May 2024) "The ΛCDM model faces several tensions with recent cosmological data and their increased accuracy. We conclude that a standard ΛCDM model with an unknown bias in the Cepheids distance calibration represents a model that reaches a remarkable agreement, statistically better than previously proposed extensions with $H_0 \sim 73$ for which such a comparison can be performed."

Indefinitely Flat Circular Velocities and the Baryonic Tully–Fisher Relation from Weak Lensing T. Mistele *et al.*, The Astrophysical Journal Letters **969**, Number 1, L3 (2024) doi:10.3847/2041-8213/ad54b0 "We use a new deprojection formula to infer the gravitational potential around isolated galaxies from weak gravitational lensing. The results imply circular velocity curves that remain flat for hundreds of kpc, greatly extending the classic result from 21 cm observations. Indeed, there is no clear hint of a decline out to 1 Mpc, well beyond the expected virial radii of dark matter halos." *The hypothesis of 'dark matter' is, once again, falsified. This has negative implications on the validity of ΛCDM. (However, that doesn't mean MOND is correct...)*

"The discovery and significance of fast radio bursts" D.R. Lorimer, M.A. McLaughlin, M. Bailes, arXiv:2405.19106 [Submitted on 29 May 2024] "In 2007 we were part of a team that discovered the so-called "Lorimer Burst", the first example of a new class of objects known as fast radio bursts. We review the discovery of FRBs and present some of the highlights from the vast body of work by an international community."

"DESI 2024 VI: Cosmological Constraints from the Measurements of Baryon Acoustic Oscillations" DESI Collaboration: A.G. Adame *et al.* arXiv:2404.03002 "We present cosmological results from the

measurement of baryon acoustic oscillations (BAO) in galaxy, quasar and Lyman-α forest tracers from the first year of observations from the Dark Energy Spectroscopic Instrument (DESI). We find $\Omega_m = 0.307$ and $H_0 = 67.97$ km/s/Mpc. With a constant dark energy equation of state parameter w, DESI BAO alone require $w = -0.99^{+0.15}_{-0.13}$. In models with a time-varying dark energy equation of state, combinations of DESI with CMB or with SN Ia individually prefer $w_0 > -1$ and $w_a < 0$. This preference is 2.6σ for the DESI+CMB combination, and persists or grows when SN Ia are added in, giving results discrepant with the ΛCDM model at the 2.5σ, 3.5σ or 3.9σ levels for the addition of Pantheon+, Union3, or DES-SN5YR datasets respectively."

"Insights from HST into Ultramassive Galaxies and Early-Universe Cosmology" N. Sabti, J.B. Muñoz, and M. Kamionkowski, Phys. Rev. Lett. **132**, 061002 (9 February 2024) arXiv:2305.07049 "The early-science observations made by the James Webb Space Telescope (JWST) have revealed an excess of ultra-massive galaxy candidates that appear to challenge the standard cosmological model (ΛCDM). Here, we argue that any modifications to ΛCDM that can produce such ultra-massive galaxies in the early Universe would also affect the UV galaxy luminosity function (UV LF) inferred from the Hubble Space Telescope. Our analysis severely disfavors a cosmological explanation for the JWST abundance problem."

"Frequency–Redshift Relation of the Cosmic Microwave Background" R. Hofmann and J. Meinert, Astronomy **2** no. 4, pp. 286–299 (Nov. 2023) doi: 10.3390/astronomy2040019 "We point out that a modified temperature-redshift relation (T-z relation) of the cosmic microwave background (CMB) cannot be deduced by any observational method that appeals to an a priori thermalisation to the CMB temperature T of the excited states in a probe environment of independently determined redshift z"

It is often argued (by Big Bang cosmologists) that the "observed" increase of the CMB temperature vs redshift shows that the universe is expanding. However, it is clear to anybody who reads the papers that the analysis depends on the assumption of a CMB temperature increasing as $(1+z)T_0$. *See e.g. the circular argument presented by Klimenko and Ivanchik https://doi.org/10.1088/1742-6596/1697/1/012013 who write "Other parameters of the fit were fixed to* $T_{CMB} = 11.6$ *K", and then "We estimate the CMB temperature to 14.2 K at* $z = 3.287$*, that is in agreement with the expected* $T_{CMB}(z_{abs})$*".*

"The many tensions with dark-matter based models and implications on the nature of the Universe" P. Kroupa *et al.* arXiv:2309.11552 [Submitted on 20 Sep 2023] "Fundamental tensions between observations and dark-matter based cosmological models have emerged in view of the profusion of thin disk galaxies, the pronounced symmetrical structure of the Local Group of Galaxies, the common occurrence of planes of satellite systems, the El Gordo and Bullet galaxy clusters, significant matter inhomogeneities on scales much larger than 100 Mpc, and the observed rapid formation of galaxies and super-massive black holes at redshifts larger than 7."

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.

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[2] When the thesis is supported by empirical evidence.
[3] ACG currently has 34 followers and many more participating to acg\Discussions.