The Milky Way Panorama Credit: ESO / S. Brunier

Newsletter of *A Cosmology Group* - June 2023

In memory of Hilton Ratcliffe 1949-2023

ACG Editorials

$\mathcal{ACG}$ now has a new website at cosmology.info on GitHub.com. The mailing list cosmology@gaggle.email is unchanged, but the *ACG discussion forum* is now public on acg\Discussions. To post on the forum **and receive email notifications**, users can sign up for a free account on *GitHub.com*. A GitHub account will also let users edit the website (subject to 'Guidelines' and guidance by the repository's 'admins').

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

Louis Marmet, June 29, 2023
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Reviewed Publications[1]

- Redshift, Hubble parameter, Expansion

"The Hubble Constant: A Historical Review" R. Brent Tully, arXiv:2305.11950 (2023-5-19) "For 100 years since galaxies were found to be flying apart from each other, astronomers have been trying to determine how fast. The expansion, characterized by the Hubble constant, H_0, is confused locally by peculiar velocities caused by gravitational interactions, so observers must obtain accurate distances at significant redshifts. Best values of H_0 from the distance ladder lie in the range $73-75$ km/s/Mpc. On the other hand, from detailed information available from the power spectrum of fluctuations in the cosmic microwave background... there is the precise prediction that $H_0 = 67.4$ to 1%. If it is conclusively determined that the Hubble constant is well above 70 km/s/Mpc as indicated by distance ladder results then the current preferred ΛCDM cosmological model based on the Standard Model of particle physics may be incomplete."

"Testing the Cosmological Principle: On the Time Dilation of Distant Sources" O.T. Oayda, G.F. Lewis, accepted for publication in MNRAS, arXiv:2305.06771 (2023-5-11) "We present a novel test of the cosmological principle ... a fundamental assumption in modern cosmology, underpinning the use of the Friedmann-Lemaître-Robertson-Walker metric as part of the concordance ΛCDM paradigm. However, the observed dipole imprinted on the Cosmic Microwave Background (CMB) is interpreted as our departure from the Hubble flow, and such a proper motion will induce a directionally-dependent time dilation over the sky. We illustrate the feasibility of detection of this 'time dilation dipole' and sketch the practical steps involved in its extraction from a catalogue of sources with intrinsic time-scales." "... more recently there has been a claimed tension between the magnitude and direction of cosmic dipoles when compared to the CMB. Insofar that this evinces disagreement between the standard of rest defined by the CMB and other sources of cosmological origin, some have proposed that the tension represents a challenge to the cosmological principle and hence the foundations of modern relativistic cosmologies."

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

- Galaxy and Large-Scale Structure Formation

"Detection of stellar light from quasar host galaxies at redshifts above 6" X. Ding, M. Onoue, J.D. Silverman *et al.* Nature doi: 10.1038/s41586-023-06345-5 and arXiv:2211.14329 (2023-6-28)
See also "Starlight and the first black holes: researchers detect the host galaxies of quasars in the early universe" www.eurekalert.org/news-releases/993930

"The detection of starlight from the host galaxies of quasars during the reionization epoch ($z > 6$) has been elusive, even with deep HST observations. ... we report rest-frame optical images and spectroscopy of two HSC-SSP quasars at $z > 6$ with JWST. ... we find that the host galaxies are massive (stellar masses of 13× and 3.4×10^{10} $M_\odot$, respectively), compact, and disk-like. NIRSpec medium-resolution spectroscopy shows stellar absorption lines in the more massive quasar, confirming the detection of the host. 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."

Inspiraling streams of enriched gas observed around a massive galaxy 11 billion years ago S. Zhang *et al.* arXiv:2305.02344 Science, 5 May 2023 (accepted version) doi: 10.1126/science.abj9192 (2023-5-3) "Stars form in galaxies, from gas that has been accreted from the intergalactic medium. Simulations have shown that recycling of gas – the re-accretion of gas that was previously ejected from a galaxy – could sustain star formation in the early Universe. We observe the gas surrounding a massive galaxy at redshift 2.3 and detect emission lines from neutral hydrogen, helium, and ionized carbon that extend 100 kiloparsecs from the galaxy. The kinematics of this circumgalactic gas is consistent with an inspiraling stream. The carbon abundance indicates that the gas had already been enriched with elements heavier than helium, previously ejected from a galaxy. We interpret the results as evidence of gas recycling during high-redshift galaxy assembly."

In the Big Bang paradigm, a galaxy has at most 2.8 billion years to form, produce carbon, and eject the gas that would be recycled by this galaxy. Thats not much time considering that no merger is mentioned, and the simulations use a 'spiral galaxy'.

"Watersheds of the Universe: Laniakea and five newcomers in the neighborhood" A. Dupuy, H.M. Courtois, submitted to A&A (AA/2023/46802) arXiv:2305.02339 (2023-5-3) "This article delivers the dynamical cosmography of the Local Universe within $z = 0.1$. Laniakea, our home supercluster's size is confirmed to be 2×10^6 (Mpc h^{-1})^3. Five more superclusters are now dynamically revealed in the same way: Apus, Hercules, Lepus, Perseus-Pisces and Shapley. Also, the central repellers of the Bootes and Sculptor voids are found and the Dipole and Cold Spot repellers now appear as a single gigantic entity. Interestingly the observed superclusters are an order of magnitude larger than the theoretical ones predicted by cosmological ΛCDM simulations."

"JWST Reveals a Population of Ultrared, Flattened Galaxies at $2 \leq z \leq 6$ Previously Missed by HST" E.J. Nelson *et al.* The Astrophysical Journal Letters **948** 2 L18 (2023-5-10) doi 10.3847/2041-8213/acc1e1 "It is well established that our census of galaxies as viewed by the Hubble Space Telescope (HST) in rest-frame optical wavelengths is incomplete. Measurements at infrared and submillimeter wavelengths reveal a population of dusty star-forming galaxies at $z \gtrsim 2$ that host such extreme starbursts that they are often entirely obscured by dust at ultraviolet and optical wavelengths" " These populations... dominate the total star formation rate budget of the universe at $z \lesssim 4$" "The discovery of these new objects at relatively late cosmic epochs—where we thought we had a reasonable census of the universe—highlights the incredible discovery space enabled by JWST."

"Solution of Problem Questions of Astronomy and Geology Using the Optimized Galactic Model" A.A. Barenbaum, In book: Physical and Mathematical Modeling of Earth and Environment Processes–2022 (2023-4) doi: 10.1007/978-3-031-25962-3_21 and www.researchgate.net/publication/370120897_Solution_of_Problem_Questions_of_Astronomy_and_Geology_Using_the_Optimized_Galactic_Model "On the basis of an optimized version of the galactic model, the problematic issues of the Galaxy spiral structure determining, as well as the geology problems associated with presence of various geochronological scales, which differ in age of boundaries. The galactic model establishes a close causal relationship between the cyclicity of global geological processes in Earth history with Sun's movement in Galaxy and bombardments of Solar System by galactic comets."

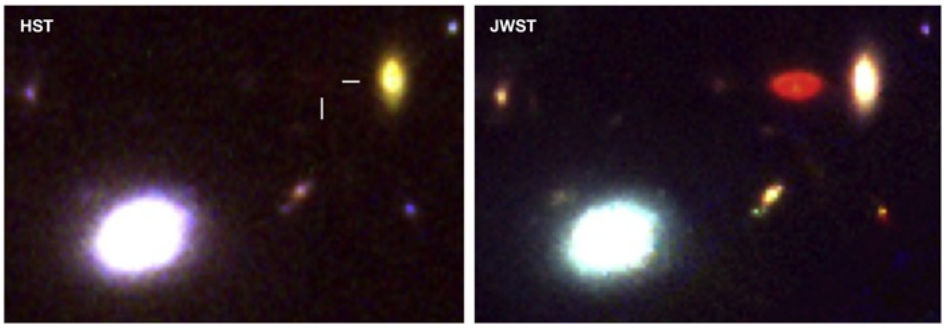

Figure 1: An example color image of one extended galaxy to demonstrate that while these objects are nearly or completely invisible in HST/WFC3 imaging (left: color composite of F606W, F125W, and F160W), these galaxies are extremely red and prominent in JWST/NIRCam imaging (right: color composite of F150W, F277W, and F444W). (Adapted from Fig. 1 in Nelson *et al.*)

- Cosmology

"Life beyond 30: Probing the $-20 <$ MUV < -17 Luminosity Function at $8 < z < 13$ with the NIRCam Parallel Field of the MIRI Deep Survey" Pablo G. Pérez-González *et al.* ApJL **951** L1 doi:10.3847/2041-8213/acd9d0 (2023-6-27)
See also "The James Webb telescope detects much more light than expected coming from the primeval universe"

"We present the ultraviolet luminosity function and an estimate of the cosmic star formation rate density at $8 < z < 13$ derived from deep NIRCam observations taken in parallel with the MIRI Deep Survey of the Hubble Ultra Deep Field (HUDF), NIRCam covering the parallel field 2. Our deep NIRCam observations reach an F277W magnitude of 30.8 (5σ), more than 2 mag deeper than JWST public data sets already analyzed to find high-redshift galaxies... Comparing our results with the predictions of state-of-the-art galaxy evolution models, we find two main results: (1) a slower increase with time in the cosmic star formation rate density compared to a steeper rise predicted by models; (2) nearly a factor of 10 higher star formation activity concentrated in scales around 2 kpc in galaxies with stellar masses $\sim 10^8$ $M_\odot$ during the first 350 Myr of the universe, $z \sim 12$, with models matching better the luminosity density observational estimations ~ 150 Myr later, by $z \sim 9$."

"Spatially Resolved Properties of Galaxies at $5 < z < 9$ in the SMACS 0723 JWST ERO Field" C. Giménez-Arteaga, ApJ **948** 126 doi:10.3847/1538-4357/acc5ea (2023-5-16) "We present the first spatially resolved measurements of galaxy properties in the JWST ERO SMACS 0723 field. We perform a comprehensive analysis of five $5 < z < 9$ galaxies with spectroscopic redshifts from NIRSpec observations. ... This approach allows us to study the internal structure and assembly of the first generations of galaxies. We find regions of considerably different specific star formation rates across each galaxy, which points to very bursty star formation happening on small scales, not galaxy-wide. ... Studying these galaxies in an integrated approach yields extremely young inferred ages of the stellar population (< 10 Myr), which outshine older stellar populations that are only distinguishable in the spatially resolved maps. This leads to inferring $\sim 0.5 - 1$ dex lower stellar masses by using single-aperture photometry, when compared to resolved analyses. Such systematics would have strong implications in the shape and evolution of the stellar mass function at these early times, particularly while samples are limited to small numbers of the brightest candidates. [T]he evolved stellar populations... imply an extended process of early galaxy formation that could otherwise be hidden behind the light of the most recently formed stars."

"One matter density discrepancy to alleviate them all or further trouble for ΛCDM model" Z. Sakr, arXiv:2305.02846 (2023-5-4) "We investigate whether the two cosmological discrepancies on the Hubble constant (H_0) and the matter fluctuation parameter (σ_8) could be traded by only one on the present value of the matter density (Ω_M). We combined different probes in an agnostic approach by, either relaxing the calibration parameters in each probe in order to be set by the data, or by only including priors with the condition that they are obtained independently from the discrepant parameters... We found when combining, as our baseline, galaxy clusters counts

+ cluster baryon fraction probe + cosmic chronometers + direct Ω_M + priors from BBN and CMB, that both parameters, H_0 and σ_8, are consistent with those inferred with local probes...
However discrepancies appeared when we combined SN in addition to CC suggesting either inconsistencies between the SN sample and the other probes used or a serious challenge to our hypothesis. We conclude that, either reconciling both tensions requires local inferred values of matter density at odd with those obtained by CMB, reviving by then an overlooked discrepancy, or simply that further evidences are indicating that the ΛCDM model is facing more difficulties to accommodate simultaneously all the current available observations."

More epicycles needed...

"Cosmological implications of the anisotropy of ten galaxy cluster scaling relations" K. Migkas *et al.* A&A **649** A151 (2021-5) doi: 10.1051/0004-6361/202140296 "The hypothesis that the late Universe is isotropic and homogeneous is adopted by most cosmological studies, including studies of galaxy clusters. The cosmic expansion rate H_0 is thought to be spatially constant, while bulk flows are often presumed to be negligible compared to the Hubble expansion, even at local scales. The effects of bulk flows on the redshift–distance conversion are hence usually ignored. Any deviation from this consensus can strongly bias the results of such studies, and thus the importance of testing these assumptions cannot be understated. Scaling relations of galaxy clusters can be effectively used for this testing.

In this work, we make use of up to 570 clusters with measured properties at X-ray, microwave, and infrared wavelengths to construct ten different cluster scaling relations and test the isotropy of the local Universe; to our knowedge, we present five of these scaling relations for the first time. Through rigorous and robust tests, we ensure that our analysis is not prone to generally known systematic biases and X-ray absorption issues. By combining all available information, we detect an apparent 9% spatial variation in the local H_0 between $(l, b) \sim (280^o, 15^o)$ and the rest of the sky. ...we assess the statistical significance of the anisotropy to be $> 5\sigma$."

"Modified Newtonian Dynamics (MOND): Observational Phenomenology and Relativistic Extensions" B. Famaey, S.S. McGaugh, Living Rev. Relativ. 15, 10 (2012-9-7). doi: 10.12942/lrr-2012-10 "A wealth of astronomical data indicate the presence of mass discrepancies in the Universe. The motions observed in a variety of classes of extragalactic systems exceed what can be explained by the mass visible in stars and gas. Either (i) there is a vast amount of unseen mass in some novel form – dark matter – or (ii) the data indicate a breakdown of our understanding of dynamics on the relevant scales, or (iii) both."

In the paper, §4 – Some Challenges for the ΛCDM Model is rather interesting. In 2012 this was presented as a "mass discrepancy", but McGaugh now explains it as an "acceleration discrepancy". The next step beyond MOND is to recognize the "velocity discrepancy" that arises from the interpretation of redshift as velocity...

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 following 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.

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