The Milky Way Panorama Credit: ESO / S. Brunier

Newsletter of ***A Cosmology Group*** - May 2020

ACG Editorial

The APS April Virtual Meeting was free to attend, but no amazing revelation was made. It was interesting to hear James Peebles talk about "Exploring the Universe" and express his distaste for the name *Big Bang*. There were many talks on the failure to detect any dark matter particles and the dipole moment of the electron/neutron/etc., meaning there is still no explanation for the dark force nor why matter/anti-matter are not found in equal amounts.

In a talk titled "Fitting the Coupling Between Dark Energy and Dark Matter as Fields", I was impressed by how much can be calculated about things we know nothing about.[1] A session called "Unconventional ideas in Astrophysics and Cosmology" had nothing interesting. I was surprised that such a topic was tolerated at the APS conference... but then this is no worse than hypothesizing a coupling between unknown dark entities.

Of greater interest were the talks about precision measurements. "Precision Astronomical Spectroscopy with Laser Frequency Combs" by Scott Diddams described the high precision spectroscopic measurements needed to measure the *redshift drift*. The major problem is not the lack of an accurate spectral reference, it is that spectral lines emitted by stars are very broad which make it difficult to measure Doppler shifts to a few cm/s. It will take decades before we can measure directly that there is no expansion of the universe.

There were some changes made to the ACG website. The site now has two main pages: cosmology.info links to technical observational information and a.cosmology.info is for readers who have a more general interest in cosmology. In addition, a token contribution to ACG is now required to post on some mailing lists. The contributions will be used toward the expenses of maintaining the website and hosting the forums.

In this Newsletter: no overdensity near quasars, unexplained long magnetic filaments, a cold and stable galaxy 1.5 Gy after the Big Bang, and the cause of reionization remains unknown. If contemporary cosmology was based on a steady state model, none of these papers would appear in this newsletter...

Louis Marmet, May 31, 2020
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ACG - Leading Science into a New Cosmological Paradigm

Reviewed Publications[2]

- Large-Scale Structure

"No excess of bright galaxies around the redshift 7.1 quasar ULAS J1120+0641"
C. Simpson, D. Mortlock, S. Warren *et al.*, MNRAS 442, 4, p. 3454, 21 August 2014
doi: 10.1093/mnras/stu1116

We present optical and near-infrared imaging of the field of the $z = 7.0842$ quasar ULAS J112001.48+064124.3 taken with the Hubble Space Telescope. We use these data to search for galaxies that may be physically associated

[1] This was like Bill Murray explaining how the proton pack works on ecto-plasm ghosts.
[2] Quoted text is adapted from the original articles: underlined text is my emphasis, *italicized text are my comments.*

with the quasar, using the Lyman break technique, and find three such objects, although the detection of one in Spitzer Space Telescope imaging strongly suggests it lies at $z \sim 2$.

The detection of only three candidate $z \sim 7$ galaxies in our field is surprising, given that we detected the same number in the smaller (by a factor of 2.3) HUDF after making the data comparable in depth. Clearly, there is no evidence for an overdensity of galaxies within 1 Mpc of the quasar, as might be expected if it is a signpost to a highly overdense region of the early Universe.

This region of space does not seem to be overdense. Yet, a paper published a year later on the same system (see below) concludes that a black hole was growing in mass more than 100 times faster than the stellar bulge, relative to the mass ratio measured in the local universe.
There are inconsistencies about galactic counts near a quasar.

"**Collimated synchrotron threads linking the radio lobes of ESO 137-006**"
M. Ramatsoku, M. Murgia, V. Vacca *et al.*, A&A 636, L1, April 2020
doi: 10.1051/0004-6361/202037800 and arXiv:2004.03203

With these sensitive MeerKAT observations, new features have been revealed in the form of multiple collimated synchrotron threads connecting the lobes of the radio galaxy. It is worth noting that examples of filamentary structures associated with radio galaxies are well known in the literature. However, these filaments are usually observed inside the radio lobes. The collimated synchrotron threads detected in ESO 137-006 are different in that they are observed outside the main body of the radio galaxy and connecting (at least in projection) the two radio lobes. ... the filament ... could be a relic jet from a past epoch of activity, [but] this interpretation does not hold for ESO 137-006 where we observe multiple close-by threads formed at the same time (as suggested by their similar spectral-index distributions).

"The filaments in ESO 137-006 are telling us about exceptionally strong magnetic fields at play in these radio lobes, it is amazing that these features can be maintained [over vast distances and times] without being broken up by the passage of other galaxies in the cluster" *explains Gregory Taylor (University of New Mexico). It seems there is a big problem in the model here.*

"**Detection of anisotropic galaxy assembly bias in BOSS DR12**"
Andrej Obuljen, Will J. Percival, Neal Dalal, arXiv:2004.07240, April 2020
arXiv:2004.07240

We present evidence of anisotropic galaxy assembly bias in the Baryon Oscillation Spectroscopic Survey Data Release 12 galaxy sample at a level exceeding 5σ. Galaxy samples selected using additional properties exhibit strongly varying degrees of anisotropic assembly bias, depending on which combination of properties is used to split into subsets. This may explain why previous searches for this effect using the Fundamental Plane found inconsistent results. We conclude that any selection of a galaxy sample that depends on σ_* can give biased and incorrect Redshift Space Distortion measurements. The different dependence of the quadrupole on R_0 and σ_* is somewhat surprising...

It seems we still have a lot to learn about measuring galaxy distribution.

- Old Systems

"**A cold, massive, rotating disk galaxy 1.5 billion years after the Big Bang**"
M. Neeleman, J. Xavier Prochaska, N. Kanekar, M. Rafelski, Nature 581, p. 269, May 2020
doi: 10.1038/s41586-020-2276-y and arXiv:2005.09661

Massive disk galaxies like the Milky Way are expected to form at late times in traditional models of galaxy formation, but recent numerical simulations suggest that such galaxies could form as early as a billion years after the Big Bang through the accretion of cold material and mergers. Observationally, it has been difficult to identify disk galaxies in emission at high redshift in order to discern between competing models of galaxy formation. Here we report imaging, with a resolution of about 1.3 kiloparsecs, of the 158-micrometre emission line from singly ionized carbon, the far-infrared dust continuum and the near-ultraviolet continuum emission from a galaxy at a redshift of 4.2603, identified by detecting its absorption of quasar light.

These observations show that the emission arises from gas inside a cold, dusty, rotating disk with a rotational velocity of about 272 kilometres per second. The existence of such a massive, rotationally supported, cold disk galaxy when the Universe was only 1.5 billion years old favours formation through either cold-mode accretion or mergers, although its large rotational velocity and large content of cold gas remain challenging to reproduce with most numerical simulations.

"There is still much debate surrounding the exact pathways by which gas accretion and its assembly into stars occurs, and how it relates to the formation of physical and dynamical structures in galaxies over time" (Alfred Tiley, in the same issue of Nature 581, p. 267, May 2020)

"**The spectral energy distribution of the redshift 7.1 quasar ULAS J1120+0641**"
R. Barnett, S.J. Warren, M. Banerji *et al.*, A&A 575, A31, March 2015
doi: 10.1051/0004-6361/201425153 and arXiv:1411.5551

We present new observations of the highest-redshift quasar known, ULAS J1120+0641, redshift $z = 7.084$, obtained in the optical, at near-, mid-, and far-infrared wavelengths, and in the sub-mm.
This is excellent work. What is puzzling is the unrealistic conclusion needed to fit the observations. They write:
We find that, at the time observed, the black hole was growing in mass more than 100 times faster than the stellar bulge, relative to the mass ratio measured in the local universe.

"**The ALPINE-ALMA [CII] survey - Survey strategy, observations and sample properties of 118 star-forming galaxies at** $4 < z < 6$"
O. Le Fèvre, M. Béthermin, A. Faisst *et al.*, submitted to A&A, 2019
arXiv:1910.09517

The ALMA-ALPINE [CII] survey aims at characterizing the properties of a sample of normal star-forming galaxies. ALPINE, the ALMA Large Program to INvestigate 118 galaxies observed in the [CII]-158μm line and far Infrared continuum emission in the period of rapid mass assembly, right after HI reionization ended, at redshifts $4 < z < 6$.

We find a surprisingly wide range of galaxy types. This diversity indicates that a wide array of physical processes must be at work at this epoch, first and foremost galaxy merging.

"We are finding nicely ordered rotating galaxies at this very early and quite turbulent stage of our universe,... How do galaxies grow so much so fast? What are the internal processes that let them grow so quickly?" *says Faisst*. *An observation that is very difficult to explain.*

"**A giant galaxy in the young Universe with a massive ring**"
T. Yuan, A. Elagali, I. Labbe *et al.*, Nature Astronomy 25 May 2020
doi: 10.1038/s41550-020-1102-7 and arXiv:2005.11880

In the local (redshift $z \sim 0$) Universe, collisional ring galaxies make up only $\sim 0.01\%$ of galaxies and are formed by head-on galactic collisions that trigger radially propagating density waves. These striking systems provide key snapshots for dissecting galactic disks and are studied extensively in the local Universe. However, not much is known about distant ($z > 0.1$) collisional rings. Here we present a detailed study of a ring galaxy at a look-back time of 10.8 Gyr ($z = 2.19$). Compared with our Milky Way, this galaxy has a similar stellar mass, but has a stellar half-light radius that is $1.5 - 2.2$ times larger and is forming stars 50 times faster. The large, diffuse stellar light outside the star-forming ring, combined with a radial velocity on the ring and an intruder galaxy nearby, provides evidence for this galaxy hosting a collisional ring. If the ring is secularly evolved, the implied large bar in a giant disk would be inconsistent with the current understanding of the earliest formation of barred spirals. Using a scaling relation of $(1 + z)^{4.5}$ from a previous study, Collisional Ring Galaxies are expected to be ~ 140

times more common at $z \approx 2$. Contrary to previous predictions, this work suggests that massive collisional rings were as rare 11 Gyr ago as they are today.

A scaling relation of $(1+z)^{4.5}$ *is even more strongly dependent on* z *than galactic evolution (from the Tolman test). It is difficult to trust the validity of such a large dependence, and the conclusion of this work supports that.*

"**Rapid Reionization by the Oligarchs: The Case for Massive, UV-bright, Star-forming Galaxies with High Escape Fractions**"
R.P. Naidu, S. Tacchella, C.A. Mason *et al.*, The Astrophysical Journal 892, Number 2, April 2020
doi: 10.3847/1538-4357/ab7cc9 and arXiv:1907.13130

The protagonists of the last great phase transition of the universe - cosmic reionization - remain elusive.

That says it all, we have no consistent mechanism that explains reionization.

- Cosmology

"**Four direct measurements of the fine-structure constant 13 billion years ago**"
M.R. Wilczynska, J.K. Webb, M. Bainbridge *et al.*, Science Advances 6, no. 17, eaay9672, 24 Apr 2020
doi: 10.1126/sciadv.aay9672

Observations of the redshift $z = 7.085$ quasar J1120+0641 *(a popular quasar!)* are used to search for variations of the fine structure constant, α, over the redshift range 5.5 to 7.1. These are the most distant direct measurements of *alpha* to date and the first measurements using a near-IR spectrograph. Four measurements from the x-shooter spectrograph on the Very Large Telescope constrain changes in a relative to the terrestrial value (α_0). The weighted mean electromagnetic force in this location in the universe deviates from the terrestrial value by $(\alpha_z - \alpha_0)/\alpha_0 = (2.18 \pm 7.27) \times 10^{-5}$, consistent with no temporal change. Combining these measurements with existing data, we find a spatial variation is preferred over a no-variation model at the 3.9σ level.

An interesting measurement, but that's barely better than the measurement in 2005 which showed a relative variation of α *of less than* 3.3×10^{-5}. *As for the spatial variation, it's probably just as wrong as the measurement they refer to in the paper, Ref. (44). This idea that the fundamental constants would change dates back to Dirac's numerology argument (known as "Dirac's large number hypothesis") but has no basis whatsoever in observations. Laboratory measurements give a change* $\dot{\alpha}/\alpha < 1 \times 10^{-17}$*/year.*

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 a Big Bang cosmology. The *ACG Newsletter* highlights observational results that are anomalous in terms of the ΛCDM model and provides a critical examination[3] of the methods and investigations used in cosmology.

The *Newsletter* is published irregularly, editor's schedule permitting, and when interesting papers are available. ACG subscribers[4] receive notifications of *Newsletter* publications. You can subscribe to *ACG* by sending a request to `redshift@cosmology.info`.

If you would like to suggest a paper for review, please send a direct reference to `redshift@cosmology.info`. Published work in a refereed journal and with open access (e.g. a preprint on `arXiv` or `HAL`) is preferred. Current topics and research in cosmology will be presented at the next ACG Conference.

[3]When the thesis is supported by empirical evidence.
[4]ACG currently counts 94 members.