The Milky Way Panorama Credit: ESO / S. Brunier

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

ACG Editorial

Here is something uplifting and inspiring to start off your day:

Observations keep chipping away at the Big Bang theory*!*

Sadly, Margaret Burbidge, one of the greatest astronomers of the 20^{th} century, won't be with us to witness the next cosmology revolution. Stay healthy, you don't want to miss what's coming next*!*

In this Newsletter: limitations on reconstructing dark matter distribution, mysterious coherence over several megaparsec, string theory takes a beating, more 'non-detection' of dark matter, and cosmic discordance: ΛCDM needs to be replaced by a drastically different model.

Louis Marmet, April 9, 2020
redshift@cosmology.info

What about this slogan?
ACG - Leading Science into a New Cosmological Paradigm

Reviewed Publications[1]

- Large-Scale Structure

"Systematics in lensing reconstruction: dark matter rings in the sky?"
P.P. Ponente, J.M. Diego, A&A 535, A119, November 2011
doi: 10.1051/0004-6361/201117382 and arXiv:1110.3979

Non-parametric lensing methods are a useful way of reconstructing the lensing mass of a cluster without making assumptions about the way the mass is distributed in the cluster. These methods are particularly powerful in the case of galaxy clusters with a large number of constraints. On the other hand, non-parametric methods have several limitations that should be taken into account carefully.

We explore the space of the solutions of the convergence map and compare the radial density profiles to the density profile of mock clusters. When the inversion matrix algorithms are forced to find the exact solution, we encounter systematic effects resembling ring structures, that clearly depart from the original convergence map.

Caution is prescribed: dark matter can appear out of improper analysis.

"Mysterious Coherence in Several-megaparsec Scales between Galaxy Rotation and Neighbor Motion"
Joon Hyeop Lee *et al.*, ApJ 884, 104, 2019
doi: 10.3847/1538-4357/ab3fa3 and arXiv:1908.10972

[1]Quoted text is adapted from the original articles: underlined text is my emphasis, *italicized text are my comments.*

We show unexpectedly strong evidence of the dynamical coherence between the rotation of the CALIFA galaxies and the average line-of-sight motion of their neighbors within several Mpc distances. From this result, a simple but hard question is propounded. How can the dynamical coherence be established over such large scales? Undoubtedly, direct interactions are impossible between galaxies separated by several *(*~ 6*)* Mpc. Then what caused this mysterious coherence in large scales?

One possible scenario for the large-scale dynamical coherence is as follows: A large-scale structure may have its own motion. The motion is different from the streaming motions of galaxies within the structure, but it indicates an extremely slow displacement of the structure itself. For example, imagine a large-scale filament or sheet with non-translational motion (different parts of the structure move at different speeds; differential motion). If such a motion influences the individual angular momenta of the galaxies in the structure, then the large-scale dynamical coherence signals can manifest as discovered in this paper.

Unfortunately we do not have sufficient evidence supporting this scenario now, but we continue our speculation based on it.

That doesn't explain what causes the coherence in the "differential motion and how it influences individual angular momenta of the galaxies..." Could the 'large scale filament' they mention be a plasma current? Could rotational coherence be established with plasma currents, given a sufficiently long time ($\gg 100$ *Gy)?*

"**The dark matter interpretation of the 3.5-keV line is inconsistent with blank-sky observations**"
C. Dessert, N.L. Rodd, B.R. Safdi, Science 367, 6485, p. 1465, 2020
doi: 10.1126/science.aaw3772

X-ray data constrain dark matter decay: Dark matter may consist of previously unknown forms of subatomic particles. An unidentified astronomical x-ray emission line has been interpreted as being caused by the decay of a dark matter particle. If this is correct, then dark matter in the halo of the Milky Way Galaxy should produce a faint emission line across the whole sky. Dessert et al. tested this hypothesis using observations by the XMM-Newton (X-ray Multi-Mirror Mission) space telescope. Analyzing blank-sky regions with a total exposure time of about a year, they found no evidence for the predicted line and set upper limits on the decay rate that rule out the previously proposed dark matter interpretation.

"**Astrophysical Limits on Very Light Axion-like Particles from Chandra Grating Spectroscopy of NGC 1275**"
C.S. Reynolds, M.C.D. Marsh, H.R. Russell *et al.*, The Astrophysical Journal 890, Number 1, 59, 2020
doi: 10.3847/1538-4357/ab6a0c and arXiv:1907.05475

Some scientists think that axions could explain the mystery of dark matter, which accounts for the vast majority of matter in the universe. These as-yet-undetected particles should have extraordinarily low masses. Scientists do not know the precise mass range, but many theories feature axion masses ranging from about a millionth of the mass of an electron down to zero mass.

By searching through galaxy clusters, the largest structures in the universe held together by gravity, astronomers using NASA's Chandra X-ray Observatory were able to hunt for a specific particle that many models of string theory predict should exist. While the resulting non-detection does not rule out string theory altogether, it does deliver a blow to certain models within that family of ideas.

See chandra.harvard.edu/press/20_releases/press_031920.html. Another failed attempt at detecting dark matter.

And since we're there, another null result...

"**Extended Search for the Invisible Axion with the Axion Dark Matter Experiment**"
T. Braine, R. Cervantes *et al.* (ADMX Collaboration), Phys. Rev. Lett. 124, 101303, 2020
doi: 10.1103/PhysRevLett.124.101303 and arXiv:1910.08638

This paper reports on a cavity haloscope search for dark matter axions in the galactic halo in the mass range

2.81 − 3.31 μeV. This search excludes the full range of axion-photon coupling values predicted in benchmark models of the invisible axion that solve the strong CP problem of quantum chromodynamics,

In other words: "A new search for axion dark matter rules out past numerical predictions"
m.phys.org/news/2020-03-axiom-dark-numerical.html

"Searching for Space Vampires with TEvSS"
Maximilian N. Gnther, David A. Berardo, arXiv:2003.14345 for 1 April 2020
arXiv:2003.14345

This paper was about 'dark matter', but 'Space Vampires' is equivalent.
We showcase our search for transit signatures of tidally locked space vampires, trapped in the gravitational pull of late M-dwarfs. We search lightcurves from the Transiting Exo-Vampire Survey Satellite (TEvSS) using a template matching algorithm and fit them using our *allesfitter* software. Adding the information gained from TEvSS data, we constrain $\eta_{spacevampire}$ to a range of 0% to 100% (or more).

- Old Systems

"The first blazar observed at $z > 6$"
S. Belladitta, A. Moretti, A. Caccianiga *et al.*, A&A 635, L7, March 2020
doi: 10.1051/0004-6361/201937395 and arXiv:2002.05178

Assuming that this is the only blazar at this redshift, we can infer the first unbiased (not affected by obscuration effects) measurement of the space density of RL AGNs at $z \sim 6$, including the contribution of dust reddened and obscured (Type 2) sources.

PSO J0309+27 was selected in an area of $\sim 21000\,\mathrm{deg}^2$ corresponding to a comoving volume between redshift 5.5 and 6.5 of $359\,\mathrm{Gpc}^3$. This value should be considered a lower limit as our spectroscopic follow-up is still ongoing. This estimate agrees with the predictions based on the cosmological evolution presented by Mao et al.

This is however based on the simplifying assumption that there is only one blazar at this redshift, but once others are discovered, the agreement will no longer exist.
"Thanks to our discovery, we are able to say that in the first billion years of life of the Universe, there existed a large number of very massive black holes emitting powerful relativistic jets, {*towards Earth*}" Belladitta says.
https://www.sciencealert.com/scientists-find-incredibly-ancient-blazar-aiming-its-particle-beam-directly-at-earth

- Cosmology

"Cosmic Discordance: Planck and luminosity distance data exclude LCDM"
E. Di Valentino, A. Melchiorri, J. Silk, A&A 635, L7, March 2020
arXiv:2003.04935

We show that a combined analysis of CMB anisotropy power spectra obtained by the Planck satellite and luminosity distance data simultaneously excludes a flat universe and a cosmological constant at 99% C.L. These results hold separately when combining Planck with three different datasets: the two determinations of the Hubble constant from Riess et al. 2019 and Freedman et al. 2020, and the Pantheon catalog of high redshift supernovae type-Ia.

We conclude that either LCDM needs to be replaced by a drastically different model, or else there are significant but still undetected systematics. Our result calls for new observations and stimulates the investigation of alternative theoretical models and solutions.

“**Inhomogeneity effects in cosmology**”
G.F.R. Ellis, Classical and Quantum Gravity 28, 16, 164001, 2011
doi: 10.1088/0264-9381/28/16/164001 and arXiv:1103.2335

This article looks at how inhomogeneous spacetime models may be significant for cosmology. First it looks at how the averaging process may affect large scale dynamics, with backreaction effects leading to effective contributions to the averaged energy-momentum tensor. Secondly it considers how local inhomogeneities may affect cosmological observations in cosmology, possibly significantly affecting the concordance model parameters. Thirdly it presents the possibility that the universe is spatially inhomogeneous on Hubble scales, with a violation of the Copernican principle leading to an apparent acceleration of the universe. This could perhaps even remove the need for the postulate of dark energy.

“**Probing cosmic isotropy with a new X-ray galaxy cluster sample through the LXT scaling relation**”
K. Migkas, G. Schellenberger, T.H. Reiprich *et al.*, A&A 636, A15, April 2020
doi: 10.1051/0004-6361/201936602

The significance of cosmic isotropy for the standard cosmological paradigm is undisputed. Designing scrutinizing methods to test this hypothesis is vital since much new information about the Universe can be revealed through such tests.

One can assume that the isotropic expansion of the Universe holds, but a cosmological probe could still consistently show a significantly anisotropic behavior. This could result in the identification of yet unknown factors with a surprisingly strong impact on the data collection, analysis, or both. Since these factors are not accounted for in previous studies using similar wavelengths (e.g., X-rays) or the same astrophysical objects, these biases could in principle extrapolate to many aspects of relative research fields.

It's interesting that the conclusion was toned down (probably as a requirement for the paper to be accepted - it was submitted 2019 August 29.) The statement on the ESA website is a bit stronger:
Astronomers have assumed for decades that the Universe is expanding at the same rate in all directions. A new study based on data from ESAs XMM-Newton, NASAs Chandra and the German-led ROSAT X-ray observatories suggests this key premise of cosmology might be wrong. (http://www.esa.int/Science_Exploration/Space_Science/Rethinking_cosmology_Universe_expansion_may_not_be_uniform)

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[2] 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[3] 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. New cosmologies are listed on A Cosmology Model or can be presented at the next ACG Conference.

[2]When the thesis is supported by empirical evidence.
[3]ACG currently has 96 members, with 68 active on the discussion forum.