The Milky Way Panorama Credit: ESO / S. Brunier

Newsletter of *A Cosmology Group* - May 2019

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[1] 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[2] receive notifications of *Newsletter* publications. You can subscribe to *ACG Notifications* either by sending a request to redshift@cosmology.info, by joining the ACG Forum 'Alt Cosmology' on *Yahoo! Groups* at groups.yahoo.com/neo/groups/altcosmology/info#, or by following @CosmologyGroup on *Twitter*.

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. Summaries of new cosmologies are collected on A Cosmology Model or can be presented at the next ACG Conference.

ACG Editorial

This month: the Axis of Evil, self-annihilating dark matter, Fermi Bubbles, the solid angle subtended by an elephant standing in a room, and even better - dark photons!

Also, a debate which came to my attention: a philosopher stands up against ΛCDM; Bjørn Ekeberg, "*Cosmology Has Some Big Problems*," Scientific American Blogs 2019-4-30. A science journalist replies: Ethan Siegel, "*Cosmology's Only Big Problems Are Manufactured Misunderstandings*," Forbes 2019-5-7. Ekeberg's reply: "*Cosmology has no Problems of Conviction*," Dr. Bjørn Ekeberg Blog 2019-5-18. Siegel replies on Twitter @StartsWithABang 2018-5-18: "*You know how some make statements like "I'm not a scientist in your field, but <insert false statement that mischaracterizes the science of your field>," right? - Don't double-down here. - Try and learn more cosmology instead of digging deeper. - Put the shovel down.*"

Regards,

Louis Marmet, May 22, 2019
redshift@cosmology.info

Reviewed Publications[3]

- Microwave Background

"Room for New Physics in the Rayleigh-Jeans Tail of the Cosmic Microwave Background"
M. Pospelov *et al.*, Phys. Rev. Lett. 121, 031103, July 2018

[1] When the thesis is supported by empirical data.
[2] ACG has 49 subscribers to *ACG Notifications* and 70 followers on *Alt Cosmology Yahoo! Group* and *Twitter*.
[3] Quoted text is adapted from the original articles: underlined text is my emphasis, *italicized text are my comments.*

doi: 10.1103/PhysRevLett.121.031103, and arXiv:1803.07048

How an observation that is unexplained by ΛCDM becomes "New Physics". (See "Can Early Dark Energy Explain EDGES?" in arxiv:1803.07555 and the ACG Newsletter of Feb. 2019.)

We show that despite stringent constraints on the shape of the main part of the CMB spectrum, there is considerable room for its modifiation within its Rayleigh-Jeans (RJ) end, $\omega \ll T_{CMB}$. We construct explicit New Physics models that give an order one (or larger) increase of photon count in the RJ tail. This class of models stipulates the decay of unstable particles to dark photons that have a small mass, non-vanishing mixing angle with electromagnetism, and energies much smaller than T_{CMB}. *That's three additional ad-hoc hypotheses introduced simultaneously!* The non-thermal number density of dark photons can be many orders of magnitude above the number density of CMB photons, and even a small probability of oscillations, can significantly increase the number of RJ photons. We show that resonant oscillations of dark photons into regular photons can be invoked as an explanation of the recent tentative observation of a stronger-than-expected absorption signal of 21 cm photons.

"**Missing dust signature in the cosmic microwave background**"
V. Vavryčuk, Monthly Notices of the Royal Astronomical Society: Letters 470, Issue 1, Page L44, September 2017
doi: 10.1093/mnrasl/slx069, and arXiv:1706.04771

This is an earlier paper on the topic (See: https://doi.org/10.1093/mnras/sty974.) The maximum spectral distortion of the CMB light coming from z = 10 predicted at 300 GHz is at least 20 times higher than the detection level of the COBE/FIRAS measurements and at least 35 times higher than the detection level of the WMAP or Planck measurements.

Four papers showing the difficulty in obtaining a clean microwave map. The Axis of Evil *does not go away!*

"**Multipole vectors of completely random microwave skies for $l \leq 50$**"
M. Pinkwart, D.J. Schwarz, Phys. Rev. D 98, 083536, October 2018
doi: 10.1103/PhysRevD.98.083536, and arXiv:1803.07473

The purpose of this work was to study the complete randomness of the microwave sky by means of multipole vectors (MPV) in the hope of identifying deficits in our understanding or the data analysis of CMB full-sky maps. We observed numerically a correlation of the full-sky cleaned maps with the cosmic dipole on the largest angular scales $2 \leq l \leq 5$ and intermediate angular scales $l = 20, 21, 22, 23, 24$. Furthermore around $l = 40$ low likelihoods cluster and the multinomial p-value drops. These are the same multipole numbers which also deviate from the theoretical expectation in the angular power spectrum.

One main conclusion we draw is that the SEVEM map is still strongly correlated with the Galactic Center and especially the Galactic Pole in our analysis. One should especially focus on detailed studies of the dipole and reveal its true nature. Analyses of the radio sky with galaxy surveys hint towards an increased radio dipole amplitude, which could be caused by an intrinsic, nonkinematic CMB dipole.

"**The Microwave Thermal Emission from the Zodiacal Dust Cloud Predicted with Contemporary Meteoroid Models**"
V.V. Dikarev, D.J. Schwarz, Astronomy and Astrophysics 584, A9 2015
doi: 10.1051/0004-6361/201525690, and arXiv:1501.04780

Predictions of the microwave thermal emission from the interplanetary dust cloud are made using several contemporary meteoroid models to construct the distributions of cross-section area of dust in space, and estimating the temperatures and emissivities of dust particles. Three models of the interplanetary dust cloud are used in combination with the optical properties of olivine, carbonaceous and iron spherical particles. The Kelsall model has been widely accepted by the Cosmic Microwave Background (CMB) community.

We have found that the meteoroid engineering models depict the thermal emission substantially brighter and distributed differently across the sky and wavelengths than the Kelsall model does. Both the Divine model and IMEM confirm an earlier estimate of a $\sim 10\mu$K thermal emission from interplanetary dust for the WMAP observations, provided that the dominant particle composition is carbonaceous. At smaller solar elongations, interplanetary dust can be orders of magnitude brighter, naturally. More detailed search for and account of interplanetary dust are therefore worthwhile in the CMB experiment results.

"**Large-scale alignments from WMAP and Planck**"
C.J. Copi *et al.*, Monthly Notices of the Royal Astronomical Society 449, Issue 4, 3458, 2015
doi: 10.1093/mnras/stv501, and arXiv:1311.4562

The largest structures in the microwave sky, the quadrupole and octopole, are aligned with one another, with the dipole direction and the Ecliptic plane. These alignments, first observed and discussed in the 1-year WMAP data, have persisted throughout WMAP's subsequent data releases, and are now confirmed in the 1-year Planck data. This is surprising: cleaned, full-sky maps are required to see these alignments, and the removal of foregrounds and other systematic effects, makes it challenging to accurately produce full-sky maps on large angular scales.

While it may be tempting to explain away the observed large angle alignments in the CMB by postulating additional, unspecified corrections to the maps, such explanations so far have not been compelling. We think it is preferable to acknowledge that the existence of anomalies seen in the WMAP and Planck maps at large angular scales may point to residual contamination in the data or to interesting new fundamental physics.

"**Lack of large-angle TT correlations persists in WMAP and Planck**"
C.J. Copi *et al.*, Monthly Notices of the Royal Astronomical Society 451, Issue 3, p. 2978, 2015
doi: 10.1093/mnras/stv1143, and arXiv:1310.3831

The lack of large-angle correlations in the observed microwave background temperature fluctuations persists in the final-year maps from Wilkinson Microwave Anisotropy Probe (WMAP) and the first cosmological data release from Planck. A cut-sky analysis of the Planck HFI 100GHz frequency band, the 'cleanest CMB channel' of this instrument, returns a p-value as small as 0.03 percent. These findings are in stark contrast to expectations from the inflationary Lambda cold dark matter model and still lack a convincing explanation. If this lack of large-angle correlations is a true feature of our Universe, and not just a statistical fluke, then the cosmological dipole must be considerably smaller than that predicted in the best-fitting model.

- Large-Scale Structure

"**The First Direct Search for Inelastic Boosted Dark Matter with COSINE-100**"
C. Ha, G. Adhikari *et al.*, Phys. Rev. Lett. 122, 131802, 2019
doi: 10.1103/PhysRevLett.122.131802, and arXiv:1811.09344

A search for inelastic boosted dark matter (iBDM) using the COSINE-100 detector with 59.5 days of data is presented. This relativistic dark matter is theorized to interact with the target material through inelastic scattering with electrons, creating a heavier state that subsequently produces standard model particles, such as an electron-positron pair. No excess over the predicted background event rate is observed. Therefore, we present limits on iBDM interactions under various hypotheses, one of which allows us to explore an area of the dark photon parameter space *(dark photon?!)* that has not yet been covered by other experiments.
That's what you get for trying to measure a hypothesized particle based on an untested metaphysical hypothesis.

"**Energy equipartition between stellar and dark matter particles in cosmological simulations results in spurious growth of galaxy sizes**"
A.D. Ludlow, J. Schaye *et al.*, arXiv Astrophysics of Galaxies (astro-ph.GA) 2019
arXiv:1903.10110

Cosmological simulations of collisionless dark matter (DM) make reliable predictions for the innermost structure of DM haloes. *Really? That's a bold statement to make considering dark matter has never been detected directly!*

Such simulations incur relatively modest computational cost and have been repeated at ever increasing resolution, exposing the limits of their reliability. One possible issue is the importance of 2-body relaxation for the stellar component of simulated galaxies. Stars are treated as collisionless particles in cosmological simulations *(!?)* and, like DM, their dynamics must be subject to 2-body scattering. Galaxies formed in cosmological simulations, while calibrated to resemble observed systems, may evolve in a way that is subject to numerical artefact.
Their simulation shows galactic evolution with redshift, but depending on their assumptions about dark matter and on the type of simulation, the results disagree. Garbage-in, garbage-out...

"**Baryon Budget of the Hot Circumgalactic Medium of Massive Spiral Galaxies**"
J.-T. Li, J.N. Bregman *et al.*, The Astrophysical Journal Letters 855, Number 2, March 2018
doi: 10.3847/2041-8213/aab2af

The baryon content around local galaxies is observed to be much less than is needed in Big Bang nucleosynthesis. Simulations indicate that a significant fraction of these "missing baryons" may be stored in a hot tenuous medium around massive galaxies extending to or even beyond the virial radius of their dark matter halos. Here, we report stacking X-ray observations of six local isolated massive spiral galaxies. We conclude that the hot baryons within the virial radius of massive galaxy halos are insufficient to explain the "missing baryons."

"**Unveiling the Origin of the Fermi Bubbles**"
H.-Y.K. Yang, M. Ruszkowski, E.G. Zweibel, Galaxies 6(1), 29, 2018
doi: 10.3390/galaxies6010029, and arXiv:1802.03890

The Fermi bubbles, two giant structures above and below the Galactic center (GC), are among the most important discoveries of the Fermi Gamma-ray Space Telescope. Despite their importance, the formation mechanism of the bubbles is still elusive. The solid angle of the bubbles is about 1 sr, which is roughly that of an elephant standing in a room. There have been numerous efforts, both observational and theoretical, to uncover the nature of the bubbles. We present an overview of the current status of our understanding of the bubbles origin, and discuss possible future directions that will help to distinguish different scenarios of bubble formation.
This is indirectly related to ΛCDM, but if we don't even understand our own Milky Way, how can we expect to understand galactic evolution?

"**The Fermi Galactic Center GeV Excess and Implications for Dark Matter**"
M. Ackermann, M. Ajello *et al.*, (The Fermi LAT Collaboration), The Astrophysical Journal 840, Number 1, 2017
doi: 10.3847/1538-4357/aa6cab, and arXiv:1704.03910

The region around the Galactic Center (GC) is brighter at energies of a few GeV than what is expected from conventional models of diffuse gamma-ray emission and known gamma-ray sources. We study the GeV excess using data from the Fermi Large Area Telescope. The GC would be expected to have the brightest signal from annihilation of weakly interacting massive dark matter (DM) particles. However, control regions along the Galactic plane, where a DM signal is not expected, show excesses of similar amplitude relative to the local background. The spectrum and morphology of the excess are not obviously consistent with the expectations for DM annihilation, or at least suggest an underlying astrophysical component on top of a potential DM component.

"**Dark Matter Strikes Back at the Galactic Center**"
R.K. Leane, T.R. Slatyer, Report number: MIT-CTP/5104, arXiv:1904.08430 [astro-ph.HE], 2019
arXiv:1904.08430

Statistical evidence has previously suggested that the Galactic Center GeV Excess (GCE) originates largely from point sources, and not from annihilating dark matter. We examine the impact of unmodeled source populations on identifying the true origin of the GCE. We discover striking behavior consistent with a mismodeling effect in the real Fermi data, finding that large artificial injected dark matter signals are completely misattributed to point sources. Consequently, we conclude that dark matter may provide a dominant contribution to the GCE after all.