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Giant galactic outflows and shocks in the cosmic web

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Propositions

accompanying the dissertation

Giant galactic outflows and shocks in the Cosmic Web

by

Martijn Simon Soen Liong Oei

1. **Altar-ing history**

Edward Appleton, who won a Nobel Prize for his *‘investigations of the physics of the upper atmosphere’*, received substantial theoretical help from the young Wilhelm Altar in the years 11925–11926. Strikingly, during this time, Altar wrote a draft manuscript in which he derived the Appleton–Lassen equation years before Appleton would publish it — without mentioning Altar. The IAU should amend the official name of the Appleton–Lassen equation to include Altar’s. (*Introduction and Chapter 2*)

2. **Trouble from home**

The synchrotron Milky Way is a previously underappreciated foreground hampering observations of the synchrotron Cosmic Web — especially if the dominant particle acceleration mechanism in filaments is volume-filling. (*Chapter 3*)

3. **Future forecasts of the synchrotron Cosmic Web**

Predictions produced by combining Bayesian inference of the initial cosmic matter distribution with full-fledged cosmological simulations (i.e. including baryonic physics) are one half of the future of statistical searches for the synchrotron Cosmic Web. (*Chapter 3*)

4. **Gaia’s greater giants**

As galactic outflows grow, their radio surface brightness drops and they become harder to detect. The fact that Alcyoneus’ lobe surface brightness is close to current survey noise levels implies that even larger giants exist — or else this proximity would be a coincidence. As foreshadowed by his fight against Athena and Nike, portrayed on the Pergamon Altar’s Gigantomachy frieze, Alcyoneus’ struggle for supremacy over the Cosmos shall once again be in vain. (*Chapters 4 and 7*)

5. **A grand finale for all**

Giants are not generated through physical mechanisms distinct from those at play in their smaller kin, nor are they born in exceptional environments. Rather, they embody a standard end phase in the lives of galactic outflows with a range of jet powers. (*Chapter 7*)

6. **Cosmic magnetogenesis by active supermassive black holes**

Giants have the quantitatively correct instantaneous lobe volume-filling fraction, lobe

magnetic field strengths, and synchrotron radiative timescales for a scenario in which they had a leading role in astrophysical magnetogenesis — especially given the smaller volume of the younger Universe and buoyant motions of evolved lobes in the Cosmic Web. (*Chapters 6 and 8*)

7. **The ideal astronomer (a projection)**

An anonymous astronomer recently insisted that 4.99 should be rounded to 4.9 rather than to 5.0, illustrating the questionable level of mathematical literacy in astronomy. With more of astronomy turning into a precision science, astronomers must inevitably increase their mathematical fluency. Resistance to this trend, out of affection of a simpler past, hampers scientific progress.

8. ***Aster and artes: more than just anagrams***

The astronomer and the artist have a shared calling: to evoke wonder and offer perspectives that estrange and raise the human spirit from its at times petty and self-centered thoughts. We should take the spiritual dimension of astronomy serious. Disseminating high-quality visuals and using terminology that is clear to the public should be regarded a priority — and not an afterthought or nuisance — by astronomers and journals alike.

9. **The willingness to go green: a condition for habitability**

Our greatest enemy is the Second Law of Thermodynamics, and global heating is its most menacing Earthly accomplice. The astronomical community, for which adopting a cosmic, long-term perspective should come natural, must show bold leadership through rapid decarbonisation. As part of this process, starting next summer, all astronomical papers should contain the following lines on their title page: *‘The production of this paper led to an estimated X kg CO₂e of greenhouse gas emissions. Y% of these emissions have been offset by the authors, their host institutions, or this journal.’*

10. **Where are you, cosmopolitan?**

Deprovincialisation must start in primary school: along a survey of the Netherlands, Europe, and the Earth, topography lessons should cover the Solar System, the Milky Way, the Local Group, and the surrounding Cosmic Web.

11. ***Sic itur ad astra: physics education for wanderers***

The high-school physics curriculum needs a rebranding, and should be regrounded in astrophysics to directly speak to the young’s innate appeal to explore the old, the far, and the grand.

12. **J12000 coordinates**

Science is humanity’s main worldview-building enterprise. In comparison with the Anno Domini calendar, the Human Era calendar is a more obvious choice for a scientific calendar. Twelve-thousand years ago, it was *modest* not to adopt the Human Era calendar; today, it is *arrogant* not to.

Martijn S.S.L. Oei
Leiden, 12 December 12023