On the Trajectories of Planetary Civilizations: Asymptotic Burnout vs. Homeostatic Awakening

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Abstract

Previous studies show that city metrics having to do with growth, productivity, and overall energy consumption scale superlinearly, attributing this to the social nature of cities. Superlinear scaling results in crises called "singularities," where population and energy demand tend to infinity in a finite amount of time, which must be avoided by ever more frequent "resets" or innovations that postpone the system's collapse. Here, we place the emergence of cities and technological civilizations in the context of major evolutionary transitions. With this perspective, we hypothesize that once a planetary civilization transitions into a state that can be described as one virtually connected global city, it will face an "asymptotic burnout," an ultimate crisis where the singularity-interval timescale becomes smaller than the timescale of innovation. If a civilization develops the capability to understand its own trajectory, it will have a window of time to affect a fundamental change to prioritize long-term homeostasis and well-being over unyielding growth—a consciously induced trajectory change or "homeostatic awakening." We propose a new resolution to the Fermi paradox: civilizations either collapse from burnout or redirect themselves to prioritizing homeostasis, a state where cosmic expansion is no longer a goal, making them difficult to detect remotely.

Introduction

The evolution of life has been characterized as a series of "major transitions" in units of selection, information processing, and energy transduction (e.g., Szathmáry & Maynard-Smith 1995; Judson 2017). These transitions are not limited strictly to biological evolution but can also be extended to encapsulate advancements of human society, culture, and the dataome (Scharf 2021).

Bettencourt et al. (2007) offered a quantitative explanation for the accelerating pace of innovations, specifically in the development of cities. They found that city metrics having to do with growth, productivity, and overall energy consumption obey scaling laws where the scaling exponent $\beta > 1$ (unlike in purely biological systems, where $\beta < 1$) and attribute this to the *social* nature of cities. Systems where $\beta > 1$ will trend towards crises called "singularities," where population and energy demand tend to infinity in a finite amount of time. For any chance of long-term survival, these singularities must be avoided by "resets," which correspond to innovations that postpone the system's collapse. Singularities can be avoided so long as the timescale between singularities, t_{cycle}, is greater than the timescale of innovation, $t_{\mathrm{innovation}}$. However, the cadence of the unavoidable singularities and necessary resets increases in frequency over time.

Civilization Burnout

Scharf (2021) defines the "dataome" as the recording and processing of information that life performs external to its biology. The dataome encompasses books, architecture, computers, etc., as well as the coevolution of those infological organisms atop of a collection of biological organisms. Due to how deeply intertwined the dataome and human biome have become, it is possible that we are in the midst of another major informational phase transition: one that pushes civilization into a state where the physical colocation of humans in cities is no longer the dominant constraint on human interaction. Because it is human interactions that appear to give rise to the $\beta > 1$ scaling laws of cities, if civilization transitions into a state that can be described as one virtually connected globalized city, it is likely that such an organizational structure will exist in the same universality class as cities. In other words, we conjecture that a technologically connected civilization's productivity, growth, and resource consumption would be characterized by scaling laws with a scaling exponent $\beta > 1$ (Wong & Bartlett 2022).

As advances in artificial intelligence are made, it is also possible that human–human interactions may become less important than human–technology, and eventually technology–technology interactions. While human–human interactions are constrained by time and cognitive capacity, the ability for technological agents to interact with one another in an ever-growing digital planetary network could be boundless. What effect these near-future shifts may have on the scaling coefficient of a globalized city remains speculative, but we find it plausible that such transitions could result in an even larger β.

Like cities, planetary civilizations may naturally set themselves on trajectories towards singularities and experience an ultimate crisis that we call "asymptotic burnout," where the singularity-interval timescale becomes smaller than the timescale of innovation. Additionally, as information processing and free energy–harnessing capabilities grow, the magnitude of a civilization's internal fluctuations also increases; examples of past, current, and future fluctuations driven by free energy and informational expansions include: the oxygenation of the atmosphere, anthropogenic climate change, nuclear warfare, and a "disinformation catastrophe." Thus, with time, the singularity timescale, t_{cycle}, decreases while potentially harmful fluctuations become more likely to derail innovations. Once

t_{cycle} becomes short enough that internal fluctuations or external perturbations can cause $t_{innovate} > t_{cycle}$ with some non-negligible probability, collapse/regression may be inevitable.

Homeostatic Awakening & Reorientation

A civilization may have a window of time, Δt_{window}, between when they develop the capability to understand their own trajectory and when they reach burnout (Fig. 1). During this potentially slim window of opportunity, perhaps a civilization can affect a fundamental change to prioritize long-term homeostasis and well-being over unyielding growth and cycles of necessary innovation—a consciously induced trajectory change that we call "homeostatic awakening." A homeostatic reorientation would require rewriting of the fabric of global civilization so that unbounded growth is no longer the priority, or at least no longer the outcome (Wong & Bartlett 2022).

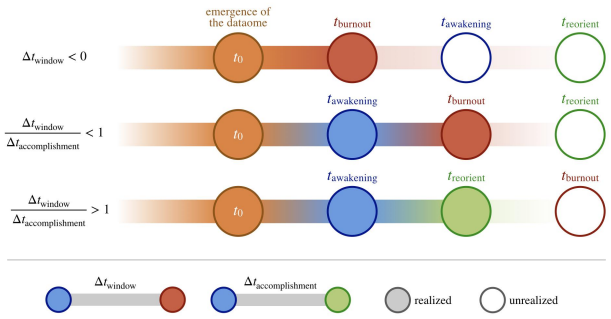

Figure 1: Three scenarios for the evolution of a civilization on a burnout trajectory. *Top*: $\Delta t_{window} < 0$. In this scenario, the civilization does not realize its trajectory before it suffers from burnout. *Middle*: $\Delta t_{window} > 0$, but $\Delta t_{window}/\Delta t_{accomplishment} < 1$. In this scenario, the civilization realizes it is on a trajectory but is unable to accomplish a reorientation towards homeostasis before burnout. *Bottom*: $\Delta t_{window} > 0$, and $\Delta t_{window}/\Delta t_{accomplishment} > 1$. In this scenario, the civilization is able to both understand that it is on a burnout trajectory and is able to reorient towards prioritizing homeostasis.

Reasons for optimism include: historical "mini-awakenings" (e.g., the banning of CFCs); non-expansionist national policies (e.g., Bhutan's policy of maximizing "Gross National Happiness" instead of gross domestic product); and previous evolutionary transitions (e.g., the emergence of regulatory mechanisms in cell-to-cell communication that allow cells to cooperate towards organ-level and organism-level homeostasis). Self-awareness-driven reprioritization towards homeostasis may be the next transcendence that life takes (or must take) after civilization as we know it (Frank et al. 2022).

Implications for the Fermi Paradox

We propose a new "resolution" to the Fermi paradox: the reason we do not observe a galaxy teeming with evidence of extraterrestrial civilizations is that civilizations either collapse from burnout or redirect themselves to prioritizing homeostasis, a state where cosmic expansion is no longer a goal, making them difficult to detect remotely (Figure 2). If the burnout–awakening hypothesis does indeed describe the fate of civilizations across the cosmos, then the lifetime of planetary civilizations may have a *bimodal* distribution.

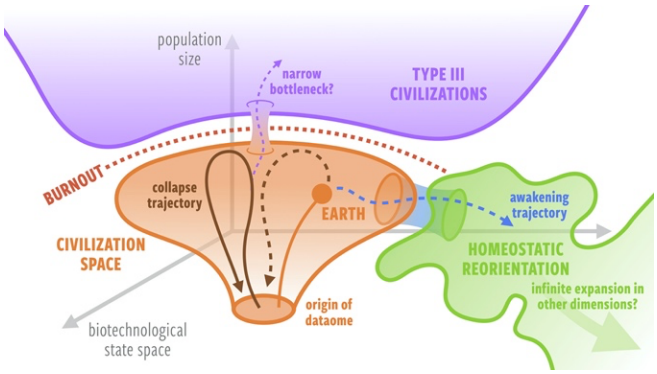

Figure 2: Perhaps hypothetical "Type III" civilizations are in an inaccessible (or difficult to access) region of biotechnological–population size state space because civilization trajectories are bounded by a "burnout horizon" and long-lived civilizations have consciously reoriented their trajectories away from growth in population size and length scales to explore other dimensions of biotechnological state space.

The burnout–awakening hypothesis does not preclude the remote detection of exo-civilizations via planetary-scale technosignatures. In fact, civilizations that are near burnout may be the *most* detectable exo-civilizations, as they would be altering their environments and dissipating free energy in a wildly unsustainable manner—fluctuations on the planetary scale that exhibit the largest signal-to-noise. This presents the possibility that a good many of humanity's initial detections of extraterrestrial life may be of the *intelligent*, though not yet *wise*, kind. Observing such burnouts (provided humanity is long-lived enough to do so) would provide potential confirmation of part of our hypothesis. On the other hand, persistent civilizations that transition through homeostatic awakening may be difficult or impossible to detect.

Conclusions

We have outlined a hypothesis that planetary civilizations, virtually connected by their dataomes, may grow along trajectories toward asymptotic burnout. As burnout approaches, civilizations may attain the cognitive horizon to understand their trajectory and affect a reprioritization towards homeostasis. Either outcome—homeostatic awakening or civilization collapse—would be consistent with the observed absence of Type III civilizations (Wong & Bartlett 2022).

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