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Cryodynamics, Silence, Snow

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Introduction

The present study is comprised of three parts. The first part gives an overview of the emerging discipline of *cryodynamics*, contextualizing it in its relationship to thermodynamics and cyclical cosmologies. Downscaling this cosmological approach, the second part applies cryodynamic thinking to material infrastructures and cultural phenomena related to ice and coldness, such as the (artificial) cryosphere, cryopolitics, and cryocultures. In this contex, the opposite side of the spectrum is discussed in terms of data heat and thermopolitics. The third part, moving to the subjective level, presents a phenomenology of snow, outlining characteristics that may be used to describe a future cryodynamics. Here, special attention is placed on the relationship between snow and silence. As cryodynamics represents an underlying phenomenon relevant to the levels of cosmology, infrastructures, and subjectivity, this study emphasizes the need to advance research on cryodynamics.

1. Cryodynamic Cosmologies

The view that the universe is continuously expanding from a “big bang”, first appearing in the observations of Edwin Hubble, has for long time dominated the cosmology of modern physics. This cosmology developed alongside and in tandem with the science of thermodynamics, which emerged in 1865 when Clausius coined the term *entropy* (as an onomatopoeia to energy), in order to describe dissipative behaviour within a closed system. But while entropy dominates in a system at all times, the opposite behaviour can occur in a sub-region or a sub-system, enabling *biogenesis* (Rössler et al., 2017). While Clausius’ thermodynamics were related to the irreversability of energy dissipation and the linear arrow of time, the opposite behaviour seems to underlie systemic complexification and biogenesis; this behaviour appears to be compatible with the cosmologies of de Chardin and Whitehead. In response to Clausius’ probabilistic thermodynamics, different conceptualizations of anti-dissipative behaviour emerged in physics, first in the form of Schrödinger’s (1944) “negative entropy”, which was shortened by Brillouin to “negentropy” (Brillouin, 1953), and later to *syntropy* (a “converging tendency”), in lexical analogy to entropy.

On the scale of cosmology, a science describing anti-dissipative behaviour is coherent with the “big crunch” hypothesis, according to which the universe contracts into singularity. Teilhard de Chardin referred to this singularity as the ‘Omega Point’. Even further,

synthesizing expansive and contracting movements, Roger Penrose is known for his conception of the universe as moving through continuous multiple “big bang” and “big crunch” cycles. Penrose called this a “conformal cyclic cosmology” (CCC), where no initial “big bang” stage exists (Penrose, 2013).

As alternative models to merely expanding cosmologies emerge, it becomes clear that the science of thermodynamics is not sufficient to describe processes of complexification. In response to this, the German physicist Otto Rössler has recently established the science of *cryodynamics* as a “sister discipline” to thermodynamics, in which particles are governed by an attractive potential, and in which their “qualitative behavior is not dissipative as in thermodynamics, but anti-dissipative” (Rössler & Kuske, 2011). As themodynamics describes entropy *increase*, and cryodynamics describes an entropy *decrease*, this enables the notion of a “eternally recycling cosmos”, anticipated by Heraclitus’ cosmology of the “metabállon anapaúetai” – “metabolizing it rests unchanged” (Rössler, 2012). However, as cryodynamics is a young discipline, “almost all of its properties remain to be discovered” (Rössler, 2011).

Moving from the scale of the cosmos to an ‘individual’ scale, we can affirm that biological systems rely on their ability to maintain dynamic equilibrium. While they are continuously exposed to environmental erosion, they maintain their structure through anti-dissipative behaviour. This behaviour is central to the process of homeostasis and individuation in a living organism. As a model for the process of individuation within society, Simondon uses the metaphor of crystallisation:

> “In crystallisation the individual is understood as a part of a process which goes from the encounter between a simple individual (the crystal seed) and a milieu full of potentials (the supersaturated solution) producing a partially individuated system. Such an encounter functions as the trigger [amorce] of the system phase- shift [déphasage] into a complex individual (the crystal) and a milieu deprived of potentials (the low-concentration solution).” (Bardin, 2014)

Ilya Prygogine in 1977 described “dissipative structures” as thermodynamically open systems that operate far from equilibrium and complexify by drawing energy from their environement (in the case of humans: matter through nutrition; information through education). Crucially, in Rösslers cryodynamics, the resulting complexification “would not be a secondary effect but rather the main feature, much like heat death is in the older case”. Rössler further asks, “Is the cosmos at large alive? Such a strange question would have been impossible to raise as a falsifiable scientific hypothesis before the discovery of cryodynamics” (Rössler, 2011). In Prygogine’s and Rösslers model, heat concentrates in a subsystem, rather than dissipating evenly. This creates “heat pockets”, as is the case in the phenomenon of a ‘body temperature’; these heat pockets allow for the development of complexification and which protect the emerging structures from the cold. The French philosopher Michel Serres went as far as to suggest that the organism’s need for warmth could have represented the precise moment of semiogenesis:

> “The homoiothermal [warm-blooded] organism generates the need for communication. It is, in energy or thermal needs, analogous to what will be common speech, in terms of signals and information. I imagine that one of the first forms of behavior, like one of the first signals, may be

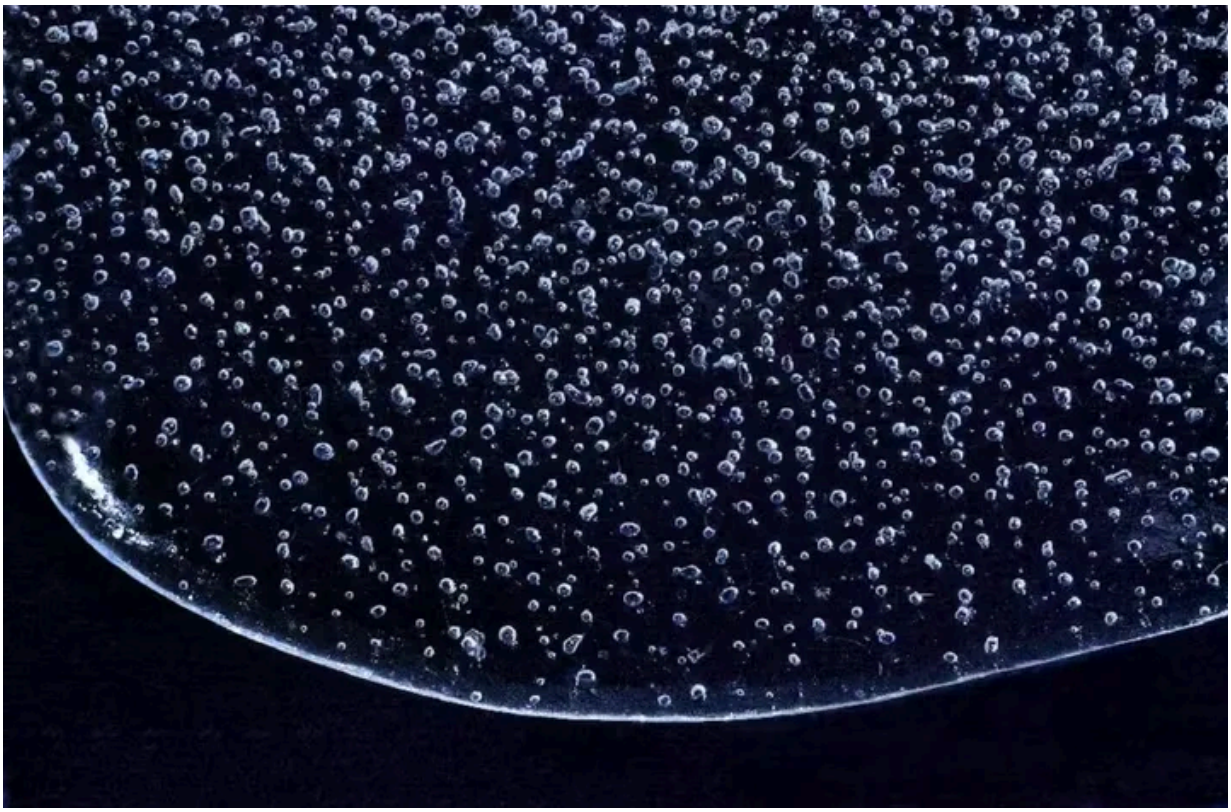
> reduced to this: 'keep me warm'." (Serres, 1982)

Interestingly, much like the concept of 'syntropy' developed through multiple developments to stand in lexical analogy to 'entropy', the science of cryodynamics developed in lexical analogy to thermodynamics, as *thermós* in Greek means "hot", while *cryós* means "cold". From this binary construct, we can reconstruct two linguistic metaphors as representations of temperature-modulation. The first one is that of "ice", as the root of the "ice-crystal" comes from the same root *cryós,* which also means "ice-cold". An ice-crystal represents a negentropic structure itself, which in the sense of Brillouin can be understood as a "highly improbable structure" (Brillouin, 1950). The second linguistic metaphor is that of "fire", as a representation of intense heat and thermodynamics. In the next section, we apply "ice" and "fire" in the context of material infrastructures as linguistic representations of thermodynamics and cryodynamics.

2. Infrastructures of the Cryosphere

Using "ice" and "fire" as linguistic representations, we can think of material infrastructural developments through systems theoretical approaches proposed by thermodynamics and cryodynamics. Such an approach was followed by Bernard Stiegler in *The Neganthropocene*, where he attempted to describe technological capitalism through an unsustainable large-scale production of entropy (Stiegler, 2018). Similar planetary considerations can be found in the problematization of global warming and data-heat. A cryodynamic approach to infrastructure could represent precisely a restorative, regenerative approach inspired by the negentropy of natural systems. To this end, we examine the properties of ice in the context of infrastructures.

As a substance, ice has the property of maintaining something and freezing it in time. In an infrastructural sense, the entirety of ice and frozen forms is called the *cryosphere*, which includes glaciers, permafrost, and solid precipitation like snow. The cryosphere can also be read as a knowledge infrastructure, in which past events are recorded through the reduction of particle movement: data from far-away time can be retrieved from ice cores and permafrost, and organic data which we deem crucial can be stored through seed vaults and the practice of cryogenics. In this sense, ice becomes an "interscalar vehicle", an object that allows one to "move simultaneously through deep time and human time, through geological space and political space" (Hecht, 2018). In this context, "deep time reckoning" represents the attempt of creating mechanisms for resisting the temporal flattening of knowledge through energy dissipation.



Air bubbles in an ice core. British Antarctic Survey.

We can understand ice and the cryosphere as a negentropic phenomenon, representing highly structured and encoded information. This information is subject to heat, and can be destroyed. To give an example, decades of medical research were destroyed after the failure of a freezer at a Swedish university (Guardian, 2024). The scarcity and value of resources information encoded in the cryosphere, alongside the increasing geopolitical relevance of arctic navigation gives rise to *cryopolitics*, the politics of cold, which describe the struggles for control over the cryosphere, as well as new possibilities of exploitation through the extraction of rare minerals (Bravo & Rees, 2006). Twilley (2025) has recently discussed the emergence of an *artificial cryosphere*, "a vast synthetic winter", which has the function of preserving food through cooling infrastructure. The paradox presented is that while the artificial cryosphere expands, its energy demands actually accelerate climate change that melts the natural cryosphere (Twilley, 2025). This perspective emphasizes that although coldness is usually associated with death, it is actually a crucial aspect of maintaning life. The recent research project "Cryocultures" charters precisely the "centrality and importance of techniques of cooling and freezing to the constitution of life" (Perry, 2025).

As ice represents a knowledge infrastructure, the issue of categorizing this knowledge arises. Bruno Latour, in *Pandora's Hope*, observes that when researchers map the forest, scientific knowledge is produced through classification, while the forest itself is lost. The branch of a tree, for instance, in being classified, becomes a sign, going from the ontological domain of nature to that of language. However, the botanist soon falls behind, "drowning in a sea of data", as the linguistic forest becomes "as thick as tangle of branches from which we started" (Latour, 1999). Importantly, Latour sketches the conclusion that "the pace must be accelerated if we are to avoid being overwhelmed by worlds of trees, plants, leaves, paper,

texts." (Latour, 1999). The same is the case in the classification of data from the cryosphere: in the rush towards aquiring knowledge encoded in the ice, the ice itself retreats, producing greater issues.

Ice Core Samples, National Ice Core Laboratory

To describe the concerning political processes concerning heat and data infrastructures,Velkova (2021) introduces the notion of "thermopolitics of data". Producing data requires energy, and in turn excess heat is produced. Big-tech firms make use of this process, maximising their profit. For instance, due to cooler climate and cheaper electricity, "multiple urban and rural locations in Sweden, Finland, Denmark and Norway have been turned into nodes of 'cloud' computing". In this narrative, the heat that these data centers emit could in turn be used for the heating of urban areas, reducing the use of fossil fuels (Velkova, 2021). However, it is often the case that even the infrastructures of seemingly sustainable resources like data and wind are "entangled with non-renewable energy systems and tax evasive capital" (Bresnihan & Brodie, 2021).

It becomes clear that information overload is a problem of itself: "overheating effects of information technology are structurally similar" to other overheating phenomena like "fossil fuels, growing cities, increased mobility, waste production" (Eriksen, 2016). Bonneuil and Fressoz (2016) introduce the notion of the "Thermocene", emphasizing the detrimental effects of global heating. In the face of these issues, developing material and conceptual techniques of cooling may be detrimental. To this end, we can conceptually tie Stiegler's imagined Neganthropocene to an imagined *Cryocene,* in which systemic dissipation is overcome through anti-dissipative, cryodynamic infrastructures and technologies. To develop such techniques, the question of energy will remain central. A solution to the

problem of energy in the Thermocene may come from cryodynamics itself: as one of the material applications of cryodynamics, Rössler outlines how the technology of nuclear fusion in hot-plasma fusion reactors promises “unlimited free energy” in the future (Rössler et al., 2017).

3. Cryodynamics, Silence, Snow

We can conceive of a relationship between cryodynamics and silence. As thermodynamics describes the increase of noise, cryodynamics describes a reduction of noise. In information theory, this may correspond to the dualism between noise and signal: as noise descreases in a system, the signal increases, carrying structured information. Here, the negentropy can be thought of as proportional to the information of a system, or the signal contained in a message (Eco, 1989).

We can further argue that semiolinguistic systems and processes are themselves anti-dissipative. They can be described as negentropic, as they represent highly complex and improbable structures (Brillouin, 1950) that can transmit knowledge through time. Language emerges, as Hjelmslev argued, through the cutting out of certain structures from the pre-linguistic “amorphous continuum”. For Umberto Eco, a key function of language is precisely its filtering dimension, through which certain elements are forgotten while others are retained; this “addition of subtraction”, as he calls it, can be described as a syntropic movement, as the removal of information causes structure and complexity to emerge.

In information theory, Shannon-entropy measures the amount of uncertainty contained in a message. The higher the uncertainty, the higher the information: each “bit” of information represents a choice between a dyad, and when each bit of a system is uncertain, its information is higher. However, negentropic systems, like systems of language, behave the opposite: paradoxically, they contain higher information when “bits” are determined in a structured way, and a signal is produced. An enunciated instance of language represents a choice based on meaning; this choice represents an increase of information in terms of “hubits”, which measure “potential information available in a message. (...) Thus a signal (measured in bits) is communicative and informative (measured in hubits) if it expands the receiver’s awareness or introduces him/her to something new.” (Tomaselli, 1985). Since a signal communicates precisely through the addition of silence to a noisy environment, cryodynamics may provide an invaluable put to understand the process of signification.

In developing an emerging cryodynamics, it may then be fruitful to examine the properties of *silence*, in other words, the increasing certainty within a system when absolute information (bits) decreases and the signal (hubits) increases. Of course, there exists no perfect silence in nature; however, it may be relevant that excessive noise can drown out a potential signal. Through the reduction of the overall noise, it may be possible to hear again certain nuances of sound. In the next section, we analyse precisely the relationship between silence and “snow”, as a representation for cryodynamic behaviour. Moving to the level of subjectivity, we consider *snow*, previously defined as “solid precipitation”, from a phenomenological point of view.

3.1 La Neige et le Silence

Building on previous notions, we can expand cryodynamics through a phenomenologal perspective on snow and silence. We find this perspective in *Snow, Forest, Silence: The Finnish Tradition of Semiotics*, which includes a chapter by Mattieu Guillot titled *La Neige et le Silence*, examining the "deeper reasons why snow appears naturally or automatically inseparable from the idea of silence":

> "If we think about it, what could be more definitively—and yet more despairingly—silent than a vast landscape entirely covered in snow? What could be more wonderful, yet at the same time more oppressive, than seeing whiteness take possession of everything, transfiguring without a sound even the smallest element of nature that still trembled, and freezing it into absolute immobility? What could be more mysterious, ultimately, than these immense immaculate spaces that almost merge with the winter sky as it seems to meet them far on the horizon?" (Guillot, 1999)

Guillot follows Bachelard in arguing that snow does not allow itself to be classified and dismissed as simple frozen water: "To "grasp snowy silence in its pure state," (...) we must strive to keep our reflection at the level of sensory presence, following the path of Bachelard, who understood that "poetic knowledge of the world precedes [...] rational knowledge of objects," that "the world is beautiful before it is true," and "admired before it is verified" (Guillot, 1999).

Snow appears as an elusive, mystifying phenomenon, one that we feel drawn to naturally. In *The Uncontrollability of the World*, the German sociologist Hartmus Rosa discusses the elusiveness and uncontrollability of snow: "Falling snow is perhaps the purest manifestation of uncontrollability. We cannot manufacture it, force it, or even confidently predict it, at least not very far in advance." (Rosa, 2020). For Rosa, our relationship with snow, our desire to control it, reflects precisely the modern desire for controllability, "Yet it is only in encountering the uncontrollable that we really experience the world. Only then do we feel touched, moved, alive." (Rosa, 2020). What we feel in our encounter with snow may also apply to the allure of poetic language and form, which Eco described precisely as an attempt of "controlled disorder" (Eco, 1989).

Guillot further argues that silence may not exclusively belong to the realm of audition, meaning that there are visual "appearances of silence" present in snow: "Why? Because the experience of snow seems to teach the eye, quite insistently, that it too can register the impression of silence". Further, "Bachelard perceptively identifies a "substantial synthesis of air, cold, and silence," concluding that "through air and cold, it is silence that is inhaled, silence that is integrated into our very being". We encounter in Guillot's account a multisensory phenomenology of snow that extends into the very subject.

Finally, we can describe a further characteristic of snow, namely that of its implicit blueness behind its whiteness. In *On Being Blue: A Philosophical Inquiry*, William H. Gass reflects deeply and poetically on the different facets of the color blue, the word itself, and its use. He calls it the "colour of deep ice", and argues how "among the ancient elements, blue occurs everywhere: in ice and water, in the flame as purely as in the flower..." (Gass, 2014). Describing the property of blueness, he writes that "blue contracts, retreats, it is the color of

transcendence, leading us away in pursuit of the infinite" (Gass, 2014). Due to its short wavelenghts, the color blue produces a contracting effect. As it is present in ice and snow, it may be used to describe the character of a future cryodynamics.

Kawase Hasui, 1922

Conclusion

In considering the newly emerging science of cryodynamics, we have outlined a cosmology opposed to the expansive and dissipative cosmology of thermodynamics. Cryodynamics opens the possibility of anti-dissipative behaviour, and enables an eternally "self-recycling cosmos" in the wake of Penrose and Heraclitus. This is relevant to us since the same processes of dissipation and anti-dissipation occur on the temporal scales that affect us. In thinking about material infrastructures, a systemic approach highlinghting the importance of cooling mechanisms for the stability of the system is crucial, as data-heat and global warming dominate the "Thermocene". Further developing cryodynamics may present crucial resources for the conception of regenerative tools for our infrastructures. To this end, this study has highlighted characteristics of ice and coldness through a phenomenology of snow, emphasizing the psychological dimension of cryodynamics. Snow and coldness seem to be intimately linked to silence; this may be particularly relevant in the context of increasing noise and data heat. Through enabling cooling and silencing processes and techniques, it may be possible to restore a dimension of hearing subtleties.

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