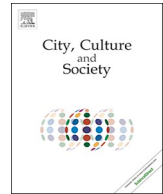




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## Urban phases: Crystallisation

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## ABSTRACT

An analysis of the city through its crystallising processes is here proposed. Because crystallisation involves phase transition, a review of the latter, as well of the notion of phase in its relation to order, is first submitted. Then the question is posed: Can we suggest that cities have phases? What would it imply to study cities as “phased beings”, or phased phenomena? Which characteristics of crystalline phases can prove most relevant for cities? The paper explores crystallisation as a lens for understanding spatial order, temporality, individuality and perception in the course, and in the context, of the urban process and urban life.

## 1. Introduction: on the possibility of enquiring into urban phases

Three perhaps uncommon ways of looking at the urban process include attending: (1) *the vegetative stratum* of the city, which encompasses a layer of existence inherent in the functions of vegetation and the states associated with it (not necessarily related to plants only); (2) its *animistic moments*, which include qualitatively characterised events that express lively novelty (not necessarily related to religious or spiritualistic beliefs only); (3) its *crystallising processes*, where an aspect of the urban process undergoes a quick transformation towards a new state contradistinguished by increased order and symmetry breaking (not necessarily related to rocks only). This essay contemplates and expands on the third point only, while previous essays have been dedicated to the previous two (Brighenti, 2018; Brighenti & Kärholm, 2018). To achieve its aim the paper reviews the notions of phase and phase transition, subsequently relating these physical occurrences to urban conditions and manifestations.

In physics, a phase is defined as a state of matter manifesting uniform properties. A phase, however, is not a uniform situation in itself. For instance, the temperature and pressure of a medium may vary extensively without affecting its phase. It is only when certain *critical points* in the parameter space are attained that a *phase transition* occurs. During phase transition, the properties of the medium undergo an often dramatic – discontinuous or, as we may also say *catastrophic* – transformation. In other words, a phase can be understood as a region, province, or “territory”, for the deployment of certain homogeneous variations that can be recorded in a medium.

It may be intriguing to determine whether, and to which extent, a similar conceptualisation of the phases of matter may turn useful for the study of cities. Can we suggest that cities have phases? To put it more

clearly, can we legitimately infer that there exist given bounded phases in the production of the urban process? What would it imply to study cities as “phased beings”, or phased phenomena? What insight would the consideration of phase transitions across different urban phases contribute to our knowledge of urban life? Perhaps – and this is the hypothesis entertained here – the notion of *urban phase* may illuminate certain urban characteristics in ways that differ from the most currently widespread approaches in urban studies.

Certainly, the use of physical metaphors in social theory always commends caution. There are risks inherent in describing social realities as physical, corporeal or organic realities. One is reminded that, while in the 19th century the discipline of sociology was created under openly organicist auspices, the critique of the organicist metaphor has spanned the entire 20th century (Collins, 1988; Münch, 1994; Turner, 2010). In particular, what has been regarded as untenable by critical observers is the use of supposedly stable, self-contained and highly-integrated phenomena (objects, bodies, organisms) to explain dynamic, plural and only partially integrated – if not conflict riddled – phenomena (societies).

In response to such by-now classic critique of organicism, however, more recent awareness in the social science has pointed out that, in the disciplines of physics, medicine and biology, a profound redefinition of the basic notions have been under way for quite some time. The outcome of such epistemological reorientation – which has emerged in many cases through experiments on the ground, often in conjunction with the deployment of new technologies and new experimental protocols – is the re-articulation of our intuitive notions of objects (or matter), bodies and organisms.

All these now look as much more imbued with relations and constituted in a multifarious way that in many respects recalls,

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interestingly, social interaction. Dynamic and chaotic complex systems appear, in other words, to imbued with a type of “social life.” For instance, quantum physics has revealed that the basic of states of matter are not atomic in the classic sense and can only be understood relationally (Susskind, 2014), while contemporary medicine assists the body of the patient through technical “prolongations” (Mol, 2002), and the neuroscience treats the brain, not simply as a social organ, but as an actual “society of cells” (Bettinger, 2017; Meloni, 2014). If so, the challenge lies in refining our understanding of what is social life. Social theory, in this sense, might benefit from accessing a larger arena where insights from the physical and life sciences can be significantly coupled with its own long-term preoccupation concerning human nature and its social dimension.

Once these caveats have been entered, the notions of phase, phase transition, and crystallisation as an instantiation of phase transition, may as well be tested in the study and interpretation of social phenomena. After all, if the crystal does not designate any specific substance, but a general state of being, a special mode of organisation, then there is no way to restrict a-priori the number and the type of “substances” that may be subject to crystallisation processes. The case of the city provides a perfect testing grounds, given the particularly interdisciplinary and dynamic nature of the field of urban studies, open as it is to contributions from beyond the human sciences, including disciplines such as ecology, geology, meteorology, materials science, informatics, and so on. One or more of the following reasons may be considered:

- (1) The urban process can be studied both *quantitatively*, measuring the magnitudes that are associated with it (e.g., population density, ecological footprint, transport infrastructures etc.), and *qualitatively*, capturing the colouration of specific manifestations of urban existence (e.g., a sense of crowding, the liveliness of urban life, the architectural style of a street, etc.). From this perspective, phases and variations within phases correspond to quantitative study, while phases transitions correspond to qualitative study;
- (2) The urban process presents us with both *continuities* and *discontinuities*. As seen above, what defines a phase is not fixity, but continuity in transformation. Continuous transformation can be opposed to the situation of sudden change, i.e. to the discontinuity that contradistinguishes phase transitions. Notably, this is not just a re-proposition of the “classical” structuralist dialectic between invisible structure and visible event (Braudel, 1943) – for in fact, a phase transition occurs when a whole set of variables reaches a determined, topical situation that can be described and effectuated in a multi-dimensional parameter space.
- (3) In the sphere of the social imaginary – which is then inevitably reverberated in the sphere of social practice – the urban process is often regarded as existing on the verge between *order* and *break-down* (an archetypal theme of sci-fi fiction and sci-fi movies). From a formal-mathematical point of view, a “catastrophe” has been described a type of event involving the production of “singular points” where the structures defining a certain form undergo a sudden change (breakdown or deep reorganisation). If so, the relation between continuity and discontinuity turns into a crucial focus for investigating the urban.

All these tensions are encapsulated in crystallisation and somehow constitute its proper locus. With these considerations in mind, the piece proposes to analyse the features of crystallisation in order to see how the city, its parts, its surroundings, its connections and the events it defines could be observed through the proposed key.

## 2. Crystallisation and individuation

Indeed, to discover in the analysis of the small individual movement the crystal of the total event.

W Benjamin, *The Arcades Project* (1927–40)

Crystalline states are familiar in our mundane existence. Indeed, crystallised elements are part of our bodily constitution: the skeletal apparatus, the teeth, and the lens of the eye all represent crystalline parts of our body. If we pay attention to these bodily parts, we may become receptive to one peculiar relation we entertain with them: we rely on these crystals for the provision of structural stability. Because we most often take these crystallised parts of ourselves for granted, one could say that they are of “infrastructural” nature: as has been famously argued by Bowker and Star (1999), infrastructures have a tendency to recede into invisibility, and only become visible when they fail.

In practice, we avoid challenging the limits of our crystallised body parts: breaking one's bones is not pleasant. Put differently, the limits of consistence of our crystallised parts are also the limits of our safety, as well as our proper comfort zone. While we are constrained within the limits of such crystallised parts, we do not usually feel them as constraining our movement at all. On the contrary, our natural experience favours attention to the breadth of bodily experience that is *enabled* by them. Our crystallised parts form, so to speak, “the obverse” of our corporeal experience.

The crystal is not defined exclusively by rigidity, and rigidity is not to be confused for the marker of crystallisation. In fact, there are amorphous rigid materials, such as glass, which are the antithesis of a crystal. In crystals, atoms are located in regularly spaced positions – or, as one could also say, they are disposed *rhythmically*. Because they possess rhythm and regularities, crystalline states are more specific, less general than non-crystalline ones: more conditions need to be met before crystallisation occurs than in the alternative situation where a systems persists in non-crystallised state.<sup>1</sup> While a fluid is geometrically isotropous – i.e., its atoms look the same from all directions – a crystal is not: its atoms look different once inspected from different perspectives. This fact preliminary highlights some features that are exhibited by crystalline states, which we need to probe more in details.

What is most interesting for our argument is not only the accomplished crystal, but also and especially, the crystallisation dynamic. The amorphous and the crystalline states are separated by a discontinuity. The process of crystallisation produces and expands a stable order: it entails a gain-in-structure and a gain-in-order in a given material. Besides the properties of the material, other physical factors such as temperature, pressure, and time have in most cases important effects on the form and the qualities of the resulting crystal: consequently, in order to grasp the characters of a crystal, it is more important to know *how* the crystal was made than *what* it is made of (Goodwin, 2001).<sup>2</sup> Because, as said, crystallisation entails a structural and energetic change in the organisation of materials, while amorphous bodies are isotropous, crystals are anisotropous, due to the existence of privileged directions in them.

Crystallisation occurs in two steps: the first stage, known as “nucleation”, corresponds to the formation of a crystal germ, or seed, of critical size inside a homogeneous medium (a “solution”). Such a germ, as we shall see, can be philosophically described as a *singularity*, in that it is capable of precipitating the qualitative transformation of a whole system when it becomes part of it. At the second stage, the crystalline structure expands (grows) and the crystallised region amplifies by transforming the potential energy of the environment into an actual

<sup>1</sup> Nature, however, is even more subtle, given the existence of structures known as *quasicrystals*, where the atomic pattern is ordered, but not periodic, and the ensuing three-dimensional symmetry does not stick to the classic crystal two-, three-, four- or six-fold symmetry (Levine & Steinhardt, 1984; Steinhardt, 2018).

<sup>2</sup> Goodwin notices that, in general, crystals are polymorphic entities: knowing a given material composition is not enough to determine the actual form a crystallising material is going to assume. As a classic example, both graphite and diamond are carbon crystals.

energy of the individuated crystal.

A “saturation curve” of crystallisation represents the moving threshold which separates crystallised states from not-yet-crystallised ones, so that the abovementioned “privileged direction” introduced in the material by the crystallisation process corresponds to, precisely, the saturation curve along which the crystal expands. To account for the overall form of the ensuing crystal, one also needs to consider that, during growth, crystallised regions deriving from one crystal germ are confined by adjacent developing crystals, forming neighbouring crystal “grains” (known as crystallites): because the latter form independently from one another, their crystal structure develops tilted in various directions, which gives the ensuing crystal its peculiar, unique conformation. What grows in a crystal is a specific “style of being” that calls for attention.

In the 1950s, the French philosopher Gilbert [Simondon](#) (2013[1964–89]) first advanced the idea that phase transition entailed by crystallisation can be associated with a process of “individuation”, i.e., the coming about of a new individual entity. For [Simondon](#), the crystal represents an instance of simple yet complete generation of a new individual. The philosopher describes crystal growth as a movement of “amplificatory transduction”, whereby the region surrounding a crystal germ comes to be crystallised by the proximal advancing of the qualities of the crystal germ. The overall movement of crystallisation inside an amorphous medium thus derives from a phase transition that travels from neighbour to neighbour and consolidates a newly appeared regime (ordered atomic pattern).

In [Simondon](#)'s terms, the crystal as a new individual emerges as the *resolution* of an inner tension within a metastable system rich with potentials. The individuation of physical objects is, in this sense, inherently related to thermodynamic phase transition: the individual entity must prolong in itself the energetic and structural (although not necessarily material) conditions of the operation of its own constitution. The structural condition, the energetic one, and the “analogic” or “informational” one (related to polarisation, or as we have said, tilting) are, for [Simondon](#), the three determinants of physical individuation. In synthesis, one could say that structure, energy, and information are the three dimensions of every individuation.

### 3. Crystalline life

As hinted above, crystallisation is a process that involves *growth*. Crystalline growth is, however, fundamentally different from organic growth, which for the sake of clarity we may call “vegetative” growth ([Brighenti, 2018](#)). In material terms, it is all the difference between carbon and silicon, living organisms being based on carbon, which allows them a fundamentally different chemistry from silicates. More than that, however, vegetativeness and crystallisation could be understood as exhibiting two varieties of growth that require attention.

A curious situation ensues from crystal growth. The crystal stands at the same time as the antithesis of life – what is stable, immutable, “immortal” – *as well as* as a model of life itself – life as not simply an arrangement of transitory materials, but an ordered set of immaterial (“geometrical”) relations emerging from a special phase transition (birth). A meta-stable equilibrium underpins life, an equilibrium capable of persisting through variation. In life, the symmetry of amorphous states is broken and time begins to matter (irreversibly) ([Goodwin, 2001](#); [Rosen, 1991](#)). In autopoietic systems theory, this aspect of life is known as the closure of organisation cycles, in opposition to, yet in conjunction with, the openness of the thermodynamic exchanges between the living creature and the environment ([Varela, Maturana, & Uribe, 1974](#)).

Clearly, a notion such as that of “crystalline life” could not be accepted by a theorist like [Simondon](#). His major work on individuation is articulated into two main parts, on the basis of a fundamental distinction between physical individuation and living individuation.<sup>3</sup> For [Simondon](#), the phenomena of life are fundamentally different from the

rest of physical phenomena: whereas the physical individual can grow indefinitely, the biological individual cannot; whereas in the individuation of the physical individual occurs instantaneously and abruptly, the biological individual prolongs and continues within itself its own process of individuation, in a constant *individuation by the individual*, or “individualisation”; consequently, the activity of individuation in the physical individual, such as a crystal, occurs only on its outer boundary, whereas in the biological individual individuation unfolds from an inner centre through internal resonance; finally whereas the coming about of a physical individual resolves a previous condition of metastability, that same condition of metastability is the vital condition for the biological individual. While these distinctions by [Simondon](#) are certainly insightful, they can also be criticised from a number of perspective, which clearly cannot be fully tackled here. Suffice to say that the limit between life and non-life is far from clear in virtually all contemporary science. The situation of viruses, in this respect, is symptomatic: the recent discoveries in virology concerning multipartite viral systems challenge even more strikingly any clear line of demarcation between living individual and non-living matter ([Sicard et al. 2019](#)). In a different context, digital objects seem to pose an analogous problem of unassignability across the threshold separating the living from the non-living ([Hui, 2016](#)).

From this perspective, [Simondon](#) appears as a rather classic theorist, building on a slightly scholastic distinction between physics and biology, vis-à-vis more radical theorists such as Gilles Deleuze (who, at the same time, held [Simondon](#)'s work in high esteem, and was significantly influenced by him). Rather than straightforwardly expelled from the domain of life, the phenomenon of crystal growth may be characterised as an instance of what [Deleuze and Guattari \(1980: 623 et passim\)](#) used to call “inorganic life” or “organ-less life” (“...une intense vie germinale inorganique, une puissante vie sans organes...”). In an attempt to renew, or re-found, vitalism, Deleuze elaborates the notion of inorganic life, which he images as a mode of life that is not grounded in an organic system – a life that is not carbon-based.<sup>4</sup> From this perspective, organisms appear as one type of machines that are specialised in – temporarily, at least – “localising” life.

How is it possible that crystals possess a life of their own? Following [Thom \(1988\)](#), one major requirement of life is the topological fact of having *form*. Here, form must be understood, not as a given inert shape that happens to be there, but as a special attainment, a special energetic elaboration and “orchestration” of materials. In this sense, [Bachelard \(1948: 299\)](#) called the crystal an “active centre” – what today in mathematics we would conceive of as an “attractor” towards which an equation evolves. Form is thus better understood as formation, or formative process: form-taking, morphogenesis, or *prise de forme* as [Simondon](#) discussed it; and the process of crystallisation can be counted as one such processes. This means that crystallisation inherently includes a temporal aspect, it possesses a temporality. As summarily seen above, phase transitions entail sudden organisational and structural transformations. The very idea of “suddenness” calls into question the quality of the crystallisation time. While certainly the duration of crystal formation can be measured quantitatively, crystallisation as a

<sup>3</sup> This is made clear in the 2013 edition published by Millon, reinstating the original articulation of [Simondon](#)'s dissertation, defended in 1958.

<sup>4</sup> In a 1980 interview, with prescience towards the increasing importance of computers in the contemporary world, [Deleuze \(2003: 164-5\)](#) described crystalline life as follows: “Aujourd'hui on assiste à quelque chose de très curieux: la revanche du Silicium. Les biologistes se sont souvent demandé pourquoi la vie était « passée » par le Carbone plutôt que par le Silicium. Mais la vie des machines modernes passe par le silicium: c'est toute une vie non-organique, distincte de la vie organique du carbone.” [Today we see a curious phenomenon: the revenge of silicon. Biologists often were puzzled by the fact that life had to pass through carbon, instead of silicon. But the life of the modern machines passes through silicon: it is a whole non-organic life, quite distinct from the organic life of carbon.]

whole speaks of certain quality of temporality that is perhaps best revealed in the discovery of “time crystals”.

The interlocking vicissitudes of crystals and time have recently led to a scientific breakthrough. In 2017, two groups of experimental scientists in quantum physics have managed to create in laboratory what have been called “time crystals”, following the insight launched by the theoretical physicist and Nobel Prize Frank Wilczek (2012). Just as spatial crystals break symmetry in space, time crystals appear to break symmetry in time. Technically speaking, in the case of time crystals, it can be said that the system “exhibits temporal correlations at integer multiples of the fundamental driving period, breaking the discrete time-translational symmetry of the underlying drive” (Choi et al. 2017: 221). These crystals may perhaps also be called “periodic” crystals, which return to the same configuration at intervals. Rhythm is here temporal as much as spatial; and the fact of a recurring crystallisation suggests that privileged directions can appear in not only space, but also time. From this perspective, the temporality of these crystals is even more reminiscent of the temporality of organic life.

Quantum time crystals have been hailed by physicists as potentially constituting a new and distinct phase of matter, as they seem to entail a different phase transition form traditional crystals. At a different scale, in the domain of biology, the study of a specific type of crystals, namely liquid crystals, has also attracted attention. Biological membranes and cell membranes can be said to constitute liquid crystals, where some qualities of fluids (e.g., flowing) are found mixed with the qualities of crystals (e.g., atoms and molecules orientation). For her part, the Chinese geneticist Mae-Wan Ho (2010), controversially combining insights from genetic biology, Chinese traditional thought and vitalistic philosophy, has argued that the basis of organic life itself lies in “dynamic liquid crystalline phases”, of lyotropic type (i.e., where both temperature and density matter to define the phase). Ho has stressed that the polarisation of tissue water seems to be essential for obtaining the hydration shell of proteins and the DNA. At the cellular level, not only is the cytoskeleton a dynamic structure capable of transporting materials where needed, but the cytoplasm itself is highly organised as a living protoplasm “switching effortlessly between low and high density states to provide the ‘engines of life’” (Ho, 2010: 121).

The convergence between life and crystalline states can also be explored in the domain of perception, where issues of density and rhythm are no less relevant. Crystallised states, whether spatial or temporal, produce a peculiar type of perceptual rendering. In his two books on cinema, Deleuze has elaborated on Bergson's *Matter and Memory* (Bergson, 1896; Deleuze, 1983, 1985) to expand on the significance of crystallised perception. In the philosophy of Bergson, a continuum exists between actual perceptions, on the one hand, and pure memories or recollections, on the other. Of course, perception in animals has evolved as naturally connected with action (movement). Perception is evolved precisely *in view of* exerting a possible range of actions through one's body – that is why Bergson (1896: 86) argues that “perception prolongs itself into nascent action”. Pure memories, on the other hand, correspond to a virtual state that is unlimited, completely detached from action – they represent, so to speak, the virtual state of the world (possibly, Simondon's notion of potential non-actual energy derives from this Bergsonian insight).

In the context of cinema, Deleuze translates Bergson's duality into the distinction between what he calls “sensory-motor-images” – perception directly and naturally connected to the course of action – and “pure optical or aural images” (what he also calls “opsigns” and “sonsigns”). Whereas the former animate sensory-motor images (movement-images), the latter evoke special images where pure optical-aural images crystallise with their own virtual images (into time-images). In a perfectly crystallised image, actual and virtual remain separate by nature, but become practically indiscernible. A state is generated where virtual and actual mirror into each other and exchange their reciprocal place and role. This is the “shortest circuit” or “inner limit” of the relation between image and matter. Crystallised perception, in this sense,

defines a type of immobile attention, an image detached from its natural prolongation into action, turned towards the inner circuit (the shortest possible circuit), that attracts it into a pool of virtuality. As Deleuze (1985: 108) writes inimitably:

L'image-cristal a ces deux aspects: limite intérieure de tous les circuits relatifs, mais aussi enveloppe ultime, variable, déformable, aux confins du monde, au-delà même des mouvements du monde. Le petit germe cristallin et l'immense univers cristallisable: tout est compris dans la capacité d'amplification de l'ensemble constitué par le germe et l'univers.

[The crystal-image has these two aspects: internal limit of all the relative circuits, but also outer-most, variable and deformable envelope, at the edges of the world, beyond even the moments of the world. The small crystal germ and the immense crystallisable universe: everything is enclosed in the capacity to expand the ensemble constituted by the germ and the universe.]

#### 4. Urban crystallisations

There was first the ferry boat moving softly from the Jersey shore at dawn – the moment crystallized into my first symbol of New York.  
FS Fitzgerald, *My lost city* (1932)

Do cities crystallise? And, if so, what happens when they do? What is the advantage of studying the urban process through the lens of phase transition and crystallisation?

From the previous discussion, a number of points that seem to deserve attention have emerged: first, crystallisation looks like a process whereby a given threshold in the phase parameters space is crossed, and a phase transition occurs around given critical points; second, the association of the crystal with an individual entity causes the fact that the crystal comes to embody a moment of individuation, the emergence of a novel relation between two elements that are being distinguished, but can only exist in relation (a relation that, as Simondon stresses, belongs to their own being), namely the individual and its environment; third, more dynamically, crystals are defined rhythmically in either space or time, through the apparition of recurrent features and privileged directions; fourth, crystal growth leads to gain-in-structure and a gain-in-order in a given material that break spatial and temporal symmetries of amorphous states; fifth, the crystal is related to a type of life, albeit of non-organic type, according to a vitalistic stance that rejects any clear-cut line between what is living and what is not living; sixth, the crystal also corresponds a peculiar type of perception (pure optical-aural image), intimately connected to an immediate and most intimate perception of bare time.

When a city or some of its parts crystallise, they become *legible*. As in Fitzgerald's short story from 1932, in those moments, the city is looked at as through an ice pane. This may be just a fleeting, momentary perception, but a moment that subverts the whole regular order of time – it suspends regular sensory-motor-images to let pure optical-aural images emerge. Legibility is a quality urban planners have classically attributed to situations where inhabitants feel at home in the city (Lynch, 1960). In the case of crystallised states, however, legibility is attained through the introduction of a unhomely distance between the observer and the city. In the crystal, the observer can come to see the structure and the energetic reserve of the city, so that its specific consistency can be sensorily experienced; but curiously, the ensuing feeling can also be one of extreme lightness, a sense of completeness and fulfilment – to speak with Whitehead, the encompassing enjoyment of an “actual occasion”.

The urban built environment provides a first approximation of urban crystallisation. Built structures can be easily recognised as sharing the features of crystals. As said above, in a compound entity, crystallised parts assume an infrastructural role: they enable structure, confer order, and provide a sense of security. That is indeed a major

function buildings perform: they shelter, sort activities in space, and make possible stacking social practices. Buildings are suited to assume the role of crystallised urban parts also due to their relative detachment from the requirements of action, which they share with crystalline perception (purely-optical-aural perception, rather than movement-perception).

Not all rigid structures are necessarily crystalline, though. At first look, the typical Central Business District of the North American city, for instance, with its landscape dominated by glass towers, can hardly be said to be crystalline. Glass is a rigid but amorphous material, almost the antithesis of the crystal. Glass towers are more of solidified fluids than crystal states. The merely material layer, however, is not all that matters in the urban process. In this sense, the CBD could still be said to function as a kind of urban element capable of precipitating some crystallisation of social life.<sup>5</sup> To understand this, some additional considerations about crystallisation as a movement of individuation can be entered.

Crucial in the composition of the city is the limit between, on the one hand, solidified built structures, and, on the other, more ethereal urban atmospheres. Such composition somehow corresponds to the embrace of the Aristotelian elements of earth and air: cities are ensembles of earth and air, between the always menacing attractions of water and fire. The philosopher Gaston Bachelard (1948) first attempted an analysis of the crystal in the context of the four elements. For him, just like cities, the crystal too is located at the limit – the interface space – between the terrestrial and the aerial. In crystals, Bachelard suggested, one can read the struggle between light and darkness, occasioning a continuum ranging from paleness to lightning (a problem Roger Caillois, too, will be specifically concerned with).

The crystal has to do with imagination, but Bachelard specifies that what is at stake in it is a “material imagination” – one where images are written or incorporated directly into the materials themselves: so, matter imagines itself even before an external observers appears (the latter point is also a recurrent theme in Bergson, well represented in his doctrine of the movement-image). A special “crystalline reverie” ensues, to which Deleuze would later return in his study of crystallised, purely-optical-aural images. In parallel, the city crystallises as not simply a built form – such as for instance, a steel shell – but as a compound entity at the interface between different *elements* – such as precisely earth, air, water and fire. Different degrees of crystallisation are to be taken into account, just as are the different ways of crystallisation according to environmental variables affecting the system.

With regard to the imagination of matter, and the imagination of cities in particular, crystallisation seems to push forward a distinctly *aesthetic* take on materials – as is made clear for instance, in a different context, by the famous metaphor of love as a salt-crystallised bough in Stendhal's (1822) treatise.<sup>6</sup> As also shown above, the crystal confers to an environment, or system, a new way of perceiving, a new way of looking at the object that affects both.

These considerations can perhaps be better understood with reference to the dynamic view of crystallisation outlined above. The growth of the crystal germ offers a case for capturing a certain type of urban development, such as urban expansion. In the mid 1950s, in the

<sup>5</sup> A similar function was attributed, for instance by the architect Victor Gruen to the shopping mall in the development of the suburbs (see *infra*).

<sup>6</sup> Stendhal's description deserves a quotation here: “In the salt mines, nearing the end of the winter season, the miners will throw a leafless wintry bough into one of the abandoned workings. Two or three months later, through the effects of the waters saturated with salt which soak the bough and then let it dry as they recede, the miners find it covered with a shining deposit of crystals. The tiniest twigs no bigger than a tom-tit's claw are encrusted with an infinity of little crystals scintillating and dazzling. The original little bough is no longer recognizable; it has become a child's plaything very pretty to see. When the sun is shining and the air is perfectly dry the miners of Hallein seize the opportunity of offering these diamond-studded boughs to travellers preparing to go down to the mine.”

US, the architect Victor Gruen designed what he called “regional shopping malls”, intended as urban clusters or, as he called them, “urban crystallisation points” (Gruen, 1962). While shopping malls are today seen as part of a continuous, amorphous suburban landscape, Gruen detested sprawl, which he regarded as a chaotic and degrading environment, and sought measures to counter it. His idea was that retail spaces could be turned into points around which a certain type of urban order and urban culture could be catalysed, stirring a phase transition from amorphous to structured system.

The new building type of the shopping mall would have to be able to generate a series of urban occasions, “offer[ing] the suburban population significant life experiences” (Mennel, 2004: 121; Zuccaro Marchi, 2017: 76; Maumi 2018), which, in Gruen's original view, should not have been limited to shopping.<sup>7</sup> Architectural and urban design aimed to provide crystal germs that could effectively grow via amplificatory transduction, precipitating a number of social activities in its proximities. This way, the mall could act as a crystallisation point of social life in the suburbs, structuring the environment well beyond the single building at stake. Implicitly, Gruen endorsed the idea that the crystal constituted a gain-in-order vis-à-vis the disordered suburban spread. According to him, such crystallisation process could help bridging different spatial scales, ranging from the architectural, via the urban, through the regional – hence, his idea of “environmental architecture”.

## 5. Scalable crystals, temporality and individuality

At the regional scale, cities themselves can be observed as inserted in expanding crystalline lattices. Walter Christaller's 1933 theory of urban systems famously crafted the geographical notion of “central places” as constitutive of regional networks of villages and cities. In a theory that was perhaps factually best suited to Southern Germany, human settlements appeared to him located at the conjunction of nets of relations defining hexagonal crystalline regional systems (Christaller, 2000[1933]). Before Gruen, Christaller had envisioned different orders of spatial crystallisation of human settlement, which amounted to five, starting from sparse hamlets, through villages, towns and cities to, finally, the metropolis.

While later serving during World War II as regional planner for the Nazi secret *Generalplan Ost*, where the eastward expansion of the German Reich was ruthlessly implemented, Christaller defined the situation of the Polish territory in 1940 as “fluid”. Opposing the image of fluidity to the crystalline structure of his central places theory, Christaller was implicitly suggesting – as in fact was meant by the regime he was working for – that the eastern European region was in need of a new crystallisation, which could have been carried out according to the Nazi directives of ethnic cleansing, deportation and forcible “Germanisation” (Burleigh, 1988).

If, in their obvious difference,<sup>8</sup> both Christaller and Gruen seemed to more or less implicitly associate crystallisation with various forms of urban territorial *expansion*, it is interesting to observe how, perhaps not too paradoxically, even phenomena like urban *shrinking* and urban *decay* can also lead to instances of crystallisation. In physics, it is known that the corrosion of a crystal with the use of acids produces “negative crystals” of dissolved materials. Conversely, the growth of the crystal does not equate with the expansion of the city. In the US, the almost archetypical case of Detroit reveals how urban failure and downsizing

<sup>7</sup> Indeed, Gruen was among the first to design large, fully enclosed and air-conditioned retail spaces: the prototype was the famous Southdale Center in Edina MN, inaugurated in 1956. Gruen thought that, around the shopping function, the centre would have also catalysed a vast array of other community activities.

<sup>8</sup> Including the fact that, while Christaller was employed by the Nazi regime, Gruen, who was from a Jewish family, fled Vienna after the *Anschluss*. Both, however, were undeniably informed by a broad Mitteleuropean modernist socialist idea.

may lead to strangely crystallised urban lands.

As noted above, the crystal enables the perception of a “bare time”, detached from immediately purposeful action. In documentaries such as *Requiem for Detroit?* (Temple, 2010), *Detropia* (Ewing and Grady 2012), or in a movie such as *Only lovers left alive* (Jarmusch 2013), a thriving of purely optical-aural images is recorded, especially in conjuncture with ruined buildings and discarded urban landscapes now in stand-by. Like ancient cathedrals, ruins are more manifestly a crystallisation than the original buildings ever were. Aside from the harsh social justice struggles of the former industrial workers, and of local inhabitants and their embittered feelings of being abandoned by the municipality, the urban ruin reveals a remarkable path of crystalline growth.

Especially in frozen winters, night-time shots of iconic American ruins, such as the Michigan Central Depot, the United Artists Theatre, the Michigan Theater, or the Fisher Body 21 Plant, make one perceptually experience the practical meaning of the amplificatory transduction that lies along the saturation curve of crystallisation. The vast vacant, overgrown sites that lie among ruins also demonstrate how the vegetative and the crystalline may enjoy an uncanny coexistence in the city (it is possible to better appreciate here that the three perspectives presented at the outset of this piece are not exclusive, but complementary).

The non-linear relation between order and break-down can perhaps be described as “cathectic”: in life, order and entropy do not repel, but entertain each other on a critical verge. The role of downfall and catastrophe in the urban process highlights the relevance of a continuous, variation-based temporality counterpointed by sudden, discontinuous phase transitions. On the one hand, form presupposes *discontinuity*, in that each form can only appear if severed from its background, or surroundings (producing a *Gestalt* configuration with it), endowed with a degree of persistency through time; on the other hand, however, form also presupposes *continuity*, in that each form is but a temporary achievement in a more embracing process of generalised metamorphosis. Form is a (cathectic) slowing down of catastrophe. In the case of spatial, living and social forms, the occurrence of a catastrophe introduces new, qualitatively distinct temporalities mirrored in “arrested”, or purely-optical images, attesting to a life in the course of elaborating its own rhythm.

By crystallising, the city also becomes more individual, it becomes unique (an “haecceitas”). And, just as the city, so do its component parts, its sectors, its neighbourhoods, its parks, its streets, down to a single instantaneous snapshot form a certain street corner. Such a uniqueness is clearly correlated to the spatial anisotropy of crystal states – what makes one truly “individual” is one’s own peculiar “polarisation”. The nucleation phase of crystallisation sheds light on the inception of individuality as the result of a singularity operating upon a multiplicity. This insight may be of some interest, considering that, in a sense, 20th-century sociology has been but a protracted attempt to grapple with the vicissitudes of the individual in the city: city is crowd, and crowd is the melting point of individuality. Singularity differs from individuality, in that singularities travel across individuals, spreading and resonating as active centres at a distance. As reconstructed above, the process of crystal growth involves the crystal grain reaching outwards, until it encounters other growing grains, their encounter ultimately determining both a reciprocal limitation and the composition of a larger crystal rock.

Grains are co-isolated, they only share their boundaries, while the respective orientation of their atoms (their rhythmic imprint) is independent. Organic life is substantively different, in this respect: the living thing does not so much expand centrifugally as it self-constructs centripetally, defining modes of self-gravitation. As Simondon (2013 [1964–89]: 157–8) put it, biological individuation is not indefinitely extensible, and the organic living being is not only an individual entity, but also one that *continues* to individualise itself (“individualisation” rather than simple “individuation”). This however brings Simondon to suggest that the biological individual is in fact a relatively abstract reality, and only the group, colony, or species (the “city”, if one wishes) offer the concrete reality of the vital unit. For him, the psychic and

social domains have a “trans-individual” existence, they can never be enclosed within a biological individual.

Despite their difference, in both the biological and the inorganic types of life we have to do with incipient individual entities prolonging within themselves the energetic and structural conditions that oversaw their constitution. Each new individual is an attempt to tame or resolve systemic structural tensions, a protracted, more or less sophisticated attempt to coordinate the singularities enclosed inside oneself by actualising the pre-existing energetic potentials of a situation. Certainly, in the pure crystalline form, such an attempt is minimal, as it consists in the “simple” juxtaposition of co-isolated grains. Yet once we have pluralised the imagination of the crystal by taking into account phenomena such as semi-crystals, liquid crystals, quantum time crystals, and probably other conformations not yet discovered by science, the rigid boundaries between different types of life may give way to a more subtle, comparative gaze into the degrees, the ways, the thresholds and the energetic-morphogenetic peculiarities of individuation, the vagaries of becoming-individual under various conditions and across different phases.

According to a classic dichotomy, the city encompasses its built environment (*urbs, saxa*) and its social environment (*civitas, habitatores*). From this point of view, the crystallisation of the human – and more generally, animal – component of the city is matched by concurrent social crystallisations. Which is the subject of a social crystallisation? Although the city can be read through its groups, its colonies, its “races”, its “classes”, the quintessentially collective urban actor remains, as seen above, the crowd. Are human crowds better understood as an amorphous state, or as a new, incipient process of crystallisation?

Since the 1920s, the urban – and especially suburban – masses have been repeatedly accused of *formlessness* (Borch, 2012). Perhaps in connection with this, the 20th century has been the great century of *organisation*, the century when new modern principles of urbanisation have been extensively implemented (sanitation, housing, schooling and healthcare for the masses, etc.). What in the 1930s Siegfried Kracauer (1995) called “The Mass Ornament” – which he observed particularly in mass culture and mass entertainment – appears in this sense as a principle of crystalline order cast upon a social multiplicity. The mass ornament was, for Kracauer, characterised by an abstract rationalism that stood opposed to veritable human rationality: what came to be included as part of the ornament was not the individual person in its wholeness, but some of its parts, some of its traits, some (physical or spiritual, in any case “abstract”) segments of the individual.

The ornament, Kracauer concluded, could never be truly individual, and rather corresponded to a “fraction of a [human] figure” [*Bruchteile einer Figur*]. Albeit in a different historical configuration, Kracauer’s insight still proves of considerable value today. The complexity of the urban condition lies in the combinations of individuality and singularity of both inhabitants and their city. Certainly, the crystalline regime only captures one facet of this unfolding equation. Crystallisation is a far from ubiquitous condition (its anisotropy means that it is more specific than non-crystalline states). It may, however, be an important facet of it.

To follow the contemporary evolutions of the urban ornament would require examining all the situations where the individual is cut across by the crystalline operation – where the crystal, so to speak, works as an inorganic knife upon organic materials. Deleuze famously called what resulted from such operation a “dividual”, instead of an individual.<sup>9</sup> In this sense, for instance, the new digital media have

<sup>9</sup> However, the individual and the dividual may just in the end be but two poles of the same operation, with crystallisation defining thresholds and paths towards individualisation. After all, no perception without individuality – given that perception must always relate the perceived images to a centre of gravity, to a perceiving subject. Perception is always a subjective matter. At the same time, though, the subject itself is an objective phenomenon: it can only exist as a gravitation centre correlate to a series of perceptions, and as an gap between sensory-motor images, or between stimulations and reactions.

greatly expanded the domain of urban dividuality, the domain where the ornament is at work, and where crystallisations intersect the everyday life of urbanites.

## 6. Conclusions

At the beginning of this piece, the risks inherent in the use of physical metaphors to describe social life have been considered. That notwithstanding, the above discussion suggests that the crystal may be more than a metaphor for thinking the sociality and materiality of the urban process. Ultimately, in the study of social life, it is not thoroughly possible to separate the abstract diagram from the materials that perform the diagram: for social life lies not the abstract schema, but in the reality of the materials that such schema organises – and that, insofar as they are active, “excitable” media, can never be operationally neutral.

Once one moves beyond the register of the metaphorical, a more complex scenery can be delineated – here only in a preliminary rough sketch. The analysis of urban phases leads the researcher towards taking into account matters of organisation, understood as the on-going articulations of materials within a system endowed with given virtual energetic reservoirs to be actualised at critical moments. Phases, as seen above, are characterised by continuous movement and smooth fluctuation, as opposed to the catastrophic discontinuity entailed by the crossing of thresholds between different phases. If phase transitions occurs at critical points, we may also come to identify the critical points in the parameter space with the crystalline singularities described above – crystal seeds capable of precipitating, under specific metastable circumstances, transitions towards new states of being.

Crystal growth follows a saturation curve that breeds a special temporality, a distinct type of perception, and an incipient individuation. Possibly, the science of cities today could be enriched by a more thorough investigation of these phenomena. In conclusion, one may want to puzzle more deeply over the *qualitative* aspects of crystallisation. This is where the ethical-political implications of urban phases become explicit. Crystallisation is not only part of the natural history of cities, but of their political history as well. Questions like the following ones are worth being asked and dwelt upon: Is there any wisdom in crystallised states? Do they teach peace in the form of some underlying, legible order of phenomena? Or do they, on the contrary, convey all unresolved contradictions of the city as an irredeemably compound, even explosive entity? Can urban struggles and contentious politics be regarded through the lens of the amplificatory transduction of a given phase? How are qualitative phase transitions correlated to “decisional” collective events? These are just some of the avenues opened up by the study of cities as phased beings.

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