

Complicating the Quantity-Quality Transition

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Philosophy lacks the advantage from which the other sciences benefit, namely the ability to presuppose both its objects as immediately endorsed by representation of them and an acknowledged method of knowing, which would determine its starting-point and progression.

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Final draft, ready for submission 28 September 2021

Introduction *

Developments are not always smooth, they often take place by leaps and bounds. The Roman philosopher Seneca already addressed this issue.² The first modern thinker who thoroughly tackled the observation that a quantitative reduction or increase can lead to a change in the nature (quality) of an entity was G.W.F. Hegel,³ who elaborates on this in his *Logic of Science* (1832),⁴ known as the ‘Greater Logic’, and more extensively in his ‘Lesser Logic’, the *Encyclopedia of the Philosophical Sciences*, part 1 (1830).⁵ He builds on insights from his *Phenomenology of the Spirit* (1806-7), in which we find the example of: ‘a child, who after a long silent period of nourishment draws his first breath and shatters the gradualness of only quantitative growth – it makes a qualitative leap and is born.’⁶ Importantly, we have to realise that Hegel never stipulated ‘dialectical laws’, as they became coined by Friedrich Engels and his followers. This is also true for the ‘law’ of the Quantity-Quality Transition (hereafter QQT). In this research note we will discuss the perceived simplistic universality of

* This work is part of the *Marxism and Science & Technology* project of the Dutch Socialist Research Collective: www.soc21.nl .

¹ Georg Wilhelm Friedrich Hegel, *Encyclopedia of the Philosophical Sciences in Basic Outline. Part 1: Science of Logic*. Edited and translated by Klaus Brinkmann and Daniel O. Dahlstrom (Cambridge: Cambridge University Press, 2015), §1.

² ‘It is no new idea that certain objects change as they grow. ... Certain things not only grow in size as they develop, but grow into something else.’ Seneca, *Moral letters to Lucilius (Epistulae morales ad Lucilium)*. Translated by Richard Mott Gummere. Vol. 3 (London: William Heinemann and New York: G.P. Putnam’s Sons, 1925), Letter 118, 14.

³ David Gray Carlson, ‘Hegel’s Theory of Quantity’, *Cardozo Law Review*, 22, 2 (January 2001), pp. 425-594.

⁴ Georg Wilhelm Friedrich Hegel, *The Science of Logic*. Edited by George Di Giovanni (Cambridge: Cambridge University Press, 2010).

⁵ Hegel, *Encyclopedia of the Philosophical Sciences*.

⁶ Georg Wilhelm Friedrich Hegel, *The Phenomenology of Spirit*. Edited and translated by Terry Pinkard (Cambridge: Cambridge University Press, 2018), p. 9.

this notion and argue that although a QQT is clearly visible in many a situation, its expressions are certainly plural given the contingencies of the situation at issue.

The QQT became a widely discussed issue after Friedrich Engels published his book *Herr Eugen Dühring's Revolution in Science* nearly half a century after Hegel's death (1878, English translation 1907).⁷ It is important to note here already that both Hegel and Engels considered the dialectical 'laws' as pertaining to the whole world, material as well as social. The concept reached its final codification when Engels's unfinished manuscripts, written between 1873 and 1882, were published in German and Russian in 1925 (English translation 1939) as the collection *Dialectics of Nature*.⁸ In his notes Engels tried to anchor the idea of universal (overarching) dialectical 'laws' through a variety of examples from the natural sciences. After all, a materialist approach, contrary to Hegel, has to start from the material substrate which in its development gives rise to living and thinking matter. Both friends, Karl Marx and Friedrich Engels, applied Hegel's dialectics in their works. Marx focused on the critique of political economy and added cases of QQTs from this critique in the second edition of *Capital*, volume I.⁹ Here we read about the rate and mass of surplus value:

Hence, the possessor of money or commodities actually turns into a capitalist only where the minimum sum advanced for production greatly exceeds the known medieval maximum. Here, as in natural science, is shown the correctness of the law discovered by Hegel, in his *Logic*, that at a certain point merely quantitative differences pass over by a dialectical inversion into qualitative distinctions.¹⁰

And in the chapter on primitive accumulation it is said that the centralisation of capitals leads to:

...the revolt of the working class, a class constantly increasing in numbers, and trained, united and organized by the very mechanism of the capitalist process of

⁷ Friedrich Engels, *Herr Eugen Dühring's Revolution in Science*, in: *MECW*, vol. 25, pp. 5-309 [hereafter *Anti-Dühring*], especially pp. 110-119.

⁸ Friedrich Engels, *Dialectics of Nature*, in: *MECW*, vol. 25, pp. 311-588.

⁹ Compare Engels, *Anti-Dühring*, p. 117: 'Thus, for example, the whole of Part IV of Marx's *Capital*—production of relative surplus-value—deals, in the field of co-operation, division of labour and manufacture, machinery and modern industry, with innumerable cases in which quantitative change alters the quality, and also qualitative change alters the quantity, of the things under consideration.'

¹⁰ Karl Marx, *Capital*, Volume I. Trans. Ben Fowkes (Harmondsworth: Penguin, 1976), p. 423.

production. The monopoly of capital becomes a fetter upon the mode of production which has flourished alongside and under it. The centralization of the means of production and the socialization of labour reach a point at which they become incompatible with their capitalist integument. This integument is burst asunder.¹¹

Engels stressed that the dialectical 'laws' including the notion of a QQT can be observed everywhere in nature and society, hence, can be considered – like Hegel did – as a universal rule.¹² Engels elaborated in particular three examples to illustrate the QQT: liquid water that, under constant pressure and with rising or falling temperature, turns into vapour or ice; the periodic table of chemical elements; and the homologous series of alkanes.¹³

Neither Engels nor Marx elaborated on the foundations of the QQT, but mainly illustrated the phenomenon with examples. It is remarkable that the analysis of QQ transitions has made almost no progress since the late nineteenth century. Among Marxists it became a standard expression for change, often used casually as a well-known fact; a reflection of an objective truth. Nikolai Bukharin stated only that: 'The transformation of quantity into quality is one of the fundamental laws of the motion of matter; it may be traced literally at every step both in nature and society.'¹⁴ Leon Trotsky did not say much more when he wrote: 'To determine at the right moment the critical point where quantity changes into quality is one of the most important and difficult tasks in all the spheres of knowledge including sociology'.¹⁵ And Josef Stalin considered the QQT as a fundamental doctrine,

¹¹ *Ibid.*, p. 929.

¹² See e.g., his 'The Part Played by Labour in the Transition from Ape to Man' (876), *MECW*, vol. 25 p. 452-464.

¹³ The example of boiling and freezing water goes back to Hegel, *Science of Logic*, pp. 321-322, and Georg Wilhelm Friedrich Hegel, *Hegel's Philosophy of Nature: Being Part Two of the Encyclopaedia of the Philosophical Sciences (1830)*, Translated from Nicolin and Pöggeler's Press, 2004), Edition (1959), and from the *Zusätze in Michelet's Text (1847)*. Trans. Arnold V. Miller (Oxford: Clarendon Press, 2004), § 322.

¹⁴ Nikolai Bukharin, *Historical Materialism: A System of Sociology*. Edited by Alfred G. Meyer (Ann Arbor: University of Michigan Press, 1969), p. 80.

¹⁵ Leon Trotsky, 'The ABC of Materialist Dialectics' (1939), in Trotsky, *In Defence of Marxism* (New York: Pathfinder Press, 1973), p. 50.

instead of a method.¹⁶ Interestingly, after destalinisation, we see a slow development in East European communist philosophy from fundamental law¹⁷ to heuristic tool.¹⁸

The relationship between Quantity and Quality

It is timely to rethink and refine the frequently mentioned notion of a QQT. In the following, we want to discuss the problems that arise from an oversimplified interpretation, as QQT harbours various aspects. To that end, we will identify a number of complications and provide initial impetus for further analysis. But first, it makes sense to return briefly to the idea's originator, Hegel. Hegel wants to transcend the formal, Aristotelian, logic with its static notions of true and false statements. For him, motion is pivotal. According to Hegel we can only understand change if we accept the unity of being-here and not-yet-being-there, since 'there' must exist before we can move towards it. Change, and qualitative change in particular, requires the dialectical understanding of a conceptual triad: Quality, Quantity, and Measure.

Thus, for instance, one measures the lengths of various strings that are made to vibrate with a view to the qualitative difference of the sounds produced by the vibration, insofar as that difference corresponds to the difference in length. Similarly in chemistry the quantity of substances (*Stoff*) that are combined with one another is ascertained to come to know the measurements that condition this combination, i.e. those quantities that underlie specific qualities. In statistics, too, one deals with numbers but they are of interest only because of the qualitative results conditioned by them. By contrast, the mere ascertaining of numbers as such (without the guiding perspective specified here) rightly counts as an empty curiosity that is unable to satisfy either any theoretical or any practical interest.¹⁹

¹⁶ J. V. Stalin, *Dialectical and Historical Materialism* (New York: International Publishers, 1940). Compare Engels's letter to Werner Sombart (11 March 1895). 'But Marx's whole way of thinking [*Auffassungsweise*] is not so much a doctrine as a method. It provides, not so much ready-made dogmas, as aids to further investigation and the method for such investigation.' In: *MECW*, vol. 50, p. 273.

¹⁷ Józef M. Bochenski (ed.), *Die dogmatischen Grundlagen der sowjetischen Philosophie. [Stand 1958] Zusammenfassung der 'Osnovy Marksistoj Filosofii'*, *Sovietica*, (Dordrecht: Reidel, 1959), p. 17.

¹⁸ Herbert Hörz and Ulrich Röseberg (eds), *Dialektik der Natur und der Naturerkenntnis (1990)*, (Leipzig: Edition Unica, 2013).

¹⁹ Hegel, *Encyclopedia*, § 106.

In more abstract terms Hegel argues that Being includes within itself the triad of notions:

Quality is, to begin with, the determinacy that is identical with being in the sense that something ceases to be what it is when it loses its quality. By contrast, *quantity* is the determinacy that is external to being and indifferent in relation to it. Thus, for instance, a house remains what it is, whether it is bigger or smaller, and red remains red, be it brighter or darker. The third stage of being, *measure*: is the unity of the first two, qualitative quantity. All things have their measure: that is, they are quantitatively determined, and their being either this big or bigger is indifferent to them. At the same time, however, this indifference has its limits, and if those limits are overstepped by an additional more or less, things cease to be what they were.²⁰

Hegel's argument is that if a change in Quantity can lead to a change in Quality, then Quantity and Quality must be related to each other. With every given Quantity corresponds a certain Quality. Hegel therefore says that every given Quantity has its own 'measure' (*Maß*). A certain (range of) Quantity belongs to each Quality, delineated by limits.

However, if by limit we understand one which is quantitative and, for instance, a field alters its limit in this sense, then the field remains a field just as before. If, on the contrary, it is the qualitative limit of the field which is altered, what is altered is the determinateness that makes the field a field, and the field then becomes a meadow, a forest, and so on.²¹

Now let's take a closer look at one of Engels's favourite examples of QQT: the periodic table of chemical elements, which received its semi-final form around 1870 in the work of Dmitri Mendeleev. Here the chemical elements are presented in tabular form according to chemical similarity, reflecting the fact (not yet known to Mendeleev) that increasing the number of protons in an atomic nucleus completely changes the chemical characteristic.²² With one proton we have the volatile gas hydrogen, with two we get the

²⁰ *Ibid.*, § 85 addition.

²¹ Hegel, *Science of Logic*, p. 90.

²² Note that in Hegel's, Mendeleev's, and Engels's time this was not yet known. Periodicity of characteristics of elements was analyzed by their relative atomic weight. This is a less exact measure than the number of protons in the nucleus which is equivalent to the number of electrons 'circling' the nucleus. This is a nice example of the historical contingency of laws.

inert (noble) gas helium and with three the metal lithium. The increase of a countable quantity, the number of protons, completely changes the chemical quality.

However, at a deeper level, this example is incomplete. Atomic nuclei also harbour neutrons and the combination of the number of neutrons in relation to the number of protons is not fixed. The different forms of an element (isotopes) may vary widely. For example, iron with 26 protons is most common in nature in combination with 54 neutrons, but less stable forms can also have 55 or even 72 neutrons. Although the chemical quality of iron remains the same, these iron-isotopes do not always react in the same way and have different physical properties. In other words, we determine the chemical properties by the number of electrically positively charged protons, and the same number of negatively charged electrons, but the physical properties of isotopes can diverge considerably. So, which quality are we talking about, in the Hegelian sense?

A comparable example of simple counting used by Engels is the homologous series of alkanes. This is an example of a series in which every addition of an extra 'unit' in a molecule produces an entirely new substance.²³ For example, the gas methane has one carbon atom, ethane has two, propane has three, etc. Once more we need to be very clear which quality (in the previous case it was a proton or electron and here a carbon atom) we take as a starting point. Engels's examples are therefore incomplete, to say the least.

A second complication is that one has to distinguish between different kinds of measures: do we use cardinal counting, ordinal counting, or don't count at all but talk about e.g., many, a lot, heaps of, etc.? In other words, are we able to count an (finite or even infinite) amount or are we dealing with a quantity where numerical representation is secondary? Cardinal numbers describe the size of a collection or set: a human has two eyes. Cardinals are well-defined numbers pertaining to a well-defined object, as in the case of chemical substances. Methane has one carbon atom, propane has three. This is a count of absolute quantities (the number of carbon atoms). The amount defines a pertinent quality. Ordinal numbers are obtained when ordering: which higher or lower position does an object occupy in a series? Ordinals describe a continuous (countable) increase of a property. For

²³ Engels, *Anti-Dühring*, p. 118; Engels, *Dialectics of Nature*, pp. 359-360. An alkane consists of hydrogen and carbon atoms arranged in a tree structure in which all the carbon-carbon bonds are single. Alkanes have the general chemical formula C_nH_{2n+2} .

example, the measure of a yard of linen or a sugar loaf (as Marx uses) where an amount is measured by an – in principle arbitrary – standardized unit of something else. This is the basis of trade.²⁴

Numerical counting of same units (beads, money, and yards), that is to say comparing two different objects by a third common feature, is a further abstraction towards a general equivalent (money). Hegel talks about: '[the] *amount* [*Anzahl*], which is the moment of discreteness, and the *unity* [of a mathematical unit], which is the moment of continuity.'²⁵ This suggests that transitions necessarily imply only numerically countable elements (see also below). In fact, numerical counting and counting systems are a social and not a genetically human ability, just like writing, in contrast to speech; it is also a human capacity which has to actively be acquired. It is important to realize that the ability to count is a very early human achievement, something appreciated only recently.²⁶

Different forms of QQT

Apart from the counting issue, there are several types of QQT. But before we describe them we should clarify that not every qualitative change represents a QQT. There are two possible reasons for this. First, some changes are accidental (a kitten is killed by a car); while other changes are unavoidable (a kitten grows up and dies of old age). In the words of Scott Meikle: 'It is not in the nature of kittens that they meet with fatal accidents, but it is in their nature to develop into cats. One cannot say of a kitten that developed into a cat that 'it met with an accident'. Developing into a cat, unlike getting hit by a car, is necessary not accidental. It is only against a thing's essence that we are able to chart its accidents.'²⁷ QQT always concerns *necessary* changes. This is best exemplified by the Social-Democratic fallacy

²⁴ Witold Kula, *Measures and Men*. Translated by Richard Szepter (Princeton: Princeton University Press, 1986); Emanuele Lugli, *The Making of Measure and the Promise of Sameness* (Chicago: The University of Chicago Press, 2019).

²⁵ Hegel, *Encyclopedia*, § 102. This is not the place to discuss Hegel's struggle with continuity and the foundations of the calculus.

²⁶ Caleb Everett, *Numbers and the Making of Us: Counting and the Course of Human Cultures* (Cambridge, MA: Harvard University Press, 2017).

²⁷ Scott Meikle, *Essentialism in the Thought of Karl Marx* (London: Duckworth, 1985), p. 161.

that a fundamental social change will be based on a majority vote in elections for a bourgeois parliament.

Secondly, a qualitative change may have been caused by another qualitative change. Take the example of photosynthesis where, under the influence of sunlight, carbon dioxide (CO₂) and hydrogen dioxide (water, H₂O) are converted into sugar and oxygen (6CO₂ + 6H₂O → C₆H₁₂O₆ + 6O₂). Here we see a transformation of two qualities into two other qualities without a quantitative change in building blocks: the total number of hydrogen, carbon and oxygen atoms involved remains the same; a typical characteristic of a chemical reaction, from which no chemical atoms disappear. We could call this a *quality-quality transition*.

But *what* is changing with necessity in a QQT? Freezing and evaporation of water are necessary transitions under certain conditions (e.g. pressure). Water has three possible states (steam, liquid, and ice) and may undergo two QQTs. But ice, water, and vapour are all hydrogen dioxide (H₂O). So, in a way nothing fundamental happens with freezing or evaporation, we still talk about water. What then exactly is it that does modify? What is actually changing when the caterpillar becomes a butterfly? Perhaps it is useful to distinguish two kinds of necessary changes: one form involves a change of appearance (*Erscheinung*), the other a change of essence (*Wesen*).

In addition, it is possible to distinguish at least three variations depending on the mechanisms causing the transition. First of all, there is the QQT in which a quality changes due to an *external force or a combination of external forces*. The standard examples are again the phase transitions of water. At a constant pressure of one atmosphere, ice changes into water at 0 °C and into vapour at 100 °C. The relevant energy that causes the phase transitions (back and forth) comes from outside the quality of water.²⁸ In other words, the transition only takes place if there is an external heating or cooling source. In such a system it is the measurable amount of the external energy supplied by or extracted from a source that gives a change of appearance. However, the different manifestations (appearances) of water have fundamentally different characteristics, hence qualities. For example, that one can skate on ice or that one can set an engine in motion with steam. Here again it becomes

²⁸ See also Engels's discussion on the notion of latent heat: *Anti-Dühring*, pp. 57-60.

clear that it is of the utmost importance to determine what quality we are talking about in what situation.

Secondly, there is the QQT due to *growth or contraction*. We have already quoted Hegel's child birth example. The change we are talking about is in fact an internal change of quality. Once a combination of genes has been brought together that can develop in the right nourishing environment, we can deal with a similar QQT as with a phase transition. After all, the developing genotype expresses itself in its development in different phenotypes from first simple cell multiplication via growth stages within the food environment (placenta, egg) and then extreme shape changes to a new and independent quality. Note that the metamorphosis from the fetus to a baby is different from the example of boiling water as during gestation mother and fetus are one organism. Even under situations of terrible undernourishment babies are born, because the body of the mother is an endogenic source of energy, contrary to the external heat administered to liquid water that makes it boil. If we stop heating (by lamp or hen) a chicken egg no development will take place, as if we were heating a stone.²⁹

A third form is the QQT as a result of the formation of a *critical mass*. This notion is derived from nuclear physics and refers to the amount of a substance or combination of substances that may or may not cause a violent explosion. This phenomenon is different from, for example, the accumulation of matter surrounded by a thin wall (as with volcanoes or pustules), where we talk of continuous building-up of pressure until the wall tears apart. Critical mass is the amount of substance needed to make a chain reaction possible, and ultimately a nuclear explosion. In concrete terms, this concerns the build-up of a sufficient number of neutrons (e.g. in a plutonium sphere) where the increase is greater than the reabsorption in order to get a self-amplifying situation. The quantity is then actually the neutron density. This physics-derived understanding of 'critical mass' as a form of QQT, has fostered new insights into the rise and fall of social protest. For example it is claimed that in the United States in the late 1960s, the size of the student body was the only significant

²⁹ Mao Tse-Tung: 'In a suitable temperature an egg changes into a chicken, but no temperature can change a stone into a chicken, because each has a different basis.' *On contradiction*, August 1937.
https://www.marxists.org/reference/archive/mao/selected-works/volume-1/mswv1_17.htm.

predictor of demonstrations and other disturbances on college campuses.³⁰ Obviously, size is here seen as a dominant factor. The same can be said for the Indians of the North American Plains in the nineteenth century:

For most of the year, the members of a Plains tribe lived in small bands of 50 or so. During this time their social structure was exceedingly simple. There was a band headman, but he had little power and few duties. A band that size needed little more. However, when the two dozen or so bands of a typical Plains tribe came together for the summer buffalo hunt, everything changed. A tribal council of band leaders was formed which elected one of their number as tribal chief, and in that capacity he enjoyed greatly expanded powers. He organized and directed all tribal activities, being assisted by the men's societies, which sprang into being as soon as the whole tribe assembled. One of these societies acted as a police force and was charged with keeping order during the buffalo hunt and the Sun Dance ceremony that followed.³¹

Reversibility

QQTs are sometimes reversible and sometimes not. In the case of a change of appearance, where an external influence is crucial, as in a thermodynamic system, things are simple: cool steam and you get water. But if you split a uranium atom into krypton and barium, energy is released and it is impossible to undo this change. The raw materials that compose a biological being perish after death. The cycle 'from dust to dust' is more of a metaphor than a material reality, because the primordial matter is of a very different kind than our remains – unless, of course, we consider the atomic initial and final state. The movements of balls in a billiard game are ideally reversible, but most movements are not. The fact that in the current state of affairs physical laws assume that time (as the measure of change in seconds)

³⁰ Joseph W. Scott and Mohamed El-Assal, 'Multiversity, University Size, University Quality and Student Protest: An Empirical Study', *American Sociological Review*, 34, 5 (October 1969), pp. 702-709; Pamela E. Oliver and Gerald Marwell, 'Whatever Happened to Critical Mass Theory? A Retrospective and Assessment', *Sociological Theory*, 19, 3 (2001), pp. 292-311.

³¹ Robert L. Carneiro, 'The Transition from Quantity to Quality: A Neglected Causal Mechanism in Accounting for Social Evolution', *Proceedings of the National Academy of Sciences of the United States of America*, 97, 23 (November 7, 2000), pp. 12,926-12,931, at p. 12,928.

is reversible, is only a further indication that real changes are not yet fully understood, as only on the lowest level of understanding motion is truly reversible.³²

Layering

That is why it makes sense to speak of a layering of the situation (social, biological, or physical). A certain level has processes that we can express in operational laws. When we enter a higher or lower level, these laws are only ingredients/building blocks for the higher level or results of a lower level. Whilst some (physical/social) laws might continue to hold in more levels, other laws are layer (context) dependent. This levelling is clearly expressed in sequential economic developments such as subsistence economies, capitalism, and socialism. Marx analyses the (immanent) laws of the capitalist mode of production, not those of the Babylonian economy, though in order to reach the capitalist mode of production, deep knowledge of earlier stages is relevant for the analysis of its growth and demise.

However, the way back is not according to the same 'walking map', but through destruction. A society does not go back from capitalism to feudalism. However, for whatever reason, capitalism can self-destruct and enter a period of barbarism.

Freeman and slave, patrician and plebeian, lord and serf, guild-master and journeyman, in a word, oppressor and oppressed, stood in constant opposition to one another, carried on an uninterrupted, now hidden, now open fight, a fight that each time ended, either in a revolutionary re-constitution of society at large, or in the common ruin of the contending classes.³³

Feudal-like structures might again arise from the chaos of barbarism. However, it is not a repetition of moves in a reversible process, but the possible return of forms of domination that resemble historical earlier forms; think of the fallacy of immediately calling any authoritarian regime fascist. History doesn't repeat itself and neither does physical time, contrary to so-defined mathematical time (the parameter t). Within the natural sciences, this

³² This not an obstacle for playing fields like cosmological models that have big bangs and big crunches in their mathematical model. In standard mathematics the parameter ' t ' is certainly linear in both directions.

³³ Karl Marx and Friedrich Engels, 'Manifesto of the Communist Party', in: *MECW*, vol. 6, p. 482.

is a central problem in so-called statistical mechanics, which posits, on the basis of observations, that there is a continuous growth of entropy (chaos) in a closed system. ‘

At this point the discussion on the nature of quantum mechanics is important. The ‘causal’ interpretation of David Bohm arrives at the same experimental results as the ‘orthodox’ interpretation of the Copenhagen school. However, Niels Bohr stipulates that ‘in principle’ the buck stops here and nature is fundamentally (ontologically) probabilistic, which is the reason why many people think physics proves that the world is, in the final analysis, probabilistic. However, David Bohm (an avid reader of Hegel) stipulated that what we see as statistical behaviour is only the result of deterministic processes in a sub-quantum realm.³⁴ Also in solid state physics more levels of organisation with their own conceptual structure can be determined as P. W. Anderson forcefully argues against the idea of a pure hierarchical build-up of matter from so-called elementary particles.³⁵

An important concept for characterising this stratification of reality is called ‘emerging properties’ – properties that pop-up only at a certain level of complication.³⁶ This can be illustrated with the well-known example that, seen from an airplane, the sea is smooth and can therefore be described with simple geometric aids, while the closer we get to the sea surface, the greater the visible irregularities of wave formation and turbulence become.

Transition periods

QQTs rarely happen in a flash; generally there seems to be a shorter or longer transition period. This is even true for an apparently instantaneous change such as the phase transition from ice to fluid water; in fact, a relatively slow melting process occurs in which the added heat has to penetrate every nook and cranny of the sample. Look at your whiskey on the rocks and question the schoolbook wisdom that first the whole ice cube must reach zero degrees before it melts. There always is an intermediary period, however short. Similarly, the metamorphosis from fetus to baby, the act of birth, can take many hours. Infants who

³⁴ David Bohm, *Causality and Change in Modern Physics* (London: Routledge & Kegan Paul, 1957).

³⁵ P. W. Anderson, ‘More is different’, *Science*, 177 (1972), no. 4047, pp.393-396.

³⁶ For an excellent introductory account see: Robert B. Laughlin, *A Different Universe: Reinventing Physics from the Bottom Down* (New York: Basic Books, 2005).

try to stand for the first time on average fall 14.6 times before they succeed; they thus experience 'multiple transitions'.³⁷ The collapse of complex societies such as the Western Roman Empire or the Chinese Western Chou Empire took between 163 and 310 years.³⁸ And the replacement of capitalism by communism is only thinkable as: 'a period of the revolutionary transformation of the one into the other', with a corresponding 'political transition period'.³⁹

How do we define transitions and is it an immediate action or a process? Did the Russian Revolution start in February 1917 or in October 1917? And when was the revolution complete? After Brest-Litovsk? At the end of the Civil War? With the introduction of the five-year plans? Or with the second constitution of 1936, and the emerging of the notion of non-antagonistic contradictions, which, according to the Stalin school, meant that the USSR had reached a fundamentally new societal stage in which the old dialectical laws would be no longer valid and need a novel law?

Our distinction of phases or stages also depends on our level of abstraction (several phases exist in solid matter; transition from solid to gas via liquid intermediate phase or not, etc.). Phase transitions, revolutions, etc. are processes themselves. There exist transitions within the transitions.⁴⁰ George Novack distinguished, in an anthropocentric way, three stages in any 'full and normal' transition:

1. A prenatal or embryonic stage when the functions, structures and features of the nascent entity are growing and stirring within the framework of the already established form.
2. The qualitative breakthrough of its birth period, when the aggregate of the novel powers and features succeeds in shattering the old form and stepping forth on its own account. At this point the fresh creation continues to retain many residues belonging to its preceding state.
3. The period of maturation when the vestigial characteristics unsuited to its proper mode of existence are largely sloughed

³⁷ Karen E. Adolph, *et al.*, 'What is the Shape of Developmental Change?', *Psychological Review*, 115 (2008), pp. 527-543, at 532, 536.

³⁸ Joseph Tainter, *The Collapse of Complex Societies* (Cambridge: Cambridge University Press, 1988), pp. 9-11.

³⁹ Karl Marx, 'Critique of the Gotha Programme' (1875), in: *MECW*, vol. 24, p. 95.

⁴⁰ Tim Wohlforth, 'Transition to the Transition', *New Left Review*, 1/130 (1981), pp. 67-81.

off and the new entity is unmistakably, firmly, strongly developing on its distinctive foundations.⁴¹

All three stages may know several sub-stages. The observation frequently made by ecologists, that 'the transition between two different [ecological] regimes usually involves a period with lower order than either regime',⁴² is an interesting proposition, contrary to Hegelian ever transcending movements to higher stages.

The nature and duration of a transition period depends on intrinsic dynamics as well as on external pressures. The usage of the QQT concept in the social sciences depends on a keen knowledge of the contingencies of the process and on an understanding of its layering. The suggested universality of QQTs in social as well as physical realms is too simple, as in both fields contextuality and proper definitions of a quality as well as the measure of a quantity are equivocal. The Russian Revolution combined three intertwined elements: the struggle of the workers, the struggle of the peasants, and the struggle of the oppressed nationalities each with their specific dynamics. The working class was not very large – possibly two million people in 1917 – but its strike movements achieved an enormous impact. At the same time, the proletariat could never have brought about the downfall of the Tsarist Regime on its own; it needed the support of other social forces. And the (sub) cultures and self-images of workers, peasants and oppressed nationalities in turn diverged enormously and were grounded in the old society. Under these circumstances, the transitional phase of the QQT was structurally determined (in the sense of: setting limits, exerting pressures)⁴³ and the space for political maneuvering restricted.

Lawfulness and predictive value

As we mentioned above, QQT is often seen as a law, but do changes in quantity always lead to changes in quality?

⁴¹ George Novack, 'The Problem of Transitional Formations', *International Socialist Review*, No. 189 (November-December 1968), pp. 17-34, at p.19.

⁴² Leisha Vance *et al.*, 'Toward a Leading Indicator of Catastrophic Shifts in Complex Systems: Assessing Changing Conditions in Nation States', *Heliyon*, No. 3 (2017), e00465.

⁴³ Raymond Williams, *Keywords. A Vocabulary of Culture and Society*. New Edition (Oxford: Oxford University Press, 2015), p. 62.

Perhaps it is more correct to say that the occurrence of a QQT depends on a combination of two factors: on the qualities (pertinent characteristics) of the entity as such and on the external influences acting on it. In this sense, there is always at least one combination of entity and external influences that leads to a QQT, but that combination may be rare in some cases, so that it seems that certain entities always remain ‘themselves’.

Engels called QQT a ‘law’.⁴⁴ But he also thought that it would be better to talk about a method and not a doctrine.⁴⁵ With the advent of modern science in the 19th century, the notion of a fundamental law gained currency, but also laws are expressions of human ingenuity and contingent knowledge. Hence, they are prone to change or reformulation in novel situations, not only in, e.g., civic law, but also in the natural sciences.

First, laws are usually descriptions of highly idealised situations. Once we have defined a law, we can use it to predict a future within the validity of its context and assumptions. When we discover the confines of a law, we must either: (i) add additional defining terms, (ii) redefine our basic concepts, (iii) view the law as part of a more comprehensive law, or (iv) abandon it.⁴⁶ Interestingly, in his studies of Hegel, Lenin already emphasised this in his remark on Hegel’s dictum ‘Hence Law is not beyond Appearance, but is immediately present in it; the realm of Laws is the *quiescent* [Hegel’s italics] reflection of the existing or appearing world...’: ‘This is a remarkably materialistic and remarkably appropriate (with the word ‘ruhige’) determination. Law takes the quiescent—and therefore law, every law, is narrow, incomplete, approximate.’⁴⁷

Secondly, societal laws can only be called ‘objective’ in a very limited sense, since subjective factors always play a crucial role.

What is the corrective to be applied here? It is not, of course, to banish from social theory all the objective factors (that condition human activity), all the non-arbitrary factors in the human disposition and all the structural determining factors in social life. The task is rather: (1) always to relate these factors to active subjects, (2) to

⁴⁴ Engels, *Anti-Dühring*, pp. 60-61, 116, etc.

⁴⁵ See the quote in note 15.

⁴⁶ Richard P. Feynman, *The Character of Physical Law* (Cambridge, MA: MIT Press, 2017); Nancy Cartwright, *How the Laws of Physics Lie* (Oxford: Oxford University Press, 1983).

⁴⁷ Lenin, ‘Philosophical Notebooks’, in *Lenin Collected Works*, vol. 38, p. 151.

grant the subjective a qualitative primacy (for 'objective conditions' are what they are only in relation to definite subjective behaviour trends); and (3) to articulate those aspects of the subject's action that originate in him, are *causa sua*.⁴⁸

Coda

In the foregoing we have tried to show that QQTs can take very different forms. QQT is an 'umbrella' notion which encompasses many variations. QQT cannot be 'proven' by a collection of examples, combined with the pertinent idea that because the world is a unity and humans are a part of it, the same law expresses itself in all situations and levels of organisation. Such a metaphysics smacks of theology and paralyses the human quest for understanding as a force for conscious change. It is necessary to delineate the intricate interplay of the various mixed (or non-linearly interpenetrating) levels of processes. As C. L. R. James said: 'neither nature nor history presents us with the logical forms in their purity. ... We have to co-relate logic and history. ... If you jump at it abstractly, then you will be betrayed as sure as day.'⁴⁹

Acknowledgments

We are indebted to Michael Brie, Hans de Beer and Marta Kirejczyk for kindly providing critical comments on the first draft of this article. We thank Graham Hobbs for securitizing our English.

⁴⁸ Helmut Fleischer, *Marxism and History*. Trans. Eric Mosbacher (New York: Harper Torchbooks, 1973), p. 44.

⁴⁹ C. L. R. James, *Notes on Dialectics: Hegel – Marx – Lenin* (London: Allison & Busby, 1980), p. 183.