A debate over the possibilities for foundations of knowledge has been a key feature of theoretical discussions in the discipline International Relations. A number of recent contributions suggest that this debate is still active. This article offers a contribution to this debate, by suggesting that the study of complexity may provide a contingent foundation for the study of international relations. We examine the grounds on which such a claim might be made, and examine the implications for taking complexity as a foundational claim.

Keywords: complexity theory; foundations; differentiated complexity; international relations
International Relations has, for over twenty years, been engaged in what has variously been called the positivism vs post-positivism dispute, ‘Third Debate’, or sometimes ‘Fourth Debate’. Central to this discussion has been the issue of ‘foundations’ – in other words, what are the bases for the claims to knowledge that we make. The dispute in International Relations reflected a wider reaction across the social sciences to ‘the weakening of deeply rooted urges for firm foundations, invariant truths, and unities of knowledge’ (Lapid 1989, 250). Anti-foundationalists argued that there are no foundations for claims to knowledge. Foundationalists would suggest that there are. In between these two pole positions, a number of other ways of conceptualising foundations have emerged. That this remains a vibrant debate in International Relations is indicated by the recent contributions in *Journal of International Relations and Development* and *International Theory*.\(^3\) Despite the animation of this discussion, research of various types has proceeded regardless, either with a claim to foundations, or on the basis of there being no absolute foundations for knowledge (and it not mattering).

The debate over foundations in International Relations has been seen as central because it relates to what Smith (1995, 28-30) has termed the ‘self image of the discipline’. In the simplest formulation, foundationalism has been seen as central to the claim that there is an external world of which we can knowledge. Anti-foundationalists reject this view. For many students of International Relations, foundations have been seen as crucial because they provide a basis to evaluate competing claims about the processes of international relations. For those that argue that a foundation of knowledge is significant, it is essential for the discipline to be grounded in law-like regularities which allow the possibility of making claims about how the ‘international’ operates. Empiricism provides the foundation for any such claims backed up by statistical methods.\(^4\) Critics of such a foundation have found it relatively easy to pick holes in such an approach on the basis that such empiricism is ultimately a political act and that any such claim is at a minimum mediated by language. Those that are sceptical about foundational claims would make a contrary claim that developments elsewhere (across the range of social and other science) undermine such foundational claims. The study of complexity provides an alternative way of assessing these issues. Complexity has been observed across a range of human and non-human situations, and has made a transition from the study of the non-human world into the study of the social world. It provides a foundation for the study of International Relations because it is an observable phenomena and because many of the concepts developed (such as complex adaptive system, emergence and co-evolution) in association with this phenomenon are applicable to global processes.

The purpose of this article is to examine what contribution a complexity-inspired approach might make to the debate regarding foundations. We concur with Jackson’s (2009, 457) claim that the search for absolute foundations is ‘a specific

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\(^3\) See the symposium in *Journal of International Relations and Development* (2007) 10(1), continued by Wight (2007); and Monteiro and Ruby (2009), plus the symposium in *International Theory* (2009) 1(3).

\(^4\) Two examples of such an approach would be the Correlates of War Programme, and the considerable work that attempts to establish the democratic peace theory. For a discussion of the former see Dessler (1991), for an example of the latter see Lektzian and Souva (2009).
cultural and intellectual project of the European Enlightenment’, however we will argue, drawing on critical realist perspectives, that a complexity inspired approach does provide the basis for a contingent foundation – one worthy of further investigation.

In the first instance, we will claim that complexity does indeed provide a foundation for the study of the social world. In the words of the French social scientist Edgar Morin (2008, 20) complexity is ‘inscribed in phenomena’. Complexity is a phenomenon that can be observed across a range of both physical and social systems, and while, as we will acknowledge, social systems are of a particular character, and they are embedded in non-social and non-human systems. A further claim that we will make is that the social sciences in general have ignored the links between the social world and the rest of the material world.

However, and while up to this point foundationalists (of whatever level of commitment) may have found much to agree with in this article, taking complexity as a foundation has a number of epistemological implications, which will (perhaps) find us closer to an anti-foundationalist position. In complexity thinking, neither the physical nor the social world is mechanical - regularities are not the basis for knowledge; there is no object/subject differentiation; the complex world is ‘unknowable’ in the sense that prediction will always be undermined by uncertainty. In short, a complex approach to the social world will require a profound epistemological re-thinking, or perhaps ‘unthinking’ (Gunaratne 2003).

The article has three sections. The first will explore, briefly, the character of the foundational/anti-foundational debate in International Relations. The second section will establish our claim that complexity provides a foundation for the study of international relations. In this section we will introduce some key complexity concepts, and untangle various complexity ‘approaches’. We will also discuss some of the appropriations of complexity in the social sciences. The third section will consider some of the implications for the study of international relations of taking a complexity approach.

**What is a Foundation?**

A foundation can be seen as the warrant upon which a claim to knowledge can be made. It is the base from which all other theoretical claims can be erected. The most obvious example of a foundational claim is that offered by empiricists: that observation and measurement provide the basis of knowledge. If we can observe something with our senses, then we can claim that it is true. The physical sciences would appear to provide the securest area of human investigation for making foundational claims. In the physical sciences, in particular physics and chemistry advances have been made on the basis of a ‘scientific method’, in particular, the possibility of independent scientists repeating experiments, and verifying results. The possibility of a scientific method has traditionally provided the basis of a claim to

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5 Some overlaps between complexity approaches and post-structural work have been identified by, for example, Dillon (2000) and Cilliers (2005).

6 We prefer to avoid the term ‘natural sciences’ as this is counter to our overall position regarding the anthropocentric qualities of the social sciences in general, and in the current instance, the study of international relations.
knowledge. However, even in the physical sciences, this foundation has shown some signs of weakening. In physics the study of quantum mechanics has opened up many questions about the character of reality (see, for example Wilczek 2008), the most famous being Hesienberg’s ‘uncertainty principle’. Furthermore, Kuhn’s (1962) work on the character of scientific revolutions, suggests that what counts as knowledge is influenced by existing paradigms. Foucault’s (1970) notion of a regime of truth, where what counts as knowable is a function of power makes a similar argument. Hence in the physical sciences the notion of a secure foundation has become open to challenge.

However, the cracks that were starting to appear in the foundations of physical sciences these came back with greater force to haunt the social sciences, or as Brown (1994, 214) described, somewhat more apocalyptically, the surfacing of a ‘crisis of modern thought’. One problem is the difficulty in reproducing results (psychology, and rational choice forms of economics might be exceptions here). In International Relations, the problem is even more extreme – attempting to test a theory about the causes of war is unthinkable. Attempting to observe and detail regularities replaces the possibility of duplicating results (for example, in the case of the increasingly shaky democratic peace theory), and these doubts inform the so-called Third Debate in International relations. In the first instance, if there are reasons to query the certainty of our observations, these are more apparent when it comes to the social world. Most critiques of the reliability of our observations can be traced back to Nietzsche’s comment that our ‘senses nowhere lead to truth’ (Nietzsche 2006 [1873], 115). Secondly, a key contribution of the Frankfurt School has been to argue that we are not dispassionate observers of the social world – we are embedded, socialized and biased by our position in it. To twist Cox’s famous phrase ‘observation is always for someone and for some purpose’. Madison (1991, 25) describes this as ‘context-relevant’. Poststructuralists take the argument further to suggest that our experience of the world is based on the language we use to create it – there is no world of which we can have knowledge independent of the language that we use to describe it, and hence no grounds ultimately for making foundational claims. Madison (1991, 25) describes this as ‘context-dependent’.

The Third Debate in International Relations is often typified as being underpinned by a debate about foundations, with two main positions: foundationalism, and anti-foundationalism. Foundationalists would claim that ultimately it is possible to make truth claims, while anti-foundationalists would dispute this. Yet very few would adhere to these pole positions. In between a spectrum of positions have emerged, which would accept that there will always be room for doubts about any foundational claim, yet would seek to avoid the total relativism implied by an absolute anti-foundational position. There are a number of different terms here, and no consistency of use has emerged. Examples would include ‘weak foundations’ ‘minimal foundations’, ‘contingent foundations’, post-foundationalism, and non-foundationalism.

Without attempting to provide a definition of all these positions, a central dividing line and issue which underlies these viewpoints is whether there can be said to be a reality independent of the human mind. The majority of post-foundationalists would advocate that the world can only be known through language, and hence is not
independent of language. This isn’t to say that there is only language, but rather that ‘one can no more step outside of language so as to compare it with what it supposedly “refers” to than one can step outside of one’s own consciousness so as to compare it with the “reality” it is supposed to “mirror.”’ (Madison 1991, 19). Pouliot uses the term in a broadly similar sense to argue that social constructivists can treat ‘social facts’ as real, because this is how they are considered by actors: ‘social facts are not only the ontological common ground of constructivism, but also its epistemological “foundations of reality”’ (Pouliot 2004, 330).

Weak (or contingent) foundationalists by contrast would argue that there is an external world of which we can have knowledge, even if that knowledge is ‘context-relevant’ and always open to challenge and correction. Shapiro (2005, 174) sees foundationalism as a human need for ‘elegant explanations that make human life intelligible, meaningful and predictable. We want to be able to derive our moral injunctions from a small number of indubitable premises, if not a single one’. We can no more abandon such certainty, he argues, ‘than we can cease to be intelligent creatures’ (2005, 175). Shapiro suggests that it may be better to build our theories with shaky foundations (which are ultimately open to improvement or refutation) rather than no foundations at all. While such ‘contingent naturalist foundations’ will be ‘incomplete and largely empirical’ they could be the basis of ‘principled social criticism’ (2005, 177). From this perspective, science is a progressive undertaking, where making claims about the world constitutes a ‘wager’ open to acceptance or refutation. Foundational claims can be seen as ‘starting points’, which are open to rejection or transformation ‘into ever deeper knowledge of the world’ (Wight 2006, 38).

Our position is that Complexity Theory provides a ‘staring point’ for enquiries regarding international relations. As such it provides in Shapiro’s term, a contingent foundation. It is also in a sense a naturalist foundation because the warrant for this claim would be the large amount of empirical work based on the manifestations of complexity in the non-human world. We argue that the study of complex phenomena provide just such a contingent foundation, open to refutation, or allowing the possibility of deeper knowledge of the world. The next section explains the basis for this claim.

The Foundations of Complexity

This section provides an argument, based on the extensive research into complexity, for the claim that complexity theory provides a foundation for the study of international relations.

Before addressing this issue, however, it is necessary to address the question of the character of complexity theory, and the ways it has been appropriated in the study of the social world. There is no one complexity theory, but rather a series of approaches which draw upon complexity inspired concepts. Two key concepts are shared by complexity approaches: the complex adaptive system; and emergence, or autopoiesis. Systems are understood to exist in a web of connections with other

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7 Though Monteiro and Ruby (2009: 18) use post-foundationalist to mean a position that recognises the ‘limits of foundational arguments’ rather than ‘rejecting their usefulness in toto’.
systems and are internally complex. The term ‘emergent properties’ describes specific qualities that emerge at a certain level of systemic complexity and are not apparent at lower levels. Thus in ecology for example, systems are understood as communities of organisms which link together in a network (Capra 1996, 34-5). Complexity scientists often speak of systems as ‘nested’, with larger scale systems enclosing myriad smaller scale systemic processes (Holling, Gunderson, and Peterson 2002, 68-9). One of the most common and simple elements of the complexity notion of system, is the distinction between a system and its environment which is that the system has boundaries, is delimited and distinguishes itself from its ‘environment’, that is, everything which is outside it. Although distinct, systems interact with one another in a way which has been referred to as ‘coupling’ (Maturana and Varela 1980, 109). Coupled systems may themselves be self-reproducing, so they may come to depend on each other for the preservation of their identities.

Systems have ‘autopoiesis’ and are self-making, self-defining, and self-organising or regulating. Neuroscientists Maturana and Varela (1980, xvii) considered that in adapting and recreating the conditions of life, natural systems should be seen as engaging in a process of cognition. A system then, has internal processes which internally connect its elements and actively reproduce the system as a whole. A controversial and well-known model is Lovelockian earth systems science. Lovelock (2000) developed the hypothesis that the earth was a ‘superorganism’ able to regulate its own temperature. A vast network of feedback loops bring about such regulation, and link together living and non-living systems. In this model, the earth constitutes a single system within which multivariate networks of systems exist, implicating all species, in symbiogenic relations assuming multiple forms. So there are different levels of organized complexity here, and social and natural systems are interlinked.

Changes are processed by systems through feedback loops which synthesise new information and result in the dynamic qualities of systems. Feedback can result in stability, or if there is positive feedback and a change is reinforced rather than dampened down, dramatic shifts can take place and a system can be said to have become ‘path dependent’. Natural systems are characterized in this view by constant, unpredictable and sometimes dramatic change. Systems change though interaction, and complexity scientists have used a notion of co-evolution to describe how systems complexly adapt to their environment. Rather than simply impacting on one another (as implied by a hierarchical model of system) systems have complex reactions to relations with other systems (due to the presence of their own internal systemic features). All individual interacting systems, often of different levels of complexity and scale are changed in their interaction. Thus, change is difficult to predict for systems ‘couple’ – interact in such a way that they assist in the reproduction of each other (Maturana and Varela 1980). Kaufmann (1993, 1995) uses the concept of ‘fitness landscape’ in order to explain how, as one system evolves, it changes the landscape within which other systems evolve. This process involves selection as systems adapt to or are deformed by, other system changes. It also involves temporality. Any process of change takes time (particularly given that Kaufmann’s arguments are developed with respect to the co-evolution of species!).

Change is both temporal and sequenced, and the notion of path dependency has been crucial as a way of understanding how the effects of the past carry through into the present. In complexity science, path dependency has been used in order to
describe how events situated in one moment in time have consequences (in terms of events or developments) later in time (Capra 1996).

This raises a number of issues for understanding processes across time. For example – whether the ‘paths’ taken are significant or rare, and how temporarily they might be taken (Liebowitz and Margolis 1995). Social scientists have been interested in how to theorize the nature of the ‘turning points’, that is, the points at which paths are adopted (Mahoney 2000). Thus in complexity accounts of the world, the simple abstractions of linear analysis (wherein events have direct and proportionate responses) do not apply (Capra 1996). Such understandings have been found pertinent to the study of the social world, for example in terms of social movement processes and institutional change (with respect to gender relations and other forms of intersectionalised inequalities, for example Walby 2007, 2009).

Complexity approaches have been used in a variety of studies of the non-human world. In physics and chemistry complex processes have been identified in numerous instances (see Capra 1996, chapter 5) while in biology complexity approaches have made significant contributions, in particular with reference to the appearance of new life forms. Kauffman’s studies (1993, 1995, 2000) of the evolution of species suggest that more than Darwinian natural selection is at work. Systems have properties of self-organisation that work in tandem with selection to produce ‘the staggering facts of increasing diversity and complexity that stare us in the face’ (Kauffman 2000, 243).

There have also been a range of complexity inspired approaches in the social sciences. The fields of economics (North 1990; Arthur 1994) and management science (Sterman, 2000, 2002; McMillan 2008) have been particularly fertile fields, but as Byrne (1998) points out complexity approaches have contributed to the study of urban planning, education, health provision, and the development of regions, cities and neighbourhoods. In sociology Urry (2003) and Bauman (2000) have drawn extensively on concepts derived from complexity approaches in considering the uneven impact and processes of globalisation. Others have looked at the developments of complex social inequalities across different kinds of national and supranational contexts (Walby 2009) or the non-linear dynamics of individual social movements (Biggs 2001). Less concretely, complexity has inspired a re-working of the concept of ‘a social system’ in sociology (Luhmann 1995). The notion of non-linear development and path dependency has been used to understand the role of political institutions that ‘lock-in’ certain paths to development (Nee and Yang 1999; Pierson 2000, 2001).

International Relations however, has, so far, been relatively more immune to the possibilities of complexity inspired research. Rosenau (1990, 2003) was an early advocate of the application of complexity to the study of global processes. His study of turbulence in international politics (1990) drew on complexity inspired concepts. In a subsequent study (2003, 219) he noted that despite being limited in terms of their capacity to predict such approaches ‘challenge prevailing assumptions that political, economic, and social relationships adhere to patterns traced by linear processes.’ More recently he has become sceptical about the utility of complexity inspired approaches (Earnest and Rosenau, 2006). Further contributions have been made by Jervis (1997), who drew on complexity notions to revive systems based analysis, whilst Cederman (1997) used the concept of emergence to provide the basis for an account of the development of states and nations. Gaddis (2002) has argued that
insights from complexity approaches have much to contribute to the writing of history. A strong case for complexity approaches is made by Harrison (2006) who has brought together a number of researchers working within this framework, though much of this work comprised of network analysis, which is discussed below. Kavalski (2007) in a wide ranging summary of the impact of complexity theory and International Relations has suggested that the approach will inspire a fifth debate. We suspect that this is perhaps over-stating the case, and in the conclusion will consider some reasons why complexity approaches have made less impact on International Relations compared to other areas of the social sciences.

One problem with the application of complexity theory is that, certainly with regard to the social sciences, its core features have been appropriated in a number of different ways. This is to such an extent that it has been seen to be meaningless, and to offer little more than the complexity already available in existent disciplinary canons (sociology, for example, McLennan 2006a, 2006b). We have identified four main ways in which the core concepts have been used. The elasticity of the concepts and their usage has meant that social theorists not only mean very different things in their deployment, but suggest either the existence or negation, of foundations.

**Complexity as a metaphor**

Metaphoric approaches to complexity tend to use complexity concepts as description devices for social processes. The social world can be thought about as complex; it is ‘as if’ the kind of complexity discussed by scientists could be at work. Complexity here provides a terminology, a conceptual repertoire for talking about the social. Sociologist John Urry elaborates an approach to understanding ‘the global’ in complexity terms where complexity is a ‘concept’ (2003, x), albeit one that can contribute significantly to understanding social events. He argues that complexity acts as a metaphor and that notions from complexity thinking can be ‘interrogated in order to assess their fruitfulness in representing those processes implicated in … global ordering’ (2003, 16). While drawing on ideas from complexity theorists such as Capra and Prigogine, Urry (2004, 58) explores whether complexity theory can generate ‘productive metaphors’ that could illuminate globalised social and political events. ‘The science of complex systems,’ he argues, ‘provides a way of thinking about social order’ (2003, 105). In other words, for Urry, complexity would appear to provide a set of concepts for describing the social world, rather than deploying a scientific understanding of complexity as an inherent quality of material reality.

**Complexity as a unified science**

A very different kind of approach to complexity is one that seeks to utilise its insights as a means of providing a unified approach to science. The goal of developing a unified science has been one that has attracted theorists across the social and physical science. EO Wilson’s (1999) discussion of concilience is perhaps one of the clearest calls for such an approach. Unified approaches can be divided between discussions more influenced by mathematics, and those with a more social science/systems approach. A clear example of the latter is the work of Fritjof Capra (a physicist who has turned his attention more to social sciences and ecological issues).

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8 This is discussed further in Cudworth and Hobden (2009).
Capra’s most recent work (2003), *The Hidden Connections* builds on his previous explorations of ecology and complexity physics (Capra 1975) and a broad range of complexity science approaches (Capra 1982, 1996) in specifically analysing ‘upwards’ to the social world. Capra argues that ‘it makes sense to ground the understanding of social phenomena in a unified conception of the evolution of life and consciousness’ (Capra 2003, 3). In other words it is possible to develop means of thinking about the social world which link it with the wider non-human world. Capra (2003, 70) makes the ‘assumption that there is a fundamental unity to life, that different living systems exhibit similar patterns of organization’. If we can gain an understanding of these patterns then this can allow us insights into the workings of human societies.

**Complexity as a network**

A variation of this unified approach is found in the work of physicists and mathematicians who have developed a network approach to understanding social phenomena. The key implication of such an approach is that it opens the social world up to mathematical and computational modelling. Potentially, through the use of such an approach ‘it may be possible to discover mathematical laws and meaningful patterns in the human world’ (Buchanan 2003, 2). Researchers drawing on this perspective go further and argue that the ubiquity of networks in the human and non-human worlds implies ‘that many of the inherent complexities of human society actually have little to do with the complex psychology of humans; indeed, similar patterns turn up in many other settings where conscious beings play no role at all’ (2003, 2). In other words such an approach has profound implications for the study of the social world.

In particular, on a methodological level, they suggest that mathematical and computational methods can be applied, while epistemologically they take the view that complexity theory can be predictive. Miller and Page (2007: 4), for example, ‘hope that there is a complex systems equivalent of Newton’s Laws of Motion.’ They advocate the use of computational methods to analyse complex systems, ‘such tools are naturally suited to these problems, as they easily embrace systems characterized by dynamics, heterogeneity, and interacting components’ (2007: 27).

**Differentiated complexity**

We would argue that there are problems with all three ways in which complexity has been applied as discussed in the previous three sections. Seeing models of complexity as a metaphor undermines the potential contribution that a complexity approach can make. They do not take the social sciences beyond the social and cannot consider the co-constituted qualities, as well as the differences, between social and natural systems. The concilience approaches are divergent, but in some cases there is an inability to account for the distinct features of social systems. Approaches which understand complexity in terms of networks give insufficient attention to the multi-leveling of complex systems, whilst also containing a determinism that is at odds with the notion of dynamic and unpredictably emerging and creative systems. We favour an approach that allows for analytical separation between social and natural systems and can account for the distinctive features of the social, whilst also allowing for inscribed complexity in both human and non-human
systems and the possibility of over-lapping, interrelating and co-constituting qualities of social and natural systems.

There are impacting and co-constituting systems that result from the inter-relation between human social systems and those involving non-human natures. Holling, Gunderson and Peterson use the notion of ‘panarchy’ to describe such systemic configurations which are themselves living systems, with internally dynamic and historically non-static structures which develop mutually reinforcing relationships which are co-constitutive and adaptive (2002, 72-74). There are multiple connections established by feedback mechanisms between both different kinds of system, and different levels of a system. It is not only panarchies involving human systems which demonstrate decision making properties, rather a huge variety of non-human animals make collective decisions and engage in individual decision making behaviour with a cumulate system effect (2002, 85-87). Living systems of humans, non human animals and plants develop self-organized interactions with physical processes. These self-organized interactions do not result in stability. Rather, systems may be vulnerable – ecosystems may collapse or be undermined by human endeavours, political systems may be vulnerable due to the collapse of natural systems on which populations depend for resources, or social shifts (such as economic exploitation, increased literacy rates and so on). Importantly also, these configurations of systems in interaction are themselves complex systems with their own emergent properties (Holling and Gunderson 2002, 41).

This does not collapse the social into the natural (as do network and concilience models) or the natural into the social (as metaphorical approaches tend to do). Rather, there are some qualitative and quantitative differences between ‘natural’ and ‘social’ systems, in particular, because the self-organizing properties of intra human systems outstrip those of natural systems (Westley et al 2002, 104-5). Ecosystems and human social systems are all complex systems in their own right (Scheffer et al 2002, 210). Whilst social and natural systems may be shaped and structured by similar processes, ‘signification allows human systems to divorce themselves to some degree from space and time, the critical organizing dimensions of ecosystems’, and the reproduction of social systems means that they are more mutable (Westley et al 2002, 110). In addition, whilst natural systems have the capacity for ‘remembrance’ for example, biotic legacies), humans and intra-human systems have properties of consciousness and reflexivity.

This however, does not mean that change operates towards self regulation in terms of the maintenance of equilibrium. Rather, human systems may become more easily locked into paths of development that may have serious consequences for certain human and non human species populations. And of course, human systems reproduce and develop formations of relational social power, which, like capitalism, patriarchy and so on, are usefully understood as complex adaptive systems. It is perhaps this which gives us an added challenge in using complexity in social relations. Thus in a differentiated complexity account, there is much to be accounted for. In any specific cases a social scientist might examine, there are likely to be various systems of social power relations at work. These will operate across and through different kinds of institutional systems in the social world that implicate multiple species, and ecosystems in which various kinds of human collectivities are embedded.
While human and non-human systems have distinct features, ultimately they are co-constitutive, overlapping and intersected. Rather than seeing a separation between the human and the non-human, differentiated complexity sees the human world as embedded within the natural world, with the variety of human social systems intersecting with those of other natural systems. Varieties of social systems overlap and intersect with resulting implications for a range of other natural systems (species, scapes, and the wider biosphere). The notion of panarchy provides an effective depiction of the sets of inter-relating systems.

Differentiated complexity allows us to consider systems as distinct, interactive and co-constitutive. It allows for both the embedding of social systems in a range of non-human systems and for specific properties of human social systems, such as the operation of systems of social exclusion and inclusion and multiple power relations. A variety of different sets of power relations have been analysed by social scientists. These represent the operation of different sets of systems, such as patriarchal, capitalist, ethnocentrist, which can have an impact on each other, and have implications for non-human systems. We would argue that, while these can be considered as distinct systems, the development path of each has implications for other systems. This allows for the development of multiple levels and scales of analysis from the smallest of scales to the biospherical. Ultimately, envisioning human systems embedded within a wider range of systems overcomes the duality inherent in the majority of approaches in the social sciences in which the non-human lifeworld is ‘out there’, rather than constitutive of, and reactive to, human systems.

The Complexity of Foundations: Implications for the Study of International Relations

To summarize thus far, we have argued that complexity provides a foundation for the study of international relations on the basis of complex phenomena being observable across a range of physical and social situations. We would argue that complexity has a basis in physics, and therefore we would argue that it is ‘more than a metaphor’, however it is not physics all the way down, as those seeking a unified approach, or consilient, approach would argue. Social systems do exhibit complex characteristics, but do need to be analysed distinctly due to the human ability to be aware of, and to modify, their circumstances.\(^9\)

At this point, it is perhaps useful to distinguish between what Strand (2007, 197) describes as a ‘thick’ and ‘thin’ account of complexity: ‘Within some discourses and practices, complexity [thin] is a well-defined property, simulated in computers, managed by experts and sometimes even quantitatively measured. On the other extreme, [thick] there are other discourses in which the word ‘complexity’ would stand for the quality of neither allowing adequate scientific description nor technological control.’

Complex systems display a number of characteristics that have implications for their study. Many studies of international relations have been based on a

\(^9\) We would not make the claim that this is an exclusively human characteristic, but given the human capability to transform its environment to such an extent that it threatens its own species (along with many others) survival, and to be aware of this situation, is distinctly noticeable amongst human beings.
Newtonian approach to the study of the social world. The central characteristics of such an approach perceive the world akin to a gigantic calculating machine the outcomes of which are regular, repeatable, and pre-determined. This equates to Laplace’s (1902 [1840], 4) speculations regarding an ‘intelligence sufficient vast’ that would be able to ‘embrance in the same formula the movements of the greatest bodies in the universe and those of the lightest atom; for it nothing would be uncertain and the future, as the past, would be present to its eyes’ This model, adapted from the world of physics, is now largely being rejected as a model of the physical world, but ironically clings on in the social world, particularly in rational choice models (seen in the work of Buchanan (2003), for example), and closed system thinking such as structural realism. It is bizarre, as Homer-Dixon (2009, 10) notes that ‘mechanistic and largely deterministic analogs of Newton’s concepts of force, mass, acceleration and equilibrium were infiltrating the social sciences’ at the same time that this mechanical view of the world was being challenged by physicists themselves. As Wallerstein (2000, 31) observes, complexity approaches imply a rather different approach to scientific study:

the sciences of complexity have challenged the fundamental model of modern science, sometimes called the Baconian/Cartesian/Newtonian model, which was determinist, reductionist and linear… this older and dominant model, far from describing the totality of natural phenomena, in fact is descriptive of very special and limited cases. The scientists of complexity invert almost all the premises of Newtonian mechanics, insisting on the ‘arrow of time’ and the end of certainties.

This section assesses the implications for International Relations of adopting a non-Newtonian approach to the study of the social world, and will examine three characteristics of complexity theory which contribute to such an approach: complex systems are non-mechanical and unpredictable; complex systems require a historical understanding of phenomena; the study of complex systems involves a rejection of subject-object differentiation.

**Complex systems are non-mechanical and unpredictable**

A key feature of complex systems is that they can behave in both linear and non-linear ways. In a linear system we would expect there to be a constant and predictable relationship between cause and effect. For example, if I throw a ball twice as hard, I might expect it to go twice as far. Waltz (1979) anticipated a regular relationship between the number of great powers and the characteristics of international relations: a bi-polar system will exhibit greater stability than a uni-polar system. In a non-linear system this relationship between variables breaks down. There is no predictable pattern in terms of the relationship between events, and there is no expectation that the same events will result in the same pattern of results. As Elliott and Kiel (1997, 68) observe ‘Nonlinear dynamics… lead us to question the extent to which we may be capable of both prediction and control in social and policy systems.’

Ultimately a complex approach to the study of the social world suggests that there are very definite limits to which predictability is possible. This is, of course, a less comfortable viewpoint, in particular for a discipline that originated in an attempt
to put controls on the operation of the social world – specifically to find and put limits on the occurrence of warfare. This may indicate why complexity theory has, thus far, made little impact on the discipline (or where it has, primarily in terms of actor based modelling approaches). It is much more reassuring to be able to offer predictions, and to suggest that there may be obvious connections between policy and outcomes. Complexity theory suggests that whilst complex systems can exhibit linear behaviour, this may be the exception rather than the rule, and that prediction based on linearity is successful by coincidence rather than by correlation. As Baker (1993, 133) observes ‘order is always transitory. The pattern of interaction is repeated and then without warning, a change occurs’. It is more reassuring to seek order and predictability, and this may explain the persuasiveness of approaches that suggest that this is possible. However, as Bertuglia and Vaio (2005, 242) indicate ‘a linear tool, even if substantially inadequate to describe natural and social phenomena, with the exception of a very limited number of cases, erroneously appears to be more useful and more correct than a nonlinear one, because the latter does not not allow us to make predictions, whereas the former does.’ Complexity theory suggests that, although less comfortable, the possibilities for prediction-making are limited. Certainty is, of course, a good thing, but ‘if it is a false certainty, then this is very bad’ (Morin 2008, 97).

**Complex systems and ‘time’s arrow’**

The previous section has suggested that the all-pervasiveness of complexity in human and non-human systems implies that they may follow non-linear and unpredictable paths of development. They also follow a non-reversible pattern. A key element of Newtonian physics is that physical processes are reversible, in other words ‘laws governing behavior work the same in both temporal directions’ (Ulanowicz 2007, 29). This notion of reversibility, together with a mechanical view of the world as described in the previous section has been carried over into the analysis of the social world. However such reversibility is not a feature of complex systems, they are the subject of what complexity theorists describe as ‘time’s arrow’.

Time’s arrow has been described by the chemist Prigogine (2003, 56) as ‘the irreversible succession of events’. In essence this relates to the self organizational properties of complex systems. They are in a constant state of flux, and are ‘active and creative’ (Gulbenkian Commission 1996, 61). In other words, complex systems do not remain in a ‘constant state’ where the interactions between the parts can be modelled, as if their features were fixed. They are constantly changing, and in particular, over time become more complex. Complex systems develop in an organic fashion whereby the interactions between the parts, and the character of their interactions, become increasingly multifaceted. In this process systems and agents change in ways that are not reversible. As McGlade and Garnsey (2006, 3) observe, ‘It is … difficult, if not impossible to study [a complex system’s] properties by decomposing it into functionally stable parts’.

Complicating matters further, in complex systems feedback mechanisms are seen as central to the understanding of systems development. Furthermore, complex systems are seen as being very susceptible to minute changes in initial conditions. In other words very small fluctuations in starting circumstances can result in major changes in terms of the development of the system. The classic example of this is, of course, Lorenz’s notion of a butterfly flapping its wings in Brazil resulting in a
tornado in Texas, though it might perhaps not be too difficult to think about similar examples from the realm of international politics.

These characteristics of complex systems have considerable implications for the study of the social world. We have already argued that complex systems exhibit unpredictability. We would also argue that because of their actively creative features, it is the development of social systems that should be studied. This would be a distinctly different approach from that of, for example, Waltzian Neorealism. Waltz sees the international system as essentially unchanging because of the determinant features of anarchy, which conditions states to act in certain ways. Complexity theorists would argue, assuming that the international system is a complex system, that while it may be stable for a certain period of time, autopoiesis would be likely to result in changes in the character of the system. The central contribution that students of international relations can make is to study the development of that system, its self-organising characteristics, and its relations to other human (such as capitalism, colonialism, patriarchy) and non-human (other species, the biosphere) systems. Sensitivity to initial conditions and the very large potential impacts of very small events also suggests that causal analysis is a rather uncertain undertaking in the analysis of complex systems. Ultimately a historical approach is the only means to understanding the development of complex systems and the character of complex systems implies the need to adopt a historical approach. As has been argued, the future of International Relations is the study of the past (Hobden 2002).

**Complexity Theory and Subject-Object Differentiation**

As noted in the previous section, a feature of complex systems is that small events can have a large impact. This extends to the role of the researcher, and the impact that pursuing a particular line of enquiry might have. Based on a Newtonian worldview that saw the world as external to the observer much of the social sciences have maintained a view of a strict distinction between subject and object. This strict distinction between subject and object started to break down in the physical sciences in quantum mechanics where in the famous two slit experiment, the result of the experiment was found to depend on what was actually being measured. As the physicist Heisenberg (quoted in Law and Urry 2004, 395) observed ‘What we observe is not nature itself, but nature exposed to our method of questioning’. Subject-object differentiation has come under considerable criticism in the social sciences and in International Relations. Initial scepticism came from a critical theory perspective, noting that our values direct and colour our observations, and from a poststructural perspective where the focus has been on the analysis of discourse.

A complexity approach would acknowledge (in common with Critical Theory) that values play a role in the research process, though (contrary to poststructuralism) that there is an external world of which we can have knowledge (however contingent that knowledge might be). Where subject-object differentiation breaks down for complexity theorists is in the inter-connectedness and over-lapping of systems. By carrying out research and measurement, students of international politics impact on the subjects of study. As noted by Bertugalia and Vaio (2005, 268), complexity approaches imply ‘the idea that an observer cannot be detached from the real situation that [s]he is describing. The act of measuring in itself perturbs the state of what is being measured, which leads to the abandonment of the idea that we can obtain a totally objective description of a reality detached from the observer and in itself
objective’.

This is a slightly different position from radical constructivists (see for example Smith 2004), however it does suggest that the act of study is neither neutral nor without impact. Our research can cause ‘perturbations’ in and beyond the systems that we are studying with unpredictable results. Hence, as Wendt (2006, 217) notes there is an ethical element to our undertakings: ‘If IR scholars are irreducibly participants in the super-organism that is world politics… then we have ethical responsibilities to the other subjects of those politics in measuring them, responsibilities which we do not necessarily have if facts and values can be clearly separated as in the classical worldview.’ Small actions then can have a larger impact, and though we would disagree with Law and Urry (2004) that in carrying out research we are ‘enacting the social’, which sound far too purposeful and determinist, our actions as students of international politics are not without potential (though unpredictable) results. The Newtonian notion of a distinction between subject and object breaks down from a complex perspective because of the overlapping of complex systems and the possibility that action can occur at a distance.

**Conclusion**

This article has argued that complexity and the study of complexity provide a foundation for the study of international relations. Complexity is an observable phenomenon across a range of human and non-human systems, and complexity theory has made considerable in-roads in other social sciences. A variety of reasons could be advanced as to why complexity theory has, to date, made relatively little impact on International Relations. In our view these issues say more about International Relations as a discipline rather than about the potential for complexity inspired approaches to contribute to an analysis of global processes.

Firstly there are misunderstandings as to what is meant by a complexity approach. As we have indicated, complexity thinking in the social sciences has been developed along several, significantly different pathways in the social sciences, with some major ontological and epistemological implications. One view of complexity approaches is to see it as linked to biological determinism (Bell, 2006). As we have argued, a key feature of the complexity approach that we advocate is their non-determinist character. A further misunderstanding is that complexity approaches cannot analyse power. This was at the core of Earnest and Rosenau’s (2006) critique. In their view complex adaptive systems were different from those that have authority structures. While we would agree that some complexity approaches have provided an inadequate account of power, recent work, in particular that by Walby (2009: 46) has drawn on the notion of ‘fitness landscape’ to develop an analysis of power relations.

Perhaps a more significant problem for International Relations theory is the view of science that complexity approaches imply. Under challenge, the bulk of mainstream International Relations theory has relied on a positivist approach where predictability of outcomes has been a key indicator of ‘good science’. As with much of the social sciences this view is modelled on a Newtonian account of science which complexity approaches have done much to undermine (Guarante 2003). Rather than making a ‘fundamental assumption that the universe is ordered’, complexity approaches bring a focus on ‘variation, change, surprise and unpredictability to the center of the knowledge process’ (Baker 1993, 123-124). In other words, a central
claim of complexity approaches is that we need to learn to live with uncertainty rather than rely on a predictability that is not achievable (Morin 2008, 97). This challenges the central tenets of the mainstream of international relations.

While we have argued that complexity theory provides a foundation for the study of international relations, these foundations are far from straightforward, and imply a profound epistemological re-think. According to Gingrich (quoted in Beaumont 2000, 4) complexity ‘does not yield answers, at least not in the sense of those we have typically sought to describe our world and predict its events since the beginning of the Scientific Revolution. What it does yield is a new way of thinking about the world’. Complexity theory suggests that there are limits to what the social sciences are capable of. It is possible to study the processes of emergence and to track the developments of social systems, and to increase our awareness of them as embedded within other social systems. It does ‘not provide us with exact tools to solve our complex problems, but shows us (in a rigorous way) exactly why those problems are so difficult’ (Cilliers 2005, 257). However the grounds for prediction are limited, apart from to predict the unexpected. Indeed, given the history of the past twenty years, an approach to the study of international relations whose core message is to expect the ‘unexpected’ might have been anticipated to make a considerably larger impact.

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