Forum: The Philosophy of Classification

Some Classifications Will be Natural

Rachel Cooper

I'm very grateful for the opportunity to contribute to this forum on the philosophy of classification. My Ph.D. was in the History and Philosophy of science,

I think it is plausible that we have evolved to see certain classifications

and much of my research has concerned philosophical problems regarding classification in psychiatry. My book *Classifying Madness: A Philosophical Examination of the D.S.M.* (Springer, 2005) was reviewed by Professor Birger Hjørland in 2008 in this journal. The D.S.M., or Diagnostic and Statistical Manual of Mental Disorders to give it its full name, is the classification of mental disorders published by the American Psychiatric Association. The system is revised every fifteen years or so, and the next edition, D.S.M.-V, is expected to be published in 2013. Although a U.S.-based system, the D.S.M. is influential worldwide. Psychiatric research commonly employs D.S.M. diagnostic criteria to select subject populations; psychoactive drugs are developed for the treatment of particular D.S.M. diagnoses; textbooks in psychiatry frequently follow the structure of the D.S.M. In *Classifying Madness* I consider four main issues that have arisen in the debates about the D.S.M.

– What are the boundaries of mental disorder? How can one distinguish mental disorders from moral failings or normal forms of human suffering?

(continued next page column 1)

Kinds, Classification and Realism

Fulvio Mazzocchi

I would like to thank *Knowledge Organization* for this interesting initiative, as well as their authoritative contributors for having triggered a stimulating ex-

There are no fixed boundaries between kinds or a unique way of carving nature at its joints

change of ideas on foundational issues. I do believe that the issue of classification is particularly apt to promote a space for transcending the disciplinary and sub-disciplinary barriers in which the communities of different areas of specialization are divided, and any effort in this direction is a worthwhile undertaking.

The philosophy of classifications relates closely to the natural kinds problem. This is treated at many levels, since it implies a position on what exists (ontology); how we come to know what exists (epistemology); and the meaning of the terms assigned to what exists (philosophy of language). Classification is a fundamental aspect of science too. Scientific theorization is associated with the development of classification schemes. It is not a coincidence that Kuhn (2000) in his later works tended to replace the idea of paradigm with the notion of lexical taxonomy, i.e. the taxonomic structure projected by scientific theories upon the world. The debate about natural kinds is a central topic of the philosophy of many scientific disciplines, chemistry included. In this short piece, I will not enter into the discussion on the periodic system as a natural classification. Instead the focus will be on

(continued next page column 2)

– Can mental disorders be natural kinds? Does the aim of constructing a classification of mental disorders that reflects natural distinctions make sense?
– What is the relationship between classification and scientific theory? Is it possible to have a theory-free classification system?
– How has the D.S.M. been shaped by social and financial pressures?

The first issue is specific to psychiatry, but my findings with regard to the other three issues may be of relevance for thinking about classification more generally. In this discussion piece I will outline the main findings from my own work with regard to each of these issues, and consider how this might connect with the discussion between Professors Hjørland, Scerri and Dupré on the Periodic Table in the previous forum.

1.0 Natural kinds and promiscuous realism

Natural kinds are the kinds of thing or stuff that are recognised by science. When philosophers talk of natural kinds the primary examples they have had in mind have been chemical elements and biological species. Identifying natural kinds is important because classifying on the basis of natural kinds will allow us to control, predict and explain the behaviour of the entities in a particular domain. For example, once I know that a particular sample is lead, I can predict how that sample will behave and how I should treat it if I wish to achieve particular aims. In the case of chemistry, classifying by element plausibly works because all samples of an element share the same atomic number, and this lawfully determines many of their other properties.

In *Classifying Madness* I consider whether any notion of natural kinds can be applied to mental disorders. I make use of Dupré's Promiscuous Realism, which he originally developed when thinking about classification in biology, and argue that it can usefully be applied to the psychiatric case (Dupré 1981, 1993). The key claim of Dupré's Promiscuous Realism is that the world is such that very many potentially fruitful classifications are possible. Dupré asks us to imagine the properties of some domain mapped out in a multi-dimensional property space, as in cluster analysis. In such a space, entities that share many properties will cluster closely together, while those that share fewer properties will be far apart. If we were to map biological organisms some clusters would correspond to traditional biological species.

(continued next page column 1)

the question of realism that underlies the natural kind debate and the possibility of maintaining a realistic position while acknowledging the role of the observer in how reality is known.

When Scerri (2011, 21) affirms that "the chemist did not impose a structural prejudice upon chemical analysis. The latter is a feature that arose, presumably because the world itself contains discrete structural components such as atoms and electrons," he is expressing a classical form of realism, according to which the world exists independently of—being prior to—human thought. It is divided into (at least basic) kinds and an objective (scientific) knowledge can be gathered about it by reproducing its real structure. In the Western tradition the first formulation of a realism about natural kinds can be found in Plato's *Phaedrus*, in which his method of collection, "seeing together things that are scattered about everywhere and collecting them into one kind," and division, "cut up each kind according to its species along its natural joints," is described. Thereby, nature is believed to be structured into parts that are demarcated by objectively existing boundaries (the joints).

Natural kind realism can, however, be formulated into two main versions, namely monism and pluralism. Monistic realism implies the singleness of boundaries between kinds: only one natural way of distinguishing them. It is often associated with essentialism, whereby all members of the kind share a common essence by which they can be identified. Essentialism has a long established tradition originating from Aristotle. Its contemporary versions, too, basically claim that the true nature of things is formed by an intrinsic set of properties, which are contrasted with accidental properties. Essences are what make an object "what it is."

Scientific realism frequently incorporates monistic and essentialist assumptions. It supposes that for any scientific field there is only a single set of non-overlapping natural kinds, which are distinguished by means of their essences (generally coming in the form of microstructural properties), and that their discovery can be encapsulated in a single, comprehensive classification system. Scientific classifications basically aim, therefore, at representing real divisions in nature. This is what is believed to occur in the case of the periodic system of chemical elements, a classification system at the core of chemistry. The periodic system is used to define the chemical elements, which indeed represent one of the most paradigmatic examples of natural kinds. The elements are identified by means of their atomic number. For example, as stated

(continued next page column 2)

However, the structure of clusters will be messy and complex. Some clusters will be clear, others will blend into each other. Depending on the level of resolution, we may see one cluster or a grouping of smaller clusters. We might focus in on particular dimensions and just classify with regard to particular properties; for example, we might classify mushrooms on the basis of whether or not they are edible. Dupré's picture is realist—the ways in which entities cluster depend on the properties that they possess, but it is promiscuous in that the world is such that many distinctions could be drawn and so decisions have to be made as to which distinctions are of importance.

In some of Dupré's writings he gives the impression that classification can be based on any similarity relations whatsoever—one gets the impression that classification on the basis of colour can be on a par with classification by atomic number (1981, 1993). In other writing the possibilities for fruitful classification are restricted, and only classifications on the basis of distinctions that are of some theoretical importance are permitted (2002). I suggest that the less permissive version of Dupré is the most fruitful. Dupré himself tends to shy away from talk of natural laws, but someone who lacks his metaphysical scruples might think of classification and properties in the following way: The properties that an entity possesses lawfully determine the sorts of causal interactions that it can undergo—for example, the property of having sharp teeth might fit an animal for meat eating, the property of having a complete outer shell of electrons makes a chemical inert. On such a picture, not all properties will be equal. Some will be of greater significance because they will be lawfully linked to greater numbers of other properties. For example, colour properties are plausibly relatively unimportant because they are lawfully linked with few other properties, whereas a property like atomic number is lawfully connected to many more properties. When the aim of classification is to predict and explain the behaviour of the entities in some domain (i.e. in most scientific classification) we do better to focus on those properties that are of greater causal significance. In certain domains, for example, plausibly biology and psychiatry, different ways of classifying the domain may be live possibilities. In his work, Dupré argues that different classification systems are best suited to the needs of different researchers in the life sciences (2001). Ecologists are most interested in the current characteristics of organisms, and for such purposes distinguishing species on the basis of current phenotypical features makes sense. Evolutionary

(continued next page column 1)

by Scerri (2011, 22): "the identity of gold does not reside in its being a certain color or possessing a shiny appearance or indeed in displaying any particular 'property' as such but just in its having an atomic number of 79."

Scientific realism can also take on a pluralistic form, which is usually associated with anti-essentialist positions. Natural kinds are seen as classes of individual items that share some properties, but this does not necessarily mean these are intrinsic properties or essences of the kinds. Pluralistic realism conceives the structure of the world as being made of a multidimensional complexity. Things are interconnected and interrelated to one another in many complex ways. There are no fixed boundaries between kinds or a unique way of carving nature at its joints. This complexity cannot be encapsulated into a single, universal way of classifying. Every classification is formulated not only by means of the (objective) properties of the objects, but also in response to the special purpose of the classification. Since the latter can change, e.g., being science-oriented or pertaining to what is considered part of ordinary life, multiple ways of segmenting the world into kinds are possible, and yet none can be seen as prevailing over the others. This occurs also within the context of science. For example, there are different modes of taxonomizing biological entities, depending on the approach employed in biological systematics. To put in Dupré's words (1993, 18): "My thesis is that there are countless legitimate, objectively grounded ways of classifying objects in the world. And these may often cross-classify one another in indefinitely complex ways. Thus while I do not deny that there are, in a sense, natural kinds, I wish to fit them into a metaphysics of radical ontological pluralism, what I have referred to as 'promiscuous realism.'"

Interestingly, also Aristotle, who is credited with being the father of essentialism, with regards to zoology, sustained (in *Parts of Animals I* and *History of Animals*) a view about natural kinds that resembles contemporary versions of pluralistic realism (Henry 2011). Aristotle conceives the living world as containing natural kinds, which are demarcated by real, objective boundaries. However, he denied that it is possible to ascribe zoological entities to a unique set of mutually exclusive and non-overlapping kinds. Nature is typified in fact by many cross-cutting joints. Which joints are chosen to be cut along depends at least partially on the explanatory framework. Animals can be arranged according to a multiplicity of perspectives, and this might imply multiple cross-

(continued next page column 2)

theorists, on the other hand, pose research questions that are best served by a classification that depends on relations of ancestry. Dupré argues that all can live in harmony, and that particular subdisciplines should be permitted to classify as best suits their needs.

Given that my work draws heavily on Dupré, I had expected to agree with his comments in the previous forum. However, the discussion of the Periodic Table surprised me. All three authors seemed to accept the idea that the Periodic Table is in some way a good example for thinking through how classification can be expected to work in science more generally. Thus the question of whether one or multiple classification schemes are imaginable in chemistry became key. Although chemistry is of course an important area of science, and figuring out how the Periodic Table might work is thus of interest, I would want to challenge the assumption that a discussion of the Periodic Table can inform discussion of classification in science more generally. Most science isn't like chemistry. In particular I was surprised that Dupré seemed so concerned to prove that pluralism is a reasonable stance to take with regard to chemistry. Given that Promiscuous Realism is a realist position, the divisions that we can sensibly distinguish depend on the structure of the world. Maybe it will turn out there are some domains where the causal structure of the domain is such that one particular classification system just makes far more sense than others. I take it that Dupré's work on classification in biology has been sufficient to show that multiple classification systems are not only imaginable but actual in the life sciences. Given that the life sciences are important in their own right, this is sufficient to prove the case for Promiscuous Realism, and I think that Dupré could afford not to care whether alternative classification systems are viable in chemistry.

2.0 Theory and classification

The third chapter of *Classifying Madness* asked whether classification in psychiatry requires a theory of mental illness. One of the reasons the D.S.M. is a particularly interesting classification system is that the committees responsible for constructing the D.S.M.-III (1980) sought to make it atheoretical. They reasoned that theories of mental disorder are so contested that it would be best to aim for a purely descriptive classification system that made no theoretical assumptions. The hope was that such a classification system would be acceptable to practitioners with widely different theoretical models of mental disor-

(continued next page column 1)

classifications and overlapping kinds. According to Henry (2011), the main difference between Aristotle's and contemporary pluralistic positions like Dupré's promiscuous realism, is that while the latter tends to consider most classifications (including those based on common sense) of a certain domain of reality as equally legitimate, for Aristotle only scientifically significant groups that have an explanatory power on the basis of their role in causal investigations are recognized as natural kinds. A set of individuals is seen as forming a real kind when it can be proved that the unification of their common features is based on the existence of a determinate cause: corresponding to what is known as essence. Hence, the naturalness of a kind depends by far on the causal structure of the world. Since the biological world is typified by a complex causal structure, pluralism in classification derives from the fact that different causal investigations will focus on different (and equally valuable) types of causal relations.

The pluralistic line of argument furnishes a perspective on natural kinds (chemical kinds included) that is based on the acknowledgement that the world is highly complex and that a linear, univocal representation cannot be easily provided. It is still admitted, if my reading is correct, that the multiplicity of kinds into which, in relation to different purposes, the world can be segmented, exists independently of the human mind. Perhaps with the tacit assumption that the way in which the kinds are in actual fact, is matched very closely by the way in which we perceive and describe them.

I will now briefly explore another possible (and weaker) version of realism that refers to the theoretical background of constructivism and partially puts into question this last assumption.

In the light of constructivist epistemology, knowledge is not seen as a reproduction but as a viability within constraints (von Glaserfeld 1984). It depends on reality since any observer is exposed to (individual) stimuli from the world-environment: cognition starts with a stimulus from the external or internal environment. The world retroacts, produces a feedback, on the way in which the observer attempts to portray it (and yet any feedback is still understood in the light of a given standpoint). Finally, the world is investigated by a subject exhibiting life and mental properties, and all of this is still part of reality. It depends nonetheless also on the observer since stimuli are first selected and then manipulated (categorized and classified) according to the observer's aims and cognitive means.

(continued next page column 2)

der (psychoanalysts, biologically-oriented psychiatrists, and so on). Similar movements have occurred elsewhere in science at particular times. In some of the biological sciences, numerical taxonomy (factor analysis, cluster analysis, and so on) has been championed on the basis that so little is known about evolutionary history, that a "purely empirical" method of classification is to be preferred (Sokal and Sneath 1963).

In my work I examined the techniques of numerical taxonomy, as applied in psychiatry, and argued that all such techniques require one to have a theory of mental disorders. Before one can perform a cluster analysis or factor analysis, one has to collect data on many variables. However, those with different theories will disagree about the variables that are worth measuring. For example, in a cluster analysis of psychopathology, biologically-orientated psychiatrists will want to include biological variables but may well consider variables linked to "defence styles" to be irrelevant. Psychiatrists adhering to different theoretical frameworks will disagree. As a theory is needed to determine which properties will be relevant, classification in psychiatry cannot be theory-free.

How generalisable are these claims? Is classification always informed by a theory? I think that the arguments that I employed in arguing that classification in psychiatry is always theory-based cannot be fully generalised. In classifying certain domains our evolutionary history may play a greater role. For example, different species of middle-sized organisms generally look different to humans. We don't need to try hard to discover kinds of middle-sized biological organisms because we have evolved to be able to see similarities and differences in this domain. Plausibly, this is because an ability to sort such biological organisms has been evolutionarily beneficial, as it helps humans work out what is good to eat, and how to get it. Similarly, one may expect humans to be fairly good at picking out kinds such as water (at least in the sorts of environments in which we evolved). I think it plausible that we have evolved to see certain classifications. Such a claim is compatible with adopting a Promiscuous Realist stance about classification in the life sciences. An evolved ability to see some of the distinctions that might be drawn between organisms is compatible with there being a variety of other distinctions that sciences might choose to recognise.

In many areas of science, however, the entities being classified are not ones with which humans would have had close acquaintance throughout evolutionary history. Pure elements are rarely found in nature,

(continued next page column 1)

Our knowledge of the world contains, therefore, both an objective and a subjective (in the sense of being linked to a given established perspective or tradition of thought) dimension.

This is in agreement, I believe, with realistic assumptions that humans develop their thoughts "in a world that exists independently," or that "nature cannot be forced into any conceptual structure that we provide. Nature makes resistance. Our conceptual structures therefore – in the long run—have to adapt to reality" as stated by Hjorland (2011, 13) paraphrasing Kuhn. The world does not seem in fact an inert matter. It is instead dynamic, flexible but offers also resistance. Many but not all representations of it are possible or produce the expected results.

The question here is to establish what (of the world) exists independently and what exists also in reason of our descriptions. There is a big difference in hypothesizing an underlying level of reality to be not much more of a continuum (some sort of a distribution of energy, for example), or as if it were made by individual items, or postulating that classes of things, such as kinds of animals or objects, "exist independently." Furthermore, not only our conceptual structures in the end have to adapt to reality, but man, also by means of these, acts on the world-environment and can modify it. The subject-observer and the object-as-the-world (or its parts) are involved in a circular process of mutual interaction and adaptation. Reality holds the power to determine the success or failure of our constructions, and at the same time it reveals the marks of their influence.

The sort of realism I have in mind could be named constructive realism. This term, which seems almost an oxymoron, is already employed in philosophy of science to indicate an approach sharing some of the assumptions discussed here. This means that our way of representing the world, i.e. our "world-version," which still determines the character of the world in which we live (including the fact that it is populated by given natural kinds), are in a sense relative to us. However, what is not relative to us is the world-in-itself, whose very existence forms the basis for different versions of it to be developed (Vihalemm 2003).

In the light of this, the search for natural kinds can perhaps function as a regulative ideal, and the possibility that the world-in-itself is divided into some sort of natural kinds can be still admitted. This does not necessarily imply, nonetheless, that the kinds exist in the world-in-itself precisely in the way in which we perceive and describe them from our positioned standpoint, i.e. as they appear in our world-versions.

(continued next page column 2)

mentally disordered people were only found in numbers with the development of asylums, viruses can only be seen under microscopes. In such areas, a theory is needed before the domain can be classified.

3.0 Classification and its applications

The third issue I addressed concerned the ways in which classification systems are affected by their uses. The D.S.M. is used for a wide range of purposes—textbooks are structured around D.S.M. categories, drugs are marketed for the treatment of particular diagnoses, researchers use the criteria to select subject populations, and so on. In *Classifying Madness* I examined the ways in which the D.S.M. has been shaped by its use by the US medical insurance and pharmaceutical industries. In the US, one major use of the D.S.M. has been to justify payments by medical insurance companies. Because funders will only pay if a disorder has a D.S.M. code, various groups have lobbied to have conditions included in the D.S.M. because they seek insurance payments. For example, Vietnam veterans lobbied to have Post Traumatic Stress Disorder included in the D.S.M. because this would mean that their treatment would be reimbursable. Other important uses of the D.S.M. are in the development, use, and marketing of psychopharmaceuticals. Drug trials use the D.S.M. criteria to pick out subject populations for drug trials, drugs are licensed for the treatment of particular D.S.M. disorders, and treatments tend to be aimed at particular disorders. Pressures stemming from such uses affect the D.S.M. For example, David Healy has shown that the activities of drugs companies seeking to develop niche markets for their products have brought particular disorders to prominence (Healy 1997).

One part of Hjørland's review of my book that I found particularly suggestive concerned the ways in which classification systems like the D.S.M. come to inform the ways in which knowledge is organised. Hjørland talks about how thesauri have been "made compatible" with the D.S.M. It seems to me possible that via such mechanisms a bootstrapping effect might emerge. Suppose a theory is the best at some point in time. Knowledge is organised on the assumption that the theory is correct. Given that future researchers depend on dictionaries, libraries and so on in conducting their research, their research may now be more likely to confirm the initial theory. Maybe by such mechanisms a theory might become entrenched.

Certainly the D.S.M. has been affected by pressures emerging from the ways in which it is used, but

(continued next page column 1)

The problem of most realistic positions is not therefore to postulate the objective existence of (a given set of) natural kinds or of their distinctive features as such, but when an absolute value is assigned to these postulations. Of course, what we conceptualize as natural kinds are involved in many scientific explanations and causal relationships: as scientific entities, they "went through long periods of adaptation, correction, and modification, and then allowed scientists to produce previously unknown effects" (Feyerabend 1989, 400). They can also be implicated in various long-settled practices of ordinary life. And on the other hand, in different historical ages, also in association with different scientific paradigms, and in different cultural environments, man has found meaningful alternative ways of describing the world and dividing it into discrete parts.

To summarize, what I have called constructive realism acknowledges that a reality-in-itself exists and, of course, influences our way of rendering it. Every description and subdivision into kinds is constrained by the resistance posed by this reality. And yet, multiple descriptions and classifications are possible as far as they offer a meaning to the life of people employing them, and a basis for surviving and co-adapting in their world-environment.

References

Dupré, John. 1993. *The disorder of things: metaphysical foundations for the disunity of science.* Cambridge, MA: Harvard University Press.

Feyerabend, Paul. 1989. Realism and the historicity of knowledge. *The journal of philosophy* 86: 393-406.

von Glasersfeld, Ernst. 1984. An introduction to radical constructivism. In Watzlawick, Paul, ed., *The invented reality: how do we know what we believe we know?* New York: W.W. Norton, pp. 17-40.

Henry, Devin. 2011. Aristotle's Pluralistic Realism. *The monist* 94: 197-220.

Hjørland, Birger. 2011. The periodic table and the philosophy of classification. *Knowledge organization* 38: 9-21.

Kuhn, Thomas S., Conant, James, and Haugeland, John. 2000. *The road since structure: philosophical essays, 1970-1993, with an autobiographical interview*. Chicago: University of Chicago Press.

Scerri, Eric. 2011. What is the nature of the periodic table as a classification system? *Knowledge organization* 38: 9-10, 21-23.

(continued next page column 2)

can similar effects be expected in other areas of science? I expect that classifications in other areas of science will also be affected by pressures stemming from their applications. However the mechanisms via which classification systems can be shaped will vary from case to case, and so case-based studies would be required to understand how such effects operate.

4.0 Concluding comments: are classifications discovered or constructed?

Finally, it is time to tie the discussion together and consider the big question on which I've been asked to comment: Are classifications discovered or constructed? In making such questions tractable, a suggestion by the philosopher Ian Hacking may be useful. Hacking argues that at their core disagreements between social constructivists and realists can be understood as being about the contingency, or otherwise, of scientific findings (Hacking 1999). The constructivist about x claims that if history had developed differently our conception of x would be very different. Applied to classification schemes, the claim would be that if history had been somewhat different the classifications that we recognise today would never have been recognised.

In my work, I have argued that at least within psychiatry, the world is such that multiple classification systems are possible, classification depends on theory, and the D.S.M. has been shaped by its applications. Together these claims imply that the contingency claim is true. If history had been somewhat different, if for example, psychoanalysis hadn't fallen from prominence in the United States, or if psychoactive drugs hadn't been discovered, then instead of something like the D.S.M. we would have some other sort of classification system. The contingency claim is thus true of the D.S.M. This being said, successful scientific classification systems, such as the D.S.M., map at least some of the causal structure of their domain. The world is such that the distinctions drawn by the D.S.M. are amongst those distinctions that are causally significant.

In other areas of science, things may be somewhat different. I have suggested that we may have evolved to see certain domains as being structured in particular ways. In such areas, some classifications will be natural, in the sense that all humans, regardless of their theoretical beliefs, may be expected to see them. In general, we do well to bear in mind the enormous range of classifications. Different domains differ in important respects, and classifications are created to serve a huge variety of needs. Though case studies examining particular classification systems are suggestive, generalising their findings is never straightforward.

References

American Psychiatric Association. 1980. *Diagnostic and statistical manual of mental disorders.* Washington, D.C.: American Psychiatric Association.

Cooper, Rachel. 2005. *Classifying madness.* Dordrecht: Springer.

Dupré, John. 1981. Natural kinds and biological taxa. *The philosophical review* 90: 66-91.

Dupré, John. 1993. *The disorder of things: metaphysical foundations of the disunity of science*. Cambridge, Ma.: Harvard University Press.

Dupré, John. 2001. In defence of classification. *Studies in history and philosophy of biological and biomedical sciences* 32: 203-19.

Dupré, John. 2002. Is 'natural kind' a natural kind term? *The monist* 85: 29-49.

Hacking, Ian. 1999. *The social construction of what?* Cambridge, Mass.: Harvard University Press.

Healy, David. 1997. *The antidepressant era.* Cambridge, Mass.: Harvard University Press.

Sokal, Robert B., and Sneath, Peter H.A. 1963. *Principles of numerical taxonomy*. San Francisco: W.H. Freeman.

Vihalemm, Rein. 2003. Natural kinds, explanation, and essentialism in chemistry. *Annals of The New York Academy of Sciences* 988: 59-70.

Contact: Institute for Complex Systems, CNR - National Research Council, Via Salaria Km 29,300 - C.P. 10 00015, Monterotondo St. (RM), Italy.
<fulvio.mazzocchi@isc.cnr.it>

* * *

Contact: Rachel Cooper, PhD, Senior Lecturer in Philosophy, Politics,Philosophy & Religion, County South, Lancaster University, Lancaster, UK.
<r.v.cooper@lancaster.ac.uk>

* * *