Chapter 11

The Science and Teaching of Energy

The central feng shui notion of *chi* has been for centuries translated into English as 'energy', this being the term used in the first English translation of Ricci's *China Journals* (Ricci 1615/1953). Clearly attention needs be paid to the changing meaning of the word in English, or more accurately to the progressive differentiation of the scientific meaning of 'energy' from the multifarious, everyday meanings of the term. When *chi* is translated as 'energy' there is a tendency to think that because scientists and feng shui practitioners are using the same word they are talking about the same thing. They are not. Neither talking about the same thing, nor talking about it in the same way.

Energy and Metaphysics

Energy is the central conceptual component of modern science – all modern science, not just physics (Coopersmith 2010, Feekes 1986, Sherman 2018). Mario Bunge observed: 'All the sciences that study concrete or material things, from physics to biology to social science, use one or more concepts of energy' (Bunge 2000, p.458). There are as many types of energy as there are types or classes of natural processes: kinetic, potential, magnetic, nuclear, chemical, and so on. Energy is a property of all existent things; hence it is universal. But it does not exist apart from things of which it is a property. Einstein's 'most famous equation in the world' unites energy with mass, energy with something; there is no 'free-floating' energy (Fernflores 2012, Lange 2001). For Bunge:

> Because it is ubiquitous, the concept of energy must be philosophical and, in particular, metaphysical (ontological). (Bunge 2000, p.458)

But being metaphysical does not license obscurantism, incoherence, or contradiction. Richard Feynman in his famous *Lectures on Physics* well stated the centrality of energy in modern science:

> There is a fact, or if you wish, a *law*, governing all natural phenomena that are known to date. There is no known exception to this law — it is exact so far as we know. The law is called the *conservation of energy*. It states that there is a certain quantity, which we call energy, that does not change in the manifold changes which nature undergoes. That is a most abstract idea, because it is a mathematical principle; it says that there is a numerical quantity which does not change when something happens. (Feynman 1963, Lect.4.1-4.2)

And that:

> It is important to realize that in physics today, we have no knowledge of what energy *is*. We do not have a picture that energy comes in little blobs of a definite amount. It is not that way. However, there are formulas for calculating some numerical quantity, and when we add it all together it gives "28"—always the same number. It is an abstract thing in that it does not tell us the mechanism or the *reasons* for the various formulas. (Feynman 1963, Lect.4, sect.4.1, p.2)

Although he modestly says that he does not know what energy is, he is prepared to defend the claim that whatever it is, it is conserved. And far from Feynman's lecture legitimating all alternatives to orthodox scientific understanding of energy, he is prepared to say that

psychoanalysis is not a science and that witchdoctors' recourse to spirits as the cause of disease likewise marks them as non-scientific (Feynman 1963, Lect. 3, sect. 3.6). So long as chi remains in the spiritual heavens, then its violation, or otherwise, of energy conservation cannot be ascertained. But as soon as chi putatively engages with worldly processes and enters terrestrial energy chains, such as the supposed 21 bodily meridians, then it enters the domain of science and can be shown to violate the conservation law. So there is a stark choice: maintain the cornerstone of science or have chi; having both is not possible.

History and Conceptual Refinement

Some history is also important because it shows fundamental differences between modern (post 17th century) scientific approaches to understanding energy, and approaches in the ancient and contemporary feng shui tradition. The scientific term 'energy' was introduced by Thomas Young (1773-1829) in his Royal Society lectures of 1802 and given currency when these were published in 1807. For Young:

> The term 'energy' may be applied, with great propriety, to the product of mass or weight of a body, into the square of the number expressing its velocity. (Young 1807, p.52)

He is saying that 'energy' is the word to designate the quantity mv^2 which was Huygens, Leibniz and Laplace's measure of *vis viva* (vital force). Eventually half of this quantity, $\frac{1}{2}mv^2$, became the measure of one of the many manifestations of energy, namely kinetic energy, that is the energy of a moving body.

Young did not invent the word; the English word 'energy' had a heritage of 2-3,000 years stretching back to the pre-Socratic philosophers. Heraclitus (c.535-450BC) uses the Greek word *ενέργειας* to refer to the source of movement. The term was Latinized as *enérgeia* a compound of *en* (to) and *ergon* (work). For Heraclitus:

> En-ergon is the father of everything, king of all things and, out of it, all forms of contrast originate. Since 'en-ergon' is common to everything, it is vital for life itself. (Feekes 1986, p.1)

This Pre-Socratic conceptual connection of work with energy was thereafter cemented.

Aristotle's use of *enérgeia*, as with all of his philosophical concepts, cast a long shadow in pre-modern Western philosophy and natural philosophy. Aristotle took up and to some degree refined extant meanings of the term, but still it has different meanings in his own writings. In his *Ethics* and his *Metaphysics,* it refers to actual activity in contrast to the potential or disposition for activity which is Latinized as *dýnamis*; change (the process of moving from potential to actual) cannot happen without involvement of *enérgeia* (Lindsay 1974, chaps.1, 2).

Although movement, especially 'natural motion' was important for Aristotle's physics, there is little attempt to quantify it. And the vital distinction between work (effort) being done (expended) over *time* and effort being expended over *distance* was not made. In the late-medieval period, better measurement, conceptualization, and experimentation on what Aristotle labelled 'local motion' (what is now called simply movement), and the formulation of the conservation of momentum law, was the prelude to modern understanding

of energy. This was an ambiguity which centuries later caused significant, but needless, controversy between Descartes and Leibniz over the conservation, or otherwise, of force.

As with so much else in classical mechanics, it was Galileo's pendulum investigations that were central to ideas of the conservation of momentum.[1] When a pendulum bob at rest was released, it swung down gathering speed and rose to exactly the same height; if the swing was interfered with by a nail in a board or wall, then the bob still rose to the same height even if it travelled a shorter path. In all cases, ideally, the 'motion' gained at the nadir of the swing was precisely that needed for it to regain its initial height. Galileo knew that in reality, due to impediments and accidents, the bob did not regain its exact initial height. If the bob collided with a suspended identical stationary bob, the latter rose to the original bob's height. Galileo in his *Dialogues Concerning Two New Sciences* writes:

> But all these momenta which cause a rise through the arcs BD, BG, and BI are equal, since they are produced by the same momentum, gained by fall through CB, as experiment shows. (Galileo 1638/1954, p.172)

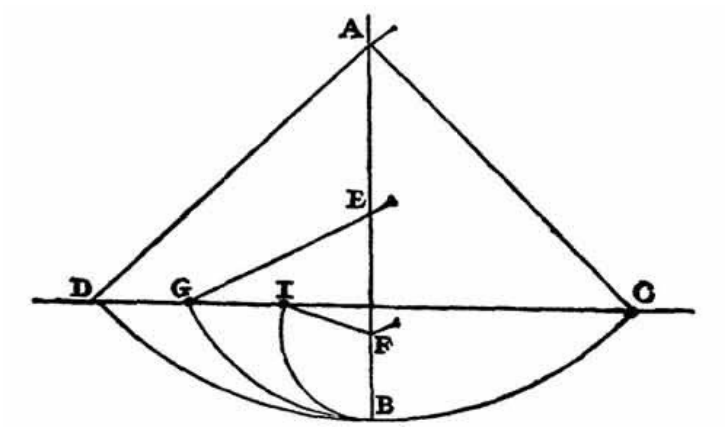

Fig. 11.1 Galileo's Pendulum

Galileo's idea or 'law' of conservation of movement (*momenti*) which was a multiple of mass and speed (mv) enabled him and others to do many things in early modern mechanics, including to answer the seemingly incontrovertible argument of the stationary earth proponents that bodies dropped from the top of a tower on a spinning earth should *not* fall to its base, but fall a considerable distance to the west (Finocchiaro 2010, pps. 124-29). Descartes in his *Principles of Philosophy* famously took up the conservation idea giving it a philosophical and theological interpretation:

> … it seems to me evident that it is God alone, who in His omnipotence created that matter with motion and rest, and who now preserves the universe in its ordinary concourse as much motion and rest as He put into it at creation. For although motion is nothing but a mode of moved matter, it exists in a certain quantity which never increases or diminishes, although there is sometimes more and sometimes less in certain of its parts. (Hall 1970, p.268)

Neither Galileo nor Descartes clearly separated force from momentum, and they did not conceptually separate motion as a *scalar* quantity (modern day 'speed') which had no

[1] See the 32 contributions to Matthews, Gauld & Stinner (2005).

direction, from motion as a *vector* quantity tied to direction (modern day 'velocity'). What will become the Newtonian and modern 'conservation of momentum' law applies only to momentum (**p**) as a direction-dependent vector quantity: **p** = m**v**. It is only for vector quantities that Descartes collision laws held, and then only for elastic collisions. In these cases, momentum before a collision equals momentum after the collision, and given that mass is known, velocities after a collision can be determined.[2] The problem was by-passed by Huygens who used mass multiplied by the square of velocity as his measure of momentum (force); this was then a scalar, that is, direction-independent quantity. It became known as a measure of a body's *vis viva* (vital force).

This was fundamentally a conceptual, and ultimately a philosophical, not an empirical problem, at the birth of modern physics. The concepts under discussion included force, quantity of motion, momentum, quantity of progress, vis mortua (dead force), and vis viva (living force). The issue 'raged' between followers of Newton (1643-1727), Descartes (1596-1650) and Leibniz (1646-1716) over about a fifty-year span following publication of Leibniz's 1686 critical essay 'A Brief Demonstration of a Notable Error of Descartes and Others Concerning a Natural Law' (Leibniz 1686/1956). The debate is known as the *Vis Viva Controversy* (Iltis 1971). The subtitle of Leibniz's essay is revealing: 'According to Which God is Said Always to Conserve the Same Quantity of Motion'.

All the foremost Western scientists of the period were comfortable with invoking the Deity as justification both for their research, and as foundation for their axioms and principles. Modern science assuredly was not Godless – Leibniz, for instance, wrote a defence of the Roman Catholic doctrine of Eucharistic Transubstantiation (Leibniz 1668/1956) - but God did not figure in Newton's, Descartes', or Leibniz's scientific systems. God does not appear in any equation or explanation of an experimental outcome. Where in the latter cases, this might appear to happen, God is there as a place-holder until a naturalistic explanation is uncovered. In no case in modern science is it sufficient to say: 'God did it' and then walk away. How God did it? And, Does He always do it? Are the inevitable questions. This is in stark contrast to comparable yin-yang and five-element explanations in the fung chi tradition.

The *vis viva* controversy was finally clarified using the mathematical derivation which begins with the definition of uniformly accelerated motion and is now readily found in standard physics textbooks. The standard expression for force times displacement is:

$$F\,s = \frac{1}{2}mv_2^2 - \frac{1}{2}mv_1^2$$

and it shows that, when a resultant force is considered as acting over a *displacement*, then the familiar terms for kinetic energy appear, with force times displacement being the change in kinetic energy.

Similarly, the expression for force times time is:

$$F\,t = mv_2 - mv_1$$

and, in turn, this shows that, when a force is considered as acting over a period of *time*, then the familiar terms for momentum appear, with force times time being the change in

[2] This is the textbook equation: $m_1v_1 + m_2v_2 = m_1v_1' + m_2v_2'$.

momentum. It was Jean d'Alembert (1717-1783) in 1743 who saw that both measures (force times distance, and force times time) were just different conventions for measuring the manifestation or effect of the one force.

Newton - by 'standing on the shoulders of giants' as he says of his dependence on the achievements of Galileo, Brahe, Kepler - came to believe that nature was united by the operation of a very limited number of universal forces:

> For the basic problem of philosophy seems to be to discover the forces of nature from the phenomena of motions and then to demonstrate ther other phenomena from these forces … we derive from celestial phenomena the gravitational forces by which bodies tend toward the sun and toward the individual planets. Then the motions of the planets, the comets, the moon, and the sea are deduced from these forces by propositions that are also mathematical. If only we could derive the other phenomena of nature from mechanical principles by the same kind of reasoning. (Newton 1726/1999, p.382)

And he adds:

> For many things lead me to have a suspicion that all phenomena may depend on certain forces by which the particles of bodies, by causes not yet known, either are impelled toward one another and cohere in regular figures, or are repelled from one another and recede. Since these forces are unknown, philosophers have hitherto made trial of nature in vain. But I hope that the principles set down here will shed some light on either this mode of philosophizing or some truer one. (Newton 1726/1999, pp.382-383)

His other 'phenomena of Nature' were to include optical, magnetic, chemical, thermal and sundry other effects. Newtonians attempted to bring all of these, along with electrical phenomena, into one explanatory force-based, atomistic system which became known as the 'mechanical worldview' or 'corpuscularianism' (Dijksterhuis 1961/1986, Schofield 1970, Westfall 1971). There was an ambiguity in this programme between 'mechanical' meaning 'by contact', the Cartesian view, and 'mechanical' meaning 'contact and deterministic force acting at a distance', the Newtonian view, the common denominator was uniformity and determinism; things happened because of external, regular, 'knowable' causes (Westfall 1971). The mechanical worldview was opposed to all chaotic, spirit-moved, undetermined views of the world. This 'naturalism' became a presupposition for the conduct of modern science. As Fang Lizhi observes, it was in contrast to the situation in traditional Chinese natural philosophy:

> A major difference between ancient Chinese astronomy and its Western counterpart was that the latter was always concerned with *explaining* the apparent irregularities and anomalies in the motions of the planets, while the former was not. … Chinese astronomers were untroubled by phenomena that departed from the norm, and in fact were quite taken with them. (Fang 1989/1992, p.34)

The whole Newtonian idea of recourse to unseen force, or forces, as the explanation of visible events was criticized by Ernst Mach (1838-1916) from his staunchly positivist perspective. He maintained that force (or any other such theoretical construct) was unnecessary and uninformative; the idea of force added nothing to what was already seen, it

had only a 'book-keeping' function (Mach 1893/1974, pp.298-305).[3] Nevertheless the Newtonian programme as laid out in his *Principia* (Newton 1726/1999) prepared the ground for the modern physics of energy which began appearing in the middle 19th century (Harman 1982).

Of course, the extant concepts that were the object of Mach's empiricist critique, did have a book-keeping function because they were rigorously defined and connected to empirical states of affairs. Chi lacks any reference; nor can it perform a book-keeping role as it is persistently ill-defined or not defined at all.

Animal Magnetism

Natural philosophers had done many quantitative and experimental investigations of different energy phenomena – heat, magnetism, light, electricity, etc. Through the 18th and into the 19th centuries they were each thought to be independently the result of the workings of separate fluids or substances – animal magnetism, phlogiston, caloric, igneous fluid, magnetic fluid, electrical fluid, luminiferous ether, and so on. They were referred to as 'imponderable' or 'subtle' fluids.[4] They are as close as Western science has come to entertaining anything comparable to universal chi energy. Attention to how mainstream science examined and made judgement on these conjectured subtle fluids provides lessons for the diligent appraisal of chi claims; lessons for both the West and the East. Such lessons highlight an important difference between science and pseudoscience: the former applies a critical and sceptical analysis to its theories and hypotheses, dismissing or modifying them when they don't measure up, whereas the latter has no such internal evaluative mechanisms; conjectures and assertions are not checked, they are taken on authority or self-interest.

A prominent example of the development of a chi-like 'science' in Europe was that promoted by the German physician Franz Anton Mesmer (1734-1815). He was well educated in philosophy, theology and law; and then studied medicine at the University of Vienna, where in 1766 he completed a doctoral thesis 'Physical-Medical Treatise on the Influence of the Planets' (Mesmer 1766/1980). The title reflects his conscious, or otherwise, connection to the Hermetic tradition in European thought. He took as a given the influence of the moon on bodily function, repeating the commonplace observation that: 'The symptoms of epileptics tend to reappear at the new moon and especially at the full moon, resulting in their being called *lunatics* (Mesmer 1766/1980, p.15).

Mesmer's early Viennese studies and clinical experiences led him to postulate an all-pervasive, superfine, invisible, cosmic 'fluid' that held the solar system together and enabled Newton's gravitational forces to operate at a distance. But beyond astronomical duty, this fluid also seeped into human and animal bodies affecting their constitution and behavior. His 1766 thesis launched 'animal magnetism' on to the Western scientific and medical stage:

> There is a force which is the cause of universal gravitation and which is, very probably, the foundation of all corporal properties; a force which actually strains, relaxes and agitates the cohesion, elasticity, irritability, magnetism, and electricity in the smallest fluid and solid particles of our machine, a force which can, in this report, be called *animal gravity*. (Mesmer 1766/1980, p.14)

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[3] Many philosophers have discussed this issue. See at least Ellis (1976), Hunt & Suchting (1969).
[4] Among many studies, see Alexander (2015) and Schofield (1970, chap.8).

By 1775, in a letter to Dr. A.M. Unzer, he had changed his terminology to *animal magnetism* and reported on many properties of the fluid and on its clinical manipulation by natural and artificial magnets: 'Menstrual periods and hemorrhoids were restored to their normal condition … I cured all kinds of hypochondriac, convulsive, and hysterical irregularities' (Mesmer 1775/1980, p.28). Animal magnetic fluid could be manipulated by magnets because of its 'extreme subtlety and similarity to nervous fluid' (Mesmer 1775/1980, p.29). And the fluid could be transferred from doctor to patient over distances:

> Without any direct communication and from a distance of eight to ten feet, moveover being hidden behind a man or a wall, I roused jolts in another part of the patient that I wanted to, and with a pain as ardent as if one had hit her with a bar of iron. (Mesmer 1775/1980, p.28)

In his 1779 Dissertation he quotes another 1775 letter to another 'Foreign Physician' in which he gave an 'exact idea of my theory':

> I set forth the nature and action of ANIMAL MAGNETISM and the analogy between its properties and those of the magnet and electricity. … all bodies were like the magnet, capable of communicationg this magnetic principle; that this fluid penetrated everything; that it could be stored up and concentrated, like the electric fluid; that it acted at a distance … Finally, I accounted for the various senstations and backed these assertions with experiments which enable me to put them forward. (Mesmer 1779/1980, p.51)

Elsewhere he emphasizes the 'alternating "flow" of streams – coming and going – of a subtle fluid which fills the space between two bodies. … it is impossible to cause a displacement without a corresponding replacement' (Mesmer 1779/1980, p.107). This morphs into the supposition of both positive and negative animal magnetism or positive and negative fluids. He encapsulated his theory in a series of 27 propositions, including:

1. There exists a natural influence between Heavenly Bodies, the Earth and Animate Bodies.
2. A universally distributed and continuous fluid, which is quite without vacuum and of an incomparably rarefied nature, and which by its nature is capable of receiving, propagating and communicating all the impressions of movement, is the means of this influence.
3. This reciprocal action is subordinated to mechanical laws that are hitherto unknown.
4. This action results in alternate effects which may be regarded as an Ebb and Flow. (Mesmer 1779/1980, pp.67)

27...In conclusion, this doctrine will enable the physician to determine the state of each individual's health and safeguard him from the maladies to which he might otherwise be subject. The art of healing will thus reach its final stage of perfection. (Mesmer 1779/1980, p.70)

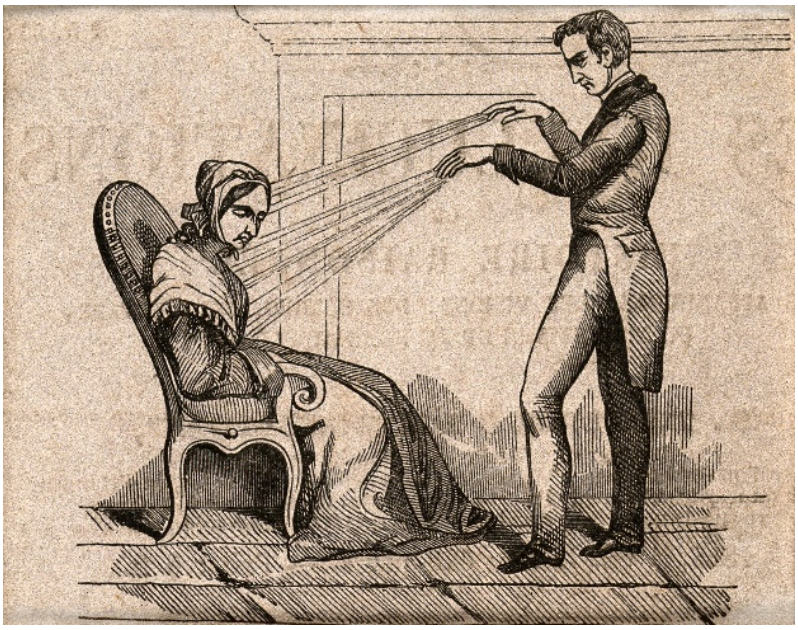

Fig. 11.2 Animal Magnetism Therapy[5]

Mesmer describes curing many patients in Vienna, Swabia and Switzerland. Overwhelmingly they were women suffering from a range of maladies including colic, apoplexy, hemiplegia, ophthalmia, and blindness. He used natural and artificial magnets and touch to add, substract or move a patient's animal magnetism. His fame spread; he was admitted to the Scientific Academy of Münich; folk 'flocked to my house'. Between 1774 and 1775 he was caught up in a dispute over the curing practices of an Austrian Catholic priest: half of Vienna regarded him as a charlatan, half saw him as the agent of God's miraculous interventions. Mesmer thought neither: the priest had unknowingly become a 'tool of Nature' by stumblingly onto the manipulation of animal magnetism (Mesmer 1779/1980, p.57). But popular fame was accompanied by professional disappointment:

> However, being wearied by my labors extending over twelve consecutive years and still more so by the continued animosity of my adversaries …I felt I had done my duty by my fellow citizens. (Mesmer 1779/1980, pp.64-65)

In 1778 Mesmer left Vienna and set up a large medical and healing practice in pre-Revolutionary Paris. Newspapers of the time had stories headed: 'Everyone is occupied with mesmerism', 'The great subject of all conversations in the capital is still animal magnetism', 'Men, women, children, everyone is involved, everyone mesmerizes' (Darnton 1968, p.40). In most major cities 'Societies of Harmony' were founded to promote magnetic therapy. But there was professional opposition, and by 1781 Mesmer had 'insulated' his theory by claiming that animal magnetism could only be detected by a hitherto unrecognized sixth 'artificial' sense; something he had and could only be enabled by training: 'it must be transmitted by experience. Experience alone can render my theory intelligible' (Mesmer 1781/1980, p.135).

Enough Parisian physicians and natural philosophers regarded him as a charlatan, or perhaps simply as an out-of-town competitor, that in 1784 they succeeded in having Louis

[5] From Wellcome Collection: https://wellcomecollection.org/works/h5ccrkrf

XVI establish a Royal Commission, chaired by Benjamin Franklin and including Antoine Lavoisier, to investigate Mesmer's claims.[6] It issued, just five years before the beginning of the Revolution, 'The Franklin Report' (Franklin et al. 1784/2002, 1784/2014).[7]

The terms used nearly 250 years ago to justify the Commission have a contemporary ring:

> The government could not remain indifferent to a question of this kind that affected the health and the life of its citizens, and, because according to the system of M. Mesmer and his disciples any individual could simply by practising magnetism, cure anyone, the whole science of medicine would become useless; it would be necessary to close the medical schools, to change the system of instruction , to destroy the corpus of works believed until the present to be depositories of medical knowledge and to change everything to the study of magnetism. In an affair of this importance the government had to be on its guard against both too facile belief and too unbridled incredulity. It was necessary to acquire information before coming to an opinion, it was essential at least to avoid the reproach of precipitate prejudice. Such are the motives that have given rise to the setting up of the Commission whose report we present. (Franklin et al. 1784/2014, p.30)

These are all the very same concerns raised in 'Alternative Medicine' debates, especially when matters of government funding, health insurance, university credentially, and treatment efficacy are on the agenda.

The Commission gave an honest digest of Mesmer's theory, saying that for him, animal magnetism was:

> An agent universally distributed throughout the whole of Nature; it is the mechanism of a mutual influence between the celestial bodies, between the earth and animate bodies; it is combined in such a way as not to allow any vacuum; its subtlety is beyond comparison; it is capable of receiving and propagating all the impressions of movement; it is susceptible to flux and reflux. The animal body demonstrates the effects of this agent and it is by insinuating itself into the nerves that it affects them immediately. One recognizes, in the human body in particular, properties similar to those of the magnet; in it diverse and opposite poles can be distinguished. The action and the power of animal magnetism can be communicated from one body to other bodies, animate and inanimate. This action takes place at considerable distance without the intervention of any intermediate body; it is augmented [when] reflected by mirrors, and communicated, propagated and increased by sound; this power can be accumulated, concentrated and transported. Although this fluid is universal, all bodies are not equally susceptible to receiving and transmitting it; there are even some, though a small number, which have a property so opposed [to it] that their mere presence destroys all the effects of the fluid in other bodies. (Franklin et al. 1784/2014, p.30)

The commissioners recognized, in the way that most current feng shui and alternative medicine advocates do not, that merely testing the effectiveness of treatment did not advance the main question because many illnesses cure themselves, placebo effects are rampant, and cures have ultimately to be linked to specific mechanisms in order to have scientific sanction. Not surprisingly, given Franklin's and Lavoisier's involvement, the Commission was sensitive to methodological issues:

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[6] The commission actually examined a surrogate for Mesmer, another magnetic physician, M. Deslon.
[7] The context, composition, and functioning of the Commission is described in Darnton (1968, pp.62-64).

> The art of drawing conclusions from experiments and observations consists in evaluating the probabilities and in judging whether they are large enough, or numerous enough, to amount to proof. This type of calculation is more complicated and more difficult than one thinks; it demands great sagacity and is, in general, beyond the powers of most men. It is upon their errors in this type of calculation that is founded the success of charlatans, sorcerers and alchemists; and, in other times, of magicians, enchanters and all those who deceive themselves and attempt to pretty on public credulity. (Franklin et al. 1784/2014, p.26)

And:

> After having seen the effects at the public treatment it was necessary to disentangle their causes and to look for evidence of the existence and the utility of Animal Magnetism. Animal Magnetism can well exist without being useful, but it cannot be useful if it does not exist. (Franklin et al. 1784/2014, p.43)

They observed that:

> Touchings, imagination, imitation, these are the real causes of the effects attributed to this new agent advertised under the name *animal magnetism*. The practice of magnetism consists of the art of increasing the imagination by degrees; gaze, pressure, touching seem to act as a preparation, the nerves begin to be agitated, imitations communicates and expands impressions. (Franklin et al. 1784/2014, p.36)

And: 'Magnetism seemed ineffective on those who submitted to it with some scepticism' (Franklin et al 1784/2014, p.52). They conducted many 'cures' and concluded that 'imagination necessarily accounts in great part for the effects attributed to magnetism' (Franklin et al 1784/2014, p.55). After much testing and examination their conclusion was comprehensive and damning:

> The Commissioners, having recognized that this animal magnetic fluid cannot be perceived by any of our senses, that it has no effect, either on them or on the patients who are subjected to it; being assured that the pressures and touching occasion changes which are rarely favourable to the animal economy, and disturbances that are always disturbing to the imagination, having finally shown by decisive experiments that the imagination, with magnetism, produces convulsions, and that magnetism without imagination produces nothing, have concluded unanimously about the question of the existence and utility of magnetism, that nothing proves the existence of animal magnetism; that this non-existent fluid is consequently useless. (Franklin et al. 1784/2014, p.37)

And they ruled out the possibility of any refinement of Mesmer's theory because its ontological presuppositions were simply false, they did not accord with how the world was:

> If M. Mesmer announces a larger theory, it will only be more absurd; celestial influences are an old chimera whose falsity has been long recognized; all this theory can be judged in advance by that which magnetism necessarily as for its base, and it can have no reality because the animal fluid does not exist. (Franklin et al. 1784/2014, p.70).

They could have, but did not, point to the 'get out of jail' card that Mesmer had dealt himself by adding 'negative' animal magnetism to his ontology. Among his 27 Summary Propositions, is:

> 19. This opposing property also penetrates all bodies; it may likewise be communicated, propagated, stored, concentrated and transported, reflected by mirros and propagated by

> sound; this constitutes not merely the absence of magnetism, but a positive opposing property. (Mesmer 1779/1980, pp.67-68)

So the failure of a test does not count against the animal magnetism theory, rather it supports the theory by indicating the presence of negative magnetism. Despite the scientific penumbra around Mesmerism, this in-built, no-failure clause renders it non-scientific on standard Popperian and falsificationist criteria. Given that Mesmerism wears a scientific cloak, this built-in no-failure clause makes it a pseudoscience. Such clauses define pseudosciences.

With Franklin and Lavoisier among the Commissioners its procedures and methods reflected Enlightenment science. This makes the Animal Magnetism episode instructive for scientists, philosophers and students. The commissioners were not simple positivists. They were not of the 'If we cannot see it, it is not there' school. They recognized that while scientific entities and realities were legitimately inferred from observation, not all such inferences were warranted. Different Mesmerists were riding on the back of gravitational attraction, magnetic fields, caloric, and electric phenomena to claim existence for their particular 'unseen', 'weightless', 'colourless' magnetic fluid. The Commissioners were conscious of needing to rule out the latter in a way that did not rule out the former; to rule out Mesmer but not Newton. [8]

The Commission's findings dealt a blow, but not a fatal one, to Mesmerism. Many leaders and supporters of the Revolution embraced Mesmerism on account of it being opposed by the cultural, academic and medical elite of the *Ancien Régime* (Darnton 1968, chap.3). Some opined that the Commission's tests, their methodology was 'stacked against' a version of science that was not adequately captured by the tests: 'the commissioners were mistaken in treating it as a science by performing controlled empirical tests' (Weyant 1980, p.102).

Magnetisers crossed the channel and operated in England. Dr Mainauduc lectured to packed halls and founded the Hygeian Society. Dr Benjamin Perkins effected cures by use of a metallic tractor (hand-held instrument) which powerfully directed the patient's magnetic fluid. This was impressive; but became decidedly less so when Dr John Haygarth cured his patients by using a 'metallic' tractor made of wood! He read a paper on the matter to the Literary and Philosophical Society of Bath, and in 1800 published a pamphlet 'Of the Imagination as a Cause and Cure of Disorders, exemplified by Fictitious Traction' (Haygarth 1800). For the same group of five patients, he used both wooden and metal tractors, patients thinking they were the same instrument, the same cures were affected by both. This might be the first research published on the Placebo Effect.[9]

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[8] On this see Donaldson (2005) and Weyant (1980).

[9] The whole episode is described in Gratzer (2000, chap.5). The term comes from the Latin rendering of Psalm 114:9, *Placebo Domino*, 'I will please the Lord'. Haygarth said that doctors were giving medicine more to please the patient than cure the patient. Two centuries later, this has not changed. Studies routinely show that doctors (a quarter in Canada, a half in the USA) regularly give patients medicine, or prescribe treatment routines, in order to please not cure the patient; in some cases, just to 'get them out of the surgery' (Alcock 2018, p.336). It is a mistake to speak of placebo 'effects' as the placebo (water, sugar, soothing words, white coat) has no effect. For an individual in a particular circumstance it has no effect but generates a response. So the expression should be 'placebo response'.

The Commissioners rejected Mesmer's magnetism as the cause of the convulsions, and cures that they observed in magnetic therapy, but their favoured cause - 'imagination' - was not without its own problems: What did imagination have that magnetism did not? Charitably, it can be seen as a 'place-holder'; a belief that mental or psychological states can affect bodily states, and that the exact mechanisms and ontological status of the mental, are yet to be uncovered. This is a legitimate and standard scientific procedure. Positively it directs research within the individual; negatively, it says do not bother looking for extra-individual or trans-individual forces or entities. But the positive work had to be done, otherwise the Commission's position is just hand waving. A century later, the psychologist Alfred Binet (1857-1911) and physician Charles Fèrè (1852-1907) in their book on *Animal Magnetism* said of the putative 'imagination' cause that:

> In our day, this would appear to be an insufficient explanation. We might as well say that hysteria is due to the imagination. (Binet & Fèrè 1890, p.17)

The subsequent history of scientific studies of psycho-somatic illness can be seen as the 'cashing in' of the Commission's 'imagination' promissory note. Whether the Freudian medical tradition is part of the cashing-in has been a matter of century-long debate about its scientific or otherwise status.

German physicians, scientists and philosophers did persist with Mesmer's ideas; the second volume of Mesmer's collected studies was published in Berlin in 1815. Karl von Reichenbach (1788-1869), the prominent German chemist, engineer, industrialist, and esteemed member of the Prussian Academy of Science, claimed to have discovered the hitherto unknown Odic force which cannot be detected by any instrument, but can only be seen and felt for special individuals who he labeled 'sensitives' of which he was one, others being some young girls in his circle. All substances were either odic positive, negative or neutral. The positive substances were warm, disagreeable and emitted a red light; the negative substances were cool, agreeable and emitted a blue light. Odic force extended through the entire universe. Reichenbach thought that his odic force could explain many hitherto puzzling phenomena, so the frequent appearance of ghosts in graveyards is just odic light emanating from decaying corpses. While experimenting he:

> Maintained a strict regimen of rest and diet and refrained from touching metals all day. Then at evening he held the hand of his sensitive while she reported hour by hour the variations of odic force transmitted through the Baron's hand; all of which is charted in curves, as professionally as the record of an experiment in thermodynamics. (Jastrow 1935/1962, p.347)

Parallels with feng shui practice are obvious, but Reichenbach did not have the whole superstructure of chi cosmology to support his lonely speculation.

Though Mesmerism, Odic forces and magnetic therapy had been rejected by the scientific and medical establishments by the early 19th century, it lived on in 'alternative' circles. And it emerged full-blown and unembarrassed in the late 20th century. On 11 August 1997, the American *ABC World News Health Report* had a programme describing 'bio-magnetic therapy', a multimillion-dollar business sweeping across international sports medicine, and beyond locker-rooms. The therapeutic magnets, costing $89, were being sold in a thousand golf pro shops. On the programme a plastic surgeon explains how 'magnetics provide a static or magnetic force that allows changes in the tissue'. A physical therapist informs viewers that 'magnets are another form of electric energy that we now think has a powerful effect on bodies'. The CEO of the main magnet firm explains that 'All humans are

magnetic, every cell has a positive and negative side to it'. A graphic shows blood being drawn to damaged tissue by the magnet. Viewers probably think that is OK as everyone knows that blood contains iron. But the iron in hemoglobin is in a chemical state that is not ferromagnetic; there is absolutely zero scientific basis for the claim that blood is influenced by magnetic fields.[10] Although a multimillion-dollar business, it is really a multimillion-dollar racket. It is simply another incarnation of the kind of fraud and racketeering that Matteo Ricci identified being perpetrated by feng shui practitioners in 16th century China.

Versions of the whole Mesmeric picture can be found in ancient and modern feng shui manuals. For example, a 2002 publication claims:

> Chi is the cosmic breath of the life force. It is the vital breath and maintains physical, emotional, and environmental balance, and links man to his environment. It connects knowledge and substance. It creates a process of rapid flow and cessation, flowering and wilting, increase and decrease, and so on. Chi is vitality. (Taylor 2002, p.14)

Some feng shui practitioners point to the affinity with Mesmerism as a demonstration of the universality of feng shui cosmology; of how its basic principles have been recognized, under other names, by different cultures in different times (Fenton 1996).

Imponderable Fluids

The findings of the French Royal Commission may have dinted enthusiasm for animal magnetism, but not the idea of imponderable fluids. By the middle of the eighteenth century, it was apparent that the scientific mechanical, corpuscularian worldview that underpinned the new science of Galileo, Boyle and Newton, was incapable of coherently explaining the documented and divers range of magnetic, electrical, optical and thermal phenomena with which natural philosophers were engaged. Different 'imponderable fluids' were resorted to in order to explain some or all of the mechanical-resisting phenomena (Schofield 1970 chap. 8). As early as 1745 Cadwallader Golden (1688-1776) - an Irish natural philosopher, Governor of the New York colony, friend of Franklin, and 'corrector' of some mistakes in Newton - thought that investigations of electricity would illuminate the 'nature of that subtile, elastic and aethereal medium, which Sir Isaac Newton queries on, at the end of his *Opticks'* (Schofield 1970, p.159). Benjamin Franklin, Mesmer's *bête noire,* postulated electrical fluid to explain the phenomena he was documenting (Cohen 1956). He thought that such fluid was diffused through all matter, and that the earth was its inexhaustible reservoir.

In 1839 Golding Bird (1814-1854), the English physician and chemist, in his *Elements of Natural Philosophy* claimed that:

> The subtle and invisible forms of ethereal matter, when caused to assume a vibratory or undulatory movement with sufficient rapidity, produce a peculiar set of phenomena, whose effects are known by the terms of light and heat; effects of vast importance, for without them nature would be dead to us, its beauties no longer apparent, and this world a cheerless place. (Alexander 2015, p.2)

A decade later, Henry Morley wrote:

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[10] This business, and more on contemporary magnetic therapy, is detailed in Park (2000, pp.58-62).

> We are in the present day upon the trace of a great many important facts relating to the imponderable agencies employed in nature. Light, heat, and electricity are no longer the simple matters, or effects of matter, that they have aforetime seemed to be. New wonders point to more beyond. (Alexander 2015 p.1)

Herman von Helmholtz (1821-1894) in his 1862 lecture 'On the Conservation of Force' said that the extensive investigations of thermal phenomena by eighteenth and early-nineteenth century natural philosophers documented processes that 'could at that time be explained in no other manner than that heat is a substance [caloric]' (Helmholtz 1862/1995, p.114). That is, heat is a fluid; just how imponderable was to be investigated.

The new scientific era of exact measurement, sophisticated instruments and precision is well demonstrated in nineteenth century investigations of the putative imponderable fluids. Careful attempts were made to ascertain the weights of the conjectured fluids, after all if they were fluids they should have weight, but no such weight was ever registered, at least none that was not accounted for by standard measurement deviations. Using ever more sensitive instruments in ever more controlled circumstances, it was found that when iron was heated it did not gain weight, when pith balls were electrostatically charged they did not gain weight and so on. But as natural philosophy uncovered many strange things, some thought that a weightless fluid could just be added to the list of remarkable things; such a supposition was not *prima facie* ruled out of court, nor out of science.

These imponderable fluids are perhaps the closest that modern European science has come to the universal chi of Asian feng shui. But the former were carefully and experimentally investigated in the way that the latter never was, and eventually the whole programme of imponderables was abandoned by Western scientists. William Grove (1811-1896), in his Presidential Address to the 1866 Nottingham meeting of the British Association for the Advancement of Science could say:

> … when we pass to the consideration of those other attributes of matter which were at one time supposed to be peculiar kinds of matter itself, or, as they were called, 'imponderables', but which are now generally, if not universally, recognized as forces or modes of motion, we find the evidence of continuity still stronger. (Grove 1866/1970, p.90)

Grove was convinced, as also was Helmholtz, by the works of Humphry Davy who melted ice by sliding one block on another within a cooled and insulated container; there was no outside source of heat or imponderable fluid, yet ice moving on ice seemingly created heat sufficient for melting.

Benjamin Thompson (Count Rumford 1753-1814) began doubting the caloric theory when he weighed water then froze it and could not detect any loss of weight as the departure of caloric might predict; even with scales sensitive to one part in a million he could detect no loss of weight. More famously Rumford in his 1798 *Philosophical Transactions* paper - 'An Inquiry Concerning the Source of the Heat which is Excited by Friction' (Thompson 1798) - had noted the immense heat generated in boring brass cannons in the Munich Arsenal where the drill bit was powered by two horses tethered to either end of a rotatable bar.[11]

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[11] He further noted that the measurable heat generated by the boring was roughly the same as the heat generated by burning the hay eaten by the working horses! This observation and measurement might be seen as the beginning of biophysics.

Beyond noting the heat, in the characteristic manner of modern science he quantified it by having the brass bored in a weighed water bath and measuring its rise in temperature. On the imponderable fluid account, the caloric was supposedly released from the brass rod when the filings were opened and separated; but he found that these discarded filings had the very same specific heat as the original brass from which they had been bored. If they had given up their igneous fluid, they should have carried less heat than untouched strips of new brass. He heated both the filings and brass strips from the cannon, put both into the same quantity of water at the same temperature and both waters rose exactly to the same temperature. He wrote:

> The heat of the mixture, at the end of 1 minute, was just 63^0 as before. …Each of the above experiments was repeated 3 times, and always with nearly the same results. (Thompson 1798, p.82)

After other experiments, all described in detail so that they could be reproduced by anyone reading his Royal Society account, he concluded:

> the capacity for heat, of the metal of which great guns are cast, *is not sensibly changed* by being reduced to the form of metallic chips, in the operation of boring cannon. (Thompson 1798, p.87)

He noted 'that the source of the heat generated by friction, in these experiments, appeared evidently to be *inexhaustible*' (Thompson 1798, p.99) and added:

> any thing which any *insulated* body, or system of bodies, can continue to furnish *without limitation*, cannot possibly be a *material substance*. (Thompson 1798, p.99)

After other controlled experiments, Rumford proposed that heat was the consequence of motion not of the transfer of caloric or igneous fluid. He says that he could not form any idea of how:

> the heat was excited and communicated in these experiments, except it be MOTION. (Thompson 1798, p.99)

Rumford refined this claim by ingeniously showing that heat was only the consequence of *resisted* motion. He had a set-up of wheels turning wheels, turning other wheels, with the last turning atop a piece of phosphorus; it was only when the last was braked did the phosphorus below it explode (Grove 1866/1970, p.91).

He was conscious of Newton's methodological advice against 'feigning hypotheses',[12] writing:

> But, although the mechanism of heat should, in fact, be one of those mysteries of nature which are beyond the reach of human intelligence, this ought by no means to discourage us,

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[12] In the General Scholium of the *Principia* Newton wrote:

> 'I have not as yet been able to deduce from phenomena the reason for these properties of gravity, and I do not 'feign' hypotheses. For whatever is not deduced from the phenomena must be called a hypothesis; and hypotheses, whether metaphysical or physical, or based on occult qualities, or mechanical, have no place in experimental philosophy.' (Newton 1726/1999, p.943).

On this contentious subject, see at least Harper (2011, pp.343-346) and Wootton (2015, pp.388-391).

> or even lessen our ardour, in our attempts to investigate the laws of its operations. (Thompson 1798, p.100)

Helmholtz in his 1862 lecture, delivered four years before Grove's BAAS address, surveyed the theoretical and experimental field, and concluded:

> These facts no longer permit us to regard heat as a substance, for its quantity is not unchangeable. It can be produced anew from the *vis viva* of motion destroyed; it can be destroyed, and then produces motion. We must rather conclude from this that heat itself is a motion, an internal invisible motion of the smallest elementary particles of bodies. (Helmholtz 1862/1995, p.118)

The idea of 'imponderable fluids' was abandoned in physics, though some qigong promoters are resuscitating the notion under the banner of 'subtle energy' and saying that this is the physicist's name for chi energy (Wozniak, Wu & Wang 2001, p.130). This is nonsense. But in the absence of decent science education, or even of a skeptical disposition, who is to know?

Spiritualist Science

In the mid-nineteenth century, beginning in the USA, there was an outbreak of enthusiasm for the influence of spirits in the world; of communications with the dead; of engagement with 'the other side'. This constituted the Spiritualist Movement, which with some ups and downs is still extant; now mostly taking the form of parapsychology.[13] Spiritualism began in 1848 with the young Fox sisters from Hydesville New York and their travelling road-show of séances and ghostly interventions causing tables to move, bowls to shake, pointers to swing, Ouija boards to reconfigure, and so on. Soon mediums were setting up business everywhere on both sides of the Atlantic offering to put audiences in contact with their departed loved ones (Brandon 1983). The words 'telepathy' and 'medium' made their appearance in print. In 1855, the US chemist Robert Hare wrote of his experience at one séance where he was convinced the spirit of his long-dead father was in the room and communicating via a moving pointer (Hines 2003, p.49). His scientific reputation and testimony were great boosts to the spirit business. The movement known as *Spiritualism* spread and resonated way beyond its Anglo-American roots.

In June 1853 the *Illustrated London News* was disappointed and surprised that:

> Railroads, steam, and electricity, and the indubitable wonders which they have wrought, have not proved powerful enough to supersede and destroy that strong innate love of the supernatural which seems implanted in the human mind. Thousands of people in Europe and America are turning tables, and obstinately refusing to believe that physical and mechanical means are in any way connected in the process. (Noakes 2004, pp.25-26)

For a period in the late-nineteenth century a community of British, American and European scientists entertained the notion of spirits as legitimate scientific entities in order to explain psychic phenomena. These included top-rank scientists such as Charles Richet, Robert Hare, Oliver Lodge, Alfred Russel Wallace, William Crookes, Gustav Fechner, and J.J. Thompson. In 1866 Alfred Wallace (1823-1913) wrote a defense of spiritualism, saying:

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[13] See Brandon (1983, chap.3), Ferguson (2012), Lamont (2013), Noakes (2004), Oppenheim (1985), Shermer (2001, chap.8) and Webb (1971, chap.1).

> A little enquiry into the literature of the subject, which is already very extensive, reveals the startling fact, that this revival of the so-called supernaturalism is not confined to the ignorant or superstitious, or to the lower classes of society. On the contrary, it is rather among the middle and upper classes what the larger proportion of its adherents are to be found …. And among those are numbers of literary, scientific, and professional men. (Shermer 2001, p.190)

In 1885 the Austrian Archduke Johann was alarmed at the spread of Spiritualism writing:

> That this modern superstition flourishes not only among the weavers of the Braunauer country, or among the workmen and peasants in Reichenberg, but it has also fixed its abode in numerous palaces and residences of our nobility, so that in many cities of the monarch, and especially in Vienna and Buda-Pesth, entire spiritualistic societies exist, carrying on their obscure nuisance without any interference. (Webb 1971, p.16)

In a 1785 autobiographical essay, Wallace wrote of his journey to spiritualism with which many feng shui adherents would identify:

> Up to the time when I first became acquainted with the facts of spiritualism, I was a confirmed philosophical sceptic, rejoicing in the works of Voltaire, Strauss, and Carl Vogt, and an ardent admirer (as I am still) of Herbert Spencer. I was so thorough and confirmed a materialist that I could not at that time find a place in my mind for the conception of spiritual existence, or for any other agencies in the universe than matter and force. Facts, however, are stubborn things. My curiorsity was at first excited by some slight but inexplicable phenomena occurring in a friends's family, and my desire for knowledge and love of truth forced me to continue the inquiry. The facts became more and more assured, more and more varied, more and more removed from anything that modern science taught, or modern philosophy speculated on. The facts beat me. (Shermer 2001, p.197)

But what were the facts that drove Wallace's journey? In 1882 the Society for Psychical Research was established to scientifically investigate the alleged, and widely believed, medium-induced occurrences and phenomena. Its journal has been published quarterly and continuously since 1884. Initial areas of research were Thought-Transference, Mesmerism, Mediumship, Reichenbach Phenomena (also known as Odic Force), Apparitions, Haunted Houses, and Séances.

Oliver Lodge (1851-1940), the knighted, physicist, socialist, Christian and pioneer of radio theory and technology, was one of the most prominent Spiritualists (McCabe 1914), Lodge did significant original work on electromagnetic radiation that convinced him of the reality of the ether, and he came to believe that this was the realm of real, active, causally empowered spirits, including that of his loved son Raymond who had been killed in the Great War, and with whom he still regularly communicated (Lodge 1909, 1916, 1930). Many, including Lodge, saw a scientifically approved spiritualism as a counter to the un-Godly materialism associated with 19th century science. Among other things, it reconciled theistic belief in the human soul, shared by nearly all religions, with Darwinian accounts of the evolution of *homo sapiens* which did not provide for the onset of souls. The First Spiritual Temple website says of Lodge that:

> Sir Oliver sought to bring together the transcendental world with the physical universe. He affirmed, with great conviction, that life is the supreme, enduring essence in the universe; that it fills the vast interstellar spaces; and the matter of which the physical world is composed is a

> particular condensation of ether for the purpose of manifesting life into a conscious, individual form.[14]

Given the repute and caliber of the 'Spiritualist' scientists, it is clear that the intellectual heart of the late-19th century debate - carried on in books, journals, conferences, newspapers, clubs, fairs, and meeting halls - was not between scientists and pseudoscientists, or between science and religion, it was about the proper understanding of science; it was, at core, an internal debate among scientists about philosophy of science. The spiritualists were scientists, and understood themselves as advancing, or opening-up, a scientific research field.

Clearly not all believers saw spiritualism as endorsement of religious, specifically Christian, faith and ontology; many were wary of being associated with something functioning outside of official channels and likely to blow up. Michael Faraday (1791-1867), the founder of electromagnetic theory, was a life-long devout Christian of the Sandermanian sect who in 1853 dedicated serious experimental effort investigating spiritualist phenomena. His conclusion was there is no such specifically *psychic* phenomena; the visible movements, once deliberate fraud was discounted, were the consequence of unconscious muscular movement of the psychic (Hyman 1985). Psychologists have now recognized this as an outcome of the medium being in a *dissociative state*. This state can, and has been, scientifically investigated without recourse to non-natural entities or forces.

However, apart from all other considerations, Einstein's relativity theory rendered Lodge's ether redundant (Einstein 1922). The ether followed crystalline spheres, phlogiston and caloric out of the vocabulary and practice of science. Spirits were homeless. By the 1940s, scientific spiritualism had disappeared. Although some maintained their beliefs, and even established the supposed discipline of parapsychology (Grove 1985), most of the spirit-scientists came back to the 'fold' or drifted out of science. For some scientists, the ether remained, but it had stricter occupancy rules: 'no spirits here'.

It is yet another testament to the credulity of people that spiritualist enthusiasm was barely dinted by early revelations that the Fox sisters were charlatans who rigged all of the 'psychic' phenomena dramatically seen at their séances. And predictably, a good many other mediums were exposed as frauds (Kurtz 1985).

The contrast of spiritualism with feng shui is instructive. They both posited immaterial causally-effective entities (spirits and chi), to account for phenomena; and they asserted parallel material and non-material universes. But to their credit, most of the spiritualists took science seriously. They engaged with it, tried to quantify, and measure their posited entities; and in the end, were prepared to walk away from the spiritualist edifice when the accumulated scientific evidence failed to support it. There is no parallel in feng shui: it is not conducted by scientists and does not engage with science. It is a pseudoscience.

Conservation of Energy

The numerous different 'forces' were found to be convertible: chemical force into electricity (Volta), electricity into magnetism (Oersted); magnetism into electricity (Faraday); heat into electricity (Ritter and Scheele); mechanical energy into heat (Joule); work into heat (Rumford). Not only were they convertible but by diligent and carefully controlled

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[14] See, http://www.fst.org/lodge.htm

experiment they were shown to be *precisely, uniformly,* and *always* convertible. For instance, Helmholtz cited Joule's experiments on conversion of work to heat and his formulation of a *unit* of heat as 'the heat necessary to raise one gramme of water through one degree centigrade' (one calorie) saying that it is equal to 'the work which a gramme would perform in falling through a height of 425 metres'; Helmholtz cited other experimenters who found equivalences of 426.3m, 425.3m and 424.9m (Helmholtz 1862/1995, p.117). The mounting evidence for conversion undermined the explanatory power of the imponderable fluids; they were spectators, left sitting idly; literally, doing no work. At the same time, the nineteenth-century conversion experiments prepared the ground for postulation of a common something – energy – which was conserved in the conversions.

For Helmholtz, and others, all of this pointed to a foundational conservation law:[15]

> The law in question asserts, that the *quantity of force which can be brought into action in the whole of Nature is unchangeable,* and can neither be increased nor diminished. (Helmholtz 1862/1995, p.98)

He explains that 'quantity of force' is 'more popularly expressed … as *amount of work* in the mechanical sense of the word' (ibid).

The energy-focused conservation and unification movement of the nineteenth century culminated in the great German chemist, Nobel Laureate, and monist, Wilhelm Ostwald's (1853-1932) *Energetics* programme (Hakfoort 1992, Ostwald 1901). Convinced by Mach's empiricist critique of atomism, Ostwald held that energy was a substance, indeed it was the *only* substance, with everything else being its manifestation. It was an alternative to both materialism and idealism; it could be seen as a move from Western to Eastern science. But energetics as a scientific programme collapsed; what became entrenched was the understanding that energy is a property of something, not a process; much less the universal process of Ostwald. He was correct in seeing energy as universal, but this is because it is a universal property of all things that exist; there can be no energy without things; there is no 'free floating' energy. Fragments of the energetics programme can still be read in different popularizes of feng shui and Eastern mysticism.

It was not just better technical solutions or more efficient industrial processes that emerged from the multitude of natural philosophers conducting all this exacting and public measurement, observation, experiment, and hypothesis testing. A scientific outlook on the world, a scientific or naturalistic worldview emerged. Helmholtz painted it in moving terms in the conclusion of his 1862 lecture:

> What I have to-day mentioned as to the origin of the moving forces which are at our disposal, directs us to something beyond the narrow confines of our laboratories and our manufactories, to the great operations at work in the life of the earth and of the universe. The force of falling water can only flow down from the hills when rain and snow bring it to them. To furnish these, we must have aqueous vapour in the atmosphere, which can only be effected by the air of heat, and this heat comes from the sun. The steam-engine needs the fuel which the

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[15] Thomas Kuhn names Helmholtz and eleven other natural philosophers who between 1842 and 1847 independently enunciated a conservation of force law by which a single quantity or feature was conserved across its numerous manifestations – dynamic, thermal, electrical, chemical, etc. He said: 'The history of science offers no more striking instance of the phenomenon of simultaneous discovery' (Kuhn 1959/1977, pp.68-69).

> vegetable life yields, whether it be the still active life of the surrounding vegetation, or the extinct life which has produced the immense coal deposits in the depths of the earth. The forces of man and animals must be restored by nourishment; all nourishment comes ultimately from the vegetable kingdom, and leads us back to the same source.
>
> You see then that when we inquire into the origin of the moving forces which we take into our service, we are thrown back upon the meteorological processes in the earth's atmosphere, on the life of plants in general, and on the sun. (Helmholtz 1862/1995, p.126)

Here is the germ of the we-are-all-in-it-together, environmentalist, naturalistic worldview which 150 years later underpins most global governmental, scientific, cultural, and educational climate change and environmental education efforts.

Many accounts of feng shui theory or principles seem, superficially, to echo this mid-nineteenth century depiction of the modern naturalistic worldview. Consider for instance one such statement:

> Feng shui doctrine is encapsulated in a saying from the *Book of Burial* [Pu 300 BC]: 'Ch'I blows as wind, ascends to the clouds, falls as rain, nourishes the soil and gives birth to everything on earth'. Since energy is the universe, the goal of feng shui is not to obstruct or harness it. (Rolnick 2004, p.31)

Others talk of yin and yang as forces of attraction and of repulsion. Angle and Tiwald in their *Neo-Confucianism* book translate *qi* as 'vital stuff'. Such commonly repeated statements can give an appearance of scientificity to feng shui; but really such statements are simulacrums: they are deceptive substitutes for serious scientific claims or analysis. Scientific words are sprinkled over pages without attention to their scientific meaning or their coherence in the page. Feng shui's energy-related claims have been largely stable for three thousand years; they are little affected by experiment nor informed by the critical spirit which is so evident in the history of elaboration, refinement and correction of notions of force and energy in orthodox science.

Feng shui theory is not informed by development in other sciences, something which is a characteristic of all scientific disciplines. Utilising John Donne (1572-1631), a contemporary of Galileo: 'No science is an island entire of itself; every science is a piece of the continent'. Indeed, cross-disciplinary borrowing and information-sharing is so normal that 'mixed disciplines' are a standard marker of the growth of science: geochemistry, biochemistry, electrochemistry, biophysics, geophysics, paleobotany, paleoanthropology, and so on. Such hybrids as there are in feng shui – romantic feng shui, monetary feng shui, lucky feng shui – are merely 'come here with your money' banners for the gullible, they are not mixed sciences.

Teaching About Feng Shui in the Science Programme

One obvious and non-controversial way to raise issues about feng shui in science classes is to do so when teaching about energy. The saturation of everyday conversation, TV, newspapers and social media with concerns about new forms and sustainability of energy, provides an appropriate base for such teaching. But the very same saturation gives rise to multiple and well documented misunderstandings and barriers to learning the science of energy: conceptual and ontological confusion abounds for both teachers and students. Such confusion is predictable as the term 'energy' has had a documented history of at least 2,500

years and it is only in the past 150 years that the modern and coherent scientific meaning of the concept has emerged whilst leaving a forest of other every-day and technical meanings intact.

Most of the everyday talk – for example of 'energy creation' - are simply inconsistent with scientific understanding. Separating out the scientific meaning of 'energy' from the 'buzzing confusion' of everyday multiple meanings is a prime task of science education. In the foregoing case, all talk of energy 'creation' should be instead of energy 'conversion'. A simple matter, but a whole worldview pivots on it. And this clarifying task also then involves separating out the scientific understanding of energy from a host of scientifically-related concepts with which it is oft confused – power, force, momentum, work, impulse, entropy and so on.[16] 'Energy' is a polysemic word.

From the earliest age children hear about and are taught the need for 'responsible use of energy'. Later they are taught about the global energy crisis, about the deleterious effects of fossil fuel as an energy source, about the importance of solar, wind and other 'green' or renewable energy sources, about the dangers associated with domestic use of nuclear energy and the catastrophic impact of its military use, about being environmentally responsible and utilizing low-energy appliances and transport, and about many other energy-related matters. Energy is a recurrent concept in the marketing of drinks, foods, clothing and 'supplements' or potions. Seemingly everything good for a person either saves, boosts or gives them energy; just as cars are high or low in petrol, so people are high or low in energy. Chinese-influenced Asia has all of the foregoing, and much more because feng shui discussion and deliberation is a commonplace part of life for so many; it is part of the woof and warp of much Asian culture.

Throughout the world at all educational levels - elementary, secondary and college - energy is a ubiquitous topic in science programmes simply because energy is ubiquitous in nature. The study of energy is one of the core requirements in the English school science programme where students are expected to detail different sources of energy and know how different cultures utilize these sources. Energy is also one of the core 'cross cutting concepts' in the USA *Next Generation Science Standards* (NRC 2013).[17]

Energy Literacy

In the USA, the Department of Energy (DoE) produced an educational guide that specifies an 'energy literate' person has:

> An understanding of the nature and role of energy in the universe and in our lives. Energy literacy is also the ability to apply this understanding to answer questions and solve problems. (Department of Energy 2012, p.4)

The US Department further elaborates that such a person 'Can assess the credibility of information about energy'.

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[16] Among hundreds of substantial studies on the teaching and learning of energy, see at least: Arons (1999), Chen et al. (2014), Coelho (2009), Duit (1986, 1987), Goldring & Osborne (1994), Papadouris & Constantinou (2011), Williams & Reeves (2003) and contributions to Bevilacqua (2014a). A comprehensive review of the field is provided by Bächtold & Guedj (2014).

[17] Papers presented at an international conference to link research to the teaching of energy in the NGSS can be seen in Chen et al. (2014).

Given the centrality of 'energy' in feng shui discourse and practice, and given the wide influence and impact of feng shui in Asian and now Western culture, these DoE objectives can assuredly be advanced by explicit treatment of feng shui in science classes. The DoE guide can reasonably be taken to mean that students be able to assess the credibility of feng shui energy claims. If daily feng shui forecasts are on the nightly news, then asking a class to assess their credibility is hardly an outside imposition on the class.

All feng shui claims make reference to energy. As previously noted, Elliot Jay Tanzer, a modern astrologer and feng shui consultant, says of chi that: '*Qi* is the Chinese word for "energy." Everything animate and inanimate, real or conceptual, has *qi'*.[18] Many thousands of feng shui web sites attest to the centrality of this primeval, all-pervasive, encompassing 'peculiar' energy that has such a multitude of amazing properties. One site authoritatively announces:

> The dynamic movement of energy changes with the passing of time — in the year, month, day, and hour. Flying Star Feng Shui shows you how these changes and movements of energy can affect space and people. That's why Flying Star is considered one of the most dynamic and effective techniques in Classical Feng Shui. It is used not only to assess the current condition (i.e., the energetic quality) of the home, but it can also be used as a valuable forecasting tool.[19]

HPS-Informed Teaching

The confusions about energy are mirrored in teaching about force. In the popular mind force is connected to energy; and was an important stepping-stone – via the metaphysical idea of *vis viva* (vital force) and the law of inertia - in development of the science of energy. Max Jammer in his book on *Concepts of Force* writes:

> It is the purpose of this book to clarify the role of the concept of force in present-day physics. It is pointed out how ancient thought, with its animistic and spiritual interpretations of physical reality, laid the foundations for the development of the concept and how in pre-classical science the concept of force became invested with a multitude of extra-scientific connotations that greatly influenced the interpretation of the concept until very recent times. (Jammer 1957, p.viii)

He justifies his book because:

> … in our present system of academic instruction a thorough and critical discussion of fundamental and apparently simple concepts in science is consciously omitted. … A historico-critical analysis of the basic conceptions in science is therefore of paramount importance, not merely for the professional philosopher or historian of science. (Jammer 1957, p.vii)

Such teaching is also of paramount importance for science teachers. But even a moderately sophisticated understanding of energy requires a number of things: first, some historical awareness of how the concept emerged from investigations in different domains of physics and then chemistry and biology; second, some epistemological appreciation of how

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[18] See: http://abodetao.com/feng-shui-guidelines-to-energy-flow-analysis-what-is-*qi*-and-how-*qi*-flows/

[19] http://www.fengshuitoday.com/shop/advanced-flying-star-feng-shui-gm-dr-stephen-skinner/

scientific claims about energy, in particular the conservation law, are justified partially by experiment and partially by fiat; third, some ontological awareness about what energy is – is it the state of some thing (or multiples of things) or is it itself something?

Such HPS-informed teaching of energy results in better and deeper understanding of the science of energy; and also a richer understanding of the nature of science (NOS), something which is increasingly a separate curriculum objective. Two Cypriot researchers have written:

> We propose a teaching approach, for students in the age range 11-14, that introduces energy as an entity in a theoretical framework that is invented and gradually elaborated in an attempt to analyze the behavior of diverse physical systems, and especially the various changes they undergo, using a coherent perspective. This theoretical framework provides an epistemologically appropriate context that lends meaning to energy and its various features (i.e., transfer, form conversion, conservation and degradation). (Papadouris & Constantinou 2011, p.961)

Commitment to a 'coherent perspective' is simply a precondition for a scientific treatment of energy. It should be obvious that the entry of chi into the picture, or equation, makes the treatment incoherent.

Photosynthesis is rightly a universal component of science programmes. It is a topic that well illustrates the contribution of HPS to good science teaching, and also shows the superfluousness of the chi concept. Proper teaching of photosynthesis exposes students to a scientifically-revealed marvel of nature; this should diminish the need to seek marvel or awe outside the workings of the world that science has illuminated. All animate and inanimate processes on earth depend on energy whose ultimate source is solar radiation from the sun, which in turn derives from nuclear fusion inside the sun. All life on earth is predicated on the property of the chlorophyll molecules of green plants to utilize sunlight to convert carbon dioxide and water into organic compounds (starch) for animal and human food and oxygen for animal and human breathing. Without this action of chlorophyll, called photosynthesis, all life on earth would slowly some to an end; and indeed would not have started. The complementary processes are:

Photosynthesis:
carbon dioxide + water + energy (light) → organic compounds (starch)+ oxygen

Respiration:
organic compounds + oxygen → carbon dioxide + water + energy

The first process represents both 'carbon capture' and the restoration of air by oxygen. The second process shows that when buried coal seams are dug up, or forests cut down and burnt there is massive carbon dioxide release. The two processes are major components of the earth's 'carbon cycle'. Clearly it is important for students to learn about these processes, and their wider social, economic, cultural and ethical dimensions and impacts. This is part of responsible citizenship. But additionally there is great value in learning about how these fundamental processes came to be discovered and understood; such learning provides appreciation and understanding of the nature of science and the scientific enterprise. And it provides enough marvel and awe to make ying-yang and chi talk less captivating.

The English polymath Joseph Priestley (1733-1804) and the Dutch medico-scientist Jan IngenHousz (1730-1798) were the separate discoverers of photosynthesis. Priestley was a most remarkable man.[20] Frederic Harrison in his Introduction to a nineteenth-century edition of Priestley's *Scientific Correspondence*, said of him:

> If we choose one man as a type of the intellectual energy of the eighteenth century, we could hardly find a better than Joseph Priestley, though his was not the greatest mind of the century. His versatility, eagerness, activity, and humanity; the immense range of his curiosity in all things, physical, moral, or social; his place in science, in theology, in philosophy, and in politics; his peculiar relation to the Revolution, and the pathetic story of his unmerited sufferings, may make him the hero of the eighteenth century. (Bolton 1892, Introduction)

Priestley did not begin serious chemical studies until his early 30s, during his ministry at the Leeds Presbyterian Chapel (1767-1773). In quick succession, by utilising a new method of collecting airs over water and mercury, and by utilising a new and massive burning lens as a source of heat, he created, isolated, and listed properties of a dozen or more of the major 'airs'. The experiments and investigations of airs, conducted in Leeds by Priestley, were announced to the scholarly world in a series of talks he delivered to the Royal Society in London in March 1772. The talks subsequently were published as his famous 118-page paper in the Society's *Philosophical Transactions* of the same year – 'Observations on Different Kinds of Air' (Priestley 1772). This paper was translated into many European languages; it was widely read, including by Lavoisier; and in 1773 it was awarded the coveted Copley Medal of the Royal Society – the eighteenth-century equivalent of the Nobel Prize.

In the Royal Society address, Priestley noted:

> The quantity of air which even a small flame requires to keep it burning is prodigious. It is generally said, that an ordinary candle consumes, as it is called, about a gallon in a minute. Considering this amazing consumption of air, by fires of all kinds, volcanoes, etc. it becomes a great object of philosophical inquiry, to ascertain what change is made in the constitution of the air by flame, and to discover what provision there is in nature for remedying the injury which the atmosphere receives by this means. Some of the following experiments will, perhaps, be thought to throw a little light upon the subject. (Priestley 1772, p.162)

Priestley's Christian worldview motivated this quest: with centuries of animal and human respiration, plus volcanoes and natural fires, the atmosphere should be progressively rendered unfit for human life; but there were theological reasons why this could not happen. A beneficent all-powerful Creator would not design such a world; God must have made some provision for the natural restoration of air. Priestley's first thought, or hypothesis, was the commonsensical one: as air is necessary both for animal and vegetable life, then both animals and plants must process air in the same manner. But experiment led him to reject this idea. As he wrote:

> One might have imagined that, since common air is necessary to vegetable, as well as to animal life, both plants and animals had affected it in the same manner, and I own that I had that expectation when I first put a sprig of mint into a glass jar standing inverted in a vessel of water; but when it had continued growing there for some months, I found that the air would

[20] The definitive biographical study of Priestley is Robert Schofield's two volume work (Schofield 1997, 2004). See also Matthews (2015a chap.7) and literature cited therein.

> neither extinguish a candle, nor was it at all inconvenient to a mouse, which I put into it. (Priestley 1772, p.162)

He continued:

> This observation led me to conclude, that plants, instead of affecting the air in the same manner with animal respiration, reverse the effects of breathing, and tend to keep the atmosphere sweet and wholesome, which it had become noxious, in consequence of animals living and breathing, or dying and putrefying in it. (Priestley 1772, p.166)

Priestley did suggest a mechanism for the beneficent effect: 'this restoration of vitiated air is affected by plants imbibing the phlogistic matter with which it is overloaded by the burning of inflammable bodies' (Priestley 1775-1777, vol.1, p.49), but in keeping with his strict epistemological principle of only giving cautious or provisional status to conjectured unseen mechanisms, he added 'whether there be any foundation for this conjecture or not, the fact is, I think indisputable' (ibid). His distinction between observational facts upon which there could and should be agreement, and unseen, putative mechanisms was a fundamental one for Priestley.

He was prepared to think further about the source of the pure air he saw released by green matter and plants in his phials. Initially he thought it came *from* the green matter or leaves, but he was able to devise a nice experimental test of this hypothesis. In September 1779 he wrote to his good friend Benjamin Franklin (1706-1790) relating that:

> Though you are so much engaged in affairs of more consequence [drafting the Declaration of American Independence], I know it will give you some pleasure to be informed that I have been exceedingly successful in the prosecution of my experiments since the publication of my last volume [his *Experiments and Observations on Different Kinds of Airs*].
>
> I have confirmed, explained, and extended my former observations on the purification of the atmosphere by means of vegetation; having first discovered that the *green matter* I treat of in my last volume is a vegetable substance, and then that other plants that grow wholly in water have the same property, all of them without exception imbibing impure air, and emitting it, as *excrementitious* to them, in a dephlogisticated state. (Schofield 1966, pps.178-79)

Other experiments confirmed that the green matter, along with aquatic green leaves only produced pure air in the presence of sunlight; heat was no substitute for light. Thus the vegetable hypothesis was restored, and indeed extended: not only did vegetation restore atmospheric air depleted by fires and animal respiration, it also restored water that had dissolved unhealthy air and whose dissolved air was being rendered noxious by respiration of fish. Priestley's research on the restoration of air basically finished at this point. Most of the outlines of what would in the late nineteenth-century come to be called 'photosynthesis' were in place.[21.]

Forty years after Priestley's death, Julius Robert von Mayer (1814-1878) the German chemist, physicist and a founder of thermodynamics, was able to write straightforwardly and without argument in 1845 that:

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[21] For the history of photosynthesis, see Nash (1948); for the contribution of Jan IngenHousz, see Magiels (2010).

> Nature set herself the task of capturing the light flooding toward the earth, and of storing this, the most elusive of all forces, by converting it into an immobile force. To achieve this, she has covered the earth's surface with organisms which while living take up the sunlight and use its force to add continuously to a sum of chemical difference. The plants take in a force, the light, and bring forth another force, the chemical difference. (Sherman 2018, p.240)

Subsequently the exact atomic processes whereby light 'ejected' electrons off chlorophyll molecules thus enabling breakdown of carbohydrate molecules has become known (Sherman 2018, pp.240-245). Chi does not appear anywhere in this truly marvellous process of energy-conserving and life-giving photosynthesis; here was a chance for it to appear, but it did not; it remains scientifically idle.

Compare the foregoing accounts of the detailed, prolonged scientific investigation and measurement of energy transformation with what, as mentioned in Chapter 4, the International Feng Shui Society (UK) says of the putative omnipresent reality of chi:

> Chi, or *qi*, is the oriental word for the vital intangible natural energy that emanates from everything in our universe, a combination of both real and abstract forces: energy from the earth's magnetic field, sunlight, cosmic influences, colour vibrations, the nature of our thoughts and emotions, the form of objects, the quality of the air around us. Depending on whether it flows harmoniously or not, chi influences how a place feels and how we feel in it.[22]

This may or may not be a nice word picture, but it is fundamentally nonsense; and dangerous nonsense when construction, health, therapy and planning policies are predicated upon it. It opens a wide door for charlatans of every kind to walk in and exploit people.

A co-ordinated, cross-disciplinary approach to the inclusion of feng shui in a curriculum could look like Figure 10.3.

School Curriculum Subject Areas & Topics				
RELIGION AND ETHICS	**HISTORY**	**SCIENCE**	**SOCIAL STUDIES**	**PHILOSOPHY**

[22] http://www.fengshuisociety.org.uk/

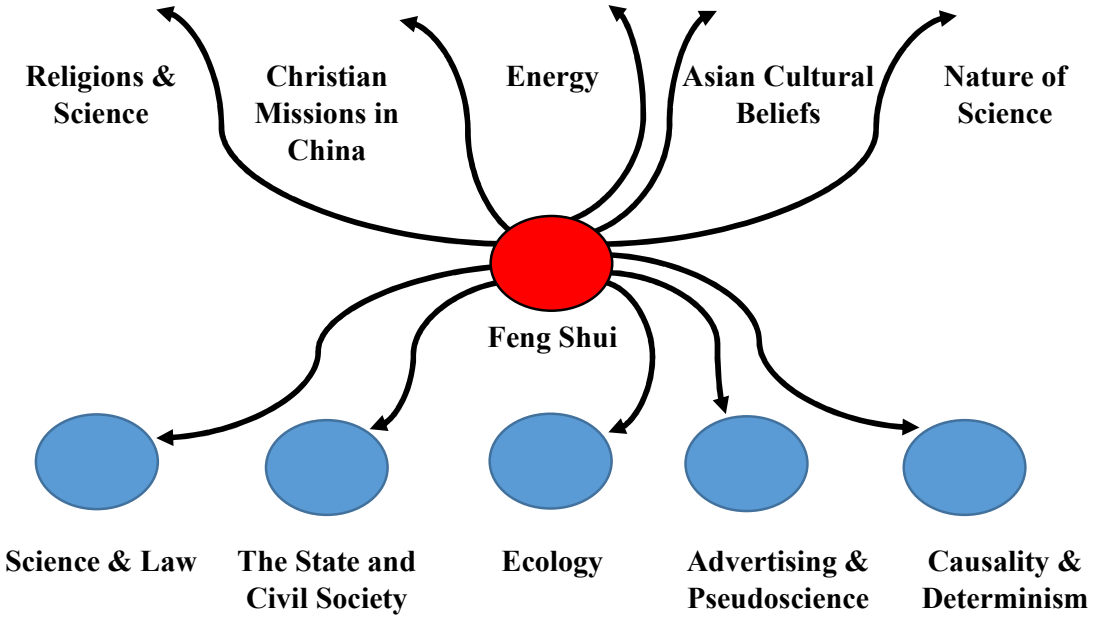

Fig. 11.3 Cross-Disciplinary Teaching of Feng Shui

Such cross-disciplinary co-ordination is characteristic of Liberal Education (Carson 1997, Schwab 1949/1978); it is a feature of all proposals for General Education (Bernal 1939/1949, Conant 1945); and it typifies the current international calls for integrated STEM-Humanities, or STEAM (science-technology-engineering-arts-mathematics) education programmes (Kim 2014, Rosicka 2016). This cross-disciplinary pattern has been fleshed out for a more connected teaching of photosynthesis in biology (Matthews 2009c, 2015, p.293) and pendulum motion in physics (Matthews 2014b, p.51). Other authors have done so for other topics.

Otto Blüh in the Preface to his Ernst Mach-inspired 1950s physics textbook indicated one way in which this can be approached:

> This book further offers the student the opportunity of becoming acquainted with the historical and cultural relations of physics, in the belief that the education of a scientist can be advanced most effectively by giving a significant place to the philosophical, social, and moral implications of physical science within the physics curriculum rather than through supplementary so-called humanistic and social studies. (Blüh & Elder 1955, p.vii)

The different school disciplines are connected. This is a matter of intellectual and historical fact. There is no physics without mathematics or without technology and philosophy; and physics grew whilst intertwined with theology, music and social forces. There is no biology without chemistry, mathematics and microscopes; and biology developed in a philosophical and theological context. Integrated or even co-ordinated teaching brings this cultural reality into focus for students. Having feng shui as a node or science topic in such an integrative curriculum can shed great light on feng shui, on the nature of science, on Chinese history, on cultural transmission and commercialisation, and much else.

From the beginnings of modern science, 'near enough' was never 'good enough'. For example, the long-standing assumption that the earth was spherical was rejected by Huygens on account of his pendulum clock having to be shortened by 3 mm in order to beat seconds in

equatorial regions.[23] By the nineteenth century, precision became the hallmark and norm for all sciences; it was an Age of Precision.[24] It was typified by Sir William Thomson's (Lord Kelvin 1824-1907) oft-quoted opening assertion when giving his 1883 address to engineers on the need for units of measurement in electricity:

> In physical science a first essential step in the direction of learning any subject is to find principles of numerical reckoning and methods for practicably measuring some quality connected with it. I often say that when you can measure what you are speaking about, and express it in numbers, you know something about it; but when you cannot measure it, when you cannot express it in numbers, your knowledge is of a meagre and unsatisfactory kind; it may be the beginning of knowledge, but you have scarcely, in your thoughts, advanced to the stage of *science*, whatever the matter may be. (Thomson 1891-94, vol.1, p.73)

The implication of Thomson's position for chi-based feng shui thinking is clear: it is not science. And given that thinking, or at least talking, about chi has been going on for three millennia, it is unlikely anytime soon to become science.

Multicultural Considerations

All of the foregoing is predicated on the premise that modern science is the most reliable and vindicated source of knowledge about the natural and social worlds that we have, and so should constitute the content of science programmes. But in the past 40-50 years this unremarkable premise has been challenged by multicultural educators appealing on the one hand to constructivist epistemology wherein no distinction or ranking can be made between systems of cogent belief; and on the other hand to ethical considerations fuelled by awareness of Western colonial and imperialist traditions (Matthews 1994, chap.9). Multiculturalists affirm that feng shui is an integral part of Chinese, and more broadly Asian, culture and so needs be considered and appraised from a multicultural perspective; specifically, its truth claims cannot be challenged from the standpoint of 'alien' modern or Western science.

There is a spectrum of alternatives that have been adopted by science teachers when teaching science in multicultural situations where fundamental cultural beliefs clash with science:

> *Imperialist*, where traditional understandings of nature and phenomena are ignored and modern science is taught as it is in the metropolitan centres: PSSC Physics in Polynesia, Nuffield Science in Newfoundland, CBA Chemistry in Colombia, NGSS in New Guinea, and so on. Traditional beliefs and systems are only attended to in order to prepare the ground for new knowledge which will supplant the old.
>
> *Integrationist*, where alternative understandings and ways of thinking about nature are recognized, respected and made use of, but in the last resort only as a more effective means of having students learn about modern science. Ethno-science is dealt with in an anthropological, non-judgemental way: what other cultures believe and the reasons for their beliefs are pointed out and students can make their own decisions.
>
> *Non-interventionist*, where ethnic or traditional science is recognised as an intellectually legitimate alternative to modern science and cultivated in its own terms

[23] The episode is discussed in Matthews (2015a, pp.232).
[24] See contributions to Wise (1995).

> along with varying degrees of modern science and technique. In some places both traditions are fully taught and a 'best of both worlds' approach is taken; in other places, just traditional sciences are taught.

The non-interventionist view is partly supported by ethical and political considerations that say that existing belief systems and cultures need to be respected, and that only internally instigated changes ought be sanctioned. As one African educator has said:

> The purpose of education in Africa is not to destroy its own civilization or its own culture, in order to replace it with something that is conceived to be 'better'. To proceed in that direction or with that implicit attitude is to create unnecessary difficulties in science education in Africa. (Urevbu 1988, p. 8)

And another maintains that it is:

> Unfair if Western science is forced upon students who do not share its values, meanings, or practices. (Lee 1999)

The same argument would be mounted for the maintenance of those parts of Asian culture for which feng shui is integral.

It is not intended here to appraise these complex cultural, ethical and political arguments for nonintervention; instead only the philosophical arguments proffered for the position will be examined. The core epistemological argument for non-intervention is the rejection of universalism as a theory of knowledge. Universalism is rejected in favor of some form of relativism which says that different knowledge systems are equally valid, and so there is no good cognitive reason to introduce modern science to traditional cultures. One can find many statements of this in the literature on multicultural science education. The following are a sample:

> Science is a way of knowing and generating reliable knowledge about natural phenomena. Other cultures have generated reliable knowledge about natural phenomena, therefore reason invites exploration of the possibility that other cultures may have different sciences. But science teachers wanting to celebrate this diversity have been so indoctrinated in the Western cultural tradition of science that they lack a methodology enabling examination of the science of other cultures with little more than tokenism. (Pomeroy 1992, p.257)

> There is a need to struggle to assert the equal validity of Maori knowledge and frameworks and conversely to critically engage ideologies which reify Western knowledge (science) as being superior, more scientific, and therefore more legitimate. (Smith 1992, p.7)

> For the developing countries of Africa dominated and governed by non-western socio-cultural factors, western science means an imposition of one culture over another. It means the replacement of the anthropomorphic worldview with a mechanistic one. (Jegede 1997, p.1) … From this can be seen the need to design science education that satisfactorily meets with the needs of Africa in such a way that the African view of nature, sociocultural factors, and the logical dialectical reasoning embedded in African metaphysics are catered for within a changing global community. (ibid. p.15)

These observations are sufficient to illustrate the argument of this book, namely that some core epistemological and ontological assumptions of modern science are in objective conflict with core assumptions of some traditional, including feng shui, belief systems.

The matters of ontological contention are:

1) Is the world constituted in such a way as to serve human interests?
2) Are processes in the world teleological? That is, do events and behaviors occur in order to bring about some fitting end state?
3) Are inanimate and nonhuman animate processes activated and controlled by spiritual influences?

The modern scientific tradition, that began in the West with Galileo and Newton in the sixteenth and seventeenth centuries, answers 'no' to each of the above questions; while many traditional belief systems, feng shui included, affirm some or all of the propositions. The basic matters of epistemological contention are the following:

1) Does knowledge come from the observation of things as they are in their natural states?
2) Are knowledge claims validated by successful predictions?
3) Do particular classes or authority figures define knowledge or become the custodians of knowledge?
4) Is knowledge a fixed and unchanging system?

Modern science, after centuries of debate, answers 'no' to each of these questions, whilst many traditional societies, and the core feng shui tradition, affirm some or all of them. Of course, there is some debate about these questions of natural states, prediction, the institutionalization of knowledge, and accretion versus revolutions in knowledge development. But these are in-house or family debates. Robin Horton in his classic 1971 study drew attention to a fundamental difference between traditional and modern sciences:

> The key difference is a very simple one. It is that in traditional cultures there is no developed awareness of alternatives to the established body of theoretical tenets; whereas in scientifically orientated cultures, such an awareness is highly developed. It is this difference we refer to when we say that traditional cultures are 'closed' and scientifically oriented cultures are 'open'. (Horton 1971, p. 153)

As will be documented in Chapter 13, despite modern China's unequalled material and technological advances, is a 'traditional closed culture'; alternatives to the established body of CCP-dictated theoretical tenets cannot be discussed or even entertained.

Conclusion

One can recognise among the pre-Socratic philosophers the slow, awkward attempts to distance their thought about the world from the mythical worldviews that were characterized by anthropomorphic, animistic and teleological dimensions (Sambursky 1975). There has been the same naturalistic efforts in the Chinese tradition. In traditional China, Needham identifies it with some of the Daoists and Mohists of the same period as the pre-Socratics. In the twentieth century, the thread continued with the New Thought movement, and later with Marxist Materialism. The CCP did enormous damage to Chinese science, scientists, and culture with its enthronement of 'Marxism-Leninism-Mao Zedong Thought' (the phrase Deng Xiaoping introduced at the Twelfth Party Congress in 1982) as the judge and arbiter of all economic, social and cultural questions, including, disastrously, fundamental scientific

questions. This should have been seen as insane when first introduced in 1949; its insanity became more obvious with each passing decade. With the upper echelons of CCP losing intellectual and philosophical credibility, it is important that ordinary philosophers, scientists, educators and teachers themselves grapple with the compound philosophical, scientific, cultural and educational issues presented by the omnipresence of feng shui belief and practice in society.