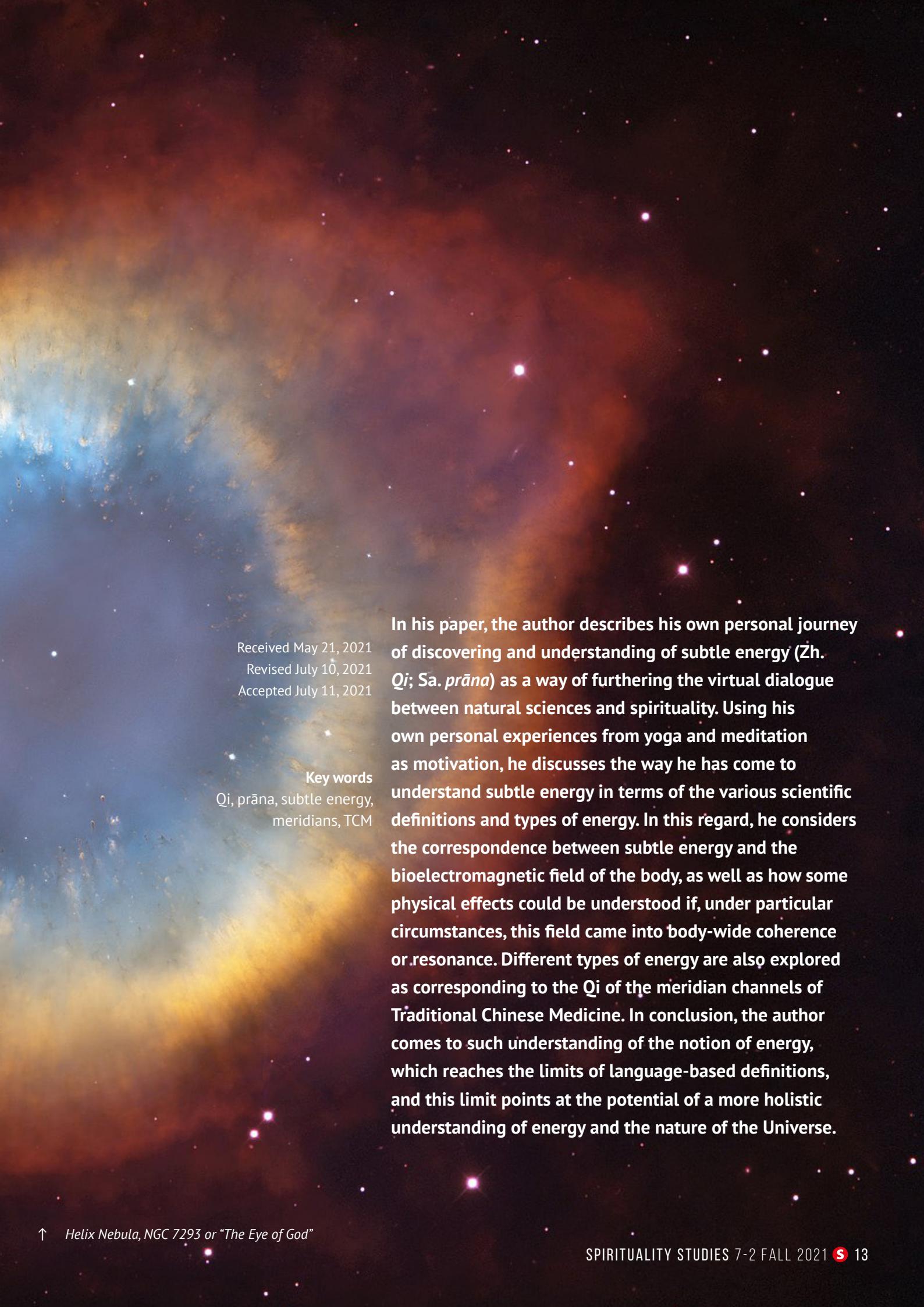
A portrait of a man with a shaved head and glasses, smiling, set against a vibrant, multi-colored nebula background. The nebula features swirling patterns of red, orange, yellow, and blue, with numerous small white stars scattered across the dark space.

Mark Westmoquette

Qi: A Personal Take on the Intersection of TCM and the Natural Sciences



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In his paper, the author describes his own personal journey of discovering and understanding of subtle energy (Zh. Qi; Sa. *prāna*) as a way of furthering the virtual dialogue between natural sciences and spirituality. Using his own personal experiences from yoga and meditation as motivation, he discusses the way he has come to understand subtle energy in terms of the various scientific definitions and types of energy. In this regard, he considers the correspondence between subtle energy and the bioelectromagnetic field of the body, as well as how some physical effects could be understood if, under particular circumstances, this field came into body-wide coherence or resonance. Different types of energy are also explored as corresponding to the Qi of the meridian channels of Traditional Chinese Medicine. In conclusion, the author comes to such understanding of the notion of energy, which reaches the limits of language-based definitions, and this limit points at the potential of a more holistic understanding of energy and the nature of the Universe.

1 Encountering Subtle Energy

About the author

Mark Westmoquette, Ph.D., obtained his doctoral degree in astrophysics in 2007 and subsequently spent seven years as a professional astronomer. After training as a yoga teacher in 2009, he has taught yoga worldwide. In 2015 he spent a short period as a Zen monk, and after recently living for two years on the remote island of St. Helena in the South Atlantic, he now teaches yoga, Zen, and mindful stargazing from his base in London. He is the author of four books: *Mindful Thoughts for Stargazers*, *Stars: A Practical Guide to the Key Constellations*, *The Mindful Universe* and *Zen and the Art of Dealing with Difficult People*. Mark's email address is mark@markwestmoquette.co.uk.

I've always had a very rational, mathematical mind. When I was eighteen (in 1999) I went to University College London to study astrophysics. A year or so before, however, when I was about seventeen, I got into target rifle shooting as a sport. When I joined the university shooting club and started getting more serious, I read it would be helpful to start doing something like yoga to improve body and breath awareness – two things essential in target shooting.

I found a yoga class in the university gym and started going regularly. Having not been particularly sporty as I grew up, I enjoyed the physical challenges yoga presented and I marveled at how other students were able to gracefully flow through a *sun salutation* and do *headstands*. However, I was almost completely put off by talk of subtle energy – *chakras*, and *prāna*. The fluffy, pseudo-scientific language of esoteric energy jarred immensely with what I was hearing in my physics lectures.

From my young, hyper-rational perspective, the existence of *prāna* was undoubtedly imaginary (or at best ungrounded in any scientific reality). It was too “woo woo” for me! So, in those first few years, I gravitated towards physically stronger, less “spiritual” yoga classes, and felt uncomfortable every time mention of *prāna* or *chakras* came up.

In 2007 I met my Zen teacher Daizan Roshi. He perceptively presented meditation practice to me in an appealingly scientific way. He suggested that I see my body as the lab and follow the methodology he described, but that there was no foregone conclusion – it was up to me to find out for myself what the effects of meditation were. I committed to a daily meditation practice and began investigating my mind-body from this new angle. Daizan is also a yoga teacher and had started running Zen-Yoga teacher training programs. I felt very drawn to this, so in 2009 attended one of his intensive residential training courses in Devon, UK.

I had several experiences on that teacher training retreat that blew my mind with regards to my understanding of subtle energy. First came after doing some simple Qigong based

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movements. When we held our hands apart with eyes closed and concentrated our awareness on the palms, I felt a magnetic kind of resistance and attraction between them. I now know many people can feel this (see e.g., Kam-Chuen 1991, 75; Jahnke 2002, 100; Cohen 2018, 207), but this was my first undeniable physical experience of Qi energy – and it forced my rational, scientific self to take notice.

On the retreat we did *yoga nidra* (Rama 1986; Desai 2017) every day. During this daily practice, Daizan introduced us to the practice of allowing the digestive fires of the belly to blaze up through the central channel and melt the cool nectar from a point known as *bindu* in the head (Mallinson 2004, 113; Tracy 2020). After some days of working with this, the instruction was to let the nectar melt down into the fire. At the point for me when the nectar connected with the fire, I experienced a totally unexpected, very pleasurable – almost orgasmic – ripple of sensation through my body, and my back convulsed with a series of jerky movements.

In the years that followed, I worked with various other yoga teachers in developing my practice. Through them I started to hear about, then come across, others whose bodies would jiggle and convulse during their practice – sometimes in the spine, sometimes in the legs or arms. All this again blew my mind!

These pivotal events were irrefutable – I'd felt them and seen them for myself. But (in my experience) modern physics or biology had nothing to say about what might have caused them. In yoga, Qigong and Zen, they're understood as being caused by energy – prāna or Qi – but what exactly causes the feeling of magnetism, the spinal convulsing, or the intense pleasurable feelings? And what kind of energy is this?

These questions prompted me to begin a deep inquiry into the possible nature of Qi and prāna, and how to square it with concepts of energy that exist in physics. I'm positive I haven't got to the end of this inquiry, and I acknowledge I may not reach a fully satisfactory conclusion in my lifetime, but I'd like to explain where I've got so far.

The Sanskrit word *prāna* and the Chinese word *Qi* (also *Chi*) are often translated into English as “energy”. However, the original words are very difficult to define and consequently translate into one equivalent word. The poet William Blake takes the view that “*energy is eternal delight*” (Blake 1975). In the book *Energy Medicine East and West: A Natural History of Qi*, the editors (Mayor and Micozzi 2011, 321) compiled a list of the words most used within the book in association with *Qi* or *prāna* and came up with the following: flow, circulation vs. block, energy, balance or homeostasis, life force or vitality, breath or wind or cloud-vapor, heat, movement or dynamic. I think this list well describes the range of meanings we find in Eastern teachings about *Qi* or *prāna*.

Let's now look at what energy means from a Western standpoint. Strangely enough, the meaning of energy in English is also hard to pin down (perhaps just as much as *Qi*).

The Oxford Dictionary of Physics defines energy to be “*a measure of a system's ability to do work, measured in joules*” and that it “*can be classified into two forms: potential and kinetic energy*” (*Oxford Dictionary of Physics* 2003, “*energy entry*”). *The Cambridge Dictionary* defines it as “*the power and ability to be physically and mentally active*” as well as “*the power from something such as electricity or oil that can do work, such as providing light and heat*” (*Cambridge Advanced Learners Dictionary* 2008, “*energy entry*”). Other definitions include “*the capacity that an object has for performing work*” and that “*work is done by a force acting on an object*” (Halliday et al. 2010, 183; Malone and Dolter 2010, 94). Thus, we find a similar range of associated terms relating to the Western concept of energy: power, ability, doing work, capacity, force, transference, heat, and light.

In physics, we learn that energy can exist in a variety of forms, such as potential, electrical, mechanical, or nuclear. It's been found empirically that energy can be converted from one form to another, but seemingly neither created nor destroyed (a finding that's been enshrined in the law of conservation of energy). Let's examine the types of energy known to physics that are found in the human body. I'd like to note that nuclear energy is not mentioned here since it's not found in body – thankfully! (Nuclear energy arises from fission, decay, or fusion of an atomic nucleus, and is distinct from the energy of other atomic phenomena such as ordinary chemical reactions, which involve only the orbital electrons of atoms.)

Electromagnetic energy is found in:

- The molecular bonds between the atoms and molecules, such as H₂O, that make up our tissues (in the form of electrostatic attraction between atoms that share pairs of electrons, forming a covalent bond; Malone and Dolter 2010, 58).
- Nerve impulses (in the form of “action potentials” – waves of alternating charge polarity that pass along the membrane of a neuron; Garber 2002, 173).
- Currents of charge that pass-through bone and connective tissue (fascia) generated via the piezoelectric effect by compression or tension forces as we move. The piezoelectric effect is the ability of certain materials to generate an electric charge in response to applied mechanical stress. Certain cells in bone and fascia sense the current that's generated and react by laying down new material to optimize the strength of the tissue (Myers 2020, 20).
- Direct electrical currents and polarity differences that are found in the body, including skin electrical resistance and currents that exist particularly after injury (Becker 1985, 105).
- The electromagnetic field in and around the body. Physics tells us that all moving electrical currents generate an electromagnetic field. This field generated by the electrical activity of the heart is detected with electrocardiograms (ECGs) and by the brain with electroencephalograms (EEGs). The electromagnetic field penetrates the body and extends outside the body, diminishing in strength with distance like all electrical fields (Becker 1985, 81; McCraty 2015, 36).
- The thermal infrared radiation emitted by the skin surface (what's detected by infrared cameras; Halliday *et al.* 2010, 1094).

Chemical energy is manifested:

- In the metabolic processes of the body. Oxygen is absorbed via respiration (and waste CO₂ emitted) and combined with glucose (formed from the fats, proteins and carbohydrates that are absorbed from our food) to form ATP (adenosine triphosphate). ATP is the main energy currency of organic cells, driving muscle contraction, nerve impulse propagation, chemical synthesis, etc. In essence, all chemical reactions are the result of the transference of the electromagnetic energy of electrons. Most reactions entail the replacement of weak molecular bonds with stronger ones (Ody and Norris 2017, 28).
- As chemical messengers called hormones (e.g., adrenaline, serotonin, histamine) when in the blood or neurotransmitters in the brain. These pass energy around the body in the form of information and impulses to action (Ody and Norris 2017, 168).

Kinetic energy is manifested:

- In the form of heat. Any atom or molecule above absolute zero (-273 °C) will vibrate. This vibration is called thermal energy, or heat. The vibrations cause the radiation of heat energy in the form of photons in the thermal infrared range (8–15 μm; Halliday *et al.* 2010, 640).
- In mechanical stress. Even at total rest, the tissues of the body are under mechanical tension and compression. This is how the body keeps its shape. As we move, the transmission of tensional and compressional forces follow certain lines of myofascial connection across the body (Myers 2020).
- In the rhythmical movements of the life-sustaining functions of the body (e.g., the respiratory rhythm, heartbeat pulse, craniosacral rhythms, etc.).
- In body posture (e.g., body language, semaphore) and body movements (e.g., waving goodbye).

Potential energy is manifested:

- In the gravitational pull of Earth on our body – the higher we climb, the greater potential energy the body gains. Gravitational potential energy can be a distinct source of fear when we're standing on a cliff edge! (Halliday *et al.* 2010, 215).
- In the elastic qualities of the body's tissues. For example, when we throw a ball, we know to swing our arm back before accelerating it forwards. Part of that back-swing is to elastically stretch the tissues in our arm, so that when we throw (via muscular contraction), that elastic potential will be released and will increase the speed of the ball (Halliday *et al.* 2010, 217; Schleip and Baker 2015, 229).
- In the chemical potential energy of stored fats, glucose, etc. A candle, for example, converts chemical potential energy into heat (thermal kinetic energy) and light (electromagnetic energy) (Ody and Norris 2017, 28).
- In the mass of every particle that makes up the body. In his theory of special relativity, Einstein derived his famous equation E=mc², meaning energy is equivalent to mass, or put another way, mass is simply a manifestation (or solidification, confinement, or localization) of energy (Einstein 1905, 639).

There's one more form of energy I want to mention. You won't find it in a physics textbook, but nevertheless it's very real; that is intention. Intention is a type of mental energy and represents a determination or commitment to doing something by carrying out a volitional action or set of actions. Intention acts to bring together and direct all the energies we've mentioned thus far for a particular purpose and can be exceedingly powerful. Intention built the pyramids, sent a man to the moon, and is the creator and destroyer of civilizations!

3 The Subjective Perception of Qi

Many people dismiss the concept of *Qi* since no correspondence with any one anatomic system has been found. But if we see *Qi* as a collective term, just as we use the word *energy* in English as a collective term for all these different forms of energy, then the concept of *Qi* makes total sense. In different contexts, *Qi* will mean different things. Sometimes it means the body's electromagnetic field, sometimes mechanical force, and sometimes the information energy encoded into hormones.

I'd now like to examine the subjective perception of *Qi* in the body. This is where things get subtler and stretch the edges of our scientific understanding.

The idea of perceiving or sensing energy was one of the things that I found most off-putting and confusing about my early encounters with yoga. I had no idea what to do in order to "feel my root chakra opening" or "sense the flow of energy through my kidney meridian". A big part of the problem was that the language and terminology were unfamiliar to me, and the teachers didn't properly explain what they meant (or perhaps didn't fully understand themselves).

I see now that the idea of feeling energy in the body needn't be so esoteric. Even in Western culture, different forms of energy are felt subjectively in the body and discussed in everyday language. On an overall body-level, we all know when we feel low in energy (feeling tired, heavy, or exhausted), and when we're high in energy (feeling wide awake, excited, or wired). Sometimes seeing these energy states is easier in others than yourself. If I asked you to rate your overall level of energy right now, you'd probably have a good idea.

Changes in energy in specific parts of the body can also often be very noticeable. For example, when you step into the shower and notice your toes going from feeling cold to comfortably warm. Another example is feeling "butterflies in the stomach" when we get anxious or nervous about something. Those butterfly tingles are, in fact, the subjective feeling of blood being redirected away from digestive system as part of the fight or flight stress reaction. As our body awareness and sensitivity deepens, we might notice more subtle feelings, shifts and changes, like tingling in other parts of the body or the build-up of heat or coolness. Tingles or "pins-and-needles" in any part of the body are often to do with changes in blood flow and pressure caused by vasoconstriction or dilation. We could call it the movement or build-up of *Qi*, or we could say, "*I'm feeling tingling in my skin due to changes in my blood vessels that are part of a complex response to my external environment.*"

3.1 Energy in the Palms

Other feelings we might notice include the magnetic or heat feeling in the palms mentioned above. The palms are typically very sensitive, so these types of feelings are easiest to detect here. With practice it becomes possible to sense those kinds of feelings when palm-to-palm with another, or in other parts of the body. Yoga students and energy healers often talk about sensing hot-spots and cool-spots as the palms pass across the body of yourself or another.

It's possible that what we feel in the palms is actual heat radiating from the skin, but it's also possible that these magnetic or heat sensations are our subjective interpretation of sensing the electromagnetic field around the body. We know the body produces a detectable electromagnetic field that can be measured several feet away in the lab using sensitive detectors. We also know that the skin varies in its electrical sensitivity (known as its electrical conductance, galvanic skin response or electrodermal activity) depending on skin moisture levels. These moisture levels are controlled by activation of the sweat glands by the autonomic nervous system, which responds to our general mood and level of emotional or psychological arousal (Van der Valk and Groen, 1950, 303; Korr *et al.* 1958, 77; Farnsworth 2018). Thus, the skin's sensitivity to electrical currents changes with our level of arousal and emotions.

Normally the autonomic nervous system cannot be controlled consciously. However, research done on the Taoist yoga master, Mantak Chia, shows that with training, it's possible to gain a level of conscious control over this, otherwise, autonomic response. This allows him to vary his skin electrical conductivity at will making his skin sensitive to detecting external electromagnetic fields (Chia 1997).

Our ability to detect the electromagnetic field of another through, for instance, our palms may result from an interplay between our own skin electrical sensitivity and our ability to increase this sensitivity with training and learning to become aware of and interpret the subtle, subjective feelings that arise from interacting with that electromagnetic field.

4 Energy of the Heart

Physics claims that any moving charge will create an electromagnetic field (Halliday *et al.* 2010, 708). Thus, all nerve impulses and piezoelectric currents in the fascia will produce a small electromagnetic field. The brain, containing millions of neurons, creates a great buzz of nerve electrical activity. However, because currents travel in every direction, the resulting overall field is attenuated by the fact that impulses travelling in opposite directions will cancel each other out. In the body, it's the heart that produces the largest electromagnetic field. This is because the nerve impulses that instigate each heart beat all fire simultaneously, thus creating fields that constructively adding together rather than some canceling others out. Each heartbeat creates a coherent pulse of electrical activity measuring 2–3 watts, resulting in an electrical field about 60 times greater in amplitude than the generated by the brain.

Studies of couples have shown that when they are in a state of rapport or emotional connection, their heart rates will synchronize (McCraty 2015; Goldstein 2017, 7). In physics, resonance happens when one object vibrates at the natural frequency (or one of the natural frequencies) of a second object, causing that second object to vibrate at that frequency (think of a singer's high note breaking a glass or when the walls and furniture vibrate when you play music on a heavy beat). Thus, you could understand heart rate synchrony as arising when the electric field of one person's heart causes – or is allowed to cause – a resonance in the electric field of another person's heart.

However, it's becoming evident that the heart's electromagnetic field encodes information beyond just the pulse rate. For example, positive emotions such as compassion and love seem to generate a more harmonious pattern in the heart's rhythm, leading to coherence (an increased *heart rate variability* indicating greater emotional regulation; McCraty 2018; Morales 2020). This is communicated throughout the body and into the external environment via the heart's electromagnetic field, just like a radio mast emits an electromagnetic field that's picked up by your car's radio antenna.

An attraction or aversion to someone may therefore be detected and felt in the heart, and only processed, acknowledged, and labeled as a feeling when it's interpreted in the brain.

4.1 The Heart Protector

In the energy system of the body laid out by Traditional Chinese Medicine (TCM), the *heart* is seen as the *emperor or supreme controller*, and the *pericardium* – the fascial sheath around the heart – is the *heart protector* (also *heart constrictor* or *guardian of the heart*; Kaptchuk 2000, 124; Unschuld and Tessenow 2011, 273). TCM sees the pericardium's job as protecting the heart from emotional trauma and helps it to express the love and joy of the heart.

In Western understanding, the pericardium is a sack of tissue that envelops the heart mirroring the double-layer fascial membranes around all other organs that act as separators and lubricated membranes to allow easy movement. However, what makes the pericardium different is that it has an outer (third), much thicker and stronger layer called the fibrous pericardium. This is made from a thick, matted matrix of collagen fibers and is understood to protect the heart from infection and physical trauma.

Collagen is a fascinating substance. The fibers of this protein form into a semi-crystalline structure known as a liquid crystal matrix. This matrix is also a semiconductor, meaning it can conduct electricity under certain circumstances and not in others. These fibers can also generate electricity when they are deformed through a process known as the *piezoelectric effect*. Thus, the thick, matted fiber matrix of the pericardium is a mesh of nano-sized wires, which could easily act as a physical and electrical shield – a *heart protector*. But it's not inert like a *Faraday cage* – a wire cage used to block electromagnetic fields. It's living, and therefore very likely capable of changing its properties depending on the state of the individual just like our skin electrical conductivity. Thus, it could act to modify, allow, or block the electrical fields from others (Keown 2014, 210), or indeed modify the electromagnetic field emanating from your own heart.

Like this we could see the pericardium as a mediator of our heart energy – allowing our energy (electromagnetic field) out unimpeded (equivalent to having an open heart) or restricting it (a closed heart) and allowing us to sense other people's heart energy.

4.2 Kundalinī Qi

Let's turn our attention to what might be happening when we experience convulsive movements in the spine – often together with feelings of electrical shocks and/or waves of pleasure. In yoga, this is called *Kundalinī* (Sivananda 1991) – the rising of the snake-like coiled up potential energy that's seen to reside at the base of the spine. In another yogic metaphor, it's the energy of the earth or feminine rising up to meet the energy of the heaven or masculine (Narayanananda 1960; Sivananda 1991). In Zen, this rising energy is called *sho-ten-ki* – "heavenly piercing energy".

Since our nervous system is based entirely on electrical impulses generated and triggered by our cells, it's not a huge leap to think that the body could produce large-scale alignments or patterns of electromagnetic energy that could be felt as tactile sensations. In my mind, it seems reasonable to see these electric shock-like convulsions as arising when the body-wide electric field comes into some sort of phase correlation or resonance. In physics, phase correlation means there is a relationship between the phases of different waves (even if they aren't precisely in phase), and the level of that correlation is described by the coherence. A so-called state of "coherence" occurs when two wave sources take on identical frequency and waveform.

Having said this, various teachers through the years have also told me that these convulsions arise only because the energy pathways in the body aren't yet clear enough of obstructions or blockages to handle that level of power. The idea is that as energy courses through our channels, it will bounce off these blockages and cause the jerky movements. At first reading, this sounds very unscientific and metaphorical. What kind of energy do they mean, which pathways is it traveling in, and what are these so-called blockages?

Starting from a purely empirical point-of-view, my experience would support this explanation – even without understanding what's happening. As my practice has progressed, those

jerky convulsions have reduced and now hardly ever happen – even though I still feel the waves of pleasure. My body, it seems, has adapted to be able to handle the increased flow of energy.

To understand what might be happening, let's explore what we mean by yoga and meditation practice and what progresses. Yoga and meditation are about encountering ourselves, either through movement or stillness, and doing our best to allow whatever is noticed to be acknowledged and let go of as we settle into the present-moment reality of things. The stuck parts of ourselves (i.e., the blockages) can occur on the physical, emotional or psychological levels, and can impede the movement of all types of energy: blocked arteries impede the movement of blood; a tight lower back restricts our posture; a desire to stop feeling grief and sadness takes us away from the reality of how things are; a strong belief that Qi doesn't exist closes our mind to new possibilities; and a fear of commitment might hold us back from forming deep relationships. These are all blockages to different forms of energy. Through our practice of exploration, acknowledgement and welcoming encouragement, these different kinds of blockages gradually unwind, unbind, and free up. We get more physically flexible, aligned, and coordinated, less blown around by emotions and less caught up in the dramas of our own self-centered preoccupations. In one Zen metaphor, we unfreeze and start flowing more naturally.

If it's true that certain practices can bring the body-wide electromagnetic field into some sort of coherence, and then we have blockages in the system, then it's no wonder that a physical reaction happens (as in convulsions or jiggles). From my limited experience, I get the sense there's a wide diversity in the types of reactions people experience to this kind of energy, depending on the types and strengths of blockages they have.

4.3 Energy Channel Qi

How can we understand the energy meridian lines that underlie the system of TCM?

Meridian lines – *Mai* in Chinese, “channel” or “vessel” in English – have a superficial component that runs just under the skin, and an internal component connecting to the organs after which they are named (Kaptchuk 2000, 106). The *points* accessed in acupuncture – called *Jie* in Chinese, literally meaning “node” or “critical juncture” – are all on the superficial component of the lines. The subjective experience of feeling the flow of energy in these channels varies greatly from person to person. As I’ve come to understand it, part of that may be because the meridian channels follow the pathways of various kinds of energy in the body, depending on the depth and location.

Some of the internal lines, deep within the torso, seem to correspond to clear functional relationships and dependencies between the organs (e.g., the energetic or physiological connection between the kidneys and urinary bladder, the lungs and trachea, and the gall bladder and digestive tract). However, the origin of some of the other proposed energetic connections and relationships seem obscure – until you reference embryology and how the fetus grows and develops in the womb (e.g., the heart forms from a tube folding in on itself that originates from the mesoderm, together with the kidneys, thus creating the strong heart-kidney connection; Keown 2014, 142).

Parts of some meridian lines seem to follow veins or arteries (blood energy). For example, the section of the stomach meridian line from the clavicle down to the top of the leg, follows at first the internal mammary artery – passing through the nipple – then, at the junction of the ribs and abdomen, follows the superior epigastric artery followed by the inferior epigastric artery before joining the external iliac artery (Kaptchuk 2000, 114). Interestingly, the nipple is clearly associated with the gut and nutrition through providing the infant with breast milk. Other mammals – like dogs or pigs – have a chain of nipples that are located exactly along the path of the stomach energy line. In another example, the liver meridian follows the great saphenous vein from the inside of the foot, up the inside of the leg, and into the peritoneal space via the femoral canal (one of two fascial openings at the bottom of the peritoneum) to the organ itself (Keown 2014, 234).

4.4 Mechanical Force Transmission

Other parts of the meridian lines follow fascial continuities. In the last few decades, a buzz of interest has developed around fascia – the connective tissue of the body (Lesondak 2017; Myers 2020). Previously it was seen as a kind of inert packing material and disregarded. Now it’s understood to have great functional import in the body and is full of sensory nerve endings.

The work of people like anatomist Thomas Myers have shown that it’s possible to trace lines of continuous fascial connection through the body (Myers 2020). With these developments, muscles are no longer seen as individual units acting independently, but as part of a network of connected tissue that transmit mechanical forces such as tension, compression, and torsion throughout the whole system. This type of holistic, interconnected arrangement has been described as a *tensegrity structure*, which is a term coined by Buckminster Fuller in the 1960s (Swanson 2013, 34).

It comes as no surprise to see that many of the myofascial lines of connection – *anatomy trains* as they’re called by Myers – bear a striking correlation with the meridian lines of TCM – at least in the periphery of the body. For example, the *superficial front line* is co-located with the *stomach meridian*, the *lateral line* with the *gall bladder meridian*, and the *superficial back line* with the *bladder meridian* (Myers 2020, 273).

It’s become clear to me that one of the forms of energy that are transmitted along the meridian lines is that of mechanical force – tension, compression, and torsion. For example, if I extend my arm at shoulder height and stretch it backwards with the thumb facing front, I’ll be transmitting mechanical tension through the *lung meridian* line, which, from this perspective, closely corresponds to the *fascial deep front arm line*. However, because the whole fascial network is interconnected, changes in one part of the system will be felt across the whole system meaning, when something happens in one place, we might feel the consequences in seemingly unconnected and distant parts of the body, as often happens, when we receive acupuncture.

4.5 Electrical Qi – ElecQicity

We know that fascia is a semiconductor, generating and conducting electrical currents under conditions of mechanical stress (remember, these electrical currents are separate and independent from those transmitted in the nerves). Lines of fascial connection, therefore, transmit not just mechanical forces, but also the electrical currents generated by those forces. In his book *The Spark in the Machine*, Keown (2014, 81) calls this electrical information *ElecQicity* – “the electrical component of Qi”.

Meridian channels follow lines of fascial connection, but it may be that, more precisely, they follow the contact surfaces between fascial membranes (e.g., between separate muscle fiber bundles, between muscle fibers and nerves or blood vessels, or between muscle fibers and the organs they’re next to; Langevin and Yandow 2002, 257). There’s also evidence to suggest that some acupoints are located at the intersection between two of more fascial planes (a fascial intersection; Langevin and Yandow 2002, 257).

Qi is often said to flow from areas of concentration (the torso) to the extremities (fingers and toes; Keown 2014, 85). These fascial planes, therefore, may offer routes of “least resistance” (thus acting like wires in an electrical circuit) for the flow of extra-neuronal electrical currents from the body’s center to periphery. For example, when I stretch my arm out behind me with the thumb facing front, I’m not only transmitting mechanical tension along the myofascial of the Lung meridian, but the movement will also generate a piezoelectric current, which will travel along the fascial planes of that line of tension. This is similar to the situation known in physics where a charge is seen to flow around a circuit consisting of capacitors and resistors until the potential difference across each capacitor is equal (here the capacitors would represent different areas of fascia). The stretch will also generate a substantial level of sensations, which will further bring that meridian line into my awareness, generating a strong mind-body (awareness-sensation) connection.

5 Conclusion

When I started practicing yoga, I had just arrived at university to study astrophysics, and I became convinced that the existence of prana or Qi was imaginary or at least ungrounded in scientific reality. But over the years I’ve come to see how it can be understood in terms of physics.

The concept of energy in the West and Qi in the East are both difficult to define since their meanings change with context and experience. In the West we define energy in terms of a capacity to do work or exert force. It comes in forms like kinetic (mechanical, thermal, etc.), electromagnetic or potential (gravitational, elastic, chemical, etc.). The Eastern concept of Qi is more often described more in terms of movement, flow or circulation, and vitality or life force – of the energy that sustains and supports life. In both uses of the word, energy is a collective term that encompasses many different forms.

Since energy isn’t a “thing” in the traditional sense, it strains at the limits of language-based definitions and labels. This proved a major issue in the revelations of sub-atomic physics and the development of quantum mechanics in the early-mid 20th century, when particles were seen to behave like waves under some circumstances, and waves behaved like particles in others (Westmoquette 2020, 125). The problem was the discriminative nouns of our language became inadequate for describing world as it really is. In 1905, Einstein published his famous equation $E=mc^2$, showing that mass is equivalent to energy (Einstein 1905, 639). As the meaning of this equation became understood, quantum physicists realized that particles are not distinct from waves. Sub-atomic particles are better thought of as confined or localized energy waves with particular properties such as position, momentum, spin, etc. The universe of “things” became a universe of energy: ever-changing and ever transforming.

Thus, both physics and spiritual investigation show us that, fundamentally, there are no things, only energy – no fixed permanence, only change and transformation, no primary building blocks of matter, just a seething field of interactions and relations.

When we realize this, we see that Qi is not just individual (limited to a personal life force confined to each body), it is universal. For example, the strength of the electromagnetic field around your body (like most fields in physics) falls off as $1/r^2$ (i.e., inversely proportional to the square of the distance, where “r” is the distance; Halliday *et al.* 2010, 714). That means it has a valid mathematical expression that extends to infinity. The electromagnetic field of your body permeates the whole universe as does everyone else’s.

In this article, I’ve described some of the basic, experiential feelings of Qi that I have had and attempted to relate them to some of the forms of scientific energy found in the human body. We’ve explored magnetic or heat feelings that can arise in the palms in terms of sensing our external electromagnetic field, and how our sensitivity to that can change depending on our skin electrical conductivity otherwise known as *galvanic skin response* or *electrodermal activity*. We’ve also explored the significant role the heart plays in producing that electromagnetic field, and how the fascial sheath around it, known as the pericardium, may be able to modulate that field creating a condition of what we might call open or closed heartedness. We’ve also touched on some research that indicates that the heart’s electromagnetic field may resonate with the electromagnetic field of other hearts, and encode more than its pulse rate, including more complex information about our emotional state. This can be detected by others just like a radio antenna resonates with radio emissions from nearby masts. We’ve explored Kundalini, the rising or uncoiling of Qi or prāna in the spine, in terms of our electromagnetic field coming into a kind of phase correlation or resonance. In Eastern teachings, when this energy begins to rise it can encounter certain blockages that are seen as the cause of physical convulsions or spasms. This led us to discussing what these blockages might be from a spiritual and scientific point-of-view. Finally, we’ve explored the meaning of energy in the meridian lines in terms of blood energy and nerve impulses, mechanical force transmission, and conduction of extra-neuronal (outside the nerves) electric currents.

Qi has been studied for centuries in the East and is very well understood. But the Eastern form of understanding isn’t always satisfactory to our Western scientific minds. Qi is most often described in terms of its experience and use, using metaphor and analogy.

When this is translated and read by a Westerner who’s used to descriptions involving dissectible anatomy and empirical physiology, it sounds unscientific and “woo woo”! When a Qigong teacher says, “*imagine a powerful hosepipe of energy gushing out of your fingers*”, a Western, scientifically oriented person might ask, “*but what is it exactly that’s supposed to be gushing out of my fingers?*”

To me, however, it’s possible to find an equivalent analogy that doesn’t ask us to imagine an esoteric kind of energy, for example, “*imagine there’s a chocolate biscuit just outside your reach, now reach for it...*”. Both instructions engage our intention, which is a form of mind energy, using visualization and imagination. And as we previously mentioned, intention acts to corral and direct all the different physical energies in the body for a particular purpose. I wonder, though, if the chocolate biscuit visualization is as effective, especially if you’re trying to cut down on chocolate biscuits.

Much of the Eastern understanding of Qi is still not understood in scientific terms. People like Daniel Keown (2014) are starting to make the connections. In my view, he’s done a remarkable job in showing a correspondence between the two systems to the point where the subtitle of his book is *How the science of acupuncture explains the mysteries of Western medicine*. But there are many questions still unanswered. For example, how closely do the meridian lines follow the interfaces between fascial membranes? Why does TCM assert that energy flows in only one direction through the meridian lines? Is there any evidence of changes in the pericardium that could act to modulate the heart’s electric field? Can the body-wide electromagnetic field really come into some kind of phase correlation or resonance? How is the body’s electromagnetic field affected by strong external electromagnetic fields, such as that produced by power lines or domestic electrical wiring (some people seem to be more “electrically sensitive” than others; some suffer acutely), and does that affect our ability to feel energy?

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