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Structure and property changes in certain materials influenced by the external *qi* of qigong

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Abstract Temperature, time, pressure (or stress) are considered important factors in changing the Gibbs free energy and optimizing the structure and properties of materials during materials processing. The effects of some other variables, including the magnetic field, electrical field, electromagnetic and ultrasonic radiation, and chemical reactions have also been well characterized. These factors have been widely applied in materials processing, and their limitations have been discovered. Thus additional factors and innovative techniques are constantly being sought to overcome those limitations. This paper presents such an innovative technique called qigong. Three sets of materials-related experiments conducted by qigong doctor Yan and his collaborators are described in which for the first time the effects of *qi* on inanimate matter samples with no mechanical or electrical connection to the system are revealed on laboratory instruments. These experiments show that external *qi* of qigong produces significant structural changes in water and aqueous solutions, alters the phase behavior of dipalmitoyl phosphatidyl choline (DPPC) liposomes, and enables the growth of Fab protein crystals. These results demonstrate objective phenomena resulting from qigong and the potential of this ancient technology system, even in material processing. Important attributes of *qi* are summarized and the possible implications of these results from the materials perspective are discussed.

Key words Qigong · Qi · Material structure · Material property · Raman · Water · Protein · Liposome · Saline · Glucose

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I Introduction

To materials scientists, the factors usually considered important in changing the Gibbs free energy and optimizing the structure and properties of materials in materials processing are temperature, time, and pressure (or stress). Many other variables normally have only negligible or insignificant influences in the process. Under certain conditions, however, these variables, including the magnetic field [1], electrical field [2, 3], electromagnetic [4–6], and ultrasonic radiation [7, 8], as well as chemical reactions [9, 10] may have significant influences. After years of extensive research, these factors are now well characterized and many related processing techniques have been successfully developed and widely used. At the same time, many desirable materials properties are still beyond our reach due to the inherent limitations of the available processing techniques. Thus significant efforts are directed towards searching for new factors and innovative techniques that can expand the capability of currently available processing techniques in order to obtain other much desired materials properties.

Qigong (pronounced *chee gung*), an ancient technology system originated in China, appears to have the po-

tential as an innovative technique for materials processing. Qigong may be described as a discipline which specifically studies high-energy substantial *qi* inside and outside the human body; the functional use of organs hosting the *qi*; the functional effects or capabilities of organs hosting the *qi*; as well as the generation, development, transformation, and utilization of the above three aspects. Thus "internal *qi*" refers to *qi* inside the human body and "external *qi*" refers to *qi* projected outside a human body by a highly talented practitioner.

Many rigorous scientific qigong experiments have been conducted over the last ten years by Dr. Yan, a world-renowned qigong doctor, together with a number of scientists in leading universities and research institutions in China as well as in the United States. Most of these experiments were originally designed to explore the objective and physical bases of qigong therapeutic effects that go much beyond ordinary psychological treatments. The present experiments involve the interaction between external *qi* of qigong and non-living matters at different structural levels, from the molecular to the atomic level. Some of the molecular level qigong experiments fall into the domain of traditional materials processing and demonstrate the utility of applying qigong techniques in this field.

Although no sound theoretical framework in modern scientific language is yet available for explaining the mechanism of the qigong effects, a body of experimental research on this subject is accumulating and certain special attributes of *qi* may be summarized, speculated upon, and characterized phenomenologically. It has also been reported that applying qigong techniques in large-scale industrial productions has been very successful with certain bio-chemical processes [11–13]. With the available experimental evidence and certain phenomenological understanding of qigong techniques, innovative yet reasonable ideas may be designed and tested, including those directly related to the key technology areas of materials development.

The rest of this paper is divided into the following six sections: section II, review of previous efforts and experimental designs; sections III, IV and V, experimental results on the effects of external *qi* on laser Raman spectra of tap water and three aqueous solutions, on the phase transition behavior of liposomes, and on the growth of Fab protein crystals, respectively; section VI, certain phenomenological attributes of *qi*; and section VII, conclusions.

II Previous efforts and experimental design

Qigong is generally associated with a broad range of mental and physical training exercises that are widely regarded as beneficial for disease elimination and prevention, as well as health maintenance and enhancement. Qigong, which originated in China, is widely appreciated in China, Japan, and other Asian countries, and has been rapidly growing in popularity in North America [14]. It has been estimated that over one hundred million people worldwide practice qigong.

Beginning in the late 1970s, qigong began to emerge from its often superstitious guise and became accessible for scientific study. An unprecedented upsurge in interest in qigong science followed [15, 16]. For example *The Nature Journal*, a refereed general science journal in Chinese, in its first issue in 1978 included a paper by Gu and Lin [17] from the Shanghai Institute of Nuclear Physics. This paper reported an unusual infrared radiation time spectrum recorded 1.2 centimeters from the *Laogong* acupuncture point (the center of the palm) of qigong practitioner Lin's right hand when he emitted *qi* using his right hand. This time spectrum was different from the infrared radiation time spectrum from the palm of a non-qigong practitioner. Lin's spectrum had a group of slow wave crests referred to as low frequency amplitude modulation by Gu and Lin [17, 18].

Another important experiment was conducted by Prof. Feng and her group at the General Naval Hospital in Beijing together with qigong practitioner Bao. They studied the growth and annihilation of bacteria under external *qi* treatment [19–21]. The results indicated that the effect of the external *qi* can be bi-directional. During the experiments, Bao emitted *qi* for one minute to a test tube in her palm containing *E. coli* or *Shigella* in a culture. In one experiment 44%–89.8% of the *E. coli* and 66.7%–98.9% of *Shigella* were dead after a *qi* emission with an intention of "termination". In contrast, in another experiment the quantity of *E. coli* was increased 2.4–6.9 times and that of *Shigella* 1.3–7.4 times after a *qi* emission with the intention of "growth". This bi-directional effect came from the external *qi* of the same *qi*-emitter, the difference originates with the intention at the time of *qi* emission. The intention of "termination" or "growth", led to significant differences.

Physiological effects of qigong practice were also explored extensively. For example, a comparative study on the clinical effects and prognosis of 204 hypertensive patients treated with qigong in a 20 year follow-up study has been reported [22].

Following the early research, the last twenty years have seen a rapid development in qigong scientific experimental research in China [11–13, 15–43]. Before qigong doctor Yan began collaborating with scientists in 1986, most of the early research activities can be approximately classified into three categories by their experimental methods:

1. Investigation of the nature of external *qi* and the mechanism by which it accomplishes its effects by directly applying external *qi* to the sensors or detectors of analytical instruments.
2. In vivo monitoring and measurement of the changes in various physiological parameters and tissues of human beings and other organisms during the emission of external *qi* or the circulation of internal *qi*.
3. In vitro monitoring and measurement of the effects of the external *qi* on bacteria or cells in tissue culture (i.e. cancer cells).

It appears that the effects of qigong can manifest in many forms and that the levels of qigong effects are complex as well. For instance, the external *qi* emitted by highly-talented qigong doctors can affect not only the sensors, but also other parts (transmitter, amplifier, and display) of modern analytical instruments, confounding experimental results in an *in situ* high-level qigong experiment unless appropriate provisions are made.

In those early experiments, a system of "human-human" or "human-organism" was usually adopted, i.e., a qigong doctor emits his external *qi* to a human being or a non-human organism, and the effects on the subject are monitored by instruments. It is difficult in "human-human" experiments to exclude the psychological interference from the human being subjected to external *qi*. For non-human organisms, other factors can also influence the experimental results, such as individual variations and environmental conditions.

Therefore it is useful to design experiments with fewer variables than are present in biological subjects. This experimental system should be a "human-matter" system, i.e., a highly-talented qigong doctor emits his external *qi* to a non-living matter.

In the three sets of experiments presented in this paper, inanimate matter samples that have simple structure and are stable under normal conditions, such as tap water and three aqueous solutions, dipalmitoyl phosphatidyl choline (DPPC) liposomes, and Fab protein solutions were used.

Because the samples are very stable under normal conditions, they can only be changed under the influence of qigong doctors with very refined talents. Therefore in this kind of research, such a highly-talented qigong doctor is essential in the design and finalization of the experiments. Because the level of *qi* emission by a qigong doctor may be influenced by a number of complex factors including the physical and mental conditions of the qigong doctor and the time and environment, the qigong doctor has to be consulted in deciding whether the experiment can proceed and how and when the emission of external *qi* should start. These kinds of experiments differ from non-qigong-related scientific research in that the highly-talented qigong doctor is the most important participant.

Experiments on the long-distance effects of external *qi* were also conducted in which, Dr. Yan, the *qi* emitter, was separated from samples by tens of meters, a few kilometers, and much longer distances.

This type of experiment presents new challenges. For each experiment, depending on different situations and conditions, the highly-talented qigong doctor has to use multiple qigong methods to prepare, to emit external *qi*, and to end the process. The performance of the qigong doctor is affected by the physical, mental, and environmental conditions, therefore the emission level and effects of external *qi* are not identical in every experiment. As long as the procedure of the experiments is clear, the analytical methods are correct, and the effects can not come from known causes unrelated to external *qi*, the experimental results can be conclusive based on a limited number of experiments. More detailed background information and some other early experiments have been described in a book recently published in English, *Scientific Qigong Exploration* [15].

III Results: Laser raman observation on tap water and three aqueous solutions under the influence of external *qi*

Experimental considerations and setup

The purpose of this set of experiments was to see whether the external *qi* of qigong could cause measurable changes in the physical properties of tap water and three aqueous solutions.

A set of experiments were carried out on the long-distance effects of external *qi* on tap water, 0.9% saline, 50% glucose solution, and 1.5 mg/ml medemycine solution. The total concentration of Ca2+, Mg2+, and Na+ in the tap water was 5.7 mg/l. The measurements were carried out using the laser Raman spectrometer to observe and ascertain whether external *qi* would affect the samples.

Laser Raman spectroscopy is a powerful technique in studying the molecular structure of liquids. Each liquid has a unique scattering spectrum corresponding to its molecular structure at a given state. A change in the spectrum signals a change in the molecular structure. The instrument used in this set of experiments was a SPEX 1403 laser Raman spectrometer. Its specifications are:

Resolution:	0.15 cm^{-1} (Hg 579.1 nm).
Raman shift range:	5–4,000 cm^{-1}.
Wave number accuracy:	±1 cm^{-1} (<4,000 cm^{-1})
Reproducibility:	0.2 cm^{-1}.

Because the normal performance of analytical instruments can be affected in an *in situ* experiment participated in by a highly-talented qigong doctor, the samples for our experiments were put in a designated laboratory separated from the analytical instrument to receive external *qi*. After the emission of external *qi*, the samples were taken to another location and examined using a laser Raman spectrometer. To ensure that the instrument functioned properly, established standard control samples were frequently examined using the same instrument. The examination conditions were: an argon laser scanner with a detection power of 400 to 500 mW, a wavelength of 5,145 Å, illumination angle at 90°, and a scanning speed at 0.5 s.

In each experiment, test samples and control samples were taken from the same large container where the solution for the experiment was prepared to ensure a consistency between the test samples and the control samples.

The background of each sample was checked before each experiment. Results indicate that the background of

Table 1 A summary of the experiments reported

Date of the experiment	Sample(s) involved	Room temp (°C)	Method of communication	Distance *qi* emitted from	Result: change?
12/22/86	Tap water	13		3 m	Yes
12/27/86	Tap water	12	Telephone	7 km	Yes
12/31/86	Tap water glucose solution saline	12		20 m	Yes
1/5/87	Glucose solution saline	13	Telephone	7 km	Yes
1/8/87	Tap water glucose solution saline	11	Telephone	7 km	Yes
1/9/87	Tap water	11	Telephone	7 km	Yes
1/12/87	Glucose solution saline medemycine solution	10	Telephone	1,900 km	Yes
1/17/87	Glucose solution saline medemycine solution	11	Telephone	1,900 km	Yes
1/20/87	Glucose solution saline medemycine solution	11	Telephone	1,900 km	Yes
1/23/87	Glucose solution	11	Telephone	1,900 km	Yes

samples taken from the same solution was the same in all measurements.

The test samples were put in a designated laboratory, the door was locked so no one could enter the room while external *qi* was being emitted. Qigong doctor Yan then started to emit external *qi* from a long distance at a time agreed upon before the experiment. The distance was usually about 7 kilometers, and the duration of the emission of external *qi* was about 10 minutes. After the emission, the test samples were sent to the laser Raman laboratory for examination. The control samples were always kept in the same laser Raman laboratory. The sealing and measurement of the samples were carried out by the operator of the instrument, no one else participated. During the measurements, no one else was present in the laser Raman laboratory other than the operator.

Ten rounds of experiments were performed during a period of 33 days, including four rounds over ultra-long distance (1,900 km). Reports regarding a number of other ultra-long distance experiments were presented elsewhere [34,40]. The conditions and results of this series of experiments are listed in Table 1. Similar results were obtained with short distance and ultra-long distance experiments.

Experimental results

The background of tap water was measured about twenty times. The background laser Raman spectra showed that there is a stretching vibrational peak for OH at 3,410 cm^{-1}, and a deformed and weak vibrational peak for HOH at 1,635 cm^{-1} at about 12°C. These data compared well to 3,440 cm^{-1} for OH and 1,645 cm^{-1} for HOH reported in the literature [44].

However, the laser Raman spectra of the tap water affected by the external *qi* showed a huge unknown peak that spanned from 1,000 to 3,000 cm^{-1}. A typical spectrum is shown in Fig. 1.

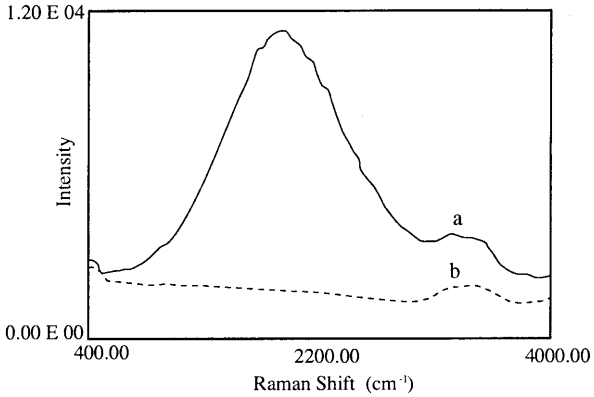

Fig. 1 Raman spectra of tap water *a* – after the emission of external *qi*; *b* – before the emission of external *qi*

After the emission of external *qi* was completed, the Raman spectra of samples were traced while the analytical conditions were kept the same. Results showed that the unknown peak disappeared within 2 h, see Fig. 2.

Since both the test samples and control samples were tap water from the same container, and the background spectra of the control samples were normal, the test samples should have no contamination-induced fluorescence. Because the unknown peak repeatedly appeared in the laser Raman spectra of the test samples after the emission of external *qi*, while it never appeared in the background spectra of control samples, it is reasonable to conclude that the appearance of the unknown peak was caused by external *qi*.

The experiments were extended to other aqueous solutions such as saline and glucose solutions, which are critical to the physiological functions of a human body. Four rounds of experiments were performed. All the results

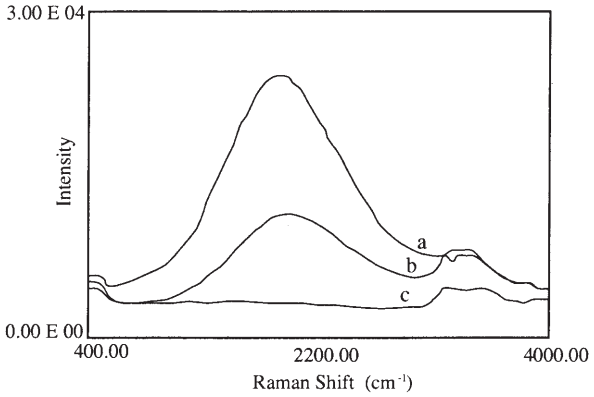

Fig. 2 Raman spectra of tap water after the emission of external *qi*. *a* – after 0.5 hour; *b* – after 1. 5 hours; *c* – after 2 hours

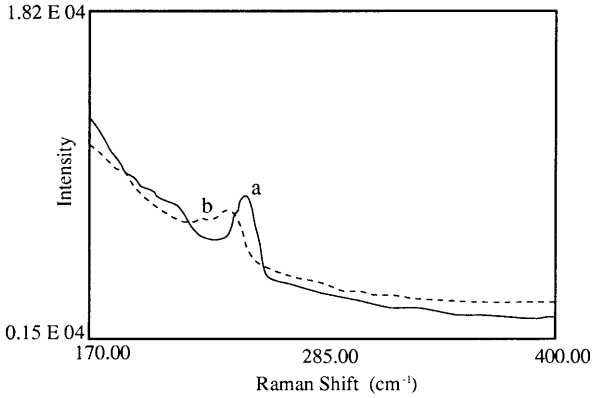

Fig. 3 Raman spectra of 0.9% saline. *a* – before *qi* treatment; *b* – immediately after *qi* treatment from qigong doctor Yan 20 meters away

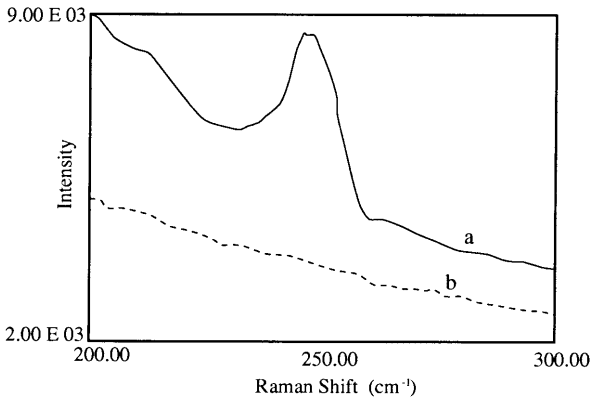

Fig. 4 Raman spectra of 0.9% saline. *a* – before *qi* treatment; *b* – immediately after *qi* treatment from qigong doctor Yan 20 meters away

showed structural changes of the test solutions treated by external *qi*, as indicated by their Raman spectra.

For 0.9% saline samples, a primary change was that a 248 cm^{-1} peak in the low wavelength range shifted to 238 cm^{-1}. A typical result is shown in Fig. 3. In one instance, though, the 248 cm^{-1} peak disappeared completely and no peak appeared at 238 cm^{-1}, see Fig. 4. This different result was apparently caused by some variation in the conditions under which qigong doctor Yan emitted the external *qi*.

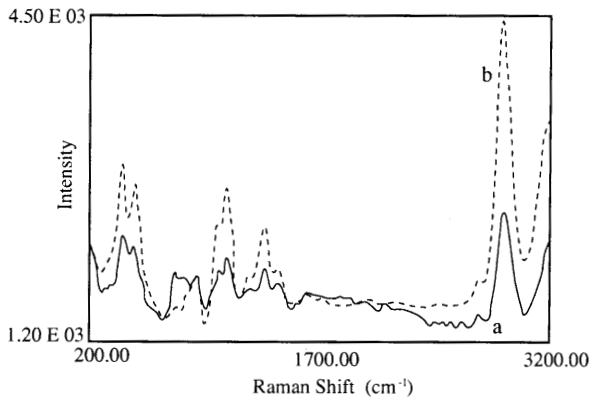

Fig. 5 Raman spectra of a 50% glucose solution. *a* – before *qi* treatment; *b* – after *qi* treatment from qigong doctor Yan 20 meters away

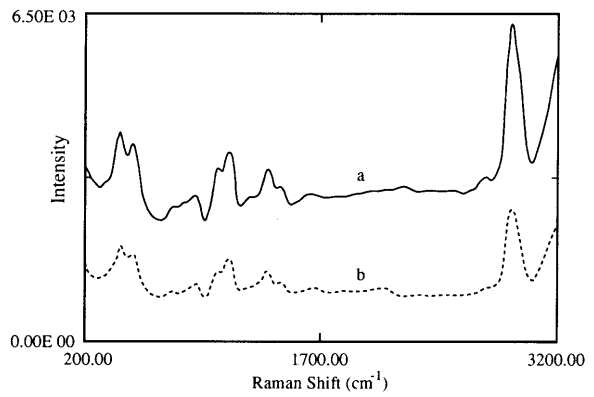

Fig. 6 Raman spectra of a 50% glucose solution in follow-up measurements. *a* – immediately after *qi* treatment; *b* – 2 days after *qi* treatment from qigong doctor Yan 20 meters away

Similar to the experiments on tap water and 0.9% saline, the laser Raman spectra of a 50% glucose solution showed some changes in comparison to the normal spectra of the control samples. A typical result is shown in Fig. 5. Obviously, the 710 cm^{-1} peak in Fig. 5 has disappeared.

Later the participating scientists asked the qigong doctor Yan if he could maintain the *qi*-induced effect on the test solutions. A follow-up experiment on a glucose solution was conducted. It was indeed observed that the *qi* effect was maintained for at least four days. For example, Fig. 6 shows the comparison between the Raman spectrum measured two days after *qi* treatment and that measured immediately after *qi* treatment.

Discussion and conclusion

The tap water and three aqueous solutions used are very stable under normal room temperature conditions. The

control samples were also examined before, after, and randomly during the experiments to ensure that the instruments were functioning properly. Therefore, we were able to detect any changes between the laser Raman spectra of samples submitted to external *qi* and that of the control samples not submitted to external *qi*. The observed effects must have been caused by the effect of external *qi*.

IV Results: The effect of external *qi* on DPPC liposome phase behavior

In an effort to explore the effect of external *qi* on biomembranes, experiments were conducted to investigate the effect of external *qi* on the phase transition of dipalmitoyl phosphatidyl choline (DPPC) liposomes (artificial lipid membrane) using Differential Scanning Calorimetry (DSC).

Experimental setup and preparation

The liposome DPPC was obtained from Sigma Company, USA. The calorimeter, model 1090B, was supplied by Du Pont Company, USA. The precision of thermal flux measurement was 1 mW/cm.

The DPPC liposomes were prepared as follows: 2 mg of phospholipid were accurately weighed and added to 100 µl of PBS (140 mM NaCl, 5 mM $Na_2HPO_4 \cdot NaH_2PO_4$, pH 7.4). The suspension was vortexed to break up the phospholipid and then sonicated in a water bath sonicator at 50°C.

Experimental procedure

After the DPPC liposomes were prepared, a sample of 10 µl was taken with a microsyringe and injected into an aluminum sample holder for the DSC measurement. As a control experiment, the sample was measured three times during a seven hour period from the end of sample preparation to the beginning of the *qi* experiments. The phase transition of the DPPC liposome from gel phase to liquid crystal phase occurred at 41.5°C, similar to the value of 41°C reported in the literature [45]. As indicated by the repeated measurements, the peak position of the phase transition did not change and the sample was stable. Next, the sample was placed by researchers in a *qi* treatment room. Inside the *qi* treatment room, qigong doctor Yan emitted external *qi* to the sample for 5 to 10 min without touching it. The sample was then taken out of the *qi* treatment room and sent back to the measurement room by the researchers for the DSC measurement. During the entire experiment, qigong doctor Yan never touched the samples. The process of the *qi* treatment and subsequent DSC measurement was repeated 2 to 3 times for each sample. The DSC scanning range was from 20 to 60°C, the rate of temperature increase was 2°C/min. Data were recorded and processed using thermal analysis software on a personal computer.

Table 2 The conditions and results of DSC measurements conducted on samples #1, #2 and #3. The experiments started on February 21, 1987

Sample information		Time of measurement	Temp of phase transition (°C)	Thermal absorption step	
				Peak position (°C)	Width (°C)
Background	Right after sample prep	16:00	41.4		
	5 h later	21:00	41.6		
	Divided into 3 samples				
	#1	23:33	41.5		
	#2	00:11	41.7		
		Average 41.55±0.08			
After *n*th *qi* emission					
Sample #1	n=1, on site	00:33	41.6	48	6.4
	n=2, 20 m	01:18	41.6	49	7.4
Sample #2	n=1, on site	01:48	41.7	46–48	4.3–6.3
	n=2, 10 km	04:05	41.7	51.5	9.8
Sample #3	n=1, 3 km	02:09	41.7	47	5.3
	n=2, 10 km	03:09	41.6	47.5	5.9
	n=3, 10 km	03:30	41.7	49.7	8
		Average 41.66±0.05			
Sample #1	On the day of the experiment	01:18	41.6	49	
	2nd day	10:30	41.6	48.5	
	3rd day	10:45	41.6	48	

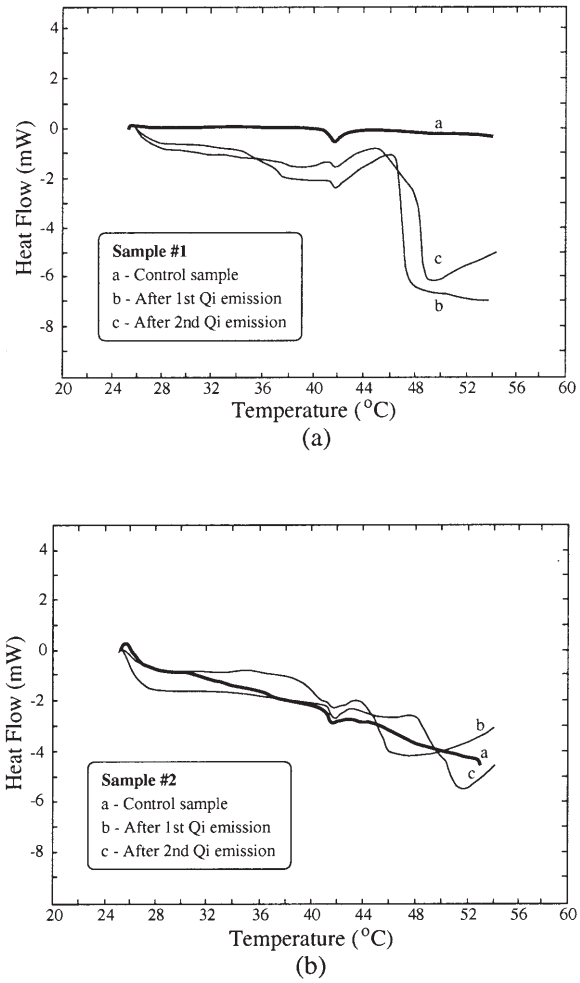

Fig. 7a, b The differential scanning calorimetry curves of DPPC liposome samples with and without *qi* treatment. Note the large extra heat absorption step for samples treated with *qi*

Experimental results

In this experiment, a total of five samples were tested with 11 sessions of *qi* emission – twice in the *qi* treatment room, once 20 m outside of the building, twice 3 km away, and 6 times 10 km away from the samples.

Each measurement was clear and dramatic, and did not vary with the distance between the sample and the *qi* emission site. The results from samples #1 and #2 are shown in Table 2 and Fig. 7. The results on sample #3 are also shown in Table 2. All measurements showed that after the *qi* treatment of the DPPC liposomes, in addition to the original phase transition peak position at 41.5°C, a new large thermal absorption step occurred at about 46°C. The thermal flux of this new step was 10 times greater than that of the original peak at 41.5°C. More DSC measurements were conducted on sample #1 in the next six days and the shape of its DSC curve was essentially unchanged, see Fig. 8.

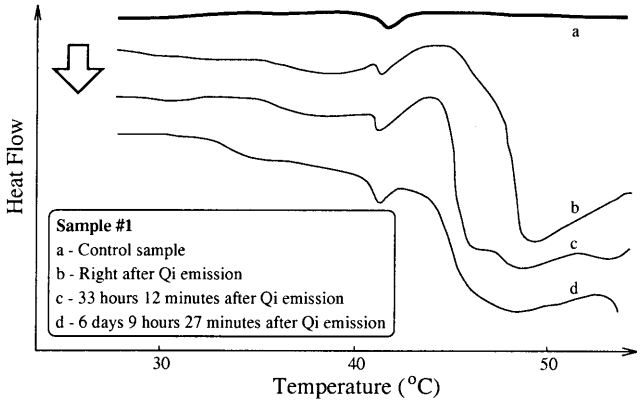

Fig. 8 The differential scanning calorimetry curves of sample #1 taken during the six days after the *qi* emission. Note the shape of the DSC curve of the *qi*-treated sample #1 was essentially unchanged with time

Discussion and conclusion

Is it possible that the thermal absorption step at 46°C was caused by the instability of the DPPC liposome? DPPC is a rather stable type of phospholipid. In cell membrane studies, it is often used to prepare liposomes as a model membrane for the study of the structure and function of cell membranes. Previously, we incorporated fluorescein calcein within DPPC liposomes. If there were any defects in the liposome membrane caused by degradation of the liposome, there would be leakage of fluorescein calcein. Therefore observation of fluorescein calcein leakage could be used to determine the stability of the liposome. During a previous nine-month-long observation, no fluorescein calcein leakage was observed. The duration of each of our experiments was not longer than five hours; or twelve hours if the time for sample preparation is included. Thus, the liposomes were reliably stable.

After the first emission of external *qi*, the thermal absorption step of sample #2 was at 46°C, but after the second emission of external *qi*, it shifted to 51°C. From the six-day tracing measurement on sample #1 we know that the thermal absorption step of the sample was stable and that it was impossible to vary by 5°C or more in a very short period of time, so this phenomenon can only be due to the effect of external *qi*.

It is well known that if DPPC does not degrade and keeps its molecular structure, its phase transition point is at about 41.5°C and no other phase transition peak should be present. The large thermal absorption step at above 46°C suggests certain changes in the molecular structure of DPPC, for example, the degradation of its polar head portion, the breakage of its fatty acid chain, or the occurrence of free radicals.

Thin-layer chromatography (TLC) was then used to analyze sample #4, which had an unusually large thermal absorption step. It was discovered that, in some DPPC molecules, the choline ($(CH_3)_3N(OH)CH_2CH_2OH$) of phosphatidyl choline (PC) in the polar head was found to

be degraded to phosphatidyl ethanolamine (PE, $NH_2CH_2CH_2OH$).

V The effect of external *Qi* on Fab protein crystallization

Introduction

The growth of protein crystals is a critical step in resolving the structure of proteins by X-ray crystallography. In this set of experiments, the effect of external *qi* treatment on protein crystal growth is investigated. Fab 21/8 and 26/9 are the antigen binding fragments of monoclonal antibodies to a peptide immunogen from influenza virus hemagglutinin [HA1(75–110)]. Fab fragments of these antibodies have been crystallized in complex with their peptide antigen of various lengths [46–48]. However, to date all attempts under normal laboratory conditions to crystallize these Fab fragments in the absence of the peptide antigen have been unsuccessful.

Experimental setup

Four crystallization trays were prepared for the qigong experiment. Trays A and B contained native Fab 21/8 whereas trays C and D contained native Fab 26/9. Fabs were concentrated to 10 mg/ml for crystallization by the vapor diffusion method (reviewed by McPherson [49]) in sitting drops (Stura and Wilson [50]) at room temperature (about 22°C) using 24 well tissue culture plates. Sitting drops were prepared by mixing 5 µl of either Fab 21/8 or 26/9 and 25 µl crystallization solutions. Tray C was placed in the incubator as the control, away from the focus of *qi* emission. The incubator temperature was set at 25°C. Trays A, B, and D were also placed in the incubator, except when they were taken out to the *qi* treatment room and were at room temperature for 15–30 min during *qi* treatment. Crystal growth was checked under a light microscope.

Experimental results

The *qi* treatment consisted of an initial session in which qigong doctor Yan visited the laboratory and 5 subsequent sessions in which Dr. Yan emitted external *qi* from a distance (see Table 3).

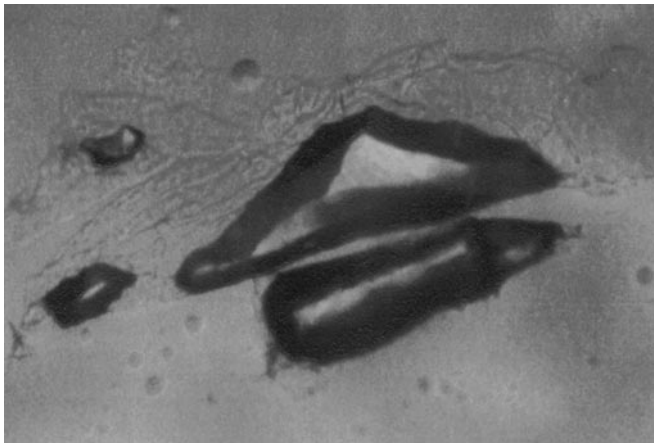

Fig. 9 Two pieces of Fab protein crystals were observed after *qi* treatment in well 6A of tray A. The size of the longer crystal was $0.2\times0.4\times1.0$ mm^3 and the size of the shorter crystal was $0.2\times0.3\times0.6$ mm^3

One sixth of the wells in the external *qi*-treated trays grew into very thin, plate-form crystals whereas no sign of crystallization was observed in the control tray. In addition, five crystals were observed in the *qi*-treated samples after 36 days of treatment whereas none were observed in the control tray C. Two crystals of 21/8 were observed in well 6A and one in well 4C of tray A. Two crystals of 26/9 were observed in well 4C of tray D. Figure 9 shows the picture of well 6A in tray A; the size of the longer crystal was $0.2\times0.4\times1.0$ mm^3, and the size of the shorter crystal was $0.2\times0.3\times0.6$ mm^3. Attempts to collect X-ray diffraction data from the crystals were unsuccessful due to their extreme fragility. In fact, two of the crystals collapsed during the mounting procedure prior to X-ray exposure. Furthermore, during the mounting, the crystal floated to the surface of the solution rather than sinking to the bottom which is indicative of high solvent content.

Discussion

External *qi* emitted by qigong doctor Yan appeared to facilitate the formation of protein crystals. However the crystals obtained were very fragile and were unusual in that they floated during the mounting and did not survive the manipulations for further experiments. This could be due to a higher than normal solvent content of the crystals that formed in the *qi*-treated samples and precludes

Table 3 *Qi* treatment: time and location

#	Date	Time (PST)	Location of Qi emission
1	3/15/1993	7:00–7:15 am	Corridor adjacent to the laboratory (5 *m*)
2	3/15/1993	12:48–1:03 pm	95 *km* north of San Diego
3	3/16/1993	6:00–6:30 pm	Los Angeles (160 *km* away)
4	3/17/1993	8:00–8:30 pm	San Francisco (750 *km* away)
5	3/18/1993	8:00–8:30 pm	New York (4,600 *km* away)
6	3/19–4/19/1993	6:00–6:30 pm	New England (4,800 *km* away)

the possibility that the crystals are of the salt in the crystallizing solution. Crystals of low-molecular weight molecules are more resilient than those of larger molecules such as the Fab fragments. The fragility of the crystals suggested that it is very difficult for the native Fab molecules to form adequate contact for stable crystal formation. This could explain why no native crystals of Fabs 21/8 and 26/9 had been obtained using conventional protocols in the 5 years which have elapsed since these experiments were performed.

VI Certain phenomenological attributes of qi

The results obtained from the above three sets of qigong experiments are clearly extraordinary. They are also fundamentally important to materials research. Water and various aqueous solutions are the major ingredients and critical to the physiological functions of most life forms. Phase transformation and crystallization are two fundamental material behaviors and are highly relevant to the field of materials processing. In particular, these experiments are also directly related to the processing and treatment of bio-materials that play an increasingly important role in our society and on which proportionately more research is being conducted. Thus, it is worthwhile to explore whether the results are reliable, and what physical attributes of *qi* we can surmise from the results. As we have discussed in section II, a system of human-inanimate matter was chosen for the experiments, i.e. qigong doctor Yan emitted his external *qi* to non-living substances such as tap water, aqueous solutions, liposomes, and Fab protein crystallization solutions. Thus psychological influences can be ruled out. Furthermore qigong doctor Yan emitted his external *qi* to test samples while he was physically separated from the test samples at varying distances. This further eliminated other possible interference. Since the test samples are normally stable in an ambient environment, as evidenced by the unchanged control samples, any structural changes in the test samples after *qi*-emission must come from the effect of the external *qi*.

These reliable results demonstrate that the effects of the external *qi* of qigong are clearly observable through its interaction with matter. Thus the external *qi* would appear to be "material". The external *qi* is also energetic since structural changes in substances such as water require an activation energy. The external *qi* is also possibly intimately associated with the reception, transport and execution of information because it is capable of finding the test samples from far away and does not alter the control samples, which in some experiments were at the same distances although located separately.

Qi also seems to be bi-directional and reversible. For example, following an instance of successfully altering the molecular characteristics of water using *qi* (see Fig. 1), a number of researchers participating in the first set of experiments wondered if the results were erroneous. To determine whether the results were false and whether the molecular characteristics of water were actually modified, these researchers suggested to make the altered water reverted to the pre-emission state, that is, to see the original molecular characteristics of water restored through the use of *qi*. Follow-up observations and measurements were carried out on *qi*-treated water every half hour. Within several hours, the laser Raman spectrum of *qi*-treated water with altered molecular characteristic gradually reverted to a spectrum of the original molecular characteristics of water (see Fig. 2). These participating researchers were then convinced of the validity of the experimental results and became aware of the bi-directionality and reversibility of external *qi*. This reversibility differs from the ordinary decay of energy, and from the half-life of medicines or radioactive nuclei because it happens according to wishes of the *qi*-emitter.

Based on current scientific qigong experiments [11–13, 15–43], the *qi* of qigong appears to have the properties of matter, energy, and information. Moreover, *qi* can be influenced, disturbed, or controlled by the will of the *qi*-emitter. At the same time, according to different purposes of the experiments, *qi* can also display different attributes, such as being bi-directional, distance-transcending, reversible, and targeted.

However, the current scientific qigong experiments are still limited in scope – many areas have not been studied. The areas studied have merely focused on ordinarily measurable phenomena. In fact there are possibly many more, deeper and even more perplexing phenomena yet to be investigated. Although there are partial explanations for the experimental observations, these have not been integrated with systematic theories of modern science. No basic theories have been systematically formed. Nevertheless, these preliminary experimental results can be utilized to expand scientific research projects, to broaden our view beyond the current confine, and to make significant progresses in the field of applied qigong science.

The application of qigong technology may be analogous to the use of X-ray technology. No comprehensive and satisfactory theories on the origin of X-rays were established immediately after its discovery by Roentgen in 1895. But that did not prevent X-ray from becoming a widely useful technology in such fields as medical science and solid state physics. In fact the wide application of X-ray technology eventually stimulated the development of a fundamental theory which expanded our understanding of the physical universe. Since the discovery of X-rays, thirteen Nobel Prizes have been awarded for research involving X-ray technology, including the well known Bragg's law in crystallography and the elucidation of the DNA double helix structure. Given the tremendous potential of qigong technology, it is possible that its application will result in as many advances as X-ray technology did, if not more.

VII Conclusions

This paper presents the results of the interaction of an innovative and ancient technique called qigong with inanimate matter. The effects of the external *qi* of qigong emitted by qigong doctor Yan on water and three aqueous solutions, DPPC liposome phase behavior, and the growth of Fab protein crystals are presented as follows:

1. Tap water, 0.9% saline, 50% glucose solution, and 1.5 mg/ml medemycine solution were treated by external *qi* at varying distances from 3 m to 1,900 km. The laser Raman spectra of test samples evidenced significant changes after *qi* treatment while that of control samples remained unchanged. The changes in the laser Raman spectra indicate changes in the molecular structure of water and three aqueous solutions affected by the external *qi*.
2. Dipalmitoyl phosphatidyl choline (DPPC) liposome samples were treated by external *qi* at varying distances from 20 m to 10 km and examined by Differential Scanning Calorimetry (DSC). The *qi* treatment induced a thermal absorption step at 46°C or 51°C ten times larger than the original phase transition absorption peak at 41.5°C. The new absorption step was possibly caused by a degradation of choline of phosphatidyl choline in the polar head of some DPPC molecules to phosphatidyl ethanolamine.
3. The crystallization solutions of Fab 21/8 and 26/9 protein fragments were treated by external *qi* at varying distances from 5 m to 4,800 km. Very thin, plate-form crystals were observed in one sixth of the wells in the *qi*-treated trays, and five crystals were observed in the *qi*-treated samples, whereas no sign of crystallization was observed in the control samples. Two representative sizes of the crystals were measured at $0.2\times0.4\times1.0$ mm^3 and $0.2\times0.3\times0.6$ mm^3, respectively.

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