

The System of the *Book of Changes* and Chinese Science*

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One of the best known Chinese classics, frequently translated, much venerated by traditional Chinese scholars, yet quite complex, is the *I Ching* 易經, or the *Book of Changes*, compiled sometime between the — 8th and the — 3rd century. The system of the *Book of Changes*, is based on the ancient Chinese concept of the two cosmological forces *Yin* 陰 and *Yang* 陽. The first conveys the idea of something that is feminine, or dark, cloudy, shady and cold while the second reminds one of something that is masculine, bright, sunny and warm, among a host of other meanings. In the *Book of Changes*, *Yin* is represented by a broken line -- and *Yang* by a full line —. Taking these two lines, three at a time, eight different possible combinations are obtained. These are the so-called eight Trigrams, *Ch'ien* 乾 ☰, *K'un* 坤 ☷, *Chen* 震 ☳, *Sun* 巽 ☴, *K'an* 坎 ☵, *Li* 離 ☲, *Kên* 艮 ☶, and *Tui* 兌 ☱. The significances of these Trigrams are shown in Fig. 1.

Going a step further and taking the *Yin* and *Yang* lines six at a time, the total number of possible combinations is 2^6 , i.e. 64. These are the 64 hexagrams in the *Book of Changes*. These 64 hexagrams have been put down by the Chinese in two different orders. One of these two orders, namely the 'prior to heaven' (*hsien t'ien* 先天) system, so fascinated the great mathematician Leibniz towards the end of the +17th century that the inventor of the calculus went to the extent of deriving the binary notation to account for it. In the binary notation we can write down the figures 0 to 63 as follows:

000000 = 0
000001 = 1
000010 = 2
000011 = 3
000100 = 4
000101 = 5
.....
etc.
111110 = 62
111111 = 63

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Fig. 1. The Trigrams in the *Book of Changes*.

No.	Trigram	Name	polarity	associated Element	associated natural objects	associated colour	Primary concept
1.	☰	乾 Ch'ien	Yang	Metal	heaven	deep red	being, strength, force, roundness, expansiveness
2.	☷	坤 K'un	Yin	Earth	earth	black	docility, nourishment of being, squareness, form, concretion
3.	☳	震 Chen	Yang	Wood	thunder	dark yellow	movement, speed, roads, legumes and young green bamboo sprouts
4.	☵	坎 K'an	Yang	Water	moon and fresh water	blood-red	danger, precipitousness, curving things, wheels, mental abnormality, abysses
5.	☶	艮 Kên	Yang	Wood	mountain	—	passes, gates, fruits, seeds
6.	☴	巽 Sun	Yin	Wood	wind	white	slow steady work, growth of woods, vegetative force, mercantile talent
7.	☲	離 Li	Yin	Fire	lightning	—	weapons, dry trees, drought, brightness, catching adherence of fire and light
8.	☱	兌 Tui	Yin	Water/ Metal	sea and sea water	—	reflections and mirror-images, passing away

Now if we replace the symbol 0 by the broken *Yin* line -- and 1 by the full *Yang* line —, then we can write out the 64 Hexagrams in exactly the same fashion as we have just written down the numbers 0 to 63 using the binary notation. Thus we have



The fame of Leibniz and the usefulness of the binary notation in modern computers both have a catalytic effect on the revival of interest on the system of the *Book of Changes* in recent years concerning its application to science. This will be discussed briefly towards the end of this lecture, but right now we still have more to speak about the system itself.

Although the order in which the 64 Hexagrams are arranged according to the numbers 0 to 63 in the binary notation has been called the 'prior to heaven' system and attributed to the legendary emperor Fu Hsi 伏羲 himself, we have not yet been able to trace it in writing further back than the middle of the +11th century, the time of the celebrated Sung philosopher Shao Yung 邵雍. The other system of arrangement of the 64 Hexagrams has been called the 'posterior to heaven' (*hou t'ien* 後天) order, said to originate from Wên Wang 文王 (c. -1150) father of the founder of the Chou dynasty. The significances of the 64 Hexagrams and their traditional arrangements according to the Wên Wang system are shown in Fig. 2. It is interesting to note that the Hexagrams are grouped in pairs, nearly all with a mirror-image relationship, for example, 3 & 4, 5 & 6, 7 & 8, 9 & 10, 11 & 12, while the remainings are grouped such that the corresponding lines are complements to each other, as in the cases of 1 & 2, 27 & 28, 29 & 30, and 61 & 62.

Together with the *Yin* and *Yang* theory and the theory of the Five Elements (Wu hsing 五行), the system of the *Book of Changes* became a fundamental idea of traditional Chinese science besides its many other applications. One can give examples to illustrate how this system was applied to explain problems in astronomy, biology, anatomy, and medicine. The system of the *Book of Changes* may be a marvellous one in many respects, but even Joseph Needham cannot find a favourable judgement of the role it played in the progress of traditional Chinese science. He says that it tempted those who were interested in Nature to rest in explanations which were no explanations at all, and calls it a stupendous *filing-system* where natural novelty was filed and then nothing more was done about it. If we observe the part it plays in the history of Chinese alchemy we shall not fail to notice its correlation with the rise and decline of this particular field of human endeavour.



















For a long time the idea of whether the human life span could be prolonged indefinitely by one way or another had occurred in the minds of the Chinese people. This concept of physical immortality went back to prehistorical days












Fig. 2. The Hexagram in the *Book of Changes*.

No.	Hexagram	Name	common lexicographical meanings	concrete or social significance	abstract significance
1.		乾 Ch'ien	heaven, paternal, dry, male	Heaven, king, father, ordering, controlling	Donator
2.		坤 K'un	earth, maternal	Earth, people, mother, supporting, containing, docile, subordinate	Receptor
3.		屯 Chun	sprout	Initial difficulties	Factors showing the onset of a process
4.		蒙 Mêng	cover	Youthful experience	Early stages of development
5.		需 Hsü	need, procrastinate	Cunctatory policy	Stopping, waiting
6.		訟 Sung	litigation	Strife, contention at law	Opposition of processes
7.		師 Shih	army, general, teacher	Military affairs	Organised action
8.		比 Pi	assemble	Union, concord	Coherence
9.		小畜 Hsiao Hsü	to rear	Creative force modified by mildness, taming	Lesser inhibition
10.		履 Li	shoe, to tread	Hazardous success attained by circumspect behaviour, treading delicately	Slow advance
11.		泰 T'ai	prosperous	Geniality of Spring, peace	Upward progress
12.		否 P'i	bad	Beginning of autumn	Stagnation, or retrogression
13.		同人 T'ung Yen	lit. people together	Union, community	State of aggregation
14.		大有 Ta Yu	lit. great having	Abundance of possessions, opulence	Greater abundance
15.		謙 Ch'ien	humility	Hidden wealth, modesty	Highness in lowness
16.		豫 Yü	pleased	Harmonious excitement, enthusiasm, satisfaction	Inspiration
17.		隨 Sui	follow	Following	Succession

18.		蠱 Ku	virulent poison	Troublesome work in a decaying society	Corruption
19.		臨 Lin	approach	Approach of authority	Approach
20.		觀 Kuan	to look	Contemplation, looking for omens, letting influence radiate	View, vision
21.		噬嗑 Shih Ho	gnawing sound of voices	Crowds, markets, and courts, criminal law	Biting and burning through
22.		賁 Pi	bright	Ornamental	Ornament, pattern
23.		剝 Po	to peel, flay	Falling, overthrowing, collapse, like a house held together only by its roof	Disaggregation, dispersion
24.		復 Fu	return	Year's turning-point	Return
25.		无妄 Wu Wang	not reckless, not false	No recklessness, no insincerity, not guilt, yet difficulties	Unexpectedness
26.		大畜 Ta Hsü	to rear	Creative force suppressed by something stationary and heavy	Greater inhibition
27.		頤 I	jaws	Mouth	Nutrition
28.		大過 Ta Kuo	to overstep	Large excess, strangeness not necessarily unfavourable	Greater top-heaviness
29.		坎 K'an	pit	The edge of the ravine, danger and the reaction to it; below, the torrent of water	Flowing motion
30.		離 Li	separate, apart	The meshes of a net, catching adherence of fire and light	Deflagration, adherence
31.		咸 Hsien	all	Mutual influence, interweaving, wooing	Reaction
32.		恆 Hêng	constant	Perseverance	Duration
33.		遯 T'un	to hide oneself, conceal	Withdrawal, retreat	Regression
34.		大壯 Ta Chuang	great strength	Great strength	Great power
35.		晉 Chin	to rise, advance	Advance in feudal rank	Rapid advance

Fig. 2. (Continued)

No.	Hexagram	Name	common lexicographical meanings	concrete or social significance	abstract significance
36.		明夷 Ming I	intelligence repressed	Lack of appreciation of the services of a good official	Darkening, extinction of light
37.		家人 Chia Fen	family people	Members of a family or household	Relation
38.		睽 K'uei	separated	Division and alienation	Opposition
39.		蹇 Chien	lame	Lameness, inhibition	Retardation
40.		解 Chieh	dissection, analysis	Unravelling	Disaggregation, liberation
41.		損 Sun	spoil, hurt, subtract	Removal of excess, payment of taxes	Diminution
42.		益 I	benefit	Increase of resources, addition	Increase, addition
43.		夬 Kuai	fork, settled, decision	Breakthrough, release of strain	Eruption
44.		姤 Kou	copulation	Advance to casual encounter, meeting, intercourse	Reaction, fusion
45.		萃 Ts'ui	thicket, congregate	Process of collection, consolidation of people around a good ruler	Condensation, conglomeration
46.		升 Shêng	to rise	Career of a good official	Ascent
47.		困 K'un	surrounded, distressed	Straitened, distress, bewilderment	Enclosure, exhaustion
48.		井 Ching	a well	Dependableness	Source
49.		革 Ko	skins	Moulting of skins, hence change	Revolution
50.		鼎 Ting	tripod cauldron	Nourishment (of talents),	Vessel
51.		震 Chen	quake, rock, thunder	Moving exciting power	Excitation
52.		艮 Kên	limit	Stability, as of a mountain	Immobility, maintenance of stationary position
53.		漸 Chien	gradually tinge	Slow and steady advance	Development, slow and steady advance

54.		歸妹 Kuei Mei	lit. returning, younger sister	Marriage	Union
55.		豐 Fêng	abundance (good harvest)	Prosperity	Lesser abundance
56.		旅 Lü	travel, travellers	Strangers, merchants	Wandering
57.		巽 Sun	gentle	Penetration of wind	Mildness, penetration
58.		兌 Tui	exchange	Sea, pleasure	Serenity
59.		渙 Huan	broad, swelling, irregular	Dispersion, alienation from good	Dissolution
60.		節 Chieh	joints of bamboo	Term, section, regular division, regulation, meditation	Regulated restriction
61.		中孚 Chung Fu	lit. central; confidence	Inmost sincerity, kingly sway	Truth
62.		小過 Hsiao Kuo	to overstep slightly	Small excess	Lesser top-heaviness
63.		既濟 Chi Chi	lit. end; up to the mark	Completion, successful accomplishment	Consummation, perfect order
64.		未濟 Wei Chi	lit. not quite; not quite up to the mark	Position when all is not yet completed nor successfully accomplished	Disorder, potentially capable of consummation, perfection, and order

in Chinese legend. One of the ways and means to achieve such a state was to procure and eat an elixir of life. By the —4th century such a concept has already firmly established itself. Besides the emperor Ch'in Shih Huang-ti 秦始皇帝, we read from the official dynastic histories the exploits of not a few Han emperors, each regarding himself as worthy candidates to the rank of the immortals. The end of the Han period became a land-mark in the development of Chinese alchemy, for it was then that the first book in the alchemical language was written. This was the *Chou I Ts'an-t'ung-ch'i* 周易參同契, written in about the year +142 by Wei Po-yang 魏伯陽. Written in a beautiful but very obscure style the book has given rise to a large number of later commentaries and interpretations, usually

Fig. 3. Different interpretations of the Trigrams.

the Trigrams	☱ Tui	☵ K'an	☴ Chen	☲ Li	
the 'Elements'	Metal	Water	Wood	Fire	Earth
Colours	White	Black	Blue	Red	Yellow
<i>wai tan</i> (practical alchemy) interpretation according to TT/994	metallic lead	lead ore	mercury	cinnabar	
<i>nei tan</i> (physiological alchemy) interpretation according to TT/991	lungs	kidneys	liver	heart	

TT refers to the book number in Wieger, L., *Le Taoisme; Bibliographie Générale*, Hsienhsien, 1911.

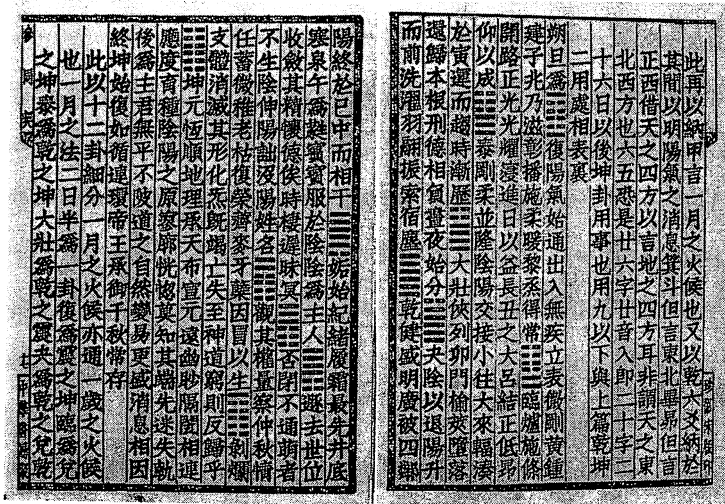


Fig. 4. Diurnal heating process.

with one commentator criticising its predecessors. Most of them, however, fall within two main schools, the *wai tan* 外丹 or school of practical or operative alchemy and the *nei tan* 內丹 or school of physiological alchemy. Wei Po-yang makes use of the system of the *Book of Changes* freely to explain his process. Fig. 3 shows how some of the Trigrams used by him are interpreted by two different commentators of these schools. According to an operative alchemist the trigram *Tui* could refer to metallic lead, *K'an* lead ore, *Chen* mercury and *Li* cinnabar. In another commentary *Ch'ien* refers to the stove and *K'un* the reaction-vessel. I shall now proceed to demonstrate how the Hexagrams and the Trigrams are used by Wei Po-yang in two rather obscure passages to explain the process of heating and cooling. Let us take a look at a translation of one of these passages as shown in Fig. 4, which was rendered by Wu Lu-ch'iang and Tenney L. Davis in 1932 as below.

- At the first double-hour of the day, which corresponds to the
- Fu [Fu] Hexagram, the Yang ch'i (positive ether) begins to operate and at once appears to be slightly strong. At this time when the
- Tzu Huang-chung coincides with the ordinal [Tzu] a flourishing beginning is promised. Let there be warmth and all will be well.
- Lin When the furnace [is working with] sticks, room is made for the propagation of light. With the increase in brilliance the day
- Ch'ou becomes longer. This corresponds to the ordinal [Ch'ou] and to the Ta-lü. Appropriateness is now realised.
- Face upward to attain the [T'ai] (greatness). Hardness and softness both come to have sway. Yin and Yang (negativeness and positiveness) are in contact with one another. Undesirable things give place to desirable ones. Activities centre at this, the
- Yin ordinal of [Yin] when fortune is at its high tide.
- Ta Chuang Gradually the rule of the [Ta Chuang] (great brave) Hexagram is passed. This corresponds to the Chia-chung and the ordinal
- Mao [Mao]. The elm seeds fall, returning to their origin. Just as punishment and forgiveness are opposite to one another, even so is the day distinguished from the night.
- Kuai At the [Kuai] Hexagram when the Yin (negativeness) beats its retreat, the Yang (positiveness) rises forth, washing its feathers
- (Ch'ên) [to rid them of] accumulated dust.
- Ch'ien The strong light of the powerful [Ch'ien] (male, positiveness) covers the neighbourhood on all sides. The rule of Yang comes to an end at the ordinal [Ssu], which occupies a central position
- Ssu with good connections.
- Kou A new period begins with the [Kou] Hexagram. As this is the transition to coldness, it should be faced with perfect calmness.

- Wu It is now the ordinal [Wu] corresponding to the Sui-pin. Yin has come to be the mistress.
- Tun When the [Tun] Hexagram is here, retirement is in order.
(Wei) With the retirement the unusual powers go into hiding, waiting to reappear at the propitious time.
- P'i The [P'i] Hexagram brings with it an unpropitious time, when
(Shen) Yin [gathers power] at the expense of Yang and vegetation grows no more.
- Kuan At the [Kuan] Hexagram the powers and capacities of things
(Yu) are observed. In [mid-autumn] different things happens to the plants. Some plants ripen their flowers into fruits and seeds so as to enable the aged and decaying to flourish anew. Wheat and shepherd's-purse bud forth to thrive.
- Po (Hsü) And then comes the [Po] Hexagram. [The body is torn to pieces so that the form is no more]. For, as the ch'i (ethereal essence) of transformation is exhausted, the divinest is lost.
- K'un When the limit of the Tao (Way) is reached, a return to the
(Hai) primordial [K'un] (negativeness) is made. The lay of the land should always be given due consideration and the sky should be obeyed. The mystically obscure and distinctly indistinct are [separated] yet related. To propagate according to the proper measures is the foundation of Yin and Yang. Everything is obscure and unknowable. Although at a loss at first, it finally becomes the ruler.
- Without the valley there will be no hill. This is in the nature of the Tao (Way). Similarly there exists a contrast between rise and fall, and between growth and degeneration. The K'un Hexagram marks the end and the Fu hexagram marks the beginning: like a cycle they go. Throughout and forever the monarch lives to rule.

It is extremely difficult to understand what the author Wei Po-yang had in mind from the translation, and indeed one cannot help agreeing with one of the statements in this text that 'everything is obscure and unknowable'. Let us now look again at the original Chinese text. It is possible to guess what Wei Po-yang was trying to explain without having to go into the philological aspect of the text or to provide a translation. This passage is taken from a text with a commentary written in +1197 by the Sung neo-Confucianist scholar Chu Hsi 朱熹 for the reason that this is the only version that illustrates the Hexagrams, although we can note immediately that its first Hexagram is wrongly printed. Altogether 12 Hexagrams are used, and associated to each is an ordinal (ti chih 地支). This is not very clear at first sight, but we shall soon see that 6 of them

are concealed in the text itself by the author in the form of puns or cryptograms. Let us now examine how these 12 Hexagrams were selected and also the particular ordinal attached to each of them.

The first Hexagram in the list is *Fu* ䷗ and the ordinal that goes with it is *Tzu* 子, which is the double-hour 23.00 hr to 01.00 hr. The second Hexagram *Lin* ䷒ goes with *Ch'ou* 丑 (01.00 to 03.00 hrs); *T'ai* ䷊ with the ordinal *Yin* 寅 (03.00 to 05.00 hrs); *Ta Chuang* ䷌ with *Mao* 卯 (05.00 to 07.00 hrs). The next hexagram is *Kuai* ䷊, but the ordinal associated with it is not clearly indicated in the text—instead it is concealed in the right-hand-side of the word *chên* 振, which Wu & Davis render as 'to rid them of'. This ordinal is *Ch'ên* 辰 (07.00 to 09.00 hrs). The next Hexagram *Ch'ien* ䷀ has with it the ordinal *Ssu* 巳 (09.00 to 11.00 hrs), and then *Kou* ䷔ has with it *Wu* 午 (11.00 to 13.00 hrs). After this things become a little more complicated, as the ordinals are either concealed or described in rather obscure terms.

The ordinal that goes with the Hexagram *Tun* ䷌ is *Wei* 未 (13.00 to 15.00 hrs), but this is hidden in the right-hand-side of the word 'mei 昧', meaning 'obscure or dark', The Hexagram *P'i* ䷔ goes with the ordinal *Shên* (15.00 to 17.00 hrs), which is hidden in the right-hand-side of the word *shên* 伸, which the translators renders as 'gather power'. Next comes the Hexagram *Kuan* ䷁, with its corresponding ordinal indicated only by the words 'mid autumn'. From the *Huainan-Tzu* 淮南子 book we find a statement to the effect that 'in the month of mid-autumn the stars of the constellation *Chao-yao* 招搖 point towards the direction *Yu* 酉'. Hence the ordinal indicated here is *Yu* (17.00 to 19.00 hrs). For the Hexagram *Po* ䷇ its ordinal *Hsü* 戌 is to be found in the word 'mieh 滅' (to destroy), and explained by the pun 'the body is torn to pieces so that the form is no more'. After removing the 'water radical 氵' and the word 'huo 火' (fire) from this word, we obtain the ordinal *Hsü* (19.00 to 21.00 hrs). Lastly, the ordinal that goes with the Hexagram *K'un* ䷁ can be found right inside the word 'ai 闕', which means 'to obstruct' or 'to shut out', and which is rendered by the translators here as 'separated'. We can see the word *Hai* 亥 (21.00 to 23.00 hrs) enclosed by the 'door radical 門'.

The whole passage that we have here is meant to describe the cyclical heating and cooling of the alchemical substances, which were probably gold amalgam, if not lead amalgam or mercuric sulphide. Wei Po-yang has chosen these particular 12 Hexagrams out of the 64 of them such that the first of these, *i.e.* *Fu* begins with one single full line of Yang — counting upwards from the bottom. This marks the beginning of the firing process, starting with a gentle fire, at the *Tzu* double-hour, *i.e.* from 23.00 to 01.00 hrs. The full line Yang is added one

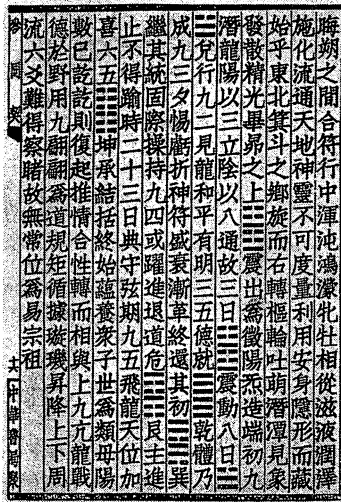
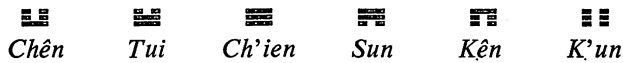


Fig. 5. Monthly heating cycle.

at a time to explain the gradual increase of the fire, to form the next four Hexagrams until *Ch'ien* is reached at the double-hour *Ssu* (09.00 to 11.00 hrs), when the fire is at its maximum intensity. The single broken line Yin — in the next Hexagram *Kou* shows that the fire is to be decreased from midday, and each additional broken line Yin tells us that the cooling is to be carried out gradually until finally there is complete cooling at the *Hai* double-hour (19.00 to 21.00 hrs) as shown by the six broken lines in the Hexagram *K'un*.

The system of the *Book of Changes* is also employed by Wei Po-yang to explain the monthly cycle of heating and cooling [See Fig. 5]. Here he uses six of the eight Trigrams, namely *Chên*, *Tui*, *Ch'ien*, *Sun*, *Kên*, and *K'un* to explain the state of firing on the 3rd, 8th, 15th, 16th, 23rd, and the 30th day of the lunar month. These six Trigrams are shown below:



It is obvious that these Trigrams indicate the gradual increase of firing from the 3rd to the 15th day, and gradual cooling from the 16th to the 30th day. Of course the description in the text itself is not so obvious, and Chu Hsi illustrates the Trigrams with Hexagrams.

The use of the system of the *Book of Changes* has contributed directly to the obscurity of the text of the *Ts'an-t'ung-ch'i*. One is reminded of a statement made by the author Wei Po-yang himself that 'a thousand readings will bring out some points, and ten thousand perusals will enable him to see. At last revelation will come to bring him enlightenment.' Indeed, believing himself to have already attained enlightenment, each one of the host of commentators of

this book has set himself about to write criticising his predecessors for not understanding the real meaning of the text!

The +4th century saw the beginning of the golden age of Chinese alchemy, which lasted some five hundred years until the end of the +8th century. This began with Ko Hung 葛洪 the author of the *Pao-p'u-tzu nei p'ien* 抱朴子內篇 which, in contrast with the *Ts'an-t'ung-ch'i*, was written in a lucid style. Ko Hung made no attempt to hide his descriptions on alchemical procedures under the cloak of the system of the *Book of Changes*, in spite of the fact that he has demonstrated his skill in the use of this system in his defense of a cosmological theory. Ko Hung was followed by a number of other great alchemists such as Su Yüan-ming 蘇元明, T'ao Hung-ching 陶弘景, Sun Ssu-mo 孫思邈, and Mêng Shên 孟詵. There appeared to be a general trend to write in a clear and simple style. Su Yüan-ming for example even went as far as to explain the synonyms and the so-called 'hidden names' used by the other alchemists. The absence of the use of the system of the *Book of Changes* is also significant among the writings of these alchemists. Sun Ssu-mo, for example, used the Trigrams *Li* ☲ and *Tui* ☱ only in a rare occasion to denote two alchemical substances. These, according to some commentators of the *Ts'an-t'ung-ch'i* could refer to cinnabar and metallic lead, but Nathan Sivin has recently shown that they probably meant cinnabar and white lead in Sun Ssu-mo's alchemical text.

From the writings of Su Yüan-ming and Sun Ssu-mo we can find that many of their elixirs were highly poisonous, contain mercury, lead, arsenic and other minerals. A clear case of elixir poisoning is that of the Chin emperor Ai Ti 哀帝 (reign +362 to +365), who, as a result of his effort to avoid growing old, died at his very prime aged only 25. Among the T'ang emperors in the +9th century, as another example, we can easily count no less than five emperors, namely Hsien Tsung 憲宗 (reign +806 to +820), Mu Tsung 穆宗 (reign +821 to +824), Ching Tsung 敬宗 (reign +825 to +826), Wu Tsung 武宗 (reign +841 to +846), and Hsüan Tsung 宣宗 (reign +847 to +859), who fell victim, one after another, to the elixirs they took. Many alchemists themselves must have also fallen martyr to their own beliefs. The same fate was shared by some of the aspirants to immortality among the officials, the scholars and the wealthy.

There seems to be a general trend in alchemical writings since the +9th century to change from originality to compilation, from clarity in style to obscurity and from the emphasis on *wai tan* i.e. practical alchemy, to *nei tan*, i.e. physiological meditational alchemy, whereby longevity was supposed to be attainable through meditation and proper control of respiration. Here we can only take up the problem of obscurity in style, and once again we see that the system of the *Book of Changes* comes into play. First, the *Ts'an-t'ung-ch'i* regained popularity and it was followed by a long series of commentaries since the Wu Tai period in the +10th century. Other original writings tried to match them



Fig. 6. An obscure passage in a Taoist alchemical text.

in obscurity. A good example is furnished by the last paragraph in the *Ta huan tan chao chien* 大還丹照鑑 (Reflection on the Great Cyclically-Transformed Elixir), written by an anonymous author in the year +962. This is shown in Fig. 6. It says:

Lead is lead, mercury is mercury. Only these two (substances) are lead and mercury. The Dragon is the Dragon, the Tiger is the Tiger, and only these two share the same ancestors. If one can understand this (one can next consider) the positions of the trigrams *K'an* and *Li*. Under the position of *Li* is found yellow earth, from which comes forth the yellow sprout that bears the golden flower. When the golden flower is formed beneath it congeals the purple essence. When the golden flower comes into being the white metal is formed below it. The white metal sinks, while the yellow metal floats. The part which sinks is taken as the concentrated elixir portion, (but) a search has to be made for the red marrow. After mixing they have to be sown. There is proper time for sowing and for reaping. Muscles are changed and bones are added so that one lives as long as the heavenly and earthly immortals. Do not think of transmuting lead, iron and fragments of broken tiles. One, Two, Three, Four, and Five: Water, Fire, Wood, Metal and Earth. To understand just this one secret instruction is the way to achieve immortality.

After the *Ts'an-t'ung-ch'i* the most influential Taoist book bordering on

alchemy since the Sung period is the *Wu chên p'ien* 悟真篇 (Poetical Essays on the Understanding of the Truth), written in the +11th century by Chang Po-tuan 張伯端. We can see that the author made use of the system of the *Book of Changes* in the following passage so that it is not easy to decide whether he was actually writing about alchemy or something else. He says: [see Fig. 7].

The sun occupying the position of the (trigram) *Li* turns over to become female. The (trigram) *K'an* when paired with the moon becomes male. One who does not appreciate the meaning of this inversion (principle) ought not boast about with his shallow knowledge.

After Chinese alchemy had seen its heyday by the +9th century it continued to flourish for about another five centuries. With the fall of the Chinese empire into the hands of the Mongols in the +13th century alchemy began to lose popularity together with Taoism. Many alchemical writings were destroyed along with other Taoist texts when the Mongol emperors ordered that to be set on fire after the Taoists were defeated by the Buddhists in open disputes in the imperial court. Chinese alchemy soon fell into a state of decline, from which



Fig. 7. A passage from the *Wu Chen pien*.

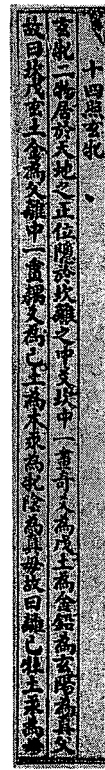


Fig. 8. A passage from the late +16th-century alchemical text *Huang pai ching*.

it has never recovered. During the Ming dynasty (+1368 to +1644) there was some revival of interest in alchemy, and we know that one of the emperors, Shih Tsung 世宗 (reign +1522 to +1566) even ventured to take some elixirs prepared for him by an alchemist-physician named Wang Chin 王金 and became seriously ill. However, alchemy was already caught in the doldrums of the general decline of indigenous science in China. Not a single alchemical text of any significance was produced in the Ming period, with most of the writers regressing to the +2nd century, still arguing among themselves as to the exact meaning of the *Ts'an-t'ung-ch'i* if not debating about Chang Po-tuan's *Wu-chên-p'ien*. An example taken from the well-known so-called alchemical text of that period, namely the *Huang-pai-ching* 黃白鏡 (Mirror on Alchemy), written by Li Wên-chu 李文燭 in +1598, once again shows how much the system of the *Book of Changes* has contributed to the obscurity of the text. The passage reads [See Fig. 8]:

14. (*The Mirror*) reflecting on the real Yang and the real Yin (*hsüan p'in* 玄牝).

The two things real Yang and real Yin occupy the main seats of heaven and earth and hide within the middle lines of the *K'an* and *Li* (Trigrams). The line in the middle of the *K'an* (trigram) ☵ is an odd line, which is the Earth (Element) of the (cyclical number) *wu* 戊, the metal lead, the male Yang, and the real father. Hence it is said: "The *K'an* (trigram)'s (cyclical number) *wu*, being the male Earth (Element) is the father of the Metal (Element). The even line in the middle of the *Li* (trigram) ☲ is the Earth (Element) of the (cyclical number) *chi* 己, mercury of the wood (Element), the female Yin, and the real mother. Hence the saying: "The *Li* (trigram)'s (cyclical number) *chi*, being the female wood (Element) and mercury, is the mother".

We do not know whether the author was writing about alchemy or something else. But if he was talking about the amalgamation of lead then he had gone backward by more than 1400 years in the progress of Chinese alchemy. We thus found the Chinese alchemists too much engrossed in and diverted by the system of the *Book of Changes*. The same can be said of those of many other branches of Chinese indigenous science. If they were fully satisfied with an explanation they could find from the system of the *Book of Changes* they would not go further to look for mathematical formulations and experimental verifications in their scientific studies. Looking at the system of the *Book of Changes* in this light, one may regard it as one of the inhibiting factors in the development of scientific ideas in China.

In recent time there has been some revival of interest in the system of the *Book of Changes*, stimulated by the attention paid by Leibniz to this system and to the modern applications of the binary notation. Let us take a few examples as a matter of interest to see how the system still has its appeal.

If we represent the Yin -- symbol by x and the Yang — symbol by y then

the 64 Hexagrams will yield the result

$x^6, 6x^5y, 15x^4y^2, 20x^3y^3, 15x^2y^4, 6xy^5, y^6$ which is the sum of x and y raised to the power of 6, *i.e.* $(x + y)^6$.

Again if we replace the eight Trigrams by the letters $a, b, c, d, e, f, g,$ and $h,$ then the 64 Hexagrams can be produced by taking these eight letters two at time. We shall find that these 64 Hexagrams give the square of the sum of the polynomial, *i.e.* $(a + b + c + d + e + f + g + h)^2$.

If we look back into Fig. 1 we shall notice that the Trigrams are also classified according to their 'sex'. *Ch'ien* consisting of 3 *Yang* lines is male, *K'un* with 3 *Yin* lines is female. However the next Trigram *Chen* is classified male although it has two *Yin* lines and one *Yang* lines, and this applies again to the next Trigram *K'an*. This is an analogy with what we have in modern genetics in what the biologists call the recessive and dominant factor in a genotype.

All these sound rather fascinating. But not a few among the Chinese *literati* regard the *Book of Changes* as something which would not only affect human destiny but also solve the riddles of the universe. From a sentence in its so-called 'Appended Judgement' (*hsi tz'u* 繫辭) which says: 'When it is stationary the *Ch'ien* Hexagram does it with one mind, and when it moves it keeps straight' some claim that the *Book of Changes* anticipated Newton's 1st law of motion. Some even believe that the idea of the mass-energy equivalence of Einstein and his unified field theory already occurred in the mind of the originator of the *Book of Changes*, for in this system all the Hexagrams can be unified into the eight Trigrams, which can be explained in terms of the two signs *Yin* and *Yang*, and which can go back to the so-called 'Supreme Pole' (*t'ai chi* 太極), the source of all things. The important difference between the present and the past is that those absorbed in the system of the *Book of Changes* are seldom the scientists themselves, although it may be regarded by scientists as a hobby. Hence the system can no longer play a part as an inhibiting factor to the progress of modern science among the Chinese people.