Materials for the talk entitled

A brief sketch of the mathematical and medical contents of three kinds of Manchu manuscripts
—the *Fundamentals of Arithmetic*, the *Essentials of Calculation* and the *Manchu Anatomy*—

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CHAPTER 1   MANCHU BOOKS ON WESTERN MATHEMATICS: the *FUNDAMENTALS OF ARITHMETIC*

The following argument depend on the manuscript owned by the Tôyô Bunko 東洋文庫, Tokyo.

SECTION 1.1   The List of Definitions, Propositions and Algorithms in the "suwan fa yuwan ben bithe" (the *Fundamentals of Arithmetic*)

Note that the following descriptions are not faithful translations of the Manchu text. Here we give priority to the simplicity of explanation.

§1   DEFINITIONS

(1)   A number as a collection of units.

Comments.   See HE's *Elements*-b7-Def.2, 數理精蘊上五-1-1.

The first sentence of the main text of the Manchu version of the *Fundamentals of Arithmetic* is "emke serengge. ton –i fulehe. (What is called the unit is the root of numbers.)" It corresponds to HE's *Elements*-b7-Def.1, but it is not a definition of 1 as a unit.

數理精蘊 says "衆一相合而数繁焉". This statement gives a relation between the unit (一) and numbers (数) on the asumptionn that readers already have the notion of numbers (数). It is not a definition.

(2)   'Measurability' in the sense of Greeks, i.e. divisibility in the modern sense.

Example.   8 & 2.

Couterexample.   8 & 3.

Comments.   See HE's *Elements*-b7-Def.3 & 4 & 5, 數理精蘊上五-1-1

§2   DEFINITIONS

(1)   An even or odd number.

Example 1.   Even numbers 2, 4, 6, 8 and 10.

Example 2.   Odd numbers 3, 5, 7, 9 and 11.

Comments.   See HE's *Elements*-b7-Def.6 & 7, 數理精蘊上五-1-2

(2)   An even-times-even or odd-times-even or odd-times-odd number.

Example 1.	An even-times-even number 8,
	An odd-times-even number 30,
	An odd-times-odd number 15
Comments.	See HE's *Elements*-b7-Def.8 to 11, 數理精蘊上五-1-2

§3 DEFINITIONS

(1) A prime number.

| Examples. | 5, 7 and 11. |
| Comments. | See HE's *Elements*-b7-Def.12, a part of 數理精蘊上五-1-16. |

(2) Relatively prime natural numbers.

Examples.	15 & 8,
	5 & 6 & 9.
Comments.	See HE's *Elements*-b7-Def.13, and a part of 數理精蘊上五-1-16

§4 DEFINITIONS

(1) A natural number with a nontrivial divisor. (i.e. a composite number)

| Example. | 12 with a divisor 4. |
| Comments. | See HE's *Elements*-b7-Def.14, and a part of 數理精蘊上五-1-15 |

(2) A set of natural numbers with a nontrivial divisor.

Examples.	12 & 16 with a common divisor 4,
	10 & 15 & 20 with a common divisor 5,
	7 & 14 & 21 with a common divisor 7.
Comments.	See HE's *Elements*-b7-Def.15, and a part of 數理精蘊上五-1-15.

§5 DEFINITION

A length or an area or a volume corresponding to a natural number.

Example.	A rectangle with sides 5 chi (尺) and 7 chi (尺) long.
Counterexample.	Consider a square with a side 5 chi (尺) long. The length of its sides and its diagonals are discussed.
Comments.	See 數理精蘊上五-2-26

§6 DEFINITIONS

(1) Multiplication of natural numbers. (Multiplication as repeated addition)

Example.　　　　　　6×10 = 60

Comments.　　　　　See HE's *Elements*-b7-Def.16, 數理精蘊上五-1-3.

(2)　　　　A 'rectangular number' (i.e. a composite number in a graphical sense)

Example.　　　　　　24 (= 4×6)

Comments.　　　　　See HE's *Elements*-b7-Def.17, 數理精蘊上五-1-4.

(3)　　　　A square number and the square root.

Example.　　　　　　25 (= 5×5)

Comments.　　　　　See HE's *Elements*-b7-Def.19, 數理精蘊上五-1-4.

§7　　　DEFINITIONS

(1)　　　'A number of rectangular parallelepiped' (i.e. a composite number which is the product of three nontrivial natural numbers).

Example.　　　　　　24 (= 2×3×4)

Comments.　　　　　See HE's *Elements*-b7-Def.18, 數理精蘊上五-1-7.

(2)　　　　A cubic number and the cubic root.

Example.　　　　　　27 (= 3×3×3)

Counterexample.　　12

Comments.　　　　　See HE's *Elements*-b7-Def.20, 數理精蘊上五-1-7

§8　　　PROPOSITION (Relations between division, multiplication and geometric quantities, etc.)

(1)　　　Let *a* and *b* be two given natural numbers. If numbers *x* and *y* satisfy the relations $(a/b) = x1 \,\&\, a = yb$, then we have $x = y$.

Example.　　　　　　12/4 = 3 = 3×1 & 12 = 3×4

Comments.　　　　　See 數理精蘊上五-1-9

(2)　　　Let *a* and *b* be two natural numbers. Then we have $(a/b) \times b = a$.

Example.　　　　　　60/12 = 5 and 12×5 = 60

(3)　　　The corresondense of a divisor and the quotient of a rectangular number and the lengths of the sides of a rectangle.

Example 1.　　　　　30/5 = 6 and 5×6 = 30

Example 2.　　　　　30/3 = 10 and 3×10 = 30

Comments.　　　　　See 數理精蘊上五-1-10

§9 DEFINITION

'Similar numbers' (two composite numbers corresponding to similar rectangles or rectangle parallelpiped.

Example 1.   12 (= 2×6) & 27 (= 3×9)   (2:3 = 6:9)

Example 2.   48 (= 2×4×6) & 162 (= 3×6×9) (2:3 = 4:6 = 6:9)

Comments.   See HE's *Elements*-b7-Def.22.

§10 PROPOSITION

Two square numbers or two cubic numbers are always similar.

Example.   9 (= 3×3) & 36 (= 6×6) (3:6 = 3:6)

§11 DEFINITION

A perfect number.

Example 1.   6 = 1+2+3

Example 2.   28 = 1+2+4+7+14

Comments.   See HE's *Elements*-b7-Def.23.

§12 PROPOSITION

Let a, b, c, … be natural numbers. If a natural number d measures all of them, then it can also measures their summation $a+b+c+\cdots$.

Example. $a = 8$ & $b = 12$ & $c = 20$ with a common divisor = 4.

Comments.   See a part of 數理精蘊上五-1-15.

§13 PROPOSITION

Suppose that we have three natural numbers a, b, c. If the number a (resp. b) measures the number b (resp. c), then a measures c.

Example. $a = 3$ & $b = 6$ & $c = 24$

§14 PROPOSITION

Let a, b, c, d be natural numbers. Assume $c \neq d$ and $b = c + d$. Moreover assume that a measures b and c. Then a measures d.

Example. $a = 3$ & $b = 15$ & $c = 6$ & $d = 9$

§15   ALGORITHM

Decide whether two given natural numbersare relatively prime or not. (Euclid's algorithm.)

Example.   11 & 7.

Comments.   See HE's *Elements*-b7-Prop.1，數理精蘊上五-1-18.

§16   ALGORITHM

Suppose that we have two natural numbers which are not relatively prime. Compute their nontrivial common divisor. (Euclid's algorithm.)

Example.   16 & 6.

Comments.   See HE's *Elements*-b7-Prop.2，數理精蘊上五-1-17.

§17   ALGORITHM

Suppose that we have two natural numbers which are not relatively prime. Compute their geratest common divisor. (Euclid's algorithm.)

Example.   24 & 18.

Comments.   See HE's *Elements*-b7-Prop.2

§18   PROPOSITION

Suppose that we have two different natural numbers. Any common divisor measures the greatest common divisor.

Example.   18 & 12.

§19   ALGORITHM

Decide whether three given natural numbers are relatively prime or not. (Euclid's algorithm.)

Example.   12 & 29 & 25.

Comments.   See HE's *Elements*-b7-Prop.3.

§20   ALGORITHM

Suppose that we have three natural numbers which are not relatively prime. Compute

their greatest common divisor. (Euclid's algorithm.)

Example.　　　　　　16 & 12 & 8.

Comments.　　　　　HE's *Elements*-b7-Prop.3.

§21　　PROPOSITION

Suppose that we have four numbers *a*, *b*, *c* and *d* such that there exists a natural number *n* satisfying the conditions

$$a + \cdots + a \ (n \text{ times}) = b \ \& \ c + \cdots + c = d \ (n \text{ times}),$$

then we have

$$(a + b) + \cdots + (a + b) \ (n \text{ times}) = c + d \ .$$

Example.　　　　$a = 6$, $c = 4$ and $n = 3$

Comments.　　　　See HE's *Elements*-b7-Prop.5，數理精蘊上五-2-1 .

§22　　PROPOSITION

Multiplication is commutative.

Example.　　　　　$4 \times 3 = 3 \times 4$

Comments.　　　　See HE's *Elements*-b7-Prop.16. The "suwan fa yuwan ben bithe" is sensitive to the fact that the commutativity of multiplication is not trivial.

§23　　PROPOSITION

Let *a* and *b* be two arbitray natural numbers. Then the product *ab* can be measured with the number *a*, and we have

$$ab = a + \cdots + a \ (b \text{ times}) \ .$$

Example.　　　　　a = 3, b = 4

§24　　PROPOSITION

If two natural numbers *a* and *b* satisfy the relation

$$b = a + \cdots + a \ (b/a \text{ times}),$$

where we assum that b/a is a natural number, then *a* and *b* also satisfy the relation

$$b = (b/a) + \cdots + (b/a) \ (a \text{ times}) \ .$$

Example.　　　　　$a = 12 \ \& \ b = 3$

§25   PROPOSITION

(From the liguistic viewpoint, two interpretations are possible in each part.)

(1)

Interpretation 1.   Let $a, b, c, \cdots$ be arbitrary natural numbers. Then we have
$$ab : ac : \cdots = b : c : \cdots .$$

Interpretation 2.   Let a, b and c be three arbitrary natural numbers. Then we have
$$ab : ac = b : c .$$

Example. $a = 6$ & $b = 8$ & $c = 10$.

Comments.   See HE's *Elements*-b7-Prop.18,上五-2-3. It is doubtful that editors
                     of 數理精蘊 was conscious of the order of multiplication.

(2)

Interpretation 1.   Let $a, b, \cdots$ be arbitrary natural numbers. Then we have
$$a^2 : ab : \cdots = a : b : \cdots .$$

Interpretation 2.   Let a, b and c be three arbitrary natural numbers. Then we have
$$a^2 : ab = a : b .$$

Example. $a = 6$ & $b = 8$.

§26   PROPOSITION

Suppose that we have two rectangular numbers $a = cd$ and $b = ef$ and consider the length of their sides. If c and e are equal, then we have $a : b = d : f$.

Example. $a = 24 = 6{\times}4$ & $b = 32 = 8{\times}4$

Comments.   See HE's *Elements*-b7-Prop.17, 數理精蘊上五-2-24

§27   PROPOSITION

(From the liguistic viewpoint, two interpretations are possible.)

Interpretation 1.   Let $a, b, c, \cdots$ be arbitrary natural numbers. Then we have
$$ac : bc : \cdots = a : b : \cdots .$$

Interpretation 2.   Let a, b and c be three arbitrary natural numbers. Then we have
$$ac : bc = a : b .$$

Example. $a = 6$ & $b = 8$ & $c = 5$

Comments.   This proposition is diffrent from Proposition in §25 only in the
                     order of multiplication.

§28	ALGORITHM

Construct finite geometric sequences the common ratio of which is equal to the given rational number.

Example.	A sequence 9, 15, 25 and a sequence 27, 45, 75, 125 with a common difference 5/3.

§29	PROPOSITION

(From the liguistic viewpoint, two interpretations are possible.)

Interpretation 1.	Let $a, b, c, \cdots$ be arbitrary natural numbers. Then we have
$$(a/c):(b/c):\cdots = a:b:\cdots.$$

Interpretation 2.	Let a, b and c be three arbitrary natural numbers. Then we have
$$(a/c):(b/c) = a:b.$$

Example.	$a = 12$ & $b = 15$ & $c = 3$.

Comments.	The values of the example are not correct, but the corrector made no correction here. See 數理精蘊上五-2-4

§30	PROPOSITION

Suppose that we have four natural numbers a, b, c and d. If they satisfy the proportional relation $a:b = c:d$, then we have $ad = bc$.

Example.	2:6 = 3:9 and 2×9 = 3×6

Comments.	See the first half of HE's *Elements*-b7-Prop.19, 數理精蘊上五-2-5

§31	PROPOSITION

Suppose that we have two rectangular numbers $a = cd$ and $b = ef$. If c and e are equal, then we have $c:e = f:d$.

Example.	6:8 = 3:4 and 6×4 = 8×3

Comments.	See the second half of HE's *Elements*-b7-Prop.19.

§32	PROPOSITION

Consider a geometric sequence a_1, a_2, a_3. We have $a_1 a_3 = (a_2)^2$.

Example.	A sequence 4, 6, 9.

Comments.　　　　　See 數理精蘊上五-2-6.

§33　　　PROPOSITION (A relation between division and ratios)

Let *a*, *b* and *c* be three arbitrary natural numbers. Then we have

$$(a/b):(b/c)=c:b.$$

Example.　　　　　36/4:36/6 = 6:4

Comments.　　　　　See 數理精蘊上五-2-7

§34　　　PROPOSITION

(From the liguistic viewpoint, two interpretations are possible.)

Interpretation 1.　　Suppose that we have a sequence of natural numbers $a,b,c,\cdots$. If this set is the 'smallest' one in the set of sequences $d,e,f,\cdots$ satisfying the condition $a:b:c:\cdots=d:e:f:\cdots$, then the numbers $a,b,c,\cdots$ measure $d,e,f,\cdots$ respectively.

Interpretation 2.　　Suppose that we have a pair of natural numbers *a* and *b* If this pair is the 'smallest' one in the set of pairs *d* and *e* satisfying the condition $a:b=d:e$, then the numbers *a* and *b* measure *d* and *e* respectively.

Example.　　　　　2:3 = 6:9

Comments.　　　　　See HE's *Elements*-b7-Prop.20 for Interpretation 2.

§35　　　PROPOSITION

(From the liguistic viewpoint, two interpretations are possible.)

Interpretation 1.　　Suppose that we have a sequence of natural numbers $a,b,c,\cdots$ which are relatively prime. This set is the 'smallest' one in the set of sequences $d,e,f,\cdots$ satisfying the condition $a:b:c:\cdots=d:e:f:\cdots$.

Interpretation 2.　　Suppose that we have a pair of natural numbers *a* and *b* which are relatively prime. This pair is the 'smallest' one in the set of pairs *d* and *e* satisfying the condition $a:b=d:e$.

Example.　　　　　*a* = 4 and *b* = 7.

Comments.　　　　　See HE's *Elements*-b7-Prop.21 for Interpretation 2..

§36　　　PROPOSITION

(From the liguistic viewpoint, two interpretations are possible.)

Interpretation 1.　　Suppose that we have a sequence of natural numbers $a,b,c,\cdots$. If

this set $a, b, c, \cdots$ is the 'smallest' one in the set of sequences $d, e, f, \cdots$ satisfying the condition $a : b : c : \cdots = d : e : f : \cdots$, then each of $a, b, c, \cdots$ cannot be measured with other ones.

Interpretation 2.   Suppose that we have a pair of natural numbers a and b. If this pair is the 'smallest' one in the set of pairs d and e satisfying the condition $a : b = d : e$, then each of a and b cannot be measured with the other one.

Example. $a = 4$ & $b = 5$.

Comments.   See HE's *Elements*-b7-Prop.22 for Interpretation 2.. The conclusion in the *Elements* is relatively primeness of the pair a and b.

§37   PROPOSITION (A Wrong Proposition!)

Suppose that we have two natural numbers a and b each of which cannot be measured with the other number. If a natural number c measures either a or b, say a, then the rest of them, say b, and the number c cannot be measured with each other.

Example. $a = 4$ & $b = 9$ & $c = 3$.

Comments.   See HE's *Elements*-b7-Prop.23.

The statement of this proposition is not correct. The case $a = 4$ & $b = 6$ & $c = 2$ provides a counterexample. If we replace indivisibility with relatively-primeness, this proposition will be correct, and the eaxample given in this section satisfies the conditions on the relatively-primeness. Moreover, its demonstration is not correct, because in a sentence a Manchu word for negation 'waka' was added too much. Both errors were not corrected by the corrector of this manuscript. Note that the corresponding proposition in the *Elements* is correct.

§38   PROPOSITION

Suppose that we have three natural numbers a, b and c.If the pair a, c and the pair b, c are are relatively prime, then the pair ab, c are relatively prime.

Example. $a = 7$ & $b = 3$ & $c = 8$

Comments.   See HE's *Elements*-b7-Prop.24

§39   PROPOSITION

Let a, b be two natural numbers which are relatively prime. Then the two numbers a^2 and b are relatively prime.

Example. $a = 5$ & $b = 7$.

Comments.   See HE's *Elements*-b7-Prop.25

§40   PROPOSITION

Suppose that we have four natural numbers $\left\{a_i, b_j\right\}_{i,j \in \{1,2\}}$. If the two numbers a_i and b_j are relatively prime for arbitrary i and j, then the products $a_1 a_2$ and $b_1 b_2$ are relatively prime.

Example. $a_1 = 3$, $a_2 = 5$ & $b_1 = 2$, $b_2 = 4$.

Comments.   See HE's *Elements*-b7-Prop.26

§41   PROPOSITION

Let a, b be two natural numbers which are relatively prime. Then the numbers a^2 and b^2 are relatively prime. a^3 and b^3 are also relatively prime.

Example. $a = 2$ & $b = 3$.

Comments.   See HE's *Elements*-b7-Prop.27

§42   PROPOSITION

Suppose that we have a prime number p and a natural number q which cannot be measured with p. Then they are relatively prime.

Example. $p = 5$ & $q = 6$.

Comments.   See HE's *Elements*-b7-Prop.29

§ 43   PROPOSITION

If a prime number p measues a rectangular number a, then this p also measures the length of each side of the rectangle associated with a.

Example. $p = 3$ & $a = 24$.

Comments.   See HE's *Elements*-b7-Prop.30

§44   ALGORITHM

Suppose tha we have a finite sequence of natural numbers $a, b, c, \cdots$. Construct the smallest sequence of natural numbers $d, e, f, \cdots$ satisfying the condition

$$a : b : c : \cdots = d : e : f : \cdots.$$

Example.　　　　　6, 4, 8.

Comments.　　　　See HE's *Elements*-b7-Prop.33, and a part of 數理精蘊上五-1-19

§45　　ALGORITHM

Suppose that we have two natural numbers *a* and *b* which are relatively prime. Compute the lowest common multiple of *a* and *b*.

Example.　　　　　$a = 4$ & $b = 5$

Comments.　　　　In the explanation of this algorithm, the author of this book failed to cite a correct proposition. The corrector tried to fill the gap. See HE's *Elements*-b7-Prop.34 (and HE's *Elements*-b7-Prop.39), a part of 數理精蘊上五-1-21. The statement in 數理精蘊 is to compute a common multiple, and its minimality is not required. Moreover, the assumption on the relatively-primeness is not mentioned there.

§46　　ALGORITHM

Suppose that we have two natural numbers *a* and *b* which are not relatively prime. Compute the lowest common multiple of *a* and *b*.

Example.　　　　　$a = 4$ & $b = 6$

Comments.　　　　See HE's *Elements*-b7-Prop.34. Possibly b7-Prop.39.

§47　　PROPOSITION

Suppose that we have two natural numbers *a* and *b*. The lowest common multiple of *a* and *b* measures an arbitrary common multiple of this pair.

Example.　　　　　$a = 2$ & $b = 3$

Comments.　　　　See HE's *Elements*-b7-Prop.35

§48　　ALGORITHM

Compute the lowest common multiple of three natural numbers *a*, *b* and *c*.

Example.　　　　　$a = 3$ & $b = 4$ & $c = 5$.

Comments.   See HE's *Elements*-b7-Prop.36, a part of 數理精蘊上五-1-21. The method discussed in 數理精蘊 is to compute a common multiple, not to compute the lowest common multiple. The condition on relatively-primeness is also omitted in 數理精蘊.

§49   ALGORITHM

Reducing fractions with trivial numerators to a common denominator.

Example.   1/2 & 1/3 & 1/4.

Comments.   See 數理精蘊上五-1-23？

§50   PROPOSITION

Suppose that we have two natural numbers a and b. If they are relatively prime, thenthe sequence $a, \cdots, b$ is the smallest one in the set of sequences $c, \cdots, d$ satisfying the conditions $a : \cdots : b = c : \cdots : d$.

Example.   A sequence 4, 6, 9

Comments.   See HE's *Elements*-b8-Prop.1, a part of 數理精蘊上五-2-19.

§51   ALGORITHM

Construct the 'smallest geometric sequence the commnon ratio of which is equal to a given positive rational number.

Example.   A sequences 4, 6, 9 and a sequence 8, 12, 18, 27 with the common ratio = 12/8.

Comments.   See HE's *Elements*-b8-Prop.2, a part of 數理精蘊上五-2-19.

§52   PROPOSITION

Consider geomtric sequences with a given common ratio and a given length. If a sequence is the smallest one in the set of all such sequences, then its first term and last term are relatively prime.

Example.   A sequence 8, 12, 18, 27.

Comments.   See HE's *Elements*-b8-Prop.3

§53   PROPOSITION

The ratio two rectangular numbers is equal to the product of the the ratio of their verti-

cal sides and the ratio of their horizontal sides.

Example. $24 = 6 \times 4$ and $48 = 16 \times 3$

Comments.   See HE's *Elements*-b8-Prop.5

§54   PROPOSITION

Suppose that we have four natural numbers *a*, *b*, *c* and *d* satisfying $a:b=c:d$. If there exist *n* natural numbers $e(1),\cdots,e(n)$ such that the sequence $a,e(1),\cdots,e(n),b$ is a geometric sequence, then there exist *n* natural numbers $f(1),\cdots,f(n)$ such that the sequence $c,f(1),\cdots,f(n),d$ is also a geometric sequence.

Example. $a=24, b=81, c=32, d=108, a:e(1):e(2):b=24:36:54:81$.

Comments.   See HE's *Elements*-b8-Prop.8, 數理精蘊上五-2-17. It seems that 數理精蘊 only treat a special case.

§55   PROPOSITION

Suppose that we have two square numbers *a* and *b*. There exists a natural number *c* such that the sequence *a*, *c*, *b* forms a finite geometric sequence.

Example. $a = 4$ & $b = 9$ & $c = 6$.

Comments.   See HE's *Elements*-b8-Prop.11, 數理精蘊上五-2-20（An appendix to §55 corresponds to 數理精蘊上五-2-27.）

§56   PROPOSITION

Let *a*, *b* be two arbitrary square numbers. There exist two natural numbers *c* and *d* such that the sequence *a*, *c*, *d*, *b* is a geometric sequence.

Example. $a = 8$ & $b = 27$ and $c = 12$ and $d = 18$.

Comments.   See HE's *Elements*-b8-Prop.12, 數理精蘊上五-2-22.

§57   PROPOSITION

Suppose that we have two similar rectangular numbers *a* and *b*. Then there exists a natural number *c* such that the sequence *a*, *c*, *b* is a geometric sequence.

Example. $a = 6$ & $b = 24$ & $c = 12$

Comments.   See HE's *Elements*-b8-Prop.18.

§58   PROPOSITION

Suppose that we have two rectangular numbers *a* and *b*. Then there product *ab* is a square number.

Example.　　　　　　　$a = 6$ & $b = 24$.

Comments.　　　　　　See HE's *Elements*-b9-Prop.1, 數理精蘊上五-2-21

§ 59　　PROPOSITION

Let *a*, *b* be square numbers. Then their product *ab* is also a squyare number.

Example.　　　　　　$a = 4$ and $b = 9$

§ 60　　DEFINITION

(1)　A finete arithmetic sequence with a positive common difference.

Example.　　　　　A sequence 2, 4, 6, 8, 10, 12.

(2)　A finite geometric sequence with a common ration 2.

Comments.　　　　See a part of 數理精蘊上五-2-31

§ 61　　PROPOSITION

Suppose that we have a finite strictly-increasing arithmetic sequence $a_1, \cdots, a_n$ with a common difference *d*. Then for each $k \in \{1, \cdots, n\}$ we have $a_k = a_1 + (k-1)d$.

Example.　　　　　A sequence 3, 6, 9, 12, 15, 18 and a relation $15 = 3 + 4 \times 3$.

§ 62　　PROPOSITION

Suppose that we have a finite strictly-increasing arithmetic sequence $a_1, \cdots, a_n$. Take arbitray natural numbers *i*, *j*, *r* satisfying $1 \le i - r < i < j < j + r \le n$. Then we have an equality $a_{i-r} + a_{j+r} = a_i + a_j$.

Example.　　　　　A sequence 5, 8, 11, 14, 17, 20, 23, 26, 29 and a relation $11 + 23 = 5 + 29$

Comments.　　　　See 數理精蘊上五-2-11.

§ 63　　PROPOSITION

Suppose that we have a finite strictly-increasing arithmetic sequence $a_1, \cdots, a_n$. Then for arbitrary $k \in \{1, \cdots, n\}$ we have $a_k = (a_{k-1} + a_{k+1})/2$.

Example.　　　　　A sequence 2, 4, 6, 8, 10, 12 and a relation $8 = (6 + 10)/2$.

Comments.   See 數理精蘊上五-2-12. The proposition in 數理精蘊 is a special case.

§64   PROPOSITION

Suppose that we have a finite strictly-increasing arithmetic sequence $a_1, \cdots, a_n$. Then the sum of this sequence is given by $n(a_1 + a_n)/2$.

Example.   A sequence 2, 4, 6, 8, 10, 12 and the relation (2+12) ×6/2 = 2+4+6+8+10+12.

Comments.   See 數理精蘊上五-2-32

§65   PROPOSITION

Suppose that we have a finite strictly-increasing arithmetic sequence $a_1, \cdots, a_{2n-1}$ with odd length. Then the sum of this sequence is given by $(2n-1)a_n$.

Example.   A sequence 4, 7, 10, 13, 16 and the sum $10 \times 5 = 4 + 7 + 10 + 13 + 16$.

§66   PROPOSITION

Consider the finite strictly-increasing arithmetic sequence $a_1, \cdots, a_n$ with a common difference 1 satisfying $a_1 = 1$. Then we have $\{(a_n + 1)a_n\}/2 = a_1 + \cdots + a_n$.

Example.   A sequence 1, 2, 3, 4, 5, 6, 7, 8.

§67   PROPOSITION

Consider the finite strictly-increasing arithmetic sequence $a_1, \cdots, a_n$ with a common difference 2 and the first term $a_1 = 1$. Then the sum of this sequence is equal to the square of its length.

Example.   A sequence 1, 3, 5, 7, 9, 11, 13.

Comments.   See 數理精蘊上五-2-33.

§68   PROPOSITION

Consider the finite strictly-increasing arithmetic sequence $a_1, \cdots, a_n$ with a common difference 2 and the first term $a_1 = 2$. Then the sum of this sequence is given by $n(n+1)$, where n denotes the length of this sequence.

Example.   A sequence 2, 4, 6, 8, 10, 12, 14 with length 7.

§ 69   PROPOSITION

Suppose that we have a finite strictly-increasing arithmetic sequence $a_1, \cdots, a_n$ with a common difference d. Then we have $(a_n - a_1)/d = n$.

Example.   A sequence 1, 3, 5, 7, 9, 11.

§ 70   ALGORITHM

Suppose that we have a finite strictly-increasing arithmetic sequence $a_1, \cdots, a_n$ with a common difference d. Compute the value of the last term a_n from the values of the first term a_1, the common difference d and the length n.

Example. $a_1 = 3,\ d = 4,\ n = 6$.

§ 71   ALGORITHM

Suppose that we have a finite strictly-increasing arithmetic sequence $a_1, \cdots, a_n$ with a common difference d. Compute the sum of this sequence from the values of the first term a_1, the common difference d and the length n.

Example. $a_1 = 5,\ d = 3,\ n = 6$.

§ 72   ALGORITHM

Suppose that we have a finite strictly-increasing arithmetic sequence $a_1, \cdots, a_n$ with a common difference d. Compute the value of the first term a_1 from the values of the last term a_n, the common difference d and the length n.

Example. $a_n = 26,\ d = 4,\ n = 6$.

§ 73   ALGORITHM

Suppose that we have a finite strictly-increasing arithmetic sequence $a_1, \cdots, a_n$ with a common difference d. Compute the value of d from the values of the first term a_1, the last term a_n and the length n.

Example. $a_1 = 3,\ a_n = 28,\ n = 6$.

§ 74   ALGORITHM

Suppose that we have a finite strictly-increasing arithmetic sequence $a_1, \cdots, a_n$ with a common difference d. Compute the length n from the values of the first term a_1, the last term a_n and the common difference d.

Example. $\qquad a_1 = 6,\ a_n = 26,\ d = 4.$

§ 75 ALGORITHM

Suppose that we have a finite strictly-increasing arithmetic sequence $a_1, \cdots, a_n$ with a common difference d. Compute the values of the first term a_1 and the last term a_n from the values of the common difference d and the length n and the sum of the sequence.

Example. $\qquad d = 4, n = 6, \text{the sum} = 78$.

CHAPTER 2   MANCHU BOOKS ON WESTERN MATHEMATICS: the
ESSENTIALS OF CALCULATION

SECTION 2.1   The Table of Contents of the *Essentials of Calculation* Found
in the Beginning of the Manuscript in BNF

The author of this article have not read the chapters form Chapter 10 to Chpter 15, so
we omit English translations of some of these chapter or section titles. It seems this list
corresponds to that of the *Suan-fa Zuan-yao Zong-gang* 算法纂要総綱, which was
written in Chinese.

ujui meyen[1], (Chapter 1.)

    oron be toktobure arga. (Numerical Positions.)

jai meyen, (Chapter 2.)

    nonggire arga. (Addition)

ilaci meyen, (Chapter 3.)

    ekiyembure arga. (Subtraction.)

duici meyen, (Chapter 4.)

    kamcire arga. (Multiplication.)

sunjaci meyen, (Chapter 5.)

    faksalara arga. (Division.)

ningguci meyen, (Chapter 6.)

    ilan šuwai bifi duici šuwai be baire arga. (Computing the value of the fourth variable
    from the values of three variables.)

        emtelingge be ijishūn -i bodoro arga. (6-1. The direct method for simple
        quantities.)

        emtelingge be fudarame bodoro arga. (6-2. The inverse method for simple

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[1] Usually a Manchu word 'meyen' corresponds to 'a section', not to 'a chapter'. But in
this manuscript the word 'meyen' is used in a very confused way. A block of paragrahs
corresonding to each excercise is often called 'meyen', too. So we will translate the
word 'meyen' in this level as 'a chapter'.

quantities.)

kamcibuhannge be ijishūn -i bodoro arga. (6-3. The direct method for complex quantities.)

kamcibuhangge be fudarame bodoro arga. (6-4. The inverse method for complex quantities.)

nadaci meyen, (Chapter 7.)

kamcibuha ilan šuwai be bodoro arga.[2]

jakūci meyen, (Chapter 8.)

ton be acabufi baha ton be neihen akū -i dendere arga[3]. (Dividing the sum of numbers unequally.)

emteli ton -i arga. (8-1. Simple quantities.)

kamcibuha ton -i arga. (8-2. Complex quantities.)

uyuci meyen, (Chapter 9.)

ton be gaifi teodenjeme yargiyalara arga[4]. (Transferring and verifying obtained numbers.)

juwanci meyen, (Chapter 10.)

holo ton be dahūn dahūn -i gaifi teodenjeme yargiyalara arga. (Transferring and verifying virtual numbers obtained one after another.)

juwan emuci meyen, (Chapter 11.)

neicin durbejengge neire arga. (Extraction of square roots.)

undu suwaliyame neicin durbejengge be neire arga. (11-App.)

juwan juweci meyen, (Chapter 12.)

ilan hošoi arbun be bodoro uheri arga. (Computation of quantities related to triangles.)

emteli gao gu be bodoro arga. (12-1. Single right triangles.)

kamcibuha gao gu be bodoro arga. (12-2. Combinations of right triangles.)

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[2] This chapter title is different from the one found at the beginning of the main text of this chapter. The latter is 'suwaliyaganjahangge be bodoro ilan šuwai -i arga' ('the method of three variables for computing quantities in mixtures').

[3] This chapter title is different from the one found at the beginning of the main text of this chapter. The latter is 'ton be acabufi, adali akū -i dendere arga'.

[4] This chapter title is different from the one found at the beginning of the main text of this chapter. The latter is 'ton arafi ishunde duibulere arga' ('the method of comparing hypothetical quantities and real quantities').

tondo hošo akū eiten hacin -i ilan hošoi arbun be bodoro arga. (12-3. Generic case, i.e. triangles without a right angle.)

juwan ilaci meyen, (Chapter 13.)

eiten hacin -i arbun -i dere de baktahangge be bodoro arga. (Computation of the areas of plain figures of all types.)

eiten hacin -i tondo jecen -i dere de baktakangge be bodoro arga. (13-1.)

emteli muheren -i neicin dere be bodoro arga. (13-2.)

muheren de kamcibuhangge be bodoro arga. (13-3.)

eitan hacin -i arbun -i dere be nonggire ekiyembure arga. (13-4.)

encu arbun -i dere be ishunde duibulere arga. (13-5.)

juwan duici meyen, (Chapter 14.)

tob durbejengge beye be neire arga. (Extraction of cubic roots.)

undu jecen be suwaliyame golmin durbejengge beye be neire arga. (14-App.)

tofohoci meyen, (Chapter 15.)

eiten hacin -i baktakangge be bodoro arga. (Computation of the volumes of solid figures of all types.)

jergilehe derei emteli arbun -i beye be bodoro arga. (15-1.)

kamcibuhangge be bodoro arga. (15-2.)

muhaliyan arbun de šungkuhe ba bisire emteli beyebe bodoro arga. (15-3.)

kamcibuhangge be bodoro arga. (15-4.)

duibulere duibulen adali beye be ishunde nonggire ekiyembure arga. (15-5.)

eiten hacin -i beyebe kūbulibure arga. (15-6.)

sunja hacin -i aisin be baitalara arga. (15-7.)

SECTION 2.2   An Example of the Main Text of the *Essentials of Calculation*.

Chapter 6 'Computing the value of the fourth variable from the values of three variables.'

Excercise 29 of 6-1 'The direct method for simple quantities.' (The 3rd fascicle, pp.69-73)

MANCHU TEXT

geli duibuleci, emu niyalma de juwe jui bi. jaci jui hendume, mini se ama -i sei sunja ubu -i emu ubu ombi. mini ahūn -i se, amai sei ilan ubu -i emu ubu ombi. mini ahūn, minci jakūn se ahūn. ama, ahūn, mini beye meni meni se udu seme fonjire de, sunja -i dorgi ci ilan be ekiyembufi sunja ubu -i emu ubu, ilan ubu -i emu ubu -i turgun. funcehe juwe be ujui šuwai, geli sunja ilan be ishunde teherebume bodofi. bahara tofohon -i ton be jai šuwai, fulu jakūn se be ilaci šuwai obume bodofi, bahara duici šuwai -i ninju sere ton, uthai terei amai sei ton inu. ere ninju be ilan ubu obume dendehe emu ubu -i orin, uthai terei ahūn -i sei ton inu. ninju be sunja ubu obume dendehe emu ubu -i juwan juwe sere ton, uthai jacin jui sei ton inu. juwan juwe, orin ci jakūn ekiyehun ofi, ahūn -i fulu jakūn se de acanahabi.

adarame seci, ilan be, sunja -i emgi, emu -i emgi teherebume bodoci, tofohon -i ton, ilan -i ton bahambi. suwan fa yuwan ben -i orin sunjaci meyen -i songkoi, tofohon beilan de duibulerengge, sunja be emu de duibulere adali. ilan, tofohon -i sunja ubui emu ubu ofi kai. geli sunja be ilan -i emgi emu -i emgi teherebume bodoci tofohon -i ton sunja -i ton bahambi. suwan fa yuwan ben -i orin sunjaci meyen -i songkoi, ilan be emu de duibulerengge, tofohon be sunja de duibulere adali. sunja, tofohon -i ilan ubu -i emu ubu ofi kai. geli ilan -i ton sunja -i ton be tofohon de duibulerengge, juwan juwe -i ton orin -i ton be ninju de duibulere adali. duibulen adali ofi, gi ho yuwan ben -i ningguci fiyelen -i juwanci meyen -i songkoi, sunja -i ilan ci fulu oho juwe be, tofohon de duibulere duibulen, uthai orin -i juwan juwe ci fulu jakūn be ninju de duibulere duibulen -i adali ombi.

ENGLISH TRANSLATION

Moreover, for example, (consider a case that) a man has two sons. The second son says, "My age is one-fifth of my father's age. The age of my brother is one-third of my father's age. My brother is eight years older than I." And he asks, "How old are my father, my brother and I?" (The answer is as follows.) Let two, which is obtained by subtracting three from five, Here five is the denominator of the fraction one-fifth and three is the denominator of the fraction one-third. be the value of the first variable, and in addition, let fifteen, which is obtained by multiplying five and three together, be the value of the second variable, and let eight years, which is equal to the difference in age between two sons, be the value of the third variable.

Then sixty, which is the value of the fourth variable and is obtained from three variables, is his father's age. Twenty, which is equal to one-third of sixty, is the age of the elder son. Twelve, which is equal to one-fifth of sixty, is the age of the younger son. Twelve is less than twenty by eight, and this deficiency coincide with eight years, which is equal to the difference in age between two sons.

Let us explain its details in the following. If we multiply three by five and one, we will obtain fifteen and three respectively. According to Section 25 of the *Fundamentals of Arithmetic*, comparing fifteen with three is equivalent to comparing five with one, because three is one-fifth of fifteen. Moreover, if we multiply five by three and one, we will obtain fifteen and five respectively. According to Section 25 of the *Fundamentals of Arithmetic*, comparing three with one is equivalent to comparing fifteen with five, because five is one-third of fifteen. Moreover, comparing three and five with fifteen is equivalent to comparing twelve and twenty with sixty respectively. Since the comparisons are equivalent, according to Section 10 of Chapter 6 of the *Fundamentals of Quantity*, the comparison given by comparing two, which is equal to the difference between five and three, with fifteen, is equivalent to the comparison given by comparing eight, which is equal to the difference between twenty and twelve, with sixty.

CHAPTER 3   MANCHU BOOKS ON WESTERN MEDICE: the *MANCHU ANATOMY*

Our arguments are based on the following manuscript of the *Manchu Anatomy*:

[BNF]   the manuscript in Bibliothèque Nationale de France.

[TB]   the manuscript in the Tôyô Bunko 東洋文庫 with a call number Ma2-19-1.

[BPKr]   the manuscript in the Tôyô Bunko 東洋文庫 with a call number Ma2-19-2.

[KS]   the manuscript in the Kyô-u Sho-oku 杏雨書屋.

[RA]   the manuscript in the St. Petersburg Branch of the Institute of Oriental Studies, the Russian Academy of Science.

SECTION 3.1   The list of contents of the *Manchu Anatomy*

The upper part of the book entitled "dergici toktobuha ge ti ciowan lu bithe", which has been called the *Manchu Anatomy* by European scholars, describes the macroscopic anatomy of Europe developped in the 17th century. It takes the form of regional anatomy, in other words, the structures of a particular region of the human body are collected one place. Note that its arrangement is very different from the standard adopted by the contemporary European textbooks on anatomy. European textbooks were used as guidebooks of actual dissection, so they start their description from the abdomen, which is the most perishable part of a dead body. On the other hand, the *Manchu Anatomy* starts its description from the head, and moreover, when it describes the internal organs such as the heart and small intestine, it follows the Chinese classification of the internal organs established in the *Nei-jing* (内経).

The following is the table of contents of the final form of the *Manchu Anatomy*. Manchu section titles are the ones found in the beginning of the manuscripts. Note that in many cases the English section titles in this list are not literal translations of Manchu section titles. We chose English section titles each of which reflects the contents of the corrsponding section.

The table of contents of the upper part of the *Manchu Anatomy*.

1   The First Volume of the Upper Part

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[5] Cerebral ventricles are described in detail.
[6] The eyebrows, eyelids and eyelashes are also explained.
[7] Lachrymal glands.
[8] These membranes mean the retina, cornea, etc..
[9] These objects mean the lens, vitreas body, etc..
[10] The significance of the sense of hearing is discussed, and the auricles are described.
[11] Various organs of the middle and internal ear, and the ear canal are described here.
[12] The significance of the sense of smell is discussed, and the external nose is

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described.

[13] Its role as a vocal organ is discussed in detail.

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[14] Mammary glands, lactiferous sinuses are also mentioned.

[15] Its role in breathing is also discussed.

[16] Body hairs are also described here. Sweat glands are mentioned.

[17] A manuscript in the Royal Library of Denmark, which is an abridged edition of the *Manchu Anatomy*, only contains analytical charts and their captions. The fibrous layer of the abdominal wall is an example of 'flesh membranes under the skin' in a chart of this manuscript.

[18] Correctly speaking, the structure explained in this section is epimysia.

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[19] Decomposiotion of the hip bone into theree parts and their fusion in the growing process are described. The differences between the male and female pelves are also described.

[20] The description of the large intestine are divided into three sections, namely, the ce-

sembi. jai meyen be kerken duha sembi. ilaci meyen be teru sembi)

---

cum, the colon and the rectum. The function of the ileocecal valve is also mentioned here.

[21] Gastric glands, gastric pits, gastric hydrochloric acid, and its submucous and muscular tissue are mentioned.

[22] Muscles around the esophagus are expaine in detail.

[23] This section contains an overview of of the whole intestine. In addition to the duodenum, the jujenum and ileum are described.

[24] The main part of the limphatic system of the whole body, such as the thrachic duct and the chyle cistern, is described and properties of lymph are discussed.

[25] Filtration of urine is discussed.

The table of contents of the lower part of the *Manchu Anatomy*.

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[26] A word-by-word translation of the Manchu title of this section is 'the sac of black bile'.

[27] The female external genitalia is also described.

[28] The growth of an embryo or a fetus is also explained.

5-1 Diseases of the Head Related with Spiritus Animales (uju, sukdun -i nimeku -i šošohon)

 5-1-1 Headache (uju nimere be gisurehengge)[29]

 5-1-2 Dizziness, Giddiness and Vertigo[30] (uju liyeliyešere be gisurehengge)

 5-1-3 Diseases of the Eye (yasai nimeku be gisurehengge)

 5-1-4 Diseases of the Sclera (yasai jai jergi alhūwa -i nimeku be gisurehengge)

 5-1-5 Diseases of the Vascular Layer (yasai ilaci jergi alhūwa -i nimeku be gisurehengge)

 5-1-6 Diseases of the Lens, Vitreas Body and Other Things in the Eyeball (yasai alhūwa de baktaka hacin -i nimeku be gisurehengge)

 5-1-7 Diseases of the Ear, 1 (šan -i nimeku be gisurehengge)

 5-1-8 Diseases of the Ear, 2 (šan -i nimeku be gisurehe sirame meyen)

 5-1-9 Diseases of the Nose, 1 (oforo -i nimeku be gisurehengge)

 5-1-10 Diseases of the Nose, 2 (oforo -i nimeku be gisurehe sirame meyen, ya g'an yoo banjire hacin be kamcime gisrehebi)

 5-1-11 Diseases of the Nose, 3 (oforo -i nimeku be gisurehe sirame meyen)

 5-1-12 Diseases of the Mouth (angga -i nimeku be gisurehengge)

 5-1-13 Diseases of the Tongue, 1 (ilenggu -i nimeku be gisurehengge. ya g'an yoo banjire. wahūn nišargan banjire hacin be kamcime gisurehebi)

 5-1-14 Diseases of the Tongue, 2 (ilenggu -i nimeku be gisurehe sirame meyen)

 5-1-15 Diseases of the Uvula and Soft Palate (ilmaha, heheri -i nimeku be gisurehengge)

 5-1-16 Dental Pain (weihe nimere be gisurehengge)

 5-1-17 Diseases of the Hypopharynks (bilha -i nimeku be gisurehengge)

 5-1-18 Diseases Caused by Disorder of Spiritus[31] (niyalma -i sukdun an ci aljafi, nimeku banjire turgun be gisurehengge)

 5-1-19 Convulsive Fits of Children, and Epilepsy (fancakū nimeku be gisure-hengge)

 5-1-20 Cerebral Apoplexy (tan ho nimeku be gisurehengge)

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[29] In addition to preliminary remedies, ten prescritions are given here.
[30] In addition to preliminary remedies, nine prescritions are given here, and the importance of the regular lifestyle is pointed out.
[31] The background of diseases such as strokes are explained here.

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[32] Several types of insanity, including the one caused by an awful fever, are discussed.

[33] Heart diseases are classified into the following three types; palpitation, irregularity of pulse caused by a transient stop of beating, and cardiac arrest accompanied with complete unconsciousness.

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[34] In this and the next sections, excessive appetite caused by intestinal worms and pica od pregnant women are discussed. There is also a description of abnormal thirst, which seems to be a result of diabetes.

[35] Pain and breathlessness caused by the pressure of pleural fluid are treated.

nimere, emu ergi suksaha fure hacin be kamcime gisurehebi. narhūn edun tuwara de cirgas-
hūn ojoro hacin be kamcime gisurehebi)

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[36] Vesical calculi are discussed.
[37] Hematuria, enuresis and dysuria are discussed.
[38] Pain, tumefaction and the growth of ulcers are discussed.
[39] Malingnant type and non-malignant type are discussed. The former one seemes to be
syphilis.
[40] This section says that febrile diseases are results of abnormal fermentation of blood.
[41] This section seems to deal with diseases of several kinds, not a single disease.
Bubonic plague is one of them.

SECTION 3.2   The contents of tags written by Parrenin

The following is the transliteration of the text on a tag atached to 3-1-1 of [BNF] and [TB]. In this tag Parrenin asked to Emperor Kang-xi what the Manchu equivalent for an acute or obtuse angle is. The contents of this tag suggests that Parrenin had not read Manchu books on mathematics written by other Jesuits in the middle of the Kang-xi era.

MANCHU TEXT

šolonggo hošo, mufuyen hošo

si yang ni bithede, žui giyo, dun giyo sehebi,

ede acanara gisun be aha be umai baharakū ofi

hergen be dahame araha.

dergici jorime tacibureo.

ENGLISH TRANSLATION

a sharp angle, a blunt angle

The Western books talk about the notions of 'žui giyo' (鋭角) and 'dun giyo' (鈍角). Since we, your servants, could not obtain appropriate words at all, we gave literal translations of these word. Please teach us appropriate words.

SECTION 3.3   Passages from the *Manchu Anatomy*

3.3.1   What Does the Title "ge ti ciowan lu" Mean?

The original Manchu tiltle of the *Manchu Anatomy* is "ge ti ciowan lu". It is obvious that this title is a transliteration of some Chinese word, but the sequence of Chinese characters corresponding to this title is not yet determined. Many candidates have been proposed until now; '格体全録'[42], '骼体全録'[43], '各体全録[44]', '割体全録[45]', etc.. The

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[42] This expression was used in the catalog of the Kyô-u Sho-oku (杏雨書屋) in Ôsaka.

[43] This expression was used in the catalog of the Tôyô Bunko (東洋文庫) in Tôkyô.

[44] This expression was proposed by Genji Kuroda (黒田源次) in 1943.

[45] This expression was used in the *Quan-guo Man-wen Tu-shu-zi-liao Lian-he Mu-lu* (全國滿文圖書資料聯合目録).

problem is to determine the Chinese character corresponding to the combination of two Manchu letters 'ge' in the whole sequence 'ge ti ciowan lu'.

We can find the sequence of letters 'ge ti ciowan lu' in the main text of the *Manchu Anatomy*. Section 5-0-1, which plays the role of the preface to the lower part of that book, explains the origin of Western anatomy as follows:

MANCHU TEXTS

… (1) weihun gurgu gasha be secime neifi, niyaman fahūn, duha do sube sudala -i jergi hacin -i holbome banjiha be narhūšame tuwaha, niyalma ulaha adali akū ofi. kemuni akūnahakū ba bisire ayoo seme, teni fafun de gamaha niyalma be neifi tuwame, ge ti ciowan lu bithe ereci deribuhe. … (2) te -i jalan -i mergese gūnin fayabume sibkime kimcime, ge ti cion lu bithe be getukeleme banjibuhangge, cohome niyalmai nimeku -i turgun be sakini sere jalin. aikabade nimeku hacin be neileme faksalame gisurerakū oci, ge ti ciowan lu bithei baitalan mangga ojoro de isinambi.

ENGLISH TRANSLATION

… (1) Scholars dissected living beasts and birds, and closely investigated the structures of their bodies, which consist of their hearts, livers, other internal organs, nerves and blood vessels. Since the results of those investigation did not coincied with the traditional knowledge[46], people had doubts on the completeness of that knowledge, and finally began to dissect and observe the bodies of executed people. This was the beginning of the books entitled "ge ti ciowan lu". … (2) Wise scholars of our age have made mental efforts to investigate the human body deeply and thoroughly and to write books entitled "ge ti ciowan lu". Their purpose is nothing but to realize the details of diseases of the human race. If we do not reveal the types of diseases and classify them into sections in our explanation, then it will be difficult to use the book "ge ti ciowan lu" in our daily medical treatments.

In the above paragrahs, 'ge ti ciowan lu' is used as a common noun which means a textbook or textbooks of anatomy developped in early modern Europe.

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[46] This is the knowledge collected by Galen. Note that the name of Galen is refered nowhere in the *Manchu Anatomy*.

3.3.2   Medical Contents. Description of the Scapulae (Shoulder Blades)

The following is the full text of Section 2-1-1 'Overview of the Upper Limb, and the Scapulae'.

MANCHU TEXT

halba, meiren, gala be gisurehengge.

niyalma -i beye de bisire eiten aššan, gala ci tucinerengge akū. yaya hacin -i jafara sindara weilere ararangge, udu gūnin ci tucicibe gala be baitalarakū sere ba akū. uttu ofi eiten deriburengge gūnin ci tucimbi. eiten šanggaburengge gala de akdahabi. meiren, mayan, gala, falanggū simhun ci aname, yooni dosi forome banjibuhannge, cohome jafara tebeliyebure seferere de ja bime hūsungge okini sehe turgun. hasutai icitai ojorongge buya juse be, gemu ajigen ci jorime tacibure de bi. ereci wesihun gala be šošome gisurehengge.

halba ci simhun de isitala ilhi aname gisureci, halba serengge, fisa -i juwe ergi meiren giranggi de acame banjiha halfiyan nekeliyen giranggi inu. ere giranggi uthai kalka -i adali fisa -i amargi ebci -i dergi ergi be dalime banjihabi. halba -i muru, ilan hošonggo tuku ergi dukduhun, doko ergi šungkutungge. šungkutu ojoro jakade, oyonggo yali farsi ereci dolo baktaka bime, ebci -i musen de acabume banjihabi.

tuku ergi -i dulimba de ešemeliyan ilhū banjiha emu justan giranggi be, bithe- de halba -i bula sehebi. ere bula -i gese giranggi -i dube ergi, buya juseingge oci buge canggi, mandume genehei orin se šurdeme oho manggi, teni giranggi banjinambi. ere bula -i gese giranggi juwe dalbade šungkutungge ofi, meiren gala be aššabure yali farsi, gemu ede latume banjihabi.

halba giranggi da ergi de juwe gargan bi. emu gargan, yali farsi de holbohobi. emu gargan, meiren -i giranggi de acame banjiha bime, geli alajan giranggi -i buge sirge de siranduhabi. senggi sudala ere juwe gargan -i sidende wesimbi wasimbi. dube ergi onco bime buge noho, giranggi de latume banjiha ba akū. damu yali farsi canggi ishunde holbome banjihangge sula ojoro jakade, tuttu meiren gala

aššara de kušun akū haihūngga ohobi.

ENGLISH TRANSLATION

Explanation of the scapulae, the arms and the hands.

In all movements of the human body, nothing is better than the movements of the upper limbs. Actions such as holding, releasing, forming and producing various things are done with our hands, however they are planned by our minds. Hence everything starts from our minds, and everything is completed by our hands. The shoulders, the arms, the forearms, the hands, the palms and the fingers, all of them face inward, so that one can hold something in our hands or arms, or grasp something easily and powerfully. Left- or right-handedness in shooting arrows can be achieved when we teach our students in their infancy. The above is an overview of the whole upper limb.

Let us explain the organs of the upper limb step by step, from the scapulae to the fingers. The scapulae are flat thin bones located on the both sides of the back, each of which is adjacent to the humerus. This bone is similar to a shield, and it covers the back side of the upper part of the ribbs. The shape of the scapula is triangular. Its front side is convex, and its back side is concave. Since its back side is concave, important muscles are holded inside, and at the same time, the scapula itself can fit the curve of the ribbs.

In the center of its front side, there is a straight line of bone running in a some-what diagonal direction. This bony line is called the spine of the scapula in our textbooks. The end of this spine-like bone is made of cartilaginous tissue if it belongs to the scapulae of children. It changes into bone tissue after the owner has grown up and turned twenty or thereabouts. The both side of this spine-like bone are depressed, and all muscles producing movements of the arm and hand are attached to these depressed areas.

Near the base of the scapula there are two branches. One branch is combined with muscles. The other branch is joined to the humerus at its base, and is con-nected with cartiginous and fibrous tissue of the clavicle. Blood vessels run up and down between these two branches. The end of the scapula is wide, and is only made of cartilaginous tissue. No part of it does not stick to any born. Only muscles are connected with it, and there is play around it. As a result, we can move the arm

and hand smoothly and their movements are not uncomfortable.

3.3.3 Medical Contents. Properties of the Pancreas and the Famous Animal Experiment Done by de Graaf (1664)

The *Manchu Anatomy* provided comtemporary knowledge of European anatomy in a detailed and often intreresting form. The following is the description of experiments with dogs done by de Graaf and published in 1664. This experiment revealed the function of the pancreas. We can find this description in Section 4-1-6 'The Small Intestine'.

MANCHU TEXT

amu serengge, hatuhūn jušuhun muke be hergere tetun inu. amu -i beye yali waka, nimenggi waka. mucu hoho -i adali cilciname, golmin duin ts'un isime. guwejihe -i fejile amargi de banjihabi. hatuhūn jušuhun muke, amu -i geren cilcin de hergebufi, meni meni cilcin -i sudala deri, amu -i dulimbai šošohon -i bade dosifi, teni dergi duha de dosimbi. ere jušuhun mukei sudala be neneme sarkū bihe. ere jalan -i giyan be kimcime mangga niyalma, erebe saki seme weihun indahūn -i hefeli be secifi, niyehe dethe -i kitala -i emu ujan be indahūn -i amu -i mukei sudala de tokofi, emu ujan be boli tamse -i angga de sisifi ukcaburakū obume hūwaitafi, indahūn -i hefeli be ufifi, emu juwe inenggi oho manggi, tamse be gaifi tuwaci tamse -i dolo amu ci dosika jušuhun hatuhūn muke bi. tereci amu -i muke, dergi duha de dosire be bahafi getuken -i sahabi.

ENGLISH TRANSLATION

The pancreas is a filter producing salty sour liquid. Its body consists of neither muscle tissue nor adipose tissue. It is a collection of glands, which looks like a bunch of grapes, and is 4 urhuns long. It is located below and behind the stomach. The salty sour liquid is purified in many glands in the pancreas, passes through the tubes of each gland, flows into the main tube in the center of the pancreas, and finally flows into the intestines. These vessels of sour liquid had not been known before. An excelent scholar of our age, who studied the general laws of nature in

details, tried to understand the properties of these vessels. He dissected the abdomen of a living dog. He took the rachis of a feather of a duck, sticked one of its ends into a vessel of sour liquid of the dog's spleen. He pushed the other end into the mouth of a small glass bottle, fixed it to the bottle with a string, and sutured the incision line in the dog's abdomen. One or two days later, he took this bottle and examined it. He found that there was sour salty liquid in the bottle, which had flowed from the pancreas. We thus understood clearly that the liquid in the pancreas flows into the upper part of the testine.

3.3.4   Medical Contents. Mention of the Surgical Removal of Dogs' Spleen Done by Zambeccari (1680)

In 1680, Zambeccari showed a dog was still alive even though its spleen had removed by surgery. His experiment is mentioned in Section 3-4-4 'The Spleen' of the *Manchu Anatomy* as follows:

MANCHU TEXT
delihun -i baitalan be, niyaman fahūn ufuhu -i jergi jaka -i adali getuken -i bahafi sara unde. ememu urse indahūn be weihun secifi, delihun be faitame gaicibe, tere indahūn bucuhekū, kemuni an -i banjihabi. tuttu ofi delihun be asuru oyonggo akū jaka obume gisurehebi.

ENGLISH TRANSLATION
We already know the functions of the heart, liver, and other internal organs well, but the level of our understanding of functions of the spleen have not attained the same level yet. People dissected living dogs and cut their spleen away, but in this process the dogs were not killed and were still alive without any trouble. Hence the textbooks on anatomy say that the spleen is not a very important internal organ.

3.3.5   Influence of the Theories of Descartes

a)   A Mechanistic View of the Human Body

The human body is compared with the mechanism of a clock in Section 1-0-2 of the *Manchu Anatomy*. It is a noteworthy fact that a mechanistic view of the human body was claimed in a book written by a Jesuit.

MANCHU TEXT

… beye -i giranggi, yali, ufuhu, niyaman -i jergi dorgi tulergi jakai ishunde falime holbome banjihangge, dz ming jung ni muheren, fa tiyoo, jeo dz -i jergi jakai ishunde holbobuha ci lakcafi somishūn ferguwecuke. dz ming jung ni dorgi jakai turgun be wacihiyame sarkū oci, dz ming jung be dasaci weileci ojorakū be dahame, niyalmai beye -i somishūn ferguwecuke be ja de getukeleme mutere be ereci ombio. urunakū niyalmai beye -i dorgi tulergi geren babe, emke emken –i narhūšame baicame gingguleme kimcici, getuken -i sara ten de isibufi, icihi gese kenehunjere ba akū de isibuha manggi, teni banin arbun be wacihiyame bahafi saci ombi. …

ENGLISH TRANSLATION

… The inseparable combination of the external and internal objects of the human body, such as bones, muscles, the lungs and the heart, is much more hidden and miraculus than the combination of objects in a clock, such as wheels, springs and shafts. Since we cannot make and repair any clock without knowing the details of its components completely, we can never expect that it is possible to clarify the secrets and miracles of the human body easily. As a logical consequence, if we examine and investigate many external and internal parts of the human body one by one, we can extend the range of our clear understanding to its limit, remove our doubts caused by defective understandings, and understand their structures and properties completely. …

b)   Emphasis on the Importance of the Pineal Body

It is well-known that Descarte regarded the pineal body as a bridge between mind and body. The importance of the pineal body is also emphasized in Section 1-1-5 'The

Brain' of the *Manchu Anatomy*.

MANCHU TEXT

ere asu be gaiha manggi, bahiya -i adali cilcin serebumbi. ere cilcin, ilan hošonggo kumdu -i amargi tob dulimba de bi. ere cilcin, bohori gese amba, manggakan bime boco suwayan, oilorgi be nekeliyen alhūwa hūsifi, juwe ergi de bisire siren, narhūn asu de holbome hūwaitahabi. julergi gisurehe bade niyalmai fehi be beye de teherebume bodoci, yaya ergengge jaka ci amba sehebi. ere cilcin be beye de teherebume bodoci, yaya ergengge jaka ci ajige. fehi de bisire halhūn sukdun, ere cilcin de hergebumbi. ede sukdun hergeburengge, duibuleci, siseku -i ufa be sisere de, siseku ele narhūn fisin oci, ufa ele narhūn ojoro adali. ere cilcin umesi ajige bime fisin oci, sen deri tucire sukdun ele bolgo ofi, enteke niyalma labdu mergen ombi.

ENGLISH TRANSLATION

Having deleted this net[47], we find a gland looking like a pinecone. This gland lies in the center of the part behind the triangular cavity[48]. This gland is as large as a pea, rather hard and yellow-colored. Its surface is wrapped by a thin membrane. This gland is bound by strings found in its both sides and is connected with the fine net. In the beginning of this section we said the following; if we compute the ratio of the brain to the body for the human race, then we see that it is the largest of the quantities of the same kind for various creatures. If we compute the ratio of this gland to the body, we see that it is the smallest of the quantities of the same kind for various creatures. Hot spiritus in the brain is purified in this gland. This purification process is similar to the process of sieving flour. If the meshes of a sieve is more and more fine, then the particles of the flour are more and more fine. If this gland is very small and compact, spiritus emitted through its small holes is purer than that of ordinary people, and in many cases the owner of this gland is wise.

Note that the way of interaction between mind and body is somewhat different from the one given by Descarte. In Descarte's theory the strength of mechanical impact on the

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[47] This net seems to be the choroid plexus.
[48] This cavity is the third ventricle of the brain.

fluid in the human brain determines the strength of the activities of mind. On the other hand, in the *Manchu Anatomy* the fineness of the fluid in the brain determines the quality of the activities of mind.

c)   The Role of Heat in Beating of the Heart

The theory of blood circulation was established by William Harvey in the first half of the 17th century. His theory was explained in Section 4-4-1 'Circulation of Blood' of the *Manchu Anatomy* without mentioning its quantitative aspects. Recall that the role of the heart in Harvey's theory is completely mechanical. Descarte also claimed the existence of blood circulation in the human body, but in his theory the heart is a kind of heat engine, and he failed to give the correct relation between the outflow of blood from the heart and the contraction of the heart.

Section 4-1-5 'Beating of the Heart' of the *Manchu Anatomy* is devoted to the role of the heart in blood circulation and the details of the process of beating. Two types of explanation are given there. One is purely mechanical one; the action of the heart muscle causes contraction of the heart, and this contraction squeeze blood from the heart. The other explation emphasizes the role of the heat in blood as follows:

MANCHU TEXT

jai niyaman -i saniyame ikūrengge, unggala de dosire senggi de akdahabi. senggi dosirengge ele labdu ele hahi oci, niyaman -i saniyara ikūrengge ele hūdun ombi. uttu ofi niyalma sujure, hūsutulerede beye wenjeme senggi sukdun halhūn ombi. senggi sukdun halhūn oci, niyaman -i unggala de dosire tucirengge hahi ombi. dosire tucirengge hahi oci, niyaman -i ikūre saniyarangge uthai hūdun ombi.

ENGLISH TRANSLATION

(1) We next say that the expansion and contraction of the heart depend on the flow of blood into the chambers of the heart. If the flow rate and velocity of blood become larger and larger, the expansion and contraction of the heart expands and contracts more and more frequent. Hence when a man is running or tensing his body, his body generates heat, and his blood and spiritus becom hot. If blood and spiritus becomes hot, blood rushes into the chambers of the heart and rushes out of those chambers as well. If it rushes into or out of those chambers, the heart expand or contract rapidly.

Here the heart is driven by hot blood in a certain sense. It is possible that this emphasis on the role of heat partly reflects Descarte's theory on the heart.

3.3.6   Influence of Thmism, the Theology of Thomas Aquinas

Section 1-0-1 of the *Manchu Anatomy*, which plays the role of the preface of the whole book, gives a type of Catholic notions on human beings. It regards a human being as a complex substance consisting of his soul and his flesh.

Note that in this preface Parrenin made a clear and explicit distinction between the material heaven and the immaterial Lord, which came to be recquired by the Vaticane in the process of escalation of the Chinese Rites Controversy. On the other hand the preface of the "suwan fa yuwan ben bithe" (the *Fundamentals of Arithmetic*") says that studying mathematics is the beginning of investigating things thoroughly and extending our knowledge (格物致知). The attitude of Jesuits to Confucianism had changed clearly, and it is probable that this change was one of the reasons why the *Manchu Anatomy* were not published during the Qing period.

MANCHU TEXT

(1) niyalma, abka na -i sidende bisire eiten jaka ci sure genggiyen wesihun erdemungge ohongge, arbun bisire beye, arbun akū fayangga, ishunde falifi banjiha emu beye -i arbun bisire abka, abka be banjibuha arbun akū ejen de uheleme holbobuha turgun. (2) arbun bisire abka de holbohongge uthai abkai sukdun de nikefi ergen taksifi bisire yali beye inu. (3) abka be banjibuha arbun akū ejen holbohongge, uthai eiten enduri ferguwecun -i sure genggiyen -i da fulehe, colhoroko amba ejen de nikefi genggiyen taksifi banjire sure fayangga inu. (4) arbun akū fayangga -i banin sure genggiyen be dahame, terei giyan, arbun bisire yali beye ci umesi narhūn somishūn. (5) uttu ofi arbun bisire beye arbun akū fayangga be meni meni faksalame getukelefi, gemu niyalmai beyebe getukelere emu hacin de baktambuha. (6) arbun bisire beyebe kimcire de ja, arbun akū fayangga be sara de mangga turgun de, arbun bisire beye be neneme gisurefi, arbun akū fayangga be amala gisurehebi. (7) niyalmai arbun bisire beye arbun akū fayanggai geren turgun be akūmbume hafume sara de isinaci, jaka be banjiha ejen

-i mohon akū ferguwecuke erdemu be tengkime safi, sure genggiyen gosin sain ginggun unenggi dahūbufi, fayangga -i enteheme elhe ojoro babe ja -i bahaci ombime, yali beyebe elhe obure, se jalgan be goidabure arga be saci ombi. (8) uttu ofi giyan jurgan be tacire urse, ere bithe be sithūci, niyalmai banjire bucere de holbobuha ten -i oyonggo babe getuken -i saci ombi. (9) daifu sa ere bithe sithūci, nimeku yoo -i banjire turgun dasara arga be hafu saci ombi.

ENGLISH TRANSLATION

(1) A human being is more intellectual, noble and virtuous than any other being existing between the heaven and the earth. This is a result of the fact that his material body and his immaterial soul, which were inseparably combined with each other to form one (complex) substance, are connected together to the material heaven and the immaterial Lord, who created the heaven. (2) What connected a human being (as a complex substance) to the material heaven is nothing but his physical body, which preserves his physical vitality and exists on the basis of the primary material[49] of the (material) heaven. (3) What the immaterial Lord, who created the heaven, has connected are the following two things: the one is the root of the intellectual abilities and the (active and possible) intellects of every angel, and the other is the intellectual soul, which came to hold the (active and possible) intellects[50] on the basis of the transcendent great Lord. (4) Since the essence of an immaterial soul is intelectual, its laws are much more suttle and hidden than those of a material body. (5) From this reason, we clarified properties of our material body and our immaterial soul respectively, and put all of them into a single subject clarifying the substance of a human being. (6) It is easy to investigate a material body, but it is difficult to understand an immaterial soul. Such being the case, we explained our material bodies first, and our immaterial souls later. (7) If we come

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[49] A Manchu word 'sukdun' was often used to express one of the most famous notion of the Neo-confucianism, 'qi' (氣), in the "han –i banjibuha sing li jing yi bithe", which is the translation of the *Xing-li Jing-yi* (性理精義).

[50] The corresponding Manchu word 'genggiyen' was often used as a Manchu equivalent for the Chines word '明'. On the other hand, Jesuits' translation of the word 'intellectus' was '明悟'. So it is probable that 'genggiyen' was used as a Manchu equivalent for the word 'intellectus'. This supposition does not contradict the usages of the word 'genggiyen' in a Manchu translation of the *Tian-zhu Shi-yi* (天主實義).

to know many details of the material bodies and immaterial souls of human beings thoroughly, then we will clearly understand the infinite miraculus virtues of the Creator, and will recover intellectual abilities (toward God), love (of God), goodness, piety and faith, and finaly we will be able to obtain the eternal peace of our soul easily, and at the same time we will be able to understand how to bring peace to our phisical bodies and how to enjoy longevity. (8) From this reason, if philosophers devote themselves to learn this book, then they can clearly understand the most important facts of the life and death of human beings. (9) If medical doctors devote themselves learn this book, then they can thoroughly understand the details of various disease and remedies for them.