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The Sections on Mechanics in the Mohist Canon

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This is a brief presentation of preliminary results of joint work on the mechanics sections of the Mohist Canon that has been carried out during a workshop at the Max Planck Institute for the History of Science in August 2000, standing in the context of a project on the long term development of mechanics. The results are based on the work of William Boltz and of members of the project group at the Max Planck Institute (in particular Peter Damerow, Jürgen Renn, Matthias Schemmel, and Baichun Zhang).

China has a long tradition of natural philosophical speculation. It also has a long tradition of mechanical engeneering. But prior to the Jesuits' introduction of European Renaissance mechanics in the late 16th century, there was no science of mechanics in China. No historical source handed down to us documents a theoretical reflection on mechanical phenomena.

This is true with but one exception. In the so-called Mohist Canon, written about 300 BC, there are several passages that sinologists early classified as dealing with mechanical problems. The Mohist Canon is contained in four out of 71 chapters constituting the Mohist corpus, see Table 1. In the table, these chapters are marked in bold face. The Mohist corpus is a compilation of texts that accumulated over about 200 years and are ascribed to the Mohist school. This school, which owes its name to its legendary founder Mo Di, was, though lesser known today, one of the three great schools of Chinese philosophy, besides Taoism and Confucianism.

TABLE 1. *The Mohist Corpus (ca. 400–200 BC)*

Chapter(s)	Contents
1–7	On ethics, politics, and self-cultivation
8–10	“Elevating the Worthy”
11–13	“Conforming to Superiors”
14–16	“Universal Love”
17–19	“Rejecting Aggression”
20–22	“Economy in Expenditure”
23–25	“Economy in Funerals”
26–28	“The Will of Heaven”
29–31	“Elucidating the Spirits”
32–34	“Rejecting Music”
35–37	“Rejecting Destiny”
38, 39	Against Confucianism
40, 41	**The Canons**
42, 43	**The Explanations**
44, 45	Further ‘dialectical chapters’
46–50	On ethics, politics, and self-cultivation
51	[Chapter and chapter title lost]
52-71	On fortification and defensive warfare

Unfortunately, however, among sources from ancient China, the Mohist Canon is one of the most difficult to understand. Originally tied to an oral culture, the text lost its immediate intelligibility when the oral tradition ceased. Being transcribed without being understood, the Mohist Canon was particularly susceptible to textual corruption, which in turn rendered this unique document of Chinese thinking increasingly obscure.

There is, for instance, an abundance of otherwise unknown graphs in the Mohist Canon. This is to a great extent due to the fact that the Pre-Han Chinese script (i.e. the script in which Chinese texts were written before the rise of the Han-Dynasty in the 3rd century BC) was much less standardized than the script of later periods. Now, usually ancient Chinese texts underwent a

process of standardization in their transmission. However, because the Mohist Canon was so badly understood, standardization was carried out only hesitantly, or sometimes even inconsistently.

Another source of confusion lies in a tradition that continued throughout the history of Imperial China: the tradition of tabooing those characters that appear in the name of the Emperor. Even in the transcription of older texts, the scribes had to avoid to write these characters, often substituting them by synonymous ones. This technique obviously gives rise to a particularly subtle kind of corruption, especially when those modifying the text did not understand it.

Furthermore, the text was garbled twice in the history of its transmission. The first two chapters of the Mohist Canon contain about 180 very short texts, the canons proper. The two further chapters contain a text that was, in the course of the 19th century, gradually understood to be related to the canons. It was only in the early 1920s that the systematic relation of this text to the canons was discovered by Liang Qichao.[1] It had turned out that nine out of ten of the canons had a co-ordinated explanation to be found somewhere in these two chapters. An explanation is linked to its canon by means of a head character, i.e. the first character of both canon and explanation is the same. However, since the arrangement of the canons was garbled twice in the history of its transmission, the co-ordination of canon and explanation turned out to be a difficult problem of philology.

To fully appreciate the complexity of this problem, one has to know that a chapter of the Mohist corpus as it is handed down is written without any paragraph breaks, even without commas or periods. As a consequence, the question of wether a character is to be considered a head character, i.e. where a canon or an explanation starts and where it ends, becomes extremely difficult to answer (see the figure on the following page).

1. Liang, Qichao. *Mojing Jiaoshi*. Commercial Press, 1922.

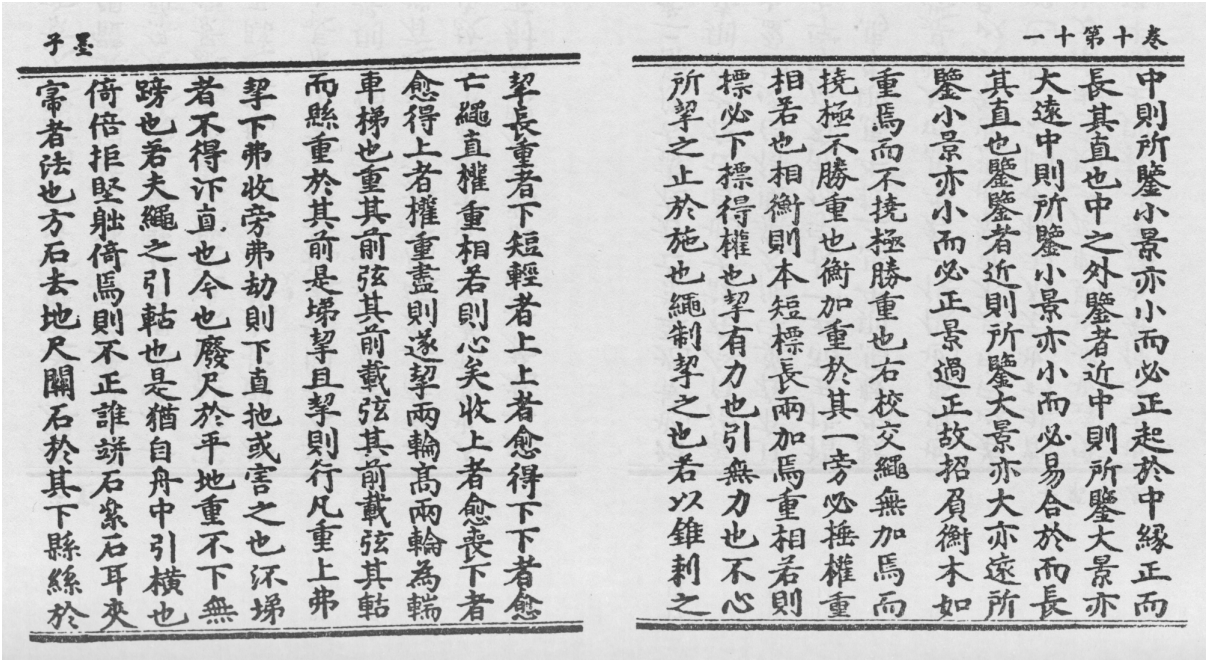

FIGURE. *Excerpt from the Taoist Patrology text of the Mohist Canon.*

Over the last centuries, Chinese philologists were able to reconstruct parts of the canon and gradually uncovered its structure. This was the basis for A.C. Grahams groundbreaking work on the Mohist Canon. His book “Later Mohist Logic, Ethics and Science,” published in 1978,[2] improved the understanding of the Mohist Canon considerably. In particular, Grahams studies showed that, assuming that the canon is a consistent and highly structured text, and that the grammar of its language is very strict, much less emendations of characters were necessary than earlier studies had suggested. Furthermore, most of the remaining corruptions turned out to be systematic and could thus be emended on firm grounds.

In particular, Graham was able to uncover the structure of the content of the Mohist Canon as it is shown in Table 2. A canon together with its co-ordinated explanation we call a section. The sections of the Mohist Canon cover “four branches of knowledge,” that are mentioned in the text itself. The first we may call logic, though it is not a logic of syllogisms, but rather a reflection on language offering procedures for consistent description in order to avoid paradoxes. The second is on ethics, the last one on the art of disputation. Of interest to us is the branch that may be referred

2. A.C. Graham. *Later Mohist Logic, Ethics and Science*. Hong Kong: The Chinese University Press, 1978.

to as concerned with science, here marked in bold face, in which the sections on mechanics can be found. Each branch of knowledge is dealt with in two places. In one place certain basic terms are defined, in the other place more complex problems are dealt with.

TABLE 2. *Structure of the Mohist Canon*

The four branches of knowledge	Definitions	Propositions
1. Explaining how to relate names to objects	"Reason," "unit," "knowing"	Procedures for consistent description
2. Explaining how to act	Conduct and government	(Expounding the Canons)
(Bridging part: knowledge and change)	Spatial and temporal conditions of knowing	Spatial and temporal conditions of knowing
3. Explaining objects	**Geometry**	**Problems in optics, mechanics, and economics**
4. Explaining words	disputation (bian)	Problems in disputation

In our work on the mechanics sections of the Mohist Canon we picked up the thread of Graham's studies, but we think that, in utilizing the experience we made with texts on mechanics from the European and Arabian tradition, we were able to achieve a deeper understanding of the text and arrive at an even more consistent and convincing interpretation.

In particular, Graham ran into a dead end, virtually all scholars had run into when studying the sections on mechanics. In some of the sections reference is made to certain instruments and machines. While appearance and functioning of these devices must have been well known to the contemporaries of the Mohists, it seems impossible to reconstruct them on the basis of the scarce information given in the canons and explanations. As a consequence, scholars have desperately tried to urge meaning out of the incomplete descriptions and have proposed various constructions. The obvious uselessness of the machines proposed, and the fact that every scholar arrived at a different construction is evidence for the futileness of such an endeavor.

When we reexamined the sections on mechanics, it turned out that a basic structure is common to all of them, including a coherent use of technical terms for mechanical qualities. This structure is quite independent of the commitment to any of the above mentioned questionable interpretations of the devices involved. To give you an impression of this structure, let us have a closer look at two of the shorter sections.

The first is the canon no. B25a and its co-ordinated explanation. Consider the plate on p. 9. In the first line we have the Chinese text, then comes a romanization that follows the pronounciation of modern Chinese. In the third line, then, we give a gloss. We use these word-by-word translations, that can, when carried out rigorously, be called a conformal translation, as research tools. When combined with a dictionary that can be built up in the process of working with the text, it enables one to have full controll over the use of terms appearing in the source, since the same words are always translated in the same way, not attempting to write a smooth English text. A translation closer to the structure of the English language is finally given below. It reads:

> Bearing without being deformed. The explanation lies with *"prevailing."*

This summing up ("The explanation lies with..." and so forth) marks the end of about half of all the canons. The character sheng^4, "prevailing," here marked in italics, is a cross-reference term. It reappears in the explanation, to which I now turn. (See the plates on pp. 10 and 11.)

The first character is the head character, which is repeating the first character of the canon and is not to be interpreted as being a part of the first sentence of the explanation. Our translation reads:

> Bearing: A cross-bar when you add a **weight** to it is not deformed. This is due to the **pole-quality** *prevailing* over the **weight**.

In bold face we marked the technical terms for mechanical qualities appearing in this passage. Besides the weight (zhong^4), there is the term ji^2, originally meaning "extreme" or "pole." From the structure of the text it becomes, however, clear that here it is to be understood as a technical term. We tentatively translated it as "pole-quality."

The last part of the explanation reads (plate on p. 11):

> A cord twisted clockwise [?], without adding [a weight] to it, is deformed. This is due to the **pole-quality** not *prevailing* over the **weight**.

This passage reveals that the weight is really understood as an abstract quality and not just the heavy object you can put onto a beam, since in this case no object is placed and the term "weight" must refer to the weight of the cord itself.

Let us sum up the structure of this section (see the plate on p. 12). In the canon a problem is raised: how does it come that something can bear a weight without being deformed. In the explanation a term is introduced, the "pole-quality," that counteracts the weight. In the case of a wooden beam, the pole-quality prevails over the weight and the beam does not bend. In case of the cord, even without adding a weight to the weight of the cord itself, the pole-quality does not prevail over the weight and the cord bends. Thus, in this section, the pole-quality seems to play the role of rigidity.

Let us take a closer look at another section on mechanics, B25b (plate on p. 13). The canon of this section was unfortunately lost and can be reconstructed only incompletely. The head character can be reconstructed from the explanation and reads "heng^2," "the beam." Besides this, only the summing-up is left to us, the cross-reference term being "de^2," "gaining," here again marked in italics. The rest of the canon is lost. However, as we will see, from the explanation it can be inferred what problem the Mohist was raising therein.

Leaving out the head character again, the first phrase of the explanation reads (plate on p. 14):

> If you add a **weight** to its [i.e. the beam's] one side [this side] will necessarily hang down. This is due to the **effectiveness [of the weight]** and the **weight** matching each other.

We have to imagine a movable beam, either suspended from above or supported from below. If a weight is attached to one side of the beam then this side will droop. Here, the term "weight" is complimented with another term, the "quan^2," originally meaning "political power." In the Mohist Canon we understand it to designate an abstract measure of the effect the weight has. In the case at hand, the weight (zhong^4) and its effectiveness (quan^2) match each other, i.e. the effect of the weight is as expected: the side where the weight is placed goes down. So far, this is in accord with our expectations and would not have required the introduction of a new term. Now, however, as the explanation continues, things get more involved (plate on p. 15):

> Level [both sides] up with each other, then the base is short and the tip is long. Add equal **weights** to both sides, then the tip will necessarily go down. This is due to the tip having *gained* **effectiveness [of the weight]**.

Now the beam with the weight attached to one of its sides is brought into the horizontal position again. To achieve this, the fulcrum, i.e. the point of suspension or of support, has to be moved. The

result is, that one side of the beam when counted from the fulcrum is shorter than the other. The Mohist calls the side having the weight attached to it the “base” (ben[3]), which now is short, an the other side the “tip” (biao[1]), which now is long. Now adding equal weights to both sides of the beam, something unexpected can be observed. While usually equal weights cause equal effects, now the tip can be observed to decline. This is what one would expect when the weight laid on the side of the tip were greater than that laid on the side of the base. It thus seems that the weight on the “tip”-side is somehow more effective than that on the “base”-side. This is expressed by the statement that the tip has gained in effectiveness. Most probably, the lost canon referred to this phenomenon that forces the Mohist to introduce the new term, “effectiveness.”

As in the case of the weight and the pole-quality in section 25a, we thus have here a pair of abstract terms, weight and effectiveness, that differentiate the term weight in order to account for its different behavior under certain circumstances. In the other sections on mechanics of the canon we could extract further technical terms for mechanical qualities. There are, for example terms for supporting a weight from below, for suspending it from above, or for pushing it from the side.

Mohist Canon and Explanation, Section B25a

Canon:

Chinese:	負	而	不	橈	說	在	勝
Romanization:	fu^{4}	er^{2}	bu^{4}	rao^{3}	shuo^{1}	zai^{4}	*sheng^{4}*
Gloss:	bear	*gp*	*neg*	be deformed	explanation	lie with	*"prevailing"*

Translation: Bearing without being deformed. The explanation lies with "*prevailing.*"

'*gp*' stands for 'grammatical particle'; '*neg*' stands for 'negation particle';
technical terms for mechanical qualities are printed in **bold face**; cross reference terms are printed in *italics*.

Mohist Canon and Explanation, Section B25a

Explanation:

C:	負	衡	木	加	**重**	焉	而	不	橈	**極**	勝	**重**	也
R:	fu^{4}	heng^{2}	mu^{4}	jia^{1}	**zhong^{4}**	yan^{1}	er^{2}	bu^{4}	rao^{3}	**ji^{2}**	*sheng^{4}*	**zhong^{4}**	ye^{3}
G:	bear	horizontal	wood	add	**weight**	to it	*gp*	*neg*	be deformed	**pole**	*prevail*	**weight**	due to

Translation: Bearing: A cross-bar when you add a **weight** to it is not deformed. This is due to the **pole-quality** *prevailing* over the **weight**.

‘*gp*’ stands for ‘grammatical particle’; ‘*neg*’ stands for ‘negation particle’;
technical terms for mechanical qualities are printed in **bold face**; cross reference terms are printed in *italics*.

Mohist Canon and Explanation, Section B25a

Explanation (cont.)

C:	右	校	交	繩	無	加	焉	而	橈	**極**	不	勝	**重**	也
R:	you^{4}	jiao^{3}	jiao^{1}	sheng^{1}	wu^{2}	jia^{1}	yan^{1}	er^{2}	rao^{3}	**ji^{2}**	bu^{4}	*sheng^{4}*	**zhong^{4}**	ye^{3}
G:	right hand side	twist	plaited	cord	do not	add	to it	*gp*	be deformed	**pole**	*neg*	*prevail*	**weight**	due to

Translation: A cord twisted clockwise [?], without adding [a weight] to it, is deformed. This is due to the **pole-quality** not *prevailing* over the **weight**.

‘*gp*’ stands for ‘grammatical particle’; ‘*neg*’ stands for ‘negation particle’;
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Romanization:	fu^{4}	er^{2}	bu^{4}	rao^{3}	shuo^{1}	zai^{4}	*sheng^{4}*
Gloss:	bear	*gp*	*neg*	be deformed	explanation	lie with	*“prevailing”*

Explanation:

C:	負	衡	木	加	**重**	焉	而	不	橈	**極**	勝	**重**	也
R:	fu^{4}	heng^{2}	mu^{4}	jia^{1}	**zhong^{4}**	yan^{1}	er^{2}	bu^{4}	rao^{3}	**ji^{2}**	*sheng^{4}*	**zhong^{4}**	ye^{3}
G:	bear	horizontal	wood	add	**weight**	to it	*gp*	*neg*	be deformed	**pole**	*prevail*	**weight**	due to

C:	右	校	交	繩	無	加	焉	而	橈	**極**	不	勝	**重**	也
R:	you^{4}	jiao^{3}	jiao^{1}	sheng^{1}	wu^{2}	jia^{1}	yan^{1}	er^{2}	rao^{3}	**ji^{2}**	bu^{4}	*sheng^{4}*	**zhong^{4}**	ye^{3}
G:	right hand side	twist	plaited	cord	do not	add	to it	*gp*	be deformed	**pole**	*neg*	*prevail*	**weight**	due to

Canon: Bearing without being deformed, the explanation lies with *“prevailing.”*

Explanation: Bearing: A cross-bar when you add a **weight** to it is not deformed. This is due to the **pole-quality** *prevailing* over the **weight**.
A cord twisted clockwise [?], without adding [a weight] to it, is deformed. This is due to the **pole-quality** not *prevailing* over the **weight**.

Mohist Canon and Explanation, Section B25b

Canon:

Chinese:	＜衡＞	[...]	說	在	得
Romanization:	heng^{2}		shuo^{1}	zai^{4}	*de*^{2}
Gloss:	the beam	[...]	explanation	lie with	*“gaining”*

Translation: The beam [...]. The explanation lies with *“gaining.”*

‘*gp*’ stands for ‘grammatical particle’; ‘*neg*’ stands for ‘negation particle’;
technical terms for mechanical qualities are printed in **bold face**; cross reference terms are printed in *italics*.

Mohist Canon and Explanation, Section B25b

Explanation:

C:	衡	加	**重**	於	其	一	旁	必	捶	**權**	**重**	相	若	也
R:	heng^{2}	jia^{1}	**zhong^{4}**	yu^{2}	qi^{1}	yi^{1}	pang^{2}	bi^{4}	chui^{4}	**quan^{2}**	**zhong^{4}**	xiang^{1}	ruo^{4}	ye^{3}
G:	the beam	add	**weight**	to	its	one	side	necessarily	hang down	**power**	**weight**	each other	match	due to

Translation: The beam: If you add a **weight** to its one side [this side] will necessarily hang down. This is due to the **effectiveness [of the weight]** and the **weight** matching each other.

‘*gp*’ stands for ‘grammatical particle’; ‘*neg*’ stands for ‘negation particle’;
technical terms for mechanical qualities are printed in **bold face**; cross reference terms are printed in *italics*.

Mohist Canon and Explanation, Section B25b

Explanation (cont.)

C:	相	衡	則	本	短	標	長	兩	加	焉	**重**	相	若
R:	xiang^{1}	heng^{2}	ze^{2}	ben^{3}	duan^{3}	biao^{1}	chang^{2}	liang^{3}	jia^{1}	yan^{1}	**zhong^{4}**	xiang^{1}	ruo^{4}
G:	with each other	(to be) horizontal	then (as a rule)	the base	(to be) short	the tip	(to be) long	two	add	to them	**weight**	each other	match

C:	則	摽	必	下	標	得	**權**	也
R:	ze^{2}	biao^{1}	bi^{4}	xia^{4}	biao^{1}	*de^{2}*	**quan^{2}**	ye^{3}
G:	then (as a rule)	the tip	necessarily	go down	the tip	*to gain*	**power**	due to

Translation: Level [both sides] up with each other, then the base is short and the tip is long. Add equal **weights** to both sides, then the tip will necessarily go down. This is due to the tip having *gained* **effectiveness [of the weight]**.

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Gloss:	the beam	[...]	explanation	lie with	*“gaining”*

Explanation:

C:	衡	加	**重**	於	其	一	旁	必	捶	**權**	**重**	相	若	也
R:	heng^{2}	jia^{1}	**zhong^{4}**	yu^{2}	qi^{1}	yi^{1}	pang^{2}	bi^{4}	chui^{4}	**quan^{2}**	**zhong^{4}**	xiang^{1}	ruo^{4}	ye^{3}
G:	the beam	add	**weight**	to	its	one	side	necessarily	hang down	**power**	**weight**	each other	match	due to

C:	相	衡	則	本	短	標	長	兩	加	焉	**重**	相	若
R:	xiang^{1}	heng^{2}	ze^{2}	ben^{3}	duan^{3}	biao^{1}	chang^{2}	liang^{3}	jia^{1}	yan^{1}	**zhong^{4}**	xiang^{1}	ruo^{4}
G:	with each other	(to be) horizontal	then (as a rule)	the base	(to be) short	the tip	(to be) long	two	add	to them	**weight**	each other	match

C:	則	摽	必	下	標	得	**權**	也
R:	ze^{2}	biao^{1}	bi^{4}	xia^{4}	biao^{1}	*de*^{2}	**quan^{2}**	ye^{3}
G:	then (as a rule)	the tip	necessarily	go down	the tip	*to gain*	**power**	due to

Canon: The beam [...]. The explanation lies with "*gaining.*"

Explanation: The beam: If you add a **weight** to its one side [this side] will necessarily hang down. This is due to the **effectiveness [of the weight]** and the **weight** matching each other. Level [both sides] up with each other, then the base is short and the tip is long. Add equal **weights** to both sides, then the tip will necessarily go down. This is due to the tip having *gained* **effectiveness [of the weight]**.

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