IWO AMELUNG

WEIGHTS AND FORCES: THE RECEPTION OF WESTERN MECHANICS IN LATE IMPERIAL CHINA

In this paper, I will investigate some aspects of the transmission of Western mechanics into late imperial China.[1] In the history of science, transmission processes are usually considered as successful when a new idea, theory or technique is actively adopted and used in further research. In the case of mechanics, this stage was not reached in China until the early Republican period, mainly due to the lack of an institutional and educational basis. Here, I will look into the earlier phases of the transmission which are commonly conceptualized as periods of 'awareness' and 'interest'.[2] In part one of my analysis, I will trace the terms coined to designate Western mechanics during the earliest phase of an emerging Chinese awareness of Western sciences and highlight some of the confusing terminological problems that often accompany the transmission of scientific knowledge across cultures. In part two, I will show that Chinese awareness of mechanics, as one of the basic disciplines of the European sciences, grew rapidly from about 1850 onwards. Further interest was incited with the (re-)discovery of a presumably independent Chinese tradition of mechanical thinking reaching back to antiquity. Although discourses on mechanics in nineteenth-century China were hardly 'scientific' in nature, but rather could be characterized as an example for the "popularization of science without the necessary scientific basis"[3], they were an important factor in making 'mechanics'—or at least its competing Chinese renderings *zhongxue* 重學 and *lixue* 力學 —well-known to the scholarly elite of the late imperial period. This popularization paved the way for the transfer of mechanical terms into other realms of discourse in the years preced-

---

[1] I would like to thank Zhang Baichun and Wang Yangzong for their many helpful comments on earlier drafts of this paper.

[2] For a systematic investigation into theoretical issues related to the transmission of sciences, see R. G. A. Dolby. 1977. "The Transmission of Science", *History of Science* 15, pp. 1–43.

[3] There is scarce research on the popularization of science in late Qing China. For general studies on the various aspects of the subject, see Terry Shinn and Richard Whitley (eds.). 1985. *Expository Science: Forms and Functions of Popularization*. Dordrecht, Boston, Lancaster: D. Reidel.

Michael Lackner, Iwo Amelung and Joachim Kurtz (eds.). *New Terms for New Ideas. Western Knowledge and Lexical Change in Late Imperial China*. Leiden et al. 2001, pp. 197–232.

ing the turn of the century. The sometimes surprising meanings which some of these terms acquired in their various new contexts will be examined in part three.

1. THE TERMS FOR 'MECHANICS'[4]

The first book introducing Western mechanical knowledge into China was the *Yuanxi qiqi tushuo luzui* 遠西奇器圖説錄最 (Diagrams and explanations of the wonderful machines of the Far West), printed in Yangzhou in 1627. This small treatise was written by the Jesuit missionary Johann Terrenz Schreck (Deng Yuhan 鄧玉函 , 1576–1630) in collaboration with the Chinese convert Wang Zheng 王徵 (1571–1644). The work has commanded considerable attention by scholars in China and the West due, on the one hand, to its illustrations which present 'wonderful machines' used in different fields in considerable detail, and on the other, because Wang Zheng was sometimes considered to be China's first 'engineer' in the modern sense. The bulk of research has focused on the origins of the illustrations[5] and the Western sources for the new knowledge that was introduced.[6] Surprisingly, much less emphasis was given to the terminology employed in the book, even though it is clear that the work was influential in this respect. In our context, the *Qiqi tushuo* is important because it contains the first references to Western mechanics in the Chinese language. The opening lines read:

---

[4] The question of the Chinese term for Western 'mechanics' is mentioned in Federico Masini. 1993. *The Formation of Modern Chinese Lexicon and its Evolution towards a National Language: The Period from 1840 to 1898*. Berkeley: Journal of Chinese Linguistics (Monograph Series, no. 6). The standard history on Chinese mechanics only touches upon the problem in passing. Cf. Dai Nianzu 戴念祖 . 1988. *Zhongguo lixueshi* 中國力學史 (A history of Chinese mechanics). Shijiazhuang: Hebei jiaoyu chubanshe, pp. 1–2. Cf. also Wang Bing 王冰 . 1995. "Woguo zaoqi wulixue mingci de fanyi ji yanbian" 我國早期物理學名詞的翻譯及演變 (The early phase of the translation of physical terms in China and their evolution), *Ziran kexueshi yanjiu* 14.3, pp. 215–26.

[5] Cf. e.g. Joseph Needham. 1965. *Science and Civilisation in China. Vol. IV: Physics and Physical Engineering. Part 2: Mechanical Engineering*. Cambridge: Cambridge University Press, pp. 170–1, 220 ff.

[6] Cf. Fritz Jäger. 1944. "Das Buch von den Wunderbaren Maschinen. Ein Kapitel aus der Geschichte der Abendländisch-Chinesischen Kulturbeziehungen", *Asia Major*, N.S. 1.1, pp. 78–96.

> The *Qiqi tushuo* has been translated from Western script. In the West, each branch of 'study' (*xue* 學) has its own name. The name of this branch was originally the 'craft of force' (*liyi* 力藝).[7]

The next passage expounds the 'nature' (*xing* 性) of mechanics:

> The craft of force (*liyi*) is the 'study of weight' (*zhongxue* 重學). Force (*li* 力) here refers to 'strength' (*qili* 氣力) and 'power' (*liliang* 力量), as in 'human strength' (*renli* 人力), the 'strength of a horse' (*mali* 馬力), 'water power' (*shuili* 水力) or the 'power of wind' (*fengli* 風力) etc. It is also a designation for the use and application of force, like the use of human strength, the strength of a horse or the power of water, wind and so on. 'Craft' (*yi* 藝) means 'a skilled method to use force'; it is the summary name for the ideal way to use and save force by means of artful devices. Within [the compound] 'study of weight' (*zhongxue*), 'study' (*xue*) is the general term and 'weight' (*zhong*) is the singular term. 'Study' is called a 'general' (*gong* 公) term because it is also used in words like *wenxue* 文學 'philology', *lixue* 理學 'philosophy', *suanxue* 算學 'mathematics' etc. And because, looking at the original meaning, the 'study of the craft of force' falls entirely under the category of 'weight' (*zhong* 重), we call it 'the study of weight' by its individual name. … The main function of the 'study of weight' is the moving of weights.[8]

Whether there is a direct source for this somewhat confusing passage is unclear. But it is obvious that in the explanation special emphasis is placed on 'weight', and this may have led the authors to coin the neologism *zhongxue* to render 'mechanics'. This term is strikingly similar to the Latin term *scientia de ponderibus* (the science of weight) that was widely employed by European medieval authors like Jordanus to describe their views of statics on the basis of the Hellenistic and Arabic tradition, most notably the *Mechanical Problems* attributed to Aristotle.[9] In the Latin translation of Simon Stevin's influential work on statics—included in his *Hypomnemata Mathematica*—which has

---

[7] Johann Terrenz Schreck (Deng Yuhan 鄧玉函) and Wang Zheng 王徵. 1993 [1627]. *Yuanxi qiqi tushuo luzui* 遠西奇器圖説錄最 (Diagrams and explanations of the wonderful machines of the Far West), in: *Zhongguo kexue jishu dianji tonghui: jishu juan* 中國科學技術典籍同彙・技術卷 (Anthology of classical works of Chinese science and technology: Technology). Edited by Ren Jiyu 任繼愈. Zhengzhou: Henan jiaoyu chubanshe, vol. 1, pp. 599–693; 610. The reprint is based on the *Shoushange* edition of 1844.

[8] Schreck and Wang 1993, p. 610.

[9] Cf. Ernest A. Moody and Marshall Clagett (eds.). 1952. *The Medieval Science of Weights (Scientia de Ponderibus)*. Madison: The University of Wisconsin Press, pp. 3–20.

been identified as one of the main sources for the theoretical parts of the *Qiqi tushuo*[10] and was available to the Jesuits in Beijing[11], the term *scientia de ponderibus* is not used.[12] It seems quite likely, however, that Johann Schreck, who had been a member of the Academy of the Lincei and had studied in Italy, knew the term. He may have been aware of the original Dutch version of Stevin's work, *De Beghinselen der Weeghconst beschreven duer Simon Stevin von Brugghe* (Elements of the science of weights described by Simon Stevin from Bruges), published in 1586[13] and probably available in the Jesuit's library in Beijing[14], and it is possible that Schreck, who was a native speaker of German and thus probably able to read Dutch, had consulted it when preparing the work.

Even if this reconstruction is correct and *zhongxue* is a loan translation of *scientia de ponderibus* (or for that matter a slightly modified loan translation for Stevin's *weeghconst*), there can be no doubt that *zhongxue* and *liyi* were used to denote Western 'mechanics' and 'statics'. 'Mechanics' here was of course pre-Galilean and pre-Newtonian mechanics and was hence neither considered as part of physics nor as a natural science.[15] In fact, it was just the opposite of physics because according to Aristotelian understanding, it was viewed as an art of tricking nature and forcing bodies to move in a way which they could not do on their own.[16] It is therefore not surprising that neither the

---

[10] Cf. Jäger 1944, pp. 81–2. The *Mechanicorum liber* by Guidobaldo del Monte, which has been suggested by Jäger as another important source, was apparently not held in the Beitang Library in Beijing. Cf. H. Verhaeren. 1949. *Catalogue de la Bibliothèque du Pé-t'ang*. Beijing: Imprimerie des Lazaristes.

[11] Cf. Verhaeren 1949, No. 2872.

[12] Simon Stevin. 1605–1608. *Hypomnemata Mathematica*. Translated by Willebrodus Snellius. Lugdunum Batavorum: Patius.

[13] Simon Stevin. 1586. *De Beghinselen der Weeghconst*. Leyden (bound together with *De Weegdhaet* and *De Beghinselen des Waterwichts*).

[14] Cf. Verhaeren 1949, Nos. 4070–4072. It is not clear, however, when this book was brought into the Beitang Library.

[15] We should note, however, that Stevin in the third appendix to the *Weeghconst* emphasizes that 'weeghconst' (or 'statics' in the Latin version) must be considered as a 'wisconst' ('liberalium artium unam') and that 'the art of weights' is placed on the same level as mathematics. Stevin 1586, p. 68. Cf. E. J. Dijksterhuis (ed.). 1955. *The Principal Works of Simon Stevin*. Amsterdam: Swets & Zeitlinger, vol. 1, p. 515.

[16] Cf. Reijer Hooykaas. 1963. *Das Verhältnis von Physik und Mechanik in historischer Sicht*. Wiesbaden: Steiner; Fritz Krafft. 1967. "Die Anfänge einer theoretischen Mechanik und die Wandlung ihrer Stellung zur Wissenschaft von der Natur", in: Walter Baron (ed.). *Beiträge zur Methode der Wissenschaftsgeschichte*. Wiesbaden: Steiner, pp. 12–33.

subject nor the term ‘mechanics’ are mentioned in Jesuit descriptions of the Western sciences as taught in European universities, such as the *Xixue fan* 西學凡 (General outline of Western learning), the *Zhifang waiji* 職方外紀 (Record of the places outside the jurisdiction of the Office of Geography) or the *Mingli tan* 名理探 (*Logica*). A short treatise entitled *Zhongxue* (Mechanics), which was at least partially compiled on the basis of the *Qiqi tushuo*, was included in Xue Fengzuo’s 薛鳳祚 (d. 1680) *Lixue huitong* 曆學彙通 (Collection of treatises on calendrical sciences).[17] The only other Jesuit work employing the term *zhongxue* seems to have been Ferdinand Verbiest’s (Nan Huairen 南懷仁, 1623–1688) *Xinzhi lingtai yixiang zhi* 新製靈臺儀象志 (Account on the new sets of observatory instruments, 1674), which drew on other mechanical terms first used in the *Qiqi tushuo* as well.[18]

After the Jesuit translation project had come to an end, the term *zhongxue* was used intermittently. The introduction of the greatly improved Western science of mechanics had to wait until 1857 when Protestant missionaries of the London Missionary Society began to publish their *Liuhe congtan* 六合叢談 (*Shanghae Serial*) at the Mohai shuguan 墨海書館 or Inkstone Press in Shanghai. Already the first issue of this publication made clear that one of the scientific topics to be introduced to the Chinese public would be ‘mechanics’ (*zhongxue*), which, like other physical sciences, was described as being “exhaustive to the extreme” and “refined in exploring the principles of things”.[19] Indeed, issues 13 and 14 of the *Liuhe congtan* contain the *Zhongxue qianshuo* 重學淺說 (Elementary introduction to mechanics), a text translated by Alexander Wylie (Weilie Yali 偉烈亞力, 1815–1887) and Wang Tao 王韜 (1828–1897) from *Chamber’s Information*

---

[17] Cf. Xue Fengzuo 薛鳳祚 (comp.). 1662. *Lixue huitong* 曆學彙通 (Collection of treatises on calendrical sciences). Beijing. I would like to thank Nicolas Standaert for drawing my attention to this work.

[18] Cf. Ferdinand Verbiest (Nan Huairen 南懷仁). 1993. *Xinzhi lingtai yixiang zhi* 新製靈臺儀象志 (Account on the new sets of observatory instruments). Reprinted in: *Zhongguo kexue jishu dianji tonghui*. *Tianwen juan* 中國科學技術典籍通彙・天文卷 (Anthology of classical works of Chinese science and technology: Astronomy). Edited by Ren Jiyu 任繼愈. Zhengzhou: Henan jiaoyu chubanshe, pp. 1–457, 21a. Another term which was used for ‘mechanics’ in this book was *qingzhongxue* 輕重學 (the study of the light and heavy). Cf. ibid., p. 23a. Other mechanical terms employed in both books include, for example, ‘centre of gravity’ (*zhongxin* 重心).

[19] Alexander Wylie (Weilie Yali 偉烈亞力). 1857. “Liuhe congtan xiaoyin” 六合叢談小引 (Preface to the *Shanghae Serial*), *Liuhe congtan* 六合叢談 1.1, pp. 1a-2b; 2a.

for the people and later published as an independent book.[20] The term *zhongxue* for 'mechanics' also figures prominently in two other works translated at the Mohai shuguan, namely as the title of a translation of William Whewell's *An Elementary Treatise on Mechanics* first published in 1859[21], and in a rendering of John F. W. Herschel's *Outline of Astronomy* published under the title *Tan tian* 談天 (On the heavens) in the same year.[22] The famous mathematician Li Shanlan 李善蘭 (1810–1882) was involved in both translations. Although *Zhongxue* was published later than *Zhongxue qianshuo*, it was probably in connection with the translation of Whewell's book, rendered into Chinese by Li and Joseph Edkins (Ai Yuese 艾約瑟 , 1823–1905), that the term *zhongxue* was first used again to translate 'mechanics'.[23] It is well known that Li Shanlan had approached the Mohai shuguan in 1852 because he wanted to complete the translation of Euclid's *Elements of Geometry*. Li had become interested in this work during the 1820s and regretted that only the first six books were available in Chinese.[24] According to his preface to the 1867 edition of *Zhongxue*, Li Shanlan "translated the geometry (*jihe* 幾何) in the morning and mechanics (*zhongxue* 重學) in the afternoon; both were finished simultaneously after two years."[25] This would suggest that the translation was already completed in 1854, and if so, it is very likely that others working at the Mohai shuguan used it as a reference for their own translations. This assumption seems to be corroborated by the similarity of the terminology employed. But why did Li Shanlan and Edkins choose to render the term 'mechanics' by *zhongxue* in the first place? While, as

---

[20] Alexander Wylie (Weilie Yali 偉烈亞力) and Wang Tao 王韜 (trs.). 1858. *Zhongxue qianshuo* 重學淺說 (An elementary introduction to mechanics). Shanghai: Mohai shuguan.

[21] Joseph Edkins (Ai Yuese 艾約瑟) and Li Shanlan 李善蘭 (trs.). 1859. *Zhongxue* 重學 (Mechanics). Shanghai: Mohai shuguan.

[22] Alexander Wylie (Weilie Yali 偉烈亞力) and Li Shanlan 李善蘭 (trs.). 1859. *Tan tian* 談天 (On the heavens). Shanghai: Mohai shuguan.

[23] Already in 1853, Zhang Wenhu 張文虎 (1808–1885) inquired about the translation of *zhongxue* in a letter to Li Shanlan. Cf. Zhang Wenhu 張文虎 . 1874. "Shuyishi chidu oucun" 舒藝室尺牘偶存 (Accidentally stored correspondence from the *Shuyi*-Studio), in: id. *Fupouji* 覆瓿集 . Nanjing: Yecheng binguan, 10.6b.

[24] Cf. Peter M. Engelfriet. 1998. *Euclid in China. The Genesis of the First Translation of Euclid's Elements Book I–VI (*Jihe yuanben. *Beijing, 1607) and its Reception up to 1723*. Leiden: Brill, pp. 447–8.

[25] Joseph Edkins (Ai Yuese 艾約瑟) and Li Shanlan 李善蘭 (trs.). 1867. *Zhongxue* 重學 (Mechanics). Shanghai: Meihua shuguan, "Preface", p. 1a.

outlined above, there were good reasons to translate the 'mechanics' (or 'statics') of the late sixteenth century as 'the study of weight', *zhongxue* seems to be a rather unlikely translation for Newtonian mechanics as presented in Whewell's work.[26] In the above mentioned preface to *Zhongxue*, Li Shanlan relates:

> The Western missionary Edkins asked me: Do you know about mechanics (*zhongxue*)? I replied: What does 'mechanics' mean? He said: Geometry (*jihe*) is the study of measurement, mechanics is the study of weighing (*quanheng zhi xue* 權衡之學).[27]

This suggests that Li Shanlan was not familiar with the term *zhongxue* which would seem very unlikely. Perhaps Edkins had used the English term for mechanics which Li then in hindsight rendered as *zhongxue* in his preface. In fact, in view of Li's interest in Western mathematics and geometry it is inconceivable that he had failed to notice the *Qiqi tushuo*.[28] That more than an accidental relationship existed between the *Qiqi tushuo* and later translations of mechanics can be seen from the continuity of some of the other terms employed, most notably *zhongxin* 重心 'centre of gravity', which plays an important part in the *Qiqi tushuo* and is also used in *Zhongxue*, and terms for simple machines such as *xiemian* 斜面 for 'inclined plane' or *ganggan* 槓桿 for 'lever', some of which are still in use today.[29]

Around 1860, *zhongxue* seemed set to become the standard translation for 'mechanics', similar to other terms first used in *Liuhe congtan*, e.g. *huaxue* 化學 for 'chemistry'. As I will discuss below, some scholars were aware that it was a technical term used to denote a

---

[26] In the first edition of his treatise, Whewell himself had defined mechanics as 'the science of force'. Cf. Crosbie Smith. 1976. "'Mechanical Philosophy' and the Emergence of Physics in Britain: 1800–1850", *Annals of Science* 33, pp. 3–29; 22.

[27] Edkins and Li Shanlan 1867, p. 1a.

[28] Li must have been aware of the 1844 reprint in the *Shoushange congshu* 守山閣叢書 by Qian Xizuo 錢熙祚 (died 1844) from Jinshan 金山 . Qian was well-known in the scholarly community of Jiangnan as a collector of books and thus surely known to Li. Moreover, in 1845 Li had met Zhang Wenhu 張文虎 who assisted Qian in editing the *Shoushange congshu*. Cf. Li Yan 李儼 . 1955. "Li Shanlan nianpu" 李善蘭年譜 (Chronological biography of Li Shanlan), in: id. *Zhongsuanshi luncong* 中算史論叢 (Collected writings on the history of Chinese mathematics). Beijing: Kexue chubanshe, vol. 4, pp. 333–61; 338; see also Ye Changchi 葉昌熾 . 1989. *Zangshu jishi shi* 藏書記事詩 . Shanghai: Shanghai guji chubanshe, pp. 641–5. Qian Xizuo's brother Qian Xifu 錢熙輔 , the printer of the 1859 edition of *Zhongxue*, was also a friend of Li's.

[29] There is even a direct reference to the *Qiqi tushuo* in *Zhongxue*. Cf. Joseph Edkins and Li Shanlan 1867, 16.14b.

clearly defined field of study, and soon the term was also employed outside the tiny 'scientific community'.

The seemingly smooth adoption of the term *zhongxue* was interrupted when W. A. P. Martin (Ding Weiliang 丁韙良 1827–1916) published his *Gewu rumen* 格物入門 (Introduction to the sciences) in seven volumes in 1868. The work, originally intended to serve as a textbook in a school established by Martin in Beijing, was soon used at the Tongwenguan and many other institutions throughout the country.[30] The collection (based on several Western sources) contains short treatises on the different branches of physics as well as an introduction to chemistry. Despite its rather poor quality[31], it proved tremendously influential, with at least one enlarged re-edition in China and reprints in Japan. The work contains one volume on mechanics entitled *Lixue rumen* 力學入門 (Introduction to mechanics). It is still unknown why Martin chose the term *lixue* 力學 (the study of force) to render 'mechanics'. It seems unlikely that he was unaware of earlier translations since he employs numerous terms used in the translations completed in connection with the Mohai shuguan.[32] One possible explanation is that Martin's book opens with an introduction to dynamics and the laws of motion and only in the second part explains the principles of statics and simple machines. Thus, he may have consid-

---

[30] Cf. Ralph Covell. 1974. *The Life and Thought of W. A. P. Martin. Agent and Interpreter of Sino-American Contact in the Nineteenth and Early Twentieth Century*. Ph.D. diss., University of Denver, pp. 233–4.

[31] The work was designed as a textbook and written in question-answer style. The poor quality of the presentation is particularly evident in the passage on the laws of motions, which is incomplete or almost incomprehensible and much less informed than the translation by Edkins and Li Shanlan. For example, Martin fails to note that the first law of motion is not only valid for moving bodies but also for bodies at rest. Cf. W. A. P. Martin (Ding Weiliang 丁韙良). 1868. "Lixue rumen" 力學入門 (Introduction to mechanics), in: id. *Gewu rumen* 格物入門 (Introduction to the sciences). Beijing: Tongwenguan, p. 1a.

[32] There is no doubt that Martin, even if he did not know the term *zhongxue*, became aware of it very soon. As is well known, Li Shanlan was appointed instructor at the Department of Mathematics and Astronomy of the Tongwenguan in 1868, shortly before Martin became the president of that institution. In a brief article on Li Shanlan, which was published in *Gezhi huibian* 格致彙編 (*The Chinese Scientific Magazine* [hereafter: *GZHB*]), Martin mentions Li's translation of *Zhongxue*. Cf. W. A. P. Martin (Ding Weiliang 丁韙良). 1877. "Li Renshu xiansheng xu" 李壬叔先生序 (A note on Mr. Li Shanlan), *GZHB* 6, p. 1. Already in 1875, Martin had used the term *zhongxue* in an article published in *Zhong-Xi wenjian lu* 中西聞見錄 (hereafter: *ZXWJL*), cf. id. 1875. "Bian di ju zhong shuo" 辯地居中說 (Refutation of the theory of the central position of the earth), *ZXWJL* 31, pp. 6a–8a; 32, pp. 7a–8b.

ered 'the study of force' as a more appropriate rendering of the term designating the discipline.

Interestingly, in 1883 Martin eventually felt the need to justify the introduction of *lixue*. In his *Gewu cesuan* 格物測算 (Scientific measurements and calculations), which was also used at the Tongwenguan, we find the following passage, that is still not very clear:

> *Lixue* in this books means *zhongxue*. *Zhongxue* is but one branch of mechanics (*lixue)* as a whole; *lixue* is in fact the basis of *zhongxue*.[33]

In spite of this new terminological competitor, *zhongxue* remained the most commonly used translation for 'mechanics' well into the 1880s. In some dictionaries, however, we can observe a tendency to give the term an additional, more specialized meaning. In these instances *zhongxue* was used not only for 'mechanics' but also for 'statics'.[34] Although this is in line with the original use of *zhongxue*, as suggested in the *Qiqi tushuo* (and perhaps mirroring Martin's view), the intentional creation of ambiguity was certainly not ideal, especially in view of the fact that a better solution had been proposed by Li Shanlan and Joseph Edkins in the 1850s. Li and Edkins had not only revived the term *zhongxue* for 'mechanics' but also elaborated a system of terms relating to the different sub-branches of the field by introducing the terms *dongzhongxue* 動重學 (the study of weights in motion) for 'dynamics', *jingzhongxue* 靜重學 (the study of weights at rest) for 'statics' and *liuzhi zhongxue* 流質重學 (fluid mechanics) for 'hydrodynamics' or 'hydrostatics'. This terminology prevailed until 1889 when John Fryer (Fu Lanya 傅蘭雅 , 1839–1928) decided to use *lixue* for 'dynamics'.[35] Thus, there were now two terms for 'mechanics' that could both be used to denote one of the sub-branches of the science at the same time. Some scholars soon realized that *zhongxue* and *lixue* referred to the same thing which is best demonstrated by the fact that

---

[33] W. A. P. Martin (Ding Weiliang 丁韙良). 1883. *Gewu cesuan* 格物測算 (Scientific measurements and calculations). Beijing: Jingshi tongwenguan. I would like to thank Guo Jinhai for drawing my attention to this passage.

[34] Cf. e.g. Wilhelm Lobscheid. 1866–1869. *Ying-Hua zidian* 英華字典 . *English and Chinese Dictionary, with Punti and Mandarin Pronounciation*. 4 vols. Hong Kong: Daily Press Office. Gustav Schlegel. 1886. *Nederlandsch-Chineesch Woordenboek met de Transcriptie der Chineesche Karakters in het Tsiang-Tsiu Dialekt*. 13 vols. Leiden: Brill, lists 'weegkunde' as an equivalent for *zhongxue*.

[35] Cf. John Fryer (Fu Lanya 傅蘭雅). 1889. *Lixue xuzhi* 力學須知 (Essentials of mechanics). Shanghai: Gezhi shushi, p. 1a: "*Lixue* means 'dynamics' (*lixue dongzhongxue ye* 力學動重學也)."

there was at least one collection of works on Western sciences which reprinted Martin's *Lixue rumen* but renamed it to *Zhongxue rumen* 重學入門. (Curiously the first line of this edition still reads: "What is discussed in *lixue*?").[36] Others, however, apparently believed that *zhongxue* and *lixue* referred to two independent sciences located on the same taxonomic level within the European system of knowledge.[37] One of the victims of this confusion was Liang Qichao 梁啟超 (1873–1929) who noted that in the West there were 'learned societies' (*xuehui* 學會) for all branches of knowledge, a system which should be emulated in China. Liang then claims that there were *zhongxuehui* 重學會 and *lixuehui* 力學會 in Europe, failing, however, to outline the scientific matters to which these societies were devoted.[38]

It is well-known that in many disciplines terminological standardization was achieved through the influence of books translated from the Japanese around and after the turn of the century. This was clearly not the case in mechanics.[39] Since all important early Chinese books on mechanics (including the *Gewu rumen*) had been reprinted in Japan,[40] even the authorative and standardizing dictionary *Butsuri-*

---

[36] Cf. W. A. P. Martin. 1897. "Zhongxue rumen" 重學入門 (Introduction to mechanics), in: *Zhong-Xi xinxue daquan* 中西新學大全 (Comprehensive collection of new knowledge in China and the West). Shanghai: Hongwen shuju.

[37] Cf. *Xifa cexue huiyuan* 西法策學匯源 (Compendium for answering policy questions on Western methods). 1898. Shanghai: Hongbao shuju.

[38] Cf. Liang Qichao 梁啟超 . 1896. "Lun xuexiao shisan" 論學校十三 (On schools, part 13), *Shiwubao* 10 (Nov. 1896), pp. 621–5.

[39] For example, some influential textbooks translated from Japanese offer *zhongxue* as a translation for 'mechanics'. Cf. Iimori Teizō 飯盛挺造 . 1900. *Wulixue* 物理學 (Physics). Translated by Fujita Toyohashi 藤田豐八 and Wang Jilie 王季烈 . Shanghai: Jiangnan zhizaoju, 1.6a. Others employ *lixue* as a rendering for either 'mechanics' or 'dynamics'. Cf. Donghua yishushe 東華譯書社 (tr.). 1903. "Wulixue wenda" 物理學問答 (Questions and answers on physics), in: id. (ed.) *Bianyi chuji jiaoyu baike quanshu* 編譯初級教育百科全書 (Encyclopaedia of translations for educational purposes, first collection). Shanghai: Huiwen xueshe, p. 12a; Nakamura Tamekuni 中村為邦 . 1906. *Jiangsu shifan jiangyi—wuli* 江蘇師範講義—物理 (Textbooks for normal schools in Jiangsu—Physics). n.p.: Jiangsu xuewuchu, 9.1.

[40] Cf. Yatsumimi Toshifumi 八耳俊文 . 1995. "Sei makki seijin choyaku kagaku kankei Chūgokusho oyobi wakokuhon shozai mokuroku" 清末期西人著訳科学関係中国書および和刻本所在目録 (Chinese books related to science, translated by foreigners in the late Qing—with indications of Japanese holdings), *Kagakushi kenkyū* 22, pp. 312–58; see also Shen Guowei 沈國威 . 1999. "Kaidai—Kindai tōsei (Ō–Chū–Nichi) bunka kōryūshi kenkyū no shiryū to shite no *Rokugō sōdan*" 解題—近代東西（欧—中—日）文化交流史研究の資料としての六合叢談 (Synopsis—The *Shanghae Serial* as material for research on cultural exchanges between Europe, China and Japan in the

gaku jutsugo Wa-Ei-Futsu-Doku taiyaku jisho 物理學術語和英佛獨對譯字書 (Japanese-English-French-German dictionary of physical terms)—a collaborative effort of all important physicists in Japan published in 1888—failed to provide a convincing solution for the designation of the field. It offers *jūgaku* (Ch. *zhongxue* 重學) for 'mechanics' and *rigaku* (Ch. *lixue* 力學) for 'dynamics' while referring to 'statics' as *seirikigaku* (Ch. *jinglixue* 靜力學).[41] The eventual shift to *lixue* as the standard translation for 'mechanics' in China did not occur until around 1910. One important step in this development was the substitution of *lixue* for *zhongxue* in the ingenious system for naming the sub-branches of mechanics invented by Li Shanlan and Joseph Edkins, which took place between 1906 and 1908: 'mechanics' was now referred to as *lixue* 力學, 'dynamics' as *donglixue* 動力學 and 'statics' as *jinglixue* 靜力學.[42] Most dictionaries, however, continued to offer older renderings as well.[43] The system was only fully adopted in the standardizing dictionaries compiled in the 1930s

---

[40] (*cont*.) modern period), in: id. (ed.). Rokugō sōdan *no gakusaiteke kenkyū* 六合叢談の学際的研究 (Studies on the academic aspects of the *Shanghae Serial*). Tokyo: Hakuteisha, pp. 1–47.

[41] Butsurigaku yakugo kai 物理學譯語會 (comp.). 1888. *Butsurigaku jutsugo Wa-Ei-Futsu-Doku taiyaku jisho* 物理學術語和英佛獨對譯字書 (Japanese-English-French-German dictionary of physical terms). Tokyo: Hakubunsha. For the compilation of this dictionary and the emergence of modern physics in Japan, cf. Kenkichiro Koizumi. 1975. "The Emergence of Japan's First Physicists: 1868–1900", *Historical Studies in the Physical Sciences* 6, pp. 3–108. Newtonian mechanics had been introduced to Japan within the framework of 'Dutch learning' (*Rangaku* 蘭學) in the late eighteenth century. The terminology employed has apparently not left many traces. Cf. Yoshida Tadashi. 1974. *The Rangaku of Suzuki Tadao: The Introduction of Western Science in Tokugawa Japan*. Ph.D. diss., Princeton University.

[42] W. W. Yen (Yan Huiqing 顏惠慶). 1908. *An English and Chinese Standard Dictionary, comprising 120,000 words and phrases, with translations, pronunciations, definitions, illustrations, etc., etc. with a copious Appendix*. Shanghai: Commercial Press. This system had been suggested *in nuce* by Chang Fuyuan in 1906. Philip Magnus' *Lessons in Elementary Mechanics*, on which Chang and Yan Wenbing's translation was based, treated statics as dependant on the laws of dynamics. Chang was nonetheless unable to provide a convincing distinction between mechanics and dynamics. He was actually so confused by the terminological situation that he proposed a completely new terminology which he refrained from applying, however, even in his own work. Cf. Yan Wenbing 嚴文炳 and Chang Fuyuan 常福元 (trs.). 1906. *Lixue kebian* 力學課編 (Textbooks on mechanics). Beijing: Xuebu bianyi tushuju, pp. 1a–b.

[43] Cf. Karl Hemeling. 1916. *English-Chinese Dictionary of the Standard Chinese Spoken Language* (*Guanhua* 官話) *and Handbook for Translators*. Shanghai: Statistical Department of the Inspectorate of Customs.

whose terminological suggestions have for a very large part remained in use until today.[44]

2. What did *zhongxue* or *lixue* mean?

Even in this early stage in the introduction of Western sciences, some Chinese scholars had a deeper understanding of the new knowledge. Xu Shou 徐壽 (1818–1884) and Hua Hengfang 華蘅芳 (1833–1902) not only frequently discussed questions of scientific content but also conducted their own experiments. Xu Shou even managed to publish one of his papers in the prestigious British periodical *Nature*.[45] Li Shanlan, although not belonging to this 'coterie' from Wuxi, was definitely an outstanding scientist as well. He was the most renowned mathematician of his time, and after joining the Mohai shuguan he worked intensively on mathematics, mechanics, astronomy and botany.[46] His translation of Whewell's *Mechanics* is of impressive quality, and Li tried his best to make it digestible to his Chinese readers by supplementing, for example, the original algebraic symbols with notations adopted from the traditional *tianyuan* 天元 method.[47] In the course of translating *Mechanics* Li seems to have developed a genuine interest in the subject. Only a few years later, he set out to translate Isaac Newton's *Principia* with Alexander Wylie and John Fryer. However, this endeavour was never completed, and the finished parts of the translation were never published.[48] Li Shanlan's interest in mechanics was of course related to his interest in mathematics and astronomy. He was aware that Western mechanics was a highly mathematized sci-

---

[44] Cf. Sa Bendong 薩本棟 (ed.). 1932. *Wulixue mingcihui* 物理學名詞彙 (English-Chinese vocabulary of physics). Beiping: Zhonghua jiaoyu wenhua jijin dongshihui bianji weiyuanhui; Guoli bianyiguan 國立編譯館 (ed.). 1934. *Wulixue mingci* 物理學名詞 (Terminology of physics). Shanghai: Shangwu yinshuguan.

[45] Cf. David Wright. 1996. *Translating Science: Chemistry and the Transmission of Western Science into Late Imperial China, 1840–1900*. Ph.D. diss., University of London, pp. 103–30.

[46] For a biography of Li Shanlan, cf. Horng Wann-sheng. 1991. *Li Shanlan: The Impact of Western Mathematics in China During the Late 19th Century*. Ph.D. diss., City University of New York.

[47] Cf. the article by Andrea Bréard in this volume.

[48] Cf. Han Qi 韓琦 . 1998. "Shuli gezhi de faxian —jian lun 18 shiji Niudun xiangguan zhuzuo zai Zhongguo de chuanbo" 數理格致的發現—兼論 18 世紀牛頓相關著作在中國的傳播 (The discovery of the first Chinese translation of Newton's *Principia*), *Zhongguo keji shiliao* 19.2, pp. 78–85.

ence, and it was probably the application of mathematical procedures that particularly attracted him to the field. At any rate, for many late Qing scholars *Zhongxue* was closely related with Li Shanlan's name, and this may be one of the reasons why mechanics was classified under the mathematical sciences in some contemporary collections.[49]

Mathematicians were indeed the first to display serious interest in mechanics. The first 'independent' treatises on Western mechanics were written by the famous mathematician Gu Guanguang 顧觀光 (1799–1862) around 1860. Although little more than a synopsis of *Zhongxue*, these treatises show that it was indeed possible to understand mechanical problems on the basis of Li Shanlan's translation—at least to a certain extent.[50] In general, however, it is difficult to find texts confirming 'scientific practice' related to mechanics. Of course, mechanical propositions were used in the important field of ballistics. For instance, Li Shanlan himself had exploited his *Zhongxue* for a short treatise entitled *Huoqi zhenjue* 火器真訣 (The real art of firearms).[51] And a certain Yin Zhilu 殷之輅 included the following explanation in his answer to an examination question on the ballistic curves of cannonballs:

> The ballistic curve is the result of the composition of three different forces. This is a necessary mechanical principle (*zhongxue zhi li* 重學之理) that cannot be changed. One force is called the 'weight and velocity of the projectile' (*danxing benzhong suli* 彈行本重速力), one is called the 'gravitational force of the earth's centre' (*dixin xiyinli* 地心吸引力)

---

[49] Cf. e.g. *Huangchao jingshiwen xubian* 皇朝經世文續編 (Sequel to the collected writings on statecraft). 1888. Edited by Ge Shijun 葛世濬 . Shanghai: Tushu jichengju.

[50] Gu Guanguang, for example, failed to notice the fundamental importance of Newton's laws of motion—he only mentions the first law. Cf. Gu Guanguang 顧觀光 . 1888. "Jingzhongxue ji" 靜重學記 (A memoir of statics); id. "Dongzhongxue ji" 動重學記 (A memoir of dynamics); id. "Liuti zhongxue ji" 流體重學記 (A memoir of fluid mechanics); and id. "Tianzhongxue ji" 天重學記 (A memoir of celestial mechanics), all in: *Huangchao jingshiwen xubian*, 7.3a–10a.

[51] This book was probably completed as early as 1858. It was first published in 1867 in Li Shanlan's collection of mathematical writings, the *Zeguxizhai suanxue* 則古昔齋算學 (Mathematics from the *Zeguxi*-Studio), Nanjing. An edition with notes by Shen Shanzheng 沈善蒸 was privately published as *Huoqi zhenjue jiezheng* 火器真訣解證 in 1883. Li Shanlan's reference to *Zhongxue* is on p. 10a of this edition. See also Liu Dun 劉頓 . 1984. "Bie ju yige de tujiefa dandaoxue. Jieshao Li Shanlan de 'Huoqi zhenjue'" 別具一格的圖解法彈導學・介紹李善蘭的《火器真訣》(Ballistics with a unique graphic method. A presentation of Li Shanlan's *Huoqi zhenjue*), *Lixue yu shijian* 3, pp. 60–3.

> and the third is called 'atmospheric resistance' (*kongqi zuli* 空氣阻力).[52]

More successful applications of mechanical principles can be found in texts on astronomy. However, these tended to draw on *Tan tian* rather than on specialized books about mechanics. To be certain, mechanics was taught at different institutions which transmitted 'Western knowledge', for example, the schools attached to the Fuzhou Shipyard. But we still do not exactly know how it was taught; it seems that instruction was mainly carried out in French and English.[53] The situation at the Tongwenguan in Beijing was similar.[54] From examination papers published in *Zhong-Xi wenjian lu* we know that questions on mechanical topics were asked in Chinese and English, and that there were students who were able to answer questions on specific weight[55], calculate the centre of gravity[56] and even solve the problem of which velocity a cannonball needs in order not to fall back on the earth (i.e. the escape velocity neglecting the resistance of the air).[57]

On the whole, a successful and 'creative' reception of Western mechanics seems to have been the exception rather than the rule. Of course, mechanics was regarded as an important element of 'Western knowledge' and thus many scholars would refer to it when describing the educational system of the 'West', discussing the usefulness or even superiority of 'Western knowledge' and advocating the need to adopt it more thoroughly in order to strengthen the country. One of

---

[52] Yin Zhilu 殷之輅 . 1898. "Qiangpao qu zhun suanfa kao" 鎗砲取準算法考 (Mathematical methods for calculating the targets of guns and cannons), in: *Huangchao jingshiwen sanbian* 皇朝經世文三編 (Third collection of writings on statecraft). Edited by Chen Zhongyi 陳忠倚 . n.p.: Baowen shuju, 9.9b–12a. The text was originally written for an examination at the Shanghai Polytechnic.

[53] Cf. Lin Chongyong 林崇墉 . 1987. *Shen Baozhen yu Fuzhou chuanzheng* 沈葆楨與福州船政 (Shen Baozhen and the Fuzhou Shipyard). Taibei: Lianjing chuban shiye gongsi, pp. 478–80.

[54] At the Tongwenguan, younger students were taught in foreign languages. Their education included a course in *gewu* 格物 'the investigation of things', here probably meaning 'physical sciences'. Older students were taught in Chinese. They had to take courses such as "Introduction to the sciences" (*gewu rumen* 格物入們) and "Measuring and calculation in mechanics" (*zhongxue cesuan* 重學測算). Cf. Zhu Youhan 朱有瓛 (ed). 1983. *Zhongguo jindai xuezhi shiliao* 中國近代學制史料 (Historical sources on the modern Chinese education system). 4 vols. Shanghai: Huadong shifan daxue chubanshe, vol. 1, pt. 1, pp. 71–3.

[55] Cf. *ZXWJL* 8 (March 1873), pp. 16a–b.

[56] Cf. *ZXWJL* 23 (June 1874), pp. 6a–9a.

[57] Cf. *ZXWJL* 25 (September 1874), pp. 6b–7b.

the earliest references to *zhongxue* independent of a translation is to be found in Feng Guifen's 馮桂芬 (1809–1874) essay "On the adoption of Western learning" (*Cai xixue yi* 采西學議), written during the late Xianfeng era and commonly regarded as an influential text by a reform-minded traditional scholar. This short essay does not say anything about the contents of *zhongxue* but remarks that it, similar to all 'Western knowledge', is based on mathematics.[58] The famous scholar and official Zheng Guanying 鄭觀應 (1842–1922) mentions mechanics several times, sometimes employing the term *zhongxue* and sometimes referring to it as *lixue*. But he also explains only that mechanics is based on mathematics. In one passage he glosses the term *lixue* stating that "*lixue* is that which examines into the power (or force *liliang* 力量) of all things". Such a 'definition' suggests that Zheng had a very limited understanding of mechanics (or for that matter *lixue*), and it is a pity that he did not gloss *zhongxue* as well, which he mentioned in the same text only a few lines before.[59]

Attempts to provide a more complete picture of mechanics in early efforts at popularizing 'Western knowledge' often entailed descriptions of the historical development of the science. Archimedes was mentioned frequently, in particular his application of mechanical principles for warfare. Galilei, Wallis, Huygens and Newton were recognized as important figures in the history of mechanics but not necessarily for the achievements they are normally associated with in the West. For example, Wang Tao wrote in his preface to *Zhongxue qianshuo*:

> The man who examined the length of the route of a projectile, the movement of water and liquids as well as the principle of the mutual attraction of the force of things was the Englishman Newton.[60]

Others related Western mechanics mainly to devices employing the principle of pressure and thus emphasized the role of figures like

---

[58] Cf. Feng Guifen 馮桂芬 . 1998. *Jiaobinlu kangyi* 校邠廬抗議 (Protest notes from the *Jiaobin*-Studio). Zhengzhou: Zhongzhou guiji chubanshe, pp. 209–13.

[59] Zheng Guanying 鄭觀應 . 1998 [1894]. "Xuexiao shang" 學校上 (On schools, part 1), in: id. *Shengshi weiyan* 盛世危言 (Words of warning in a prosperous age). Zhengzhou: Zhongzhou guji chubanshe, p. 61.

[60] Wang Tao 王韜 and Alexander Wylie. 1889. *Zhongxue qianshuo* 重學淺説 (An elementary introduction to mechanics), in: Wang Tao. *Taoyuan xixue jicun* 弢園西學輯存 (Wang Tao's collection of Western knowledge). Shanghai. Cf. also "Zhongxue chuangshi zhi ren" 重學創始之人 (The founder of mechanics). 1902, in: *Zhong-Xi jingji celun tongkao* 中西經濟策論通考 (Comprehensive compendium for answering policy questions concerning China and the West). Shanghai, 30.1b.

Toricelli, Pascal, Boyle and Marriot.[61] Sometimes, confusion was brought about by ambiguous transliterations. For example, a certain Zhu Chengxu 朱澄敍 wrote about the Englishman 'Naiduan' 奈端 :

> He examined how matter moved in fluids and the principles of resistance. … Naiduan researched the lifting of water by steam and invented several machines that make use of steam. He was also able to find out the accurate number for the resistance of bodies moving in the wind.[62]

Although such confusion between Newcomen, the inventor of the atmospheric steam machine[63], and Newton was definitely an exception, it indicates that many of those who wrote about mechanics and invariably stressed the importance of the science to push China further on her road to wealth and power did not look very carefully into the available information. Even if Li Shanlan's *Zhongxue* was mentioned, the impression remains that in most cases only the preface to the later editions, written by Li alone, was read and the rest of the book skimmed at best. A certain Che Shancheng 車善呈 , for example, who explicitly claimed to present the contents of the book, noted in respect to dynamics: "It deals with fluids, fire, wind boats, guns and cannons, spheres, seconds pendulums and the like."[64] Indeed, all these things and phenomena are mentioned in *Zhongxue* but most of them have only an illustrative function and are by no means central to the book. What is clear, however, is that since the 1880s mechanics—even if referred to as *zhongxue*—was increasingly associated with forces. Less clear was with which forces and how these forces were related. Quite common was the following view:

> The sun is the origin of all forces. It is because of this that there is the force of mutual attraction between the stars, that there is the attracting

---

[61] Cf. Zhu Chengxu 朱澄敍 . 1898. "Gezhi wen" 格致問 (Questions on the sciences), in: *Qiangxue huibian* 強學彙編 (Collection of knowledge that makes strong). Edited by Ma Guanqun 馬冠群 . Shanghai: Wenruilou, 7.1a–2a.

[62] Ibid. Originally, this text had been an examination essay for the *Gezhi shuyuan* in spring 1889. Curiously, the curator Wang Tao had failed to notice the mistake.

[63] The phonetic transcription of Newton given above was rather frequent. Newcomen, a less prominent figure in China, was mostly referred to as Niu Guomin 牛國民 , e.g. in W. A. P. Martin 丁韙良 . 1895. "Qiji rumen" 汽機入門 (Introduction to steam engines), in: *Xixue dacheng* 西學大成 (Great anthology of Western knowledge). Edited by Wang Xiqing 王西清 and Lu Tiqing 盧梯青 .Shanghai: Zuiliutang, p. 2a.

[64] Che Shancheng 車善呈 . 1898. "Gezhi zhi xue fanyi zhi shu lun" 格致之學翻譯之書論 (On scientific books in translation), in: *Qiangxue huibian* 強學彙編 , 7.10a–13a; 11a.

> and moving force of the centre of the earth, the pulling and pressing force of waves, the exciting force of the wind and the atmosphere, the expansive force of water when evaporating into steam and the burning force of heat. It comprises the conducting force of electricity and chemical affinity. These are all great manifestations of force. Because of this, Westerners have managed to manufacture devices which support force- and rely on it. Thus, the force of one hair can lift 1,000 *jun*[65] and the hand of one worker can move 10,000 *dan*.[66]

As outlined above, we are not well informed about educational practices in mechanics. We can be fairly certain that there were more men who were able to discuss mechanical problems in a 'scientific' way. We need to be aware, however, that in popular treatises and publications mechanics was mostly discussed in the way I have just described. More importantly, it was such treatment of 'mechanics' that was popularized through numerous reprints of influential collections on Western knowledge in the late nineteenth century.

Equally wide-spread was a discourse that related Western mechanics to developments in Chinese intellectual history. This discourse became known as the theory of "the Chinese origins of Western sciences" (*Xixue Zhongyuan* 西學中源) and has commanded extensive scholarly attention. Its conceptional origins and the imperial endorsement by the Kangxi emperor are well-known. The application of the *Xixue Zhongyuan* theory in the nineteenth century has been convincingly described by Quan Hansheng.[67] The theory was most important in mathematics and astronomy, especially because Western 'algebra' was taken to be a 'method from the east' (*donglaifa* 東來法). In the nineteenth century, it was expanded to cover almost the entire range of Western knowledge, including Christianity, which was said to have its origins in the Mohist notion of 'all-embracing love' (*jian'ai* 兼愛).[68] Of course, the *Xixue Zhongyuan* theory was also applied to mechanics. Even though, as suggested above, the *Qiqi tushuo* had not been well received in China, Ruan Yuan 阮元 (1764–1849) had read it and

---

[65] This is a transformed proverb: *qian jun yi fa zhi ji* 千鈞一髮之際 "hanging a heavy weight by a hair", i.e. a 'desperate crisis'.

[66] "Xixue gujin bian" 西學古今辨 (Debating Western learning in the past and present). 1898, in: *Huangchao jingshiwen sanbian*, 11.6b–8a; 7b.

[67] Cf. Quan Hansheng 全漢昇. 1935. "Qingmo de Xixue yuanchu Zhongguo shuo" 清末的西學源出中國說 (The late Qing theory of the Chinese origin of Western knowledge), *Lingnan xuebao* 4.2, pp. 57–102.

[68] This was apparently first proposed by Huang Zunxian 黃遵憲 . Cf. Quan Hansheng 1935, p. 69.

referred to it at around 1820 when explaining the Chinese origins of the 'automatic striking clock' (*zimingzhong* 自鳴鍾):

> The clocks come from the West, but the principle of manufacturing them is derived from the water clock. … Clocks were manufactured already prior to the Song, but this knowledge was not transmitted. The major merit of manufacturing instruments in the West is called mechanics (*zhongxue* 重學). Mechanics studies heaviness and lightness. All the wonderful machines (*qiqi* 奇器) are derived from it, and its applications are called wheel and screw. For this reason, the principle of the automatic striking clock is mechanics and that which is used for application are wheels and screws. The water-clocks of old had reservoirs of water which gradually diminished as it dripped down and made the wheel turn. Thus, water was gradually diminished from the heavy to the light. … If one summarizes the principles [of the clock described in the passage before], then they are all derived from heaviness being reduced to lightness. For this reason, the discipline is called 'mechanics' or 'the study of weight' (*zhongxue*). This device is derived from the old water-clocks and did not originate in the West.[69]

The point which is of interest here is that Ruan Yuan employed the term *zhongxue* that was not mentioned in the negative review of the *Qiqi tushuo* in the *Siku quanshu tiyao* (Abstracts of works in the *Imperial Library of the Four Treasuries*).[70] Since Ruan reduces mechanics to the principle of reducing heaviness to lightness, the term *zhongxue* was appropriate as a designation for this allegedly Western science, and his argument would have suffered had he used the term *liyi* which was applied in the *Siku quanshu tiyao*. Ruan's text was quoted later as proof of the Chinese origin of Western mechanics.[71]

The most important feature of the *Xixue Zhongyuan* theory was the connection drawn between Western sciences and the relevant chapters of the *Mozi,* especially the *Canon* (*jing* 經) and the *Explanations to the Canon* (*jingshuo* 經說). Probably the first author to do so was Zou Boqi 鄒伯奇 (1819–1869), an eminent mathematician and specialist of

---

[69] Ruan Yuan 阮元 . 1964. "Zimingzhong shuo" 自鳴鍾說 (On the automatic striking clock), in: id. *Yanjingshi ji* 揅經室集 (The works of Ruan Yuan). Taibei: Shijie shuju, 5.649–50. A rather faulty translation of the text is in Joseph Needham 1965, pp. 525–7.

[70] Cf. "Qiqi tushuo tiyao" 奇器圖說提要 (Abstract of the *Qiqi tushuo*). 1993, in: *Qinding siku quanshu tiyao* 欽定四庫全書 提要 (Abstracts of works in the *Imperial Library of the Four Treasuries*). Reprinted in: *Zhongguo kexue jishu dianji tonghui*. *Jishu juan*, p. 601.

[71] Cf. e.g. "Zhongxue shi yu zhongbai" 重學始於鍾擺 (Mechanics starts with the pendulum). 1902, in: *Zhong-Xi jingji celun tongkao*, 30.1b.

optics, who was the first Chinese to assemble a camera.[72] His main interest in the *Mojing* were obviously the passages on optics, but Zou also found a connection between mechanics and the *Mozi*. In a certain sense, he therefore deserves to be called the 'founding father of the historiography of Chinese mechanics':

> Mechanics (*zhongxue* 重學) means to lift heavy [things] as if they were light. This is explained in greatest detail in Schreck's *Qiqi tushuo* and Verbiest's *Lingtai yixiang tuzhi*. But its general principles can also be found in the *Mozi*. In the second part of the *jingshuo* (*Explanations* B), there is a passage on carrying [weights] on a crossbar (*zhao fu hengmu* 招負衡木) and this is the method of lifting weights (*shengzhongfa* 升重法); in addition, there is a passage on the two high wheels (*liang lun gao* 兩輪高) and this is the method of revolving weights.[73]

These two passages from the *Mozi* were later referred to as early examples of mechanical thinking and the application of mechanical principles in China. Chen Li 陳澧 (1810–1882), a friend of Zou Boqi's, added another example in his *Dongshu dushu ji* 東塾讀書記 (Reading notes by Chen Li): "There is effort involved in lifting from above, none in pulling" (*na you li ye yin wu li ye* 挈有力也引無力也). He suspected that this was similar to the 'Western method of lifting weights' (*Xiren qizhong zhi fa* 西人起重之法), but he was cautious enough to note that the original text was mutilated, corrupt and difficult to explain: "It is a pity that Tefu [i.e. Zou Boqi] has passed away. Surely he would have been able to interpret it."[74]

Until the end of the nineteenth century the importance of the *Xixue Zhongyuan* theory grew in proportion to the amount of information on Western sciences available in China. A very influential text for the *Xixue Zhongyuan* discourse seems to have been Huang Zunxian's 黃遵憲 (1848–1905) *Riben zashi shi* 日本雜事詩 (Poems on miscellaneous subjects from Japan), which was published in 1880. Describing the teaching of Western sciences in Japan, Huang notes: "I have investigated into Western learning and have found that it is the learn-

---

[72] Cf. Li Di 李迪 and Bai Shangshu 白尚恕 . 1984. "Woguo jindai kexue xianqu Zou Boqi" 我國近代科學先驅鄒伯奇 (Zou Boqi—a pioneer of modern science in China), *Ziran kexueshi yanjiu* 4, pp. 378–90.

[73] Zou Boqi 鄒伯奇 . "Lun Xifa jie gu suoyou" 論西法皆古所有 (All Western methods were already present in the past), quoted from Quan Hansheng 1935, p. 65.

[74] Chen Li 陳澧 . 1965. *Dongshu dushu ji* 東塾讀書記 (Reading notes by Chen Li). Taibei: Taiwan Shangwu yinshuguan, 12.207. Cf. A. C. Graham. 1978. *Later Mohist Logic, Ethics and Science*. Hong Kong, London: The Chinese University Press, p. 71.

ing of Mo Di".[75] He was apparently the first to refer to the *Mojing* passage:

> 均髮均懸輕重而髮絕不絕也均其絕也莫絕。
> If hairs support equal weights and, even though the weights are light, one hair snaps, then this is because the hairs are unequal. If you had equalized the one that snapped, none would have snapped.[76]

And Huang added: "This is the ancestor of mechanics (*zhongxue*)". This passage was to become very popular. It was taken up shortly afterwards by Zhang Zimu 張自牧 (1833–1886) in his "Yinghai lun" 瀛海論 (Discourse on the maritime powers) and quoted by many other Chinese scholars.[77] The second passage cited by Zhang Zimu to support his case is in my opinion unintelligible and therefore untranslatable since it is a 'collage' of three different parts of the *Mojing*. It reads as follows:

> 一少於二而多於五説在重非半弗斬倍二尺餘尺去其一[78]

Neither Qian Linzhao nor Graham think that these passages have anything to do with mechanics. One might speculate that the significance of this (forged) passage lies in the character *zhong* 重, given in the

---

[75] Huang Zunxian 黃遵憲. 1981. Riben zashi shi *guangzhu* 日本雜事詩廣註 (Annotated edition of the Poems on miscellaneous subjects from Japan). Changsha: Hunan renmin chubanshe (*Zou xiang shijie congshu—From East to West: Chinese Travellers before 1911*), p. 97

[76] Huang Zunxian 1981, p. 97. My translation follows Graham 1978, p. 421. It is insofar not quite correct as it includes, following Huang Zunxian, the first character of the *Explanation* which, as Liang Qichao discovered, only serves as a signpost to relate the *Explanation* to the relevant passage of the *Canon*. In Huang's version the passage is actually closer to the parallel phrase in *Liezi* (ch. 5). We should note that the original passage in the *Mojing*, in contrast to the *Liezi*, does not include the character *zhong* 重. Joseph Needham offers a completely different translation and explanation. Cf. id. 1962. *Science and Civilisation in China. Vol. IV: Physics and Physical Technology. Part 1: Physics*. Cambridge: Cambridge University Press, p. 28. Qian Linzhao (who was not consulted by Graham) argues that the character *zhong* must be excluded and explains the passage in terms of 'equilibrium'. Cf. Qian Linzhao 錢臨照. 1942. "Shi Mojing zhong guangxue lixue zhu tiao" 釋墨經中光學力學諸條 (Expositions of optics and mechanics in the Mohist *Canon*), in: *Li Shizeng xiansheng liushi sui jinian wenji* 李石曾先生六十歲紀念文集 (Essays commemorating the sixtieth birthday of Mr. Li Shizeng). Kunming: Guoli Beiping yanjiuyuan, pp. 135–62; 158.

[77] Cf. Zhang Zimu 張自牧. 1877–1897. "Yinghai lun" 瀛海論 (Discourse on the maritime powers), in: Wang Xiqi 王錫祺 (ed.). *Xiaofanghuzhai yudi congchao* 小方壺齋輿地叢鈔 (Collected country surveys from the *Xiaofanghuzhai*-Studio). Shanghai: Zhuyitang, vol. 11, pp. 483–95; 488.

[78] The passage is put together from *Canon* B 59, B 60 and *Canon* A 60.

original as *jian* 建 (which in a handwritten text could easily be misread as 重).[79] The obscurity of the passage did not deter others from using it, and it was included partly or in full into other writings[80], for instance, by Zheng Guanying[81] or by Wang Tao in the preface for the new edition of his *Zhongxue qianshuo,* which was included into his own collection on Western sciences published in 1889.[82] Wang may have copied it from an examination essay at the Shanghai Polytechnic where he served as a curator.[83]

The discovery of Western sciences in the *Mojing* sparked considerable excitement. In spring 1894, an examination question from the Shanghai Polytechnic demanded proof and explanations for references to calendrical, optical and mechanical sciences in the first part of the *Canon* and the *Explanations*. This was certainly a daunting task. In 1890, Xue Fucheng 薛福成 (1838–1894) had noted that optics and mechanics originated from the second part of the *Mojing*[84], and indeed most modern exegetes find mechanical thinking here. Chen Hanzhang 陳漢章 who won the contest declared that in former times the *Mojing* could not be explained because "Western learning was not clear". Obviously convinced that the situation had improved greatly,

---

[79] The most plausible explanation may be that Zhang Zimu had read Huang Zunxian's text rather superficially. The above mentioned text can be found in Huang Zunxian's *Riben zashi shi* directly after his explanation of mechanics. Huang, however, does not quote it as proof of the existence of mechanics in the *Mojing* but as an example for mathematics. Cf. Huang Zunxian 1981, p. 97.

[80] I have come across only one person who criticizes this frequent misquotation: Yin Zhilu 殷之輅 in an examination essay for the *Gezhi shuyuan* in 1894. Cf. *Gezhi shuyuan keyi* 格致書院課藝 (Examination essays from the Shanghai Polytechnic), Spring 1894. Shanghai: Shanghai tushu jicheng yinshu ju, p. 6a.

[81] Zheng Guanying 鄭觀應 . 1998. "Xixue" 西學 (Western knowledge), in: id. *Shengshi weiyan*, pp. 73–8.

[82] Cf.Wang Tao and Alexander Wylie 1889, "Preface" by Wang Tao.

[83] Cf. Peng Ruixi 彭瑞熙. 1887. "Gezhi zhi xue Zhong-Xi yi tong lun" 格致之學中西異同論 (On differences and similarities between Chinese and Western science), in: *Gezhi shuyuan keyi*, Spring 1887. The fact that Wang Tao included this passage into his work on mechanics without giving further explanations evidently conflicts with Cohen's opinion that Wang Tao did not like the *Xixue Zhongyuan* theory. Cf. Paul A. Cohen. 1974. *Between Tradition and Modernity: Wang T'ao and Reform in Late Ch'ing China*. Cambridge, Mass.: Harvard University Press, p. 180.

[84] Cf. Xue Fucheng 薛福成 . 1985. *Chushi Ying Fa Yi Bi siguo riji* 出使英法義比四國日記 (Diary of my diplomatic mission to the four states England, France, Italy and Belgium). Changsha: Yuelu chubanshe (*Zou xiang shijie congshu—From East to West: Chinese Travellers before 1911*), p. 252.

he found numerous examples from the first part of the *Canon* and the *Explanations*, for example in the following passage:

> 經云舉擬實也說云舉告以文名舉彼實也[85]

From a modern perspective, it seems impossible to translate this passage in the sense of mechanics. It is commonly considered as one of the parts in the *Canons* related to 'logical thinking', explaining the practice of *ju* 舉, i.e. employing a written concept to describe an 'actuality' (*shi* 實). In Chen's opinion, the passage was the origin of the 'simple machines' (*zhuli* 助力) which he explains as follows:

> The mass/matter (*tizhi* 體質) of all things is solid (*shi* 實). For lifting solid bodies there are simple machines like lever, pulley, wheel, axle, and the like.[86]

It seems that Chen selected this passage because it contained the words *ju* which can mean 'to lift up' and *shi* that can mean 'solid'. His arguments were based on rather crude analogies drawing on some suspected 'key terms' of mechanics, such as *ju* and *shi* in this case and *zhong* 重 'weight' and *dong* 動 'motion' further on in the text. Such arguments were only possible due to the unintelligibility and the lack of a commonly accepted interpretation of the *Mojing*.

More to the point was the essay written by Wang Fucai 王輔才 who came second in the examination:

> *Canon* A says: Force is that which causes shaped things to move (*li xing zhi suo yi fen ye* 力形之所以奮也). *Explanation* A says: Weight is a force. The falling of one thing, or the lifting of another, is motion due to heaviness (*li zhong zhi wei xia yu zhong fen ye* 力重之謂下與重奮也).[87] These are all principles of mechanics (*zhongxue*). The starting

---

[85] Cf. *Canon* A 31 and A 32.

[86] Chen Hanzhang 陳漢章. 1894. "Mozi jingshang ji shuoshang yi you Xiren suoyan lixue guangxue zhongxue zhi li qi tiao ju shu zheng yi wen" 墨子經上及說上已有西人所言歷學光學重學之理其條舉疏證以聞 (Find and prove passages in the first part of the *Canon* and the *Explanation* in the *Mozi* which already refer to the principles of calendar science, optics and mechanics that the Westerners talk about), in: *Gezhi shuyuan keyi*, Spring 1894, pp. 2a–3a.

[87] The translation follows Needham 1962, p. 19. Not surprisingly, there are several interpretations of this passage. Not all agree that it deals with mechanics. At least one modern author argues that it shows that Mozi knew about the gravitational force. See Yang Xianggui 楊向奎. 1997. "'Moxue yu dangjin shijie' congshu xuyan" 墨學與當今世界叢書序言 (Preface to the anthology *Mohism and the present world*), in: Zhuang Chunbo 莊春波. *Moxue siwei fangshi de fazhan* 墨學思維方式的發展 (The development of the forms of thinking in Mohism). Beijing: Zhongguo shudian, pp. 1–6; 1.

> point of mechanics is force. Something which is at rest moves when exposed to a force, and something which moves comes to rest when exposed to a force. When two forces oppose each other the thing stops and when two forces are added it [moves] forward. This is a principle of mechanics. Once this is clear one knows that the important principles of mechanics are the composition and resolution of forces. When two forces are impressed on a body and bring it to rest, it will rest at the resultant of the forces, when they make it move, it will move along the resultant of the forces. From this we know the composition and resolution of forces, and the forces of attraction and movement become clear. Not one among the ten thousand things does not possess force. There is force in the movement of the earth, in the attraction of the sun and the moon, in the blowing of the wind, and in the rolling waves of the sea and the rivers. Electricity has transmitting force, things have affinity, vapour has expansive force. If fire produces heat, it has burning force. Since all things are like this, how could it be that men were not alike? The force of men is hidden in their bodies. It must be produced by movement [or exertion 奮] of the body. For this reason, a small movement means to produce a small force and a large movement means to produce a large force. This corresponds exactly to the theory that 'shaped things move' [of the *Mojing*].[88]

Whatever the *Mojing* may be taken to mean, this passage illustrates once again that the application of 'mechanical knowledge' within the framework of the *Xixue Zhongyuan* theory did not necessarily require a thorough grasp of the subject. A closer examination of the cited passage reveals that the first part was once again most likely based on Li Shanlan's preface to *Zhongxue,* while the second foremostly relied on the more popular image of Western mechanics outlined above.

Very similar arguments can be found in the most influential work of the *Xixue Zhongyuan* discourse during the late Qing, the *Gezhi jinghua lu* 格致精華錄 (Records on the essence of science), which boasts a preface by Zhang Zhidong 張之洞 (1833–1909) but was actually completely based on Wang Renjun's 王仁俊 (1866–1914) voluminous collection *Gezhi guwei* 格致古微 (Ancient subtleties on science). Not always citing correct quotations from the *Mozi* and other texts, the work distinguishes between 'the method of weights at rest' (*jing-*

---

[88] Wang Fucai 王輔才 . 1894. "Mozi jingshang jishuo shang yi you Xiren suoyan lixue guangxue zhongxue zhi li qi tiao ju shu zheng yi wen" 墨子經上及說上已有西人所言歷學光學重學之理其條舉疏證以聞 (Find and prove passages in the first part of the *Canon* and the *Explanation* in the *Mozi* which already refer to the principles of calendar science, optics and mechanics that the Westerners talk about), in: *Gezhi shuyuan keyi*, Spring 1894, pp. 3b–5a.

zhongfa 靜重法) and 'the method of weights in motion', or rather 'the method of setting weights in motion' (*dongzhongfa* 動重法) since it seems to suggest that this branch of mechanics focuses on 'moving weights'. Other aspects of mechanics that the *Gezhi jinghua lu* discovered in Chinese history include something called *xizhongfa* 吸重法 ('the method of attracting weight'?) which—as far as I am aware—is not mentioned in any translated work on mechanics and is associated with the *Mojing* passage on 'equalizing' as quoted above. Wang Renjun also finds the 'inclined plane' in the *Mojing*, and he relates:

> Today the Westerners treat moving forces (*dongli* 動力), weight and velocity together and assemble machines. In addition, they are able to lift and move very heavy weights by exerting a small force.[89]

Interestingly, the *Gezhi jinghua lu* contains a passage on the Chinese origins of *lixue* 力學 as well:

> There is effort involved in lifting from above, none in pulling [see above]. … The Western methods contain the force of gravity (*zhongli* 重力), cohesion (*jieli* 結力) and affinity (*aili* 愛力). These are in principle all derived from dynamics (*dongzhongxue* 動重學) that treats the principles of the motion of all bodies and the origin of all forces. This is called dynamics (*lixue* 力學) and is all rooted in this.[90]

This was of course an extension of mechanics/dynamics that was not legitimized by the originals of the works translated into Chinese, since Western mechanics/dynamics only deals with the effects of forces and not their origins. The term *lixue* thus acquired a meaning which went well beyond its Western original, a tendency which can also be observed in the case of *zhongxue*. The latter is illustrated in an essay by Tang Caichang 唐才常 (1867–1900) who tried to locate the origins of *zhongxue* in the *Zhuzi yulei* 朱子語類 (Classified conversations of Master Zhu [Xi]):

> In the *Yulei* it is said: 'The heavens depend on form and the earth depends on pneuma (*qi* 氣).' It is also said: 'Because its *qi* is extremely solid, it supports the earth; if it were otherwise, the earth would fall down.' Note: The Westerner Newton's well-known 'Celestial Mechanics' (*tianwen zhongxue* 天文重學) says that all things have the ability of attraction. If a thing is large, its attractive force is large, if it is small, its attractive force is small. Two stones originally attract each other but the

---

[89] *Gezhi jinghua lu* 格致精華錄 (Records on the essence of science). n.d. Edited by Jiang Biao 江標 (ed.). n.p., 4.11b–12b.

[90] Ibid., 4.12b.

> force is small; they do not have a mass as large as the earth and no equal attraction. What the Westerners call 'pressure' (*yali* 壓力), 'expansive force' (*zhangli* 漲力), 'disturbing force' (*shedongli* 攝動力) and 'centrifugal force' (*lixinli* 離心力) all concurrently deal with *qi*, this is in accordance with the passage 'it supports the earth' in the *Yulei*. In his *Essentials on geology* (*Dili juyao* 地理舉要)[91], Muirhead writes that the shape of the earth was formed by the gravitational force[92], and that it started to revolve because of the gravitational force of the sun and the planets. The meaning is perfectly clear. This shows that the Song Confucians knew about the principles of gravitational force. The Westerners extended it and used it for the limitless applications of mechanics (*zhongxue*). For this reason, the origins of force go back to the sun. The mutual attraction between stars and the moon, the attraction and moving force of the centre of the earth, the power of the pressure of wind and waves, the expansive and thermal force of water and fire, and even the transmitting force of electricity as well as the affinity of chemical reactions are all derived from this. It was all handed down from [the *Zhuzi yulei*].[93]

This kind of reasoning remained dominant for quite some time. Similar problems infiltrated parts of the examination system between its reform in 1902 and its eventual abolition in 1905.[94]

3. Mechanizing philosophy and politics

After the disastrous Chinese defeat in the Sino-Japanese War of 1894–1895 the pace of reform gathered momentum. There was a widespread perception that China could not be saved by applying old solutions, and hence a frantic search for new ones began. Pusey has shown convincingly that this atmosphere paved the way for the reception of Darwinist ideas in China. As the devices employed since 1860 had

---

[91] Such a book did not exist. Muirhead only wrote a *Dixue juyao* 地學舉要.

[92] We should note that Muirhead did not give a very detailed account of problems of cosmogony. The passage referred to is conveniently quoted on the first page. Cf. William Muirhead (Mu Weilian 慕維廉). 1888. "Dixue juyao" 地學舉要 (Essentials of geology), in: *Xixue dacheng* 西學大成 (Great anthology of Western knowledge). Shanghai: Datong shuju, vol. 3, p. 1.

[93] Tang Caichang 唐才常. 1980a. "Zhuzi yulei yiyou Xiren gezhi zhi li tiaozheng" 朱子語類已有西人格致之理條證 (Proof that some passages of Zhu Xi's classified conversations already contain principles of Western science), in: id. *Tang Caichang ji* 唐才常集 (The works of Tang Caichang). Edited by Hunan sheng zhexue shehuikexue yanjiusuo 湖南省哲學社會科學研究所. Beijing: Zhonghua shuju, pp. 172–6.

[94] Cf. Benjamin A. Elman. 2000. *A Cultural History of Civil Examinations in Late Imperial China*. Berkeley: University of California Press, p. 603.

obviously not worked, Darwinian ideas were introduced not as scientific theories but as a means to induce change. While this—and the underlying racism observed by Pusey—made the Chinese reception of Darwin definitely a special case,[95] we should keep in mind that it was but one manifestation of an almost global trend. The idea of evolution was one of the predominant ideas of the second half of the nineteenth century and went far beyond its original scientific core. Such a dominance of scientific elements in public discourse was known before; the first half of the nineteenth century had been the time of physiology, and the dominant feature of the eighteenth had been the use of Newtonian concepts, especially the idea of 'attraction'[96], which not only manifested itself in the use of mechanical and physical terms in political and social discourse[97] but even led to the discovery of 'social attraction' and Fourier's famous 'law of social motion', formulated in analogy to Newton's law of (physical) motion.[98] While the larger number of physical terms, which acquired significance in political or social contexts, reached China via Japan[99], we can observe an autochthonous tendency for the application of scientific terms in non-scientific contexts in China in the very last years of the nineteenth century.

To be sure, mechanics, or Newton's law of motion, did not play the same role in China even at that time as in the West one century earlier. However, there were men who read books on mechanics for various reasons, not the least important that it could help China on her road to wealth and power. As I have tried to show above, it was partly due to the *Xixue Zhongyuan* discourse that mechanics, or rather *zhongxue*

---

[95] Cf. James Reeve Pusey. 1983. *China and Charles Darwin*. Cambridge, Mass.: Harvard University Press.

[96] Cf. Georges Gusdorf. 1971. *Les Principles de la pensée au siècle des lumières*. Paris: Payot (*Les sciences humaines et la pensée occidentale*), p. 163.

[97] Cf. e.g. I. Bernard Cohen. 1995. *Science and the Founding Fathers. Science in the Political Thought of Thomas Jefferson, Benjamin Franklin, John Adams and James Madison*. New York: Norton.

[98] Cf. I. Bernard Cohen. 1994. "An Analysis of Interactions between the Natural Sciences and the Social Sciences", in: id. (ed.). *The Natural Sciences and the Social Sciences. Some Critical and Historical Perspectives*. Dordrecht: Kluver (*Boston Studies in the Philosophy of Science* 150), pp. 1–100.

[99] Such as *fandong* 反動 'reaction', cf. Wolfgang Lippert. 1979. *Entstehung und Funktion einiger chinesischer marxistischer Termini. Der lexikalisch-begriffliche Aspekt der Rezeption des Marxismus in Japan und China*. Wiesbaden: Franz Steiner, pp. 217–21; or *yundong* 運動 'movement', cf. Rudolf G. Wagner. "Constructions of May Fourth", in: Milena Dolezelova (ed.). *The Burden of May Fourth*. Cambridge, Mass.: Harvard University Press, forthcoming.

and *lixue*, became a fairly well-known part of 'Western knowledge' and that it was connected to all kinds of 'forces' (*li*力) towards the end of the nineteenth century. Analogies between social sciences and natural sciences are of course present in translations, for example, in a rendering of Fawcett's *Manual of Political Economy* prepared by Wang Fengzao 汪鳳藻 (1851–1918) at the Tongwenguan with assistance by W. A. P. Martin and published under the title *Fuguoce* 富國策 (Strategies to enrich the country) in 1883. In this book, the 'laws' of economics were likened to the law of gravitation that are always valid even if a light body seems to fall down more slowly due to the resistance of the air (*fengqi zuli* 風氣阻力).[100] But such cases were rare and less influential than the writings and sayings of the important reformers of the late nineteenth century.

A good example is Kang Youwei 康有為 (1858–1927) who developed an early interest in Western sciences but—as is well-known—never managed to get a real grasp of scientific subjects.[101] At the age of 28 he started to write a small book later entitled *Lectures on the heavens* (*Zhu tian jiang* 諸天講) which consists of short treatises on his observations of the stars mixed with some of the knowledge he had acquired while reading Western books. Since the book was only published in 1930, it is difficult to determine when its parts were completed. However, it seems certain that Kang only modified it slightly, so that it is likely that the first chapters were largely compiled prior to the turn of the century. In a programmatic manner, Kang explains that the two persons he reveres most are Copernicus (from Italy according to Kang) and Newton for their discovery that the earth moves around the sun and the 'repulsive force of attraction'. In another brief essay, Kang mentions the 'attraction' of the heat of the sun (*rire zhi xili* 日熱之吸力), which worked in the opposite direction of the 'repulsive centrifugal force' (*lixin zhi juli* 離心之拒力). According to him, the earth

---

[100] Cf. Wang Fengzao 汪鳳藻 and W. A. P. Martin (Ding Weiliang 丁韙良). 1883. *Fuguoce* 富國策 (Strategies to enrich the country). Beijing: Tongwenguan, 1.40b.

[101] According to his autobiography, Kang Youwei started to read Western books on science in 1883. His grasp of Western science can be illustrated by a passage from his autobiography where he claims that men are becoming smaller because the earth is moving further away from the sun. His proof was that a flute he had assembled according to the instructions of the ancients turned out to be too long. Cf. Jung-pang Lo (ed.). 1967. *K'ang Yu-wei. A Biography and a Symposium*. Tuscon: The University of Arizona Press, p. 54.

moved because of 'thermal force' (*reli* 熱力).[102] If one reads the whole book, one can certainly come to the conclusion that Kang "appears to have possessed the gift of drawing daring conclusions from a minimum of available facts".[103] It is not my intention here to delve into Kang Youwei's 'scientism'. Rather, I mention these passages because we can observe how these scientific terms slipped into his political rhetoric during the late 1890s. One example is a speech he gave at the first assembly of the Society for Preserving the Nation (*Baoguohui* 保國會) in Beijing in April 1898. Here, he points out again that all life on earth depends on the thermal force of the sun that is responsible for the movement of the earth. China, however, does not move. If one wishes to save it "one must only increase the thermal power of one's heart" which can be done by exerting one's 'mental force' (*xinli* 心力).

> The greater the thermal force (*reli*), the greater the expansive force (*zhangli* 漲力) and the attractive force (*xili* 吸力); the living beings (*shengwu* 生物) will be more glorious and the growing beings (*zhang wu* 長物) will grow taller.[104]

Kang Youwei not only used mechanical terms in political argumentation but also employed them (and optical and electrical terms) in his philosophical writings. In his famous *Datong shu* 大同書 (Book of Great Unity), for example, Kang reinterprets the concept of *ren* and relates it to the 'force of attraction' (*xishe zhi li* 吸攝之力).[105] As outlined in Schäfer's contribution in this volume, the application of scientific terms for philosophical reasoning reached its first peak with Tan Sitong. While without any doubt the 'ether' (*yitai* 以太) concept

---

[102] Cf. Kang Youwei 康有為. 1990. *Zhu tian jiang* 諸天講 (Lectures on the heavens). Beijing: Zhonghua shuju, pp. 13–5. Up to now, I have not been able to find out on which source this assertion is based. 'Thermal force' was discussed in an article by Joseph Edkins in 1874 (cf. "Guang re dian xi xinxue kao" 光熱電吸新學考 [The new learning of light, heat, electricity and magnetism], *ZXWJL* 28–29); and a short article on the 'thermal force' (*reli*) of the sun was included in *Gezhi huibian*, cf. "Li chu yu mei shuo" 力儲于煤說 (On power stored in coal), *GZHB* 1877.3, pp. 6b–8a.

[103] Cf. Kung-chuan Hsiao. 1967. "K'ang Yu-wei's Excursion into Science: *Lectures on the Heavens*", in: Jung-pang Lo 1967, pp. 376–409; 384.

[104] Kang Youwei 康有為. 1981. "Jingshi Baoguohui diyiji yanshuo" 京師保國會第一集演說 (Speech given at the first assembly of the Society for Preserving the Nation), in: id. *Kang Youwei zhenglun ji* 康有為政論集 (Collected essays on politics by Kang Youwei). Edited by Tang Zhijun 湯志均. 2 vols. Beijing: Zhonghua shuju, vol. 1, pp. 237–40.

[105] Kang Youwei 康有為. 1956. *Datong shu* 大同書 (Book of Great Unity). Beijing: Guji chubanshe, p. 3.

was central to his philosophy, we may state that Tan was also fond of mechanical terms. In his famous *Renxue* 仁學 (A study of benevolence) he lists no less than eighteen forces associated with *lixue* on a single page[106], not including 'attraction' (*xili* 吸力) which in his view was just another name for 'the force of love/affinity' (*aili* 愛力).[107] Such a treatment is of course a manifestation of the eclecticism of philosophical discussion in late nineteenth-century China and the desperate need for new ideas and concepts as a basis for a new or renewed philosophy. But we may also take it as indicative of the importance accorded to the science of mechanics (*lixue*) and the tendency to 'mechanize' (albeit in a peculiar way) arguing and thinking. This tendency is also visible in the writings of Tan Sitong's friend Tang Caichang. For example, Tang Caichang concluded an article in which he called for the mechanization of Chinese industry and agriculture with the following passage:

> When we make universal use of machines, then the affinity (*aili* 愛力) will be bright and beautiful; when affinity is bright and beautiful then the force of the country (*guoli* 國力) becomes stable; when the force of the country becomes stable, the expansive force (*zhangli* 漲力) and the gravitational force (*sheli* 攝力) will be strong enough and then, even if every country attracts (*xi* 吸) [China], it will not be swallowed.[108]

Obviously, this statement was heavily influenced by Darwinian reasoning, and indeed a number of the mechanical terms employed by Tang can be found in Yan Fu's 嚴復 (1853–1921) translation of Huxley's *Evolution and Ethics* where they are, however, not used in analogies to the political realm.[109]

Even a cursory look at the writings of Tang Caichang reveals how important a role scientific terms played in his rhetoric, and quite obviously the most important ones were related to 'force' in one way or

---

[106] Cf. Tan Sitong 譚嗣同 . 1981. *Renxue* 仁學 (A study of benevolence), in: id. *Tan Sitong quanji* 譚嗣同全集 (The complete works of Tan Sitong). Edited by Cai Shangshi 蔡尚思 and Fang Xing 方行 . 2 vols. Beijing: Zhonghua shuju, vol. 2, pp. 289–374; 363.

[107] Ibid., p. 303.

[108] Tang Caichang 唐才常 . 1980b. "Ni zizao gezhong jiqi e yanghuo liquan yi" 擬自造各種機器遏洋貨利權議 (Proposal for producing all kinds of machines ourselves in order to check the profit made by foreign goods), in: *Tang Caichang ji*, pp. 38–9.

[109] Amongst others Yan Fu employed terms like *xili* 吸力 'attraction', *dili* 抵力 'resistance' and *aili* 愛力 'chemical affinity', cf. Yan Fu 嚴復 (tr.). 1981. *Tianyan lun* 天演論 (Evolution and ethics). Beijing: Shangwu yinshuguan. See also the article by David Wright in this volume.

another. In 1898, Tang published two essays in the *Xiangbao* 湘報 under the heading "On thermal force" (*Lun reli* 論熱力). In a manner similar to Kang Youwei, Tang announces the importance of 'thermal force' for all life on earth and the existence of the solar system. According to him, Westerners were able to use 'thermal force' to enlighten their people, and this was the reason why they survived the evolutionary struggle. After lengthy and sometimes confusing elaborations Tang concludes:

> If those who have no 'thermal force' do not undertake reforms, it does not hurt them and if they do they will receive no benefits. However, if those who have 'thermal force' do not reform, they will quickly perish. But if they do reform, then they will quickly become strong. And if the thermal force expands quickly, the people will have wisdom and the state will be like new. If the thermal force is large and divine, the people will be humane (*ren* 仁) and the state will be 'grouped' (*qun* 群).[110]

Reli is of course not a mechanical force in the strict sense but, as we have seen above, Tang Caichang clearly considered it as such. The interesting point is that Tang saw no need to explain the scientific terms he employed, and this suggests that they were well-known or at least suggestive enough. Indeed reformers like Tang Caichang and his colleagues at the *Xiangbao*, tried to acquaint their readers with hard scientific facts. In late nineteenth-century China the most common means to attain this goal was the inclusion of a section of "Questions by the readers" in several important newspapers and journals, something already practiced by John Fryer in his *Gezhi huibian*.[111] Such regular columns surely contributed to the popularization of scientific terms. However, due to the lack of scientific education on the part of the editors or careless reading, this endeavour was not completely without risks and wrong explanations were a frequent phenomenon. One question related to mechanics published in the *Xiangbao* was why the atmosphere does not disperse in spite of the fact that there is much room above the 130 *li* up to which it reaches. The editors of the *Xiangbao* prepared the following response:

---

[110] Tang Caichang 唐才常 . 1980c. "Lun reli" 論熱力 (On thermal force), in: *Tang Caichang ji*, pp. 140–6. On the importance and meaning of *qun* ('group') in the Chinese reception of evolutionary ideas, see Pusey 1983, pp. 63–5.

[111] In the opening issue of the *Gezhi xinbao* 格致新報 "Questions and answers" (*dawen* 答問) were considered as the 'perfect means' to transmit new insights to scholars. Cf. "Gezhi xinbao yuanqi" 格致新報緣起 (The origins of the *Gezhi xinbao*). 1898, *Gezhi xinbao* 1 (March 13, 1898), pp. 1a–b; 1b.

> The atmosphere does not disperse due to the attraction (*xili* 吸力) of the centre of the earth which is the force behind the earth's revolution. The atmosphere is like water. If you fill a porcelain jar with water and take a glass rod in order to block [the movement of the water], you will see vortexes in the water. All the small particles will float on top and you will be able to observe that they have a tendency [to float] towards the centre. This is due to the force of revolution. It only stops when the myriad things have lost this force. Thus it is due to the revolving force of the earth that the atmosphere is layer by layer drawn towards the centre. As long as this force does not stop, the atmosphere will not disperse. The ancients said: Heaven is moving without rest, therefore it can give birth to and transform the myriad beings. When it stops for one day, the myriad beings will all be ruined. Indeed, it is because of the revolution of the earth that the atmosphere does not disperse, and due to the fact that the atmosphere does not disperse, the ten thousand beings can grow and be nourished.[112]

According to the editors of the *Xiangbao* not only the world of physics was dominated by forces like the mysterious force of the earth's revolution, but also the Chinese world of the very late nineteenth century. Apart from the ubiquitous discourse on 'power and rights' (*quanli* 權力)[113] , there was 'pressure' (*yali* 壓力)[114] and all kinds of 'resistance' (*zuli* 阻力) that had to be overcome.[115] What were the 'moving forces' (*dongli* 動力) of the world?[116] Was the 'resisting force' (*dili* 抵力) strong enough?[117]

As outlined above some advised to use *aili* and *reli* in order to react to these threatening forces. In the preface to a multi-volume encyclopaedia on Western science and politics, the *Fuqiang xinshu* 富強新書 (A new book on wealth and power), published during the height of the reform period in 1898, we read:

---

[112] *Xiangbao* 88, p. 349.

[113] Cf. the article by Rune Svarverud in this volume.

[114] Cf. e.g. Xiong Chongxu 熊崇煦 . 1898. "Lun shili" 論實力 (On real forces), *Xiangbao* 21, p. 81a.

[115] Cf. e.g. Liang Qichao 梁啟超 . 1898. "Shiji huozhi liezhuan jinyi" 史記貨殖列傳今義 (The modern meaning of the biographies of traders in the *Shiji*), in: id. (ed.) *Huangchao jingshiwen xinbian* 皇朝經世文新編 (A new collection of writings on statecraft). Shanghai: Datong yishuju, 15.1a–10a; 6a.

[116] Cf. "Diqiu daju zhi dongli" 地球大局之動力 (The moving forces in the general situation of the world), *Shiwubao* 19 (February 1897), p. 25.

[117] Cf. e.g. Pi Jiafu 皮嘉福 . 1898. "Quan chashang ge" 勸茶商歌 (A song to encourage tea-trade), *Xiangbao* 70, p. 278.

> The function of attraction (*xili* 吸力) entails that it is absolutely impossible to impress anything on it [i.e. overcome it]. If it were otherwise, the spheres of the eight stars would not be bound to the sun and the universe, and the stars would grind against each other and become one. How could there be such a principle? Today, the court promotes practical learning, following both the Chinese and the Western way. In this way, the court wishes to manifest its attraction (*xili*) among the 22 provinces of Asia (*Yaxiya*) and the 400 million members of the yellow race in order to make use of cohesion (*nianli* 黏力). Oh how great that will be! … In order to make use of cohesion and to manifest the potential of attraction, one must rely on the efficiency of this book.[118]

In an article in the *Zhixin bao* 知新報 , in which Liu Zhenlin 劉楨麟 , a student of Kang Youwei, praises the soon to be aborted decision of the court to carry out a 'special examination in public administration' (*jingji teke* 經濟特科), which had been proposed by Yan Xiu 嚴修 (1861–1929) by the end of 1897[119], the function of 'attraction' is described as follows:

> Oh how great is 'attraction' (*xili*), which is discussed in mechanics (*zhongxue*)! The disc of the sun possesses attraction, and the earth, the moon and the five stars all revolve around it with great speed; they cannot abandon [the orbit] and go astray. The globe has attraction, and the mountains, rivers, men and things are all unimportant matters attached to it without [being able] to leave it. Men and beings possess attraction, and the nerves of the brain and the limbs are all forced to move and cannot disobey the commands. The extent of attraction depends on the size of the body. Thus, when two things are exposed to each other, the lighter one will be attracted to the heavier. When men meet, the worthless will be attracted to the noble. Although there is a difference between light and heavy, worthless and noble, the manifestation of attraction necessarily depends on 'thermal force' (*reli*). The sun is a mass of heat, and for this reason it attracts the earth, the moon and the five stars. The centre of the earth is extraordinarily hot, and therefore it attracts the mountains, rivers, men and things. The human body produces heat, and this is why it can attract the nerves of the brain and the limbs. If there were no heat, heaven, earth and men would all be destroyed. If we are able to strengthen our heat by our own means, all mass will be exposed to our attraction. What is 'thermal force'? Nothing but affinity. If there is mutual affinity, then there is mutual attraction. Adding cold to a hot temperature will cause the hot temperature to

---

[118] *Fuqiang xinshu* 富強新書 (A new book on wealth and power). 1898. n.p.: Sanyu shuju, "Preface".

[119] Cf. Wolfgang Franke. 1960. *The Reform and Abolition of the Traditional Chinese Examination System*. Cambridge, Mass.: Harvard University Press, p. 44.

> diminish; adding heat to a cold temperature will cause the cold temperature to expand—this is nothing but the difference between the existence and non-existence of affinity, and this is a universal law of the sciences (*gewu zhi gongli* 格物之公理). How could it be that only in respect to the government of the empire it does not apply? Power and influence are the attraction of the ruler. Grace, riches and honour are his thermal force. To expect grace, riches and honour is the thermal force of ministers and the common people. The ruler extends his thermal force upon the people, and then the ministers and the common people receive it from him. The two forces combined produce a large degree of attraction. In this way, the power and influence of the ruler are honoured and the affinity of those above and those below is strengthened. There will be no pressure from those above and there will be no resistance from those below. When above and below combine their forces, the empire will be strong.[120]

One may suspect that the reformers employed this 'mechanized' language of modernity in order to emphasize that only a complete departure from the traditional approach to politics was able to solve China's urgent problems.[121] As the strong reactions of steadfast opponents to radical reform (in the manner envisioned by Kang Youwei, Liang Qichao, Tan Sitong and others) show, the reformers apparently hit the mark. One of the main targets of the vociferous attacks of Hunan conservatives like Ye Dehui 葉德輝 and Wang Xianqian 王先謙 (1842–1917)[122] was the language used by Kang Youwei, Liang Qichao and many other reformers, and it is interesting to note that critics invariably pointed out the inadequacy and danger of 'mechanical' terms:

> They constantly write books with false accusations against Confucius in order to alarm the world and terrify the people. This cannot be called following the principles of righteousness. Their arguments and misgovernment and their plagiates of superficial Western books do not deserve

---

[120] Liu Zhenlin 劉楨麟 . 1898. "Gong du Shangyu kai jingji teke shu hou" 恭讀上諭開經濟特科書後 (After reading the edict on carrying out a special examination in public administration), *Zhixin bao* 45 (March 1898), pp. 2b–5b.

[121] In his study on the popularization of science in nineteenth-century Germany, Kurt Bayertz emphasizes that popularization efforts and in particular the stress put on the utility of scientific knowledge not only served to strengthen the social standing of the group of scientists involved but were often used for political ends. Cf. Kurt Bayertz. 1985. "Spreading the Spirit of Science: Social Determinants of the Popularization of Science in Nineteenth-Century Germany", in: Shinn and Whitley, pp. 209–28.

[122] On the Hunan reform movement and its opponents see Ding Ping 丁平 . 2000. *Hunan weixin yundong shi. 1895 zhi 1898 nian* 湖南維新運動史·1895至1898年 (History of the reform movement in Hunan from 1895 to 1898). Taibei: Hanzhong wenhua shiye gufen youxian gongsi.

> to be called 'statecraft' (*jingshi* 經世) since they do not know about the magnificent and deep meaning of the classics. On the basis of the books of Liu Shenshou 劉申受 [Liu Fenglu 劉逢祿 , 1776–1829], Gong Dingan 龔定庵 [Gong Zizhen 龔自珍 , 1792–1841] and Wei Moshen 魏默深 [Wei Yuan 魏源 , 1793–1856] they want to wipe out 2000 years of commentaries by worthies and scholars. This does not deserve to be called textual research. Since Liang Qichao, Xu Qin 徐勤, Ou Jujia 歐榘甲 edit the *Shiwubao* and the *Zhixinbao*, the language of heterodoxy and vulgar Western words such as *Zhina* 'China', *Zhendan* 震旦 'China', *reli* 'thermal force', *yali* 'pressure', *zuli* 'resistance', *aili* 'affinity', *dili* 'resisting force', *zhangli* 'expansive force', etc. everywhere strike one's eyes. The literary mood in the south-eastern provinces becomes more perverse and mean every day, one really cannot call it literary style.[123]

Similar criticisms of new terms were voiced in the "Covenant of schooling in Hunan" (*Xiangsheng xueyue* 湘省學約) that was signed by conservatives from various Hunan academies.[124] In a letter to the governor, Wang Xianqian warned that because of the use of such words "their writings are devoid of style", "utterly arousing" and "spoiling the purity of men".[125]

In spite of such attacks and the defeat of the reformers in the *coup d'état* of 1898, the new terms continued to be used. The emphasis on attraction, cohesion and the search for affinity obviously aimed at a more coherently 'grouped' society, since only such a society will be able to cope with the multitude of 'pressures' exerted from the outside. But what about the freedom of the individual in such a society? It was exactly this point that was taken up in an essay on 'the three special forces of the world' by Ma Xulun 馬敍倫 (born 1884), and with a quotation from this article I would like to conclude this brief survey of the 'mechanization' of late Qing discourse:

> I have noticed the expositions of physicists from Japan and the West who speak about three forces. One is called 'attractive force' (*yinli* 引

---

[123] "Zhangxing xueji boyi" 長興學記駁義 (Refutation of the memoir for promoting studies) in: Ye Dehui 葉德輝 (ed.). 1971 [1898]. *Yijiao congbian* 翼教叢編 (Anthology of writings on heterodox teachings). Taibei: Wenhai chubanshe, 4.35a–63b; 40b–41a.

[124] Cf. "Xiangsheng xueyue" 湘省學約 (Covenant of schooling in Hunan) in: Ye Dehui 1971 [1898], 45.14a–18b; 17a–b.

[125] Cf. Wang Xianqian 王先謙 . 1986. "Zhi Chen Youming zhongcheng" 致陳右名中丞 (Letter to governor Chen Baochen), in: id. 1986. *Kuiyuan sizhong* 葵園四種 (Four works by Wang Xianqian), Changsha: Yuelu shushe, pp. 864–5; 865.

> 力), one is called 'molecular force' (*fenzili* 分子力) and one is called 'pressure' (*yali* 壓力). About these three forces they have the following theory: 'The establishment of the world, the living of mankind, the production and reproduction of grasses and woods, insects and beasts all rely on them; humans receive surplus and profit from them and become rich without noticing it. It is just the same with the sun that resides in the centre of everything—we do not know that it allows us to live and provides nourishment for us. For this reason, when we speak about the usefulness [of these forces], we have to say that it is broad and abundant. Their work is so beautiful that we must call it high and magnificent'. Ma Xulun says: 'What kind of talk is this? What kind of talk is this?' It is precisely these three forces that hinder the force of human freedom and are responsible that we are not able to extend it. …Freedom: those who possess it, are human; those who do not possess it belong to the beasts. Those who possess it live; those who do not possess it die. Those who possess it are glorious; those who do not possess it are disgraced. Those who possess it are civilized; those who do not possess it are barbaric. Those who possess it are heroes; those who do not have it are slaves.[126]

After a lengthy elaboration of how these forces infringe on the individual's well-being and its possibilities (and incidentally noting that 'pressure' is responsible for the fact that the earth cannot leave its orbit!), Ma concludes that it is the 'three special forces' that have brought about the Darwinian state of the world:

> These great forces kill men and put the world into disorder. I really do not know how physicists can bear to praise them. Even if one knows their power, one has to be aware that [they are responsible that] the ten thousand generations will not enjoy one day of freedom.[127]

Conclusion

When Li Shanlan decided to use the term *zhongxue* as a translation of Western 'mechanics' in the 1850s, he deliberately employed a term which had been used in the first presentation of the science to China more than two hundred years earlier. This decision was consistent with his treatment of Western mathematics, in particular his translation of Euclid's *Elements* in which he relied on the terminology developed by Ricci and Xu Guangqi. Even though we do not have clear

---

[126] Ma Xulun 馬敍倫 . 1902. "Shijie san teli" 世界三特力 (The three special forces of the world), *Xin shijie xuebao* 9, pp. 1–3; 1.

[127] Ibid., p. 3.

textual evidence, we can be certain that Li Shanlan realized that the kind of mechanics he translated was different from that introduced by his forerunners. For Li and a number of other Chinese scholars, *zhongxue* was an abstract technical term employed to delineate a clearly defined field of study with a sound theoretical basis and well-established methods. This is probably best demonstrated by the fact that Li saw no problem in employing it in his unfortunately never completed translation of the first parts of Newton's *Principia* that do not touch upon 'weights' at all. Thus for him, the term *zhongxue* was as far detached from its semantic origins in the West and the meaning of its Chinese morphemes, as the term *mechanics* is detached from its original Greek meaning when employed today by a student or practitioner of modern physics.

I have tried to show that the terms denoting the field and its more important notions were known well enough in late nineteenth-century China to be applied as argumentative and rhetorical weapons in philosophical and political discourse. In many respects, nineteenth-century mechanics satisfies the demands for a science easily transmittable into a different context. It was mathematized and therefore culturally 'neutral', and for its application and development local and historical conditions were of minor importance.[128] And yet the 'study of weight' and the 'study of force' which reached China in the late nineteenth century were not identical with the science in the West. The abstract notions of mechanics and the designations for the field were de-abstracted. The terms were viewed as having concrete meanings, and this led to a reduction or expansion of the original contents of the field. At the same time, a frantic search for an indigenous Chinese tradition of mechanics began. The shift of meaning that the discipline experienced between 1860 and 1905 was corrected as soon as the institutional and educational basis for the 'adoption' of mechanics was established. However, mechanical terms continued to be employed in more figurative meanings in philosophical and political discourse. And the search for a Chinese tradition of mechanics—which would never have been discovered without contact with the West—went on. Until today, this subject is researched by numerous historians of science and professional physicists all over the world.

---

[128] Cf. Dolby 1977, p. 33.