Chapter 9
Survey: Knowledge as a Fellow Traveler

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9.1 The Stratification of Knowledge and the Historical Superposition of Globalization Processes

Usually scientific knowledge is conceived as being produced locally and valid globally. The distinction between a local context of discovery and a global context of justification may be labelled as "local universalism." It presupposes that, once global scientific knowledge is available, local conditions can only affect its application, interpretation or the choice of problems, but not modify its nature. Against this background, it is surprising that, in spite of the powerful political and economic globalization processes of the recent past and the globalization of science proceeding for centuries, today's world of knowledge is anything but homogeneous. Underneath common standards, methodologies and widely accepted results of science, there is still a great variety of local traditions, of ways to choose problems, to interpret their solutions, to integrate scientific knowledge into belief systems and societal processes. The same holds, more generally speaking, for the ways in which knowledge shapes our identities, informs our practices and pervades our social existence. It is hardly possible to understand this diversity and its relation to ongoing globalization processes without taking account of the fact that knowledge is stratified in a way similar to the stratification of geological layers, each coming with its own, often dramatic, history. The knowledge we deal with today is the result of history, of course. It is, more precisely, also the result of a historical superposition of globalization processes in which second-order knowledge, in particular in the form of images of knowledge shaping its societal role, has continued to accumulate in such a way that later layers interfered with earlier ones, without, however, eradicating them completely. Considering that bodies and images of knowledge are intertwined in a virtually endless historical chain of processes of reflection, local universalism has thus to be replaced by a global contextualism as a perspective from which to understand the globalization of knowledge in history.[1]

Over long periods of human history, knowledge was disseminated in connection with power and belief structures. Knowledge spread across long distances or over vast areas as a by-product of other diffusion processes, for instance, the expansion of empires or the spread of religions. These processes may be of transregional

[1] See chapter 25.

and cross-cultural character, but they may also be corridor-like, connecting distant regions by a thin, often indirect and fragile chain of transmission, for instance, a trade route like the Silk Road or the Jesuit mission to China.[2] Such corridors are of a special kind, holding the world together, but effacing or mystifying the distant partners in communication.[3]

As knowledge is but a fellow traveler in these processes, participating in their dynamics without governing it, the results of transmission are often only of a transitory nature, but a long-lasting sedimentation of at least some achievements is nevertheless possible, such as practices of writing and calculating which later became relevant to the appropriation of scientific knowledge. This kind of knowledge globalization began with the emergence of institutions bundling cultural activities, such as centers of trade and production, states and world religions.[4] As a consequence, transmission processes themselves also became institutionalized. Commercial, military and missionary activities provided new stimuli for knowledge transmission.

In spite of the transient and sometimes even ephemeral contexts of these globalization processes, they kept large parts of the world connected over long periods of time by common religious, economic and cultural traditions, through the exchange of technologies, practices and ideas, or through knowledge encapsulated in writing. This connectivity, however, did not lead to a uniformity of the contexts in which knowledge was being produced, disseminated and appropriated. Scientific knowledge, in particular, remained a fellow traveler until it became instrumental in shaping the economic bases of societies—which did not happen before the early modern period. By that time, the rapidly spreading scientific knowledge had begun to take root in an economically, politically and culturally diverse landscape that had also been shaped in part by earlier processes of globalization. The modern globalization of scientific knowledge that took place within this landscape thus depended on these earlier processes and their sediments.

Religious or quasi-religious traditions, such as philosophical movements or state ideologies, played a special role. These traditions, especially the world re-

[2]For a discussion of the Silk Road and relevant literature, on which the following is based, see (Rezakhani 2010; Haussig 1988, 1992). The name "the Silk Road" (*die Seidenstraße*) for the commercial routes passing through the Tarim basin into Transoxania goes back to the German explorer and scholar Baron Ferdinand von Richthofen. Silk, however, was not necessarily the only and not even the dominant trade item. Also, the Silk Road hardly served the Roman and the Chinese empires, at the extremes of the Eurasian continent, as a venue for direct interaction. The main point for our purposes is rather that the Eurasian continent remained over long historical periods connected by a network of weak ties, cf. (Granovetter 1983; Malkin 2011). The reconceptualization of the "Silk Road" in this sense remains an open question for research. For a discussion of the Jesuit mission to China, see chapter 11.

[3]Several contributions to this volume argue that, given the possibility of diffusion and conceptual similarities, the burden of proof is upon those who deny an underlying spread of knowledge, for example, chapter 10, section 10.5.

[4]See (Wallerstein 1989). Wallerstein reconstructs the emergence of centers and peripheries in an expanding European world economy. Less Eurocentric perspectives can be found in (Lippmann Abu–Lughod 1993, 75–102) and (Stern 1988, 829–872).

ligions, were not only most effective in the large-scale spread of knowledge associated with them, even across geographical, political and economic boundaries, they also provided and continue to offer overarching second-order epistemic frameworks governing the value and role of knowledge for societies and individuals. As a result of the historical superposition of globalization processes involving such frameworks, the modern knowledge economy includes large subsystems with distinct social, epistemological and normative features, such as normative Islam or Chinese medicine. These subsystems have proven relatively immune to the homogenization effects typically associated with globalization processes. This stability, however, is not just the result of the persistency of traditional settings, as it may appear, but is also due to a characteristic lack of reflexivity of modern science compared to religious or quasi-religious frameworks regarding questions of sense, purpose and identity. This instrumental character and lack of reflexivity of science is in effect often compensated by the epistemic frameworks inherited from prior history or from earlier phases of globalization. The very fact that science does not—and perhaps cannot and should not—play the role of homogenizing cultural identities as well may thus be due less to its intrinsic nature than to its role in historical globalization processes, having emerged as a fellow traveler itself.[5]

9.2 The Accumulation of a Potential for Science

As discussed in Part 1, from the third millennium BCE at the latest, the existence of trade routes connecting centers of early urbanization, for instance Egypt, Mesopotamia and the Indus valley is well documented. Technical innovations such as the development of bronze technology enhanced the need for raw materials, in this case of copper and tin, which had to be procured through an extended network of trade routes. Thus local technical, economic and political developments and the growth of networks reinforced each other. By the second millennium, large empires had emerged in Western and Eastern Asia, from Egypt in neighboring Africa, via the empires of Mesopotamia and the Hittite Empire in Anatolia, to Shang and later Zhou, China. In the middle of the first millennium, the Persian Empire extended from the Nile to the Indus and constituted an important conduit between Western Asian and Indian cultures. The Achaemenid Persian Empire, in fact, encompassed both Mesopotamia and parts of West India and Pakistan, where the easternmost Achaemenid-controlled satrapies were located (Potts 2007). This political "umbrella" created the conditions in which knowledge and technology transfer could occur within the boundaries of a single empire. Later, the Hellenistic empires of Alexander the Great and his followers, the Roman Empire, and Islamic rule established extended interaction spheres between different cultures.

[5]While Stengers (1997) is right in emphasizing that the knowledge systems of science tend to be closed worlds comprising their own control strategies and criteria of truth, this of course does not exclude multiple interfaces with other knowledge systems, which are often capable of interfering with or even overruling those intrinsic to science. Science thus never evolves autonomously, but always as part of larger knowledge systems.

The impact of such empires on social and cultural connectivity, their territorial expansivity, their reliance on extended commercial exchanges, and their continuous struggle with neighbors and nomadic populations supported (as was discussed in chapter 3) the spread of knowledge with more or less practical relevance to the functioning of these empires. This happened not withstanding the fact that empires also made attempts to keep certain knowledge secret, such as smelting technologies among the Hittites or Greek fire in the Byzantine Empire.

At the same time, wide-ranging empires contributed to the accumulation of a global potential for science over long periods of time. Consider the example of the Islamic Empire which connected the Mediterranean, the heart of classical antiquity, with the Indian ocean, opening up new roads for world trade.[6] It inaugurated a thousand-year era during which all the major civilizations of Eurasia, the Greek, Roman and Sanskrit traditions, but also Irano-Semitic and Malay-Javenese cultures, were brought into contact with each other. In the course of this process, elements from these traditions were integrated into an overarching cultural framework that survived even long after the decline of centralized political authority, a topic to which we return (Eaton 1993, 12).

The spread of knowledge induced by the spread of political power is exemplified by technologies such as agriculture, ceramics, textile fabrication and metallurgy, and of cultural techniques such as writing, accounting, monetary economy, mathematics, architecture, artistic representations, astronomy and calendar systems. For instance, mathematical puzzles, as part of sub-scientific mathematics, may have migrated across the Eurasian continent during campfire and tavern conversations among merchants and military men (Høyrup 1989). Such diffusion processes significantly contributed to the accumulation of a potential which later became significant for the emergence and diffusion of science. Remarkably, this accumulation reached beyond the eras of single empires, since their succession usually involved, even when major destruction took place, the adoption of parts of pre-existing infrastructure, the inclusion of at least some members of the intellectual elite and a continuity of local technological or cultural achievements. As a result, the historical succession of large empires from the Mesopotamian, via the Roman and the Persian empires to the Islamic Empire comprised significant global learning processes. For example, Roman regulations for agriculture found their way into the corpus of Islamic law; Persian economic achievements played the role of a model employed by the Arabs in their conquests (Glick 2005, 6–7).

This is not to say that major breaks did not occur in transitions from empire to empire, such as the disappearance of wheeled vehicles in the Islamic world, which was due to the invention of the rigid north-Arabian camel saddle (Bulliet 1977). A key example for the long-term accumulation for the potential of science

[6] See (Glick 2005, 3, fn.1) and the references therein. For the coupling of monetary economies between Europe and the Muslim world between 1000 and 1500 CE, see also (Watson 1967). For the relation between the Islamic world and Tibet, see (Akasoy et al. 2011).

is the invention and dissemination of paper as a cheap writing material.[7] It thus took on a role that was played in antiquity by clay and papyrus, which also helped to spread literacy, in contrast to the limited literacy in medieval Europe, partially caused by the reliance upon parchment and skins for writing materials. Paper making was known by the second century CE in the Han Dynasty in China and then traveled to Eastern and Western Asia, following the Silk Route. By the end of the seventh century, paper making had reached the Indian subcontinent, and by the middle of the eighth century Samarkand, transmitted by Chinese prisoners to the Abbasid conquerers. Subsequently it spread to the rest of the Islamic world.

The diffusion of paper illustrates the layered structure of globalization processes and the associated retardation effects discussed in chapter 1. Paper began to spread from China only after it became widely used. It was first introduced to other areas as a commodity and only much later reproduced by local technology. Thus paper was known to the Arabs by the seventh century, while the technology for manufacturing it arrived more than a century later. By the tenth century, paper had entirely replaced the use of papyrus. Similarly, it was known in Europe no later than the tenth century, while paper mills were constructed only about two centuries after its initial introduction. It took another century before Europeans realized that the Chinese also used paper and much longer before they became aware that it was actually their invention. The extent to which the connectivity provided by the Islamic Empire accelerated the spread of technological inventions by the Chinese is remarkable when compared to their spread before the rise of this empire (Glick 2005, 247–248). This is also true of another key example for the gradual accumulation of potential for the globalization of science: the invention of the Indo-Arabic numeral system, now in universal use.

The oldest numbers written in this place-value system with base 10 are found on the Gujarat copperplate inscriptions from about 595 CE. There is, however, textual evidence that the place-value system originated much earlier. At least since the mid-third century, a concrete number system was used in India that associates numbers with concrete or religious objects and arranges them in a place-value system. Remarkably, one of the earliest texts testifying to the use of this system is an astrological treatise based on a Greco-Babylonian astrological tradition. The Indian place-value system may thus have roots in the Babylonian tradition, but it may also go back to the use of counting boards with an intrinsic decimal place-value structure as they were used in China, from which they may have been brought by Buddhist pilgrims. While the autonomous development of the system in India cannot be excluded, its emergence from transmission and transformation processes of older knowledge brought into new contexts and represented by new media is not entirely unlikely. One new medium were Indian literary texts which made use of the above-mentioned concrete number system for reasons of style and required synonyms for ordinary number words so that the scansion of a verse would not

[7] On the history of paper, see (Tsien 1987). For its diffusion to Europe, see also (Glick 2005, 279–281) and (Burns 1985).

be ruined. Such literary contexts may have hence preceded the use of the new number system for calculation.[8]

By the seventh century, the decimal place-value system had reached Syria in the West and Cambodia, Sumatra and Java in the East. By the late eighth century, the Indo-Arabic numerals were known in the Islamic Empire. In 773 CE, a group of ambassadors from India visited Baghdad, including a scholar with astronomical and mathematical expertise. One of the first authors of mathematical treatises in Arabic was Al-Khwarizmi, from Chorasmia, who worked in the first half of the ninth century under Calif Al-Mamun in Baghdad at the House of Wisdom. His arithmetical treatise is the first known Arabic work using the Indian decimal-place system. While Indian numerals became known in the West as early as the late tenth century, it was the Latin translation of this treatise that caused them to be widely adopted in Western Europe. In the first half of the thirteenth century, easily accessible introductions to calculating with the new number system were written that became adopted as textbooks in the newly founded universities and grammar schools. They also became the basis for the widely spread mathematical training in vernacular languages (Folkerts 2001). Without the globalization of paper and Indo-Arabic numerals, the worldwide success of early modern science would have been unthinkable.

9.3 The Role of Empires and the Fragility of Higher-Order Knowledge

In the great empires of pre-colonial times, the production and dissemination of higher-order knowledge, as represented by political, religious, juridical, literary or scientific writings, depended largely on institutional structures with varying degrees of fragility and with strong dependence not just on the political and military fortunes, but also on the ideological preferences of their rulers. This changed in colonial times when such knowledge became an essential instrument for domination. More generally speaking, the transmission of higher-order knowledge depends on the existence, social status and social reproduction, as well as on the demographic size, of an intellectual elite concerned with such knowledge.[9]

The idea of an empire presents itself as a form of second-order knowledge, as may be illustrated by the fact that this idea traveled and was also emulated by populations for which this form of political organization was new. Examples are the rural and nomadic populations surrounding the Roman and the Chinese empires which eventually created similar political structures shaped by knowledge taken from the empires with which they struggled.[10] In the Chinese state bureaucracy, certain forms of moral, administrative and political knowledge were

[8] On the history of the Indo-Arabic numeral system, see (Plofker 2009, 43–48). See also (Kunitzsch 2003).

[9] Cf. the discussion in (Glick 2005).

[10] For the Roman case, see, for example, (Heather 2006); for the Chinese case, see, for example, (Barfield 2001).

transmitted over long periods of time, even across dynastic changes. As we saw in chapter 3, the Babylonian tradition of astronomical observations also survived major political upheavals. The fate of Greek and Hellenistic philosophical and scientific traditions was closely associated with the changing political support for their institutions, such as the Academy in Athens or the Museion in Alexandria, which were repeatedly endangered by ideological and military threats.

Also in the Islamic Empire, the cultivation of secular intellectual activities relied mainly on courtly patronage, in particular that of the Abbasid caliphs from the ninth to the thirteenth century.[11] The Greek-Arabic translation movement began in the second half of the eighth century in Baghdad and lasted at least until the end of the tenth century. It took place in a multicultural and multilingual environment, involving speakers of Greek, Syriac, Persian (Pahlavi), Arabic and Hebrew with translations from Greek into Arabic often passing through intermediate languages. It enjoyed the patronage of the Abbasid Dynasty and initially mainly served legitimatory purposes, creating an intellectual continuity with the great empires of antiquity and maintaining the cohesion with the various influential ethnic and cultural factions comprising the elite of the new society in Baghdad. Political and ideological motivations thus favored a continuity of learning, which was anything but self-evident in view of the major societal disruptions of that time. According to Gutas, a central background was provided by the Zoroastrian imperial ideology of the Sasanian Empire conquered by the Arabs, and was adopted by the Abbasid rulers after they transfered the seat of the caliphate to Baghdad. This ideology was still shared by a significant part of the Persian-speaking population, even after the Arab conquest. It was used by the second caliph and builder of Bagdad, Al Mansur, in the second half of the eighth century as a means to co-opt the local elite and integrate them into the new Abbasid state. The Zoroastrian imperial ideology comprised the belief that all sciences originally derive from the Zoroastrian canon, but had been appropriated by the Greeks in the course of Alexander's conquest of Iran, so that their translation into Persian (Pahlavi) was simply a recovery of the Zoroastrian heritage. The cultivation of translation activities was hence an integral part of this ideology and as such also taken over by the Abbassidian rulers. The Zoroastrian imperial ideology may be considered second-order knowledge preserving an awareness of epistemic continuity in the Middle East. The institutionalization of this knowledge for political reasons in the early Abbasid Dynasty made it instrumental in the recovery and transformation of ancient knowledge traditions through the creation of a state-supported translation movement.

The new knowledge thus generated and widely shared in the extensive Islamic state of the Abbassids then became itself an important aspect in the societal development. In particular, the acquisition of further knowledge became more de-

[11] See chapters 12 and 13, the classic paper by Benz (1961), the masterful survey by Dimitri Gutas (1998), as well as the introduction in (Abattouy et al. 2001a)—co-written by the author—on which much of the following is based.

termined, not only by the ideology that had originally motivated the translation movement, but also by intrinsic motives related to the nature of this knowledge. Although initially astronomical knowledge was mainly sought for political motivations related to the legitimatory role of astrology for the new dynasty, its acquisition increasingly became a matter of intrinsic scientific interest. Early translations tended to be connected to the practical context they purported to serve. This context was often defined by the institutional frame that supported and financed the translation work. The translation of medical texts was fostered also by hospitals, which were institutions not just of caregiving but of study as well. Greek medical knowledge competed with Indian medical knowledge that was also translated into Arabic (Dols 1987). Eventually, translation activities were more and more guided by the intrinsic development of "naturalized" Muslim sciences, institutionalized in the form of curriculae and sets of equipment and instruments that defined their further development (Sabra 1987). At the same time, the Greek-Arabic translation movement was a powerful transmission mechanism, preserving Greek scientific material, often in a form superior to the Greek texts that were simply copied within the Byzantine tradition, with its less-developed scientific culture (Lorch 2001).

In the Arabic-Latin translation process, this transmission and transformation was continued. Remarkably, it was shaped not only by local motives, but also by global political constellations.[12] Centers of transmission from Arabic into Latin typically emerged at the boundaries of the Catholic world with regard to the Islamic and Byzantine Empires and in areas that were multicultural and multilingual, such as Spain and southern Italy, particularly in Sicily.[13] A further condition favorable to the transmission of knowledge across cultural borders was the existence of boundary spaces with comparatively high political and religious tolerance. A prime example was Toledo, reconquered without bloodshed from the Arabs in 1085. In contrast to the territories controlled by the repressive regime of the Almohads in North Africa and parts of Spain, Toledo offered room for contacts and cross-cultural collaborations.[14] It thus became pre-eminent for the translation of philosophical as well as scientific texts in the Aristotelian tradition.[15] The emphasis on specific types of knowledge transmitted depended on local circumstances and interests. A real translation movement therefore did not begin before the mid-twelfth century—Gerard of Cremona being one of the leading figures—since before this time an audience interested in translations from the Arabic was scant. In 1140, an important Arabic library became available to the Christian rulers with a wealth of books on mathematics, astronomy, astrology and magic, from which Gerard probably took some of his sources. As in the case of the Greek-Arabic translation movement, translations were often performed using intermediate lan-

[12] For discussion, see (Gutas 2006), in particular p. 18.

[13] See the discussion in (Burnett 2001) on which much of the following is based. See also (Schramm 2001) and (Hasse 2006). For a more general discussion of the translation movements in Europe and the Near East, see (Kunitzsch 2008).

[14] See (Endreß 2004).

[15] See (Schmidt 1957), (Benz 1961, 147–165).

guages, in particular the vernacular, as well as in collaboration with Jews and Arabized Christians. For example, Avicenna's book on the soul was translated from the Arabic via the vernacular into Latin by the Jewish scholar Abrahim Ibn Daud, who had emigrated from the Almohad territories together with the archdeacon Domenicus Gundissalinus. As in the Greek-Arabic movement, patronage also played a key role, here by the Cathedral, especially by the Frankish archbishop of Toledo.

In Salerno, not far from the Byzantine settlements in Puglia, Greek texts on medicine began to be translated into Latin from the eleventh century on; in the twelfth century, Palermo, on the outskirts of Europe, became a meeting point for Latin and Arabic scholars who generated translations as well as new joint contributions. In the twelfth and thirteeth centuries, a network of scholarly migrations began to develop between these centers at the boundaries, and now also included urban centers which sustained scholarship in the heart of Europe, such as Oxford and Paris. The Arabic-Latin translation movement cannot be understood from a merely local perspective. It was the emergence of a European market for its products and the growth of the scholarly network and its institutionalization that fostered translation activities beyond the motives of their local inception.[16] Furthermore, the varying ways in which different cultures interacted depended on the local manifestations of conflicts of geopolitical dimensions. These ranged from courtly encounters between Catholics, Byzantine Christians and Muslims in Palermo, to the appropriation of the scholarly and technological achievements of a besieged enemy after the "Reconquista" of Toledo. Like the Greek-Arabic translation movement, the Arabic-Latin translation movement did not just involve the transmission of texts: it developed from a clash between two worlds, both of which embodied universal claims to political and ideological dominance. For Latin scholars, this resulted in an opportunity to encounter an active scientific culture previously almost inaccessible to them.[17]

Until the early modern era, the globalization of articulated higher-order knowledge such as philosophical and scientific knowledge expressed in writings was a haphazard process. Such higher-order knowledge was typically not embodied in stable social and administrative structures. It involved chance encounters, often fragile institutions, intellectual syntheses achieved by outstanding individuals, or schools such as those of Plato and Aristotle in ancient Greece or the Mohist school in ancient China, and the more or less fortunate transmission of their knowledge preserved in writing. But practical inventions, such as paper making, and the

[16]The scholarly network induced by the translation movement comprised hubs with different functions, translation centers, such as Toledo, centers of learning and dissemination, such as Paris and Oxford, and depositories of knowledge, such as the Monastery of Saint-Michel. The recent controversy about the origins of western Aristotelianism, launched by Sylvain Gouguenheim (2008), has helped to make the distinction between the functions of these different centers clear. See the afterword in (Gouguenheim 2011).

[17]Alfonso the Tenth (1252–84) concentrated the translation activities that had been scattered around Spain in one location and subdivided and organized the labors of his translators.

transformations and globalization of such higher-order knowledge in successive historical phases created some of the crucial preconditions for the emergence and spread of modern science.

The transformation of Greek science and philosophy in the Islamic world, for instance, and its transmission to the medieval Latin world, constituted a critical mass of knowledge with a shifted focus—when compared to late antiquity—and with far-reaching consequences. One example is the transformation of the ancient tradition of mechanics, dealing with a variety of mechanical instruments, into a "science of weights" focusing on the balance and giving rise to new mechanical concepts.[18] Another example is the prominence acquired by Aristotelianism and the original contributions to it in the Islamic world.[19] The circulation and appropriation of this knowledge in the West eventually helped trigger the emergence and spread of universities, as well as the formation of the scholastic worldview that later served as the matrix for the birth of modern science. In this sense, modern science was more an outcome of the globalization of ancient knowledge rather than its renaissance.

We mentioned above that the large-scale sociopolitical structures of empires fostered the travel of knowledge, in particular when it was deemed politically, ideologically or economically relevant. The thirteenth-century CE Mongol Empire, for instance, created an interaction sphere ranging from Central Europe to East Asia, effecting a horizon for thought and action that extended throughout Eurasia. It enabled the encounter of knowledge traditions that were hitherto largely separate from each other, such as the Hellenistic-Islamic and the Chinese astronomical traditions. However in this case, astronomical knowledge remained merely a useful commodity produced in an almost artisanal way; it was spread by the migration of experts or by the copying of calculational techniques (van Dalen 2002). Knowledge and personnel were exchanged, but the different intellectual traditions were not integrated into a larger system of knowledge—in contrast to what happened in late antiquity to Babylonian and Greek astronomical knowledge in the work of Ptolemy. Nevertheless, large empires such as the Mongol Empire not only created favorable conditions for long-distance traveling, but also an awareness of global political and religious constellations that offered global perspectives of intervention, even to figures not directly involved in political matters, such as merchants, missionaries, adventurers and even intellectuals. A prominent example is Marco Polo, a merchant from the Venetian Republic who served the Great Khan as a diplomat and whose travel account later inspired Christopher Columbus to search for the sea route to India after the land passage to India and China became increasingly difficult following the fall of Constantinople to the Ottoman Turks in 1453.[20]

[18] See (Abattouy et al. 2001a) and (Renn and Damerow 2012).
[19] For a standard reference, see (Pines 1979).
[20] On the voyages of Marco Polo, see (Larner 1999). On visits to Europe from Asia, see (Rossabi 2010).

In the age of European colonization from ca. 1500, the production and dissemination of knowledge, and in particular of higher-order knowledge, assumed a new and much more significant role. Its role was determined primarily, at least initially, by the function of knowledge in the colonizing societies. After the early modern age, scientific and technological knowledge in some European societies started to become more central to economic production, social organization and political regulations, as well as to the self-image of the leading classes, a process that eventually led to an industrialization involving scientific knowledge to an ever greater extent.[21] The very possibility of colonization depended on this process, which involved the production of improved ships, maps and navigational techniques, developed weaponry and sophisticated logistics, as well as the capacity to absorb knowledge from the colonized and the creation of knowledge production centers in the colonies. This is not to claim that Europeans necessarily possessed technology superior to that of other cultures. Consider, for instance, the superb equipment and navigational competence available to the Chinese in the early fifteenth century. What characterized early-modern European societies is rather the historically contingent social, political and military dynamics in systematically exploiting and enhancing their technological potential for colonial conquests.[22] The background knowledge enabling such achievements was produced and disseminated by institutions with greater social penetration and stability than ever before, not only schools, universities, guilds, archives or academies, but more generally all forms of the institutionalized transmission of practical knowledge relevant for commercial and military purposes.[23] It was the onset of a self-accelerating process that necessarily involved even those territories exposed to colonial domination and expropriation in Asia, Africa and the Americas.

European colonial endeavors also relied on earlier phases of the globalization of knowledge, from the exchange of innovations across Eurasia since the beginning of sedentariness to the awareness of the geopolitical situation after the Fall of Constantinople, which effectively blocked earlier connections between the two ends of Eurasia. If, however, only the role of these earlier globalization processes is emphasized, and, in particular, their facilitation by the East-West connectivity of

[21] For a discussion of the social and economic roots of the Scientific Revolution, see, for instance, (Lefèvre 1978; Freudenthal and McLaughlin 2009; Damerow and Renn 2010) and the older literature cited there.

[22] For Chinese seafare in the fifteenth century, see (Ptak 2007). Older literature often claims a general superiority of European cultural techniques, see, for example, (Konetzke 1964). Newer literature tends to underline the cultural contingency and the very special use Europeans made of these techniques, see (Gruzinski 2011). For information on shipbuilding, map-making and other conditions of European seafare related to the production of new knowledge, see (Harley and Woodward 1987, 410; Russell-Wood 1998, 27–31; Renn and Valleriani 2001; Padrón 2002; Kamen 2003, 159–160; Nowacki and Lefèvre 2009).

[23] The case of archives is discussed by Nicholas B. Dirks (2001) who stresses the role of archives as neutral repositories of the past, focusing on colonial Imperial British India. Ann Laura Stoler (2009) goes further when she considers archives and archival documents not only as sources, but also as having histories and itineraries of their own.

Eurasia as a primary reason for the superiority of European colonial powers over indigenous populations of Africa and America (Diamond 1998), one risks underestimating the significance of the early modern knowledge economy for colonialism and, in particular, for its sustainability beyond the first conquest. The crucial role of the link between epistemic and economic processes in this period, to which we return in the next section, also becomes visible in the different degrees to which European competitors such as Spain, England and the Ottoman Empire became successfully—from their perspective—enganged in colonial enterprises.

Non-European territories and their societies offered, on the one hand, new resources for the knowledge economy of the colonizing societies, such as new biological specimens potentially relevant for agriculture or medicine.[24] On the other hand, their domination required the extension of this knowledge economy beyond its original borders to also include those colonized societies with different cultural and epistemic traditions (Crosby 1972, 64–121). Historically, these extensions took place along radically different lines. Nevertheless, several features are common to all alternatives: the destruction or decline of local institutions concerned with the production and dissemination of knowledge; more or less successful attempts to transplant institutions of higher learning from the colonizing to the colonized societies; attempts to legitimize the transferred scientific and technical knowledge by naturalization, that is, by establishing links to indigenous epistemic traditions; the eventual integration of at least some aspects of local knowledge that turned out to be better adapted to local circumstances than globalized knowledge; and, more generally, the transformation of the dominated territories into sites of often ruthless political, social, technical and scientific experimentation. In addition, there are many cases where medical or agricultural knowledge, for instance, would have been adaptable and yet was suppressed by the colonized subjects at least as much as by the colonizing powers.

9.4 The Role of Religion and the Endurance of Higher-Order Knowledge

The power of empires never comprised just military, political and economic dominance. It was based as well on the support of belief systems that regulated social order beyond the exertion of crude force. Political and religious control was accordingly exerted by overlapping social hierarchies of rulers and priests. Religions are social systems constituting collective identities.[25] One of their means for doing so is knowledge and, in particular, second-order knowledge, prescribing the role of knowledge in the given collective identity. Shared societal belief systems have their origin in the religious practices of tribal societies as a medium of social

[24]There is a very large literature on this theme. See, for example, (Arnold 1988; Grove 1995; Müller-Wille 1997).

[25]See (Durkheim 1965; Heinrich 1986; Simmel 1995). On the transmission of social hierarchies, see also (Lincoln 2007).

self-awareness. Later, these belief systems reflected the rising social complexity of urban and state societies, and this development was accompanied by an increased social differentiation of political and religious elites. The potential range of belief systems in space and time was considerably enhanced when the medium of writing was employed for their representation. In the third millennium BCE, religious beliefs and practices were among the first subjects of written documentation outside the original use of writing for administrative purposes.[26] In this way, belief systems, as well as the corresponding literary works, practices or religious ideas, such as that of an original flood, documented in the Babyloninan Epic of Gilgamesh, could travel well beyond the spatial and temporal confines of the societal setting in which they originally emerged.[27]

Religious practices include initiation and sacrifices, prayers and other ceremonies, often timed according to astronomical events, but also institutionalized education, building activities, artistic and literary productions. Because of the close association between religious practices, teachings and institutions, such comprehensive belief systems tend to generate packages of knowledge, that is, conglomerations of diverse components pertaining to linguistic and philological knowledge, social and psychological knowledge, or practical knowledge of the arts. These packages may thus have been rather heterogenous, but at the same time they constituted relatively stable units in transmission processes. There is, moreover, one characteristic organizing principle to this bundle of knowledge: it is assembled to provide answers to questions that are unavoidably generated by the knowledge about the world with regard to the position of the individual, the group, or the society in this world. Questions could include: where do I come from and where do I go from here, what can I hope for and what can I believe in? These questions are an unavoidable consequence of the self-reflexive, self-organizing character of knowledge.[28] As individuals we cannot avoid thinking about them, while religious and other belief systems provide collectively sanctioned answers to them. Such answers are, however, highly mediated by institutional frameworks, by traditionally accepted external representations, by procedures of appropriation that may or may not achieve their goal of mediating between individual and social self-awareness.

Religious transmission processes involved, for instance, the dissemination of holy writings and their interpretations and thus fostered the spread of key cultural techniques, such as writing, translating and calculating, but also the transmission of educational processes closely related to initiation rites (Assmann 1992). Religions thus developed early, including many of the features that were later characteristic of science: educational institutions such as monasteries and madrasas

[26]In the Early Dynastic period, so-called "god lists" emerged, primarily serving administrative purposes, i.e., teaching how one writes the name of a particular god in an administrative document. The next group of written texts that emerged after administrative documents were primarily legal.

[27]See (Maul 1999; George 2003; Foster et al. 2001). For the transmission into Hittite and Hurrian, see (Salvini 1988; Beckman 2003).

[28]For the character of religious knowledge, see also (Freundenthal 2012).

(schools of higher learning), recursive traditions of interpretation, commenting, confrontation and integration with other belief systems, and a systematization of knowledge that included control structures for its legitimacy. Also in the religious context, this breadth of knowledge, often accumulated over centuries, nevertheless remained but a fellow traveler, even if an unavoidable one. The pursuit of religion was, after all, guided by motives other than the exploration and reflection on the knowledge assembled in those packages, which instead remained a mere by-product, and sometimes an undesired one.

The long-term effects of the spread of knowledge fostered by large empires was possibly surpassed by those in the wake of the world religions. At some point in their development, these may have been or may have become state religions, such as Buddhism in Northern India under King Aśoka, Christianity in the late Roman Empire and Islam under Mohammed and his followers in the Arabic world. Under these conditions they incorporated (or helped to create, as in the case of Islam) many of the institutional and representational structures of an empire state, such as differentiated social hierarchies, a more or less comprehensive worldview, and institutional mechanisms for its preservation and transmission. The self-contained and self-organizing quality of some of these state religions rendered them capable of challenging the authority of the political powers and of far outlasting their initial reference states. In ancient Judaism, for instance, the authority of the state, as well as of the state religion represented by the priests, was challenged by the prophets. Later, after the destruction of the Second Temple and the Jewish state, religious and community rule became one, with an emphasis on religious knowledge (Goodman 1998; Kalmin 2006).

Indeed, world religions could become attractive belief systems to be adopted by states and empires seeking to regulate their social order, precisely because of their self-consistent quality. As a consequence, the world religions fostered an even wider spread of knowledge and had an often more durable nature than that of the expanding empires.[29] To some extent, world religions may be considered virtual empires that share their superstructure, but not necessarily their economic basis. This is not to say that the spread of world religions was not significantly propelled by military and economic conquests.

Such all-encompassing belief systems, as world religions offer, as mentioned above, a powerful medium for articulating individual and social self-awareness and self-reflection, and in particular for their mutual interaction. They not only incorporate knowledge about social and psychological mechanisms, but also make it possible to further develop this knowledge within their representational and institutional structures. As a means for generating self-awareness and hence for reflectively constituting individual and social identity, they also impose a second-order epistemic framework that guides the selection, appropriation and agglomeration of new knowledge by determining the value of knowledge for the individual

[29]See (Bayly 2004, chap. 9) on empires of religion. See also Tyrell (2004) who investigates how German and British mission organizations contributed to globalized world religions.

and collective self (Schleiermacher 1912). This may happen in widely differing ways and may also change over time. Nevertheless, due to their social penetration and high degree of reflexivity, religious systems tend to have a greater stability than most systems of knowledge, for which they may serve as a complementary embedding providing meaning and reflexivity that these knowledge systems do not. Buddhism, for example, has developed a deconstructive epistemology largely immune to historical developments of knowledge.[30] The normative dimension of Islam is, just as is the case for Judaism, not confined to certain areas of religious practice, but extends to all dimensions of life and hence also to the evaluation of all forms of knowledge.[31]

Religious systems, comprising both an overarching second-order epistemic framework and distinct packages of knowledge, are continuously challenged by new knowledge. In the case of medieval Christianity, the integration of knowledge newly acquired through the transmission from the Islamic world led to a belief system that increasingly functioned as a universal system of knowledge and thus also became increasingly sensitive to such epistemic challenges. This system of knowledge received institutional support from the newly founded universities.[32] The Christian-scholastic philosophy, based on Aristotelian philosophy, connected the previously mentioned theological statements with rather concise statements concerning the constitution of the world. From the thirteenth century, a synthesis of the religious worldview and the available scientific knowledge emerged.[33] This highly differentiated system of knowledge was prone to the challenge which naturally accompanies the acquirement of new knowledge. The Christian scholastic system of knowledge was thus exposed to a constant process of transformation, but because of the primacy of religion dominating the dynamics of knowledge it was, at the same time, subject to externally imposed limitations. This situation helps to explain why in the sixteenth century the reform of astronomy by Copernicus, placing the sun rather than the earth at the center of the universe, could have had such far-reaching ideologic consequences: it occurred within the context of a socially dominant system of knowledge which claimed to be universal and exclusive. The impact of the Copernican Revolution on astronomical knowledge in Europe—and ultimately the European Enlightenment—would be unthinkable without the preceding epistemic transformation of Christianity.

A similar transformation of the neo-Confucian state religion dominating classical China evidently did not take place, not even in the early modern period when the Jesuits introduced the knowledge of European science on a broad scale in the

[30] See section 10.4 of chapter 10.
[31] See chapter 12, in particular section 12.1.
[32] See (Rüegg 1996a,b). The role of the universities for shaping a scientific agenda has also been stressed in (Huff 2011, 147–52). The author points to the role of the legal transformation in the twelfth and thirteenth centuries which opened up the possibility of a legal status for collective actors, such as corporations and universities, claiming this as a distinctive European development.
[33] For an overview, see, for example, (Lindberg 2008).

form of books and private and institutionalized instruction.[34] Instead the new knowledge, in particular that about calendar making and the prediction of astronomical events, was selectively assimilated to the Chinese system of knowledge. Unlike the complex of Christianity and Western science, this was not decoupled from the state to the extent that it constituted a worldview with a legitimization independent of the authority of the state. Instead, it derived its ultimate justification not from an epistemic framework, but from its constitutive role for the state. Hence, the Chinese system of knowledge could not be challenged in the same way as its Western counterpart by the accumulation of new knowledge.

In the European case, the capability of religion to challenge the authority of the state in terms of its own, internal logic eventually favored that of science to challenge the authority of religion. In early modern times, the potential of science to undermine the dominant structures of knowledge relating to religious views of the world had been reinforced by the increasingly real or anticipated practical and economic significance of science, in particular by the practical challenges for science in dealing with the large engineering endeavors of the times. The artisanal practice at the Arsenal of Venice or large building projects like the cathedral of Florence, for example, were dependent on innovative knowledge from all over the world. This practical significance of science also accounted for the development of a new image of knowledge. In answer to the dominant religious worldview, this image of knowledge started to assume the character of an all-embracing interpretation of the world, as it is found in the great philosophical concepts of early modern times, for instance in the works of Giordano Bruno or René Descartes. Science eventually became a kind of counter-ideology by which the emerging bourgeoisie could defend its claims of ruling the world, not according to a transcendent, religious order, but according to its own immanent laws.[35]

The new role of science in the West became relevant at a time when its links to the religious worldview were eroding because that worldview was challenged by the growing mass and complexity of the rapidly accumulating knowledge. This knowledge explosion counteracted all attempts to confine the expansion of knowledge and eventually helped to foster the creation of an institutional basis for science, independent of its role as a fellow traveler. In this historical situation, a self-reinforcing mechanism emerged that connected the production of scientific knowledge with socioeconomic growth. We come back to this mechanism in chapter 24. From that point on, the economy of knowledge was no longer merely a by-product of other societal processes, a fellow traveler of political, military and economic developments, but had transformed into an essential motor of this process. This development occurred in Europe but was the result of a long-ranging process of globalization of knowledge and involved the refraction of knowledge traditions across several cultural breaks, for example, from Mesopotamia to Greece,

[34] See chapter 11, in particular sections 11.1 and 11.5.

[35] For this interpretation of the Scientific Revolution, see (Lefèvre 1978; Renn and Valleriani 2001; Damerow and Renn 2010).

from Greece to the Arab world and from there to Latin Europe, as key processes of intellectual innovation. Such refractions of knowledge traditions were associated with changes in perspective and made the endeavor of modern science possible in the first place, as well as the resonance between scientific and socioeconomic globalization.

The extent to which such self-reinforcing simultaneity of scientific advances, the possibility of exploiting science for ideological purposes and a growing practical role for science also took place in the Islamic world is still an open question.[36] Further studies are needed to identify the historical opportunities—whether missed or realized—for extending the flourishing of science as a fellow traveler in the age of large Islamic empires and tolerant religious practices to an economically viable regime that favored the development of an autonomous institutional basis for science.

While knowledge as a fellow traveler of religion tends to form heterogeneous and often rather accidental packages held together by tradition and transcendent legitimacy, an autonomous societal basis for the generation and transmission of knowledge fosters the creation of systems of knowledge held together by internal coherence and intrinsic legitimacy. We thus see, once more, the self-organizing quality of knowledge systems and their transmission. The previously mentioned scholastic Aristotelianism of the Middle Ages, for example, formed such a system of knowledge with its own institutional basis and self-referential argumentative structure. While it did receive a transcendent legitimacy from its embedding in Christian theology, its own intrinsic logic was strong enough to conflict with theological assumptions and to play a generative role for the emergence of early modern science.

9.5 Science as a Fellow Traveler

Science itself, on the other hand, may act much like a religious tradition when it is transferred to a society with an epistemic framework and an institutional basis for the assimilation, production and transmission of knowledge that is different from that of the society from which science has been transferred.[37] What is being transferred under these circumstances are thus packages and not systems of knowledge. Their structure depends less on the constitution of the original system and more on the patterns of appropriation and accommodation in the target society.[38] What seemed a systemic necessity, for example, in the sequence of arguments in the context of origin, may in the new context emerge as an accidental constellation of distinct elements of knowledge, offering the option of changing their relation to each other, dropping some of them altogether, or adding others.

[36] See the discussion in chapter 13.
[37] For a discussion of the intercultural aspects of scientific exchange, see also (Aoyama and Seebold 2005).
[38] See chapter 14, section 14.5.

In consequence, one typically finds, if not just selective assimilation of new knowledge within a preexisting local system of knowledge, a remixing of the components of imported science with components of local knowledge.[39] Such a repackaging of scientific knowledge is typical of the transmission of science as a fellow traveler of religious mission, as in the case of the Jesuit mission to China in the sixteenth and seventeenth centuries, of the spread of science to the European periphery in the eighteenth and nineteenth centuries, and of colonization in the nineteenth and twentieth centuries.[40]

Science may evidently also act like a belief system in another sense: by shaping the identity of its protagonists. When science spreads as a fellow traveler of religion, its practitioners almost unavoidably adhere to different and overlapping belief systems. Conflicts of identity are thus the rule rather than the exception and may drive further development.[41] More generally, the globalization of knowledge always leads to a differentiation, both on the level of knowledge itself and on that of the identity of its protagonists. As a consequence, knowledge as a fellow traveler never remains a neutral commodity with regard to its means of transport, its sources and its recipients. Due to its self-referential qualities (the reflection of knowledge generates new knowledge), it may rather induce, under appropriate circumstances, systemic changes that tend ultimately to overcome its subordinate role as a fellow traveler. Thus the production and dissemination of scientific knowledge as a fellow traveler of colonization, could, by an active accommodation to new circumstances, also become a powerful motor of decolonization, as the example of twentieth-century India illustrates.[42] However, as long as the development of scientific knowledge remains isolated from that of knowledge at large, its transformative power, and in particular its impact on the dominant epistemic constellation, is limited. But, as we have stressed, the boundaries between first and second-order knowledge are always shifting, with the effect that any process of knowledge generation may acquire a subversive power undermining, at least in the long run, the dominant constellation.

[39] See the discussion of *métissage* in the colonial context as a form of communication wherein no "veritable fusion" of European and autochthonous knowledge took place, but quite selective and short-term practices of mixing *métissage* and unmixing *demétissage* of knowledge prevail (Lienhard 1999, 60–61). According to Ann Laura Stoler (2009, 249), knowledge in the colonial context was generally unstable. See also the discussion in the survey chapter 16.

[40] See chapters 11, 14 and 15.

[41] Such conflicts of identity are at the heart of conversion processes, as explained in (Viswanathan 1998, 75): "I propose examining conversion as an act akin to the forces of modernity in its appeal to personal (rather than collective) choice, will, and action; to the forces of colonialism in its introduction of other epistemologies, ideologies, and cultural frameworks; and to the forces of feminism in its representation of subjectivity at variance with what is legislated not only in code books of social morality but also in civil and ritual practices. Combining the effects of all three, conversion posits a severe challenge to the demarcation of identities set by the laws that govern everyday life and practice. Changes of religious belief reconstitute the shape of the nation just as forcefully as do systems of personal and customary laws, which lay the groundwork for organizing different communities along sectional lines."

[42] See chapter 15.

9.6 The Nature of Religious Knowledge

When knowledge is transmitted as a fellow traveler, its distributivity, that is, the extent to which it is shared, is governed by the medium with which it travels, be it the expansion of an empire or the spread of a religion. As the transmission of knowledge is determined by such extrinsic dimensions, these also govern its reflexivity and systematicity. Religious knowledge in particular comes, as discussed in section 9.4, in packages comprising various kinds of practical and theoretical knowledge which, however, are not necessarily strongly interrelated so that the systematicity of this knowledge is low. Religious knowledge may comprise artisanal knowledge about certain building techniques, but also theoretical knowledge which, however, does not typically relate to this kind of practical knowledge.

Buddhism, for instance, comprises techniques and styles of visual representation and of architecture that spread widely across Asia.[43] Within the monastic communities of Buddhism, social knowledge was cultivated that could be exploited under appropriate circumstances for political purposes. But the main component of religious knowledge is shared higher-order knowledge resulting from a reflection on a broad range of collective human experiences from birth to death, from love to war, from success to failure, from anxiety to joy. Religious knowledge comprises interpretative schemes that make these experiences "meaningful," typically in the sense of helping to reestablish the coherence of self or of a community in the face of challenges threatening to tear them apart. It often also comprises, however, reflections on a broad range of experiences with the working or failure of these very interpretative schemes. To which extent religious knowledge is, at its core, meta-knowledge is best illustrated by the Buddhist insight into the fragile nature of all such attempts to preserve the self, developed in opposition to Brahmanical philosophy which believes in an eternal self and equally eternal social structures.

Because of the essential role of meta-knowledge in religions, they provide second-order epistemic frameworks determining the place for other types of knowledge, with differing potentials for these other knowledge components to influence these epistemic frameworks in turn. More generally, the dynamics of knowledge production and dissemination is shaped by dominant epistemic constellations, also determined by political, economic and cultural boundary conditions mutually interacting with each other. Religions are often only one, albeit often crucial, element of these constellations. In Ming China, for instance, morality was the domain of the state, while religion was a private matter supposedly having nothing to do with the state.[44] When knowledge contained in a package with religion turned out to be relevant for the state, the natural reaction was to disentangle it from its religious context. In medieval Christian Europe, religion shaped morality and interfered with the state, but was nevertheless independent of it and could even oppose the state. Accordingly, this was also the case for knowledge packaged with

[43] See chapter 10.
[44] See chapter 11.

religion. In Islam, the ideal community of original believers sets normative standards for all dimensions of human behavior and the Koran is considered to be a holy book not comparable to other books, and hence beyond the realm of critical interpretation in terms of human knowledge production. While there was room in Islam for associating further knowledge with this epistemic core, it was apparently more difficult to challenge it.[45] Such epistemic constellations also operate on smaller, historically more specific scales: Greek-speaking Orthodox Christians in the Ottoman Empire developed an intellectual identity distinct from the Muslim East and the Catholic West. This identity expressed itself in the development of a neo-Aristotelian philosophy governing their appropriation of new scientific knowledge from the West.[46]

In accordance with the epistemic framework given by the dominant constellation, or more specifically, a particular religion, different types of knowledge are produced, transmitted and associated with each other, often according to an explicit classification of knowledge given by the epistemic framework. Religious traditions typically distinguish between religious and secular knowledge traditions, conceiving the latter as being ancillary to the former. Thus Jewish and later Islamic traditions distinguish between transmitted and rational sciences.[47] In the case of Islam, the first, the Koranic sciences, comprised Arabic grammar, lexicographic writing, Koranic exegesis, Islamic law, the edifying life of the Prophet, and heresiography, among others. Secular knowledge comprises geography, history, poetics, astronomy and mathematics, the latter considered useful for solving inheritance problems. Philosophy, in contrast, was evidently never accepted as an essential part of higher Islamic learning. One of the reasons is that, in Islam, orthopraxy, a set of behavioral norms, plays a more important role than orthodoxy, a set of beliefs that can not only be interpreted, but also extended with the help of philosophy. Another reason is the fragile institutional support for the pursuit of higher secular learning in traditional Islamic societies. The worldly sciences were cultivated at the courts and suffered the precarious situation of patronage.

Buddhism, too, as a text-based religion, furthered the accumulation of knowledge related to the exegesis of texts, in particular, grammar, logic and rhetoric. Given the epistemic focus of Buddhism on liberation from the self and its constraints, secular knowledge related to the mastery of the physical world was not cultivated within its tradition.[48] Also the extent to which knowledge production becomes institionalized depends on the dominant epistemic constellation: While philosophical knowledge, including the philosophical implications of modern science, was relevant to Greek-speaking Orthodox Christians in the Ottoman Empire, experimental knowledge and practices were not.[49] The reason was that such knowledge played a role in constituting their intellectual and cultural identity, but

[45] See chapter 12.
[46] See chapter 14.
[47] See chapters 12 and 13.
[48] See chapter 10.
[49] See chapter 14.

not in the construction of a social system of scientific research and education that remained beyond their reach. In general, the emergence of theoretical knowledge from the reflection of practical knowledge about the material world was a rather exceptional historical event. And even when it happened, as was the case in European and Chinese antiquity, it risked remaining an inconsequential singularity as long as such a coupling of theoretical and practical knowledge did not become part of a system of knowledge with a strong societal underpinning. In China soon after its emergence, the scientific tradition was, in fact, interrupted, while traditions of practical and technical knowledge continued that were part of *Herrschaftswissen* (knowledge relevant for the exertion of control and power) such as calendar making and astronomy.[50]

While religious traditions assemble heterogeneous packages of knowledge, they nevertheless tend to achieve coherence, consistency and completeness on the level of the meta-knowledge at their core. Thus, in Buddhism, as in Judaism, Christianity and Islam, sects competed in attempts to create a consistent system of thinking. They all strove for a closed, sometimes even totalitarian, worldview, immunized against the challenges provided by the inevitable assimilation of new knowledge.

9.7 The Impact of Different Forms of Knowledge Representation

To better understand the conditions for the transmission of higher-order knowledge, we turn once more to the issue of external representations of knowledge. Higher-order knowledge comprised by religious traditions and *Herrschaftswissen* relevant to imperial rule, from accounting techniques via astronomical knowledge to the distinctive literary or religious knowledge of elites, were systematically transmitted by often fragile social institutions that relied on oral traditions, texts and visual representations. No empire in history was able to advance without an economy of knowledge whose functioning determined to a great extent the potential of its leaders to exert control over society. A specific historical economy of knowledge also depends on the state of information processing: Roman archivists, for instance, ordered their holdings according to year and not to subject and were thus hard pressed when it came to finding a particular file. And even such primitive infrastructures tended to last only as long as the political structures in power (Heather 2006). Over the longest period of history, higher-order knowledge reflecting on practical knowledge and resulting in the cultivation of sciences such as mechanics, optics, medicine, or mathematics, was transmitted only occasionally and merely as a by-product of the transmission of these other forms of higher-order knowledge. No automatism existed for the spreading of higher-order secular knowledge. The existing global networks, for instance of commerce or religion, did not even necessarily spread the knowledge that made them possible in the first place,

[50] See chapter 11.

for instance, about communication technologies or mobility. Maps, for instance, were closely guarded by the Portuguese crown as part of their *Herrschaftswissen*.

The relative importance of the different forms of knowledge representation, oral, literary, visual, and the extent of institutionalization varied greatly for different traditions in a way that was largely determined by the dominant epistemic constellation. The Vedic tradition, for instance, was transmitted orally in accordance with the view that Sanskrit is a sacred language within a rigidly stratified society in which access to knowledge is a class privilege. Buddhism, in contrast, was coded in writing, in accordance with the view that language is merely a conventional means of communication.[51] Nevertheless, the translation of Buddhist texts into a great variety of languages constituted a major challenge, requiring the creation of new terminologies to represent this knowledge. Addressing this challenge of representation triggered the generation of new knowledge, in particular linguistic and philological knowledge. The ways in which this challenge was taken up differed widely in dependence on the diverse forms of transmission processes by which Buddhism traveled and in keeping with the dominant epistemic constellation of the appropriating society.

The essential message of Buddhism was represented not only by the canonical scriptures but also by visual representations of the Buddha and by the monastic community, the latter constituting a social form for the transmission of knowledge later adopted also by Christianity. Since the transmission of Buddhism depends strongly on institutions, this could be interrupted if these institutions were destroyed, as happened in eleventh- and twelfth-century India due to the Muslim invasions. Nevertheless, both in Buddhism and Christianity monasteries provided shelters for the transmission of texts and knowledge in situations of economic decline, political upheaval or military destruction. As is well known, key texts of classical antiquity survived in the monasteries of Christian Western Europe where they were copied or used as palimpsests.

In Islam, the social transmission of knowledge did not rely on monasteries, but initially merely on pious circles gathering in private homes or in mosques. Only under the Seljuq Dynasty in the eleventh century did a system of state madrasas emerge which spread widely through the Islamic world.[52] The extent to which secular knowledge was covered by their curricula varied greatly, but mostly they served as centers for spiritual training with an emphasis on calligraphy, Arabic language and grammar, Islamic theology and ethics. In traditional Islam, the flow of knowledge was also regulated by other institutions, with a particular emphasis on normative issues. Knowledge about correct social behavior, for instance, is controlled by experts on Sharia. Their argumentation typically relies on paradigmatic examples taken from the first three generations of Muslims. In addition, there is the system of Fatwas by which Islamic scholars express religious opinions, responding to new challenges and offering pious advice.

[51] See chapter 10.
[52] See chapters 12 and 13.

Access to knowledge is not solely regulated by institutions but is also mediated by the very material employed for its external representation. The long-term sustainability of the political system of traditional China relied not only on stable institutions in which the transmission of knowledge was coupled with access to power through the examination system of scholar-officials. It also relied on the existence of a book culture in which such knowledge could be stored, distributed and made accessible throughout the empire. This book culture in turn depended on the availability of cheap paper and the invention of printing, making it possible to recollect and transform the knowledge accumulated over centuries within each new dynasty. Similarly, the rapid assimilation of ancient knowledge as well as its dissemination and elaboration in early Islam was favored by the existence of paper as a cheap writing material. Scholarly communication and collaboration across a vast territory was indeed significantly aided by the trade and exchange of affordable books. To some extent, the early Islamic book culture even compensated for the fragility of institutions by ensuring the survival of the accumulated knowledge when the support for scholarly activities by patronage broke down. Paper and the techniques of paper making were transmitted to Christian Europe from Islamic Spain from the early twelfth century. Paper thus arrived at about the time of the emergence of universities as sites of higher learning in Europe, substantially extending the role of monasteries in the earlier Middle Ages. The rise of scholasticism as a Europe-wide network of higher learning and scholarly exchange would have been unthinkable, not only without the influx of classic texts from the Islamic world, but also without the emergence of new forms of representing and transmitting knowledge.[53]

As a rule, changes in the medium of external representation affect even the architecture of knowledge itself as well as, evidently, the conditions for its transmission. Without newly available books as containers of European technical knowledge, the Jesuit transmission of European science and technology to China would not have been possible, nor would the revival of some of this knowledge in China 250 years later. Another condition for this transmission was, of course, the existence of a shared domain of knowledge embodied in technologies that were available both in China and Europe such as mechanical devices. To give another example, when the Arab printing press was introduced in the eighteenth century by Christian church authorities in Syria and Lebanon, and when newspapers and magazines became available in the Arab-speaking world, the conditions for access to Western scientific and technological knowledge improved considerably, as did the availability of orientation knowledge about the global political situation.[54] But not only the access to secular knowledge became democratized, but also access to Islamic cultural heritage. The classical works of Islam were now also accessible to a broader public, with far-reaching implications for the implementation of Islamic normativity. Traditional inner-Islamic conflicts emerged on a global scale because

[53]For a discussion of the role of printing, see (Febvre and Martin 1990; Giesecke 1991).
[54]See chapter 12.

people in one region realized that people in another followed different beliefs and practices. At the same time, the mass media also reinforced the consciousness of belonging to the *umma*, the global community of Islamic believers that is now a historical actor in the globalized world.

From the beginning, the new media thus opened up multiple paths to modernity because they catalyzed the spread, not just of Western ideas of development, but also their alternatives.[55] With the arrival of the Internet, Muslims became able to access normative Islamic knowledge from anywhere in the world, and also to remix and combine Islamic norms in new ways with secular knowledge. Such developments actually considerably predate the advent of the Internet. Exploiting the potential of industrialized print media and the creation of networks of communication across wide areas, Islam already had begun to become a mass ideology in the early twentieth century. Similarly, the development of modern science in colonized territories such as India relied on heterogeneous networks of research and teaching in which aspects of Western modernization were mingled with local traditions.[56] Since the mid-nineteenth century, outside of Western Europe and the United States, collaborative international networks sustained by modern means of communication have doubtless become, for science, religion and ideology, the major conduit for knowledge production and exchange, much more important than any local institution.[57] One should not forget, however, that within such networks, scientific knowledge traveled, not just in the form of ideas and writings, but also in the form of material objects such as measurement instruments or other objects embodying high technology. In fact, their travel constituted an important channel for the globalization of material and cultural practices crucial to the spread of science.

9.8 Knowledge Transmission Processes Between Self-Reinforcement and Immune Reaction

Transmission processes in which knowledge spreads as a fellow traveler are often characterized by increasing the significance of knowledge as they proceed and may actually turn into intentional and directed processes of knowledge transmission. One of the reasons is the systemic quality of at least part of the transmitted knowledge, with the consequence that one piece of knowledge points to others and hence tends to reconstitute the system. Another reason is the empowerment which the gain of knowledge typically signifies for the receiver. But systems of knowledge may also become atomized when spreading as a fellow traveler so that isolated chunks are transmitted in a highly mediated, indirect and unintentional

[55] See also (Eisenstadt 2000, 2002).
[56] See chapter 15.
[57] Modern means of mass communication have also contributed significantly to shaping national identities in non-Western areas, as in the case of Indonesia where the spread of nationalistic ideas by mass media preceded state formation; see (Anderson 1996).

way, while being continuously recontextualized. The conditions which initially favor the transmission process impose constraints on it that may eventually hinder the transmission of knowledge, in particular when other transmission processes do not follow suit and when the production of new knowledge remains unilateral. Successful transmission processes presuppose that originator and receiver share aspects of material culture and basic knowledge that are not transmitted. Even more importantly, their sustainability presupposes a reciprocity between originator and receiver, turning them into equally significant nodes of a network of knowledge transmission. When the dominant epistemic constellations differ between receiver and transmitter, the transmission of knowledge unavoidably amounts to a transformation of knowledge.[58] A transformation of this kind occurs because the motives and structures of the appropriation of knowledge by the receivers differ from those of the transmitters. As a consequence, the transmitted knowledge is reconstituted in novel ways at the receiving end, governed by the dominant epistemic constellation, and often with repercussions for the originator. But under certain circumstances, the transmission of knowledge may also induce a change of the dominant epistemic constellation, typically when the existing constellation is in a crisis for other reasons. A change in the dominant constellation primarily induced by the influx of new knowledge is a characteristic of socioepistemic evolution and usually does not happen as long as knowledge is just a fellow traveler. Examples for the dynamics discussed in this section range from religious missionary activities to colonial science.

Buddhism, for instance, on the whole spread rather randomly, even after it had become a state religion in the third century BCE under Aśoka, the ruler of Magadha, who also fostered missionary activities.[59] Some of its conceptual assets, such as the story of the life of Buddha or the notion of hell, also spread by way of a highly mediated and indirect transmission to Christianity, obliterating their origin from a complete system of thinking. Yet, when Buddhism first took hold in a new context, for instance in China, it typically triggered activities on the part of the receiver toward the acquisition of new texts and new knowledge.

A similar process of self-accelerating transmission took place in the twelfth-century Arabic-Latin translation movement.[60] The translators were a group of self-appointed men, mostly from the lower clergy, who traveled from all over Europe to the emerging translation centers in an effort to gather new knowledge from their translation activities. They were fascinated by an alien and hostile culture supposedly in possession of superior knowledge that was believed to potentially constitute a powerful asset for Latin culture as well. Eventually, however, their efforts set in motion a self-accelerating process of knowledge acquisition. In the first step, it was mainly practical interests that motivated the translations; in the

[58]For elaborate studies of such transformation processes, see the works published in the context of the Collaborative Research Center 644 "Transformations of Antiquity," in particular (Renn and Damerow 2007; Damerow and Renn 2010; Böhme et al. 2011).
[59]See chapter 10.
[60]See (Abattouy et al. 2001b), on which the following is largely based.

second step, missing pieces of knowledge were systematically sought; in the third step, institutional and epistemological adjustments took place in dealing with the newly acquired knowledge; in the fourth step, the transmitted knowledge was reproduced and extended in a new context. Important monasteries in the twelfth century were engaged in reforms that included revisiting ancient knowledge in the context of their educational mission. While initially the hunt for new texts somewhat resembled the search for the Holy Grail, represented for instance by the secrets of astrology, the later phase was characterized mainly by organized efforts to fill the gaps in a system of science that had become gradually familiar.[61] As an alternative to a gradual emergence of a culture centering on the newly acquired knowledge, consider the complete transformation of Tibetan culture in the seventh century by the decision of the king to adopt Buddhism, and the ensuing adoption of an appropriate writing system and comprehensively organized translation activities.

Translation processes are an important medium for the transmission of knowledge, in particular when knowledge is represented in writing, and are always faced with a double challenge: a mapping between two languages, and a mapping between conceptual systems that are not usually coextensive or even compatible with each other.[62] Addressing the second challenge not only requires mastery of the contents, but often also new linguistic resources created in the course of the process. These may range from the creation of a lexicon of technical terms to that of elaborate grammars and other forms of reflection on language. As the history of Buddhism illustrates, the transmission of knowledge may hence become itself the source of new knowledge about language. The way such knowledge is created very much depends on the relevant epistemic constellations, in particular, that of the target area. While in the Tibetan case of translating Buddhist scriptures, systematic aids were created that embodied linguistic meta-knowledge, such knowledge remained implicit in the case of translations into Chinese, being represented instead by paradigmatic examples.

The very possibility of translation depends on the existence of cultural overlap, that is, of a shared basic material culture, of shared knowledge, of compatible motives and of the existence or the possibility to create or exploit multilingual environments. Indeed, most translators of Buddhist texts into Chinese came from the multilingual environments of the cities along the Silk Road and of the Persian Empire. Similarly, the Greek-Arabic translation movement involved Christians, Sabaeans, Jews, Persians and Muslims. The Arabic translators of Greek philosophical or scientific texts were not simply dealing with a dead culture, but with a living tradition still involving active scholars.

[61] See (Lemay 1962, 1963, 1977; Burnett 2001) and the discussion in (Glick 2005, 313 ff.).

[62] For a comprehensive study of the relation between translation and globalization, see (Cronin 2003), who emphasizes the importance of translation in processes establishing hegemony and its antagonisms. The transformative and generative power of translation in the context of globalization processes has been stressed by (Ning 2008, 75–87).

Successful translation movements typically involve several phases of translation activities, where, in the first phase, the emphasis is on linguistic challenges. In the second phase, it may shift to challenges of content due to the gradual build-up of an autonomous intellectual culture able to deal with the newly acquired knowledge, as was the case for the Greek-Arabic translation movement. Often translations proceed with an alternation between oral explanation and written documentation. This was the case for the translation of Buddhist texts into Chinese, and later for that of European scientific texts into Chinese. Translation processes involve, in any case, a combination of competencies that often require intercultural cooperation. They also involve a negotiation about different and often mutually exclusive goals. These goals range from a faithful rendering of the original linguistic structure to the reconstruction of the original content with new means in a new medium. As a consequence, either basic knowledge about the content is transformed and partly lost in translation, or its original linguistic representation is distorted, interfering with the possibility of rendering certain higher-order connotations of the original meaning. These connotations are in fact often represented by semantic links within the wider field of language and hence reside in the context rather than in the text. (A perfect translation is only really possible when it is no longer necessary.)

When, for instance, a new terminology is created to faithfully render the "technical" contents of an original source in the target language, then this terminology has little chance of resonating in the same way with a semantic context in the new language as the original terminology could within the source language. Conversely, the creation of such a new terminology may create new semantic fields, hence effectively changing the target language in a way that is shaped by the transmitted contents. This was the case for many Asian languages as a result of the transmission of Buddhism. Similarly, while the early modern translations of European scientific texts into Chinese had little immediate impact on the Chinese knowledge system, they did help to prepare the linguistic ground for the appropriation of European science more than two hundred years later.[63]

This case also illustrates another limit of the translation process: the communicability of higher-order knowledge specific to the source culture. The Chinese rendering of early modern European scientific texts typically resulted in compilations and hybridizations of several texts rather than translations of a single one.[64] In these Chinese versions of European scientific knowledge, the deductive structure prominent in some of the original sources is de-emphasized or even omitted. There was in fact no corresponding structure for organizing knowledge in the Chinese tradition that offered itself for a mapping of European-style deductivism. A mere linguistic rendering of this structure within the Chinese language, which was of course possible, could do little to implement this structure within the Chinese system of knowledge. Translations of single texts, even when performed as part

[63] See (Amelung 2001).
[64] See chapter 11.

of a translation movement, are operations within the realm of individual knowledge and have limited impact on the fate of the shared knowledge of a culture. Paradoxically, precisely the adequate transfer of higher-order knowledge by way of translating texts can succeed only if more primary knowledge is transferred as well, along with the social structures for its generation and transmission, so that the dominant epistemic constellation may change and no longer hinder a more comprehensive transfer of knowledge.

The dominant epistemic constellation, however, is hardly ever directly destroyed by knowledge spreading as a fellow traveler but rather determines, conversely, how incoming knowledge is selected, rejected, or appropriated. This is not to say, however, that it may not be undermined by knowledge "smuggled" in. When the Jesuits brought European scientific knowledge to Ming China, mainly the parts that resonated with the Chinese *Herrschaftswissen* were filtered out; these included military technology, calendar making, geography, and so on. Similarly, Greek-speaking scholars appropriated new scientific knowledge, for instance about Newtonian science, neither with the effect nor even the intention of changing the dominant epistemic constellation from which they benefitted as an intellectual and political elite of the Ottoman Empire.[65] They rather selected those parts of modern knowledge that were most suited to the reinforcement of their traditional Aristotelian philosophical views. As a result, the system of knowledge constituted by early modern European science was neither transferred completely nor in part, but was instead entirely disassembled under the spell of a different epistemic constellation. Yet in both cases, the transfer of new knowledge did eventually help to create the conditions for a change in that epistemic constellation when this actually took place for other, political, economic and military reasons.

In the nineteenth and twentieth centuries, European imperialism, colonialism and later decolonization were among the most significant driving forces for major changes in epistemic constellations in connection with the introduction of Western science in non-European regions. Indeed, the expansion of modern science was linked with European colonial expansion, just as the spread of religion was often linked with the building and expansion of empires. In India, North Africa and the Middle East, for example, the transmission of European knowledge only worked on a major scale—at least if compared to that of previous centuries—because it was now part of a system change. Now the new knowledge arrived with new structures of power, new educational institutions, with career opportunities despite conditions of inequality, with a growing autonomy of local knowledge production, and with the promise that the new influx of knowledge would eventually help to overcome the conditions of submission, expropriation and repression created by the imperialist powers. In many Islamic societies in the nineteenth century, for example, European educational institutions gradually gained more importance than the traditional ones, providing students with access to Western science. A similar development took place in India and other colonized territories, fostered by

[65] See chapter 14.

a variety of motives, from missionary goals to the need for the colonizing powers to educate a technocratic elite and ensure the governmentality of the occupied lands. Modern educational institutions were introduced to train technical personnel for public works and engineering useful for the colonial state.[66]

The transmission of new technological and scientific knowledge under the conditions of external pressure often provoked an immune response, mobilizing or newly inventing local knowledge traditions.[67] Their purpose was to create a second-order epistemic framework in which the appropriation of the new knowledge could be interpreted as a reinforcement rather than an alienation of the local cultural identity. In India, for instance, such a mobilization led to attempts to revive and reinterpret traditional Ayurvedic medicine in terms of Western medical and pharmaceutical knowledge. In China, the challenge of new knowledge was addressed by reinterpreting it as a return and revival of lost ancient Chinese knowledge. Similarly, in certain Koran interpretations, telephones, planes or electricity are conceived as having already been predicted in the holy text. Also due to such immune responses, the transmission of Western technological and scientific knowledge did not automatically function as the conduit for a Western-type modernization, including a secularization in which such knowledge is expected to undermine religious or other traditional belief systems. Ultimately, however, the promise of modernization due to technological, economic and social development associated with the transmission of Western science usually overrode attempts to interlace it with local knowledge traditions, unless the latter turned out to be useful in compensating some of the pitfalls of colonization and modernization. One example is the appropriation of local agricultural products by Western settlers and colonizers with the help of indigenous populations.

Eventually, and in particular in the process of decolonization and the emergence of the new, post-colonial nations, it was the educational and academic institutions rather than the knowledge structures and contents themselves that were localized in the sense of being tuned to the goals of political and economic autonomy associated with scientific and technological self-reliance.[68] Thus, as the example of post-colonial India illustrates, new epistemic constellations emerged that were modeled on the Western paradigm, but situated in an environment with substantially different preconditions for their penetration to society at large, beyond the social stratum of post-colonial technocratic elites. As a consequence, epistemic islands are formed, for example, large scientific centers where mission-oriented research is pursued. These epistemic islands are linked to their home society predominantly by top-down mechanisms of political, economic and military control. At the same time, these islands are part of the network of globalized science, with external links of communication and cooperation prevailing over in-

[66]For case studies dealing with the African situation, see (Omenka 1989; Ndongmo 2007). Valentin Y. Mudimbe calls the colonial education system "violence" (Mudimbe 1997, 61).
[67]See chapter 15.
[68]See chapters 15 and 18.

ternal ones. Within this global network, the epistemic islands of the larger South play a peripheral, but creative, role in international knowledge production; this is due as well to their remoteness from the intellectual control mechanisms, such as peer pressure dominating at the more central nodes.[69]

From the beginning of the twentieth century, with the failure to generalize and spread the dynamics of modernization beyond privileged islands, shared epistemic frameworks associated with religious and other traditional belief systems stood a chance of reactivation. Shared epistemic frameworks, such as those of traditional Islam in North Africa and the Middle East had been marginalized, but were still lingering in the background.[70] Now the immune reaction could become a rejection reaction, not so much specifically of the knowledge transferred from "outside," but rather of the dynamic and threatening role of knowledge more generally, even that rooted in the traditional belief systems themselves. While religious fundamentalists may be open to the use of advanced technologies and other assets of the modern world, they are indeed radical in their rejection of any possible impact of any kind of knowledge on the fundamental principles of their belief system. Paradoxically, they have driven the Western logic of enlightenment, which they reject, to its extreme. The split between factual and normative knowledge, traditionally considered to be an achievement of Western Enlightenment, thus has turned into the ultimate immunization scheme for protecting the epistemic core of fundamentalist belief systems against the unsettling effects of the transmission and appropriation of new knowledge.

9.9 Science as an Insular Phenomenon

In summary, for most of human history knowledge has been a fellow traveler in the sense of being subject to political, economic or religious interests rather than being itself the main driving force of societal developments. Knowledge spread with the rise and expansion of empires, along trade routes, and with the diffusion of religious belief systems. Its transmission was thus largely subject to extrinsic dynamics, which also determined its constitution in terms of systems or packages of knowledge. Nevertheless, the spread of knowledge as a fellow traveler also unfolded significant intrinsic dynamics that affected later phases of the globalization of knowledge. The transmission of knowledge may exhibit a self-reinforcing quality, strengthening the significance of knowledge as it proceeds. The spread of knowledge stimulated, for instance, the creation of new media and new institutions for its transmission. Also the production and spread of knowledge enhanced the conditions for other, extrinsic expansion processes such as conquest and colonization, which in turn fostered the globalization of knowledge, but at the same time, also its destruction.

[69] Developing countries have adopted different strategies for science policy with varying degrees of success. For a review, see (Gibbons et al. 1994, 132–33).

[70] For more on this, see (Eisenstadt 2000).

Religious belief systems, and in particular the world religions, often represent another fellow traveler of political, economic and military expansion. And yet, their spread is also subject to significant intrinsic dynamics due to their potential autonomy from societal rule, their self-referential traditions of religious learning and their universalist claims. For this reason, they have become increasingly effective carriers of knowledge as a fellow traveler than empires or commerce. But religions (or quasi-religious belief systems, such as nationalism) have had an even deeper impact on the globalization of knowledge. As collective representations of shared basic human experiences, in an essential way they shape the dominant epistemic constellation determining the place of knowledge in a society under their spell and hence also the boundary conditions for any transmission of knowledge. In comparison with the success of religions as forms of shared meta-knowledge, the rise of higher-order knowledge resulting from a reflection on material interventions leading to science was historically rather exceptional. The survival of such scientific knowledge depended strongly, moreover, on resonance effects with the dominant epistemic constellation, as it took place in early modern Europe (see section 9.4). Only when these resonance effects lasted sufficiently long could such higher-order knowledge about the material world in turn affect the dominant epistemic constellation—with powerful implications. Against this background, it becomes understandable why scientific knowledge emerged several times in history, but only once achieved a lasting global impact on human development.

The systems of modern scientific knowledge spread as fellow travelers of political, economic, military and religious processes too. They also spread, of course, by way of self-accelerating intrinsic dynamics constituting globalized science with its worldwide network of institutions, its advanced communication technologies and its fundamental role for world economy. But even when science becomes globalized, it may still constitute a merely insular phenomenon within a given society and hence remain a fellow traveler of other societal processes, with the consequence that its reflective dimension and transformative power are largely cut off. Accordingly, both spreads may affect societies only on the surface because they do not necessarily involve a change in the dominant epistemic constellation. Indeed, the spread of modern scientific knowledge takes place within a historically shaped landscape still characterized by diverse epistemic constellations. These constellations as a rule do not exhibit the same resonance effects that were at the origins of the emergence of Western science and its transformative power. While locally dominant epistemic constellations may no longer regulate the global network of science, they do determine the place of knowledge in the local society at large. However, since the impact of modern science on a given society is no longer necessarily mediated by its dominant epistemic constellation but by encompassing globalization processes, the retroaction of scientific knowledge on the local epistemic constellation is also no longer immediate. In other words, the dynamics of the globalization of science and of knowledge in a more encompassing sense are

effectively decoupled from each other—at least as long as knowledge remains a fellow traveler.

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