

1381); *al-Iktisād fīmā yata'allak bi 'l-i'tikād*, Beirut 1406; *al-Amālī*, Nadjaf 1384; *Uddat al-uṣūl*, Nadjaf 1403 (these three last works concern *ḥadīth* and dogma); *al-Mabsūṭ fi 'l-fikḥ*, ed. Biḥbūdī, repr. Tehran 1387-8; *al-Nihāya fi muḍjarrad al-fikḥ wa 'l-fatāwā*, Beirut 1390; *al-Djūmal wa 'l-ukūd fi 'l-ibādāt* (with introd. and Persian tr. by Wā'iz-zāda, Mashhad 1374; *Misbāḥ al-mutahaddīd* (in two versions—*al-kabīr* and *al-saghīr*—on Imāmī piety, Tehran 1398; (the two works entitled *Du'ā' al-djauṣḥān al-kabīr* and *al-djauṣḥān al-saghīr*, mentioned by Hidayet Hosain in *El'*, are not al-Ṭūsī's and are probably drawn from the *Misbāḥ* of al-Ka'fāmī [9th/15th century]).

Bibliography: Since the biographical dictionaries are compiled in alphabetical order, it will be sufficient to refer to these *s.n.* Ṭūsī or Muḥammad b. al-Ḥasan al-Ṭūsī; see among others Ibn Shahrāshūb, *Ma'ālim al-ʿulamā'*, Tehran 1934; ʿAmilī, *ʿĀyān al-shīʿa*, Damascus-Beirut 1935-63; Ardabīlī, *Djāmi' al-ruwāt*, Kumm 1953; Hillī, *Riḍāʾ*, Nadjaf 1961; Baḥr al-ʿUlūm, *al-Fawā'id al-riḍā'iyya*, Nadjaf n.d. Among the Sunnī dictionaries, see e.g. Ibn Ḥaǧǧar, *Lisān al-mizān*; Ziriklī, *A'lām*; Kātib Celebī, *Kashf al-zunūn*; [Subkī, *Tabaqāt al-shāfi'iyya*, iii/51 (al-Ṭūsī is regarded here as a Shāfi'ī; one wonders whether this was a tactical dissimulation on his part, from the period when he was still living in Kḥurāsān)]. Among historiographical works, see *sub anno* 448 (flight of al-Ṭūsī to Nadjaf) or 460 (year of his death), e.g. Ibn al-Aṭṭār, *Kāmil*; Ibn al-Djāwzī, *Muntaẓam*; Ibn Kaṭṭār, *Bidāya*; Ibn Khallikān, *Wafayāt*; Ibn al-Imād, *Shadḥarāt*. See also Ibn al-Nadīm, *Fihrist*, Tehran 1971, index, s.v.; al-Khaṭīb, *Tārīkh Baghdād*, ii, 184-217.

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(MOHAMMAD ALI AMIR-MOEZZI)

AL-ṬŪSĪ, NAŠĪR AL-DĪN, ABŪ DJĀ'FAR MUḤAMMAD b. Muḥammad b. al-Ḥasan, also called Muhakkīk-i Ṭūsī, Kh^āadjā-i Ṭūsī or Kh^āadjā Našīr al-Dīn, the most important and influential Shī'ī scholar in the fields of mathematics, geometry, astronomy, philosophy and theology, styled in later times *al-mu'allim al-thālith* 'the third teacher' (i.e. after Aristotle and al-Fārābī).

1. Life.

He was born on 11 Djumādā I 597/17 February 1201 in Ṭūs, in the neighbourhood of Mashhad, into a family who, according to al-Kh^āansārī (*Rawḍāt al-djannāt*, vi, 300, l. 11) originated from Djahrūd Sāwa near Kūm(m). He received his Imāmī education in Ṭūs and died in Baghdād on 18 Dhu 'l-Hijja 672/25 June 1274.

Under the guidance of his father Wadīh al-Dīn Muḥammad b. al-Ḥasan al-Ṭūsī, a respected jurist, al-Ṭūsī enjoyed his first education in Arabic, Qur'ān, *Ḥadīth*, and above all, in jurisprudence following the doctrine of the Shī'ī 'Alam al-Hudā al-Sharīf al-Murtaḍā (d. 436/1044), an adversary of the Mu'tazilī 'Abd al-Djabbār. His father's wide range of interests stimulated al-Ṭūsī to study the various sciences and doctrines, including philosophy and the Ismā'īlī doctrine. He continued his studies first at Nīshāpūr, between 610/1213 and 618/1221. Here Kutb al-Dīn al-Mīṣrī and Farīd Dāmād, both pupils of Fakḥr al-Dīn al-Rāzī, were his teachers in mathematics, natural sciences, Ibn Sīnā's philosophy and medicine. Leaving Nīshāpūr, al-Ṭūsī went to ʿIrāq, where he studied jurisprudence with the Shī'ī scholar Mu'īn al-Dīn Sālīm b. Badrān al-Māzinī. Later he studied at Mawṣil with the mathematician and astronomer Kamāl al-Dīn Yūnus (551-639/1156-1242; Brockelmann, S I, 859), who had himself been a pupil of the scholar Bābā Afḍal [q.v.].

In 630/1233, after finishing his studies, al-Ṭūsī found in Sartakḥ, in the province of Kūhīstān, a patron in the Ismā'īlī governor Muḥtasham Našīr al-Dīn 'Abd al-Raḥīm b. Abī Mansūr. He had been studying the *Fuṣūl-i muḥaddas* of the Nizārī Ismā'īlī Imām Ḥasan 'alā Dhikrihi al-Salām (d. 561/1166) and had then turned to the Ismā'īlī faith. During this period, he wrote the *Akhḥāk-i Nāšīrī* (see below), a work on ethics named after the governor Našīr al-Dīn. The first version was finished in 633/1245. Shortly afterwards, ca. 644/1246 he published his spiritual autobiography, *Sayr wa-sulūk*, in which he describes how he came to turn away from exoteric *kalām* and to profess Ismā'īlī esoteric philosophy. In ca. 644/1246 we find al-Ṭūsī in Alamūt [q.v.], the fortress of the Assassins. It is unclear whether he travelled there only as companion of Našīr al-Dīn (so Badakhchānī, 5, cf. Dabashī, *The philosopher/vizier*), or whether he had incurred the disgrace of Našīr al-Dīn and had been banned to Alamūt. It may be that, in the face of the uncertain political situation, and perhaps also out of dissatisfaction with his Ismā'īlī surroundings, he had the ambition of getting admission to the court of the last 'Abbāsīd caliph al-Musta'ṣim bi'llāh [q.v.] (r. 640-56/1247-58) in Baghdād. In any case, al-Ṭūsī stayed for about twenty years in Alamūt and Maymūndiz [q.v.]. During these long years, he was able to use the rich library there for his scientific works. In 653/1255 the Ismā'īlīs sent him as negotiator to Hūlegü, the khān of the Mongols who was preparing the conquest of Persia. In the face of the hopeless situation of the Ismā'īlīs *vis-à-vis* the Mongol superiority, al-Ṭūsī convinced the Ismā'īlī ruler Rukn al-Dīn Khurshāh [q.v.] that he should submit to the Mongols; in 654/1256 Alamūt fell into their hands anyway. The shattering of the Ismā'īlī movement was followed by the conquest of Baghdād, which al-Ṭūsī could not prevent (the accounts about his role are not unequivocal, cf. Hairī), and by the fall of the caliphate, detested by the Shī'īs. Al-Ṭūsī accompanied Hūlegü on his conquests in the west, and witnessed both the fall of Baghdād on 3 Šafar 656/10 February 1258 and the murder of the caliph. Owing to al-Ṭūsī, and probably also to Ibn al-ʿAlkamī, the Shī'ī vizier of the last 'Abbāsīd caliph, upon their occupation of Mesopotamia, the Mongols spared to a large extent the Shī'ī sanctuaries. It is possible that Hūlegü, already before the conquest of Baghdād, entrusted al-Ṭūsī with important duties, such as the administration of all religious foundations (*wakf*) and of the finances. In 1259, almost sixty years old, he

began in Marāgha, near Tabriz, the construction of an observatory whose director he became; and he also prepared the astronomical tables (*al-ẓīj al-Ilkhānī*), which he finished at the age of about seventy under Hülegü's successor, the Il-khānid Abaqa (663-80/1265-82) (see 3, below). During this period, al-Ṭūsī was in contact with a great number of scholars who came to Marāgha, not least because of the rich library which was being built there since Hülegü had begun to carry off the stores of libraries in Mesopotamia, Baghdad and Syria. In some biographies, the following names of scholars are mentioned who, among others, are said to have been to Marāgha: Barhebraeus (Abu 'l-Faraj Ibn al-'Ibrī), Fakhr al-Dīn al-Khī/alāfī from Tiflis, Fakhr al-Dīn al-Marāghī al-Mawṣilī, Ibn al-Fuwaṭī ('Abd al-Razzāk b. Aḥmad b. Muḥammad al-Shaybānī), Mu'ayyad al-Dīn al-'Urḍī al-Dimashqī, Muḥyī al-Dīn al-Maghribī (Ibn Abī 'l-Shukr), and Naḍīm al-Dīn Dabīrān al-Kāzwinī al-Kātibī (who held a scholarly discussion with al-Ṭūsī on metaphysical questions, on *wāḍiḥ wa-wuḍūd* [see WUDJUD] and on logic; see the *Muṭārāḥāt* in the bibliography of al-Ṭūsī's works). In this list, the name of Kuṭb al-Dīn al-Shīrāzī, the most important commentator of the *Tadhkira*, al-Ṭūsī's astronomical work, is missing, perhaps because he had criticised al-Ṭūsī's work, in particular in the field of philosophy, and because he is said to have denounced him to Hülegü (Wiedemann, 711). For an unknown reason al-Ṭūsī, shortly before his death, left Marāgha "with many of his pupils and followers" and went to Baghdad, where he died some months later (al-Kutubī, iii, 251, 12-13). He is said to have been buried there, according to his testament, near the tomb of Mūsā al-Kāzīm.

2. As theologian and philosopher.

Al-Ṭūsī was an extraordinarily prolific scholar. The list of his extensive oeuvre shows titles on astronomy, astrology, geomancy, mathematics, physics, mineralogy, medicine, jurisprudence, philosophy including logic, mysticism and theology (a first survey in Wiedemann, 707-27; Brockelmann, see *Bibl.*; Mudarrisī Zandjānī, *Sargudhasht*; Radawī, *Aḥwāl*; and Mu'in, *Naṣīr al-Dīn Ṭūsī*). Al-Ṭūsī wrote the greater part of his philosophical works in an Ismā'īlī environment. His first patron, the above-mentioned Ismā'īlī governor Muḥtasham Nāṣir al-Dīn 'Abd al-Raḥīm, was particularly interested in ethics. On his behalf, al-Ṭūsī translated into Persian *al-Adab al-wāḍiḥ li'l-walad al-saghīr* of Ibn al-Mukallāf [q.v.], a small treatise on the correct behaviour of children (its authenticity is doubtful, see Brockelmann, S I, 236 no. 6; ed. Dānīshpazūh in his edition of the *Ahlāk-i Muḥtashamī*; see the table of contents in Dabashi, 561-2). Muḥtasham also requested al-Ṭūsī to finish a draft of practical ethics, which he had conceived and begun. This *Ahlāk-i Muḥtashamī*, based on Muḥtasham's concept and notes, composed around 630/1233 and published under al-Ṭūsī's name, exists in an Arabic version (ed. Beirut 1981), to which in the original a Persian translation is attached, published by Dānīshpazūh, Tehran 1960, 1982. It consists of forty chapters, dealing first with the knowledge of God, with prophecy and imāmate, then mainly with the virtues of the pious and the Ṣūfī, described in each chapter one after the other with references from Qur'ān, *Hadīth* and Sunna, from poetry and the sayings of "wise people/philosophers and Ismā'īlī propagandists" (*al-ḥukamā' wa 'l-du'āt*) (cf. Dabashi, *Kh'ājah*, 559-61). It has been suggested that the work was composed as a guide for preachers and teachers (Badakhchani, 57-8). Al-Ṭūsī's ethical work *Ahlāk-i Nāṣirī*, written two years later for Muḥtasham

Nāṣir al-Dīn, has a more philosophical character. Two decades later, after the rupture with the Ismā'īlīs, al-Ṭūsī published it again with a different beginning and different conclusions, and without the dedication to Muḥtasham Nāṣir al-Dīn (cf. Badakhchani, 61, n. 30). Just like the lesser-known *Gushayish-nāma*, which deals with the esoteric aspects of ethical virtues, the *Ahlāk-i Nāṣirī* is written in the spirit of Ismā'īlī ideology. The first part is based on Miskawayh's ethical work *Tadhīb al-akhḫlāk*, which in turn is marked by Aristotle's Nicomachian ethics, but also by Platonic and Neo-Platonic teachings (Fakhry, 107-30). The first part is followed by two sections on domestic economy (*tadbīr al-manzil*) and politics (*siyāsāt al-mudun*), in which al-Ṭūsī each time mainly used Ibn Sīnā's *K. al-Siyāsa*, Bryson's *Oikonomikos*, al-Fārābī's *al-Siyāsa al-madaniyya*, the latter's *Fuṣūl al-madaniyya*, and Miskawayh's *al-Hikma al-khālida* (cf. Madelung, *Naṣīr ad-Dīn*; the analytical table of contents in Donaldson, 169-82; Fakhry, 131-42; Dabashi, 562-8). Because of its practical orientation, his work has had a lasting influence and has increasingly been popularised: al-Dawwānī [q.v.], *Ahlāk-i Djalālī* (= *Lawāmī' al-ishrāk fī makārim al-akhḫlāk*); al-Idjī [q.v.], *Risālat al-akhḫlāk* (unpublished; *Elr*, i/2, 1985, 722-3); al-Kāshifī [q.v.]; *Ahlāk-i Muḥsinī*; Aḥmad b. Muḥammad Mahdī al-Narāqī [q.v.], *Mir'āḍ al-sāda* (lith. Tehran 1883, new ed. n.p. 1993) (on the contents of this work, which is a slightly revised Persian tr. of his father's *Djāmī' al-sādat*, ed. Sayyid Muḥammad Kalantar, i-iii, Beirut 1985, see Donaldson, 190-2); S. Jalal al-Dīn Mojtābavī (who translated the *Djāmī' al-sādat* into Persian), *Religious ethics and Narāqī's innovations in his moral book, Jāmī' al-sādat* (*The collection of felicities*), in *Contacts between cultures. Selected papers from the 33rd International Congress of Asian and North African Studies, Toronto, August 15-25, 1990*, i, ed. A. Harrak, Lewiston, Queenston and Lampeter 1992, 351-2; Cole, 7 ff.; 'Ubayd al-Zakānī, *Ahlāk al-ashraf* (composed in 740/1340-1; *Elr* i/2, 1985, 723).

Probably the most important testimony to al-Ṭūsī's Ismā'īlī-oriented philosophy is his *Rawḍat al-taslim yā taṣawwuwāt*, an ethico-eschatological guide for travelling from the physical to the spiritual world. Following the Neo-Platonic doctrine of emanation, the work contains a description of Ismā'īlī cosmology; the will of the unknowable Divinity. His command (*amr*) and word (*kalima*), embodied in the Imām or in the latter's prototype 'Alī b. Abī Ṭālib, communicate themselves through emanation (*faḍl*) to the first intellect, to the 'akl al-fa'āl or to the *ḥudūdīya*, whose prototype is Salmān al-Fārisī; from this emanates the universal soul (*nafs-i kullī*), the *dā'ir*, i.e. the Prophet Muḥammad, followed by the human soul. Linked to this cosmology appears the Ismā'īlī theory of the imāmate, the doctrine of *satr*, the period of concealment of *ḥakīka* in the *bāṭin* and *ḫiyāma*, the period of the *ḫā'im* who possesses truth (cf. Daftary, *The Ismā'īlīs*, 409 ff.). The fact that the Imām necessarily possesses complete knowledge renders both his existence and the total self-surrender to him compulsory. A prerequisite is the observation of the religious duties, not only by following the *Shari'a*, but also in an esoteric way and in the ascent of the soul from the position of potentiality to "the perfection of the ascertainment of the reasoned knowledge" (*kamāl-i taḥkīk 'ilm-i 'aklī*) (cf. *Rawḍa*, *taṣawwuf*, no. xxvi).

In ca. 664/1264 al-Ṭūsī expressed his views on the theme of ethics for the last time, now in the spirit of the Ṣūfīs, whose movement became popular in the period of the Mongols. At the request of the vizier Shams al-Dīn Muḥammad Djuwaynī, he composed

the treatise *Awṣāf al-aṣṭarāf*, a guide for the Ṣūfī on the path from belief (*īmān*) to union (*waḥda*) and extinction (*fanā*) of the self into God (Madelung, *Naṣīr ad-Dīn*, 98-101; Dabashi, 568-9; Strothmann, 68-77). The approach to God results here from the behaviour of the Ṣūfī, whereas the correspondence (*murāsala*) between Ṣadr al-Dīn al-Ḳūnawī [q.v.] and al-Ṭūsī (ed. Schubert) deals with the relation between philosophical and mystical knowledge of God.

In this correspondence, which perhaps took place during al-Ṭūsī's stay in Marāgha and which was criticised by the Ḥanbalī theologian Ibn Taymiyya [q.v.] (see Michel, 12), al-Ṭūsī, among other things, goes into Ṣadr al-Dīn al-Ḳūnawī's question about how out of one thing many things can emerge, whereas from one thing only one thing can emerge (Schubert, 31-2; Chittick; Heer). Al-Ṭūsī's arguments are based on the Neo-Platonic doctrine of emanation, according to which plurality is the result of many causes which presuppose one another, but which therefore in the end go back to only one cause. This problem, which al-Ṭūsī treated in different ways in the course of his life (cf. Siddiqi, 577-8), is already found in his commentary on Ibn Sīnā's *al-Iṣṭarāt wa 'l-tanbihāt*, in which he defends Ibn Sīnā against Fakhr al-Dīn al-Rāzī [q.v.], that is to say in his *Hall mushkilāt al-Iṣṭarāt* (iii, 244-5; cf. Heer), composed around 644/1246 at the request of Muḥtaṣam Shihāb al-Dīn. It is also found in his *Risāla fi 'l-'ilal wa 'l-ma'lūlāt*, again extensively in a letter written in Dhu'l-Ḳa'dā 666/July 1268 and addressed to the judge of Harāt (ed. Dāniṣpazhūh, *Siḥ guftār*, 6-13), and finally in his *Maṣārīf al-muṣārīf*, a refutation of al-Shahrastānī's *al-Muṣārā'a*, in which al-Shahrastānī had criticised Ibn Sīnā's notion of God and his ontology. Among other things, he had attacked Ibn Sīnā's thesis according to which only one being can emerge from the absolute unique one (cf. Madelung, *As-Sahrastānīs Streitschrift*, esp. 254-5; idem, *Aspects*, Hartmann, 199-200). Al-Ṭūsī must have written this refutation of al-Shahrastānī's Ismā'īlī doctrine at a later stage of his life, when he had turned away from the Ismā'īliyya, that is to say, after 254/1256 when Alamūt fell into the hands of the Mongols. Ibn Sīnā's metaphysics come to the fore, taking the place of the Ismā'īlī norm of the prophets; they form the basis of al-Ṭūsī's theology (cf. Dabashi, *Khawāṣṣ*, 555-7), namely of the *Kawā'id al-akā'id*, and of the *Tadqīd al-ittikād*. The latter work has become authoritative in Twelver Shī'ī circles and has been commented upon several times (see *Bibl.*). In this context, it is important to note that al-Ṭūsī, notwithstanding his growing sympathy for the Twelver Shī'ī'a (cf. also his *Fitkādiyya*, a summary of undisputed Shī'ī doctrines (see for this Dabashi, *Khawāṣṣ*, 557), remained faithful to many Ismā'īlī doctrines. This is shown e.g. by the *Kawā'id al-akā'id*, partly a rendering into Arabic of what he had said earlier in his Ismā'īlī-influenced autobiography *Sayr wa-sulūk*. Yet, even al-Ṭūsī's last work, the *Talkhīs al-muḥaṣṣal* written in 669/1271, an epitomising commentary on Fakhr al-Dīn al-Rāzī's *Muḥaṣṣal afkār al-mutakaddimīn wa 'l-muta'akhkhirīn min al-'ulamā' wa 'l-hukamā' wa 'l-mutakallimīn*, still defends the Ismā'īlī doctrine of *ta'lim* and rejects the Shī'ī doctrine according to which the *naṣṣ* (designation) of the Imām can be cancelled by *badā'* (changeability of God's will). The Ismā'īlī and Shī'ī inheritance does not obscure the fact that al-Ṭūsī has become an important pioneer for Ibn Sīnā's philosophy; modifications in details can be detected here (cf. Qarā'ī, 29-30, where al-Ṭūsī's sympathies for the Shaykh al-Ishrāk al-Suhrawardī are mentioned). As witnesses of Ibn Sīnā's

influence may be mentioned his *Maṣārīf al-muṣārīf*, *Tadqīd al-akā'id*, *Kawā'id al-akā'id* and, above all, *Hall mushkilāt al-Iṣṭarāt*; furthermore, al-Ṭūsī's Persian representation of Porphyry's *Isagoge* and of Aristotle's logic, the *Asās al-iktibās* (for the concept of substance in this work, see Morewedge, *Analysis of "Substance"*). Fourteen years later, al-Ṭūsī composed in Arabic a considerably shortened version under the title *Tadqīd al-manṭiq*. It is therefore not surprising that the Ḥanbalī theologian Ibn Ḳayyim al-Djāwziyya [q.v.] followed the criticism of his teacher Ibn Taymiyya (see above) and that he, in his *Ighāthat al-lahfān min maṣā'id al-shaytān*, considered al-Ṭūsī as the most pernicious hidden atheist, for whom the Ḳur'ān is said to have been "the scripture of the masses (*Ḳur'ān al-'awām*) but Ibn Sīnā's works the scripture of the élite" (*Ḳur'ān al-khawāṣṣ*) (Perlmann 334; cf. Madelung, *As-Sahrastānīs Streitschrift*, 258 n. 8).

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(H. DAIBER)

3. As scientist.

Al-Ṭūsī was one of the major intellectual figures of 7th/13th century Islam, and his works, in fields ranging over the religious sciences, philosophy, and the mathematical sciences of Antiquity continued to have a significant effect upon the intellectual traditions of Eastern Islam well into the modern period. His influence and prestige are fittingly recorded in the titles, honorifics, and nicknames applied to him: *kh'āḍja* (distinguished scholar and teacher), *ustādh al-baṣṣar* (teacher of mankind), and *al-mu'allim al-thālith* (the third teacher).

He tells us in his autobiography, written in his forties, that in addition to his religious education, his father encouraged him to pursue the teachings of other sects as well as the ancient fields of learning represented by the philosophical and mathematical sci-

ences. He began studying philosophy (*ḥikma* [q.v.]) and mathematics with a certain Kamāl al-Dīn Muḥammad al-Ḥāsib in Ṭūs; later, he travelled widely to continue his education. He first went to nearby Nishāpūr to study with the noted physician Kuṭb al-Dīn al-Miṣrī and with the polymath Farīd al-Dīn Dāmādh. Among other things, he studied there the works of his famous Persian predecessor Ibn Sīnā [q.v.] (Avicenna), who was undoubtedly one of his most important formative influences. Later he journeyed to Irāk to read under the Shīʿī legal scholar Muʿīn al-Dīn Sālīm b. Badrān al-Miṣrī and study with Kamāl al-Dīn b. Yūnus (551-639/1156-1242 [see MASĀʿIL WA-ADJWIBA, at Vol. VI, 638a]), a renowned Shāfiʿī legal scholar who was also noted for his expertise in astronomy and mathematics; being a Shīʿī did not prevent him from studying with persons of different sectarian affiliations.

After completing his formal education, Naṣīr al-Dīn found patrons at the Ismāʿīlī courts in Persia [see ISMĀʿĪLYYA] beginning sometime in the early 630s/1230s. He would spend some 25 years in Kāʾin (in Kūhistān and at Alamūt) until the fall of the latter to the Mongols in 654/1256 (see above, 1.). Whether al-Ṭūsī was a willing convert to Ismāʿīlism, as he stated in his early autobiography *Sayr wa-sulūk* (Tehran 1335 *q.*/1956), or whether this was a necessary pretence brought about by his need for patronage and protection, was, and continues to be, a matter of dispute. In any event, during this period of his life al-Ṭūsī found a refuge from the disruptions of the Mongol invasions and produced some of his most important work.

With the fall of Alamūt, al-Ṭūsī, who had already gained considerable fame, joined the entourage of Hüleḡü/Hülāḡū [q.v.], becoming court astrologer as well as director of religious endowments (*awḳāf*). In the former capacity, he accompanied the Il-Khān on the campaign against Baghdad and witnessed the end of the ʿAbbāsīd caliphate. Later he oversaw the construction of an astronomical observatory [see MAR-ṢAD] and its instruments in the town of Marāgha [q.v.], the Mongol headquarters in Ādharbāyḏjān, and became its first director. Because of the substantial resources placed at his disposal (including religious endowments), this observatory, which also comprised a large library and school, was one of the most ambitious scientific institutions established up to that time. It attracted many famous and talented scientists and students (including, it is reported, Chinese astronomers), and, despite lasting only fifty years, its intellectual legacy had repercussions from China to Europe for centuries to come.

Al-Ṭūsī's prose writings, which number over 150 works, represent one of the largest collections by a single Islamic author. Writing in both Arabic and Persian, Naṣīr al-Dīn dealt with both religious ("Islamic") topics and non-religious or secular subjects ("the ancient sciences"). He was especially attracted to the exact mathematical sciences (especially astronomy and pure mathematics). Beyond their utilitarian value (and astrology in particular was considered immensely useful by al-Ṭūsī's patrons), their certitude was seen by him and others as an important means to the truth of God's creation; indeed, some Islamic scientists argued that it was a surer means than natural philosophy or theology. In this they followed the Alexandrian tradition of ancient Hellenistic mathematical science, represented most conspicuously by Claudius Ptolemy (2nd century A.D.) [see BAṬLAMİYŪS], who had argued against Aristotle's [see ARISTŪTĀLĪS] philosophical view and for the superiority of the mathematical sciences.

Among al-Ṭūsī's most important and enduring contributions to the mathematical sciences were his recensions (*taḥārīr*) of Greek and early Islamic scientific works, which in many ways revitalised the translation movement of 3rd/9th century Baghdad. These included Euclid's *Elements*, Ptolemy's *Almagest*, and the so-called *mutawassūṭāt* (the "Intermediate books" to be studied between the former and latter) with treatises by Euclid, Theodosius, Hypsicles, Autolycus, Aristarchus, Archimedes, Menelaus, Thābit b. Qurra and the Banū Mūsā. Al-Ṭūsī's re-editions, in which he often included insightful and original commentary, provided an opportunity for generations of students of late mediaeval Islam to study and absorb the Greek scientific tradition, either with or without a teacher. This latter point takes on added significance in view of the absence of an ongoing institutional structure for teaching the ancient sciences.

Al-Ṭūsī's monumental role as synthesiser and rejuvenator of the ancient sciences and mathematics was complemented by his original work. His attempt to prove Euclid's parallels postulate was one of the more sophisticated approaches in a long tradition of such attempts. In the 19th century, it was recognised that such "proofs" were not possible and that consistent geometries other than the Euclidian could be constructed. In another field of mathematics, al-Ṭūsī's *al-Shakl al-kaṭṭāʾ* marked a significant step in treating trigonometry as a discipline independent of astronomy, which in many ways was similar to what was accomplished later in Europe by Regiomontanus (1436-76).

However, al-Ṭūsī gained his greatest fame in astronomy. He wrote several elementary treatises on practical astronomy (*taḳwīm*), instruments, astrology, and cosmography (*ʿilm al-hayʾa* [q.v.]). In the main, these seem to have been meant for students. In addition, he compiled a major astronomical handbook in Persian for his Mongol patrons in Marāgha, which he entitled *Ẓīj-i Ilkhāni*. There are indications that it was written in haste, and it seems not to have incorporated the Marāgha observations; nevertheless, it was used extensively for several centuries.

Al-Ṭūsī's most original scientific achievement was in planetary theory. Many Islamic astronomers were disturbed by inconsistencies in the Ptolemaic system; in particular, they objected to the violation of the fundamental physical principle of uniform circular motion in the heavens. Among al-Ṭūsī's contributions toward resolving these "difficulties" (*ishkālāt*) was to devise an astronomical model consisting of two spheres, the smaller of which was internally tangent to the other that was twice as large. Al-Ṭūsī had the smaller rotate twice as fast as the larger and in the opposite direction; he could then prove that a given point on the smaller sphere would oscillate along a straight line. Incorporating this device into his lunar and planetary models, and exploiting the linear oscillation, he was able to reproduce Ptolemaic accuracy while preserving uniform circular motion. These models were first found in his Persian treatise *Hall-i mushkilāt-i Muʿiniyya*, written for his Ismāʿīlī patrons, and were incorporated and further developed in his Arabic work *al-Tadhkira fi ʿilm al-hayʾa*, written during his years with the Mongols. Al-Ṭūsī's new models were quite influential on late mediaeval Islamic astronomy, and for at least another three or four centuries encouraged many other attempts to reform the Ptolemaic system. The "al-Ṭūsī couple", as his device is now known, also had an effect in other cultural contexts, finding its way into Sanskrit and Byzantine texts as well as the works of several Renaissance astronomers, including Copernicus.

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TUSTAR [see *SHUSHTAR*].

AL-TUSTARĪ [see *SAHL AL-TUSTARĪ*].

TŪT (A.), the mulberry, *Morus* spp., of the Moraceae; also *tūth*, said by the lexicographers to be Persian while *fīṣād* is the Arabic synonym. *Tūt al-arḍ* is the strawberry and *tūt al-'ullayk* the raspberry.

The tree is known for its fruit and its leaves. Both *M. nigra* and *M. alba* have been cultivated in southern Europe and the Near East for many centuries. *M. alba*, originating from China, first reached Europe in the 12th century. Its leaves are the preferred food of the silkworm (*dūd al-kazz*), larvae of moths of the Bombyx family, whose cocoons produce silk (*harīr* [q.v.]). *M. nigra* is best known for its fruit. Concerning its medicinal uses, *tūt aswad* is cold and moist; its juice is made into a robb, for swellings of the mouth and for angina (al-Ṭabarī, 382, 482).

Ibn al-Bayṭār equates *tūt* with *mūrā* and *fīṣād* (*Tafsīr*, 155) and its robb as *diyāmīrūn*. He quotes from (a) Galen: when ripe, it loosens the belly, but unripe and dried, is very costive and even useful for ulceration of the intestines and diarrhoea, and its juice for ailments of the mouth; and from (b) Dioscorides, who

calls it laxative, and when cooked in water, effective against the poison of *akūnītūn* [q.v.]. Its leaf, crushed and mixed with oil, is good for burns (*Djāmi'*, i, 142-3). The juice of the raw fruit can relieve toothache (al-Bīrūnī, 96-7). Today, the fruit is eaten raw, and used for conserves and drinks.

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(PENELOPE C. JOHNSTONE)

TUTAK, a plain in eastern Anatolia through which the Murad Su, sc. the more southerly of the two upper arms of the Euphrates, flows in one part of its course between Malazgird and Muş, hence now in the modern Turkish *il* or province of Muş; see further, *AL-FURĀT*. (E.D.)

TUṬĪLA, the Spanish town of Tudela, situated at the confluence of the Ebro and its affluent the Queiles (Kālāsh), now in the Comunidad Autónoma de Navarra and with a population of 26,500.

The Arabic geographers give some details on this *madīna* of al-Andalus, stressing its frontier position against the Christians and its role as *chef-lieu* of a *kūra*, with other towns, fortresses and villages (such as Alfaro, Arnedo, Borja, Calahorra, Nájera, Tarazona and Viguera) in the "Upper March" [see *AL-THUGHŪR*, 2], whose capital (*ḥādīra*) Sarakūṣṭa [q.v.] or Saragossa was "50 miles" (ca. 75 km/46 miles) from Tuṭīla. Some geographers and chroniclers further mention that its foundation as a *madīna* was ordered by the Umayyad *amīr* al-Ḥakam I [q.v.], but from recent archaeological finds, it appears that the place has been inhabited since prehistoric times. Tuṭīla, with a sector of the 9th century and another added in the 10th century, extended over 22 ha.

At that time (sc. end of the 8th century and opening of the 9th one), it was made into a centre for Umayyad control over the northeast of the Upper March against the Christians of Pampeluna and also against the *muwallad* Banū Kaṣī [q.v.], who succeeded in seizing Tuṭīla ca. 198/813 and in establishing there one of the main bastions of their intermittent autonomy from the Umayyads. This lasted till the time of 'Abd al-Raḥmān III, who in 312/924 gave the town to Muḥammad b. al-Anḳar, governor of Saragossa and from the originally Arab family of the Tudjībids [q.v.], whose direct descendants held the town, also with periodic autonomy from the central power of al-Andalus, until 400/1009-10, the date when a collateral descendant of Muḥammad b. al-Anḳar, the Tudjībīd al-Mundhir, governor of Tuṭīla in 396/1005-6, constituted the *ṭā'ifa* of Saragossa, including the rest of the Upper March and also Tuṭīla. In 430/1038, this *ṭā'ifa* was dominated by the Banū Hūd [q.v.] until the conquest of Saragossa by the Almoravids in 503/1110, who were not, however, able to defend this territory from the Christians; in 1119 Alfonso I of Aragon conquered Tuṭīla. The Muslim inhabitants remained there after the conquest as Mudéjars [q.v.] and as Moriscos [q.v.] until their expulsion in 1614.

As an urban centre, Tuṭīla developed a cultural life, if only modest, under the Arabs, with the first manifestations of this in the 3rd/9th century, consol-