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The Compendium*

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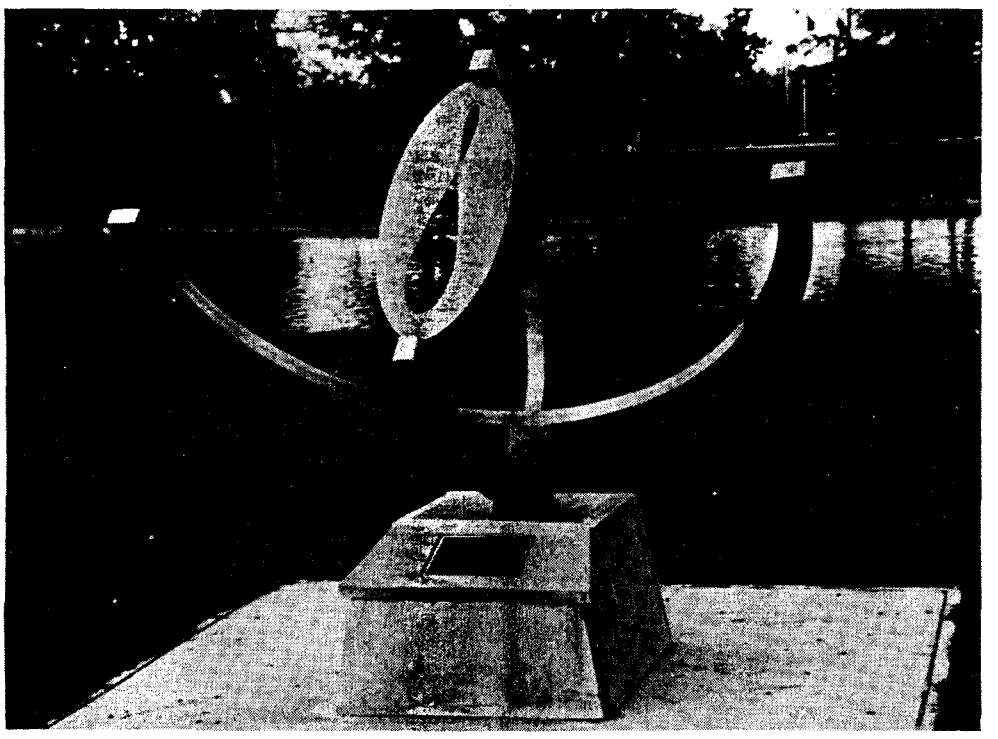

Heed also the shadows, which inform the light.

- William S. Maddux, 1998

* Compendium... "giving the sense and substance of the topic within small compass." In dialing, a compendium is a single instrument incorporating a variety of dial types and ancillary tools.

First, note that the gnomon as described so far touches the dial face in only one point. It may be easier to construct and more stable in practice to divide the gnomon into two parts separated by a space designed to lend stability. The hour scale must be similarly separated, just as is the case when a traditional dial is separated at noon for a thick gnomon (see Figure 3).

Second, note that it is a good idea to give the gnomon a significant thickness. In this way, the gnomon's shadow will have a straight line segment instead of a single point on the hour line; this makes it much easier to determine exactly which part of the shadow is to be used to tell time (see Figure 3). A straight line shadow will fall directly on the straight hour line.

Finally, for those who prefer a vertical dial, note that this exact same gnomon can be used to produce a vertical direct east or west dial, since such a dial is nothing more than a polar dial displaced 90° in longitude (6 hours in time). The cycloid will touch the dial face and lie in the equatorial plane as it does here. The hour lines will be equi-spaced and parallel to the celestial axis, with 6:00 (am or pm) replacing the original noon line, and noon now at the point where dial face and gnomon meet. Only one half of the gnomon is needed since direct east and west dials function only in the am or pm, respectively.

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Sundials In Iran

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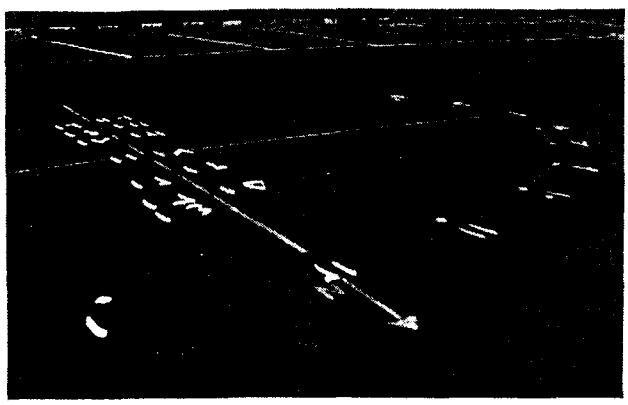
Designing sundials has a long history in Iran. In an astronomical book entitled *Zij-e Shahriyar* ("Astronomical tables of the King"), composed in pre-Islamic Iran possibly in 555 C.E., there was a chapter on a method for graduating sundials. This book was translated from Pahlavi (i.e. Middle Persian) into Arabic around 790 C.E. The original text and the Arabic translation are not extant. However, the eminent Iranian scholar al-Biruni (973-1051) has quoted this chapter from *Zij-e Shahriyar* in his Arabic work on shadows.[1]

The earliest extant treatise on sundials written by an Iranian scholar is that by Muhammad ibn Musa al-Kwarizmi (ca. 870 - ca. 950), entitled *'Amal al-saat fi basit al-rukhama* ("Construction of hour [lines] on the plane of a sundial"). The sundial described in this treatise consisted of a horizontal marble board and a gnomon. Al-Kwarizmi wrote this treatise in Baghdad.[2]

Horizontal and vertical sundials are mentioned among the astronomical instruments that a certain Jamal al-Din Bukhari took with him from Maragha (an Iranian center of astronomical activity in the 13th century to China.[3]

Ghiyath al-Din Jamshid al-Kashi, a famous Iranian mathematician and astronomer of the 15th century, was also skillful in designing sundials. He left his native city Kashan (Iran) for Samarkand upon the invitation of Ulugh Beg, Tamerlane's grandson, in whose court there was

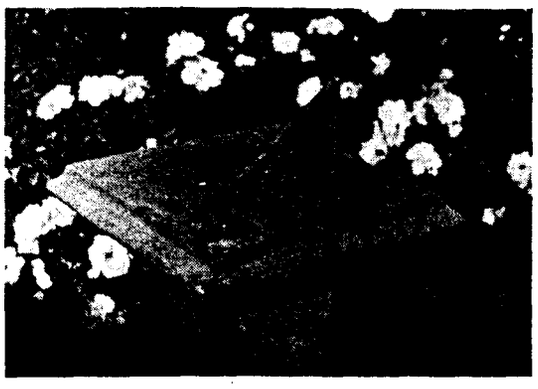


An analemmatic dial by Káran Ráshad at the Education Office in Tehran

[1] Abu al-Rayhan Muhammad ibn Ahmad al-Biruni, *Ifrad al-maqal fi amr al-zilal* ("The exhaustive treatise on shadows"), tr. & comm. By E.S. Kennedy, 2 vols., Institute for the History of Arabic Science, University of Aleppo, Aleppo, 1976, 1:199, 2:125.

[2] B.A. Rosenfeld, "Sundials in Islam:, in *Encyclopedia of the history of science, technology, and medicine in non-Western cultures*, ed. H. Selin, 1997, pp.921-922.

[3] W. Hartner, "The astronomical instruments of Cha-ma-lu-ting, their identification, and their relation to the instruments of the observatory of Maragha", *Isis*, 1950, 41:184-194.



Stone dial in al-Zahra University (Tehran) by dialist Fatemeh Azimlou

an active circle of poets, writers, artists, and scientists. He reported on his new environment in letters to his father who lived in Kashan. In one of the letters, he describes his calculation of a vertical sundial on a wall of the royal house which was neither in the East-West nor in the North-South direction.[4] There are masterpieces of composite astronomical instruments such as those made for finding the direction of Mecca and the time of day, made by skilled Iranian craftsmen in the Safavid period (16th - early 18th centuries).[5]

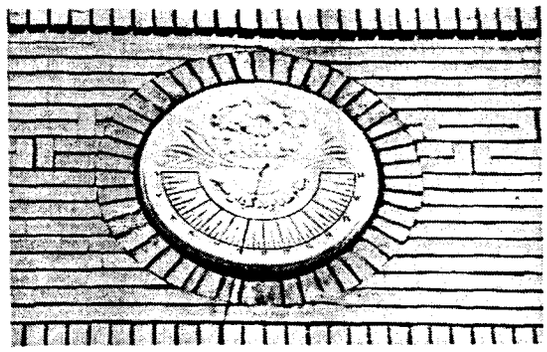
After the introduction of modern clocks in Iran, sundials were abandoned. At present, there remain some simple horizontal sundials in certain mosques or universities of Iran. However, there is a new trend towards sundial theory and practice among young Iranian amateur astronomers. A Persian book on sundials by M.A. Ahya'i was published in Iran in 1985. I have designed a sundial kit in the form of a postcard for the latitudes of the cities of Iran. It was inspired by a similar one for higher latitudes that I bought in Deutschmuseum some years ago.

There are many Persian and Arabic treatises on sundials in Iranian libraries' manuscript collections. Moreover, astrolabes and horary quadrants, as well as manuscripts about their design, construction and application, are a major part of the sundial tradition in Iran.

[4] Mohammad Bagheri, "A newly found letter of al-Kashi on scientific life in Samarkand", *Historia Mathematica*, 1997, 24:241-256.

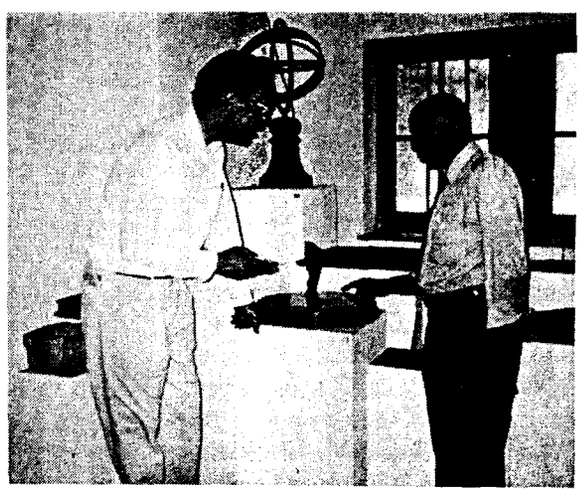
[5] D.A. King, "Two Iranian world maps for finding the direction and distance to Mecca", *Imago Mundi*, 1997, 49:62-82.

On July 13, 1998, Paolo Visintini, a young astronomer from Udine (Italy) and a member of AFAM (Associazione Friulana di Astronomia e Meteorologia) who is interested in sundials as a scientific hobby, gave a lecture on sundials at the History of Science Institute of Tehran University. The hall was full of enthusiasts for sundials.



A vertical dial in Isfahan, Iran with the motto "In the name of the God of the revolving sphere".

At present, the dialists in Iran rely on two types of sources, according to their interests and motivations in this field: the Iranian tradition of sundials as found in manuscripts, and modern European sources. Further, one may always hope to discover an abandoned sundial when traveling in Iran. With so much sunshine in our country, we hope to found our Iranian Sundial Society and to set up many more sundials in Iran.



Len Berggren and Mohammad Bagheri at a sundial conference in Liège

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