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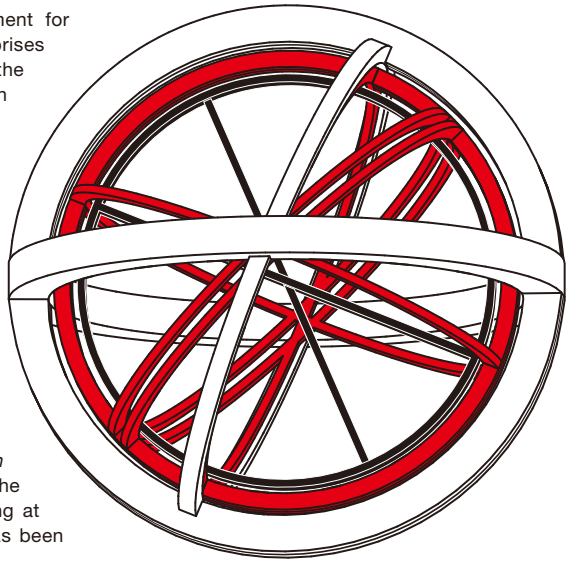
渾　儀 Armillary Sphere (1:1)

渾儀是測量天體位置的儀器，主要結構可分為外、中、內三層。最外層稱為六合儀，由天元子午圈、地平圈和天常赤道圈構成，各環互相連結，固定置於架上。中層為三辰儀，由二至圈、二分圈、遊旋赤道圈和黃道圈結合而成，整體可繞極軸旋轉。內層為四遊儀，由四遊環、天軸和窺管組成，可在三辰儀內繞極軸旋轉。

此渾儀是參照南京紫金山天文台的明代仿元渾儀複製，並已改裝至適用於香港的緯度。

The Armillary Sphere is an astronomical instrument for measuring the position of celestial objects. It comprises three sets of rings. The outermost one is called the *Liuheyi* (Sphere of the Six Cardinal Points) which consists of the Meridian Circle, Horizon Circle and Fixed Equatorial Circle welded together securely on a supporting framework. The middle one is the *Sanchenyi* (Sphere of the Three Stellar Objects) with its four components, namely, the Solstitial Colure Circle, Equinoctial Colure Circle, Mobile Equatorial Circle and Ecliptic Circle joining together and rotating as a whole around the polar axis. The innermost set which can rotate within the *Sanchenyi* around the polar axis is called the *Siyouyi* (Sphere of the Four Movements) with the Hour-angle Circle, Celestial Axis and Sighting Tube.

This is a replica of the Armillary Sphere of the *Yuan* Dynasty (1279-1368) which was reproduced in the *Ming* Dynasty (1368-1644) and is currently locating at the Purple Mountain Observatory in Nanjing. It has been adapted for use at the latitude of Hong Kong.

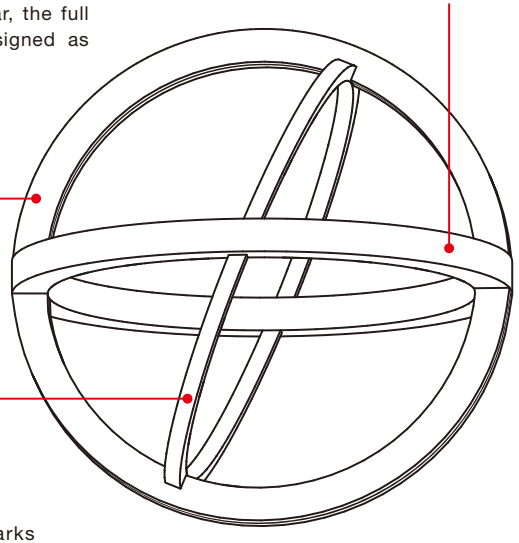


天元子午圈
南北向垂直雙環，兩面都刻有365¼度（中國古代定一回歸年為365¼日，故將周天全圓定為365¼度）
Meridian Circle
A vertical split ring along the north-south direction with graduations of 365¼ degrees on each side (As the ancient Chinese determined that there are 365¼ days in a year, the full circumference of the sky is assigned as 365¼ degrees)

地平圈
水平單環，外弧面刻四維八干十二支共24方位，內弧面刻12分野
Horizon Circle
A horizontal ring with 4 *wei*, 8 *gan* and 12 *zhi* (totalling 24 cardinal points) inscribed on the outer surface and 12 *fenye* (kingdoms and regions) on the inner surface

六合儀
Sphere of the Six Cardinal Points

天常赤道圈
對應天球赤道，
上刻十二時辰一百刻，
故又稱百刻環
Fixed Equatorial Circle
Corresponding to the celestial equator with graduations of 100 marks for 12 double hours, so also called the ring of 100 marks



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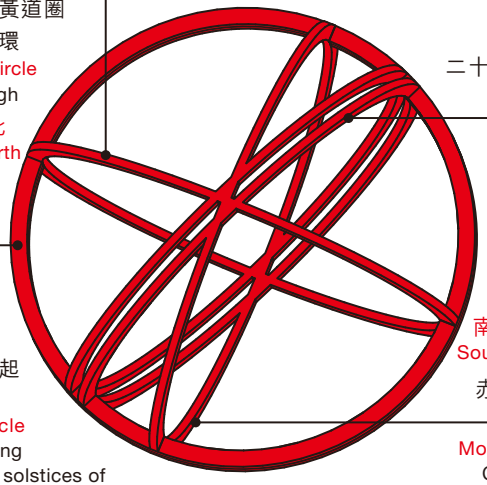
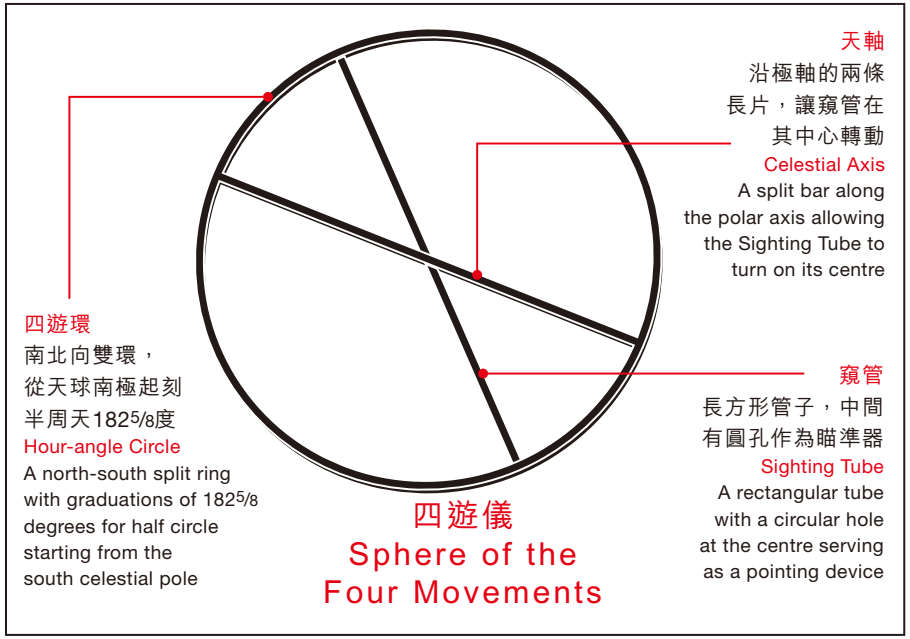
運 作

使用時先用窺管尋找最接近所需測量天體西面的距星，轉動遊旋赤道圈對正相對應的二十八宿，再用窺管觀察目標，在遊旋赤道圈讀取入宿度，並在四遊圈讀取去極度，以取得其天球座標位置。



Operation

To measure the coordinates of a particular celestial object, we first use the Sighting Tube to locate the first determinative star to the west of the target. Then rotate the Mobile Equatorial Circle so that the determinative star aligns with the mansion it belongs. After that, use the Sighting Tube to observe the target star. Its celestial coordinates, namely, the “mansion extension” and “polar angle”, can then be read from the Mobile Equatorial Circle and the Hour-angle Circle respectively.



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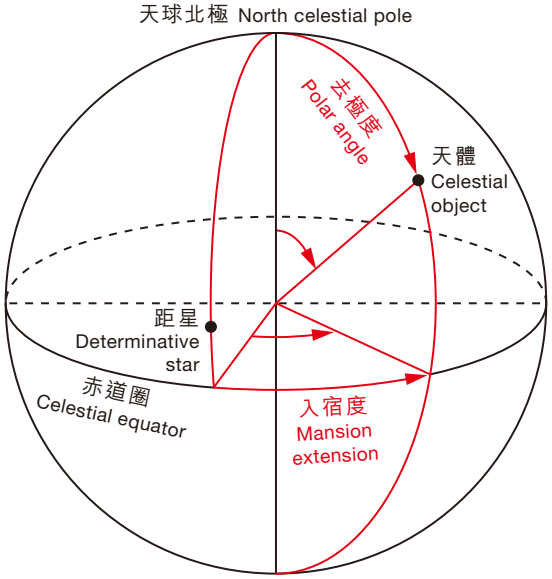
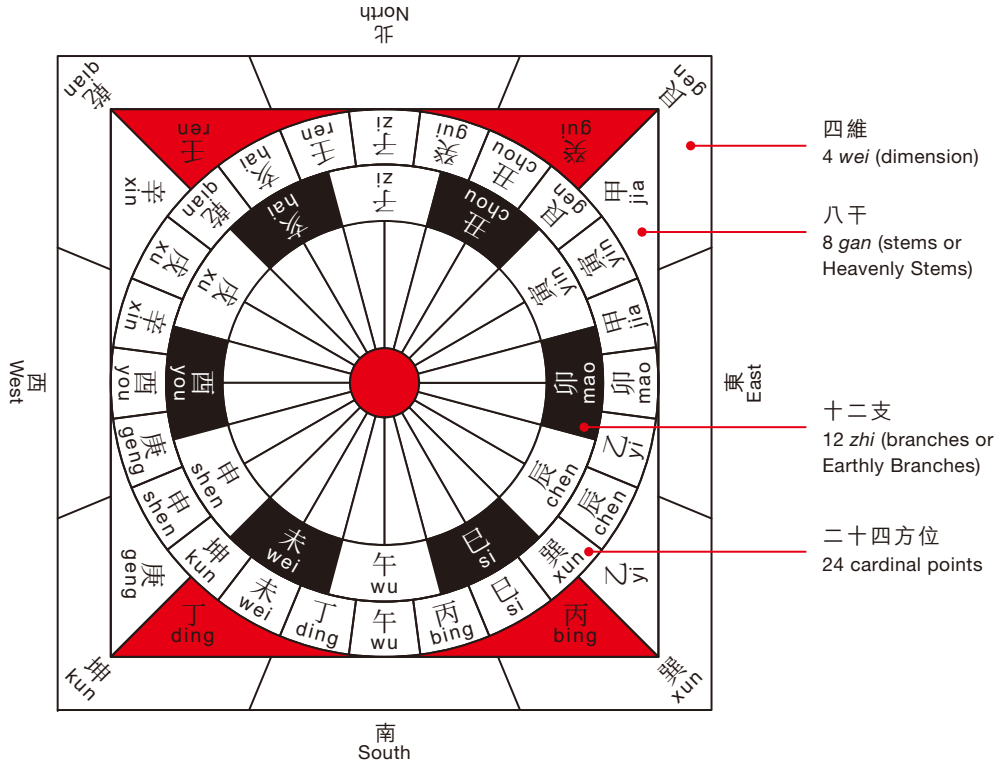
中國古代的赤道座標系統以「入宿度」和「去極度」來標示。中國將天赤道附近星空分為二十八宿，每宿選一顆距星。天體的入宿度是指該天體與它西側相鄰的距星的赤經差，去極度則是指天體與天球北極的夾角。

In the ancient Chinese equatorial coordinate system, the positions are expressed in mansion extension and polar angle. Ancient Chinese divided the region along the celestial equator into 28 lunar mansions from each of which a determinative star is chosen as a reference. The mansion extension of a celestial object is the difference in right ascension between the object and its nearest determinative star to the west while its polar angle is the angle measuring from the north celestial pole.



中國傳統方向命名方式
Traditional Chinese Naming for Directions



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如何把12時辰分為100刻？

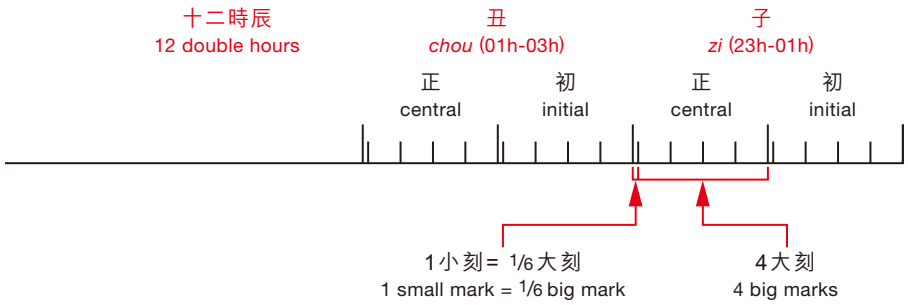
每個時辰分為初、正兩個時段，每段四大刻一小刻(一小刻相當於六分之一大刻)，故12時辰有100大刻。

12時辰 x 每時辰2時段 x 4大刻1小刻(12 x 2 x 4 1/6大刻) = 100大刻

How to divide 12 double hours to 100 equal parts (*ke*)?

Each double hour is divided into two hours: the initial and central one. Each hour is represented by 4 big marks and 1 small mark (meaning 1/6 of a big mark). Therefore 12 double hours can be divided into 100 marks.

12 double hours x 2 hours per double hour x 4 big marks and 1 small mark (12 x 2 x 4 1/6) = 100 big marks



中國傳統時間命名方式
Traditional Chinese Naming for Time

十二時辰	12 double hours	現代時間 (時) time (hour)
子	*zi*	23-01
丑	*chou*	01-03
寅	*yin*	03-05
卯	*mao*	05-07
辰	*chen*	07-09
巳	*si*	09-11
午	*wu*	11-13
未	*wei*	13-15
申	*shen*	15-17
酉	*you*	17-19
戌	*xu*	19-21
亥	*hai*	21-23

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圭 表 Gnomon (1:2)

圭表是中國最古老也是最簡單的天文儀器，由「表」和「圭」組成。表是直立的標杆，圭是南北平放的尺，用來量度太陽照射表時所投射的影子的長度。圭表可用來測定方向、一年的長度、釐定二十四節氣的日期等。此圭表是根據南京紫金山天文台的明代圭表仿製。

運 作

一年中正午日影最長的日子是冬至，而最短的是夏至。不過這只適用於北回歸線以北地區，像香港這些位於北回歸線以南的地區，日影最短的一天並非夏至。

知多一點點

清朝於重修明代所製的圭表時把表改高，上端有銅葉，中間開一圓孔。正午時，太陽影子經過圓孔射到圭面，便可直接測量表影的長度。表加高後，圭座變得長度不足，所以在北端另加一個立圭，配合簡單的幾何公式便可推算出表影總長。

The gnomon is the oldest and simplest astronomical instrument used in China. It is composed of a vertical *biao* (gnomon) and a north-south aligned ruler *gui* lying horizontally to measure the length of the gnomon's shadow projected by sunshine. The gnomon can be used to determine the direction, length of a year and dates of the solar terms, etc. This is the replica of a gnomon produced in *Ming* Dynasty which is currently displayed at the Purple Mountain Observatory in Nanjing.

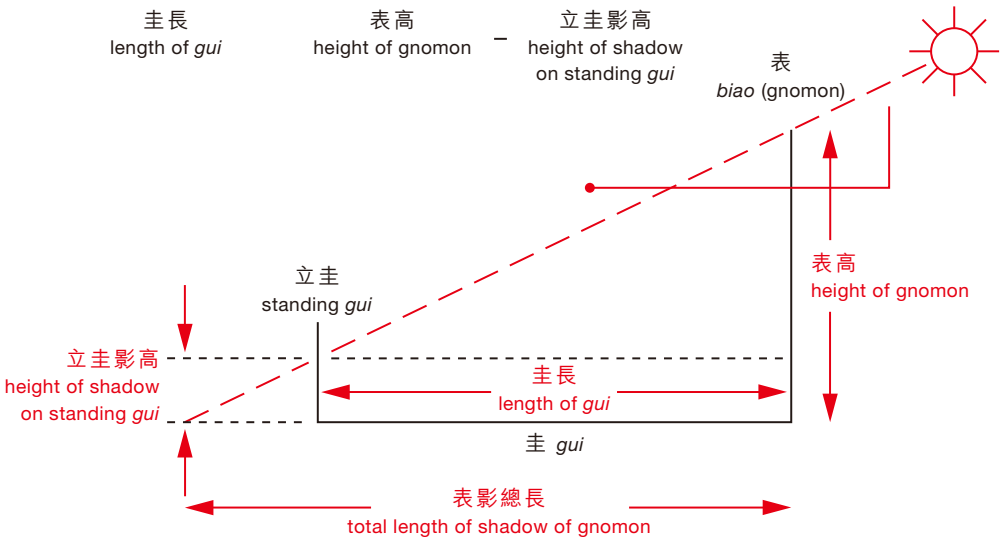
Operation

The day at noon with the longest shadow is the winter solstice while the one with the shortest shadow is the summer solstice. However, this only applies to the regions to the north of the Tropic of Cancer. The day with the shortest shadow does not fall on the summer solstice for places located south of the Tropic of Cancer like Hong Kong.

Want to Know More

The gnomon of the *Ming* Dynasty (1368-1644) was modified in the *Qing* Dynasty (1644-1911) with an increase in its height. Atop the gnomon was a copper leaf with a round pinhole. At noon, sun ray reached the *gui* through the hole so that the length of the shadow of the gnomon could be measured. As the height of the gnomon was increased, the *gui* was not long enough for measurement. So an additional standing *gui* was erected at the northern end of the *gui*. Since then, the total length of the gnomon's shadow could be computed by simple geometry.

$$\frac{\text{表影總長 total length of shadow of gnomon}}{\text{圭長 length of } gui} = \frac{\text{表高 height of gnomon}}{\text{表高 height of gnomon} - \text{立圭影高 height of shadow on standing } gui}$$



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赤道式日晷 Equatorial Sundial (1:1)

赤道式日晷(音「軌」)由晷面和一根晷針組成。晷面有時間刻度，晷針垂直於晷面。赤道式日晷的晷面與地球赤道面平行，即晷面的傾斜角度為90度減去當地緯度。

此日晷是根據北京故宮太和殿前的赤道日晷仿製，並更改至適用於香港緯度。

運 作

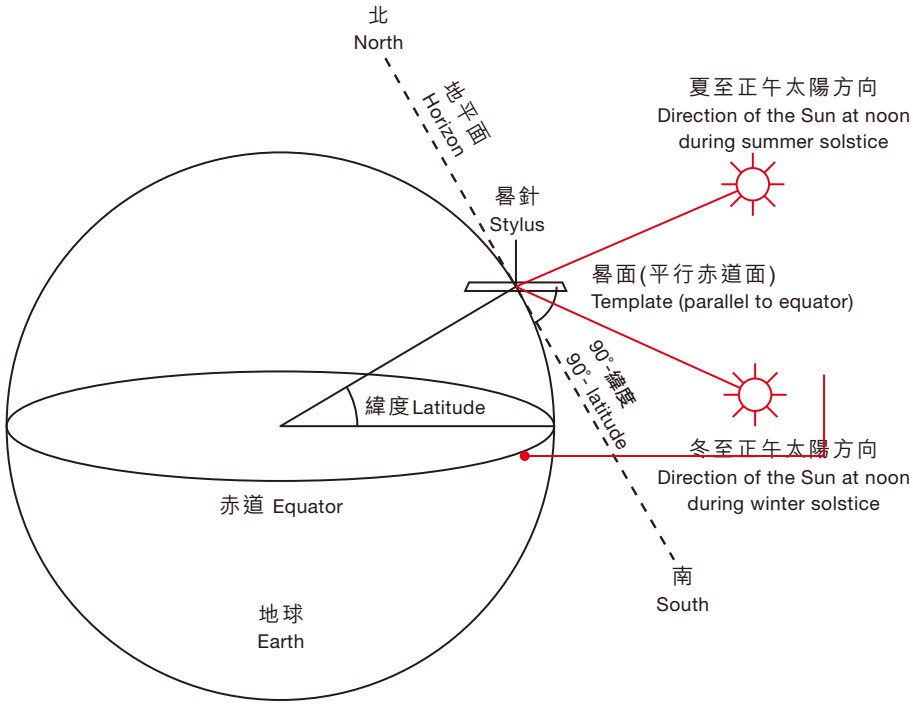
太陽照射晷針時，只要從晷面上的投影便可讀取當時的時間。在春分至秋分期間，太陽會照射日晷正面(北面)，而秋分至春分期間則會照在背面(南面)。

An equatorial sundial is composed of a template with time markings and a stylus erected perpendicularly to the template. The template is parallel to the equator, i.e. inclined at an angle of 90 degrees minus the latitude.

This sundial is a replica of the one placed outside the Hall of Supreme Harmony in the Imperial Palace in Beijing with adaptation made by referencing to the latitude of Hong Kong.

Operation

Read the time from the shadow cast on the template as the Sun shines on the stylus. Between the vernal equinox and autumnal equinox, the Sun casts its shadow on the northern face of the template. During the period between the autumnal equinox and vernal equinox, the Sun casts its shadow on the southern face.



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知多一點點

從日晷得出的時間稱為「真太陽時」，與手錶指示的標準時間可能有所不同。這是因為標準時間大概可以看成是一個虛構的太陽，在赤道面以平均速度運行來計算，而且整個時區內不同經度的地點都當作同一時間。

日晷所顯示的卻是真正的太陽運動情況。地球繞太陽公轉的軌道為橢圓形，運行速度並不均等。此外，地球以23.5度傾角繞太陽公轉，在春分及秋分點附近，太陽傾斜於赤道運行，故這運動在赤道面的投影較平均的速度慢；而在夏至及冬至附近，太陽平行於赤道運行，這運動在赤道面的投影較平均的速度快。即使把同一時區內的東部地區與西部地區比較，在東部的太陽也會較為偏西，日晷顯示的時間也會較快。

若要把從日晷得出的真太陽時轉換為手錶所示的標準時間，便須加入以上兩項因素，即均時差及經度差的調整。

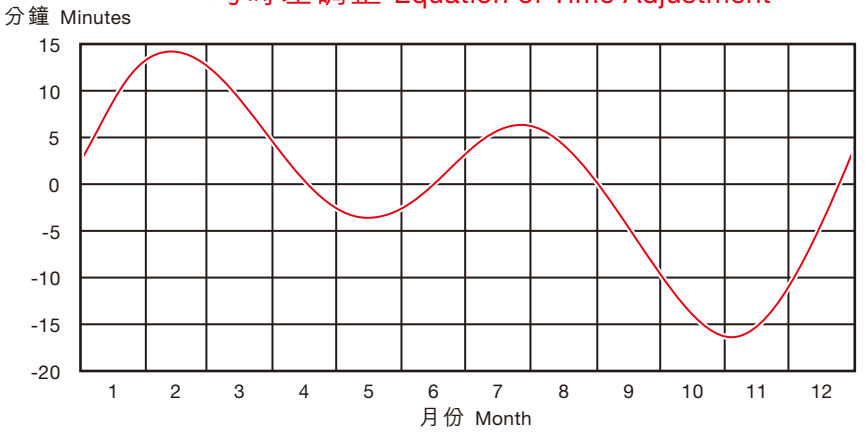
Want to Know More

The time obtained from the sundial is called the “true solar time” which may be different from the watch time. This is because the watch time can be considered as a reading obtained from a fictitious Sun moving along the equator at an average speed. In addition, different regions within the same time zone have the same watch time.

The sundial, however, displays the true motion of the Sun. The Earth orbits the Sun in an ellipse and thus at an uneven speed. In addition, due to the Earth’s axial tilt of 23.5 degrees, when the Sun crosses the equator at both equinoxes, it is moving at an angle tilted to the equator. Therefore the projection of this tilted motion onto the equator is slower than its mean motion. However, when the Sun is at both solstices, it moves parallel to the equator. Therefore the projection of this parallel motion onto the equator is faster than its mean motion. Even within the same time zone, people in areas to the east would find that the Sun is in a more westward direction as compared to that viewed by people in areas to the west. So, the sundial time in the eastern part of a time zone would be faster than that in the western part.

To convert the watch time from the true solar time, we need to make two adjustments as mentioned above, namely, the equation of time and longitude adjustment.

均時差調整 Equation of Time Adjustment



手錶時間 = 日晷時間 + 均時差調整 + 經度差

Watch time = Sundial time + Equation of time adjustment + Longitude adjustment

天文公園的經度為東經114.3度，與香港時區的標準經度東經120度相差5.7度，以360度相當於24小時計算，經度差為+22.8分鐘。

例如在7月1日，從上圖查得的均時差約為+3.5分鐘，如日晷顯示的時間是正午12時，則手錶時間應為下午12時26.3分(即12時 + 3.5分鐘 + 22.8分鐘)。

The longitude of the Astropark is 114.3°E, having a deviation of 5.7° from the standard meridian of Hong Kong of 120°E. As 360 degrees correspond to 24 hours, the longitude adjustment is +22.8 minutes.

For instance, on 1 July, the equation of time adjustment is +3.5 minutes from the above graph. If the sundial shows 12 noon, the watch time should be 12:26.3 pm (i.e. 12 hours + 3.5 minutes + 22.8 minutes).

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星 晷 Star Dial (1:1)

星晷又稱勾陳晷，是在夜間利用觀測恆星以定時刻的一種計時工具。此星晷是根據明代的記載復原製作，可惜原物未能留傳下來。

星晷由兩個同心圓盤組成，外盤刻有時刻，內盤刻有周天度數，列十二宮以分二十四節氣，中間有一條縫作窺星之用。

運 作

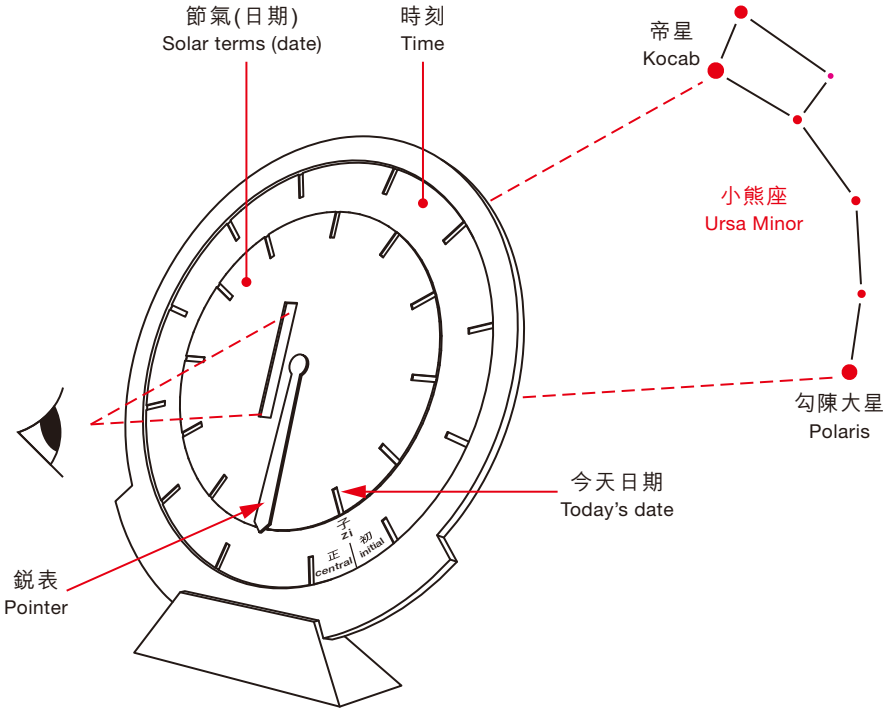
使用時將外盤子正初刻(即午夜)移至對應的內盤節氣度數，移動銅盤北望帝星(即小熊座β)與勾陳大星(即小熊座α或北極星)，使兩星同現縫中，盤面銳表所指的便是當時的時刻。

The star dial, also called the pole-star dial, is an instrument for determining the time at night by observation of stars. This star dial is reproduced according to the records of the *Ming* Dynasty (1368-1644) but the original artifact was in existence no more.

The star dial is composed of two concentric discs. The outer disc has time markings while the inner disc has graduations of the circumference of the sky, listing the 12 zodiacs and 24 solar terms and having a slit for alignment of stars in the middle.

Operation

Align the central of the double hour *zi* (midnight, Chinese character is "**子**") of the outer disc with the suitable solar term of the inner disc. Turn the dial so that Kocab (β Ursae Minoris) and Polaris (α Ursae Minoris) can appear in the silt at the same time. The time could then be read from the pointer.



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知多一點點

在北極星附近的星座如小熊座，會以均速約24小時圍繞北極星旋轉一圈，而星晷的運作原理便是建基於上述星體運行特性。在星晷上平均刻上24小時刻度，使用時只要旋轉到對應星座的位置，便可得出時間。

不過，由於地球自轉的同時也會公轉，星座每晚也會較前一晚早4分鐘抵達同一位置，因此星晷要利用日期盤來調節這每天的時間差異。

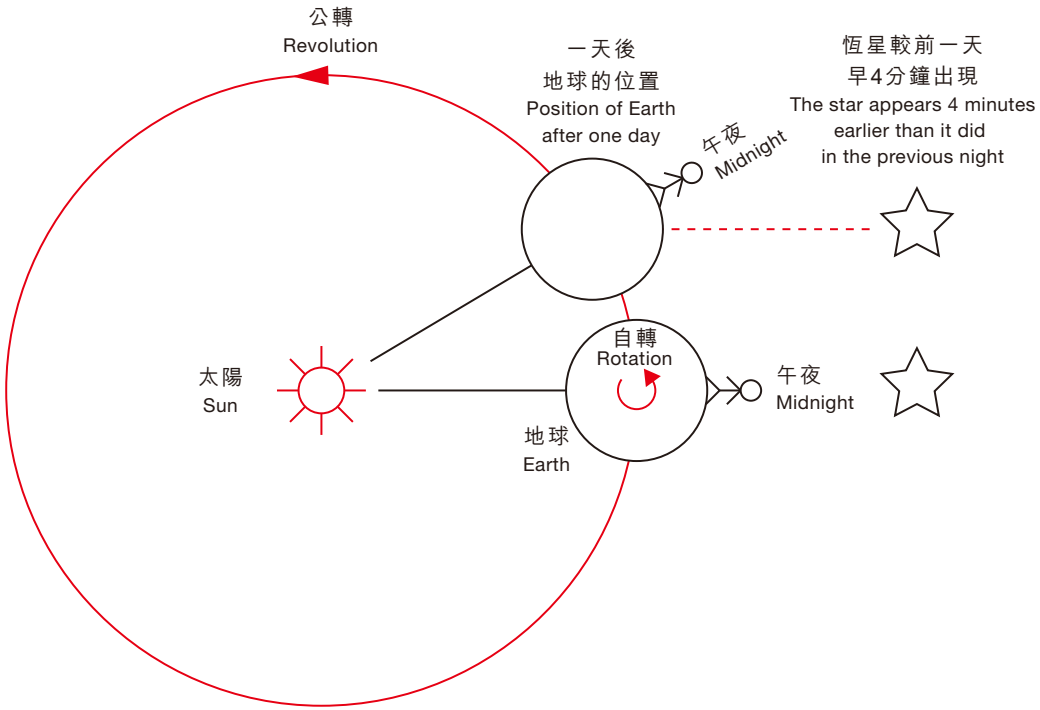
Want to Know More

Circumpolar constellations such as the Ursa Minor revolve around the Polaris once about every 24 hours. The star dial makes use of this motion and has graduations of 24 hours evenly marked on the dial surface so that turning the star dial for alignment with the Ursa Minor will tell the time.

However, as the Earth has not only rotation but also revolution, constellations will appear 4 minutes earlier each night than the previous one. To correct this daily difference, it is necessary to adjust the star dial with the date (solar terms) dial.

二十四節氣	**Solar Terms**	日期	**Date**	二十四節氣	**Solar Terms**	日期	**Date**
立春	Spring Commences	2月4日	4 Feb	立秋	Autumn Commences	8月8日	8 Aug
雨水	Spring Showers	2月19日	19 Feb	處暑	End of Heat	8月23日	23 Aug
驚蟄	Insects Waken	3月6日	6 Mar	白露	White Dew	9月8日	8 Sep
春分	Vernal Equinox	3月21日	21 Mar	秋分	Autumnal Equinox	9月23日	23 Sep
清明	Bright and Clear	4月5日	5 Apr	寒露	Cold Dew	10月8日	8 Oct
穀雨	Corn Rain	4月20日	20 Apr	霜降	Frost	10月24日	24 Oct
立夏	Summer Commences	5月6日	6 May	立冬	Winter Commences	11月8日	8 Nov
小滿	Corn Forms	5月21日	21 May	小雪	Light Snow	11月22日	22 Nov
芒種	Corn on Ear	6月6日	6 Jun	大雪	Heavy Snow	12月7日	7 Dec
夏至	Summer Solstice	6月21日	21 Jun	冬至	Winter Solstice	12月22日	22 Dec
小暑	Moderate Heat	7月7日	7 Jul	小寒	Moderate Cold	1月6日	6 Jan
大暑	Great Heat	7月23日	23 Jul	大寒	Severe Cold	1月20日	20 Jan

二十四節氣的日期或會相差一天。
Dates of the solar terms may vary by one day.



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月 晷 Moon Dial (1:1)

月晷又名太陰晷，是透過觀測月球位置而得出時刻的計時儀器。此月晷是根據現存於北京故宮慈寧宮的月晷複製而成。

月晷由兩個同心圓盤和中心遊表共三個部分組成。下盤為時刻盤，刻有十二時辰。上盤為月相盤，刻有30天及360度，並在0度位置上伸出一直表。

運 作

使用時先確定月晷的南北方位及地理緯度，再參照《月距日經度表》將遊表固定在月相盤的相應位置，然後用直表帶動大遊表與月相盤同時轉動，至遊表與月球成一直線時，從直表在時刻盤上所指的位置讀取時刻。

知多一點點

月球除了每天因地球自轉而東升西落外，也會因圍繞地球公轉，導致較前一晚平均遲出48分鐘。不過由於月球的軌道呈橢圓形，加上它與地球的軌道形成夾角，以致月球的出沒時間每天也可以相差很大，因此必須根據資料作出修正，然後月晷才可求出較準確的時刻。

The moon dial or lunation dial was a chronometer based on observation of the position of the Moon. This one is a replica of the instrument displayed outside the Palace of Benevolent Tranquillity in the Imperial Palace in Beijing.

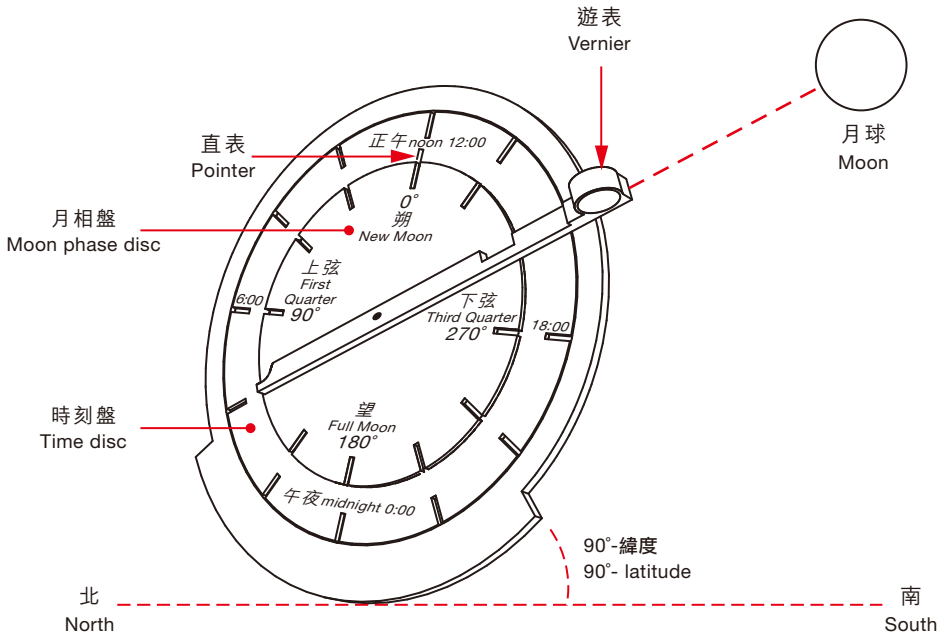
The moon dial is composed of two concentric discs and a vernier. The lower disc is the time disc with graduations of 12 double hours. The upper disc is the Moon phase disc with markings of 30 days and 360 degrees. A pointer extends from the location at zeroth degree.

Operation

Align the moon dial along the meridian and adjust to the correct latitude. Rotate and fix the vernier at the corresponding degrees on the Moon phase disc according to the table of lunar angular distance to the Sun. Then turn the Moon phase disc and the vernier together by the pointer until the vernier aligns with the Moon. The time can then be read along the pointer on the time disc.

Want to Know More

The Moon rises and sets daily like the Sun due to the Earth's rotation. In addition, the Moon revolves around the Earth, resulting in its appearance delayed by an average of 48 minutes each night. However, as the orbit of the Moon is an ellipse and the orbit is tilted, the time of moonrise and moonset can vary greatly from day to day. Therefore adjustments must be made in accordance with ephemeris so as to use the moon dial accurately.



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天文公園
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仰 儀 Upward Looking Bowl Sundial (1:3)

仰儀是元代天文學家郭守敬創製的天文儀器，用以觀測太陽以定時刻及觀測日食。

仰儀主體是一個直徑約3米的中空半球，有如一隻仰放的鍋子。儀邊刻有二十四方位，內壁刻有赤道座標網。仰儀南端有一直杆伸向中心，末端裝有一塊可向南北及東西轉動的璣板，板中有一小孔，對應仰儀的中心點。

運 作

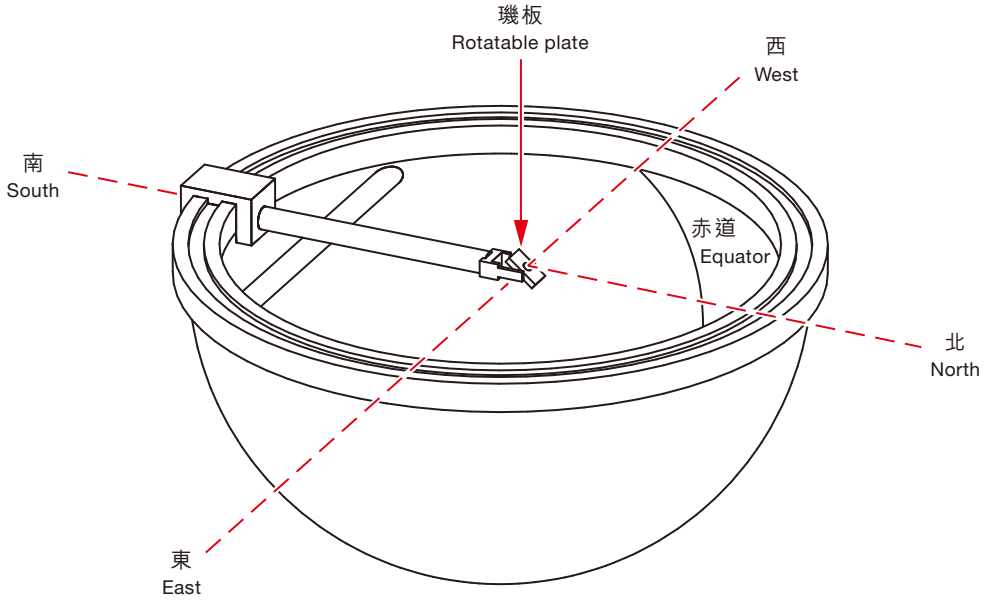
觀測時，轉動璣板至與陽光垂直的位置，太陽通過小孔成像於座標網上，從而直接讀取太陽的位置座標，並測出真太陽時。此外在日食時，透過針孔成像可清楚觀測日食的過程，測定食分及各食相的時刻和方位，避免要以肉眼直接觀看猛烈的陽光。

The upward looking bowl sundial was an astronomical instrument designed by the astronomer *Guo Shoujing* of the *Yuan* Dynasty (1279-1368) for observation of the Sun to determine the time and for viewing of solar eclipse.

The main body of this sundial is an empty hemispherical bowl facing upwards which is around 3 metres in diameter. The rim is engraved with 24 cardinal points and the inner wall with a grid of equatorial coordinates. A rod extends from the southern rim to the centre of the bowl with a rotatable plate at the end which can turn along the north-south and west-east directions freely. The plate has a small hole corresponding to the centre of the sundial.

Operation

Turn the rotatable plate until it is perpendicular to the Sun so that the sunlight passes through the hole and projects on the grid. The position of the Sun and the true solar time can be read directly from the grid. During solar eclipse, the progress, magnitude and time and position of different phases can be measured easily with the projection on the grid. The hazard of looking at the bright sunlight directly can thus be avoided.



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地平日晷 Horizontal Sundial (1:1)

地平日晷由水平的晷面和傾斜的晷針組成。三角板的斜面起著晷針的作用，指向北天極。這是根據南京紫金山天文台的明代仿元郭守敬簡儀上的地平日晷複製而成。

運作

觀測三角斜面在晷面上的太陽投影，便可得出時間。

知多一點點

地平日晷實際上是把赤道日晷的晷面投影在一水平面上，所以晷面的時間線並非平均分佈。

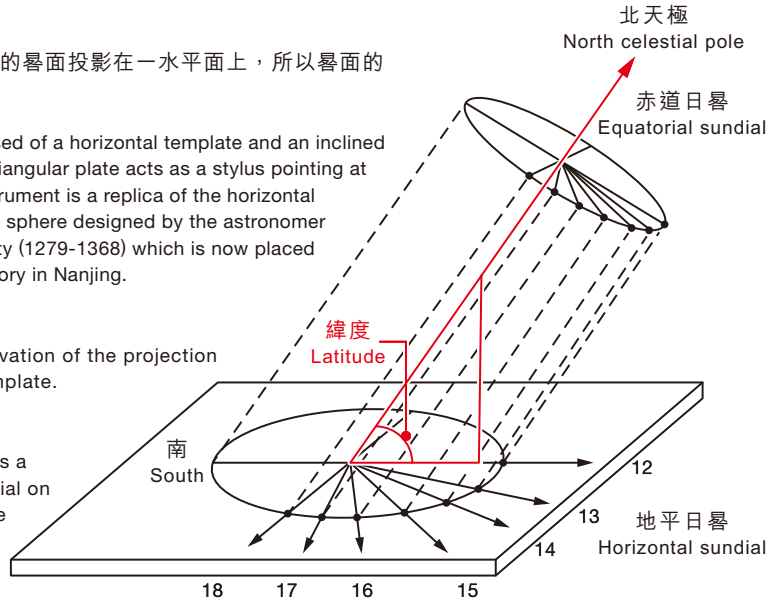
The horizontal sundial is composed of a horizontal template and an inclined stylus. The inclined side of the triangular plate acts as a stylus pointing at the north celestial pole. This instrument is a replica of the horizontal sundial of the simplified armillary sphere designed by the astronomer *Guo Shoujing* of the *Yuan* Dynasty (1279-1368) which is now placed at the Purple Mountain Observatory in Nanjing.

Operation

Time can be obtained by observation of the projection of the inclined plane on the template.

Want to Know More

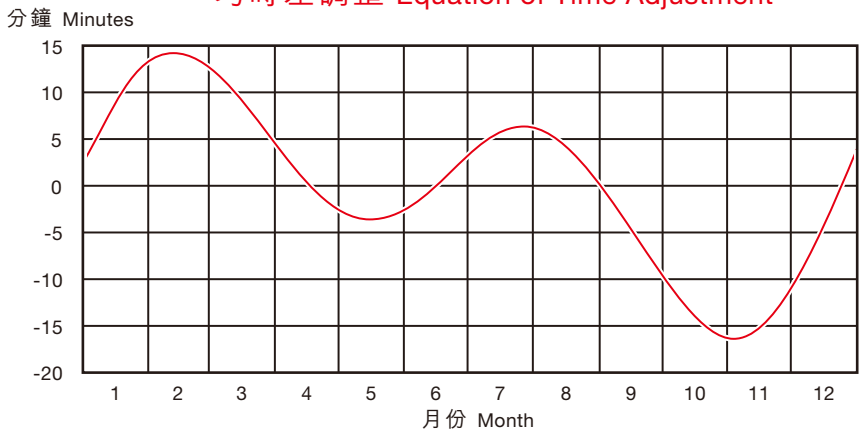
Actually, the horizontal sundial is a projection of an equatorial sundial on a horizontal surface. So the time markings on the template are not evenly distributed.



與赤道日晷一樣，從地平日晷讀取的時間是真太陽時，須要修正均時差和經度差，才會得出手錶指示的時間。

Just like the equatorial sundial, the time obtained from the horizontal sundial is the true solar time. Adjustments in equation of time and longitude have to be made to give the watch time.

均時差調整 Equation of Time Adjustment



手錶時間 = 日晷時間 + 均時差調整 + 經度差(22.8分鐘)

Watch time = Sundial time + Equation of time adjustment + Longitude adjustment (22.8 minutes)

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正方案 Direction Determining Table (1:1)

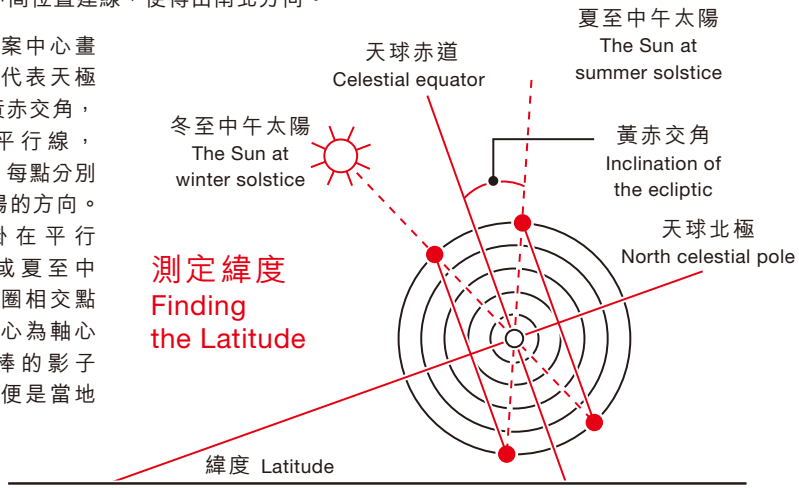
正方案是由元代天文學家郭守敬創製的天文儀器，用以測定方向及緯度。

正方案為一塊正方形平板，周圍有水渠以定水平。中心設一測影的臬(杆)，自中心起畫有19個等距的同心圓形。

運 作

測定方向時，先把正方案水平地擺放。上午日出後，待臬頂端的日影與最外圈西面相交時，在相交點做一標記，然後依次當臬頂日影與外第二圈、第三圈等各圈相交時，均一一加以標記。同樣地，東面的日影在午後與規圈相交時也如上作出標記。最後，把每個規圈東西兩標記相連，取中間位置連線，便得出南北方向。

測定緯度時，在正方案中心畫兩條正交直線，分別代表天極及天赤道方向。再按黃赤交角，在赤道上下各繪一平行線，與規圈各相交於兩點，每點分別代表夏、冬二至時太陽的方向。把正方案垂直懸掛在平行子午面，並於冬至或夏至中午時，在案中心及規圈相交點各插一小棒。以案中心為軸心轉動正方案，使三棒的影子重疊。北極線的高度便是當地緯度。



測定緯度
Finding
the Latitude

The direction determining table is an astronomical instrument designed by the astronomer *Guo Shoujing* of the *Yuan* Dynasty (1279-1368) to determine the direction and latitude.

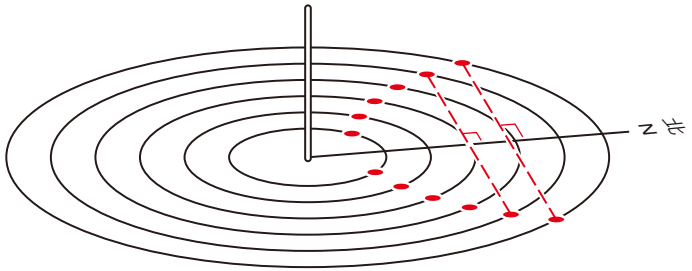
It is a square plate surrounded by a trench for levelling. A pole is erected at the centre. A total of 19 concentric circles of equidistance are engraved on the plate.

Operation

To determine the direction, lay the table horizontally. After sunrise in the morning, mark the intersection formed by projection of the pole top and the outermost circle to the west. One after another, mark all intersections formed between projection (shadow) of the pole top and all the concentric circles. Similarly, mark all intersections made between the circles and projections of the pole top to the east in the afternoon. Lastly, join the two intersections on each circle for all the 19 circles. Bisect the lines and join their mid-points will give a line showing the north-south direction.

To find the latitude, draw two perpendicular lines representing the pole line and the equator at the centre of the table. Then draw two lines parallel to the equator line on each side with a separation equal to the inclination of the ecliptic. Each of the lines will intersect with two points on the outer circle, representing the directions of the Sun at summer and winter solstices. Hang the table vertically along the meridian plane. At noon on either solstice, attach three pegs separately at the centre of the table and the two intersecting points. Rotate the table on the centre until the shadows of the three pegs align. The then inclination of the pole line is the latitude.

測定方向
Determining
the Direction



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天文公園
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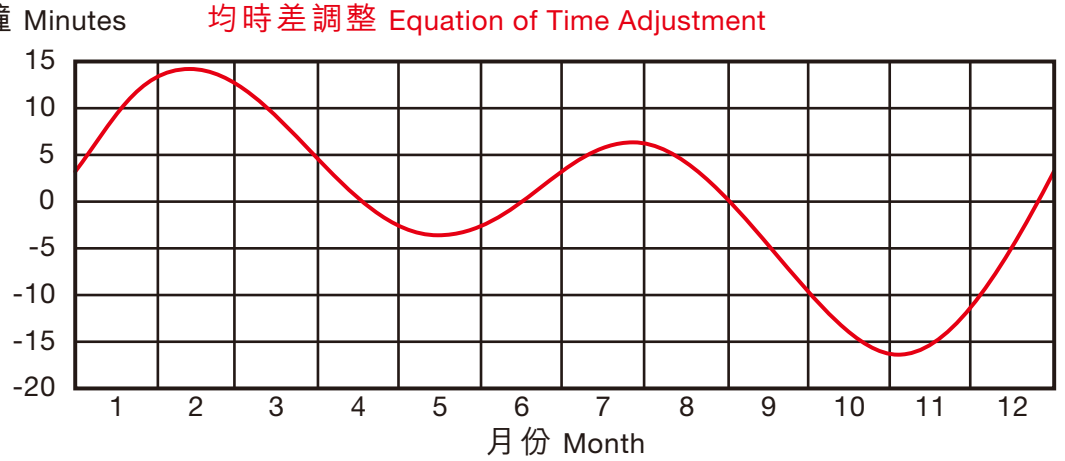
人體日晷 Human Sundial

雙腳分別站在中線的左右方，對應當天的月份，從身體的投影讀取時間。

Stand with one foot on each side of the centre line at the current month. Then read the time from your shadow.



手錶時間 = 日晷時間 + 均時差調整

(經度差已在人體日晷的刻度修正，詳情可參看赤道式日晷)

Watch time = Human sundial time + Equation of time adjustment

(Longitude adjustment is already made on the time markings of the human sundial.
Please see the equatorial sundial for details)

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