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CICLO LUNAR

When Is Chinese New Year?

Dr. Helmer Aslaksen
National University of Singapore
Singapore

FOURTH PRIZE
BOEING *GRIFFITH OBSERVER* SCIENCE WRITING CONTEST

Because the sun and the moon established the character of China's traditional calendar, the New Year was slippery. The Gregorian calendar developed in the West, on the other hand, unambiguously defines the end of one year and the beginning of the next with a familiar pair of dates, 31 December and 1 January. No matter how that Gregorian calendar is recalibrated to the seasons, the convention for slipping from one year to another is constant and simple. In fact, Pope Gregory's reformed calendar is relatively simple because it is driven only by the sun. As soon as you allow the calendar to march to the moon's tune, too, however, the frontiers of the year and public holidays modulated by the phase of the moon get a little calendrically loose.

As a professor of mathematics at the National University of Singapore, Dr. Helmer Aslaksen encountered a variety of public holidays. Because they originated in several different cultural traditions, the date for each was established by its relevant calendar, and these independent calendars included Gregorian, Chinese, Islamic, and Hindu. This profusion of calendars stimulated Professor Aslaksen's calendrical research. He has published a monograph on the Chinese calendar and developed a new course, "Heavenly Mathematics."

Dr. Aslaksen studied mathematics as an undergraduate at the University of Oslo, in Norway, and subsequently obtained his Ph.D. in the same subject at the University of California, Berkeley. His other professional interests include differential geometry, Lie theory, computer algebra, and astronomy.

In recent years, globalization and multicultural fervor have prompted many who do not otherwise make use of the Chinese lunisolar calendar to acknowledge its New Year. Chinese Lunar New Year has, in fact, become an opportunity for festivals, advertising, and even commemorative postage stamps.

In 2002, Chinese New Year falls on 12 February, and Dr. Aslaksen's article on the start of Year 4639 in the Chinese calendar felicitously occurs in our February issue. This New Year also coincides with the traditional date of President Abraham Lincoln's birthday, which used to be a national holiday. It was later combined with President George Washington's birthday, 22 February (a Gregorian date for a President born under the Julian calendar), and transformed into Presidents Day. Some references—like *The Astronomical Almanac*, published by the Nautical Almanac Office of the United States Naval Observatory and Her Majesty's Nautical Almanac Office in the U.K.—still call Presidents Day Washington's Birthday, and in 2002, "Washington's Birthday" falls on 18 February. That's because weekends extended with Monday holidays have fortified the stock of that day of the week at the expense of the date's portfolio of national tradition. Independence Day, on the other hand, still retains its grip on the Fourth of July. It's not quite as complicated as Chinese New Year, but it keeps us on our calendrical toes.

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Production Editor: Patrick So
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e-mail: info@GriffithObs.org
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(Editor's note: Professor Aslaksen submitted this article with a comprehensive and disciplined handling of all terms in Chinese. Publishing limitations have forced, however, elimination of the Chinese characters he included with each transliterated text. When reduced to an 8 point font, the characters cannot be read. In addition, the diacritical marks Professor Aslaksen included on transliterated syllables have been removed to simplify the appearance of the text for the general reader.)

Introduction

Chinese New Year is the main holiday for more than one quarter of the world's population. Very few people, however, know how to compute the date. People who are knowledgeable about science often feel that the Chinese calendar is backwards, while people who care about Chinese culture usually lack the scientific knowledge to understand how it works. For many years, the only reliable source in English was the article by LeRoy Doggett (1992) based on an unpublished work of Liu Baolin and F. Richard Stephenson, "The Chinese Calendar and Its Operational Rules." But thanks to Nachum Dershowitz and Edward M. Reingold (1997), correct information and computer programs are now available. Among Chinese sources, my favorite is the book by Tang Hanliang (1986).

Lunisolar Calendars

A lunar year of 12 lunar months equals on the average 354.3671 days, which is about 11 days shorter than a tropical (or solar) year of 365.2422 days. This was a fundamental problem for the ancients. They tried to find a longer resonance cycle and discovered that 235 lunar months is almost the same as 19 tropical years. The difference is only about two hours. This is called the Metonic cycle after the Greek astronomer Meton, who used it in 432 B.C., but it was known to the Babylonians by around 500 B.C. and to the Chinese around 600 B.C. (Chen Cheng-Yih, 1996).

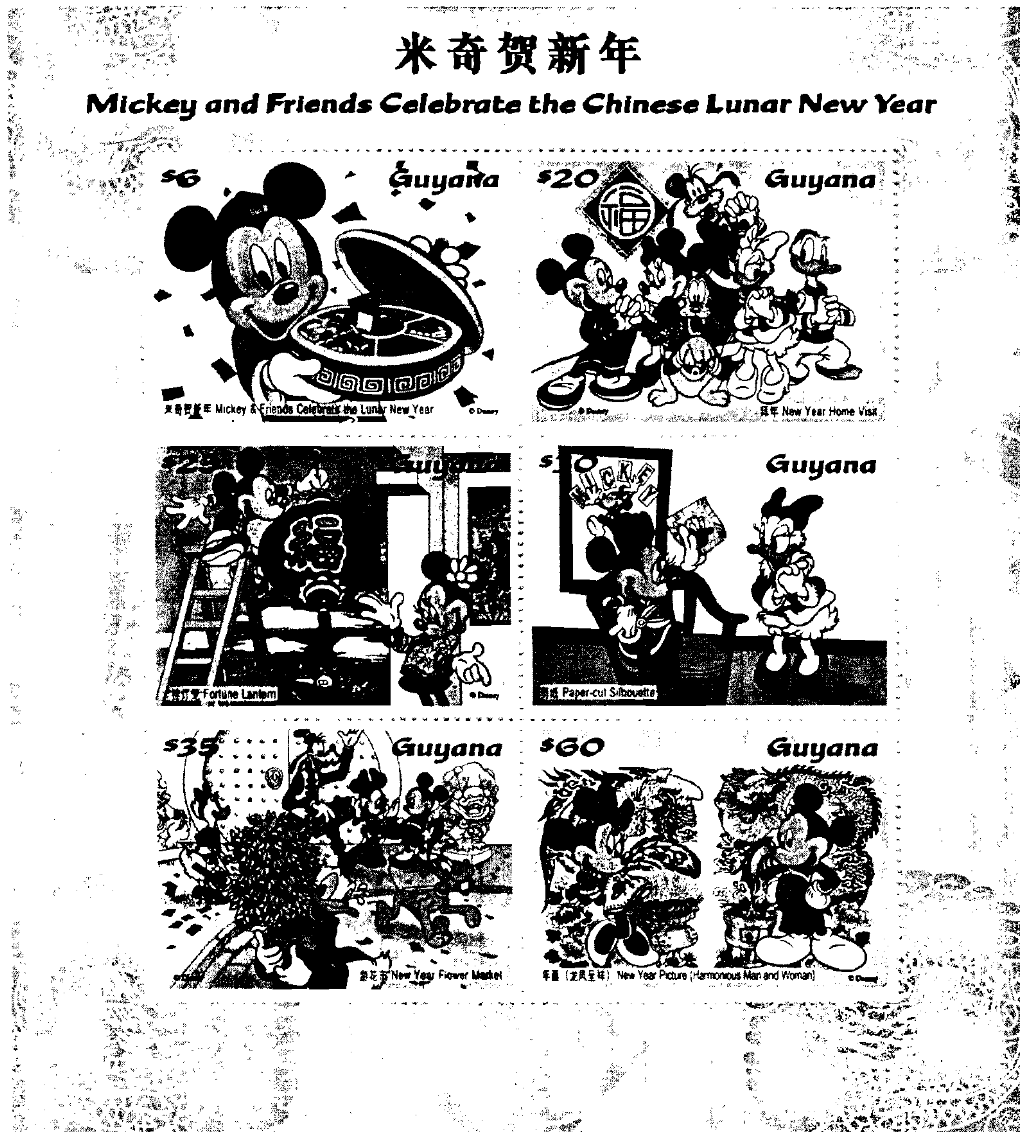
A lunar calendar ignores the sun and the seasons but follows the moon. The Muslim calendar is a well-known example. Because 12 lunar months are about 11 days shorter than the tropical year, the Islamic holidays regress through the seasons.

Lunisolar calendars use lunar months to approximate the tropical year. The Jewish and Chinese calendars are lunisolar. Because 12 lunar months are about 11 days shorter than the tropical year, a leap month (intercalary month) is inserted about every third year to keep the calendar in tune with the seasons. Notice that the Chinese calendar is not a lunar calendar! The Chinese name is *yin yang li*, which means lunisolar calendar.

One method of inserting leap months is to follow nature. An aboriginal tribe in Taiwan would

FRONT COVER
Stamping Out the Year

Many nations have adopted the habit of issuing a stamp for Chinese New Year, whether the Chinese calendar operates in their territory or not. Macao, a former Portuguese enclave on the south coast of China, actually does keep the Chinese calendar. Prior to its return to China in 1999 as a Special Administrative Region of the People's Republic of China, Macao released this souvenir sheetlet of 12 stamps, one for each year in the 12-year cycle. This cycle is frequently called a lunar cycle, and that is how it is identified here ("ciclo lunar" in Portuguese), but in fact it owes its duration to the 12-year sidereal period of Jupiter. Each year in the cycle is named after one of the 12 talismanic animals spotlighted on these stamps, and the beginning of that year is New Year's Day in the traditional Chinese lunisolar calendar. The moon's role in that calendar is what has prompted the misconception that the origin of the 12-year cycle is a lunar. The real contribution of the moon to the Chinese calendar is detailed this month by Dr. Helmer Aslaksen in his prizewinning Boeing Writing Contest article, "When is Chinese New Year?" **(collection E.C. Krupp)**



***Guyana is on the northeast coast of South America and nowhere near China. Its postal service nonetheless saluted Chinese New Year with a sheetlet of stamps on which Disney characters observe Chinese New Year traditions in traditional Chinese costumes. Candy, family reunions, fortune lanterns, papercuts, New Year flowers, and New Year pictures are all signs of the season.* (collection E.C. Krupp)**

go out to sea with lanterns at the new moon at the beginning of spring. If the migrating flying fish appeared, there would be fish for New Year's dinner. If not, the tribe would wait one month to start the year.

The Metonic cycle is more predictable. Because 235 = 9 x 12 + 7, it follows that we need to insert seven leap months to each 19-year period. This is the method used in the Jewish calendar, and it was used in the Chinese calendar before 104 B.C.

The 24 *Jíe Qi*

J1	*Lì chun*	立春	"beginning of spring"	4	February
Z1	*Yu shui*	雨水	"rain water"	19	February
J2	*Jing zhé*	惊蛰	"waking of insects"	6	March
Z2	*Chun fen*	春分	"March equinox"	21	March
J3	*Qing míng*	清明	"pure brightness"	5	April
Z3	*Gu Yu*	谷雨	"grain rain"	20	April
J4	*Lì xià*	立夏	"beginning of summer"	6	May
Z4	*Xiao man*	小满	"grain full"	21	May
J5	*Máng zhòng*	芒种	"grain in ear"	6	June
Z5	*Xià zhì*	夏至	"June solstice"	22	June
J6	*Xiao shu*	小暑	"slight heat"	7	July
Z6	*Dà shu*	大暑	"great heat"	23	July
J7	*Li qiu*	立秋	"beginning of autumn"	8	August
Z7	*Chu shu*	处暑	"limit of heat"	23	August
J8	*Bái lù*	白露	"white dew"	8	September
Z8	*Qiu fen*	秋分	"September equinox"	23	September
J9	*Han lu*	寒露	"cold dew"	8	October
Z9	*Shuang jiàng*	霜降	"descent of frost"	24	October
J10	*Li dong*	立冬	"beginning of winter"	8	November
Z10	*Xiao xue*	小雪	"slight snow"	22	November
J11	*Dà xue*	大雪	"great snow"	7	December
Z11	*Dong zhì*	冬至	"December solstice"	22	December
J12	*Xiao hán*	小寒	"slight cold"	6	January
Z12	*Dà hàn*	大寒	"great cold"	20	January

The 24 *Jíe Qi*

In order to understand the rules for the modern Chinese calendar, we must first define the 24 solar terms, or *jíe qi*. I shall call the solstices and equinoxes the seasonal markers. They cut the ecliptic into 4 sections of 90° each. The 24 *jíe qi*, cut the ecliptic into 24 sections of 15° each. The even ones are called major solar terms, or *zhong qi*, while the odd ones are called minor solar terms or *jíe qi*. The word *jíe qi*. is used in two ways. It can either refer to the 12 odd ones, or it can refer to all 24. In the table of *jíe qi* names, the approximate starting date for each period is given. The exact dates vary because of leap years in the Gregorian calendar.

The major solar terms Z2, Z5, Z8, and Z11 are simply the Western seasonal markers. The minor solar terms J1, J4, J7 and J10 start the Chinese seasons. Notice that in Western astronomy, spring conventionally begins at the March equinox, while in Chinese astronomy, spring begins midway between the December solstice and the March equinox. In Western popular culture this convention is often used, too. The traditional dates for the equinoxes and solstices were 25 March, 24 June, 24 September, and 25 December.

Fireworks are an essential element of China's traditional New Year. This Chinese papercut documents the incendiary character of this junction in the lunisolar calendar. **(from *Things Chinese* by Rita Aero. Garden City, New York: Doubleday & Company, Inc., 1980)**

Shakespeare's *A Midsummer Night's Dream* takes place on 23 June, the eve of Midsummer Day on 24 June. To Shakespeare, the June solstice was the middle of summer, not the beginning. Midsummer Day on 24 June is one of the four Quarter Days in the Legal Calendar in the United Kingdom. The others are Lady Day (or Annunciation Day) on 25 March, Michaelmas on 29 September, and Christmas on 25 December.

The Chinese beginning-of-season in markers also have their analogies in Western culture. Groundhog Day or Candlemas on 2 February is close to *li chun* ("beginning of spring") on 4 February, May Day on 1 May, and Walpurgisnacht on 30 April are close to *li xia* ("beginning of summer") on 6 May. Lammas on 1 August is close to *li qiu* ("beginning of autumn") on 8 August. Halloween (Hallowmas) on 31 October, All Saints' Day on 1 November, Guy Fawkes Day on 5 November and Martinmas on 11 November are close to *li dong* ("beginning of winter") on 8 November. These Christian holidays are related to the Celtic holidays Imbolg, Beltane, Lughnasa, and Samhain. These holidays are tabulated with their cross-cultural counterparts.

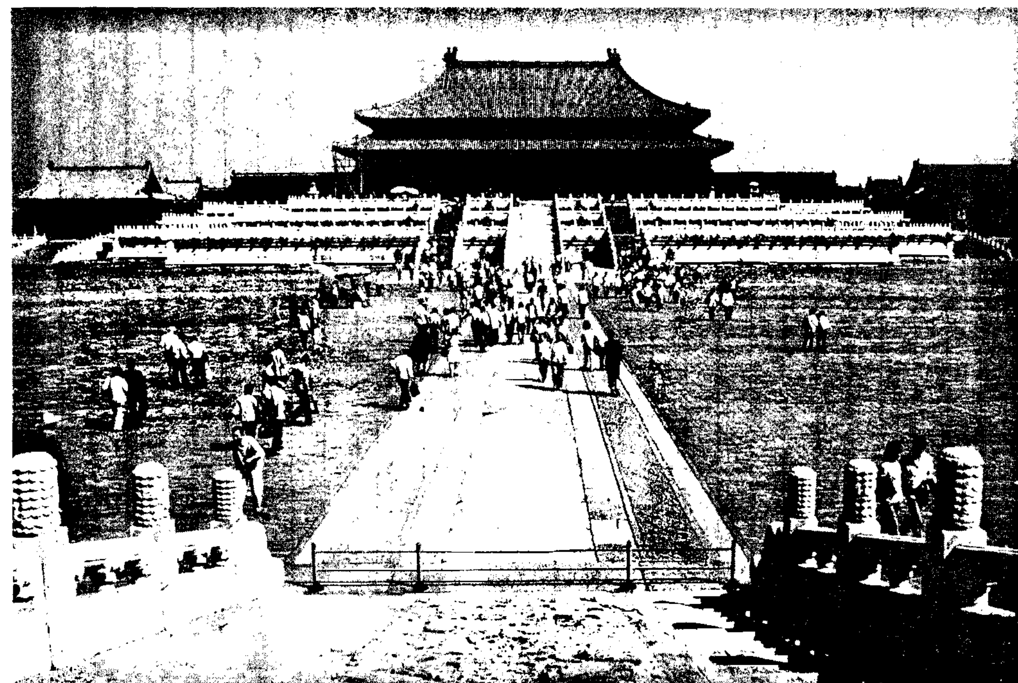
Two of the *jíe qi*'s are Chinese festivals: *qing míng* on 5 April and *dong zhi* (December solstice) on 22 December. All the other Chinese festivals are lunar. This is similar to the ecclesiastical calendar, in which Christmas Day on 25 December and Annunciation Day on 25 March are solar holidays, while all the other holidays are tied to Easter and are therefore lunar.

The Rules of the Chinese Calendar

We can now state the rules for the modern Chinese calendar:

Holiday and Season Markers

astronomical	Chinese	Western	Celtic
	li chun	Groundhog Day, Candlemas	Imbolg
March equinox	*chun fen*	Lady Day, Annunciation Day	
	li xià	May Day, Walpurgisnacht	Beltane
June solstice	*xia zhi*	Midsummer Day	
	Lì qiu	Lammas	Lughnasa
September equinox	*qiu fen*	Michaelmas`	
	li dong	Halloween, All Saints', Guy Fawkes, Martinmas	Samhain
December solstice	*dong zhì*	Christmas Day	



The emperor of China held a grand audience on New Year's Day at the Hall of Supreme Harmony (Tai he dian) at the heart of the Imperial Palace (Gu gong), or Forbidden City, in Beijing. Here, the view is due north along the axial meridian that reinforced the bond between earth and sky. The emperor was regarded as the terrestrial counterpart to the north celestial pole, around which the entire cosmos turned. **(photograph Robin Rector Krupp, 1981)**

Rule 1: Calculations are based on the meridian 120° east.

Before 1929 the computations were based on the meridian in Beijing (116°25'), but in 1928 China adopted a standard time zone based on 120° east. Since 1949, the Purple Mountain Observatory in Nanjing has been responsible for calendrical calculations in China.

Rule 2: The day on which the new moon occurs is the first day of the month.

The lengths of the months are determined astronomically. Suppose a lunation is 29.5 days and starts with a new moon at 13^h on 1 May. The next new moon then takes place at 1^h on 31 May, and so the month has 30 days. If, however, the new moon occurred at 1^h on 1 May, then the next new moon would be at 13^h on 30 May, and so the new month would start one day earlier. We would only get 29 days in that month.

Determining the Length of the Months

new moon	next new moon	length
1 May 13^h	31 May 1^h	30 days
1 May 1^h	30 May 13^h	29 days

In the Gregorian calendar, all the months (except for February) have the same number of days in different years. This is not the case for the Chinese calendar. A month may have 29 or 30 days in different years. Because the mean synodic month is 29.53 days, a little over half the months are big months, *da yue*, with 30 days and a little less than half the months are small months, *xiao yue*, with 29 days. From a naive point of view, we would expect them to more-or-less alternate, occasionally with two long months, *lian da*, in a row. This was the method until the start of the

Only the emperor could occupy this throne in Hall of Supreme Harmony. Here, on New Year's Day, the Court honored him. **(photograph E.C. Krupp, 1997)**

Tang dynasty in 619 A.D., when the mean moon, *píng shuo*, was abandoned in favor of the true moon, *ding shuo*. Kepler's Second Law requires the lunations to be longer in the winter and shorter in the summer. It turns out that it is possible to have up to four big months or three small months in a row. An example of four big months in a row is given below.

Four Big Months in a Row

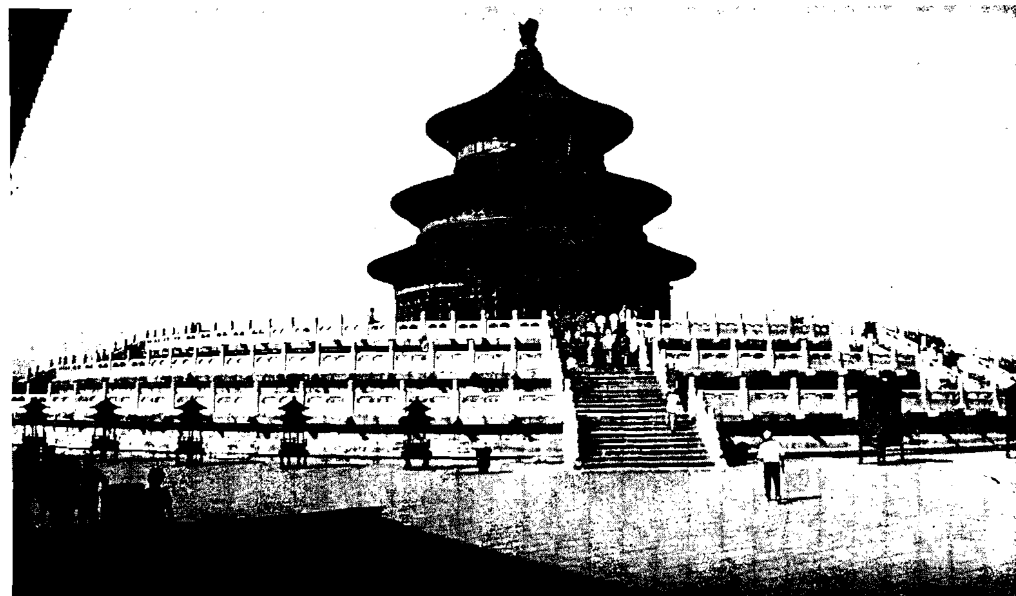
new moon	length
1990 18 Octotober 23^h 36^m	29^d 17^h 29^m
1990 17 November 17^h 5^m	29^d 19^h 17^m
1990 17 December 12^h 22^m	29^d 19^h 28^m
1991 16 January 7^h 50^m	29^d 17^h 42^m
1991 15 February 1^h 32^m	

Notice that the new moon "takes" the whole day, no matter what time of the day it occurs. So if a *zhong qi* occurred in the early morning, it is considered part of the new month, even though it may have occurred almost 24 hours before the new moon.

The Chinese Year

It is important to understand that the Chinese calendar is a combination of two calendars, a solar calendar and a lunisolar calendar. The solar calendar starts at the December solstice and follows the 24 *jie qi*. This is traditionally called the farmer's calendar. The lunisolar calendar starts at Chinese New Year and consists of 12 or 13 lunations. This is what most people think of as the Chinese calendar, and the term "farmer's calendar" has come to refer to the lunisolar calendar, even though it is not suitable for farmers.

There are therefore two different years in the Chinese calendar, the *sui* and the *nian*. A *sui* is the solar year from one December solstice to the next. A *nian* is the Chinese year from one Chinese New Year to the next. The length of a *nian* can be 353, 354, or 355 days in a normal year and 383, 384, or 385 days in a leap year. Just as we think of the Gregorian year as an approximation to the tropical year, we can think of the *nian* as an approximation to the *sui*.



The Hall of Yearly Prayer (Qi nian dian) is a signature building of Beijing. It belongs to the Temple of Heaven (Tian tan) complex south of the Imperial Palace. It is sometimes called the Hall of Prayer for Good Harvests because the emperor performed here a Great Sacrifice on behalf of the future harvest on New Year's Day. **(photograph E.C. Krupp, 1992)**

Frequency of Various Lengths of the Year 1911-2110

353 days	354 days	355 days	383 days	384 days	385 days
1	84	41	5	66	3

The tropical year tracks the return of the sun to the same declination, to the same tropic. In Western astronomy, "tropical year" used to be defined as the mean time between two March equinoxes. It is a good exercise to see why this is not the same as the Chinese solstice year (see Aslaksen, 1999, and Meeus and Savoie,1992). The modern definition is the time it takes the sun's mean longitude to increase by 360. This period is currently determined to be 365.2422 days. Here the term "tropical year" is used either for the value derived from the mean longitude, from the March equinox year, or from the December solstice year.

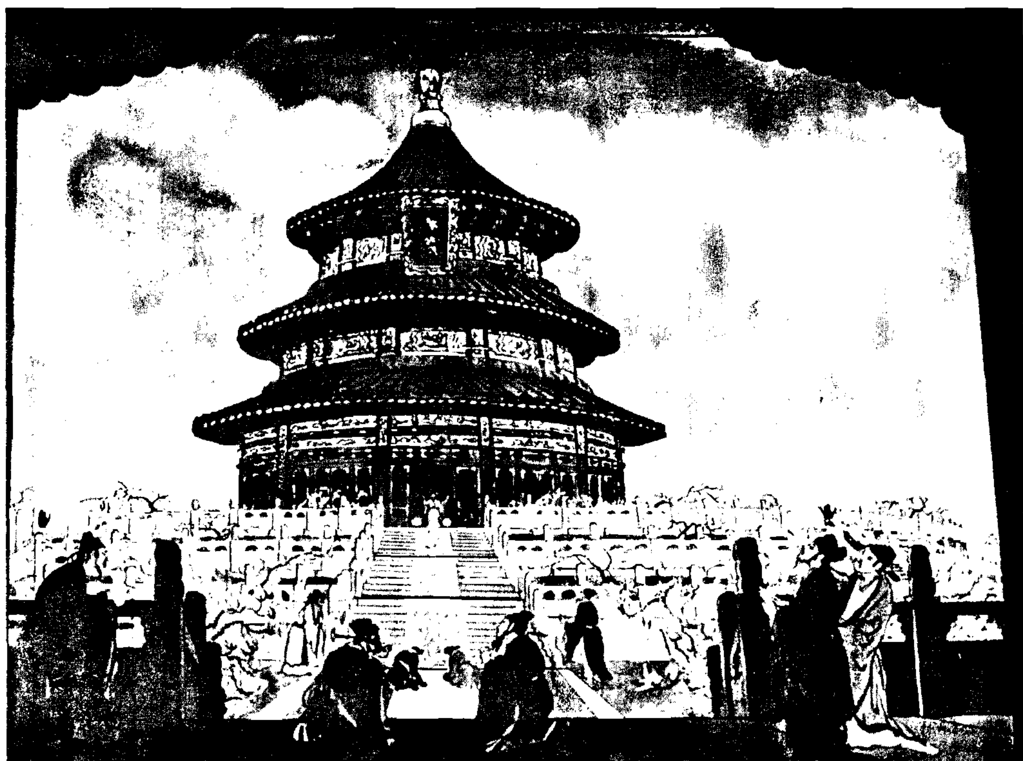
In modern Chinese, the word *sui* is only used when talking about a person's age. Traditionally, Chinese people count their age from the December solstice, but many instead count from Chinese New Year or the seventh day of the ne[w] year. Using the word *sui* when talking about [a] person's age is perhaps related to this custom.

When we say that 2033 is a leap year, w[e] mean that the *nian* 2033 contains 13 months. [A] *sui*, on the other hand, can be divided into 1[2] whole months plus about 11 days, or 11 who[le] months plus and about 40 days.

Determining the Number of Months in a *Sui*

	365 days	
5 days	354 days (12 months)	6 days
13 days	325 days (11 months)	27 days

Rule 3: The December solstice falls in the eleventh month of the *sui*. A *sui* is a leap *sui* if there are 12



You can't conduct obligatory New Year ritual without knowing when the New Year is. That takes astronomy and calendrics, and it was the responsibility of imperial astronomers to get the emperor to Hall of Prayer for Good Harvests on time. Only the emperor could offer a Great Sacrifice, and he appears alone at the top of the steps in his effort to get the year off to a good start. **(illustration Lois Cohen, Griffith Observatory)**

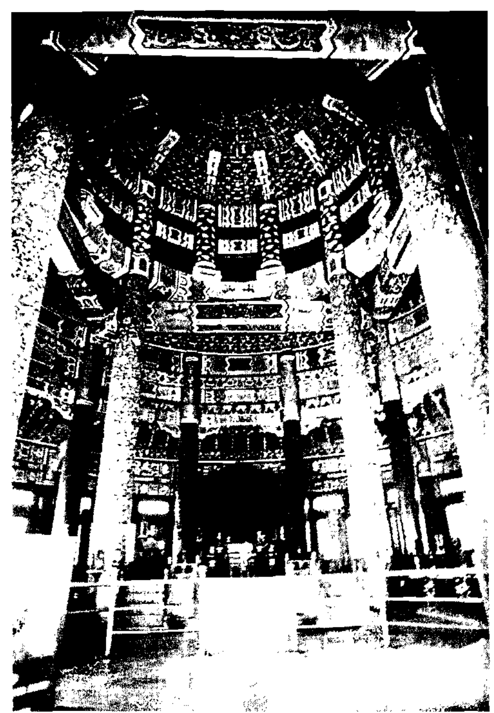
complete months between two successive eleventh months, at the beginning and end of the *sui*.

If there be a new moon on the day after the December solstice or within about 11 days, the *sui* is a leap *sui*. If there be a new moon on the same day as the December solstice or the first new moon after the December solstice is more than about 12 days later, it is a normal year. Notice that the leap year test applies to *sui*s and not to *nian*s.

Because of Kepler's Second Law, the speed of the (apparent) motion of the sun across the ecliptic is not constant, and so the time between the *zhong qi*s is not constant. This was known to Chinese astronomers since the seventh century, but it was not until the last calendar reform in 1645 that they started using the true sun, *dìng qi*, in their computations of the *jíe qì*. Before that, they had used the mean sun, *píng qì*.

Under the mean sun, system, the length between two *zhong qì*s is always about 30.44 days, which is a little bit longer than the lunar month. Hence, it is possible to have two new moons between two *zhong qì*s or equivalently, a month without any *zhong qì*. Under the true sun system, the *zhong qì*s are closer together during the winter. The time between two *zhong qì*s ranges from 29.44 days to 31.44 days. So under the modern system it is also possible to get a month with two *zhong qì*s

If we consider the first December solstice and the first eleventh month as part of the *sui*, but not the second December solstice and eleventh month, then a leap *sui* contains 13 months and 12 *zhong qì*s. Hence, there must be at least one month without a *zhong qì*. Notice that in extreme cases, there may also be a month with two *zhong qì*s, and hence two months without a *zhong qì*. This will lead to "fake leap months" (Aslaksen 1999).



The interior architecture of the Hall of Prayer for Good Harvests incorporates chronometric symbolism. The four large central poles that provide the main support for the upper roof canopy represent the four seasons. Twenty-four additional columns are divided into two concentric rings closer to the wall. One set of 12 symbolizes the 12 months that partition the year, and the other ring comprises the 12 "double-hours" that subdivide the day and night. **(photograph Curtis Leseman)**

Rule 4: In a leap suì, the first month that doesn't contain a *zhong qì*. is the leap month, *run yue*. The leap month takes the same number as the previous month.

Let me illustrate this idea. On one of my training runs I run up a gentle hill with small steps that are far apart. The distance between the steps is a little bit more than the length of my running stride. On most strides I climb to the next step, but once in a while, I land near the edge, and I have to take a "resting" stride on the same level. If you think of the steps as the *zhong qì*s, and my stride as the lunar months, you get a nice analogy with the leap month rule in the Chinese calendar. Another way is to say that whenever the lunar months have gotten too far ahead of the *zhong qì*s, they need to take a pause (leap month) to let the *zhong qì*s catch up.

Some people say that when a Gregorian calendar month contains two full moons, the second is called a "blue moon" (Olson, Fienberg, and Sinnott 1999). This concept is somewhat

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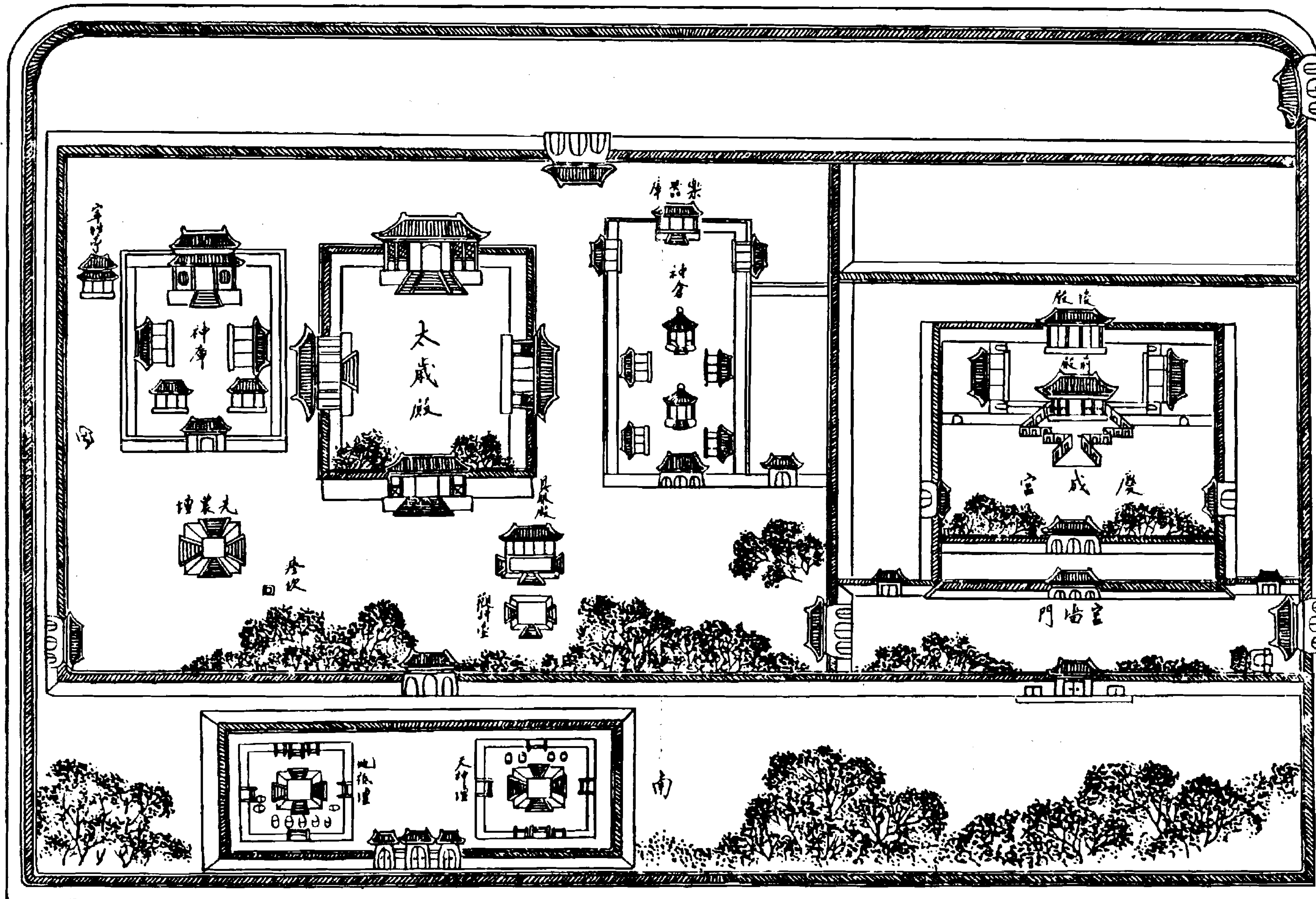
CENTER
The Emperor's New Groove

New Year ritual in Imperial China required the emperor to plough the empire's first furrow in a ceremonial plot of land in this collection of temples, halls, and open altars known as the Temple of Agriculture (Xian nong tan) in Beijing, the capital. The emperor cut this new groove before New Year's Day on a date established by the progress of the sun on the ecliptic. At the junction known as li chun ('beginning of spring"), usually close to 5 February in the Gregorian calendar, the time was ripe. Nearly all of this complex was destroyed by 1949, when the People's Republic of China was established. A large sports complex now occupies the once-fertile ground of the Temple of Agriculture. The New Year's field of dreams was located near the bottom of the largest (upper left) precinct of this monument, below the hall and terrace beneath the central enclosure in this zone. The subtleties of the Chinese calendar appear in Dr. Helmer Aslaksen's article in this issue , and it is based on his original research. **(from *Tangtu mingsheng tuhui* by Gang Tianyu, first published in 1802; reprinted in *The Dragons of Tiananmen—Beijing as a Sacred City* by Jeffrey F. Meyer. Columbia, South Carolina: University of South Carolina, 1991)**


宰牲亭
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神倉
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慶成宮
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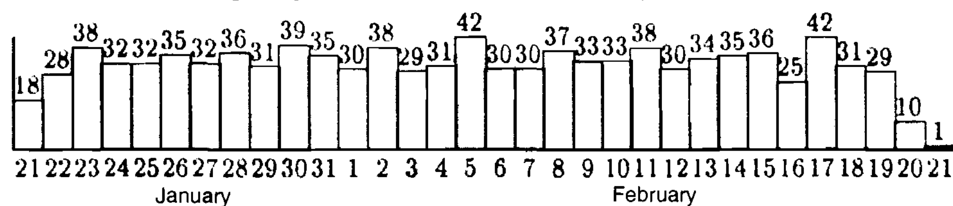
地祇壇
天神壇
南

Frequency of Date of Chinese New Year, 1645-2644



Movement of Date of Chinese New Year

1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
7/2	28/1	16/2	5/2	24/1	12/2	1/2	22/1	9/2	29/1	18/2
-10	+19	-11	-12	+19	-11	-10	+18	-11	+20	

similar to the system of Chinese leap months.

Notice that any month can be a leap month. Some Chinese astronomers claim that there can be no leap month after the eleventh, twelfth, or first month. This is true in the sense that it hasn't happened since the last calendar reform in 1645. Precession of the equinoxes ensures, however, that in the future there will be many such leap months (Aslaksen 1999). In 2033 there will be a leap month after the eleventh month. This was an error in the Chinese calendar until about 1990 (Aslaksen 1999 and Liu and Stephenson, undated). I believe that in 2262 there will be a leap month after the first month and in 3358 a leap month after the twelfth (Aslaksen 1999).

Some astrological sources use a year running from *li chun* to *li chun*, and claim that your Chinese "zodiac" animal should be based on this. In 1960, Chinese New Year fell on 28 January while *li chun* fell on 5 February. If you were born on February 1, you would not be a rat but a pig!

What Is the Date of Chinese New Year?

The exact date of Chinese New Year follows from the above rules. The possible dates for Chinese New Year between 1645 and 2644 fall between 21 January and 21 February.

Chinese New Year moves backwards by 11 days (or 10 or 12) once or twice, but if a step would take it before (or in some cases, close to) 21 January, it jumps forward by 19 (or 18 or 20) days. There are also two simple rules of thumb.

Rule of thumb 1: Chinese New Year falls on the day of the second new moon after the December solstice (approximately 22 December).

Because the December solstice falls in the eleventh month, this rule of thumb is correct provided there is no leap month after the eleventh or twelfth month. In that case, Chinese New Year falls on the third new moon after the December solstice. It can be shown (Aslaksen 1999) that there can only be a leap month between the December solstice and Chinese New Year if there is a new moon very soon after (but not on the same day as) the December solstice. The second new moon will then be around 21 January and the third around 21 February.

Rule of thumb 2: Chinese New Year falls on the day of the new moon closest to *li chun* "beginning of spring" (approximately 4 February.)

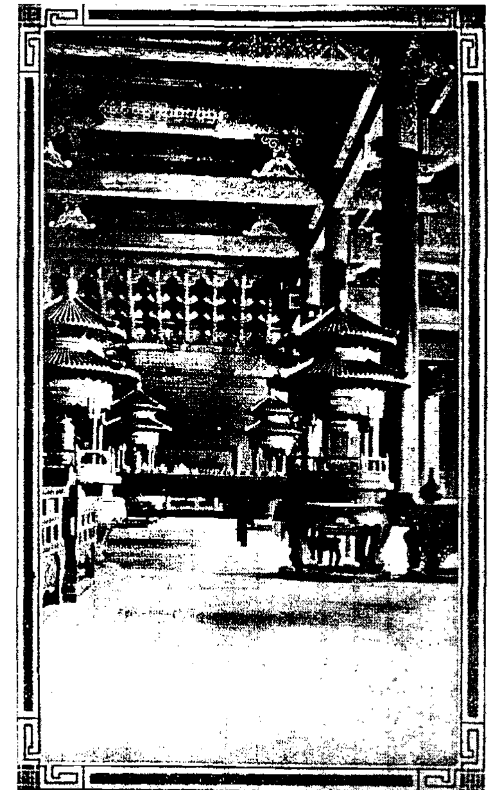
This rule of thumb explains why Chinese New Year is called the Spring Festival, *chun jie*. But it is hard to determine which new moon is closest if we have a very early or a very late Chinese New Year. The rule fails 31 times between 1645 and 2644.

Notice also that if Chinese New Year is at the "beginning of spring," then the middle of spring should be in the middle of the second month. This explains why the Mid-autumn Festival is celebrated on the fifteenth day of the eighth month.

The Chinese divided the sun's annual motion into 24 intervals known as "solar terms," or jie qi. One of these, li chun ("beginning of spring"), occurs in early February and modulates the date of the New Year. When li chun arrived, the emperor acknowledged the start of the annual agricultural cycle in a ceremony known as "meeting the spring" or as "beating the spring ox." At this time, the emperor was the empire's first farmhand, and he cut three ceremonial furrows with a decorated plough in a ritual field in Beijing's Temple of Agriculture (Xian nong tan). A large clay statue of a cow and many smaller cow figurines were then broken up at the site, and the pieces were collected by those present and transferred to their fields, where they were ploughed under on behalf of a successful harvest. **(from *Outlines of Chinese Symbolism and Art Motives* by C.A.S. Williams. Rutland, Vermont: Charles E. Tuttle Company, 1978 reprint of 1941 edition)**

The Jesuits and the Chinese Calendar

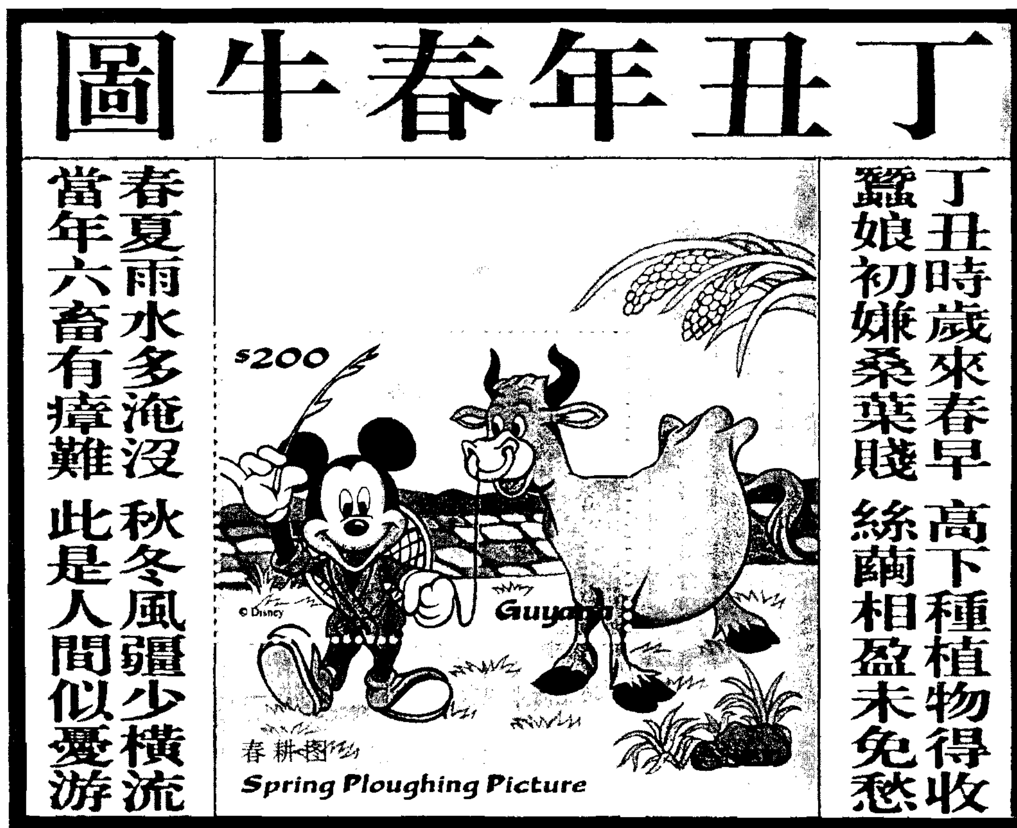
The Chinese emperor's status as the "Son of Heaven" authenticated his authority with a celestial mandate. It was understandably important for the calendar to be in harmony with



The emperor postured as a field hand in the "beginning of spring" exercises, but there was nothing agrarian about the architecture in Temple of Agriculture complex where he cultivated the new year. Huge incense burners dominate this hall that no longer exists in the area of Beijing that was dedicated to Xiannong, the mythical emperor also known as the First Farmer. **(from *Peking* by Juliet Bredon. Hong Kong: Oxford University Press, 1982 reprint of 1931 edition)**

the heavens. Unfortunately, with a lunar or lunisolar calendar, errors are much more obvious than with a solar calendar. Only astronomers would notice if a solar calendar was off by a week. On the other hand, an error of just a couple of days in a lunar calendar is apparent to everyone. The new moon visible near the end of the old month or the old moon visible in the new month would be clear evidence of discrepancy.

Because Chinese rulers invested the calendars with great importance, they were willing to



In rural areas of traditional China, the "beginning of spring" was met with a procession featuring an ox led by a child. This activity echoed the involvement of clay bovines with the year's first furrow the emperor cut in Beijing. Guyana's philatelic embrace of the Chinese Lunar New Year included this souvenir sheet with Mickey Mouse in the New Year parade. **(collection E.C. Krupp)**

incorporate foreign ideas that improved calendrical calculations. The last calendar reform came in 1645 during the Qing dynasty and was implemented by Jesuit missionaries. In 1582, the first Jesuit missionary, Matteo Ricci, came to China. At that time, the Chinese calendar was no longer accurate. Positions in the Bureau of Astronomy had become hereditary, and the astronomers no longer understood the principles behind the old calendar. When they made an error of more than half an hour in computing a solar eclipse on 15 December 1610, it caused serious embarrassment. Finally, in 1629 Xu Guang Qi, an official who was a Christian convert, was asked to revise the calendar, and he asked the Chinese and Muslim astronomers in the Bureau and the Jesuits to make predictions for an upcoming solar eclipse on 21 June 1629. The Jesuits had the best prediction, and when Xu was made director of the Bureau, he appointed the Italian Terrentius and another Jesuit as members. Terrentius had been a member of the Cesi Academy with Galileo, and he wrote to him repeatedly for help. The Pope, however, had forbidden Galileo to promote his views. Even though Terrentius promised that he would keep any assistance secret, Galileo was not very eager to help the Jesuits. Finally, in 1623, Terrentius wrote to Kepler. It took more than four years before Kepler received the letter! This was in the middle of the Thirty Years War, but even though Kepler was a Protestant, he did not hesitate to help the Jesuits. As a thank you, the

Jesuits sent him some data about old Chinese eclipse observations.

In 1644, the German Adam Schall went to the new Qing rulers and presented his calculations for an upcoming solar eclipse. Again the Jesuits' calculations were best. Schall was appointed director of the Bureau and he formulated the current rules for the Chinese calendar.

A Chinese official, Yang Guang Xian, wrote, however, that it was "better to have a wrong calendar than to have foreigners in China." He managed to have Schall and the Belgian Ferdinand Verbiest arrested in 1664. A solar eclipse was coming up and while in prison, the Jesuits predicted it would occur at 3 p.m. Yang predicted 2:15 p.m., and the Muslim Wu Ming Xuan predicted 2.30 p.m. On the day of the eclipse, the Jesuits were brought into the palace in chains, and everybody watched as the eclipse occurred exactly as the Jesuits had predicted! Unfortunately, the regents were not impressed, and the Jesuits were sentenced to death. The next day a strong earthquake struck Beijing. This was taken as a sign from Heaven that the sentence was unjust. It was first commuted to flogging and eventually to house arrest. In 1666, Schall died in house arrest.

In 1668, the Kang Xi emperor took over. The emperor ordered Verbiest, Yang, and Wu to compute the length of the shadow of a pole and the position of the sun at noon on a certain day. They were to leave their instruments pointing towards the predicted spot in the emperor's garden two weeks in advance. Verbiest easily won, and was appointed director of the Bureau, while Yang and Wu were arrested. Jesuits remained as directors of the Bureau until 1746 and it was run by other Westerners until 1826.

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New Books

Recently published books on astronomy and related subjects are announced from time to time in the *Griffith Observer*, and some of these are sometimes offered for sale at Griffith Observatory. Please see individual descriptions of books for those that may be ordered from Griffith Observatory. For others, please contact the publisher directly or your local bookstore.

Between the Lines, by Anthony F. Aveni (University of Texas Press, Austin Texas 78713-7819, $39.95 hardcover)

Dr. Anthony F. Aveni has pioneered the study of astronomical alignments in ancient monuments with fieldwork throughout Mesoamerica, in Italy, in Israel, and in Peru. He has published many research papers and articles for the general reader along with numerous books. His surveys and analyses of the Nasca lines and giant ground drawings on the desert pavement of southern coastal Peru were first comprehensively