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THE ORIGIN AND MEANING OF -COLOURFUL DESCRIPTIONS IN CHINESE ASTRONOMICAL RECORDS

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Abstract: Oriental, especially Chinese, observations of transient celestial events are often compared with mundane objects: fruits, birds and containers are typical. The comparison is sometimes thought to indicate brightness of the heavenly object in question (for night-time apparitions). Here, the matter is examined in some detail. There is evidence that the earliest descriptions referred to form and/or colour (in particular, black for sunspots). Containers probably trace back to *beidou*, the northern (big) dipper, which was a potent symbol in Chinese astrological correspondences. It is noted that many of the comparison objects were round, and that Chinese thinking considered the Sun, Moon, planets and stars as round also. It is shown that the comparison objects used were not constant in time, but changed, with certain ones preferred for centuries. A notable period coincides with much of the Song and Yuan Dynasties (1075–1360), when sunspots were almost exclusively compared with the dark plum and jujube (Chinese date) fruits, while night-time comparisons were often with stars and planets. After 1375, night-time comparisons with bullets abruptly appear, and little else was used for two hundred years. I suggest that this was inspired by contemporary military events. Although the main purpose of the observations recorded in ancient annals was astrological, there is no concrete link between the comparison objects and prognostications. A passage dating back to the Latter Han Dynasty notes that stars have their "distant connections", and goes on to say, "In the wilderness stars denote articles and objects", while elsewhere they may relate to government or society. By coupling the transient (and hence shockingly inauspicious) events to mundane objects, the imperial astronomers may have sought to distance the state from their appearance. With the possible exception of comparisons with stars and planets, it seems highly unlikely that the objects were chosen to reflect the brightness of novae, comets, meteors, etc.

Keywords: Chinese descriptions, ancient records, comets, guest stars, sunspots, meteors

1 INTRODUCTION

Any reader of Chinese astronomical treatises is likely to be struck by the regular use of imaginative comparisons in describing celestial phenomena. As Needham (1959: 435) notes about sunspots, "... their size is often described 'as big as a coin', 'as big as a hen's egg', a peach, a plum, etc." Clark and Stephenson (1978: 389) call the descriptions "... particularly picturesque, often making an allusion to size or shape." Similar comparisons can be found in reports of comets (*hui xing*, 彗星), (super)novae (*ke xing*, 客星), meteors (*liu xing*, 流星), meteor showers (*liu xing yu*, 流星雨), solar eclipses (*ri shi*, 日食), aurorae (*ji guang*, 极光) and even meteorites (*yun shi*, 陨石). As indicated by Clark and Stephenson (1978: 389), in the case of sunspots (*tai yang hei zi*, 太阳黑子) the allusion is to shape or size. In the case of luminous objects, where the description 'as large as' also frequently occurs, it is usually assumed that the reference is to brightness. The adjective 'bright' (*ming*, 明) is, however, hardly ever used.

Li (1988) argues not only that the descriptions applied to comets and supernovae were intended to express brightness, but that they can be used to establish a 'magnitude' scale for such objects. He uses 'fuzzy logic' to derive the magnitudes corresponding to a variety of descriptions. In one specific instance, a strong case can be made. Seventeenth-century Korean astronomers (comparisons like those from China were also made in Korea and Japan) assiduously followed the variations in brightness of SN 1604 (often associated with Kepler), and the light curve one derives is in excellent agreement with European observations (Clark and Stephenson, 1977: 201). However, the Koreans only compared the supernova with planets and stars (as did the Europeans), and its appearance comes quite late in the history of Oriental (especially Chinese) astronomy. Can a brightness scale 'calibration' encompass peaches, plums, planets, ladles, crows, etc. (as Li suggests), or are we truly trying to compare apples with oranges?

Several years ago, Wang investigated the question in a doctoral dissertation, and some of his work has been published. The first of three articles (Wang, 2003a) argues that human perception of the celestial sphere is of a flattened dome with a mean radius of roughly 13 m. On this basis, the Chinese unit of length, *chi* (尺, about 30 cm), can be related to the Chinese degree of 365.25 to a circle. The linear-angular scale represented by the three traditional Chinese lengths (*zhang*, *chi*, *cun*) is said to belong to a system of measurement which also includes the 'as big as ...' comparisons. The perceived flattening of the sky dome is a manifestation of the well-known Moon illusion (Rees, 1986). In his second article, Wang (2003b) argues that the comparisons in the case of sunspots referred to the area of the spot. The conclusions of his third article (Wang, 2003c) are based upon the fact that a bright object (even if point-like) will appear to be extended; the brighter the object, the more extended it seems to be. It is argued that what is perceived is the apparent area of a luminous body (even if point-like), and it is this which is related to the size of a comparison object. On the basis of meteor sightings recorded in Chinese annals, and their descriptions, Wang derives a brightness scale.[1]

In addition to the brightness issue, I have already alluded to the fact that some of the references might be to shape (Clark and Stephenson, 1978: 389). Other

properties may be suggested as well, as will be discussed below. The Korean observations of 'Kepler's supernova' demonstrate the reliability and quality which ancient visual observations were capable of. It remains unclear, however, whether there was consistency in the comparisons over some two millennia, and throughout the Chinese sphere of influence. That there may not have been is suggested by a pair of observations which must refer to the same sunspot (Clark and Stephenson, 1978: 389): "Within the Sun there was produced a black spot as large as a date." (10 February 1185, China), and "On the Sun there was a black spot as large as a pear" (11 February 1185, Korea).

The primary source of the material used is a compendium of ancient Chinese astronomical events (Beijing Astronomical Observatory [BAO], 1988).[2] Much of the text relating to comets and novae (for the rest of this paper, the Chinese term 'guest star' will be used for both novae and supernovae) has been translated into English (Ho Peng Yoke, 1962), as have most of the sunspot records (Yau and Stephenson, 1988). Records after about 1600 have not been investigated in detail, as the Jesuit presence may have influenced the descriptions used. Although my main interest is in novae, comets and sunspots, I have found it necessary to investigate all phenomena reported (including meteors and aurorae). Some preliminary results have been presented elsewhere (Strom, 2001).

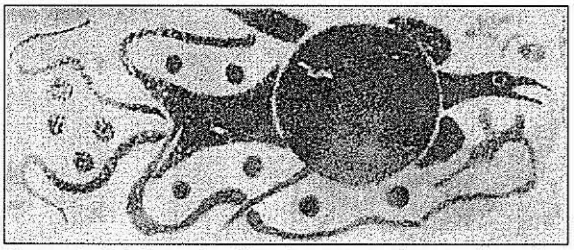

Figure 1: Rubbing of a Han Dynasty tombstone from Nanyang, Henan, China, showing a 'sun crow' (*yang wu*, 阳乌), a common design from that period.

2 CONSIDERATION OF THE AVAILABLE DATA

The descriptions to be considered typically follow the format:

<celestial object> 'large as' (or 'like') <mundane object>

where 'large as' is almost always *da ru* (大如), and 'like' is *ru* (如). (I have never come across a comparison in which 'bright' is used instead of 'large'.) Some of the astronomical phenomena have names, used in the earliest records, which also suggest such a comparison. Comets, for example, can be broom stars (*hui-* [彗] or *sao-xing* [扫星]), candle stars (*zhu-xing* [烛星]), etc. One suspects that there may have been an earlier stage when the description, star like a broom (*xing ru hui* [星如彗]), might have been used, but I have never seen it in the early records. Comparisons with brooms do occur in the sixteenth century: in 1506 a star is first described as "like a bullet" (*ru dan wan* [如弹丸]), then "like a broom" (*ru zhou* [如帚]) (BAO, 1988: 433). However, these Ming expressions come rather late.

The discovery of the three Han tombs at *Mawangdui* (马王堆), with manuscripts in tomb no. 3 which included 29 drawings of comets and their astrological portents, has added considerably to our knowledge of early Chinese astronomy (Loewe, 1980). Many of the comets are linked to botanical objects (reed, straw, bamboo, etc.), and Loewe cites a description attributed to Han Yang (韩杨): "... the shapes of comets are like those of bamboo brooms, or the branches of trees." In fact most, if not all, of the *Mawangdui* descriptive names appear to relate to morphology.

Similarly, what is perhaps the earliest description, that of a planetary conjunction, was a morphological comparison. The five (naked-eye) planets, moving across the immutable backdrop of the constellations, were seen as minions of the heavenly emperor. Their gatherings (conjunctions) in twos and threes were akin to consultations among ministers. Less frequent were the convocations of four or, rarest of all, five in a general assembly of the heavenly powers. Such get-togethers once in a half-millennium or so were coupled to events of cosmological significance: the rise and fall of dynasties as Heaven's Mandate shifted. These grand conjunctions were described as like a "string of pearls," and have been linked (Pankenier, 1998a: 29, 31) to the rise of the Xia Dynasty (1953 BCE conjunction of the five planets), superseded by the Shang (1576 BCE), which in turn was followed by the Zhou (1059 BCE).

Let us briefly survey the descriptions used in more common astronomical events, following the order in the compendium (BAO, 1988) by starting with sunspots (156 sightings recorded up to 1600). The earliest comparison (BAO, 1988: 3) is to a copper coin (*qian* [钱]), although a coin is never mentioned again. Flying birds (magpie, swallow) then become the most popular, although fruits are also mentioned (BAO, 1988: 3). There is a long period when the *zao* [枣] or jujube (*Zizyphus*) and the plum (*Prunus salicina*), *li* [李], are mainly used, though after 1250, objects ranging from people to containers come in. The choice of birds in the early records is suggestive, given the Chinese mythology of there being a crow in the Sun (Zhou and early Han periods; in fact the 'sun-crow' – *yang wu* [阳乌] – carried the Sun across the sky; see Figure 1). It has been suggested (Needham, 1959: 436) that sunspots might therefore have been observed as early as the fourth century BCE. Perhaps it was in fact sunspots which inspired the sun-crow myth in the first place. The association of a dark silhouette against the solar disk with a flying bird is in any event quite natural; what else was likely to be seen high in the sky (in pre-aviation days)?

In a dozen instances, there is mention of a star in the Sun. Elsewhere I have argued (Strom, 2002) that these were probably observations of Sun-grazing comets near perihelion. None of the descriptions is similar to the comparisons discussed above (in fact, the sunspots and stars are not mentioned together). I assume they were a different phenomenon, and have excluded them from further consideration.

We continue our survey with the aurora borealis (northern lights, observed 169 times before 1600), which results as high energy electrons from the solar wind are guided by the Earth's magnetic field to near the pole. Among the descriptions used are fire, a rainbow, the shape of a cultivated bamboo grove (BAO, 1988: 32), banners and flags (BAO, 1988: 29) and walls. The colour red is particularly noted, and the light is described as like blood.

Another near-Earth phenomenon, meteorites, was also regularly observed and recorded (203 times up to 1600). Some of the reports describe both the passage through the atmosphere, and the fallen stone itself. Descriptions in the atmosphere include cloud like a curtain, smoke first like a red whirlwind (BAO, 1988: 67), spouting fire but scattered (BAO, 1988: 69) and simply fire. The sound was also described: thunder, thunder shock (BAO, 1988: 69), drum beat (BAO, 1988: 66) and *qing* (BAO, 1988: 66) [磬, percussion instrument made of stone or bronze]. As for the fallen stone itself, it was described as like an urn, large as an iron chopping block (BAO, 1988: 65) and a blue-green stone like a jade container (BAO, 1988: 69).

Eclipses, the next three categories, do not provide much material, as might be expected. The maximum phase of a partial solar eclipse which just fails to be total was described as unfinished like a hook (BAO, 1988: 132). An annular eclipse in 1292 was likened to a golden ring, with pearl or jade earrings on either side (BAO, 1988: 203). Lunar eclipses were occasionally accompanied by a reference to their colour: like blood (BAO, 1988: 263). And there were no special descriptions for lunar occultations of stars. For the eclipses, and other categories of this section, Table 1 provides a summary of salient facts. In the period before 1600, some 1200 solar and 700 lunar eclipses were registered.

The guest stars (novae; 68 records pre-1600) provide us once more with a wide range of comparison objects. Fruits are regularly used early on. Only after 1000 CE are there comparisons with planets and stars. Noteworthy are the frequent references to the pellet (bullet) from about 1400. (I should note, perhaps, that the BAO [1988] compendium separates comets from novae on the basis of motion, mention of a tail, other suggestion of extent, etc., and not just on the terminology *ke-* or *hui-xing*.) Comets, of which some 680 were observed up to 1600, earn descriptions not unlike guest stars, also being frequently compared with a bullet in the later references. One notable difference is that comets are often compared with containers—bowls, dippers, cups—especially before the Tang Dynasty. Only much later do the guest stars get the same treatment (SN 1572, for example, being described as large as a small cup, and also large as a bullet [BAO, 1988: 377]). Another striking comparison (though infrequent) is large as a fist (or hand) (BAO, 1988: 403)—as if the observer sighted along an outstretched arm.

Finally we have the meteors and their showers. For the latter, the most common reference is to rain, one of the most obvious and naturalistic descriptions. This is the earliest comparison known (Table 1), and may have been the inspiration which ultimately led to all the rest. Other objects include the usual fruits, containers and eggs. Some striking comparisons are: breaking up and falling like snow (BAO, 1988: 579); light shiny like lightning (BAO, 1988: 580); and flow like something woven (or knit) (BAO, 1988: 580). Meteors are most commonly compared with fire, although there is also the usual assortment of fruit, containers, cloth, etc. Sound, when mentioned, is likened to thunder. Meteors can be observed on any cloudless night; some 4300 were recorded before 1600. Only 142 of the much rarer meteor showers are mentioned, half before 1100 CE, and half between 1400 and 1600.

Most of the objects mentioned evoke vivid, concrete images in the mind of the reader, and one is struck by how apt, if not obvious, many of them are (rain, thunder, fire, curtain, rainbow, etc.). They are the sort of descriptions an astronomer today might use in a popular lecture. Of course the Han, Song and other astronomers were not writing for the man or woman in the street, but they would have needed to communicate their observations to the bureaucracy, the court, and ultimately to the emperor. One can imagine that the descriptions were perhaps, in the first instance, intended for such non-professionals. However, we should not forget that the observations had an astrological purpose, for which the descriptions may have played a role—a point to which we will return later.

Table 1: First records of comparison objects for different phenomena.

Phenomenon	First Comparison	Object	Other Descriptions Used
Sunspots	28 BCE	Copper coin	Bird, egg, plum, jujube
Aurorae	154 BCE	Mat	Fire, flame, rainbow
Meteorites	11th century BCE	Urn	Flames, thunder, stone
Solar eclipses	89 BCE	Hook	Golden ring
Lunar eclipses	307 CE	Blood	Red
Novae	48 BCE	Gourd	Fruit, bullet, planet
Comets	148 BCE	2-peck; peach	Bullet, container, fruit
Meteor showers	17-16th centuries BCE	Rain	Container, fruit, egg
Meteors	204 BCE	Fire	Cloth, container, gourd

3 STATISTICS AND SOME PATTERNS IN THE RECORDS

Comparisons of some kind or other are made in a large fraction of the recorded observations, but there are differences among the various categories. As noted above, there were no comparisons made for lunar occultations of stars, while for solar and lunar eclipses, comparisons occur in around 2% of the reports. Most of the other categories have rates ranging from about 30% (guest stars, aurorae) to 60% (meteors, meteorites). Comets are the exception, with comparisons in about 15% of the records (for the 23 recorded appearances of P/Halley there are only three instances). Perhaps the low fraction for comets arises since the generic name itself ('broom star') conjures up a vivid image. In the case of the *Mawangdui* manuscript (Loewe, 1980), each comet type is given a name, often botanical, but no comparison is made. For example, entry 613 begins: "see white drops" (*bai guan jian* [白灌见]); in only a couple of instances is the term *hui-xing* used.

For most of the phenomena, comparison is made with the word *ru* (like): e.g. 'like a peach'. In the main, only for sunspots and guest stars was the wording *da ru* (large as) used (some 60% of all comparisons for these objects): e.g. 'large as a plum'. But can 'large' be taken to mean bright for luminous objects?

3.1 Contradictory Evidence on the Meaning of 'Large As'

To describe a bright star or planet as 'large' (rather than 'bright') is fairly common, and appears to occur

in most languages. As noted in the Introduction, when Korean astronomers described SN 1604 as "large as Venus", "smaller than Jupiter", etc. (Clark and Stephenson, 1977: 196), there is little doubt that it was brightness which they were comparing (and we have the independent European observations to verify it). Similarly, for the SN of 1006 (which was known to be bright on several grounds), we have descriptions from outside China such as: "a large guest star ... like Mars, and it was bright" (from Japan); "2½ to 3 times as large as Venus" (Arabic, from Egypt); "star of unusual size" (Latin, from St. Gallen); and "a large star similar to Venus in size and brightness" (Arabic, from Baghdad) (Stephenson and Green, 2002: 159-168). But with this last citation, we might wonder which "size" (apparently distinct from "brightness") is referred to, Venus being unresolved with the naked eye.

Returning to the Chinese texts, it is perhaps worth noting that an early (ca. 80 CE) textual reference used to illustrate the meaning of the Chinese character for "large" (*da*, 大) states (Commercial Affairs Book Printing House, 1999: 56) that, "Large, and small [*xiao*, 小] are opposites ... 'The Sun appears large rising and setting, at midday it is small.'[3]" This passage refers to the well-known Moon illusion (Rees, 1986), and interestingly here, large and small describe the (apparent) angular size and not the Sun's brightness (which would appear less at sunrise and sunset than in the middle of the day). It is clear that "large" and "small" can refer to either extent or brightness in a celestial body.

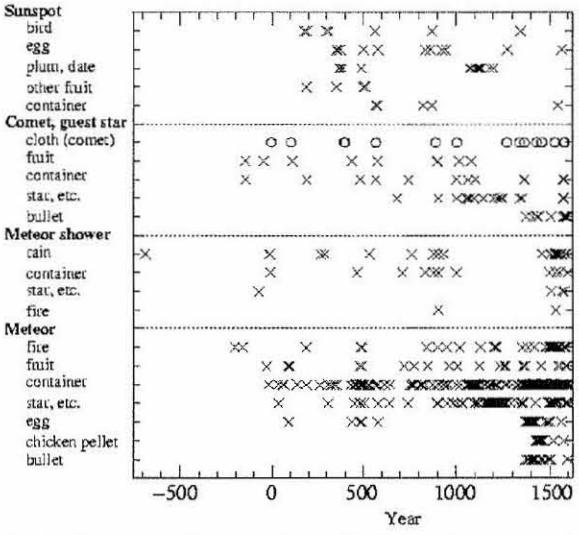

Figure 2: Usage of comparison objects for four transient celestial phenomena as a function of time (note that year 0 = 1 BCE, −500 = 501 BCE, etc.). Comets and guest stars (GS) are grouped together (for 'cloth' the symbol ○ is used, as guest stars are never so described).

In the case of objects whose extent can be readily discerned with the naked eye, the situation is somewhat different. The tails of comets are often described with an angular measure of their size. The term "large" is seldom used; rather, the tail may be described as "long" (*chang*, 长), and if discernibly wide, "broad" (*guang*, 广) as well. Yet at the same time, the comet may also be described as "large". If this refers to the head, then the meaning might be ambiguous. Bright comets can extend for many—even several tens of—degrees; sunspots constitute extended objects at the other extreme, near (or beyond) where the naked eye can discern their extent. Nonetheless, descriptions like "large as a plum" (大如李) appear regularly in the written records. Clark and Stephenson (1978: 389) consider such descriptions to refer to shape or size. But if the reference is to the latter, then as Stephenson and Green (2002: 190) note, a literal comparison pushes imagination to the verge of credulity. For a large sunspot group (say 4′ arc) and typical comparison objects, the required viewing distance is around 100 m! To quote Stephenson and Green (ibid.), "... an explanation is lacking."

Finally, to muddy the waters further (were it not already unclear enough), let us return to comets, and consider several passages from the Song Dynasty period. In addition to the usual, "large as ..." there is a description of a comet in 1147, "small as Jupiter" (小如岁星 [BAO, 1988: 421]). (On the date in question Jupiter was a night-time object, with a magnitude of −2.3.) Then a few years later (1222) we read of another comet, "its body small like Jupiter" (其体小如木星 [BAO, 1988: 421]). Here, too, we may wonder: might size actually refer to extent rather than brightness? And in 1230 yet another comet is "large as Saturn but [its colour] not bright" (大如镇星而色不明 [BAO, 1988: 421]). (This is reminiscent of the Latin description in the *Tractatus de Cometis* of a comet seen in Ulm in early 1402: "Its size was rather greater than that of Venus ..., but not as bright." (Kronk, 1999: 260-261).) Finally, what should we make of the following description of a meteor shower in March 461: "perhaps long, perhaps short, perhaps large, perhaps small" (或长, 或短, 或大, 或小 [BAO, 1988: 578])?

3.2 Pattern of Comparisons Over the Centuries

To get an overall picture of the objects which celestial apparitions were compared with, let us consider the situation for five of the topics in Table 1. (I exclude the eclipses because so few comparisons are made, and aurorae and meteorites because they are rather different phenomena to the main topic of interest, heavenly bodies.) For each phenomenon, a handful of broad comparison types (birds instead of magpies, swallows, etc.; containers instead of cups, bowls, etc.; and so forth) has been chosen to make the presentation clearer. Guest stars and comets have been combined, as there are few of the former, and this leads to no significant loss of information. Then for each phenomenon and comparison category, the usage as a function of time is shown in Figure 2.

There are several noteworthy patterns which emerge from this exercise. For sunspots, birds, fruits and eggs make most of the early running. Notable is the use of plums in the period 350-500, and plums and the *zao* (Chinese date) from 1075 to 1250. Containers, which occur frequently with other phenomena, are only mentioned occasionally. (No sunspots whatsoever are reported during the seventh and eighth centuries, a gap which also applies to guest stars. In fact, the Tang Dynasty saw something of a decline in reports of celestial phenomena generally, which may have resulted from the upheaval of the An Lushan revolt in 755.)

Among guest stars and comets, containers (especially the dipper) and fruits are the main comparison

objects until about 1000. The use of other fruits stops just when the plum and *zao* become the object of choice for sunspots after 1075. It is most striking that from 1075 until 1360, planets and stars are extensively used. And then the pellet (bullet, *dan*, or *dan wan* – 弹, 弹丸) becomes the primary comparison object for some years after 1375 (actually first appearing in 1374 in a meteor description). Cloth (or cotton) is used for comet descriptions (referring to the tail) from the earliest times.

Meteor showers are described as like rain, and meteors are compared with fire, throughout. Meteor showers are also likened to containers during the recorded period (note that there are no showers reported in the seventh and eleventh to fifteenth centuries). Meteors are also compared with containers and (less frequently) fruit over the same interval. From the eleventh century onwards, the frequency of comparison with celestial objects increases dramatically (as do the meteor reports generally). Chicken and bird eggs are often mentioned in the fifth century, and then ignored for some eight hundred years. Then, from 1369, they reappear as chicken eggs (*ji zi* – 鸡子) and are used as frequently as containers for over fifty years. In 1374 the bullet (*dan* – 弹) enters and is used regularly, although less frequently. Then, quite suddenly in 1425, chicken egg is replaced by chicken pellet (*ji dan* – 鸡弹) and used with great frequency until 1463, when it just as abruptly disappears. Sound, when noted, is almost invariably compared with thunder (but this is not shown in Figure 2).

4 DISCUSSION

What is the origin of the usages and patterns we have just noted? Let us discuss some specific examples, which may provide clues.

4.1 The First Comparisons Come From Nature

The first recorded comparison objects (see Table 1) are rain for meteor showers, and fire for meteors, very vivid and apt choices as noted above. In the *Mawangdui* document, each of the comet drawings has a descriptive name, most of them being botanical (reed broom, straw broom, etc.), but also including "flute of Heaven," shield broom, pheasant (Loewe, 1980). Many of these may have been chosen because their shapes mimic the comets in question, but in the manuscript they appear as names, not comparison objects (the construction, star like a straw broom, is not used).

Although a copper coin is the earliest comparison recorded (BAO, 1988: 3) for sunspots, if we follow the suggestion of Needham (1959: 436), then this may have actually been preceded by a (black) bird, perhaps as early as the fourth century BCE. It could even be that the Chinese myth of a crow (*wu* [乌], which also means black) carrying the Sun (Figure 1) was inspired by a sunspot,[4] a clear example of Nature inspiring myth. The example of birds (Figure 3), and other complicated shapes which appeared later, suggests that form rather than size (however defined) was the original inspiration. The same statement would apply to meteors and their showers.

Most sunspots are, however, formless to the naked eye, and a more appropriate object would be small and simple in shape. Perhaps it was the early association with birds which led to their eggs being chosen (first in 354), specifically indicating whether it was a chicken egg (*ji luan* [鸡卵], BAO, 1988: 5), that of a duck (*ya luan* [鸭卵], BAO, 1988: 5), or goose (*e zi* [鹅子], BAO, 1988: 6). Eggs may have the right shape, but even the brown or spotted eggs of many birds are hardly black. Could this have been the inspiration for choosing the typically dark purple fruit of the plum (*li* [李]) to the exclusion of almost all other objects between 365 and 495?

If this speculation is correct, then the logic of the fourth and fifth century astronomers was certainly surpassed by their Song successors. Between 1075 and 1205, there are 21 comparisons with plums or *zao*s. The *zao* is a dark, nearly black, fruit. Unlike the plum, which is round, this Chinese date has an oval shape. It is tempting to speculate that the latter was used to describe sunspots which appeared to be elongated. (This may also explain the use of the pear by Korean astronomers to describe a sunspot in 1185 [see Section 1], for like the *zao* used in the Chinese description one day earlier, the pear is usually not round. The difference in colour would then reflect the fact that the Song astronomers had rigorously adopted dark fruits for comparison with sunspots.) There are references to only three other objects in this one hundred and thirty year period: a sunspot "like millet in size" (*ru su da* [如粟大]; one first compared to a plum, then likened to grain[5] (*ru li* [如粒]); and a spot of "form like a person" (*zhuang ru ren* [状如人]). The latter might refer to a large, anthropomorphic sunspot group.

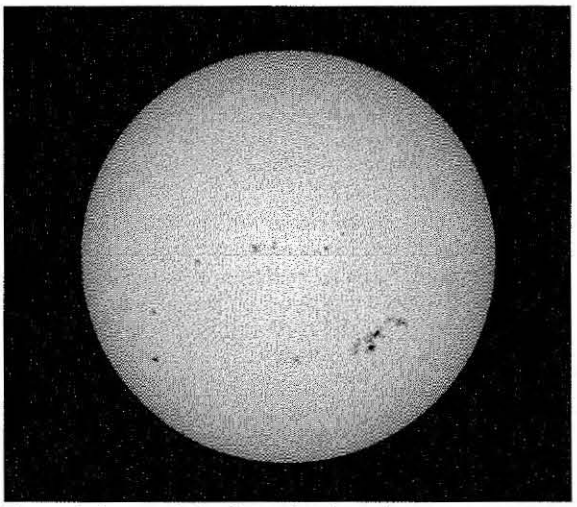

Figure 3: Image of the Sun, showing a large sunspot group (AR 9393) visible with the naked eye, seen with which it might appear to have the shape of a bird. The photograph was taken in white light on 30 March 2001, with one of the instruments of the Global Oscillation Network Group (photograph courtesy National Solar Observatory/AURA/NSF).

Just as the Song sky-gazers commence their systematic use of plums and dates to describe sunspots, they stop using fruits to compare with guest stars and comets (last report in 1021). Instead, there is almost exclusive reference to planets and stars between 1075 and 1360 (the Song practice being continued in the Yuan period as well). Planets (especially Venus) also became the preferred comparison objects for meteors throughout the Song. It seems unlikely that such systematic and well-coordinated changes arose by chance, but rather that they were intentional. The

Song Dynasty is often said to have been the most 'scientific' of China's historical periods (Ronan, 1980: 50), and this systematic, consistent approach would seem to agree with that viewpoint (though as Cullen (1996: 92) notes, "... we need to tread very carefully to avoid interpreting the thought-patterns of ancient authors in terms of our modern preconceptions."). It is possible that the comparisons with planets and stars do refer to brightness, but the matter would require further investigation.

4.2 The Importance of *Beidou (Ursa Major)*

In the period that comets and guest stars were compared with planets and stars, there is a single instance of another comparison object: a bright comet in 1106 was "like the mouth of a cup in size" (*ru bei kou da* [如杯口大]. This is but one of the numerous examples of containers as comparison object: cup, bowl, basin, jar, *fou* (缶, an ancient earthen utensil), dipper. Where did it begin?

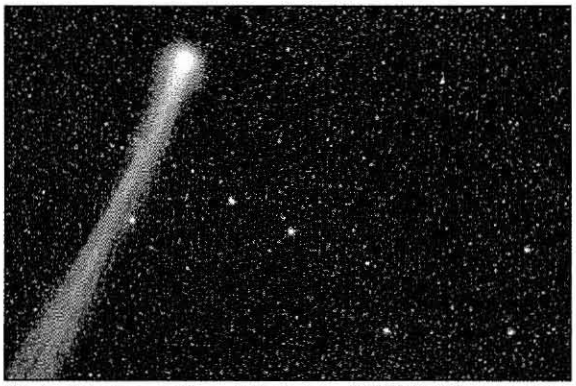

Figure 4: Image of Comet Hyakutake (C/1996 B2) and *beidou* ('Northern Dipper') taken on 25 March 1996 (photograph copyright T.G. Matheson, reproduced with his permission).

The very first comparison, which involved a comet, was recorded in 148 BCE and described it as "large as a 20 litre vessel"[6] (*da ru er dou qi* [大如二斗器], BAO, 1988: 385). The word *dou* (斗) means both a unit of dry measure (now about 10 litres) and a utensil, the dipper. The seven brightest stars of the constellation *Ursa Major* (popularly called the 'plough' in Britain, and the 'Big Dipper' in the USA), are known in Chinese as the 'northern dipper', *beidou* (北斗), a key object in Chinese asteriography. In later comparisons, the *dou* as a utensil is used: "large as a dipper" (*da ru dou* [大如斗], BAO, 1988: 402). Although none of the references is to *beidou* as such (note that there is also a southern dipper, *nandou* [南斗]), it has been shown (Needham, 1962: 270) that the asterism was also just called *dou*. I speculate that an early comet, possibly passing near or through *beidou* (as did one in 613 BCE ([BAO, 1988: 383) and as recently as 1996, see Figure 4), but in any event with a shape which mimicked a dipper, was the original inspiration for the comparison.

The symbolic importance of *beidou* should not be ignored. It was seen as controlling the heavens:

> Sima Qian implies that supernatural influence emanates from the pole by calling the Big Dipper "Di's chariot" and by portraying the Dipper's movements as the efficient cause of transformations of yin and yang, the five elemental forces, the seasons, and all natural periodicities. (Pankenier, 1995: 140).

One early astrological system, the main principles of which are no longer known, is believed to have been based upon changes in the stars of *bei dou* (Pankenier, 1999: 265). As a pointer, the dipper served as a clock at night (Pankenier, 1998b: 192). Lodestone in the shape of a spoon, the "south seeking ladle" (*si nan zhi shao* [司南之杓]), was the first magnetic compass (Needham, 1962: 262; and see Figures 329-30). During the Xin Dynasty (9–23 CE) of Emperor Wang Mang, a 'Ladle of Majesty' (*wei dou* [威斗]) in the shape of *beidou* was constructed by imperial order. Spoon-shaped, and also called *dou* (斟), such ladles served a ritual purpose (Needham, 1962: 272-273).

There is an additional characteristic which the ladle and other containers shared: they were round. This is significant, because from earliest times Chinese mainstream philosophy regarded the Sun, Moon, planets and stars as round. Consider the words of Wang Chong (王充, ca. 80 CE, sceptical philosopher who believed otherwise):

> Again, the scholars assert that the bodies of the sun and the moon are quite spherical. When one looks up at them, their shape seems like that of a ladle or a round basket, perfectly circular. (Needham, 1962: 413).

Here, the shape of the ladle presumably refers to its container. Practically all of the vessels compared with comets and novae were distinctly round. Besides the ladle and several cups (cup or glass [*bei*, 杯]; wine glass [*jiubei*, 酒杯]; small cup [*zhan*, 盏]), there are the following:

> *wan* [碗]: "bowl; hemispherical vessel, wider than it is deep." (Contemporary Chinese Dictionary [CCD], 2002: 1977);
> *hu* [斛]: "cubic measure used in former times, small at the mouth and large at the bottom." (CCD, 2002: 819);
> *fou* [缶]: "(arch[aic].) earthen utensil with large body and small opening." (CCD, 2002: 591);
> *weng* [瓮]: "urn; earthen jar with a bulging belly." (CCD, 2002: 1441); and
> *pan* [盘]: "(arch[aic].) washbasin." (CCD, 2002: 2012).

All of these have shapes which would have appeared roughly (hemi-)spherical. And when it comes to the (wine) glass, the phrase sometimes encountered was, 'like the mouth of a cup' (see above): in cross section, round.

4.3 Fruits to Bullets

Most of the fruits used in the comparisons are also spherical in shape: orange, peach and plum. The word usually translated as melon (*gua* [瓜]) is problematic, as *gua* can be a variety of fruits, including melon, pumpkin, etc. ("... any trailing or climbing plant of the gourd family." (CCD, 2002: 701)). The oval-shaped *zao* was only used in comparison with sunspots. There is one striking, and significant, addition to make to this list.

A meteor recorded in 32 BCE was described as, "large as a *hu*" (*da ru hu* [大如瓠], BAO, 1988: 619; the entire description reads: *you liu xing da ru hu* [有流星大如瓠]). The *hu* is a "calabash gourd (*Lagenaria siceraria*); ... plant with ... columnar fruit which has a light-green peel" (CCD, 2002: 825). It is similar to a cucumber, but thinner and with a lighter colour (see Figure 5). What better way to describe a meteor trail?—long, thin, lightly coloured. This early record of a fruit comparison (while not the earliest) does

suggest that fruits were mainly chosen for their shape. (The only other comparison with a *hu* that I have found refers to a meteorite which fell in 1393 (BAO, 1988: 71).) Note that there was also a Chinese asterism, the *hu gua* (瓠瓜 or 葫瓜) in Delphinus, which is rather *hu*-shaped (Ho Peng Yoke, 1962).

Fruits, as illustrated in Figure 2, were used regularly until about 1200 in comparisons with comets, novae and sunspots. Plums, as discussed above (Section 4.1), were used to describe sunspots during the chaotic period of the Eastern Jin and Liu-Song Dynasties. (Only once, during the Eastern Han Dynasty, was a comet or nova compared with a plum (BAO, 1988: 389).) The plum and *zao* were later similarly used by Song astronomers, while celestial objects replaced fruits for novae and comets, and this continued during the Yuan Dynasty. Then, quite abruptly at the beginning of the Ming Dynasty, bullets become the preferred comparison object. It seems highly likely that this was inspired by contemporary events, although the Ming aversion to anything associated with their former Mongolian (Yuan) rulers might have also played a role.

Firearms were invented in China between AD 850 and 880, some centuries after gunpowder (Ronan, 1980: 50), one of the earliest surviving examples dating from 1288 (Needham et al., 1986: 293). Thus, although reference could have been made to bullets from the thirteenth century onwards, it seems it was the extended period of carnage nearly one hundred years later, as rebellions overwhelmed Yuan rule, which triggered their use. The first mention in astronomical annals (in 1374) is when a meteor is compared with a bullet (BAO, 1988: 764). Two years later, the comparison is with a comet (BAO, 1988: 426), and thereafter comets and novae are compared with little else for two centuries.

The choice of a bullet (shot from a gun) for comparison with both meteors and comets seems typically appropriate. It provides a vivid image (especially if one imagines a gunshot in the dark) which at the time must have been experienced by much of the population: the nucleus (bullet) leaving behind a fiery trail. Moreover, a bullet is round (the modern conical shape was only introduced much later), just as the heavenly bodies were supposed to be. The comparison is as appropriate as the earlier naturalistic ones: rain for meteor showers, etc.

And while on the topic of firearms and gunpowder, there is a record of the sound of a meteorite being compared with an explosion rather than the usual thunder. In 1176, a meteorite's fall was "... compared with the letting off of a gunpowder projectile trebuchet, *ru fa huo pao*" (如发火炮). (Needham et al., 1986: 157). Such reports are again probably indicative of widespread use of explosives, in this case as the Mongols overwhelmed the Jurchen Jin, and finally overthrew the Southern Song to establish the Yuan Dynasty.

4.4 Were there Astrological Influences?

Chinese astrology was based upon a mapping of terrestrial realms and geography onto celestial asterisms ("field allocation," *fenye* [分野])—the Yellow River corresponded to the Milky Way, for example—combined with a principle of organic connectedness. As Needham and Wang (1956: 289) note, the "... idea of correspondence has great significance and replaces the idea of causality, for things are *connected* rather than caused." Events on the Earth might be reflected by changes in the heavens, something abnormal in the stars could be a precursor to trouble for the empire.

> The more unusual the changes and movements of the stars and planets, the more grave the implications, particularly since unanticipated events such as comets and eclipses were viewed with foreboding. (Pankenier, 2005: 24).

As a result, the ability to predict astronomical events was of paramount importance. Or, as Yabuuchi (1973: 93) notes, "The breadth of the Chinese ephemerides reflected the grave concern of Chinese rulers constantly to expand the demonstrable order of the sky, while reducing the irregular and ominous."

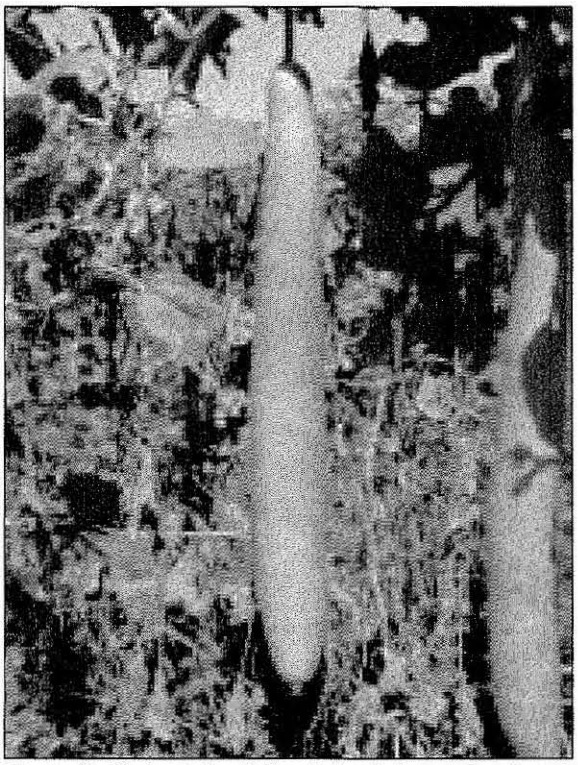

Figure 5: Photograph of the fruit of *lagenaria siceraria* (calabash gourd, the Chinese *hu zi*). The skin of this edible fruit has a light green colour (photograph from the late Professor H. St. John, reproduced with permission).

All of the phenomena considered here—sunspots, aurorae, comets, meteors, etc.—were unpredictable, in any event initially. Eclipses became predictable, to a degree at least, but the rest remained ominous. The prognostications for an unexpected event depended upon its location and nature. The new star of 1006 may be taken as an example (Stephenson and Green, 2002). Having specified its position, the *Song Huiyao Jigao* (ch. 52) goes on to say "... it belongs to the (terrestrial) division of Zheng and the (Jupiter) station of *Shouxing*." It then suggests that it was an auspicious star called *Zhoubo*, which "... presages great prosperity to the state over which it appears." The astrological implications thus depended upon location and nature of the event, and were not linked to its description (which in other records were given as, "form was like the half Moon" and "bright rays were like a golden disc" (ibid.)).

Correspondence was crucial to the interpretation of celestial events, or in the words of Berger (1990: 34): "Everything 'here below' has its analogue 'up above'." Although no specific astrological meaning can be assigned to the mundane descriptions discussed in this paper, a general significance can be construed from a statement found in the writings of the Latter Han polymath Zhang Heng. In his *Ling xian* (灵宪), Zhang notes: "... every [star] has its own distant connections. In the wilderness stars denote articles and objects; at court they denote officials; among people they denote human actions." (quoted in Pankenier, 2000: 200). If there was an astrological significance, then by using mundane objects to describe comets, meteors, sunspots, etc., a court official would be downgrading its significance from politically weighty to something of no great concern: in the wilderness, far removed from the throne.

4.5 Similar Expressions in Other Chinese Texts: A Literary Connection?

Are there other examples of similar usage in Chinese writing? In the course of sampling Chinese literature, I have come across several instances. A number can be found in a Chinese classic, *Creation of the Gods* (*Feng shen yan yi* – 封神演义 – 2000), which although compiled in its final form during the Ming period, includes many tales from much earlier in Chinese literary history. Here are some typical examples:

face like the full Moon: 面如满月 (*Feng shen yan yi*, 2000: i, 308);
face like a purple jujube, eyes like bells: 面如紫枣眼如铃 (*Feng shen yan yi*, 2000: ii, 495);
mouth like a basin: 口如血盆 (*Feng shen yan yi*, 2000: ii, 467);
head the size of a city gate: 头有城门大 (*Feng shen yan yi*, 2000: ii, 815); and
a beam of brilliant light large as a cup's mouth: 一道星光有盏口大小 (*Feng shen yan yi*, 2000: i, 263).

Although most of the descriptions are of people, the last example is strikingly similar to some of the astronomical ones. Note also the comparisons with containers, fruit and a celestial object.

Another example is from a story dating to the Tang Dynasty period, *Governor of the Southern Tributary State* by Li Gongzuo (ca. 770-850) (1999: 129-31). In the passage in question, a tortoise shell is described as, large as a dipper (大如斗). In this case the object described could well have the physical dimension of that to which it is compared. Once again the use of the dipper for comparison is most striking.

Finally, here is an example from poetry by Du Fu, perhaps China's greatest poet. In a long poem entitled *Northern Expedition* (北征) we find the following description of wild berries (Du Fu, 2001): 或红如丹砂, / 或黑如点漆 (some red as cinnabar, / some black as lacquer). Again we have colourful descriptions by comparison, not unlike examples from *Creation of the Gods*.

It would appear that there has long been a literary tradition of using picturesque expressions to describe objects. This should not be too surprising, for the Chinese language itself is rich in vivid imagery.[7] The very characters, deriving as they do from hieroglyphs, often suggest concrete linkages.[8] Many of the literary expressions use exaggeration for emphasis, and should probably not be taken too literally. By the same token, caution is advisable when interpreting the astronomical comparisons. An interesting but unanswered question is whether the astronomical descriptions preceded and possibly inspired the literature, or vice versa.

4.6 An Alternative Interpretation

My feeling is that the comparisons used in the astronomical descriptions probably did not serve a single purpose, nor were they constant in time. There are periods when they may have been intended to represent object brightness, but I doubt that this was generally the case as was argued by Li (1988). In his more thorough investigation, Wang (2003a; 2003b 2003c) arrives at a conclusion similar to Li's, and would no doubt dispute my interpretation. In particular, he says that "... records of 'big as a peach' ... are not the metaphors that observers used freely ..." but that they belonged to a traditional method of scientific thinking. When used to describe astronomical phenomena, the "... purpose was to show their apparent diameter, apparent scale or brightness." (Wang, 2003a: 42). I do not disagree with this statement, but would dispute the notion suggested by Wang that the comparisons with luminous objects were intended to express brightness. If there is one strand fairly continuous down the centuries, then in my opinion it is that the comparison objects represented form, and in some cases colour.

Wang rightly considers how our perception of the celestial vault affects our interpretation of what we see in the sky (and a similar discussion is found in Rees, 1986, with references to earlier work). He argues that the conversion from linear to angular scale is based upon imagining that the comparison object is at a distance of $\approx 13 \pm 2$ m (his estimated radius for the celestial vault). However, as Stephenson and Green (2002: 190) have pointed out, in the case of sunspots the required distance is around 100 m. Wang (2003a: 42) describes the system used from the Warring States period to the Qing Dynasty as "... widely applicable ..." geographically, and "... throughout history." However, he ignores (or does not appreciate) the changes in comparison object over the course of time (see Sections 4.1 and 4.3, and Figure 2), which suggests that the scale (if there was one) was not static. In his third paper, Wang (2003c) uses objects and qualitative descriptions of the light from meteors (such as "bright," "illuminating the Earth," "illuminating the sky," "faces were illuminated," etc.) to calibrate a brightness scale. The use of meteor observations makes sense statistically, but some of the comparison objects cover a wide range of brightness: peaches stretch from the faintest "some bright" to "the Earth was illuminated," while the *dou* (dipper) covers ten categories from "bright" to "the sky and Earth were illuminated." The final conversion from comparison object to apparent magnitude via angular diameter strikes me as problematic.

5 CONCLUSIONS

The imaginative expressions used to describe celestial objects in Chinese astronomical annals date back to some of the earliest recorded observations. Moreover, the very names of the objects themselves are vivid, concrete expressions of form: *broom stars* for comets, *streaming stars* for meteors and *streaming star rain* for

their showers. (Of course the names used in English have similar Greek roots: comet [κομήτης] = long-haired; meteor [μετέωρον] = thing in the air.) As argued above, the descriptions could have been invented to inform the non-expert, although they may have also been used for dramatic effect as in the literary comparisons.

While the Chinese descriptions are especially picturesque, early astronomical texts in European and other languages were not devoid of a degree of hyperbole. Comets, in addition to being 'hairy', were also described as *javelin-* (Kronk, 1999: 36), *horned-* (Kronk, 1999: 154), *sword-shaped-* (Kronk, 1999: 71), and *bearded*-stars (Kronk, 1999: 237). Many of the comparisons ('star like a ...') are unsurprising: "like a little torch" (Kronk, 1999: 85), "column of fire" (Kronk, 1999: 172) and "like a lantern" (Kronk, 1999: 179). Arabic texts often referred to a "star with locks of hair" (Kronk, 1999: 161). And analogous to the Chinese 'broom' [*hui*], there was a comet called the "besom of destruction" (Kronk, 1999: 84), while elsewhere a description often encountered in the Chinese records was used: "like a veil of linen" (Kronk, 1999: 190) (though in China, silk would replace linen). Finally, some of the more unusual descriptions included: "swarm of bees" (Kronk, 1999: 69), "shape of a trumpet" (Kronk, 1999: 84), "swordfish" (Kronk, 1999: 88), "vision serpent" (Kronk, 1999: 108), "erect as a sacred cupressus" (Kronk, 1999: 160), and "width like the neck of a horse" (Kronk, 1999: 196) (with this last example, as in so many of the Chinese ones, it is difficult to know exactly how a linear measure should be related to an angular one).

So in both Oriental and Occidental descriptions, shape seems to have been the original essence of the objects chosen. This may have been followed by colour: the black crow for sunspots, succeeded by dark fruits (plum, *zao*); the light (and linear) *hu* for a meteor, and other light-coloured fruits (peach, orange) for comets and 'guest stars'; and finally the glow from the muzzle of a firearm. But there are other factors which may have influenced the choice of objects, of which reference has already been made to a philosophical one: heavenly bodies were believed to be round (Needham, 1959: 413). Similarly, possible connections with Chinese literature are suggested by several examples quoted above.

Although there is no direct evidence that the comparison objects chosen had astrological significance, the use of mundane descriptions would help to demystify the otherwise shocking appearance of unexpected events, and diminish their significance. By demoting stellar apparitions to the wilderness of mere worldly objects, court officials implied that the celestial event in question was actually far removed from imperial concern.

From the chronology of the comparison objects (see Figure 2), something of a pattern can be distilled. There is an initial period, which I will call *early naturalistic*, where vivid, concrete examples, mainly from Nature, are chosen (meteor shower = rain; comet = dipper; sunspot = bird; etc.). This leads to a time of *imaginative extension*, where the dipper inspires cups, bowls and containers in general (and they are extended to phenomena other than comets), birds suggest eggs (for meteors as well as sunspots), and the *hu* is succeeded by other fruits. There follows an epoch of *mature systematization*, where small, dark fruits are almost exclusively used for sunspots, while comets and guest stars are mainly compared with planets and other celestial objects, as are meteors. And finally, there is *late whimsical* imagery, epitomized by comparing meteors and comets with bullets. Some of the relationships are sketched in Figure 6.

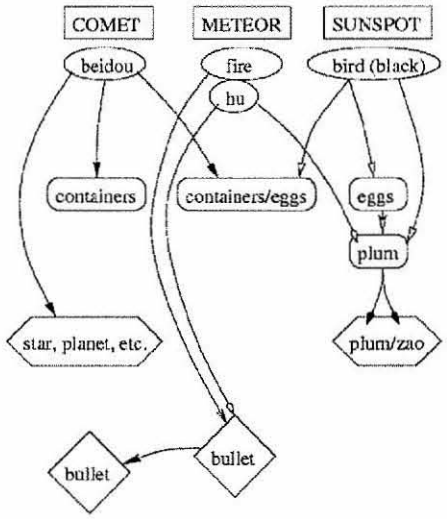

Figure 6: Sketch showing how some of the descriptions used in Chinese annals might have developed.

This investigation began with the notion that the comparisons in Oriental records might be linked to the magnitude of the (night-time) phenomena observed, as was certainly the case in the Korean observations of SN1604. Only the period of *mature systematization*, corresponding to the Song-Yuan Dynastic era, would seem to support such an interpretation. However, whether the comparisons with planets, etc., were that systematic would require further, detailed investigation. It is possible that these systematic Chinese observations were the inspiration for the later Korean ones. The fact that magnitude did not figure in most of the early comparisons should not surprise us. Few Oriental star atlases distinguished between bright and faint objects (Clark and Stephenson, 1977: 89), even in the Song period, and many determinative stars and asterism members were chosen for their location rather than prominence.

6 NOTES

1. This exposition of Wang's ideas is too brief to fully do justice to his research. The reader should consult the original articles for more information.
2. This compendium reproduces astronomical records from twenty-four imperial histories, the Qing draft history, the Ming and Qing actual collections, ten general, national local chronicles and other ancient books of records of astronomical phenomena, up to 1911.
3. The original quoted here comes from Wang Chong (王充), "*论衡• 说日*".
4. Clark and Stephenson (1978: 388) say that Needham (1959) makes a similar suggestion, but a fairly thorough search through his book has failed to locate the relevant passage.
5. Comparison with grain, and in particular millet, may be significant. Millet grains were used in China to

measure small openings (Needham, 1965: 145) and to gauge volume (Needham, 1965: 75). Perhaps here they indicate small sun spots.

6. An alternative translation would have "volume" instead of "vessel".
7. An example is the word for waterfall, *pubu* (瀑布), the second character of which means cloth: "river that falls ... looking like a piece of white cloth from afar." (CCD, 2002: 1503).
8. The character for man or male consists of two components: *li* meaning strength, depicted by a plough (力), and *tian*, for cultivated fields (田). Together they form *nan* (男): man, strong enough to plough farmland.

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