COSMOLOGY ACROSS CULTURES
ASP Conference Series, Vol. 409, © 2009
J. A. Rubiño-Martín, J. A. Belmonte, F. Prada and A. Alberdi, eds.

Astronomical and Cosmological Aspects of Maya Architecture and Urbanism

Ivan Šprajc

Scientific Research Center of the Slovenian Academy of Sciences and Arts, Novi trg 2, 1000 Ljubljana, Slovenia

Abstract. Archaeoastronomical studies carried out so far have shown that the orientations in the ancient Maya architecture were, like elsewhere in Mesoamerica, largely astronomical, mostly referring to sunrises and sunsets on particular dates and allowing the use of observational calendars that facilitated a proper scheduling of agricultural activities. However, the astronomical alignments cannot be understood in purely utilitarian terms. Since the repeatedly occurring directions are most consistently incorporated in monumental architecture of civic and ceremonial urban cores, they must have had an important place in religion and worldview. The characteristics of urban layouts, as well as architectural and other elements associated with important buildings, reveal that the Maya architectural and urban planning was dictated by a complex set of rules, in which astronomical considerations related to practical needs were embedded in a broader framework of cosmological concepts substantiated by political ideology.

1. Introduction

It does not seem necessary to argue extensively about the importance that astronomy, religious concepts and political ideology had in the structuring of built environment in archaic civilizations. Architectural orientations often corresponded to naturally significant rising and setting positions of celestial bodies, such as solstitial extremes of the Sun or lunar standstills, phenomena that must have served as the most elementary references in time computation, while more sophisticated alignment patterns referred to other celestial events, such as heliacal rises of certain bright stars, or sunrises or sunsets at certain moments of the tropical year that, in a given natural and cultural context, had some practical, mostly agricultural significance.

However, astronomically oriented buildings can rarely be interpreted as observatories, in the modern sense of the word, or as instruments serving practical needs only, because their primary functions were mostly religious, residential, or related to governmental activities. The objectives of monitoring important celestial events, measuring the passage of time and scheduling agricultural activities could have been achieved without constructing sumptuous buildings and orienting them accurately. It is obvious that exact astronomical knowledge and its practical function were intertwined with a complex set of beliefs about the structure and functioning of the universe, sustained by the ruling elite, and that these concepts had a very important role among the ideas influencing the formation of ancient cultural landscapes. General discussions on this topic and

analyses of particular cases can be found, for example, in Wheatley (1971), Eliade (1972: 328-345), Ashmore (1989; 1991), Kowalski (1999), and Aveni (2001: 217-222). With respect to the Maya settlement patterns, specifically, it has been mentioned that "both ancient and modern communities were commonly laid out as microcosms of the four-quartered world, with attendant directional symbolism, as harmonious replication, in miniature, of the encompassing universe" (Ashmore 1989: 272).

2. Astronomical Referents of Maya Architectural Alignments

Archaeoastronomical research accomplished so far has shown that the distribution of azimuths corresponding to architectural orientations in the Maya area is similar to the one found elsewhere in Mesoamerica, indicating that the most important buildings were oriented to the rising and setting positions of celestial bodies, mostly to sunrises and sunsets on certain dates of the tropical year (Aveni 2001: 245ff; Aveni & Hartung 1986; Aveni, Dowd & Vining 2003; Šprajc 2004a; 2008).

The earliest astronomical orientations, both in the Maya area and in Mesoamerica in general, referred to solstitial sunrises and sunsets (Aveni 2001: 245ff; Aveni & Hartung 2000; Aveni, Dowd & Vining 2003: 163; Tichy 1991: 55f; Šprajc 2001b: 74f; 2008: 236f), probably because the extremes reached by the Sun in its movement along the horizon are naturally significant and easily perceptible phenomena. The importance the solstices must have had since remote times seems to be reflected not only in orientations but also in the concept, apparently pan-Mesoamerican, that the corners and bearers of the sky are located at the four solstitial points on the horizon (cf. Milbrath 1999: 19; Šprajc 2001a: 281). Other two rather easily determinable dates are the so-called quarter-days of the year, or mid-points in time between the solstices (March 23 and September 21, ± 1 day). Also the alignments referring to these dates are found at early sites, such as Cuicuilco and Teotihuacan in central Mexico (Šprajc 2001b: 170ff, 208ff), or the Southeast Group of Altar de los Reyes in Campeche (Šprajc 2008: 235, 241). The solstitial and quarter-day orientations are not limited to the early periods of Mesoamerica[1]. In later times, however, more complicated orientation principles began to prevail.

A study based on a number of sites with monumental architecture in central Mexico has revealed that the alignments allowed the use of observational calendars composed of calendrically significant and, therefore, easily manageable intervals: the intervals separating the sunrise and sunset dates recorded by alignments at a particular site tend to be multiples of 13 or 20 days, i.e. basic periods of the Mesoamerican calendrical system. The correspondence between the most frequently recorded dates and the crucial moments of the cultivation cycle suggests that the reconstructed observational schemes served for predicting important seasonal changes and for an efficient scheduling of the corresponding agricultural and associated ritual activities (Šprajc 2000a; 2000b; 2001b). It

[1] While there is no compelling evidence that the true equinoxes were known in Mesoamerica, the orientations to sunsets on the quarter-days of the year are quite common (Tichy 1991: 56ff; Šprajc 1990: 91ff; 1995: 590ff; 2001b: 75ff; 2004a: 105).

should be recalled that observational calendars were of foremost practical significance, since the Mesoamerican calendrical year of 365 days, due to the lack of intercalations, did not maintain a permanent concordance with the tropical year of 365.2422 days[2].

Similar observational schemes have been proposed for several sites in the Maya area (Aveni, Dowd & Vining 2003; Šprajc 2004a). Particularly revealing are the results of a recent study in southeastern Campeche, Mexico, i.e. in the central part of the Yucatan peninsula. Orientations were determined for 23 Late Preclassic and Classic structures (c. 300 B.C. – A.D. 900) at 11 archaeological sites (Šprajc 2008). The most numerous orientations (12) cluster around the azimuth of 104°/284°. This is hardly surprising if we recall that, in the distribution of architectural alignments in the whole Maya area, Aveni & Hartung (1986: 17; 2000: 55) observed a prominent peak around 14° clockwise from cardinal directions. In southeastern Campeche, the sunrise dates corresponding to these orientations center on February 12 and October 30, and the sunsets on April 25 and August 18 (Šprajc 2008: 236f, Fig. 9.2). In central Mexico, the first pair of dates is recorded by a number of alignments, but the same orientations normally correspond to sunsets on April 30 and August 13; while there is plenty of evidence suggesting an agricultural significance of the four dates, their additional peculiarity consists in that they delimit intervals of 260 days (from February 12 to October 30, and from August 13 to April 30), equivalent to the length of the Mesoamerican ritual calendrical cycle. It was thus argued that they must have been crucial moments of a canonical or ceremonial agricultural cycle; abundant ethnographic data support this conclusion (Šprajc 2000a; 2001b: 79ff, 107ff). However, since the sunset dates corresponding to this orientation group in southeastern Campeche (April 25 and August 18) are not commonly recorded elsewhere in Mesoamerica and do not delimit calendrically significant intervals, it is likely that these alignments targeted only sunrises on February 12 and October 30.

This conclusion is supported by the spatial relationship that some buildings oriented this way have been found to exhibit with respect to others. At Yaxnohcah, Campeche, Mexico, Structure C-1 is aligned to Structure E-1-a, located about a kilometer away to the southeast. Not only are both pyramidal mounds, rising up to about 30 and 20 m, respectively, oriented around 14° south of east; since the azimuth of the line connecting the summits of the two buildings is 104°11', the observer on top of Structure C-1 could have observed sunrises on February 12 and October 30 exactly over the top of Structure E-1-a. A similar

[2]The orientations, marking critical and canonized moments of the year of the seasons, not only allowed them to be determined by direct observations; if observational schemes were composed of multiples of elementary periods of the calendrical system, it was relatively easy to *anticipate* the relevant dates (which was important because cloudy weather may have impeded direct observations on these dates), knowing the structure of observational calendar and the mechanics of the formal calendar. Particularly important for these purposes must have been the 260-day calendrical count, in which the cycles of 13 and 20 days were intermeshing, so that every date had a name composed of a number from 1 to 13 and a sign in the series of 20: given the structure of this calendrical cycle, the sunrises and sunsets separated by 13-day intervals and their multiples occurred on the dates with the same numeral, while the events separated by periods of 20 days and their multiples fell on the dates having the same sign (for the whole argument and the corresponding bibliography, see Šprajc 2001b: 99ff, 151ff).

relationship has been found between Structures B-1 and C-1 of El Gallinero, another site in southeastern Campeche (Šprajc 2008: 238), while at El Mirador, Petén, Guatemala, three alignments of this type have been detected (Šprajc & Morales-Aguilar 2007). These cases suggest that astronomical motives underlay not only the orientation of particular buildings but also the placement of some structures with respect to others.

The occurrence of the 14°-group of alignments at the Late Preclassic El Mirador has another very important implication. In southeastern Campeche, Mexico, some orientations of the 14°-group were found to be embedded in the so-called triadic groups, dated to the Late Preclassic period (c. 300 B.C. – A.D. 200); it has therefore been suggested (Šprajc 2008: 239) they may predate the urban layout of Teotihuacan, designed at the beginning of the current era and so far considered as a prototype of this orientation group (Aveni 2001: 234; cf. Šprajc 2000a; 2001b: 201ff). Now that these alignments have been found at El Mirador, involving structures securely dated to a time no later than the 2nd century B.C. (Šprajc & Morales-Aguilar 2007), we can conclude beyond reasonable doubt that their origin was, in fact, in the Maya area, possibly in the city of El Mirador itself. Recent excavations in the Moon Pyramid of Teotihuacan have revealed that the earliest building, constructed around A.D. 100, possesses an orientation clearly differing from the one adopted by the later overall grid system (Sugiyama & Cabrera Castro 2007: 116), which must have been dictated by the orientation of the Sun Pyramid, corresponding to sunrises on February 12 and October 30 (Šprajc 2000a; 2001b: 201ff).

Returning to the meaning and use of astronomical orientations, the evidence summarized above strongly suggests that most of them had an agricultural significance, facilitating a proper scheduling of activities in the yearly cycle. Apart from the results of systematic studies referred to above and based on larger samples of alignment data, several case studies focused on particular sites and alignments support this view (e.g.: Aveni 2001: 250ff; Aveni, Milbrath & Peraza 2004; García Cruz 2002; Šprajc 1990; 1995). While most orientations, including alignments composed of architectural elements that produce interesting light-and-shadow effects (cf. Šprajc 1990; 1995), can be convincingly related to solar positions on the horizon on certain dates (Šprajc 2005: 210f, 213, note 2), some orientations have been found that probably refer to Venus extremes and lunar standstills, and possibly even to certain stars (e.g.: Aveni, Gibbs & Hartung 1975; Aveni & Hartung 1978; Šprajc 1993a: 45ff; 1996a: 72ff; Galindo 2002).

3. Cosmological Aspects of Maya Architecture and Urbanism

Even if the observational function of architectural orientations indicates their relationship with practical needs, which is in accordance with what we know about the adaptive value of astronomical knowledge and its consequent importance in archaic civilizations (cf. Aveni & Hartung 1986: 56; Iwaniszewski 1989: 28f; Šprajc 1996b: 20-22), the alignments cannot be understood in purely utilitarian terms. As the repeatedly occurring directions are most consistently incorporated in monumental architecture of civic and ceremonial urban cores, entailing considerable effort, they must have had an important place in the worldview and even in the cosmologically substantiated political ideology. This can be under-

stood if we consider that the apparently immutable and perfect order observed in the sky, obviously superior to the one reigning on the earth, must have been the primary source of deification of heavenly bodies, whose cyclic behavior thus was not viewed as being simply correlated with seasonal transformations in natural environment but rather as provoking them. Assuming, therefore, that timely occurrences of these changes were believed to be conditioned by the arrival of celestial bodies, particularly the Sun, to specific points on the horizon, the directions corresponding to these events, particularly to those considered critical for a proper development of the agricultural cycle, must have acquired a sacred dimension. Because the beliefs composing the worldview were incorporated into the political ideology of rulers, who as man-gods pretended to be responsible for the proper functioning of the universe (cf. López Austin 1973; Rivera 2001: 41ff; Šprajc 1996b: 102f), the alignments reproducing significant astronomical directions in civic and ceremonial architecture can be interpreted not only as a sanctified materialization of the amply documented union of space and time in the Mesoamerican worldview (cf. Aveni 2001: 148-152), but also as a manifestation of attempts of the governing class to recreate the cosmic order in their earthly environment and to perpetuate thereby, in accordance with principles of magic, the proper functioning of the universe (cf. Broda 1982: 99-106; Ashmore 1989: 272f; Aveni 2001: 217-222; Šprajc 1996b: 21f; 2001b: 154f, 411ff; 2005: 211f).

Several authors have argued that the ancient Maya architecture and urbanism reflects cosmological concepts and directional symbolism, and that such principles of site planning were used by Maya rulers to express and reinforce their status within the political order they controlled (e.g.: Rivera 2001: 113-140, Ashmore 1989; 1991, Ashmore & Sabloff 2002; 2003). Also, the city layouts or its constituent parts have often been interpreted as materialized cosmograms. Smith (2003; 2005) quotes a number of such hypotheses, but his criticism, even though excessive (cf. Šprajc 2005), shows that many of them are hardly convincing and do not comply with basic requirements of methodological rigor.

While the Maya architecture and city plans do share a number of common characteristics, a high degree of diversity can also be observed. The largest pyramidal structures, for example, can be found both in the centers and on the fringes of site cores, and a preference for a particular cardinal direction can hardly be detected. Based on several cases, particularly from northeastern Petén, Ashmore (1989), and Ashmore & Sabloff (2002: 203) contend that the arrangement of constructions along a north-south axis was a predominant practice among the Maya, and attempt to unveil its cosmological underpinnings. However, in many sites the east-west direction is clearly more pronounced, while in others no clear axial pattern can be recognized.

In view of regional or even local peculiarities of urban layouts – attributable to the fact that the Maya were not politically united but rather lived in a series of more or less independent city states – it is obvious, as Ashmore (1989: 283) also admits, that no common cosmological denominator can be expected to account for all the characteristics observed in Maya site planning. It is highly likely that spatial relations among buildings of certain types and their associations with certain cardinal directions were, at least partly, dictated by cosmological concepts and political ideology, but the precise nature of these ideas and motives should

be studied case by case, taking into consideration contextual evidence concerning the buildings' use, construction sequences etc. (cf. Ashmore & Sabloff 2003: 233).

There is, however, a property shared by most of the city layouts in the Maya area, and even in Mesoamerica in general. Even though exceptions are found in all periods, Mesoamerican architectural orientations tend to be skewed clockwise from cardinal directions, i.e. south of east or, viewed differently, east of north (Aveni & Hartung 1986: 10; Aveni 2001: 233; Tichy 1991; Šprajc 2001a; 2001b), which means that the orientations referring to the Sun and exhibiting this skew recorded sunrises in autumn and winter and sunsets in spring and summer. The prevailing practice of orienting buildings this way could not be dictated by observational motives: the alignments could have recorded the autumn and winter dates on the western horizon and the spring and summer dates on the eastern horizon, had they been deviated south of west (north of east). It could even be argued that such orientations, corresponding to sunsets in the dry season and to sunrises in the rainy season, would have made the observations easier: in the rainy season, which in Mesoamerica lasts approximately from May to October, the sky is more likely to be clear in the morning than in the afternoon.

The characteristic clockwise skew of Mesoamerican orientations has been interpreted in terms of meteorological conditions, as reflecting the purpose of the builders to manipulate seasonal light and warmth in the most convenient ways (cf. Dow 1967: 333; Carlson 1982: 54f). As argued elsewhere (Šprajc 2004b: 165f), these suppositions are far from compelling because, considering the differing arguments they employ, it seems that any orientation can be interpreted as having some advantage in terms of climatic circumstances. Also important is the fact that the south-of-east skews are particularly consistent in the orientations of ceremonial structures, for which practical considerations must have been less relevant than in the case of housing units (cf. Aveni & Hartung 1986: 3).

Rather than on practical motives, the clockwise skew from cardinal directions must have been based on the symbolism related to the world directions. Ashmore (1989; 1991), discussing the role of directional symbolism in the principles dictating architectural arrangements and site planning, focuses on the north-south conceptual dichotomy, as manifested in the spatial distribution of architectural and other archaeological vestiges. However, a clue for understanding the clockwise skew of architectural orientations seems to be provided by symbolic connotations of the east and the west.

As mentioned above, the south-of-east skew of orientations implies that the dates recorded on the eastern and western horizon fell mostly in the dry and wet seasons, respectively, and this is precisely what the Mesoamericans most probably intended to achieve: there is evidence indicating that the dry season was conceptually related to the eastern and the rainy season to the western side or part of the universe. The symbolism and directional associations of the Sun, Moon and Venus are particularly revealing. In Mesoamerican worldview, the Sun was associated with heat, fire and drought, whereas the Moon and Venus, primarily its evening manifestation, were linked to water, maize and fertility. On the other hand, it has been shown that the Sun was related to the east, and the Moon and Venus as evening star with the west. A large amount of data supporting this conclusion, as well as the observational facts that may have

accounted for these concepts, have been extensively discussed elsewhere (Šprajc 2004b; Šprajc 1993a; 1993b; 1996a; 1996b).

Since the orientations, as argued above, pinpointed agriculturally significant moments of the tropical year and thus allowed the use of observational calendars serving practical needs, we could say that the alignments with the clockwise skew from cardinal directions, recording the dates in the dry season on the eastern horizon and those in the rainy season on the western horizon, reconciled observational necessities with the symbolism associated with the eastern and western parts of the universe.

If this interpretation is correct, it represents a cosmological rationale for one of the most pervasive features of architectural planning in the Maya area and in Mesoamerica in general. However, as mentioned above, we can also observe a number of time-dependent variations and regional or even local peculiarities; the attempts to explain them require a thorough consideration of case-specific contextual evidence, and such interpretations may only be applicable to particular areas, periods, sites, or even buildings.

One illustrative example is the structure traditionally known as the House of the Governor and located at Uxmal, a Late and Terminal Classic site in the northwestern part of the Yucatán peninsula. Built around A.D. 900, the palace was oriented to the maximum northerly extremes of Venus as evening star. Even if few similar cases are known in Mesoamerica, the idea that the Governor's Palace was intentionally oriented to Venus has a strong iconographic support. More than 350 Venus glyphs are still visible in the decoration of the Palace's façade. Since the northerly extremes of the evening star are seasonal phenomena, heralding the beginning of the rainy season, it is particularly significant that Venus glyphs are placed in the cheeks of the masks of the rain god Chac. Furthermore, the Chac masks are arranged in groups of five, whereas eight stylized double-headed serpents are set in the decoration above the central doorway, and the numeral eight in Maya dot-bar notation appears above the eyes of the Chac masks at both northern corners of the Palace; five and eight are, obviously, Venus numbers *par excellence*, considering the commensurability, well known to the Maya, of five synodic periods of the planet and eight calendar years (Šprajc 1993a: 45ff; 1996a: 72ff; 1996b: 170ff).

The Governor's Palace, facing southeast, is aligned to a low bump visible on the horizon and corresponding to the main pyramid of Cehtzuc, a small site lying about 4.5 km southeast of Uxmal. For an observer situated there, Venus as evening star would have set aligned with the northern edge of the Governor's Palace at its maximum northerly extremes, occurring every eight years. However, due to the angular width of the structure, as seen from Cehtzuc, the planet actually disappeared somewhere behind the Palace at two or three of the five northerly extremes observable in any eight-year cycle. All of them occurred in late April or early May, i.e. at the beginning of the rainy season.

This alignment can not be regarded as particularly useful in practical terms. Venus extremes, since they are not annual phenomena and do not occur constantly on precisely the same dates of the tropical year, are rather unsuitable for accurate measurement of time. However, since the orientation to these phenomena is incorporated into what is definitely the finest building of Uxmal, it must have had an enormous symbolic significance. Indeed, the Governor's Palace was built by the lord named Chac, under whose reign Uxmal reached its maximum

splendor (Kowalski 1987). Aside from the very name of the ruler, the faces of the god Chac decorating his residence and having Venus signs suggest that this personage pretended to be an incarnation of the rain deity and also of the planet Venus, celestial manifestation of the supreme provider of the precious liquid: we know of various Maya rulers whose titles, including the name of Chac, suggest they personified the rain god, and of others who identified themselves with Venus (Sharp 1981: 16f; Rivera & Amador 1994: 35f; Grube 2002; Šprajc 1996b: 102ff). If this planet, when as evening star reached its northernmost position, was believed to bring about the rainy season, then the House of the Governor can be viewed as a monumental materialization of a direction that must have been sanctified, because it marked the phenomena whose timely occurrences, conditioning crucial annual climatic changes and, consequently, a proper development of agricultural cycle, were vital for subsistence. We can also imagine that the lord Chac, by orienting his residence to the relevant position of the rain god's celestial avatar whose power he assumed or shared, displayed in a singular way his divine identity and, consequently, his kingly responsibility for a proper development of natural cycles and for maintaining the ideal cosmic order, which guaranteed the survival of his subjects.

As mentioned above, the Governor's Palace of Uxmal is oriented, apparently on purpose, to a building at another archaeological site. No systematic research has ever been undertaken to ascertain whether such inter-site alignments are common in the Maya area. However, the relationship between Calakmul and El Mirador, two huge Maya centers located in the central lowlands of the Yucatán peninsula, suggests that alignments connecting prominent and intervisible buildings at different settlements may have been, indeed, intentionally incorporated in the ancient Maya cultural landscapes. Structure I of Calakmul, the site's second highest pyramid, is skewed 14°19' clockwise from cardinal directions, recording sunrises on February 12 and October 30 (Šprajc 2008: 235, Table 9.1). Since this orientation belongs to the group that – as mentioned in the previous section – may have originated at the Late Preclassic El Mirador, and considering that the Kaan dynasty ruling in the Late Classic period from Calakmul, located about 40 km north of El Mirador, may have originally had its seat at the latter site (Martin 1997; Šprajc & Grube 2008: 273f), it is hardly fortuitous that the north-south axis of Structure I prolonged southward passes exactly over the colossal Danta pyramid of El Mirador, visible from Calakmul as a small bump on the southern horizon. If this alignment was designed with the purpose of manifesting Calakmul's relationship with El Mirador, then the place for erecting Structure I had to be carefully selected, so that the perpendicular to the intended astronomically functional east-west orientation coincided with the symbolically significant direction to the Danta pyramid of El Mirador.

4. Concluding Remarks

It is rather clear that, aside from multiple and evidently important practical considerations, astronomy and cosmology had a paramount role in Maya architectural and urban planning. The universal importance of astronomy in early complex societies is explicable in terms of its practical utility and reflected also in Maya architectural orientations, which marked important moments of the

tropical year and thus facilitated prediction of crucial seasonal changes and a proper scheduling of agricultural works. However, the fact that the astronomically functional alignments were embodied in the most important buildings, particularly temples, clearly reveals that the utilitarian aspect of astronomy was intertwined with religious beliefs and ritual practices. The annual movement of the Sun along the horizon, as well as the recurrent positions of other objects in the sky, represented a spatial materialization of the passage of cyclical time; indeed, the characteristics of the apparent motion of celestial bodies, particularly the Sun, must have been the main observational base of the well-known union of time and space in the Mesoamerican worldview. Since the sky was visualized, both in Mesoamerica and in other archaic civilizations, as an image of divine perfection and insuperable order to which the course of terrestrial and human affairs was subordinated, it is understandable that the Sun and other celestial bodies were deified and that, accordingly, the directions to their significant positions on the horizon, corresponding to important seasonal changes in natural environment, became sacred. And considering that certain observational facts resulted in beliefs associating the most important celestial bodies with the natural phenomena they controlled and the parts of the universe they presided over, it is comprehensible that these ideas, too, were incorporated in architectural design and urban patterning.

Since astronomical alignments and elements reflecting cosmological concepts in the widest sense are most patently and profusely incorporated in urban cores with important religious, civic and residential buildings, whose construction was evidently commissioned by the political elite, it is clear that both practical use of astronomical observations and the ideas about the structure and functioning of the universe formed a very important part of political ideology of the ruling class. The ability to determine specific dates, whose importance was vital for subsistence, and to lay out accurate alignments to the corresponding celestial events was obviously not a public domain based on a commonly shared world view, but rather part of the esoteric knowledge reserved for the elite. If these phenomena were observed on predicted dates, they sanctioned the ideology of the ruling class, reinforced social cohesion, and thereby contributed to the preservation of the existing political order. In general, the cosmologically-derived elements of architecture, city layouts and cultural landscape can be interpreted as reflecting the attempts to replicate and perpetuate the ideal cosmic order, of which the rulers claimed to be responsible.

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