Chapter III:
Astronomy in Malaysia

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Connection Between the Comet 1P/Halley Appearance in 760 AD and the Dinoyo Inscription (Preliminary Result)

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Abstract. According to many historical records, 1P/Halley comet was reported to appear in 760 AD. In the same year in Indonesia, the Dinoyo inscription told us the story of the Kanjuruhan kingdom which held a Vedic ceremony to purify a new shrine and statue of Agastya to repel enemy forces (or dispel the epidemic). Many traditions believe that the appearance of a comet is a sign of war, plague/epidemic, death, etc. By applying this understanding to the archaeoastronomical framework, the hypothesis is proposed, that the king's order which was written on the inscription shows the response to the 1P/Halley comet appearance in 760 AD. There are three ways to examine the hypothesis: by testing the chronological, geographical, and cultural aspects. Through some literature studies and the Stellarium Astronomy Software simulation, the initial research found that the chronological and geographical aspects support the hypothesis.

Keywords. Dinoyo inscription, Kanjuruhan kingdom, 1P/Halley comet, Archaeoastronomy

1. Introduction

If we look back in time, many astronomical phenomena happened and were well-reported by our ancestors. One of them was the appearance of the 1P/Halley comet in 760 AD. The appearance of the comet that year was reported by many people from various nations, including Chiu T'ang Shu (945), T'ang Hui Yao (961), Hsin T'ang Shu (1060) from China, Theopanes (813) from Byzantine, Agapius of Manbij (10th Century) from Arab, and also reported in Zuqnin Chronicle. According to the report, the comet was identified to appear for the first time on May 16, 760 at a distance of 0.94 au; last seen on July 760; and its closest distance to the Earth on June 2, 760. The comet was also reported seen across the constellation of Aries, Perseus, Auriga, Lynx, Cancer, Leo, and Virgo (Kronk, 1999).

In the same year in Indonesia, people from the Kanjuruhan kingdom held an inauguration ceremony called Somayajna (see Satari, 2009, pp 42). The ceremony was held in Vedic belief to purify Agastya's new shrine and statue, made by order of King Anana. The information about this event is obtained from the Dinoyo inscription that was found near Badut temple in Malang, East Java. According to the inscription, the ceremony was held in the year "nayana-vayu-rase" † or 682 Śaka or corresponds to the year 760 AD ‡, and the order was issued to repel enemy forces (Bosch, 1916) (or dispel the epidemic (Poerbatjaraka, 1926)).

† Nayana-vayu-rase is candrasengkala or the arrangement of words used to express year numbers.

‡ The difference between Śaka and AD is 78 years

So, what's the correlation between the appearance of the 1P/Halley comet and the event held by the Kanjuruhan people in 760 AD? This paper will attempt to answer the question through an archaeoastronomical framework. Archaeoastronomy is the study of ancient astronomy, utilizing archaeological and/or anthropological evidence. The archaeological evidence used here is the Dinoyo inscription and the hypothesis proposed related to the framework is that the king's order which was written on the inscription shows the response to the 1P/Halley comet appearance in 760 AD The hypothesis was put forward based on many traditional beliefs about the appearance of comets as a sign of war, plague/epidemic, death, etc.

2. Testing the hypothesis

According to the proposed hypothesis, this paper proposes three ways to examine the hypothesis: (1) testing the chronological aspect, (2) testing the geographical aspect, and (3) testing the cultural aspect of the inscription. For the chronological aspect, the premise goes "if the hypothesis is right, then the comet should be seen before the ceremony was held". For the geographical aspect, the premise goes "if the hypothesis is right, then the comet should be seen in the Kanjuruhan's sky". For the cultural aspect, "if the hypothesis is right, then the inscription must contain things that related to the comet".

For the initial research, this paper will only show the results of the examination on the chronological and geographical aspects. Testing the chronological aspect was done by studying the literature. While testing the geographical aspect wasn't done only by studying the literature but also by simulating the sky condition in the kingdom at a certain time through the Stellarium Astronomy Software.

3. Findings of the study

3.1. *The chronological aspect*

The opening exclamation of the inscription is "Swasti çakawarṣātīta 682". According to that, the inscription was written in the year 682 Śaka, which was already mentioned in section 1 that the year corresponds to the year 760 AD. In another part of the inscription, also written that the ceremony was held in the year "nayana-vayu-rase", in the month Margaśirsa, when the moon was in the house of Ārdrā, on Friday the day of the new moon, while the polar star unites the paksas (Bosch, 1916), or while the two paksas are firmly joined together (De Casparis, 1941), and under the zodiacal sign of Kumbha (van der Meulen, 1976). According to Damais † (Damais, 1955), the Śaka date coincided with Friday, November 28, 760 AD. It means that the ceremony was held after the 1P/Halley comet disappear from the sky. Thereby, the chronological aspect supports the hypothesis.

3.2. *The geographical aspect*

The geographical aspect was tested by checking the comet visibility from the Kanjuruhan sky. The visibility was checked via the Stellarium Astronomy Software (stellarium.org), where the location was set at 7∘56'34.891" S 112∘36'2.525" E (the position where the inscription was found) and the time was set at 6.00 PM on the date of the first comet appearance (May 16, 760), when it's on its closest position to the Earth (June 2, 760), a month after its first appearance (June 16, 760), a month after its closest position to the Earth (July 2, 760), and two months after its first appearance (July 16, 760). The examination of the visibility of the comet at predetermined times was carried out by referring to the reconstruction of the orbit of the comet 1P/Halley in 760 AD by Neuhäuser (Neuhäuser, *et al*, 2021).

† Damais is the first man to interpret the Śaka date on Dinoyo inscription into an AD version

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According to Neuhäuser (Neuhäuser, *et al*, 2021):

(1) On May 16, 760, the comet appeared through the constellation Aries.
(2) Around June 2, 760, the comet passed through the constellation Perseus towards the constellation Auriga.
(3) Around June 16, 760, the comet passed through the constellation Lynx.
(4) Around July 2, 760, the comet passed through the constellation Leo.
(5) Around July 16, 760, the comet passed through the constellation Leo towards the constellation Virgo.

Then, the examination through the Stellarium Astronomy Software yielded the following results:

(1) On May 16, 760, the comet was unable to be observed in the Kanjuruhan's sky, as the constellation Aries set before the sun.
(2) On June 2, 760, the comet was also unable to be observed in the Kanjuruhan's sky, as the Perseus and the Auriga set before the sun.
(3) On June 16, 760, the comet was still unable to be observed in the Kanjuruhan's sky, as the constellation Lynx also set before the sun.
(4) On July 760, the comet was finally able to be observed in the Kanjuruhan's sky, as the constellation Leo can be seen after sunset.

From the results above, we can infer that the comet was only visible at Kanjuruhan on July 760 after sunset, except the comet was bright enough to be seen during the day on May and June 760. However, the comet's visibility can still be seen from the kingdom (especially in July), so the geographical aspect supports the proposed hypothesis.

4. Discussion

There are still many shortcomings in this research. The chronological issue still needs to be reviewed, especially for the conversion of the Saka date to the AD date. The exact date that has already been obtained is the result of Damais's calculations. No one has disputed the calculations. Not because they agree, but because no one has reviewed the accuracy of the calculations. For example, many epigraphists in Indonesia believe that the Saka epoch used in many inscriptions in Indonesia is starting in the year 78 AD. The Saka calendar has many versions and has developed over time. Hence, we need to be careful about which version is applied to the inscriptions in Indonesia, especially on the Dinoyo inscription.

The second is about the geographical issue. According to the Stellarium simulation, we know that in May and June, the comet appeared during the day and set before the sun. Many comets were reported seen during the day. So, to find out whether 1P/Halley comet was visible during the day at Kanjuruhan kingdom, we need to know its magnitude. Of course, obtaining the magnitude data is not easy. We need to do some complicated calculations on 1P/Halley to get the exact magnitude in the year 760 AD.

Last but not least is the cultural aspects that are not explained in this paper. The cultural aspects play an important role in answering the big question in this study. It is quite challenging to trace the exact cultural context of the Kanjuruhan kingdom due to the lack of historical data about the kingdom. The Dinoyo inscription is the only historical relic of the kingdom from the eighth century. There are no other inscriptions or ancient manuscripts have been found relating to this kingdom in that century. However, this research can still be done using ethnographic and hermeneutical approaches.

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