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Comet 2P/Encke Observed in Ancient and Mediaeval Korea

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I. Introduction

Commencing from BC 275, in Korea, the astronomical phenomena recorded through observations for about 2000 years amount to more than ten thousand [9, 14-17]. Out of them the observation of comets, beginning from the observation of comet 27P/Crommelin in BC 44, amounts to a few hundreds. However, in the book "Physical Characteristics of comets" by Vsekhsvyakskii published in 1964, the observation data of comets recorded in ancient and mediaeval Korea are quite absent [11].

In the book "Cometograph" by Kronk [12], the historical and scientific data on comets observed from Before Christ investigated synthetically, but the study of comets observed in ancient and mediaeval Korea has a number of shortcoming that some of them missed.

The observational data of comets observed in ancient and mediaeval Korea are making important contribution to the study of modern cometary astronomy [10, 13].

For example, Ref [13] elucidated that the Comet 27P/Crommelin discovered in AD 1547 in western world had been discovered in BC 44 in ancient Korea and had observed 16 times up to AD 1547.

In this paper, on the basis of experience found the Comet 27P/Crommelin in Ref [13], from the observation dates of comets amounting to a few hundreds, by a method calculating the period, we performed the quest for finding the periodic comets.

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II. Analysis of the Observed Data

In the ancient and mediaeval times, in the absence of telescope, one would have observed comets by naked eye, and therefore, mainly luminous comets would have been observed and recorded. Therefore, we have chosen the Comet 2P/Encke discovered in AD 1786 as a luminous comet. Its period is 3.3 year [11]. Therefore, we quested the comet that the difference of observational dates was divided by an integer when one divides by 3.3 year. The results are presented in Table 1 and they correspond to appearances of the Comet 2P/Encke, which amount to 32 times.

In Table 1, the first date of observation of the comet in Gregorian calendar, the same date recorded in original chronicle, constellation where comet appeared, period, number of observed days, size of comet, and finally name of country observed the comet beside Korea are presented.

The periods presented in Table 1 are not the true period determined through the calculation of orbital elements. Those periods are values closest to 3.3 year, a multiplication of which by an integer yields the difference of neighboring observation dates.

According to Table1, the Comet 2P/Encke had orbited 524 times from AD54 to AD 1786 when its period is assumed to be 3.3 year. According to Ref [11], the period of the Comet 2P/Encke in a duration from AD 1786 to AD 1954, changed between 3.281 year and 3.318 year. (ΔT=0.037year).

Table 1: List of observations of Comet 2P/Encke

Julian Date	Original Date	Constellation	Period (Year)	Duration of Observation (Day)	Length	Note for Reference
54.Feburary	Yu Ri Wamg 31th year, 2nd month	Ja Mi Won(Dra, UMa, Cep, Cam)	3.3	1		Italy, China
153.October	Il Song Wang 20th year,10th month	East, North-East	3.02	1		Korea
186.October	Cho Go Wang 21th year, 10th month	West-North	3.3	20		Korea
383. September	So Su Rim Wang 13th year,9th month	West-North	3.28	1		Korea
640.January	Mu Wang 41th year ,1st month	West-North	3.24	1		Korea
647.August	Jin Dek Wang 1st year, 8th Month	South	3.79	1		Korea
676.July	Mun Mu Wang 16th year,7th month	BukHa(Gem), Jok(Per)	3.21	1	6~7bo	Japan, China, Europe
683.October	Sin Mun Wang 3rd year, 10th month	Ogo (Aur)	3.63	1		China
699.Feburary	Hyo So Wang 8th year, 2nd month	East	3.07	1		Korea
759.April-May 1st	Kyong Dok Wang 18th year, 3rd month		3.16	spring-autumn		Korea
838.November	Hui Gang Wang 3rd year	West	3.18	1		China, Japan, Germany
1006	Mok Jong Wang 9th year		3.34	1		Korea
1019.Feburary 6	Hyon Jong Wang 9th year,12th month, JongSa day	Chon Si Won, Jong Jeng, JongYin, Si Ru(Ser, Per)	3.48	1		Korea

1075.November 18	Mun Jong Wang 29th year,10th month, Byong Syn Day11.18	Jin	3.29	1	7ja	China, Japan
1220.Feburary 20 1220.December	Go Jong Wang 7th year	Gu Ryong, Hen Won, Buk Du(Leo, UMa)	3.39	2.6	3ja	Japan
1299.January 24	Kyong Ho Wang(Chong Ryl Wang)24th year, 12th month, GapSul day	South	3.31	1		China, Japan, Deutschland
1364.march 30	Kyong Ho Wang (Kong Min Wang)13th year, 2nd month, Syn Yu day	Tae Mi Won/Dae Gak Song/Buk Du/Je(vir, Boo, Uma, Lib)	3.38	1	1ja	Korea
1381.November 7-22	UWang 7th year, 10th month, Yim Syn Day	Jo (Lib)	3.53	15	1gil	Egypt, Japan, Russia
1391.May11-22	Kong Yang Wang 3rd year, 4th month, Gap Ja day	Ja Mi Won(Dra, Uma, Cep, Cam)	3.17	10		Egypt, Syrian, China
1404.March 1st	Tae Jong Wang 4th year Gap Syn Year,1st month, Yim Sul day	East	3.15	1		Korea
1417.May 17	Tae Jong Wang 17th year, Jong Yu year, 3rd month, Jong Hae day	East	3.30	1		Korea
1449.December 26- 1450. January 30	Se Jong Wang 32th year Kyong O year, 1st month	Chon Si Won(Ser, Her, Oph, Aqr)	3.29	36		China1
1506.July 29	Yon San Gun Wang 12th year Byong Yin year, 7th month, Jong Hae Day	Ja Mi Won(Dra, Uma, Cep, Cam)	3.32	1		China, Japan
1529.Septembe r1-18	Jung Jong Wang 24th year, Gi Chok year, 7th month, Yim Sul Day	West/China8.4-9.2	3.29	18	4~5ja	China
1539.April 20	Jung Jong Wang 34th year, Gi Hae year, 4th month	Sam Tae, Hen Won(Leo, UMa)	3.31	44	4~5ja	China
1549.March7	Myong Jong Wang 4th year, Byong Jin year, 2nd month, Gi Yu day	North-West	3.28	1		China
1578.Octover	Sonjowang 11th year	Jang	3.28	2~3month		China

1595.July 25	Son Jo Wang 28th year, UlMi year, 6th month	Dong Jong(Gem)	3.36	35		Korea
1601.December 20	Son Jo Wang 34th year, Syn Chok Year, 11th month, 26th day		3.23	1	2~3ja	Korea
1618. August 28-31 1618.November 23-1619.January 13	Gwang Hae Gun Wang 10th year, Mu O year, 6th month Gwang Hae Gun Wang 10th year, MuO year, 10th month	North-East Chon Sang, Jong Tae, Jang, Je, Ju Jong, Sep Je, Song(Boo, Lib, Vir)	3.32	4 73	1gil	China, Europe
1621. January 22	Kyong Ho Wang 12th year, 12th month		3.49	18		China
1638. May	Yin Jo Wang 16th year, Mu Yin year, 5th month	South-East	3.28	1 month		Korea

However, in Table1, the longest period is 3.78 year, and the shortest one is 3.12 year and its difference is ΔT=0.66year, but this difference is not difference produced from the exact periods, as mentioned above. However, the average of the periods presented in Table 1 is 3.31year and is close to the true period 3.3 year.

In Table 1, out of the 32 observations of the Comet 2P/Encke, the comet observed AD153, AD 186, AD 640, AD 647, AD 683 AD 699, AD 1006, AD 1404, AD 1417, AD1459, AD 1595, AD 1601 and AD 1638 are observed exclusively in Korea. Remaining observations had been performed also in China, Japan, Deutschland, Italy and so on, and therefore, dates of first appearance of the comet and sites of the comet were able to compare each other. A number of was different from one to other [12, 18-21].

Now, let us consider the variation of absolute magnitude H_{10} of the Comet 2P/Encke, which is expressed by following formula

$$H_{10} = m - 5lg\Delta - 10lgr$$

where m is apparent magnitude of the comet, Δ is geocentric distance and r is heliocentric distance of the comet.

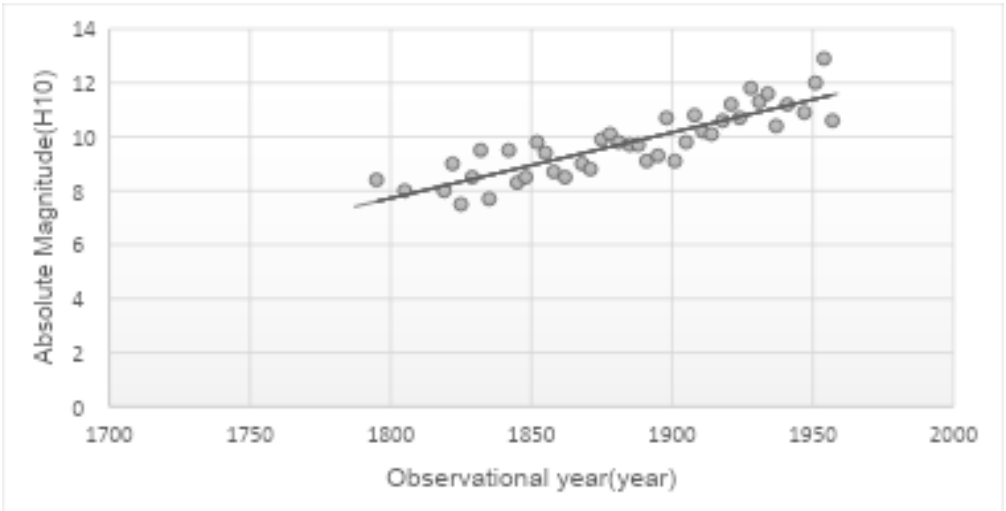

Fig.1: Absolute Magnitude Change Curve of Comet 2P/Encke

The variation of absolute magnitude of the comet in duration from AD 1786 to AD 1957 is presented in Fig 1 [11].

As we can see, the absolute magnitude of the Comet 2P/Encke, varied about $2.^m0$-$2.^m5$ in duration AD 1786-AD 1954.

This means that a rate of variation of absolute magnitude is $1.^m18$ per a year. If we assume that this variation rate in present was the same in the long past, we obtain an incredible value of absolute magnitude that the absolute magnitude in AD 54 was as more luminous as 20^m. However, the variation rate of absolute magnitude cannot be constant, so can we obtain the conclusion that in the past, the Comet 2P/Encke would have been very bright.

The Comet 1P/Halley had had an absolute magnitude of $H_{10}=2.^m0$ in AD 760, whereas it diminished to $4.^m6$ in AD 1910, and the Comet 27P/Crommelin from $H_{10}=6.^m2$ in AD 1457 to $10.^m7$ in AD 1956. Such examples show that these comets had been very bright in BC 466 and BC 44 first observed, respectively.

Therefore, the Comet 2P/Encke also would had been very luminous in AD 54, and on account of this, this comet could have been observed in ancient Korea.

III. Conclusion

In this paper, we examined extensively observational data of comets observed in ancient and mediaeval Korea and quested the comets repeatedly observed after about 3.3 year. In this procedure, we found that the 32 observation cases are correspond to the Comet 2P/Encke.

From the curve of variation of absolute magnitude of the Comet 2P/Encke from AD 1786 to AD 1954, we could suppose that this comet would be very bright in ancient Korea before mediaeval epoch, and therefore was able to easily observe by naked eye.

After the Comet Halley was discovered in BC 466 and the comet of Crommelin in BC 44, the bright comet Encke would be also discovered in AD 54. Thus, we could elucidate that this comet probably, was one out of the comets which mankind had begun to observe first in the earliest time.

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