Dhruvarāśi Takanīka in Jaina Canons

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1. Introduction

At present the commentaries on the *Sūryaprajñapti* are those due to Malayagiri[1], Amolaka Ṛṣi[2] and Ghāsīlāla[3]. Kohl[4] had contributed a text which was revised by A. Olz. Similarly, the commentaries of the *Candraprajñapti* are available[5]. These texts are from the fifth sub-composition (*upāṅga*) of the Śvetāmbara Jaina School, in Ardhamāgadhī Prākṛt. According to Jacobi and Schubring they might have taken shape during the third and fourth century B. C. According to Needham and Ling[6], they may go back to the latter part of the 1st millennium B. C. Certain descriptions are available in the contents rendered by Weber, *Ind. Stud.,* 10, 254ff. (1868) and Thibaut[7], JASB 40, comp. and also in his *'Astronomie'* in the Grundias, p. 20ff., 29.

The *'Tiloyapaṇṇatti'* was compiled by Yati Vṛṣabha (*c*. 5th century A. D. or earlier)[8]. This is in Śaurasenī Prākṛt and belongs to the Digambara Jaina School. Similarly in the same school the *Dhavalā* commentary texts were composed by Vīrasena (*c*. 9th century A. D.) on the *Ṣaṭkhaṇḍāgama* texts which were composed by Puṣpadanta and Bhūtabali (*c.* 2nd century A. D. or earlier)[9]. The *Gommaṭasāra*[10] texts of this school form the summary texts of the *Ṣaṭkhaṇḍāgama* texts, composed by Nemicandra Siddhāntacakravartī (*c.* 10-11th century A. D.).

The term *Dhruvarāśi* appears in the above texts except the *Gommaṭasāra* in which the term *Dhruvahāra* has been used. This appears to be an invariant or constant of the equation of motion and has been sometimes used as a parameter for generating a group of events which were periodic in character. The noted periodicity in the five-year *yuga* system of India was thus tackled through the *Dhruvarāśi* technique.

2. The Dhruvarāśi Technique in theTiloyapaṇṇatti

In the *Tiloypaṇṇatti,* the technique of *Dhruvarāśi* has been applied for finding out the distance between the orbits of the moon and those of the sun from the *Meru*[11].

Description of the three relevant verses is as follows :

ekasaṭṭhi guṇidā pañcasayājoyaṇāṇi dasajuttā /
te aḍadāla vimissā dhuvarāsi ṇāma cāramahī // 122 //

ekatthisahassā aṭṭhavaṇṇutaraṁ sadaṁ taha ya /
igisaṭṭhīe bhajide dhuvarāsi pamāṇamuddiṭṭhaṁ // 123 //

31158
61

paṇṇarasehiṁ guṇidaṁ himakarabimbappamāṇamavaṇijjaṁ /
dhuvarāsīdo sesaṁ viccālaṁ sayalavīhiṇaṁ // 124 //

30318
61

Translation of the above verses is as follows :

Verse 122 : On multiplication of five hundred and ten *yojanas* by sixty-one, and adding forty-eight to the product, the result (as divided by the denominator sixty-one) becomes the extension of the orbital ground called the *Dhruvarāśi.*

Note : $510\frac{48}{61}$ is equal to 31158/61. This has been called the *Dhruvarāśi* or the orbital field of the sun or the moon.

Verse 123 : The quotient obtained on dividing thirty-one thousand and one hundred fifty-eight by sixty-one has been shown as the pole-set or *Dhruvarāśi.*

Note : The above verse has been elaborated in this verse.

Verse 124 : On multiplying the diameter of the moon by fifteen, the product is subtracted from the *dhruvarāśi,* the result is the measure of the interval of all the remaining orbits.

Note : Diameter of the moon is 56/61. Hence (56/61) x 15 = 840/61. Now one can find the interval between the remaining orbits as equal to (31158/61) – (840/61) or equal to (30318/61).

Further Procedure

In the verse ahead, the following has been worked out. When (30318/61) is divided by 14, one gets the interval between every one of the orbits as

$$35\frac{214}{427}\ \textit{yojanas}.$$

Now to this amount is added the moon's diameter 56/61 *yojanas*, getting the common difference

$36\frac{179}{427}$ *yojanas*.

Thus, the first orbit is at a distance of 44820 *yojanas* from the *Meru*.

The second orbit is at a distance of

$$44820 + 36\frac{179}{427}$$ *yojanas* from the *Meru*.

The third orbit is at a distance of

$$44820 + 2\left(36\frac{179}{427}\right)$$ *yojanas* from the *Meru*.

This is carried on till the last orbit.

Similarly the method of the *Dhruvarāśi* in the *Dhavalā* has been used for confirming the measure of the set of the illusive visioned bias (*mithyādṛṣṭi jīva rāśi*) through four analytical methods[12]. However, this is altogether a different procedure for the use of the technique of a *Dhruvarāśi* away from a convention of periodicity. Further, the *Dhruvahāra* (pole divisor) concept in the *Gommaṭasāra*, is given in details[13], where a geometric regression or *guṇahāni* is produced with the *Dhruvahāra* as common-ratio.

3. The Dhruvarāśi Treatment in the Sūryaprajñapti and the Candraprajñapti Commentaries

In various commentaries of the *Sūryaprajñapti* and the *Candraprajñapti*, the *Dhruvarāśi* technique has been applied to calculate requisite sets which usually form an arithmetical or a geometrical sequence.

First of all the method is given to find out the measure of a *Dhruvarāśi* for solving a particular problem of astronomy. Then the process of obtaining the subsequent progression of desired results is given.

There are as many as twelve examples in which the use of different types of the *Dhruvarāśis* is given in the commentaries of the above texts. The *muhūrta* is divided into 62 parts and further subdivided into 67 parts. Similarly other units are divided and subdivided. The *Vedāṅga* system of time, however, is different for divisions and sub-divisions.

One of the examples may be illustrated as follows :

Suppose it is required to find out the position of the sun when it is in *yoga* with a constellation at the instant of the end of a requisite *parva* (half-lunation). For this, the following verses appear in the commentaries[14]

Transcription : Verse 1

"tettīsaṁ ca muhuttā visaṭṭhibhāgā ya do muhuttassa /
cuttī cuṇṇiyabhāgā pavvīkaya ri kkhā dhuvarāsī // 1 //

Translation

Thirty three *muhūrtas* (plus) two parts out of sixty-two parts (plus) thirty-four parts out of sixty-two into sixty-seven parts, is to be known as the half-lunation (*parva*) from of the *Dhruvarāśi* corresponding to the (sun)-constellation (*yoga*).

Trancription : Verse 2

"icchā pavva guṇāo dhuvarāsio ya sohaṇaṁ kuṇasu /
pūsāiṇaṁ kamaso jahā diṭṭhamanantaṇāṇihiṁ // 2 //

Translation

The *Dhruvarāśi* is multiplied by whatever is the requisite (sequential number of) the *parva* (half-lunation); and then from the product are subtracted (the measure of) the constellations as *puṣya*, etc., in sequence, according to the omniscient vision.

Explanation

Let the problem be as to in which sun-constellation does the first *parva* ends. For this the *Dhruvarāśi* is

33 + (2/62) + { 34 / (62 x 67) } *muhūrtas*.

Here the *Dhruvarāśi* is calculated as follows :

In all there are 124 *parvas*, out of which 62 are bright halves and 62 dark halves in course of five-year *yuga* or five sun-constellation *yogas*. Hence, for one *parva* (half-lunation) we get 5/124 sun-constellation part of a *yoga*. Now this is multiplied by 1830 to convert it into the type of 67 parts getting (5 x 1830) / 124 or 4575/62. Noting that the sun moves 1830 celestial parts in a *muhūrta* or moves through 1830 half-*maṇḍalas* or *ahorātras* in a five-year *yuga*, we convert 4575/62 into *muhūrtas* by multiplying it by thirty. Thus, we get (4575 x 30)/62 *muhūrtas* or 33+(2/62) + 34/(62 x 67) *muhūratas*. This is the *Dhruvarāśi* required for the purpose.

Now we pose the problem for the first *parva,* hence the *Dhruvarāśi* is multiplied by one. This product is to be subtracted by the period covered by the *puṣya* constellation. Hence we get 33 + (2/62) + { 34/(62 x 67) } – 19 + (45/62) + { 33/ (62 x 67) } = 13 + (19/62) + { 1/(62 x 67) }.

This period remains to be covered after the sun has passed over the *puṣya* constellation. Hence the sun remains in the *āśleṣā* for this much period. Just after this, the first *parva* in form of the coming dark 15th of the *śravaṇa* month comes to an end.

Similarly the succeeding *parvas* are to be treated. For them the multiples of the *Dhruvarāśi* are 2, 3, 4, 5,............, 61, 62 respectively. The products form a geometric progression with the *Dhruvarāśi* as the common ratio.

In the above system, it may be noted that a *muhūrta* or 48 minutes set was sub-divided into 62 parts and each such part was further sub-divided into 67 parts. This system was slightly finer than the sexagesimal system of dividing an hour into 60 minutes and each minute into sixty seconds.

Concluding Remarks

The above probe into the technique of the *Dhruvarāśi* (pole-set) appears to have been in use round about the fourth century B.C. when the *Sūryaprajñapti* types of works in the Jaina School were possibly being compiled for the *Karaṇānuyoga* group of study. The periodicity of natural phenomena and its calculations needed a group theoretic study and the *Dhruvarāśi* technique was an attempt towards it. From the several remaining examples it appears that progressions and regressions were the powerful tools for dealing with such periodic phenomena. It also appears that this technique might have played a decisive role in developing the later larger *yuga* system for the planetary motions whose account has been mentioned to have become extinct by Yativṛṣabhācārya in his *Tiloyapaṇṇatti*[15]. This group theoretic *yuga* system seems to have been converted into the theory of epicycles in Greek later on. Mention may be made also of the work of Roger Billard on the *yuga* system of India through the computer[16].

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14. Cf. (5), pp. 394-398, Cf. also (3), pp. 129-133.
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16. Cf. Billard, Roser, *L'Astronomic Indienne,* E' cole Francaise D'ex treme-Orient, Paris, 1971. The records are also available in computerized cassette.

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