The Idea of 22 Śrutis

Subhash Kak

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Introduction

In the Indian tradition the seven notes of the *saptaka* are taken to be further subdivided into 22 *śrutis*. The problem as to why this subdivision has 22 elements has concerned musicologists for a long time.[1] It is also not clear why the śrutis are divided non-uniformly into groups of four, three, and two into musical notes in Bharata's Nāṭya Śāstra (NS).

The saptaka, the "series of seven" is the same as the *octave* or the "series of eight" of Western music, spans a doubling of frequency. The seven notes of the saptaka are named *sa* (for ṣaḍja), *ri* (ṛṣabha), *ga* (gāndhāra), *ma* (madhyama), *pa* (pañcama), *dha* (dhaivata), and *ni* (niṣāda).

It must be said that we are speaking of a very old tradition. Manomohan Ghosh, who prepared the critical edition of NS and translated it, assigns it to about 5th century BC. He based his estimate on a variety of considerations.[2] These include linguistic usage, and the fact that Bharata speaks of an Arthaśāstra of Bṛhaspati and not of Kauṭilya, making him prior to the Mauryas.

Pāṇini in his Aṣṭādhyāyī (4.3.110-1) (c. 450 BC) speaks about Śilālin and Kṛśāśva as the authors of the Naṭa-sūtras, which appears to have preceded the Nāṭya Śāstra. It seems that Bharata's text was in the same tradition as Śilālin's, and the evidence indicating that Bharata preceded the Mauryas makes him a near contemporary of Pāṇini. Their two works have similarity in that they analyze language – speech in the case of Pāṇini and gesture, dance, and music in the case of Bharata – in terms of their primitives. One can see that these works could have appeared in the same intellectual atmosphere.

The Indian texts speak of three registers across three octaves. Within

each register, there are three scales (*grāma*): the *ṣaḍjagrāma*, the *madhyamagrāma*, and the *gāndhāragrāma*. The third of these, the gāndhāragrāma, is rarely referred to by Bharata suggesting that it had long ago gone out of use and that it represents an early scale used in sacred ritual. The presiding deities of the three grāmas are Brahmā, Viṣṇu, and Śiva, respectively.

The notes are termed consonant (saṃvādin), assonant (anuvādin) and dissonant (vivādin), depending on the distance in śrutis with respect to the sonant (vādin). According to NatS 28.22-23:

> Notes that are at distance of 9 or 13 śrutis from each other are mutually saṃvādin. Examples are *sa* and *ma*, *sa* and *pa*, *ri* and *dha*, and *ga* and *ni* in the *ṣaḍjagrāma*. Similar is the case in the *madhyamagrāma*, except that *sa* and *pa* are not consonant while *pa* and *ri* are.
>
> The notes that are at the distance of two or twenty śrutis are vivādin, for example *ri* and *ga*, *dha* and *ni*.
>
> The vādin, saṃvādin and vivādin notes having been determined, the remaining notes are to be called anuvādin.

The mention of the distance between the saṃvādin and vivādin notes is helpful in the understanding of the measure of śruti, and we will return to this later. Another definition is provided in NatS 22.24 where it is said that in the madhyamagrāma pañcama should be made deficient in one śruti, and this is the standard (*pramāṇa*) śruti.

Śārṅgadeva (13th century) in his Saṅgīta-Ratnākara (SR 1.3.10-22) tells us of how the seven notes can be produced on two twenty-two stringed vīṇās. One of the vīṇās is kept invariable and the other one is used in a variable mode. He shows how the notes one śruti apart merge. By this he establishes that there is a natural division into 22 audible pitch differences. But his method works because the number of stings in the vīṇās is 22, and it does not answer the more basic question of the number of microtones in a saptaka.

One theory is that the division of the śrutis provides a convenient division in terms of simple ratios. A combination of the cycle of fourths and fifths is invoked to generate 23 values from the twelve notes and the extra value of the fifth is dropped, leaving us with 22 values.

Considering the cycle of fifths, and ignoring the varying number of śrutis amongst the notes, *ri* is fifth from *pa* (in the next octave). Since *pa* is midway

through the octave (*pa* is 3/2), *ri* should be: $1/2 \times 3/2 \times 3/2 = 9/8$. This, in turn, implies that *ma* should be $3/2 \times 8/9 = 4/3$. The fourth from *ma* is *ni*, so it becomes $4/3 \times 4/3 = 16/9$. The fifth from *ri* is *dha*, so its value should be $9/8 \times 3/2 = 27/16$. Now *ga* can be calculated either as the fifth from *dha* or the fourth from *ni* and this gives us the values of 81/64 or 32/27.

This gives us the ratios upto the *sa* of the next octave:

$(1, 9/8, 81/64, 4/3, 3/2, 27/16, 16/9, 2)$

or

$(1, 9/8, 32/27, 4/3, 3/2, 27/16, 16/9, 2)$

But there is no certainty that this reasoning was followed by the ancient musicologists. These ratios do not contain the small proportions 5/3 and 5/4, which are pleasing to the ear. It is plausible that *ga* was pegged at 5/4 and *dha* was fixed at 5/3. If that was the case then the difference in the ratios for *dha* would be $27/16 \times 3/5 = 81/80$. We get the same difference at *ga* for one of the two values. This ratio is the comma.

Using the modified ratios for *ga* and *dha* we can generate new modified values for the other notes, and it has been argued that this leads to a total of 22 notes. But it is not clear what ratios of the seven notes were used in the ancient period, especially because a shift in the ratios appears to have occurred as the arched harp type of vīṇā was replaced by the stickzither vīṇā. But it is clear that the śrutis did not represent a uniform division of the saptaka into 22 parts.

In the different reconstruction in various books and articles,[3] we have the ratios of:

$(1, 9/8, 32/27, 4/3, 3/2, 5/3, 16/9, 2)$
$(1, 9/8, 5/4, 4/3, 3/2, 5/3, 15/8, 2)$
$(1, 9/8, 6/5, 4/3, 3/2, 5/3, 9/5, 2)$
$(1, 16/15, 9/8, 4/3, 3/2, 8/5, 5/3, 2)$
$(1, 9/8, 5/4, 11/8, 3/2, 27/16, 31/16, 2)$
$(1, 11/10, 7/6, 4/3, 3/2, 33/20, 7/4, 2)$

Clearly, other choices can be made, especially since the śruti interval between the notes in not the same.

It has been suggested that the 22 śrutis may be connected to the 7 notes via the value of π in a diameter to circle mapping. But no plausible theory for such a connection has been sketched. In particular, we cannot justify the specific non-uniform assignment of the śrutis to the different notes in a diameter to circle mapping.

Another theory is that the number 22 is rather connected to the number of Rudras (11), where a multiplier of 2 is used to include the corresponding śakti. The plausibility of this theory becomes stronger when it is noted that the expanded list of śrutis[4] totals 66, which will then equal twice the number of devatās mentioned in the Vedas. It is noteworthy that according to whe NS 29.23-74 there are 33 alaṅkāras (ornamentations) in instrumental music.

The number associated with the earth and also with the sun in the Vedic literature is 21. The number 22 then represents a point that goes beyond the earth or the sun.

Still another possibility may be the connection with the number of rāgas in each scale, which is $484 = 22^2$. Might this knowledge have prompted the theorists to pick 22 as the number of subdivisions based on some numerical considerations? One or more than one of these reasons may have been behind the choice of the number 22.

In this note we investigate connections between Vedic chanting and the saptaka in the early texts prior to the Nāṭya Śāstra of Bharata Muni. In particular, we examine evidence from the Śikṣā texts and the Chāndogya Upaniṣad, and we examine if the antecedents of the number 22 go before the time of Bharata.

More on the saptaka

The seven notes commencing with ṣaḍja are said to be produced respectively by the peacock, ox or cātaka, goat, crane, blackbird, frog, and the elephant (SR 1.3.46). Each note can be low (mandra), medium (madhya), or high (tāra).

Śārṅgadeva (SR 1.4.5) describes the rare use of the gāndhāragrāma by saying that it is used in the heaven, and not in this world. There is no unanimity regarding the assignment of the śrutis in the gāndhāragrāma.

From each grāma are derived a number of secondary scales (*mūrchanā*). The names of the ṣaḍjagrāma mūrchanās are: uttaramandrā, rajanī, uttarāyatā, śuddhaṣḍjā, matsarīkṛtā, aśvakrāntā, abhirudgatā (SR 1.4.10-11). The first is the original scale, the remaining are the permutations. Thus rajanī is ni sa ri ga ma pa dha.

The names of the madhyamagrāma mūrchanās are: sauvīrī, hariṇāśvā, kalopanatā, śuddhamadhyā, mārgī, pauravī, hṛṣyakā. The gāndhāragrāma

mūrchanās are: nāndī, ālāpā, sukhā, citravatī, citrā, sumukhī, viśālā (SR 1.4.22-26).

Each grāma is the foundation for pentatonic and hexatonic series of notes (*tāna*), melodic line (*varṇa*), figuration and ornamentation (*alaṅkāra*) and mode (*jāti*).

Each note (like *sa, ri,..*) not only represents that particular frequency but also the interval from the preceding note upto that note. Thus *sa* represents the entire interval from *ni* to *sa*. The notes that form the basic scale are called *śuddha*, notes lowered a śruti are called *cyuta* or *komala* (soft), and those raised by a śruti or two are called *tīvra* (sharp), *sādhāraṇa* or *kaiśika* (for one śruti) or *antara* or *kākalī* (for two śrutis). The altered notes are called *vikṛta*. SR 1.3.39-45 gives the following 19 notes that consist of 7 *śuddha* and 12 *vikṛta* notes:[5]

> *sādhāraṇa sa (1), cyuta ri (2), śuddha ri (3), śuddha ga (5), sādhāraṇa ga (6), antara ga (7), cyuta ma (8), śuddha ma (9), sadhāraṇa ma (10), triśruti pa (12), śuddha pa (13), kaiśika pa (14), śuddha dha (16), kaiśika dha (17), śuddha ni (18), kaiśika ni (19), kākalī ni (20), cyuta sa (21) śuddha sa (22).*

With this as the background, here is the traditional division of the śrutis in the three different grāmas, where the distribution for the gāndhāragrāma is one reconstruction:[6]

Table 1: Śrutis in the three different grāmas

ṣaḍjagrāma		*madhyamagrāma*		*gāndhāragrāma*	
interval	śrutis	interval	śrutis	interval	śrutis
ni-sa	4	ga-ma	4	ri-ga	4
sa-ri	3	ma-pa	3	ga-ma	3
ri-ga	2	pa-dha	4	ma-pa	3
ga-ma	4	dha-ni	2	pa-dha	3
ma-pa	4	ni-sa	4	dha-ni	4
pa-dha	3	sa-ri	3	ni-sa	3
dha-ni	2	ri-ga	2	sa-ri	2

It is noteworthy that in the ṣaḍjagrāma the distribution of the śrutis displays a symmetry about *ma*: $4, 3, 2/4/4, 3, 2$. This indicates that *pa* must

have been at the precise ratio of 3/2 with respect to *sa*. This also means that the notes could not have been powers of a simple ratio and that vikṛta notes must have been a part of the entire set from early on.

Śārṅgadeva says only the ṣadja- and the madhyama- grāmas are used in the world (*dvau dharātale*, SR 1.4.1). The gāndhāragrāma must have fallen into disuse very early on. The names of the śrutis given by Śārṅgadeva are as follows:

Table 2: Names of the śrutis

svara	śrutis
Ṣadja	*Tīvrā, Kumudvatī, Mandā, Chandovatī*
Ṛṣabha	*Dayāvatī, Ranjanī, Raktikā*
Gāndhāra	*Raudrī, Krodhā*
Madhyama	*Vajrikā, Prasāriṇī, Prīti, Mārjanī*
Pañcama	*Kṣiti, Raktā, Sandīpanī, Alāpinī*
Dhaivata	*Madantī, Rohiṇī, Ramyā*
Niṣāda	*Ugrā, Kṣobhiṇī*

The śrutis are divided into five classes:

1. *dīptā* (dazzling): tīvrā, raudrī, vajrikā, and ugra
2. *āyatā* (vast, extended): kumudvatī, krodhā, prasāriṇī, sandīpanī, rohiṇī
3. *karuṇā* (compassion): dayāvatī, alāpinī, madantī
4. *mṛdu* (tender): mandā, raktikā, prīti, kṣiti
5. *madhyā* (moderate): chandovatī, ranjanī, mārjanī, raktikī, ramyā, kṣobhinī

The Vedic tradition

There is mention at several places in the Ṛgveda of singing.[7] The ṛcas were chanted in three notes: anudātta, svarita, and udātta, or "grave", "medium", and "acute". Furthermore, there were the five sāman notes prathama, dvitīya, tṛtīya, caturtha, and mandra. The saptaka was completed with the addition of the the upper seventh kruṣṭa before prathama and the lower sixth atisvārya after mandra. The sāmans were sung in a

descending order. Vedic chanting and the singing of the Sāman were two separate musical styles.

The notes were associated with the Vedic metres: anuṣṭup, gāyatrī, tṛṣṭup,, bṛhatī, paṅkti, uṣṇik and jagatī (SR 1.3.58-59).

The metres are central to the Vedic hymns. Although, the above sequence seems to be jumbled up in terms of the lengths of the metres, with its ratios of 8, 6, 11, 9, 10, 8, 12, I think that the ratios of the notes may have had something to do with the syllables in the metres. One sequence that is plausible is:

24, 27, 30, 32, 36, 40, 45, 48

corresponding to gāyatrī (24), uṣṇik (28), atiśakkarī (30 for half), anuṣṭup (32), bṛhatī (36), paṅkti (40), tṛṣṭup (44), and jagatī (48). A sequence of the metre names is given in NS 15.43-49.

The Pāṇinīya Śikṣā (PS 12) maps the Vedic notes to the seven svaras:

> *uddāte niṣādagāndhārāvānuddātte ṛṣbhadhaivatau*
> *svaritaḥ prabhavā hyete ṣaḍja madhyama pañcamāḥ*
>
> Of the seven musical notes niṣāda and gāndhāra can arise in the high pitch (udātta), ṛṣabha and dhaivata in the low pitch (anudātta), while ṡaḍja, madhyama, and pañcama have their source in the medium pitch (svarita).

The same thing is said by the Nāradīya Śikṣā (NarS 1..8.8) and the Yājñavalkya Śikṣā (YS 8).

In NarS 1.5.1-2, Nārada equates the tones of the veṇu flute to the seven notes of the sung sāman:

> *yaḥ sāmagānāṃ prathamaḥ sa veṇormadhyamaḥ svaraḥ*
> *yo dvitīyaḥ sa gāndhārastṛtīyastvṛṣbhaḥ smṛtaḥ*
>
> *caturthaḥ ṣaḍja ityāhuḥ pañcamo dhaivato bhavet*
> *ṣaṣṭe niṣādo vijñeyaḥ saptamaḥ pañcamaḥ smṛtaḥ*

In other words, the order is *ma, ga, ri, sa, dha, ni, pa*, which is the standard saptaka in descending order excepting for a transposition of *dha* and *ni*.

The *grāmegeyagāna* and the *āraṇyegeyagāna* of the Sāmaveda provide a musical notation for the melodies. The Brāhmaṇa and the sūtra literature also has references to singing and playing of musical instruments. Nārada of the Nāradīya Śikṣā associates musical notes with deities, social classes, animals, colours, and with fingers.

The notes with 4 śrutis are called brāhmaṇa, with 3 śrutis are termed kṣatriya, with 2 śrutis are termed vaiśya, and the half-notes are called śūdra (NarS 1.4.3-4). SR 1.3.53-55 says: "Ṣaḍja, madhyama, and pañcama are brahmins, ṛṣabha and dhaivata are kṣatriya, niṣāda and gāndhāra are vaiśya, while the notes antara-gāndhāra and kākali-niṣāda are śūdra.

The classification of the notes as the sounds of the deities is as (NarS 1.4.13-14): *sa* is Agni's, *ri* is Brahman's, *ga* is Soma's, *ma* is Viṣṇu's, *pa* is Nārada's, *dha* and *ni* are Tumburu's notes.

Their respective colours are: red, pale yellow, golden yellow, sparkling white, black, plain yellow, and variegated (SR 1.3.54-55).

The Chāndogya Upaniṣad (CU) has a considerable discussion of the structure of sāmans. While examining this material, it should be noted that the Vedic system of knowledge is recursive and what is described at a gross level is also applicable at a finer level.

CU 2.10 informs us that the seven-fold sāman has 22 parts. The counting is done in terms of the syllables of the names of the seven parts of the sāman which are *hiṅkāra, prastāva, ādi, udgītha, pratihāra, upadrava,* and *nidhana.* Their individual syllable counts are 3, 3, 2, 3, 4, 4, 3, respectively.

Although this division of the sāman is for the different parts of the song, the recursive system at the basis of Vedic narrative could suggest that it was also applied to notes. If that were the case, we find an exact match with the division of the śrutis for the gāndhāragrāma.

As to the special significance of the number 22, CU 2.10.5 says:

> *ekaviṃśatyā"dityamāpnotyekaviṃśo vā ito'sāvādityo dvāviṃśena paramādityājjayati tannākaṃ tadviśokam*

> With twenty-one intervals (syllables) a man reaches the sun, for the sun is the twenty-first from here. With the twenty-second he conquers what is beyond the sun, that is glory, that is freedom from sorrow.

Other very early texts describing music include the Mārkaṇḍeya Purāṇa (chapter 23), Devīmāhātmya Purāṇa (chapters 81-93), and the Vāyu Purāṇa (chapters 86-87).

The division of the saptaka

To return to the question of the division of the saptaka, consider the fixed ratio of 1.104 which takes us through the range in seven steps, as a straightforward calculation will show. In a similar manner, one śruti in the series of 22 represents a ratio of 1.032. Table 3 presents a match between the two series:

Table 3: The svara and the śruti series

number	svara ratio	śruti ratio	error
1	1.104	1.099 (3)	0.005
2	1.2188	1.208 (6)	0.010
3	1.346	1.3278 (9)	0.018
4	1.486	1.5060 (13)	0.02
5	1.64	1.6553 (16)	0.0153
6	1.81	1.8193 (19)	0.0093
7	1.998	2.0 (22)	0.002

The match is excellent. The error between the two series is extremely small. The mapping maps the śrutis in groups of 3, 3, 3, 4, 3, 3, 3.

If one takens 21 śrutis instead of 22, the match turns out to be even closer, as expected. For this the ratio for each śruti is 1.0336. This theoretical exercise shows that the saptaka couldn't have been divided in this fixed manner. Neither could this reasoning have been at the basis of the choice of 22 śrutis. The view that the śrutis are non-uniformly distributed is supported by this calculation.

The number of rāgas

A rāga must have a combination of rising (āroha) and falling (avaroha) notes that are at least five in number. The combinations of pentatonic are called *auḍuva*, of hexatonic *ṣāḍava*, and of heptatonic *saṃpūrṇa*. In addition, there

are the sādhāraṇa tānas (NS 28.32-36). Without going into further constraints – and there are many of those –, the combinations of rāgas that are obtained are as follows (Table 4):[8]

Table 4: Number of rāgas in a scale

Category of rāga	Number of rāgas
auḍuva-auḍuva	$15 \times 15 = 225$
auḍuva-ṣāḍava	$15 \times 6 = 90$
auḍuva-saṃpūrṇa	$15 \times 1 = 15$
ṣāḍava-auḍuva	$6 \times 15 = 90$
ṣāḍava-ṣāḍava	$6 \times 6 = 36$
ṣāḍava-saṃpūrṇa	$6 \times 1 = 6$
saṃpūrṇa-auḍuva	$1 \times 15 = 15$
saṃpūrṇa-ṣāḍava	$1 \times 6 = 6$
saṃpūrṇa-saṃpūrṇa	$1 \times 1 = 1$
Total	484

This number, as we mentioned before, equals 22^2.

The śruti interval

Alain Daniélou suggests[9] that the śruti interval is the comma diesis 81/80, defined as the difference between *pa* considered as the upper fourth from *ri*, and *pa* as the lower fourth from *sa*. Vidyasankar Sundaresan[10] argues that one śruti should rightly be the ratio 256/243. Daniélou presents[11] a detailed reconstruction of the intervals of the 66 śrutis.

Although we cannot be certain as to what precise ratios were used by Bharata, scholars have argued that 22 śrutis provide a natural division of the saptaka.

Coda

From the evidence we have reviewed, it appears that the question of the origin of the 22 śrutis cannot be answered unambiguously. The choice could have been based on the significance of the number 22 that goes back to Vedic ritual, as a number that transcends the earth or the sun. The number 22 may have even been arrived at from $3 \times 7 + 1$ where the basic number is the

7 of the number of notes and the tripling is from the "three worlds" and the 1 represents the usual transcendence. Or it may be related to the capacity to distinguish the śrutis and a division that provides cycles of fourths and fifths.

If the choice of the 22 śrutis was based on the mapping of Table 3, then the original distribution of the śrutis for the various svaras must have been uniform with a single exception. From there the mapping of Bharata in his Nāṭya Śāstra represented further development. But the evidence indicates that the śrutis were not uniformly distributed. This is also clear from the fact that the transition from a five-tone octave to a seven-tone octave is not uniform.

On the other hand, the ratios as reconstructed by Daniélou or Sundaresan indicate a logical basis to the division. Bharata may have received this logic from his predecessors, given the fact that the number 22 appears earlier in the Upaniṣads. It is plausible that it was part of the musical tradition before Bharata's time.

In the Viṣṇudharmottara Purāṇa, Mārkaṇḍeya tells King Vajra that in order to learn the art of icon-making one needs to learn the art of dance, and the art of music before learning dance. Indian arts are interrelated not only at the level of aesthetic experience but also at the level of technique.[12] It is not surprising then to see the number 22 (and the related numbers of 11 and 33) appear in so many different contexts.

Concluding Remark It is a matter of great sorrow that the foundational books of Indian music such as the Nāṭya Śāstra, the Bṛhaddeśi, the Saṅgīta-Ratnākara are either out of print (the Manomohan Ghosh edition; the Satguru edition which is in print is deficient), never published in a critical edition (BrhadD), or published in an incomplete edition (SR).

Notes and References

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3. See Note 1.

4. Bṛhaddeśī; see also Shringy and Sharma, vol 1, page 404.

5. Shringy and Sharma, vol. 1, pages 141-2.

6. SR 1.4.1-5. See also Shringy and Sharma, *op cit*, vol 1, page 164.

7. Swāmī Prajñānanda, *Historical Development of Indian Music.* Firma K.L. Mukhopadhyay, Calcutta, 1960.

8. Shringy and Sharma, *op cit.*

9. Daniélou, *op cit*, page 29.

10. Sundaresan, *op cit.*

11. Daniéou, *op cit*, pages 31-36.

12. Vatsyayan, *op cit*, pages 380-396.