Svara saptah:
Intonation in Vaisnava Music

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Introduction

The Vedic scripture *Srimad Bhagavatam* is the epitome of Vaisnava knowledge. Encyclopedic in scope, poetic in composition, profound in significance, it contains all knowledge of importance to a Vaisnava; indeed, it contains—at least in seed form—all that is knowable. Just as from the vantage of a great height, features that look impressive from the ground become insignificant, so from the elevated Krsna-conscious viewpoint of *Srimad Bhagavatam*, great sciences of deep import are often summed up in a few verses or even a single line.

Take for example the science of music, specifically the issue of intonation in music, from which all other Vedic musical concepts are derived. We find many erudite tomes in the great libraries of the world containing complex expositions and conflicting arguments on this subtle, highly technical subject. Yet the entire topic is summed up in the following line from the *Srimad Bhagavatam:*

> ...Brahma's sensual activities were manifested as the seven notes of music [*svara saptah*].[1]

This *sloka* (which inspires both the content and the title of this essay) is commented upon in the following purport by Srila Prabhupada:

> "...The musical notes [*svaras*] are *sa, ri, ga, ma, pa, dha* and *ni*. All these vibrations are originally called *sabda-brahma*, or spiritual sound. It is said, therefore, that Brahma was created in the *maha-kalpa* as the incarnation of spiritual sound. The *Vedas* are spiritual sound, and therefore there is no need of material interpretation for the sound incarnation of the Vedic literature... In the ultimate issue there is nothing material because everything has its origin in the spiritual world. The material manifestation is therefore sometimes called illusion in the proper sense of the term. For those who are realized souls there is nothing but spirit."

These statements occur in the context of an elaborate discussion of the creation of the material universe, summarized as follows: The Supreme Lord, in His form as Maha-Visnu, is the master and controller of the total material substance (*pradhana* or *mahat-tattva*). By His will, material substance emanates from His pores and breathing in the form of innumerable material universes (*brahmandas*) like the one in which we find ourselves today. The Lord then enters within each of the universes as Visnu, and differentiates the *pradhana* into the categories of material elements: earth, water, air, fire, space (*akasa*), mind, intelligence and false ego

(*ahankara*). Lord Brahma then takes birth directly from the lotus navel of Visnu and continues the material creation, fashioning the various planetary systems from the inchoate material elements by the use of spiritual sound vibration (*sabda brahma*).

According to *Srimad-Bhagavatam* the *svarah sapta* are the basis of the Vedic spiritual sound vibration used by Brahma to create the material worlds. Therefore the technical terms *svarah sapta* and *sa, ri, ga, ma, pa, dha* and *ni* used in the verse and purport quoted above are much more than simply Sanskrit names for the notes of the musical scale. They embody in capsule form the complete Vedic cosmological and spiritual world view, include a comprehensive understanding of psychoacoustics and the psychophysiology of sound, and provide a working knowledge of the creative potency of spiritual sound vibration to the aspiring devotee and musician.

Finally, for the serious *yogi*, these same seven sounds offer a means for withdrawing the soul from the entanglement of matter, for they hold the key to the creation, and therefore also the annihilation, of the material universe. This paper attempts to elucidate the esoteric concept of *svara*, revealing it as a vitally important requirement for successfully chanting the Vedic *mantras*.

Research Background

In 1968-71, this author designed and performed a comprehensive series of experiments with different kinds of music to determine their effects on living beings. Analysis of the results revealed that of all musical styles, none is so beneficial to living beings as Vedic sound vibration (*raga* and *mantra*). Of the varieties of Western music tested, only very early European classical music (madrigals and Gregorian chant) had any positive effect at all on living beings. All other forms of modern music were shown to be deleterious to various degrees. These experiments are briefly summarized in the Appendix. [2]

A comprehensive survey and analysis of Vedic musical form revealed it to be composed of three elements: *svara* (tuning), *matra* or *tala* (poetic meter or rhythmic cycle) and *raga* (melodic species) in support of a sacred text (*mantra*). An additional series of experiments, utilizing these elements separately, determined that the major cause of the observed beneficial and therapeutic effects of Vedic music is its precise tuning, different from that of the Western scale. Further research in the Vedic literatures revealed that this system of tuning—called Just Intonation in Western music theory—is explicitly and scientifically explained in the Vedic literature as the *sapta svarah*, and has deep philosophical and spiritual significance.

Vaisnava Music Theory

> "Chanting the holy name, dancing in ecstasy, singing and playing musical instruments, the spiritual master is always gladdened by the *sankirtana* movement of Lord Caitanya Mahaprabhu. Because he is relishing the mellows of pure devotion within his mind, sometimes his hair stands on end, he feels quivering in his body, and tears flow from his eyes like waves. I offer my respectful obeisances unto the lotus feet of such a spiritual master." [3]

As our studies of authentic Vedic music deepen, so does our understanding of, and appreciation for the wonderful example of our spiritual master Srila Prabhupada's expert *kirtan* and *bhajan* styles. His masterful recordings always express the highest Vaisnava sentiments in a style at once simple, profound, and in tune with the highest and most esoteric principles of

Vaisnava music theory. For music is by no means an unimportant part of Vaisnava devotional service. As described above, singing, dancing and playing musical instruments according to the Vedic principles is an integral part of the temple-worship duties of the spiritual master and his disciples. Therefore an essential part of the instructions of the Gaudiya Vaisnava spiritual master to his disciples is Vedic music theory.

In general, music theory is the science of the raw materials of the art of music. It is necessarily a multi-dimensional discipline because music itself is multi-dimensional. Therefore, music theory must include a theory of aesthetics, a bit of psychology, a smattering of cosmology and physics; and playing music well demands a practical knowledge of acoustics, psychology, physiology and performance arts as well. Vaisnava music also has the spiritual dimension, which is deep and unlimited, a perfect dimension of dimensions. Therefore the theory of Vaisnava music is a superset of ordinary music theory, because it is actually the science of pleasing the Supreme Personality of Godhead through the art of music.

Music theory contains a technical language for talking about music. In the study of English, a sentence diagram uses technical symbols to analyze the grammatical parts of a sentence: subject, object, phrases, etc. Similarly, music theory contains musical notation, and many other technical symbols and terms for notating and discussing the various elements of the universal language of music. For example, **tone**, **note** and **slur** are all musical terms, and the musical staff, bars and clefs are symbols that help us notate music.

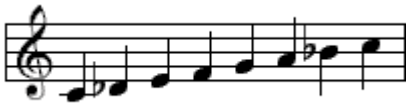


Figure 1: The musical clef, staff, bars and notes.

To enlarge upon the concept of music as a language: Music theory, like the grammar and syntax of language, also has something to say about the origin, derivation, quality, and correct usage of musical elements. The proper tuning of the notes, the correct application of rhythm and melody, the right technique of singing and playing various musical instruments are all part of music theory, as are the complex rules of musical composition. Following the rules and conventions of music theory ensures the musician that he is using the finest quality musical materials in his artistic endeavors. A painting will look better and last longer if the artist uses first-class pigments; similarly, a spiritual musician who has thoroughly mastered the fundamental materials of his art—the *svaras, talas, ragas* and *mantras* of Vedic sound vibrations—will produce a better final product.

Vaisnava music theory aims to produce music that will be pleasing to Lord Krsna, and that will help His devotees to advance toward the spiritual perfection of pure love of Godhead. This is not "art for art's sake," but art for God's sake. Therefore the prime necessity for understanding and practicing Vaisnava musical theory is a firm grounding in the devotional principles of Vedic Krsna-conscious spiritual life. Any musical practice whose aim or effect is to increase material consciousness, or which is prohibited by Vedic injunction or Gaudiya Vaisnava usage is therefore summarily rejected by Vaisnava music theory.

Vaisnava music should be fine enough to be offerable to the Deities of the Supreme Lord, and understandable enough to the listeners to help them remember Krsna. It must be based upon authorized Vedic *mantras* and poetry of pure Vaisnavas and *acaryas* (spiritual masters), which contain the *siddhanta* (philosophical conclusions) of Gaudiya Vaisnava philosophy and the

narrations of the pastimes of the Lord in ecstatic loving relationship with His innumerable devotees. Its notes must be pure and pleasing to the ear, and its melodies sweet and full of the spiritual *rasas* (spiritual mellow or ecstatic emotions) appropriate to the lyrics and to the time of day and season. Its rhythms must be expressive and appropriate, giving support to the lyrics and melody. It should use traditional Vedic instruments, such as *tamboura, kohl, karatalas, sarangi, vina*, etc. to accompany the voice. It should avoid ostentatious displays of personal virtuosity, and concentrate instead on enhancing the mood of the Lord and His devotees in their pastimes of loving affairs.

Vaisnava musicians are not self-centered, whimsical 'artistes' engaged in amplified sense enjoyment, but highly disciplined and spiritually advanced Vedic *bhakti-yogis* who understand the purports of scriptures like *Bhagavad-gita, Srimad-Bhagavatam, Caitanya-caritamrta*, etc. Without these preliminary qualifications, no one can be accepted as a first-class Vaisnava musician. So from the outset, Vaisnava music theory assumes that the musician is a pure soul with brahminical spiritual qualifications, whose aim in music and in life is to please Lord Krsna and His devotees with his art, and ultimately to go back to home, back to Godhead, and serve Krsna eternally in his constitutional spiritual identity.

Origins of Vaisnava Music

The origin of Vaisnava music is Krsna's *rasa* dance. In the *rasa* dance, Lord Krsna and His most intimate devotees, the *gopis* (cowherd damsels) meet together in the forest of Vrndavan (Krsna's spiritual kingdom) and share nights of pleasurable loving affairs in the conjugal mood. Descriptions of the *rasa* dance in Vaisnava scriptures mention many different instruments, and many beautiful songs, sung both by Krsna and the *gopis*. The *Govinda Lilamrta* by Krsnadas Kaviraj Gosvami mentions the following instruments:

> *"muraja, damaru, dampha, mandu, mamak, murali, pabika, vamsi, bipanchi, mahati, vina, kacchapi, kavinasika, svara mandalika, rudra vina,* etc."

Govinda Lilamrta also mentions several of the prominent *ragas* and *raginis*, such as:

> "Sri, Gujari, Ramakiri, Gauri, Asabari, Ghandakiri, Todi, Belabali, Mangal, Boratika, Magdha, Kaushiki, Shali, Lalita, Pala Manjari, Subhanga, Sindhura, Mallar, Karnatak, Natta, Sama Kedar, Kamod, Bhairav, Gandar, Deshag, Vasant, Malab, etc."

In another place, Krsnadas Kaviraj describes the use of:

> "22 *sruti*, 149 *tanas*, 21 *murchchana*, 3 types of *gramas*, plus *gandha grama*, which is beyond [human] comprehension."

and:

> "There are two types of singing: *nibada* and a*nibada* (measured and unmeasured or rhythmic and *a tempo*)." [4]

The following is a description of Krsna's musical activities in the *rasa* dance:

"*Sruti* became known to this world through Krsna when He sang songs containing *sruti* with His lovers in the *rasa* dance. O Srinivasa, in the *rasa-mandala* (arena of the *rasa* dance) all the types of music became personified. Krsna most feelingly manifested *sruti* from *nada* (subtle sound). *Nada* transformed into 22 *srutis* with the help of air. These 22 *nadis* have taken refuge in the heart. Those *srutis* gradually manifest themselves in the *vina* and other instruments, because they cannot manifest themselves in voices that are stricken with cold and diseases...

"O Srinivasa, who knows the real entity of *sruti?* It has been only expressed in the songs sung in the *rasa* dance, as Krsna-candra had introduced *sruti*, Sri Radhika (Krsna's female counterpart) had expressed it accurately. Lalita and the others used to take great pleasure in listening to it. The *srutis* had to thank their own fortune, for the gods used to shower flowers while listening to it. So *sruti* with *svara* used to please everyone. That which gives pleasure to the heart is called *svara*, for it is pleasing to all listeners. Svara is of seven kinds*: sadaja, rishaba, gandhara, madhyama, panchama, dhaivata* and *nisada* [*sa, ri, ga, ma, pa, dha,* and *ni*].

"All the instruments became personified in the *rasa-mandala*. O Srinivasa, on hearing the instruments playing in the *rasa* dance, Brahma and the other demigods became hypnotized. The expert in all sorts of instruments, the son of the King of Braja, along with all His lady-loves, began to enchant millions of Kandarpas (Cupids). The way He was playing the flute is unparallelled in all three worlds. His flute playing in *mandara, madhya* and *tara svara* used to mesmerize Maheswara (Siva). Radha, the enchantress of Govinda and the image of *rasa*, began to play *alavani* instruments in a pure way. The three *gramas, sadaj, madhyam* and *gandham*, had been perfectly used, both in songs and instrumental music. Lalita most playfully played *brahma-vina*, for she was an expert in using *srutis*, etc. in the instruments. Visaka, the fair maid, began to most skilfully play the *kacchapa-vina*. Sucitra, the fair maid, began to play *rudra-vina* in a beautiful way, with the use of *svara, jati*, etc. Campakalatika began to play *vipanchi* with *murcchana* and *tala*, etc. Rangadevi began to play *yantric vilas* with *gamakas*, Sudevi-sundari began to play *sarangi* in different *ragas*, in which various *parvandhas* became visible. Tungavidya began to play *kinnari*, which began to shower nectar in the *rasa* arena, and Indulekha most easily began to play the *svara-mandala*. So all the associates of Sri Radhika were experts in playing all sorts of instruments. Some of them began to play *mardala, mrdanga*, etc. Some of them began to play *muraja*, etc. And some of them began to play *damaru*, which is a favorite of Lord Siva. Some of them began to play *karatalas*, and the sound of the instruments covered the whole area of the *rasa-mandala*. Sri Radhika and her associates looked very beautiful with their instruments. The sound in a chorus used to shower nectar in the *rasa-mandala*. Sri Vrnda-devi was so happy that she began to play different types of instruments that have not been mentioned even in the scriptures. Then Raya and Kanu, being absorbed in the melody of the instruments, began to dance joyfully." [5]

There are many other scriptural quotations describing the music of Goloka Vrndavan as the origin of all other music. For example, there is one *sloka* that "the ankle bells on Srimati Radharani's feet generate thousands of *ragas* and *talas.*" Radharani is elsewhere described as being the pinnacle of the singing and dancing arts. She's considered to be the topmost original artiste of singing, dancing and playing musical instruments. And this is part of the charm that She holds for Krsna—it's one of Her extraordinary qualities. Although Krsna is known as Natabara

(master of dancing), He says in a *sloka* by Rupa Gosvami quoted in the *Caitanya-caritamrta* that "Radharani is My dancing mistress. She makes Me dance because She has hundreds of qualities that I don't have." And therefore She can captivate His mind.

One of the aims of Vaisnava music theory is to produce musicians who can satisfy the Deities by their nice presentations of music. That means we are trying to cultivate some of the qualities that Radharani has that are so attractive to Krsna. Of the eight principal *gopis*, who are considered expansions of Radharani, Tungavidya is primarily responsible for providing musical background for Radha and Krsna's pastimes. Of course, she has hundreds and thousands of *sakhis* and *manjaris* to assist her. So we can imagine that in the spiritual world, when Radha-Krsna and Their associates are performing their pastimes, there is always some appropriate music playing—vocal or instrumental—to enhance Their mood.

Actually, to encourage Radha-Krsna in Their pastimes and to enhance Their ecstatic moods is the duty of the *manjaris*. And the Rupanuga Vaisnavas are especially interested in *manjari-bhava*, as the *svarupa* of the great Vaisnava *acaryas* in our line is predominantly the *manjari-svarupa*. The *manjaris'* mood is: "Let us assist Radha-Krsna and the *gopis* in their pastimes. We do not desire to enjoy with Krsna directly, but our highest bliss is to bring Them together for Their confidential conjugal pastimes."

Pastimes of Radha-Krsna

So we can understand from this line of meditation that music appropriate for offering to Radha-Krsna Deities would be intimately linked with the *rasas* of Their *asta-kalia-lila*, or eightfold daily pastimes. What are the eightfold daily pastimes? We are somewhat familiar with them already, in the form of the daily schedule of Deity worship, bathing and dressing, offering *bhoga*, *aratis*, etc. But what do these activities of Deity worship really mean in terms of the activities of Goloka Vrndavan? There is a nice *sloka* by Rupa Gosvami:

> "The daily *lila* of the Supreme Lord is divided into eight periods as follows:
> 1. *Nisanta-lila*, the last part of the night;
> 2. *Prata-lila*, morning pastimes;
> 3. *Purvahna-lila*, forenoon pastimes;
> 4. *Madhyana-lila*, noon pastimes;
> 5. *Aparahna-lila*, afternoon pastimes;
> 6. *Sayam-lila*, twilight pastimes;
> 7. *Pradosha-lila*, evening pastimes; and
> 8. *Naisha* or *Madhyaratri-lila*, night pastimes.
>
> The Madhyana-lila and Naisha-lila take place for six *muhurtas* (48 x 6 = 288 minutes or 4 hours 48 minutes); the other *lilas* run only for three *muhurtas* (2 hours 24 minutes) each. In the *Sanatkumara Samhita*, Sri Sadashiva has narrated about this *Asta-kalia-lila* of Sri Krsna, the Supreme Lord par excellence. Through that narration we may realize this exalted subject matter." [6]

There is a similar set of eightfold daily pastimes in Gaura-lila, which we will not set forth here; but the principle is the same. In fact, Lord Caitanya is always remembering the Radha-Krsna *asta-kaliya-lila* as He performs His daily pastimes. As He enjoys this ecstatic remembrance, His associates like Ramananda Raya and Svarupa Damodara Gosvami sing the appropriate songs to enhance His devotional mood. This is discussed in *Caitanya-caritamrta*. Therefore, the art of singing appropriate devotional songs is an integral part of the worship of

Lord Caitanya, and all the *acaryas* in our line, especially Narottama das Thakur and Srila Prabhupada, are expert in rendering this particular service.

We again encounter the eightfold division of Krsna's pastimes in the division of *ragas* according to suitability for different times of day:

***Nisanta-lila Ragas* (3:36 am - sunrise [nominally 6:00])**				
Name	**Thata**	**Scale**	**Vadi**	**Samvadi**
Lalita	Shri	Sr GmM d NS	M	S
Bangala	Bhairava	Sr Gm Pd S	M	S
Vibhasa	Marava	Sr G M D S	D+	G
***Prata-lila Ragas* (sunrise [6:00] - 8:24 am):**				
Bhairava	Bhairava	Sr Gm Pd NS	d	r-
Ramakali	Bhairava	Sr Gm Pd NS	P	S
Gunakali	Bhairavi	Sr m Pd S	d	r-
Yavanapuri	Todi	S Rg m Pd n S	d	g
Asavari	Bhairavi	Sr g m Pd n S	d	r
***Purvahna-lila Ragas* (8:24 am - 10:48 am):**				
Shat	Bhairavi	Sr g m Pd n S	P	S
Bhairavi	Bhairavi	SrRg mMPd n S	S	M
Bhupala	Bhairavi	Sr g Pd S	d-	g-
***Madhyama-lila Ragas* (10:48 am - 3:36 pm):**				
Bilaval	Bilaval	S R Gm P D NS	D	G
Alhaiya	Khamaj	S R G MP DnNS	P	R
Saranga	Khamaj	S R M P nn+ S	P	R
Gauda	Kalyana	SRG+mM-PD+N+S	G	N
***Aparahna-lila Ragas* (3:36 pm - sunset [nominally 6:00 pm]):**				
Shri	Puravi	Sr G MPd NS	r-	G
Bhimapala	Kafi	S Rg m P Dn S	m	S
Multani	Todi	S r g+M+P d N+S	g	N+
***Sayam-lila Ragas* (sunset [6:00] - 8:24 pm):**				
Pilu	Pilu	SrRgGmMPdDnNS	g	N+
Puravi	Marava	S r GmMP D NS	G	N+
Marava	Marava	S r G M D NS	G	D
***Pradosha-lila Ragas* (8:24 pm - 10:48 pm)**				
Yamuna	Kalyana	S R G MP D NS	G	N
Kamoda	Kalyana	S R G mMP D NS	R	P
Kedara	Kedara	S R GmMP D NS	m	S
Bhupali	Bilaval	S R G P D S	G	D
Chhayanata	Khammaja	S R GmMP DnNS	R	P
Khammaja	Khammaja	S R Gm P DnNS	G	N
***Naisha-lila Ragas* (10:48 pm - 1:12 am)**				
Kanada	Yavanapuri	S Rg m Pd n S	R	P
Bageshri	Kafi	S Rg m P Dn S	M	S
Jayajayanti	Kafi	S RgGm P DnNS	R	P
Bahar	Kafi	S Rg m P DnNS	S	M
Kafi	Kafi	S Rg m P Dn S	P	S
Malakosha	Bhairavi	S g m d n S	m	S
Bihaga	Kalyana	S R GmMP D NS	G	N
Paraj	Shri	Sr GmMPd NS	S	P
Kalingada	Bhairava	Sr Gm Pd NS	d	G

Note: For an explanation of the notation used in this table please see the companion essay ***Acoustic and Mathematical Derivation and Rasa Expression of the Svaras.***

So the music in Goloka is a sweet, simple, spontaneous outpouring of love in intimacy with Radha-Krsna. Here, spontaneous means that the devotees in Vrndavana are situated on the platform of eternally liberated devotional service (*nitya-siddha*) above the regulative principles of *vaidi-bhakti*. Since they are endowed with perfect spiritual intelligence by Srimati Radharani, Krsna's pleasure potency, for them there is no need for a separate music theory. Their spontaneous ecstatic love for Krsna is enough. In Goloka, all the devotees are situated in their eternal identity in ecstatic relationship with the Lord (*svarupa*), and express their *rasa* with Krsna in perfect spiritual art. In Goloka, "every step is a dance, and every word is a song," [7] so there is no need of music theory as such, since the inhabitants of Goloka are perfect and infallible.

However, we residents of the material world require an elaborate and complete theory of Vedic music because, unlike the inhabitants of Goloka, our intelligence is imperfect. Therefore if we simply play music in our own way, we are certain to make mistakes. By simply speculating or improvising, we will never approach the quality of music required to offer to the Deities. Therefore Srila Prabhupada apparently discouraged musicians sometimes. We believe that his deeper purpose in this was to train us properly in the science of Vedic music so that we could offer nice music to the Deities, instead of offending Them by our well-intentioned but barbarous creative efforts.

Definition of Sound Vibration

Before beginning a study of any subject, it is necessary to define the technical terms used in the discussion. This prevents any ambiguity in terminology from clouding one's understanding of the phenomena under analysis. For the purpose of this discussion of Vedic music:

Vibration is defined as a pattern of periodic alternating quantitive changes (oscillations) in a medium, induced by the passage of energy through the medium.

For example, when a stone drops into the quiet waters of a lake, the water is the medium. The splash of the falling stone injects mechanical energy into the water, inducing it to vibrate in waves; this energy travels through the water in the form of ripples, or oscillations, that spread out from the point of impact. These waves are alternating (up and down) changes in a quantitative, or measurable, aspect of the water: its depth. The cross-section of the waves, and the concentric circles made by them, is the pattern. That each wave follows the previous one by the same distance or time interval indicates that the phenomenon is periodic; each up-and-down cycle of a wave takes the same amount of time. The terms oscillation and vibration are almost synonymous; however, a vibration is usually composed of more than one oscillation.

Sound vibration, as discussed in the Vedic literatures, is of two kinds: *anahata nada* (unstruck or subtle sound in ether) and *nada* (ordinary sound in air). *Anahata nada* is the sound one hears while reciting a *mantra* mentally; the same *mantra* chanted aloud is *nada*. The only difference between *nada* and *anahata nada* is the medium: *nada* is sound vibration travelling through the air, while *anahata nada* is travelling through the ether. For example, telephone and radio convert *nada* into *anahata nada* for transmission to a distant point, then convert it back into *nada* for listening.

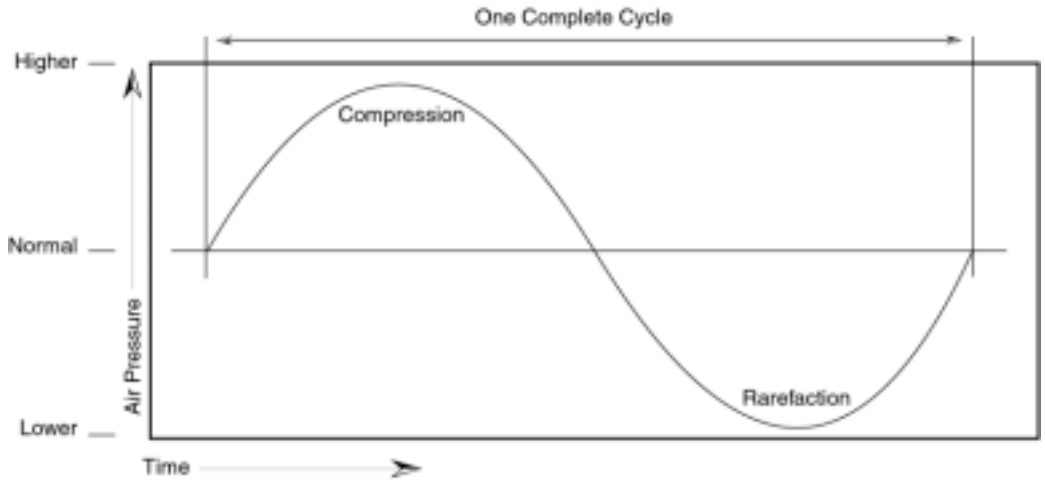


Figure 2: Anatomy of a vibration

The practice of music is mostly concerned with ordinary sound, or *nada*. In *nada*, atmospheric air is the usual medium. *Nada* can also travel through solid objects, such as the strings and wood of musical instruments. The energy behind *nada* is human muscular or mechanical energy, acting through either the voice or a musical instrument to induce sound vibrations in the air. The alternating qualitative changes are oscillations in atmospheric pressure; in other words, a wave of sound in air is composed of a compression of the air immediately followed by a rarefaction (the opposite of compression). The pattern is both the exact degree and manner of compression and rarefaction, and the geometric design of the sound vibrations set up in the acoustic space enclosing the sound vibration. Therefore a sound vibration (*nada*) is defined as a periodic pattern of alternating changes in atmospheric pressure induced by the passage of mechanical energy through the air.

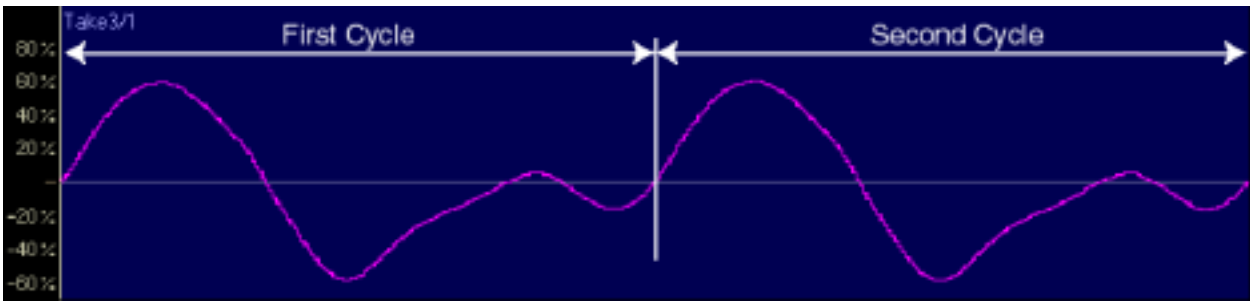


Figure 3: Sample of a string instrument sound viewed on a computer.

The Vedic Science of Sound Vibration

The story of the Vedic science of sound vibration in the material universe is intimately linked with the creation of the universe by Lord Visnu and Brahma. This is because the scientific cosmological principles of Vedic sound vibration are identical with those used in the creation of the material universe by Lord Brahma.

When the Lord desires to create the material world, He lies down in the Causal Ocean in His form as Maha-Visnu. He then glances over the total material energy (*mahat-tattva*), which,

although eternal, is in an inactive state without His glance. The Lord's glance is the catalyst of all material transformations because it is identical with the material time potency. By the influence of the time potency, the material elements gradually evolve from subtle to gross. This is all nicely described in the Third Canto of *Srimad-Bhagavatam*.

The material energy then manifests an unlimited number of seed-like material universes (*brahmandas*), which expand from the pores of the body of Maha-Visnu. He then expands Himself into each universe in His form as Garbhodakasayi Visnu. He then lies down on the snakelike form of Ananta-sesa and a lotus stem sprouts from His navel. When the lotus blossoms, Lord Brahma, the first created being in the material universe, appears in the flower.

At first Lord Brahma is bewildered by the material energy. Although he has a desire to create, he lacks the knowledge and potency to do so because he is conditioned by the material energy. Therefore Brahma undergoes penance (*tapah*) by chanting a Vedic *mantra* (*kama-gayatri*), until he achieves spiritual realization by the grace of the Lord. At this time he sees Krsna face-to-face and is granted a vision of Goloka Vrndavan. He also receives the four original *slokas* of *Srimad-Bhagavatam* from the Lord.

Armed now with realization and the seeds of transcendental knowledge in the form of the *catuh-slokas*, Lord Brahma is able to take up his duty of second-order material creation. Simply by chanting the *Vedas*, Brahma creates 14 orders of planetary systems grouped about the stem of his lotus flower. Thus by spiritual sound vibration, Brahma turns the unmanifest material elements into forms suitable for the inhabitants of the various planetary systems. Brahma also creates the bodies of various species of living entities, beginning with Narada and the Kumaras. It is interesting to note that Brahma has no tools for creation other than sound vibration, which he uses to create everything from planetary systems to a new body for himself.

The Creative Potency of Sound Vibration

The normal condition of the soul is to be in association with the Supreme Lord in the spiritual world. At any given moment, 75% of the living entities are in the normal condition. Because of the bliss experienced in love of Godhead, whose eternal form is like an ocean of *ananda*, the soul's energy is unified by intense feelings of spiritual pleasure. Thus the soul enjoys the pastimes of his eternal identity (*svarupa*) in eternal association with the Lord.

However, when the living entity, deluded by false desires for independent enjoyment, material possessions, false prestige, adoration and distinction, comes to the material world, in order to fulfil his desires he must create a new body of material energy. When the energy of the soul, in the form of desire, contacts the material energy, it loses its unity and instead manifests an unlimited number of material desires in seven basic categories: sex, sensation, movement, emotion, communication, intellect and enlightenment.

These categories of energy are exactly like the colors of the spectrum observed when white light passes through a prism. They become the subtle foundation of the material body. In this respect, they are like the anatomy of the subtle body that accompanies the soul in his wandering from body to body in the material world. According to the Vedic literatures on *Astanga-yoga*, these seven subtle energy vortexes are called *chakras*.

In the spiritual world, the soul's energy is unified by concentration on the all-attractive form of the Lord. But in the material world, the conditioned soul pursues enjoyment by means of sense gratification. In this perverted state of existence, the soul's energy is focused artificially through the identification of false ego, projecting his life energy into the material world through the seven windows of the *chakras*.

This false ego manifests the material mind, which is full of illusory thoughts such as, “I am my body,” “My name is so-and-so,” “I am a man (or a woman),” “I am very beautiful and attractive,” etc. The soul tries to relish these dreamlike illusions, which depend upon temporary conditions of the unstable material energy. Therefore he sometimes thinks himself to be enjoying, and at other times feels himself to be suffering. Actually, all this is simply illusion, like the images projected in a cinema show.

In any case, the life energy of the soul, now disunified by projection through the material energy, forms seven *chakras* which become centers of various material transformations, just like the seven bands of color in the spectrum. Under suitable conditions in the womb of a material body, the energy transformations of the *chakras* cause the surrounding material energy to condense into a new material body just suitable for the soul's misadventures in the material world.

All this happens by the catalytic action of the Paramatma expansion of the Lord, who has accompanied the living entity to the material world as his eternal Friend. Therefore the body created by the soul is determined by the Paramatma according to the desire of the soul and his current account of material *karma*, both good and bad, due to his past actions in the material world.

The Metaphysics of Spiritual Sound

How does the action of the *chakras* create the material body? All energy is vibration. Therefore the life energy of the soul (*prana*) is also vibration, although very subtle and of an extremely high frequency. When this energy is focused on the material energy, it is broken into its component frequencies, just as white light is refracted into colors by a prism. The soul's energy is desire, which is transcendental or timeless; therefore the soul's energy cannot directly affect the material energy, which is moving under the spell of material time.

The energy of the soul is spiritual, and therefore cannot directly affect matter. Spirit is so subtle that it can interpenetrate matter like an aroma penetrates the air. The link between the energy of the soul and the formation of the material body is once again the merciful glance of the Paramatma in the form of the material time potency. When the soul's desire is focused on the material energy by false ego, the Paramatma assists His friend by modulating this energy with the material time potency, which is also called the merciful glance of the Lord in the revealed scriptures. By the grace of the Supersoul, the desires of the soul can modulate the material time potency, and in this way acquire the ability to affect gross matter.

Modulation is the superimposition of one vibration upon another. An example would be to drop a large stone into the ocean. The ocean is already full of waves (vibrations), but the stone dropping into the ocean generates a new set of waves that is superimposed upon the already existing ones. The already existing and far more powerful set of vibrations is called the carrier, and the modulating vibration is called the signal.

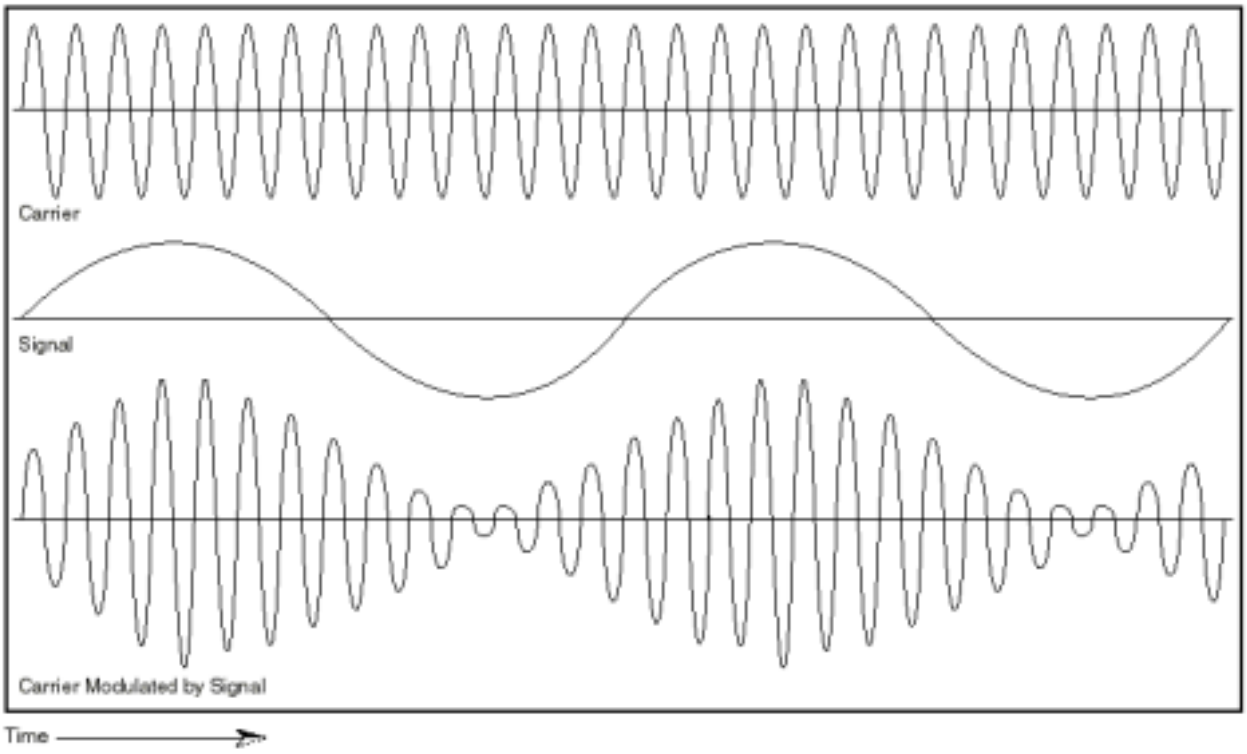


Figure 4: Modulation of a carrier by a signal

By the arrangement of an electronics engineer, the vibrations of a song can modulate a radio carrier wave, and therefore a radio in a distant place can receive the signal. Similarly, by the sanction of the Supersoul the soul's vibrations of desire can modulate material time, and induce various transformations in the material energy. In this way, the soul's energy is able to affect the material energy to the degree permitted by the Supersoul. However, in the process, the original unified energy of the soul becomes many, and his original consciousness is lost.

The energy of the soul in contact with the material energy centers around seven energy vortexes, or *chakras*. These *chakras* emanate vibrations, just like the ripples that spread when a stone falls into a pond. These vibrations affect the surrounding material energy that has a related resonant frequency, animating it and causing it to precipitate into the structure and internal systems of a material body.

Frequency is the number of vibrations per unit of time that a vibrating body naturally produces. For example, most orchestras in the West tune to a standard frequency of A-440. This means that the A-string of the violin is tuned to 440 vibrations per second, and the other strings and instruments are tuned accordingly. The human ear can hear sounds in a frequency range of about 20-20,000 vibrations per second.

Every object has a natural or resonant frequency of vibration and harmonics. For example, when a violin string is tuned to A-440, it naturally tends to vibrate at 440 vibrations per second and whole-number multiples thereof (A-880, E-1320, etc.). These whole-number multiples of the fundamental resonant frequency are called harmonics. All natural vibrations contain harmonics. The proportionate strength of the harmonics gives the vibration its characteristic sound, or timbre. A violin sounds different from a flute because the proportionate strength of the harmonics is different in each instrument.

When two objects linked by the same medium have the same natural frequency of vibration, the vibrations of one object will tend to set the other vibrating as well; this is called resonance or sympathetic vibration. For example, if I have a violin tuned to A-440 sitting on my table, and I loudly sing an A-440, the violin will be heard resonating at the same frequency. The same phenomenon will also occur, but to a lesser degree, if I play an A-880 or an E-1320 on my flute. This is called resonance of related frequencies, or harmonic resonance.

By the processes of resonance and harmonic resonance, the vibrations of the *chakras* induce similar vibrations in the surrounding matter whose natural frequency of vibration is the same as, or harmonically related to, the vibrations of the *chakras*. This gradually causes the formation of the material body in the womb. It is very interesting to note that this is exactly the same method used by Lord Brahma to create the planetary systems of the material universe, as described above. Therefore this is the principle of material creation in general. This simple principle has profound implications for human existence, the healing of individuals and society, and the development of consciousness, most of which are beyond the scope of this paper.

Brahma, after receiving spiritual knowledge from his divine Father Garbhodakasayi Visnu, vibrates this knowledge in the form of the four *Vedas* and their corollary literatures. By this complex sound vibration, assisted by the supreme intelligence of the Lord (Paramatma) acting from within, Brahma, although fundamentally a spirit soul just like ourselves, is able to create all material forms, from the 14 orders of planetary systems to the various species of organic life.

Within the second-order creation of Brahma, we create bodies by the same process of expanding sevenfold vibrations. Our desires for material enjoyment form mental image projections when artificially focused onto the material energy by false ego. Desires are formed of mental pictures (*samskaras*) that symbolize the act or situation we desire. A mental picture is frozen energy, or crystallized vibrations, like a photographic image. Thus there is no time or transformation within a single mental image picture. These static projections, when modulated by the time potency of Paramatma, form energetic, moving vibrations in material time, just like a series of still pictures, when projected in rapid sequence by a motion picture projector, form the illusion of a moving image on the cinema screen.

These subtle vibrations organize the ambient matter into a body fit for action in a particular biosphere according to the soul's *karma*. In both cases (Brahma and the living entities), energy is converted into matter by intelligent modulation of energetic vibrations. Thus the most powerful attribute of any vibrations is that they influence matter according to their specific creative potency. Whatever state of mind we model by our music will tend to be induced in the minds of all the people who hear it, directly or indirectly.

We can therefore influence our environment for the highest good if we know the science of sound vibrations. By playing music correctly, we can create an atmosphere of heavenly bliss and felicity; on the contrary, by singing or playing music that is not in accordance with Vedic directions, we create a disharmonious and discordant atmosphere. Just as we become enmeshed in the trap of illusion through the action of vibrations based upon material desire, we can become free from illusion by vibrations based upon the principles of *sabda-brahman*, culminating in the regular congregational chanting of the holy names of the Lord:

> *Hare Krsna, Hare Krsna, Krsna Krsna, Hare Hare/Hare Rama, Hare Rama, Rama Rama, Hare Hare.*

The Law of the Octave

The perfection of the science of Vedic sound vibration is expressed in the *saptaka dharma* (the Law of the Octave). All energy is vibration. These vibrations are never still; motion is their very essence. Energetic vibrations exist in packets or bunches called quanta; each quantum is the minimum amount of a particular energy that possesses all the qualities of that energy. For example, one oscillation of A-440 would be so short a sound that, if audible at all, it would sound like a tiny click instead of a tone. So a quantum of A-440 would be the minimum number of oscillations necessary to produce an auditory impression of the tone, about 10 milliseconds or about 5 oscillations for a highly trained human ear.

Quanta can be amalgamated into more complex structures that have more qualities that the sum of the parts; this is called synergy. For example, a piece of canvas, a few tubes of paint and a brush, when combined into a painting by the skill of an artist, can convey volumes of meaning that were absent in the original raw materials. Similarly, when many people combine together in pursuit of an aim, they can attain goals that are beyond the reach of a single man. This is quantum synergy.

Quanta can also be broken up into more fundamental constituents ad infinitum; this is called quantum decomposition. For example, the white light of the sun is apparently broken up into seven major colors by a prism. However, if we examine the spectrum scrutinizingly, we can see that actually there are an unlimited number of colors in it. Similarly, material scientists now know that the atom is not the smallest division of matter; atoms can be divided into electrons, protons, etc. And these tiny particles can be broken up into smaller and smaller parts without limit.

A *chakra* is a quantum of living energy. *Chakras* have different energy states that change their qualities, intelligence and modes of operation. A *chakra* can emit quanta of energy, lowering its energy state; conversely, a *chakra* can absorb quanta of related energy, raising its energy state and consciousness, and increasing its range of influence. The emission or absorption of quanta of energy by a *chakra* is called a quantum energy transaction. Quantum energy transactions may take place between *chakras* within the same body, between *chakras* in different bodies, or between *chakras* and other energy quanta, such as internal or external sense objects.

The creation, maintenance and dissolution of each material cosmic unit is nothing more than a continuous series of quantum energy transactions about a central point, called a locus. In living units, the soul is the locus. In non-living units, the locus is determined by structural considerations. Therefore quantum synergy, energy transactions and decomposition are structurally identical to the fundamental universal processes of creation, maintenance and dissolution, respectively.

The quantum structure of the human body is the microcosmic reflection of the original seven *chakras* (*svaras*, or cosmic vibrations) of the sensual activities of Lord Brahma.[8] Other bodies, such as those of animals and plants, are incomplete reflections of these seven vibratory nodes, and therefore contain less than seven *chakras*. Each complete microcosmic unit of living energy, or human body, consists of seven *chakras*, or intervals of vibrations existing in time. These vibrations sound continuously for the complete duration of the unit, or lifetime.

Thus the microcosmic vibratory range of the human body exactly mirrors the macrocosmic vibrations of the entire universe. These vibrations span a frequency range of exactly 2/1, which in musical terminology is called an octave or *saptaka*. In other words, the vibratory frequency of the highest *svara* in the *saptaka* is exactly twice that of the lowest *svara*.

Within the octave or *saptaka* are seven vibratory loci or *chakras* called *svaras*. When the octave of white light is broken up into a spectrum by a prism or a rainbow, it appears to have seven bands of color. However, upon closer examination, one can see that the spectrum is actually a continuous band of finely graduated colors without any break. Therefore the sevenfold bands of colors are due not to the objective nature of the spectrum but to the reflection of the structure of our perceptive apparatus. This is called a perceptive artifact, and it confirms the sevenfold *chakra* structure of the human body.

In the *saptaka* of the human body the energy is divided into seven nodes, or *svaras*; these *svaras* are the *chakras*. Therefore, we tend to perceive everything in terms of these seven *svaras* or divisions. In the musical scale, the *sapta svaras* are the seven notes of the scale. Therefore since music is structured in exactly the same way as the macrocosmic octave and its microcosmic reflection in the human body, it can serve as a model of the various vibratory effects found in all cosmic manifestations. This is the origin of the spiritual meaning of music and the cause of its physical, psychological and spiritual effects.

The Law of the Octave, summarized briefly above, has such profound implications that an entire book can be written about it; indeed, many already have. The is because the concept of the octave, or *saptaka*, and its seven *svaras* is so fundamental that it can serve as a universal measuring rod that remains absolute in all circumstances, regardless of the prior or subsequent transformations of the measuring and measured cosmic units. Because it is a measure of process (quantum energy transactions) instead of substance (quantity), the octave or *saptaka* is as applicable in the subjective world of psychology and spiritual life as the ruler or stopwatch is in the objective physical sciences.

The octave is therefore the ideal measuring rod for all living quantum phenomena, because its use does not interfere with the transactions under observation. Please note that this violates the so-called Heisenberg Uncertainty Principle, which states that in any quantum transaction, an observer can only measure with certainty a maximum of [*n*-1] out of *n* total properties of the transaction, because the observer must necessarily interfere with the transaction in order to observe it. While this aspect of *saptaka dharma* has profound implications for theoretical physics and many other disciplines, including the attainment of complete spiritual realization, its full discussion is beyond the scope of this short paper.

All phenomena can be measured by the octave because it synergistically contains more than the sum of the possibilities of its constituent vibrations. On the universal level, the *saptaka* is the symbol of the transcendental relationship between Visnu and Brahma, the divine creative Father and son who together contain more than the sum of all possibilities for this universe. It symbolizes the transfer of knowledge and creative potency from Visnu, who emanates the substance of the material universe and animates it by the material time factor, to Brahma, who begins the process of manifestation by his transcendental sound vibration of the *Vedas* at the beginning of creation. The octave also contains the results of those transformations, and thus it is the measure of all material forms, both gross and subtle.

Since the octave is thus the symbol of an absolute, transcendental transformation, it is also absolute and comprehensive within the universe generated by the same process. Therefore when properly understood, the octave is seen to be the plan of the universe, the microcosm that perfectly reflects the macrocosm in which it finds its ultimate origin; it is the Logos or creative word; it is OM; it is the ultimate functional symbol of the universal manifestation of the Absolute Truth.

Thus all cosmic units are vibrations of material energy, microcosmic images of the seven *chakras* or *svaras* of the original cosmic *saptaka* or octave, and can be measured and aligned to

absolute perfection by this reflection of the original cosmic creative impulse. It is because of this fact that great Vedic sages attribute wonderful results to the contemplation of the vibrations of the octave. They also ascribe great importance to the proper tuning and alignment of these vibrations in chanting of Vedic *mantras* and *stotras* (prayers), and in all Vedic musical practices utilizing the *svara saptah*.

Harmonics and the Harmonic Series

In this section we begin to explain how the exact pitches of the 22 *srutis* and seven *svaras* are derived from the universal laws of vibration. As explained above, every physical object has a natural resonant frequency at which it tends to vibrate. In addition, every object has several modes of vibration that allow it to vibrate at harmonics of the natural resonant frequency.

The harmonic mode is the number of segments in which an object vibrates. For example, if I tie one end of a rope around a tree, then pull up and down on the other end, the rope will vibrate in its fundamental or first-harmonic mode.

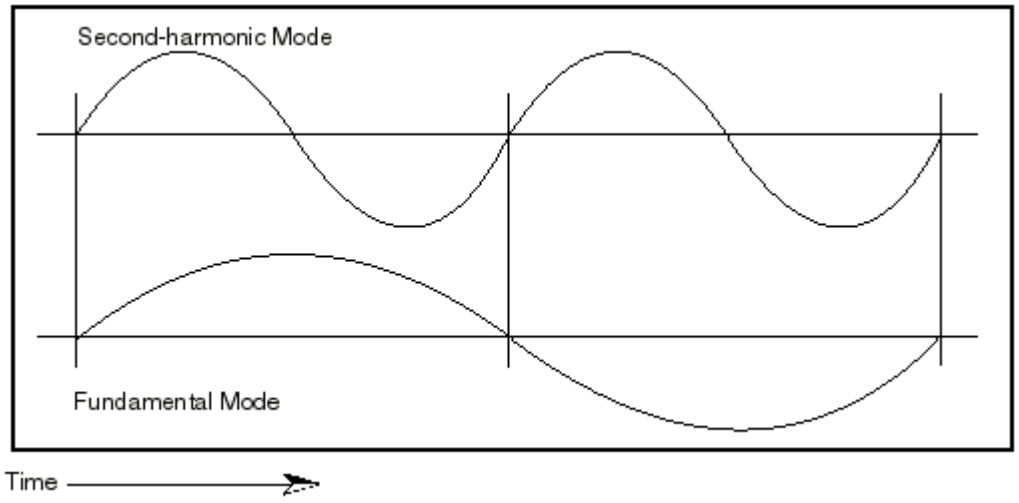
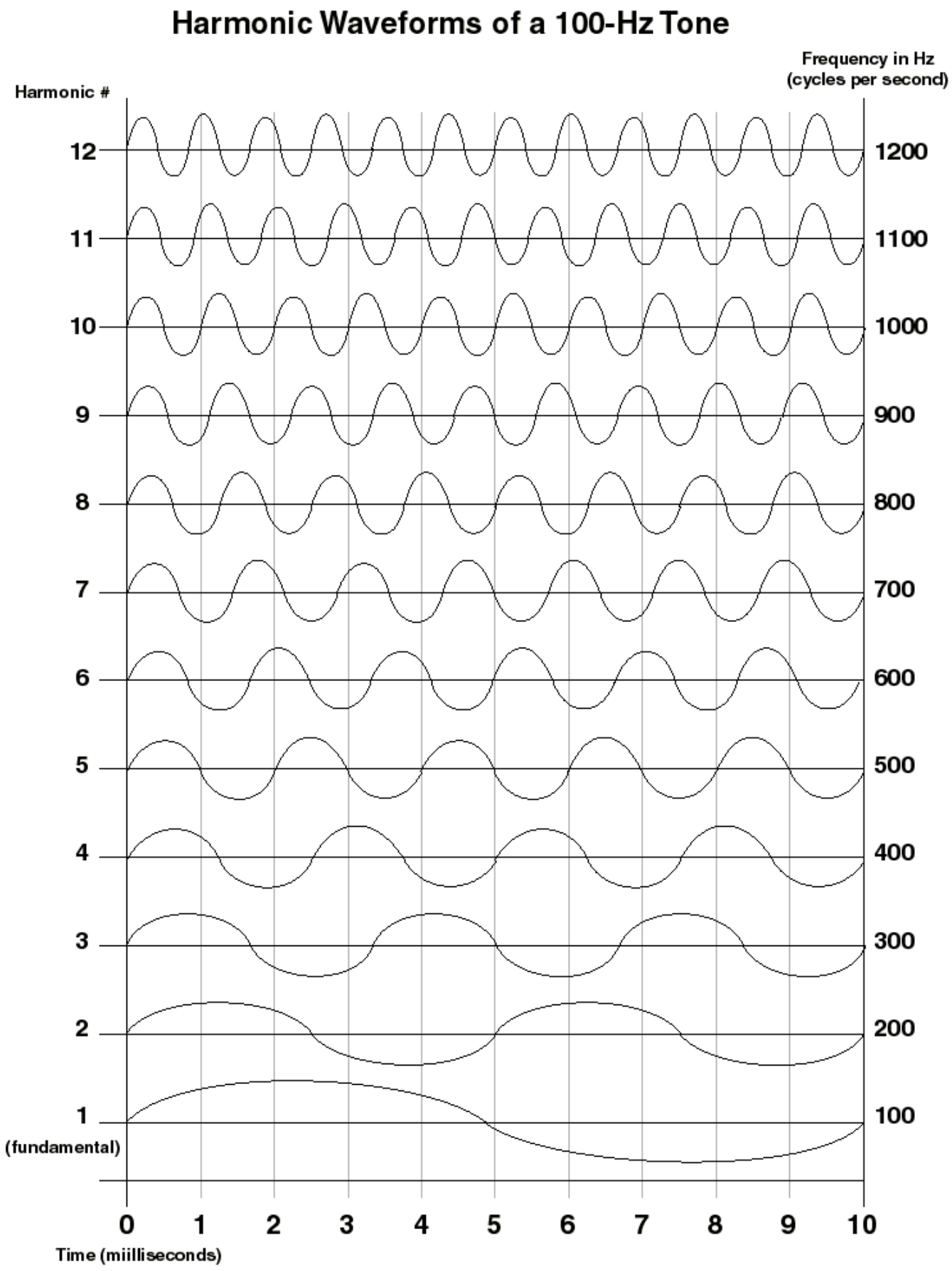


Figure 5: Fundamental and second-harmonic mode vibrations.

However, if I tie both ends of the rope to different trees, then grab the exact middle of the rope and pull, the rope vibrates in two equal segments, each of which is half the length of the entire rope. This is called the second-harmonic mode of vibration. If we examine the second-harmonic mode of vibration, we find that its frequency is precisely twice as high as the fundamental mode. As discussed above, this frequency ratio of 2/1 is called an octave. In other words, if the fundamental mode vibration of a guitar string is tuned to 100 vibrations per second, the second harmonic mode will vibrate at 200 vibrations per second.

If we can get the guitar string to vibrate in modes with three, four or more harmonics, the frequency of vibration will continue to increase as the multiple of the number of segments:



In the figure above, the starting point of 100 vibrations per second are chosen for simplicity's sake. Actually the starting point can be at any frequency or note; it is the frequency ratios and tonal relationships among the harmonics that are significant. These same harmonic frequency relationships can be found in every vibration in the universe. Every vibration, from the extremely low frequencies of galactic rotation to the extreme highs of cosmic rays, follows exactly the same law of harmonics as described above. In fact, all harmony, whether of color, sound or form, follows the simple integral (whole number) ratios of the Harmonic Series.

From this follows the principle that the closer a harmonic vibration is to the fundamental, the more harmonic or consonant it is said to be. Conversely, the further from the fundamental a vibration falls on the Harmonic Series, the less harmonic or more dissonant it is said to be. Finally, if a vibration is not derived from the Harmonic Series at all, it is called assonant or completely dissonant because it has no integral relationship with the fundamental.

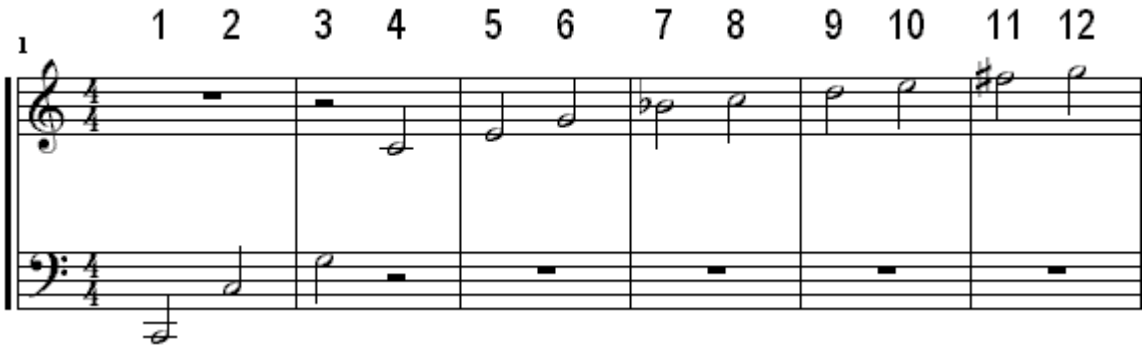


Figure 6: The Harmonic Series in Musical Notation

Harmonics are extremely important in music. The timbre or characteristic tone color of a particular instrument or voice is determined by the proportion and relative intensities of its harmonics. But even more important is the role of the Harmonic Series in determining the musical scale, because the *srutis* and *svaras* are derived from the Harmonic Series.

Derivation of the Svaras

How are the seven notes of the scale derived? We're all used to hearing the musical scale—*sa, ri, ga, ma, pa, dha, ni, sa*—but how did the notes get the way they are? Why aren't they some other way? As we have seen so far in the discussion, this is an extremely deep question that goes into physics, mathematics, the cosmic laws of the universe, how the universe was originally created by Lord Brahma, and so on. Actually this whole subject is contained in the *Srimad-Bhagavatam* verse quoted in the beginning of this paper:

> "Brahma's sensual activities were manifested as the seven notes of the musical scale [*svara saptah*]."

The seven *svaras* are *sa, ri, ga, ma, pa, dha,* and *ni*. And Prabhupada's purport declares: "All these vibrations are transcendental sound vibrations." So all music performed according to Vedic principles is spiritual. In discussing the meaning of this verse, first of all we had to go into a long series of definitions. We spent a long time defining and discussing our terms: from vibration up to the Law of Octaves (*saptak dharma*).

The Law of Octaves describes how different *svaras* in the octave are like *chakras* or loci of different energies, how they can trade energy in quantum transactions and so forth. In *astanga-yoga* the *svaras* are called the seven *chakras*, in art they are the seven colors of the rainbow, and in music they are the seven tones of the scale, but they are the same in principle. On the material level, the seven *svaras* symbolize the cosmic process of creation, maintenance and dissolution. And on the spiritual level, they express the divine *rasas* of devotional love between the Lord and His eternal devotees.

In this section we explore the connecting link among these apparently different sevenfold vibratory phenomena. How is it that when we see a rainbow, there are apparently seven bands of color? Or how come when we hear music, we naturally tend to think in terms of a seven-note scale? Why are there seven? Because there is one universal law that ties all these together. All musical phenomena have to do with vibrations—in fact all phenomena—so if we can understand the laws of vibration we can understand what's behind all phenomena.

Harmonic Interval Ratios

So far we have defined the Harmonic Series, and how to calculate the harmonics of a given fundamental. An interesting and useful way to express the intervals amongst the harmonics is in the form of frequency ratios. A ratio means one number divided by another number, as in the fraction:

$$\left[\frac{f_2}{f_1}\right]$$

Where the denominator f_1 of the fraction represents the frequency of the lower tone of the harmonic interval, and the numerator of the fraction f_2 represents the frequency of the upper harmonic tone.

The first harmonic, or fundamental, has a frequency of f, or 1 times f. The second harmonic is twice the frequency of the fundamental, 2 times f or a ratio of $\frac{2f}{f} = \frac{2}{1}$.

This is more easily expressed as 2/1. The third harmonic is $3f$ or a ratio of 3/1, and so forth. In other words, the frequency of the second harmonic is twice the frequency of the fundamental harmonic, and expressed as a ratio that is 2/1. Then the 3rd harmonic's frequency is 3 times that of the fundamental, so that's a 3/1 ratio, et cetera.

An interval is the ratio of the frequencies of two vibrations. The harmonic intervals all have integral ratios. An integer means a whole number, so an integral ratio is a ratio or a fraction that's made up of whole numbers. That is, the frequencies of the Harmonic Series can all be represented by the whole numbers 1, 2, 3, ... therefore the ratios of the Harmonic Series are made of whole numbers like 2/1, 3/1, 4/3, 5/4, 6/5.

Ratios like 3/1 express a harmonic's interval with the fundamental, but what about the intervals between the different harmonics? To get the ratio of these intervals, take the higher harmonic's ratio and divide it by the ration of the lower one. For example, say we want to calculate the ratio between the third harmonic and the second harmonic. According to our

method, that would be $\frac{3/1}{2/1} = 3/2$. Similarly, the ratio between the third and fourth harmonic is 4/3.

The following table illustrates all possible ratios of the first 12 harmonics. Out of these 144 ratios, we first may eliminate the limiting factors (1/1 and 2/1) shown in green. Next we may eliminate all ratios that evaluate to <1 or >2 (gray). Finally we eliminate the ratios between 1/1 and 2/1 that are factorable (blue). The remaining 22 intervals shown in white are the ratios of the 22 Vedic *Srutis* as derived from the first 12 harmonics.

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1	1/1	1/2	1/3	1/4	1/5	1/6	1/7	1/8	1/9	1/10	1/11	1/12
2	2/1	2/2	2/3	2/4	2/5	2/6	2/7	2/8	2/9	2/10	2/11	2/12
3	3/1	3/2	3/3	3/4	3/5	3/6	3/7	3/8	3/9	3/10	3/11	3/12
4	4/1	4/2	4/3	4/4	4/5	4/6	4/7	4/8	4/9	4/10	4/11	4/12
5	5/1	5/2	5/3	5/4	5/5	5/6	5/7	5/8	5/9	5/10	5/11	5/12
6	6/1	6/2	6/3	6/4	6/5	6/6	6/7	6/8	6/9	6/10	6/11	6/12
7	7/1	7/2	7/3	7/4	7/5	7/6	7/7	7/8	7/9	7/10	7/11	7/12
8	8/1	8/2	8/3	8/4	8/5	8/6	8/7	8/8	8/9	8/10	8/11	8/12
9	9/1	9/2	9/3	9/4	9/5	9/6	9/7	9/8	9/9	9/10	9/11	9/12
10	10/1	10/2	10/3	10/4	10/5	10/6	10/7	10/8	10/9	10/10	10/11	10/12
11	11/1	11/2	11/3	11/4	11/5	11/6	11/7	11/8	11/9	11/10	11/11	11/12
12	12/1	12/2	12/3	12/4	12/5	12/6	12/7	12/8	12/9	12/10	12/11	12/12

Key:

= Limits: unison and octave (1/1 and 2/1)
= Ratio out of limits (ratio < 1/1 or ratio > 2/1)
= Reducible ratio falling between 1/1 and 2/1
= Unique, irreducible integral ratios falling between 1/1 and 2/1 (the 22 *Srutis*)

Figure 7: Interval Ratios of the Harmonic Series

The figure above shows a mathematical proof for the derivation of the srutis from the harmonic series. The following figure demonstrates a geometric proof of the same principle. In this figure, the first 12 harmonics are shown in ascending order on the musical staff. Then by a process of elimination, we show first the unique ratios of the adjacent harmonics, then ratios using every other harmonic, ratios using every third harmonic and so forth. The largest ratios are 11/6 and 12/7, both of which span five harmonics. All other possible ratios are reducible by factoring, limiting the number of integral intervals (*srutis*) among the first 12 harmonics to 22.

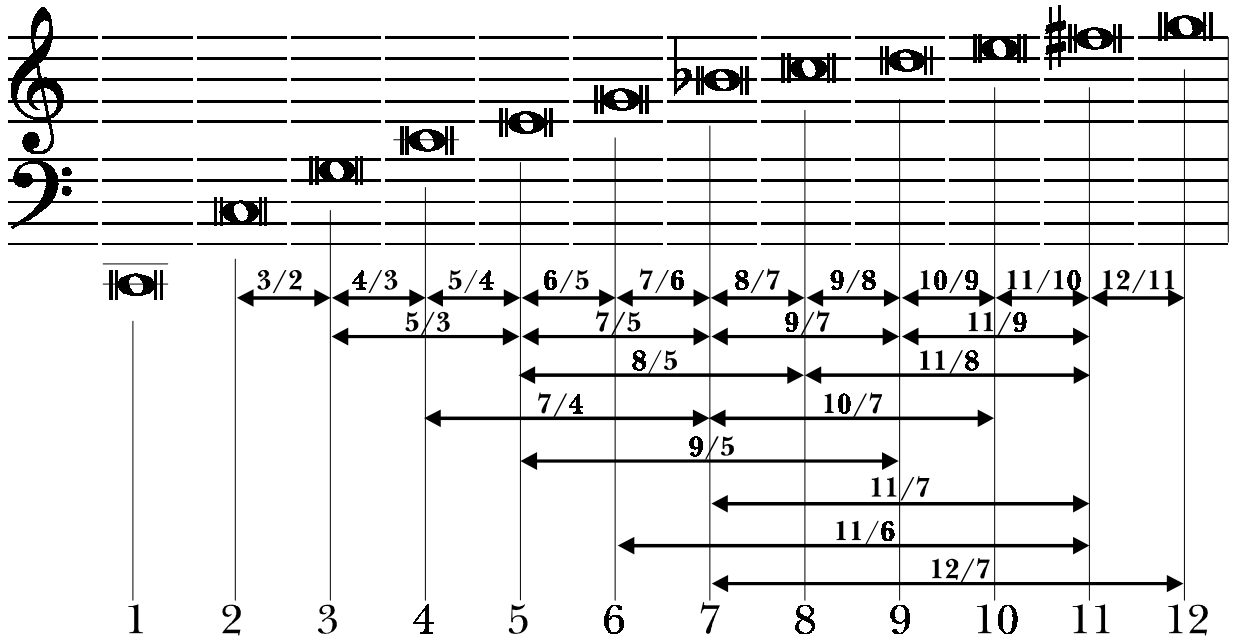


Figure 8: Geometric proof of the 22 srutis.

The following table illustrates the 22 *srutis* derived above in descending scale order, and how they map to the seven *svaras (sa, ri, ga, ma, pa, dha, ni)* and the tones of the Western scale:

Sruti #	Integral Ratio	Decimal Ratio	*Sruti*	*Svara*	Western Interval
	2/1	2.000	*Sa*	*Sa*	Perfect Octave
22	11/6	1.833	*Shuddha Ni +*	*Ni*	Major Seventh +
21	9/5	1.800	*Shuddha Ni*	*Ni*	Major Seventh
20	7/4	1.750	*Komal Ni*	*Ni*	Minor Seventh
19	12/7	1.711	*Komal Ni -*	*Ni*	Minor Seventh -
18	5/3	1.667	*Shuddha Dha*	*Dha*	Major Sixth
17	8/5	1.600	*Komal Dha*	*Dha*	Minor Sixth
16	11/7	1.577	*Komal Dha -*	*Dha*	Minor Sixth -
15	3/2	1.500	*Pa*	*Pa*	Perfect Fifth
14	10/7	1.433	*Tivra Ma +*	*Ma*	Aug. Fourth +
13	7/5	1.400	*Tivra Ma*	*Ma*	Augmented Fourth
12	11/8	1.375	*Tivra Ma -*	*Ma*	Aug. Fourth -
11	4/3	1.333	*Shuddha Ma*	*Ma*	Perfect Fourth
10	9/7	1.299	*Shuddha Ga +*	*Ga*	Major Third +
9	5/4	1.250	*Shuddha Ga*	*Ga*	Major Third
8	11/9	1.222	*Shuddha Ga -*	*Ga*	Major Third -
7	6/5	1.200	*Komal Ga*	*Ga*	Minor Third
6	7/6	1.167	*Komal Ga -*	*Ga*	Minor Third -
5	8/7	1.144	*Komal Ga - -*	*Ga*	Minor Third - -
4	9/8	1.125	*Shuddha Ri*	*Ri*	Major Second
3	10/9	1.111	*Komal Ri*	*Ri*	Minor Second
2	11/10	1.100	*Komal Ri -*	*Ri*	Minor Second -
1	12/11	1.088	*Komal Ri - -*	*Ri*	Minor Second - -
	1/1	1/1	*Sa*	*Sa*	Perfect Unison

These 22 harmonic intervals (*srutis*) are the palette from which are drawn the *svaras* of the *Vedas*. Each *raga* draws on this palette of *srutis* for its *svaras* (scale tones) and uses them to color its expression. Just as the gamut of artistic colors are ranked in order of their position in the spectrum, brightness, saturation, and other qualities, the *srutis* are also ranked and classified in terms of their musical and emotional qualities, as we shall see below.

Harmony, dissonance and assonance

The intricate question of the origin and structure of the *svara saptah* is inextricably bound up with the question of the nature of harmony. We all hear the word harmony and think we know what it means, but what is the actual scientific definition? Harmonic value is a function of the complexity of the interference pattern made up by two or more vibrations. One could think of the interaction of two vibrations as a landscape that the listener must traverse. A simple, stable landscape is easier to navigate than a complex, unstable one.

Harmonic value can be defined most easily in terms of a ratio of two or more harmonic vibrations. The measure of harmonic value of an interval or *svara* (or any harmonic musical structure) is the reciprocal of the average of the denominator and the numerator of the integral fraction describing the frequency ratios of its component harmonics.

$$V_h = \left[\frac{1}{\left(\frac{f_1 + f_2 \ldots f_n}{n} \right)} \right]$$

The closer to unity V_h is, the greater the harmonic value, and the closer to zero the less the harmonic value. For example, if I play two notes of the exact same frequency, this is called a unison. This *svara* can be expressed as the fraction 1/1. The V_h of a unison is 1.0. However, the harmonic value of the interval bewteen the 11^{th} and 12^{th} harmonics is only 0.087, making this interval the least harmonic of all 22 srutis. In between these extremes of harmony and dissonance, there are 21 other *srutis* of varying harmonic value:

***Srutis* in descending scale order:**

Sruti #	*Sruti*	*Svara*	Integral Ratio	V_h
	Sa	*Sa*	2/1	0.667
22	*Shuddha Ni +*	*Ni*	11/6	0.118
21	*Shuddha Ni*	*Ni*	9/5	0.143
20	*Komal Ni*	*Ni*	7/4	0.182
19	*Komal Ni -*	*Ni*	12/7	0.105
18	*Shuddha Dha*	*Dha*	5/3	0.250
17	*Komal Dha*	*Dha*	8/5	0.154
16	*Komal Dha -*	*Dha*	11/7	0.111
15	*Pa*	*Pa*	3/2	0.400
14	*Tivra Ma +*	*Ma*	10/7	0.118
13	*Tivra Ma*	*Ma*	7/5	0.167
12	*Tivra Ma -*	*Ma*	11/8	0.105
11	*Shuddha Ma*	*Ma*	4/3	0.286
10	*Shuddha Ga +*	*Ga*	9/7	0.125
9	*Shuddha Ga*	*Ga*	5/4	0.222
8	*Shuddha Ga -*	*Ga*	11/9	0.100
7	*Komal Ga*	*Ga*	6/5	0.182
6	*Komal Ga -*	*Ga*	7/6	0.154
5	*Komal Ga - -*	*Ga*	8/7	0.133
4	*Shuddha Ri*	*Ri*	9/8	0.118
3	*Komal Ri*	*Ri*	10/9	0.105
2	*Komal Ri -*	*Ri*	11/10	0.095
1	*Komal Ri - -*	*Ri*	12/11	0.087
	Sa	*Sa*	1/1	1.000

In descending order of V_h:

Sruti	Integral Ratio	V_h
Sa (unison)	1/1	1.000
Sa (octave)	2/1	0.667
Pa	3/2	0.400
Shuddha Ma	4/3	0.286
Shuddha Dha	5/3	0.250
Shuddha Ga	5/4	0.222
Komal Ni	7/4	0.182
Komal Ga	6/5	0.182
Tivra Ma	7/5	0.167
Komal Dha	8/5	0.154
Komal Ga -	7/6	0.154
Shuddha Ni	9/5	0.143
Komal Ga - -	8/7	0.133
Shuddha Ga +	9/7	0.125
Shuddha Ni +	11/6	0.118
Tivra Ma +	10/7	0.118
Shuddha Ri	9/8	0.118
Komal Dha -	11/7	0.111
Komal Ni -	12/7	0.105
Tivra Ma -	11/8	0.105
Komal Ri	10/9	0.105
Shuddha Ga -	11/9	0.100
Komal Ri -	11/10	0.095
Komal Ri - -	12/11	0.087

The implications of this analysis are both profound and complex. For example, it is no accident that the *tamboura*, the drone instrument that supplies the harmonic context for Vedic music, is tuned to the tonic, octave and fifth. These are precisely the intervals with the greatest harmonic value. Thus the *tamboura* serves as a harmonic foundation for all the other instruments and singers.

The harmonic value of *ragas* and Western musical pieces may also be evaluated with the same mathematical tool. The devotional *ragas* used in temple worship are often pentatonic, composed of the intervals with high harmonic value and low dissonance. *Ragas* that express desire, pain and suffering are typically septatonic (all seven *svaras*) and emphasize dissonant *srutis* with lower harmonic value. In Western music, chords of lower harmonic value tend to resolve into chords of higher harmonic value. Thus musical expression and practice have a firm theoretical basis in acoustics.

If one of the notes of the interval is out of tune, then there is no integral ratio with the tonic. This is even more dissonant, even less harmonious, even less pleasing than the most dissonant harmonic interval. Harmonious actually means pleasing; if everyone is in harmony then they are pleased with one another. But if a tone is inharmonious, or to use the musical term, dissonant, there is a feeling of conflict and discomfort. In the case of totally out of tune notes we have the inharmonious relation of assonance, where there is no integral harmonic ratio between the notes at all.

Unfortunately the term assonance also describes equal temperament, the tuning system used in Western music. In equal temperament, scale tones are calculated with a formula that uses an

irrational number, the twelfth root of two. The notes of the Western chromatic scale are cut off from their natural integral harmonic relationships with the fundamental. This assonance is the least pleasant of all kinds of tonal relationship, for it expresses a feeling of profound alienation, restlessness and discomfort.

Altogether we have three categories of intervals: assonant, dissonant, and consonant or disharmonious, inharmonious and harmonious relationships between a note and the fundamental. Vedic music is the most consonant and harmonious, and therefore pleasing, because it is based entirely upon intervals with an integral frequency relationship.

This rich, multidimensional harmonious relationship is the *svara saptah*. It can be expressed as an integral fraction. Some fractions are more complex than others. As we go into more and more complex fractions, we go farther and farther away from the simple harmony that gives us a natural feeling of aural pleasure when we hear it. In other words, harmony, harmonic value and musical pleasure are synonymous.

We also found that the harmonic value of any interval or *svara* is inversely proportional to the sum of the numerator and denominator of its fraction, its ratio or relationship of frequencies. In other words the simpler the relationships of the frequencies that go to make up our music, the more pleasant it will be to hear.

Q: Wouldn't that be boring though? A: No, why should it be boring? If everything I do gives you pleasure, even if I do very simple things it will never become boring. Krsna never becomes bored with the *gopis*. Boredom means that we perceive the possibility for perfection in something but it falls far short of our expectation.

Q: Then why don't we just have music where everyone plays the same note? A: Because variety is another aspect of pleasure. So what you are talking about is monotony, not boredom. In fact monotony means mono + tone. Someone who speaks in a flat tone is called mono-tone-ous. But Vedic music is very rich in variety. Just think of all the varieties of pitch, tone, vibrato and attacks, *gamakas*, *alankaras*, grace notes, slides (*portamento*) and other ornamentation in Indian music.

The real issue here is the quality of the basic materials that we are using for our art. If I am a painter and I am going to make a big painting, I may go down to the second-hand store and for a few dollars I buy a few old, dried-up, crumpled-up tubes of paint. And then I come home and get some regular turpentine and I start mixing paints. We can understand that is a very low-class way of painting. But if I go downtown to the best art store and I buy fresh tubes of the best Grumbacher oil and special thinner with linseed oil in it, the best and finest brush and canvas, I will start with the best material possible. I may have or not have talent, but the fact is that using such nice materials is going to give me a better result. I may be the same artist, but if I have a better instrument or if I am using better materials I can do better work.

Therefore the purest, most naturally pleasing vibrations are those whose relationship of frequencies can be described in simple whole numbers, and the simpler the numbers the better. All Vedic sound vibration is based on this principle, all the *svaras* are based on this principle: that the intervals of the notes should be composed of as simple a vibrational landscape as possible.

Maybe a bit of physics will help to clear this up. When we create sound energy, just like when we drop a rock into the pond out there, waves spread out in all directions. If we drop two rocks into the pond, then two sets of vibrations will spread across the pond. At a certain point the two sets of vibrations will meet. What happens when they meet? They are going to form a pattern of vibrations. Whether the frequencies of the vibrations are the same or different, a pattern will

be created. At some points the vibrations will reinforce each other, and at certain other places they will tend to cancel each other out. In physics this is called the interference of vibrations.

The interference of two vibrations creates an interference pattern, or grid of high and low points. If the frequencies are harmonically related to each other or harmonious, they will form a stable interference pattern. If the frequencies are very dissonant or assonant, the pattern will be unstable.

This is just like being out in the ocean in a small boat, and there are two currents, two sets of waves, coming together. One set is coming from one side, the other waves are coming from the other side. To pilot a boat safely through this kind of place, you have to make the boat hit the waves from different directions at the same time. Otherwise the boat will pitch and roll uncomfortably. In other words, you have to guide the boat properly through the interference pattern of the waves. Otherwise the boat will be unstable and may even capsize.

If you have a stable interference pattern of sound vibrations, it's comfortable. You can rely on the pattern being regular and predictable. But if the interference pattern is unstable, there will be a lot of uncertainty, which the ear interprets as noise, or assonant vibrations. Just like in the example above we don't want the waves to rock the boat, we feel the same way about sound vibrations.

The vibrations that are related by integral ratios of frequencies create stable, regular patterns of vibrations, just like the arches of a classical architectural design. The arches of Prabhupada's *samadhi* are all regular. What would we think if we saw a *samadhi* where each arch was a different width? Therefore the regular pattern is beautiful. Regularity and proportion are two elements of beauty. So when the interference pattern created by two sets of vibrations is regular and geometric, we automatically think that it is beautiful.

There is also an objective verification of this same truth (the beauty of integral ratios of vibrations). It is an obscure physiological phenomenon called combination tones. This is a phenomenon that occurs in the human body and mind when hearing two different frequencies at the same time. Let's take the Harmonic Series for example. The first two notes in the Harmonic Series form a perfect octave, frequency ratio 2/1. If the fundamental is 200, the second harmonic will be 400 vibrations per second.

When these two sounds come into our ears, our mind performs a frequency analysis on the sound. It subtracts one frequency from the other and compares the result to the original tones. In the present case, 400 - 200 = 200. The result is identical to one of the original tones. Therefore my mind can recognize that this interval is an octave, because that's the only interval with that particular configuration of combination tones. And that's how we recognize any interval, by unconsciously analyzing the structure of its combination tones. People who are “tone deaf” simply cannot hear these subtle vibrations.

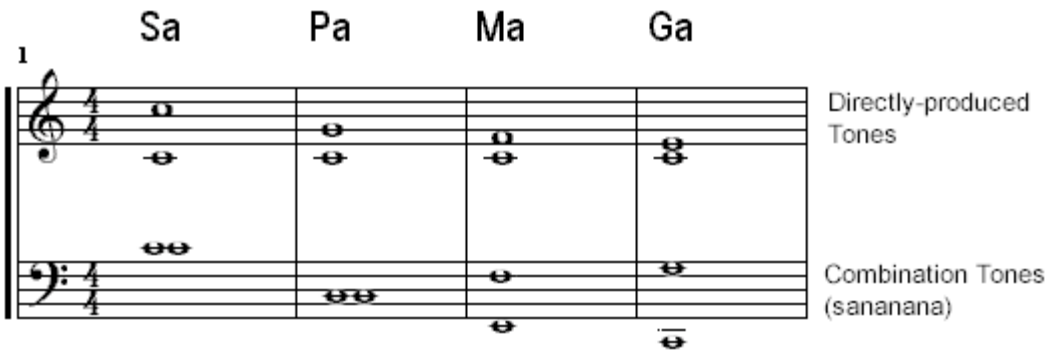


Figure 9: Intervals and their Combination Tones

In Vedic terminology, combination tones are called *sananana*. *Sananana* is a vibration that is created by our own hearing apparatus. It's not present in the air as acoustic energy, but it is present in the inner ear. If you listen carefully to a perfect interval, you can hear the *sananana*. They sound like faint bass tones in the background. It takes a special kind of hearing, because the combination tones are coming from inside your own head. Scientists are not sure whether they come from the inner ear or the brain itself. In fact they cannot explain the presence of this faculty at all. It is like a special software program in the brain for listening to music! It seems to exist only to analyze musical intervals. But anyone can learn to hear combination tones by regular practice.

To produce combination tones, the brain calculates the difference between the two directly produced sounds of the interval, and gives the result as a third tone. Not only that, it also calculates the difference between the combination tone and one of the original tones, and so on. Up to 15 levels or orders of combination tones have been observed, and theoretically their number is unlimited.

The combination tones allow our minds to establish if the interval is actually in tune or not. If the interval is in tune, the combination tones will form harmonic intervals to the original directly produced tones. In the most common harmonic intervals, one of the combination tones will be exactly an octave below one of the original tones. All the combination tones of the intervals naturally found in the Harmonic Series are also tones of the same Harmonic Series.

If you can't hear *sananana*, there is no way you can sing in tune. You can approximate the notes but you can't really hit them exactly. To tune the intervals properly we have to hear two separate instruments simultaneously. There have to be two sound sources to get the combination tones or *sanananas*. It doesn’t work if you only have one sound source. Just like if you have a radio with one speaker, and you're hearing one speaker giving out these two tones simultaneously, you won't be able to hear any combination tones. That's one thing that's really bad about radio and television: there's only one source of sound, so you can't have combination tones. Our ears require two separate sources for the two different sounds. It's part of the conditions for the phenomenon of *sanananas*.

That means monophonic recording systems amplification or P.A. systems cannot reproduce the sounds required for hearing *sananana*. But if you can hear these *sanananas*, just one tone contains a whole ocean of music, it contains symphonies, it contains all colors of the rainbow. If you listen really deeply to a perfect fifth, it will put you into a trance. In the olden days people could hear these things. All authentic Vedic *srutis* generate perfect *sanananas*. In fact *srutis* are described in the *sastras* like *Srimad-Bhagavatam* 3.12.47.

"*Srutis* became known to this world through Krsna when He sang songs containing *srutis* with His lover in the *rasa* dance. Oh Srinivas, in the Rasa Mandal all the types of music became personified. Krsna most humorously manifested *sruti* from *nada* (sound in air). *Nada* transformed into *sruti* with the help of air. These twenty-two *nadis* have taken refuge in the heart." [reference]

Now when Bramha's sensual activities are mentioned in the *Bhagavatam* verse, it also means that the human body begins from *nadis*. The word *nadi* means sound channel, like a vein, for example the *sushrumna* through which the mystic yogis are supposed to leave their bodies. The word *nadi* comes from the word *nada* which is sound, material sound vibrations, so this *nadi* or *nada* is composed of 22 *srutis*. The *srutis* became the original *nadis*. Actually there are thousands of *srutis*, but the Vedic system only uses the 22 most pure ones.

"Those *srutis* gradually manifest themselves in the *vinas* and other instruments because they cannot manifest themselves in voices that are stricken with cold and diseases. O Srinivas! Who knows the real entity of *sruti*? It has only been expressed in a song sung in the *rasa* dance. As Krsna Chandra introduced *sruti*, Sri Radhika expressed it accurately. Lalita and the others used to take great pleasure in listening to her.

"The *srutis* had to thank their own fortune for the gods used to shower flowers while listening to them. So *sruti* with *swara* used to please everyone. The definition of *svara* is that which gives pleasure to the heart, for it is pleasing to all listeners. *Svara* is of seven kinds, *sataja, risabha, gandhara, madhyama, panchama, dhaivata* and *nishada* [*sa, ri, ga, ma, pa, dha* and *ni*]. All the instruments became personified in the *rasa mandala*.

"O Srinivasa! on hearing the instruments playing in the *rasa* dance, Bramha and the other demigods became hypnotized. The expert in all sorts of instruments, the son of the King of Braja, along with His ladyloves began to enchant millions of Kandarpas. The way He was playing the flute is unparalleled in all the three worlds. His flute playing in *mandar, madyar* and *taresvara*—meaning the lower, middle and the higher octaves—used to mesmerize Mahesvara.

"Radha, the enchantress of Govinda and the image of rasa, began to play *alamarni* instruments—stringed instruments you play with a bow—in a pure way. The three *gramas: sata grama, madhan grama* and *gandha grama*—that means tonalities starting from *sa, pa* and *ga*—had been perfectly used both in songs and instrumental music. Lalita most playfully played the Brahma *Vina* because she was an expert in using *srutis* etc. in the instruments." [reference]

How expert all the different *gopis* were! And all the different instruments they played!

So all these technicalities really mean that the essence of *rasa* is contained in these *svaras* and *srutis*. The *svaras* are tuned according to the *srutis*, the *srutis* are the integral ratios of sound vibrations within the range of the octave. Actually there are thousands of *srutis*, but the main ones—the ones that are used more frequently—are the ones with the lowest sum of ratio numbers. These have the greatest harmonic value, as we discussed before, and are therefore the most *sattvic*, harmonious and pleasing.

Svara means that which is pleasing to the heart of all living entities. Because the *srutis* or the *nadis* begin from the heart, when you hear these intervals or *svaars* they naturally vibrate the *nadis* and please the heart. They actually give *rasa* within the heart. There is eternal nectar within every *svara*. Every note that is tuned according to the *srutis* has a specific *rasa* and these are illustrated in the table in the Appendix.

In other words, every interval of two notes perfectly in tune has a specific spiritual potency or *rasa*. The different *ragas* are calculated according to how they express certain combinations of

rasas. Therefore the *ragas* themselves are considered male and most of them are pentatonic. They only have five notes because there is no conflict in them. The *raginis* are thirty in number, six to each *raga*, and they have seven notes in their scales because they contain dissonant notes like the 2nd and 7th (*ri* and *ni*).

So the whole Vedic music system is calculated according to the universal laws of sound, which begin with the *rasa* dance in Goloka Vrndavan. Therefore if we play our music and sing according to these Vedic laws of sound we will please Krsna more than if we fail to follow these laws of sound. At this junction we run into a real problem because all of our Western instruments are tuned in a completely wrong way according to the Vedic instructions.

The Western tuning system is called "equal temperament". Equal temperament is a compromise based on a mathematical compromise. Each interval is the twelfth root of 2 times the previous note. The advantage of it is that each of the twelve keys is equally impure so you don't notice the difference when modulating from one key to another. The problem is though, you just can't get the purity of sound of the *sanananas*, and so you can't get the *rasa*.

I believe this is a cause that the Western musicians play so loud because they're trying to get the nectar. An interesting thing happens at high volume levels. Because of the physics of sound, these intervals actually tend to go into tune at higher volume levels and feedback etc. It's an interesting phenomenon that even on a grand piano, if you play a 5th, the pitches of notes bend a little bit to be more in tune.

These cosmic laws of sound are so strong that even if you try to violate them, still you can't get away from these laws of sound. They are very subtle, especially to our degraded senses in Kali-yuga, but they're there. It's also said that the Vedic mantras have to be chanted properly according to the *svaras* or they don't give the desired effect. So that's a very, very compelling reason for us to learn something about the *svaras* because after all, our business is supposed to be chanting Vedic *mantras*, and in this way approaching Krsna and rendering devotional service.

Conclusion

The tuning of an instrument may seem to be an obscure point to belabor with many pages of dense prose. But we are convinced that the extremely precise tuning of the Vedic *svaras*, accurate to more than one part in 10,000, has many documentable and objective effects that can be verified by any interested and intelligent party. Some of these effects, observed in our own laboratory, seem to bring the so-called myths of *brahmanas* lighting fires and making carpets fly just by singing *mantras* much closer to reality.

If music hath no power to charm, why do thousands of large stores in the West use background sound—music mixed with subliminal suggestions against shoplifting and employee pilferage—as a standard procedure? The very same principles applied to the problem of spiritual advancement can cause profound changes in consciousness, as we have experienced in the Hare Krsna movement. The ocean of potential benefits of Vedic sound vibration remains unexplored until some farsighted patron sponsors proper laboratory research into its effects.

Meanwhile, it is enough to begin a program of education in the Vedic musical science, so that if necessary, the musical tradition may endure long enough to be properly studied, at a later date, by our more enlightened successors.

Appendix 1 -- Scientific Verification

Previous to being involved with the Krsna consciousness movement, the author was a professional writer, musician and composer. However, my fortuitous adolescent studies of *yoga* philosophy fructified into a desire to know the karmic effects of my musical activities. Was I generating good or bad karmic results in the future? To know this I had to understand the objective effects of music upon the listener, especially the modern classical and jazz-fusion music I was involved with.

To explore these and other questions, the author performed a series of experiments to determine the effects of sound and music. The experiments were conducted 1968 to 1970 in a large barn in the mountains of New Mexico; in other words, in an environment of natural silence. Various styles of music were tested in controlled physiological and psychological experiments with plants, animals and people. The results of these experiments are very germane to the present discussion of intonation.

For working with plants, the experimental area was divided into eight terrariums, each with its own separate light source, water, soil beds, etc. Conditions of lighting, humidity, soil nutrients, etc. in each terrarium were made as uniform as possible. A control run was done to assure environmental parity among the terrariums. The terrariums were then fitted with identical stereo speaker systems and different kinds of music were played to the seedlings growing therein.

Other experimental facilities included a stable area in the same barn large enough to house 10 experimental animals (goats, sheep or dogs) and a standard double blind room with one-way observing mirror constructed in adjoining bedrooms in a nearby house. All these were wired for sound and similar experiments were performed.

Plants were tested for sprouting time, sprouting percentage, growth rate in size and weight, nutrient and water consumption, time to blossoming, quality of taste and overall vigor. Animals were tested for growth rate, appetite, milk production and quality, temperament and overall health and vigor. People were tested for intelligence, self-image and other personality traits such as self-liking and self-respect.

Of all the types of music and sounds tested, from Gregorian chants to New York traffic noise to psychedelic rock, Vedic styles of music had by far the best effects. Of Western styles, the only ones that showed any positive effects at all were Gregorian Chant and Madrigals. Vedic *ragas* and especially devotional music were tested and repeatedly outperformed all other types of music and sound, including natural sounds like waterfalls, wind and surf.

Another series of experiments analyzed the Vedic music into its components—melody, harmony and rhythm—to discover the active ingredient responsible for these effects. The final conclusion was that the extremely precise intonation of the Vedic *svaras* was responsible for the bulk of the effects observed in both sets of trials. The scientific reasoning behind this tuning, passed down in the Vedic tradition for thousands of years from one expert musician to another, is the subject of this report.

Appendix 2 – Expressions of the 22 *Srutis* as *Svaras* in the 36 *Ragas* of the *Asta-kaliya-lila* Daily Cycle

Svara	Lila	Raga	Description
N+	Nisanta	Lalita	Brilliant, gay, coming sunrise, tender, unstable, undecided, expecting
N+	Prata	Bhairava	Intense, self-assertive, gay, active
N+	Prata	Ramakali	(Sparing use means no selfishness)
N+	Madhyama	Alhaiya	Selfish pleasure, demand
N+	Madhyama	Gauda	Brightness, strength, sensuousness
N+	Aparahna	Shri	Sharp, ambitious, tense, desire
N+	Aparahna	Multani	Selfish, pleasure-loving, forcible, active
N+	Sayam	Pilu	Bright, joyful
N+	Sayam	Puravi	Acute, obstinate
N+	Pradosha	Yamuna	Active, forceful
N+	Pradosha	Khammaja	Acute, sensuous
N+	Pradosha	Bahar	Stubborn, sensuous
N+	Pradosha	Bihaga	Acute, sensuous, desire
N+	Pradosha	Paraj	Acute, sensuous
N	Nisanta	Bangala	(Absence indicates dreaminess)
N	Prata	Bhairava	Soft, loving
N	Madhyama	Bilaval	Soft, voluptuous
N	Madhyama	Gauda	Doubt, aspiration, softness
N	Sayam	Pilu	Soft, aspiration
N	Sayam	Marava	Soft, doubtful, pleasure-loving
N	Pradosha	Kamoda	Soft, pleasure loving
N	Pradosha	Kedara	Soft, expectation
N	Pradosha	Bhupali	(Absence shows detachment from physical pleasure)
N	Pradosha	Chhayanata	Soft, pleasure-loving
N	Pradosha	Jayajayanti	Soft, pleasure-loving
N	Pradosha	Bihaga	Tender, unsatisfied
N	Pradosha	Kalingada	Soft, pleasure-loving
N-	Pradosha	Jayajayanti	Anguish, laziness
N--	Pradosha	Bahar	Uncertain, doubtful
n+	Prata	Yavanapuri	Selfish, erotic desire
n+	Madhyama	Saranga	Desire, love
n+	Aparahna	Bhimapala	Complete abandon
n+	Sayam	Pilu	Desire, appeal
n+	Pradosha	Khammaja	Passionate, desire
n+	Pradosha	Kanada	Anxiety, desire
n+	Pradosha	Bageshri	Anxiety, desire
n+	Pradosha	Bahar	Intense, desire, love
n+	Pradosha	Kafi	Desire, passion, pleasure
n+	Pradosha	Malakosha	Desire, love
n	Prata	Yavanapuri	Appeal, love, beauty
n	Prata	Asavari	Ambition, desire
n	Purvahna	Shat	Anxious, appealing
n	Purvahna	Bhairavi	Tender, interrogative
n	Madhyama	Alhaiya	Tender, loving, charming

Svara	Lila	Raga	Description
n	Madhyama	Saranga	Tenderness, beauty
n	Aparahna	Bhimapala	Desire, demand, ambition
n	Sayam	Pilu	Beautiful, charming
n	Pradosha	Chhayanata	Beautiful, tender, supplication
n	Pradosha	Kanada	Beautiful, pure, noble
n	Pradosha	Jayajayanti	Beautiful, loving
n-	Prata	Asavari	Helpless, sad, crying
n-	Purvahna	Bhairavi	Helpless, subdued
n-	Pradosha	Bahar	Tender, beautiful
D+	Nisanta	Vibhasa	Joyful, loving
D+	Madhyama	Alhaiya	Brilliant, playful, restless
D+	Madhyama	Gauda	Brightness, confidence, prayer that will be fulfilled
D+	Aparahna	Bhimapala	Tender appeal, hope, peace
D+	Sayam	Marava	Active, energetic
D+	Pradosha	Yamuna	Bright, confident
D+	Pradosha	Kamoda	Restless, playful
D+	Pradosha	Kedara	Contented, confident
D+	Pradosha	Bhupali	Satisfied, playful, charming
D+	Pradosha	Khammaja	Restless, playful
D+	Pradosha	Bageshri	Restless, playful
D+	Pradosha	Bahar	Joyful, contented
D+	Pradosha	Kafi	Restless, playful
D+	Pradosha	Bihaga	Restless, playful
D	Madhyama	Bilaval	Soft, calm, tender
D	Madhyama	Gauda	Aspiration, prayer
D	Sayam	Pilu	Modest, prayer
D	Sayam	Puravi	Modest, prayer, aspiration
D	Pradosha	Chhayanata	Modest, soft, aspiration
D	Pradosha	Jayajayanti	Prayer, soft, aspiration
d+	Prata	Gunakali	Loving, tender
d+	Sayam	Pilu	Loving, enterprising
d+	Pradosha	Kanada	Loving, enterprising, with passion (shake)
d+	Pradosha	Malakosha	Loving
d	Nisanta	Bangala	Tender, melancholy, soft
d	Prata	Bhairava	Plaintive, doleful, interrogative
d	Prata	Ramakali	Tender, interrogative
d	Prata	Gunakali	Anxious, melancholy
d	Prata	Yavanapuri	Mild, appealing, mature, melancholy
d	Prata	Asavari	Very tender and loving
d	Purvahna	Shat	Tender, melancholy
d	Purvahna	Bhairavi	Tender, pleading
d	Aparahna	Shri	Tender, pleasing
d	Aparahna	Multani	Tender, loving, asking but contented
d	Sayam	Pilu	Tender, melancholy
d	Pradosha	Paraj	Tender, appeal
d	Pradosha	Kalingada	Tender, appeal
d-	Prata	Gunakali	Sad
d-	Prata	Asavari	Sorrowful
d-	Purvahna	Bhupala	Great sadness
d-	Aparahna	Shri	Sad
P	Nisanta	Vibhasa	(Absence means no sun)
P	Sayam	Marava	(Absence means something essential missing)

Svara	Lila	Raga	Description
P	Nisanta	Bangala	Awake, brilliant
P	Prata	Bhairava	Power, balance, strength
P	Prata	Ramakali	Active, awake
P	Prata	Gunakali	Activity
P	Prata	Yavanapuri	Clear, awake
P	Prata	Asavari	Suspense in the sadness, warmth, activity
P	Purvahna	Shat	Active
P	Purvahna	Bhairavi	Active
P	Purvahna	Bhupala	Contentment, sympathy in pain, strength to bear
P	Madhyama	Bilaval	Active, brilliant
P	Madhyama	Alhaiya	Active, pleasing
P	Madhyama	Saranga	Active, joyful
P	Madhyama	Gauda	Activity, fulness, bloom
P	Aparahna	Shri	Active
P	Aparahna	Bhimapala	Inquisitive but commanding
P	Aparahna	Multani	Active, calm, confident
P	Sayam	Pilu	Gay, joyful
P	Sayam	Puravi	Active, joyful
P	Pradosha	Yamuna	Joyful, brilliant
P	Pradosha	Kamoda	Joyful, active
P	Pradosha	Kedara	Joyful, active
P	Pradosha	Bhupali	Plentitude, life, perfection, fulness
P	Pradosha	Chhayanata	Joyful, active
P	Pradosha	Khammaja	Joyful, active
P	Pradosha	Kanada	Joy, activity
P	Pradosha	Bageshri	Joyful, active (rarely used)
P	Pradosha	Jayajayanti	Joyful, active
P	Pradosha	Bahar	Brilliant, active, confident
P	Pradosha	Kafi	Joyful, active
P	Pradosha	Bihaga	Activity, contentment
P	Pradosha	Paraj	Joyful, active
P	Pradosha	Kalingada	Joyful, active
M+	Madhyama	Alhaiya	Intense
M+	Aparahna	Shri	Intense, acute, interrogatory
M+	Aparahna	Multani	Adoration
M+	Sayam	Puravi	Intense, active
M+	Pradosha	Paraj	Intense, acute
M	Nisanta	Lalita	Acute, promising, penetrating
M	Nisanta	Vibhasa	Unstable, mysterious, critical time
M	Purvahna	Bhairavi	Intensity, tension
M	Madhyama	Gauda	Intensity, sincerity, impulse
M	Sayam	Pilu	Intense, active
M	Sayam	Marava	Intense, mysterious
M	Pradosha	Yamuna	Penetrating, active
M	Pradosha	Kamoda	Intense, mysterious
M	Pradosha	Kedara	Intense, mysterious
M	Pradosha	Bihaga	Intense, mysterious, desire, midnight
M-	Nisanta	Lalita	Perturbed, sad, anxious; enhances beauty
M-	Madhyama	Gauda	Perturbed, anxious, uncertain
M-	Sayam	Pilu	Sad
M-	Pradosha	Bihaga	Melancholy
m+	Aparahna	Bhimapala	Tender and active
m	Purvahna	Bhupala	(Absence means dejection, unsatisfied, unreal)

Svara	Lila	Raga	Description
m	Pradosha	Bhupali	(Absence means non-attachment)
m	Nisanta	Lalita	Peace, night, beauty
m	Nisanta	Bangala	Peace, satisfaction
m	Prata	Bhairava	Peace
m	Prata	Ramakali	Peace, contentment
m	Prata	Gunakali	Peace, contentment
m	Prata	Yavanapuri	Soft, peaceful
m	Prata	Asavari	Peace, contentment
m	Purvahna	Shat	Contented, interrogative
m	Purvahna	Bhairavi	Contented, interrogative
m	Madhyama	Bilaval	Joyful, carefree (absence in ascent takes away sadness)
m	Madhyama	Alhaiya	Peaceful, contented
m	Madhyama	Saranga	Peaceful, contented, tender
m	Madhyama	Gauda	Passive satisfaction, dependence
m	Aparahna	Bhimapala	Aspiration, ambition, intensity
m	Sayam	Pilu	Peace, calm
m	Sayam	Puravi	Peace, moonlight
m	Pradosha	Kamoda	Night, calm, loving
m	Pradosha	Kedara	Peace, moonlight
m	Pradosha	Chhayanata	Peace, loving
m	Pradosha	Khammaja	Peace, moonlight
m	Pradosha	Kanada	Peace, calm
m	Pradosha	Bageshri	Peace, calm
m	Pradosha	Jayajayanti	Peace, moonlight
m	Pradosha	Bahar	Peaceful, calm, pleasing
m	Pradosha	Kafi	Peace, calm
m	Pradosha	Malakosha	Peace
m	Pradosha	Bihaga	Moonlight
m	Pradosha	Paraj	Peace, moonlight
m	Pradosha	Kalingada	Peace, night
m-	Madhyama	Bilaval	Doubt, attachment (missing in ascent takes away sadness)
m-	Madhyama	Gauda	Aspiration, prayer, doubt, tender
G+	Nisanta	Lalita	Awake, penetrating
G+	Nisanta	Bangala	Will, independance
G+	Nisanta	Vibhasa	Lovely, lively
G+	Prata	Ramakali	Active
G+	Madhyama	Bilaval	Contented, calm, pleasing
G+	Madhyama	Gauda	Contentment, joy
G+	Aparahna	Shri	Contented, lively, awake
G+	Sayam	Pilu	Lively, independent
G+	Sayam	Marava	Active, energetic
G+	Pradosha	Yamuna	Contented, happy
G+	Pradosha	Bhupali	Confidence, self-reliance, tender night
G+	Pradosha	Khammaja	Awake, lively
G+	Pradosha	Paraj	Awake, lively
G+	Pradosha	Kalingada	Clear, sharp, satisfied, acute
G	Nisanta	Bangala	(Absence creates dreaminess)
G	Prata	Bhairava	Confident, calm, joyful
G	Madhyama	Bilaval	Contented
G	Madhyama	Alhaiya	Contented
G	Madhyama	Gauda	Aspiration, prayer, calm, peace
G	Sayam	Pilu	Calm, confident
G	Sayam	Puravi	Calm, strength

Svara	Lila	Raga	Description
G	Pradosha	Kamoda	Calm, pleasing
G	Pradosha	Kedara	Calm, joyful
G	Pradosha	Chhayanata	Calm, pleasing
G	Pradosha	Jayajayanti	Calm, pleasing
G	Pradosha	Bihaga	Calm, pleasing, contented
g	Aparahna	Multani	Passionate
g	Sayam	Pilu	Sensuous, passionate
g	Pradosha	Kanada	Sensuous, satisfied, happy but with passion (shake)
g	Pradosha	Malakosha	Passionate, request
g-	Prata	Yavanapuri	Very mild, appealing, interrogative, desire, questioning
g-	Prata	Asavari	Tender and loving
g-	Purvahna	Shat	Tender and loving
g-	Purvahna	Bhairavi	Tender and loving
g-	Aparahna	Bhimapala	Tender, peaceful
g-	Pradosha	Bageshri	Tender, loving
g-	Pradosha	Jayajayanti	Tender, loving
g-	Pradosha	Bahar	Tender, loving
g-	Pradosha	Kafi	Tender, lovely, affectionate, dependent
g--	Prata	Asavari	Melancholy
g--	Purvahna	Bhupala	Crying, melancholy, sadness
R	Prata	Yavanapuri	Self-assertive, forcible, manly, commanding, stubborn, contented
R	Purvahna	Bhairavi	Pleasure, impudent, active, self-assertive, forcible
R	Madhyama	Bilaval	Self-assertive, forceful, brilliant
R	Madhyama	Alhaiya	Self-confident, pleasing, active
R	Madhyama	Saranga	Forceful, active, joyful
R	Aparahna	Bhimapala	Resignation, tender, loving, asking
R	Sayam	Pilu	Self-assertion, vitality
R	Pradosha	Yamuna	Confident, gay
R	Pradosha	Kamoda	Confident, joyful
R	Pradosha	Kedara	Confident, active
R	Pradosha	Bhupali	Awake, pleasing, satisfied
R	Pradosha	Chhayanata	Confident, joyful
R	Pradosha	Khammaja	Confident, joyful
R	Pradosha	Kanada	Strong, clear, definite
R	Pradosha	Bageshri	Confident, powerful
R	Pradosha	Jayajayanti	Confident, joyful
R	Pradosha	Bahar	Confident, joyful, straightforward
R	Pradosha	Kafi	Self-assurance
R	Pradosha	Bihaga	Confident, strong
R-	Madhyama	Gauda	Anxiety, weakness
r+	Sayam	Pilu	Enterprising
r	Nisanta	Bangala	Devoted, loving, confident
r	Prata	Bhairava	Calm, not sad, confident
r	Prata	Gunakali	Confident
r	Prata	Asavari	Feminine, wisdom, soberness
r	Aparahna	Multani	Tender and loving (sparing use means veiled melancholy)
r	Sayam	Pilu	Loving, calm
r	Pradosha	Paraj	Loving, confident
r-	Nisanta	Lalita	Tender, indistinct, sleeping
r-	Nisanta	Vibhasa	Subtlety
r-	Prata	Bhairava	Tenderness, supplication
r-	Prata	Ramakali	Tenderness, supplication

Svara	Lila	Raga	Description
r-	Prata	Gunakali	Tender, loving
r-	Prata	Asavari	Very tender and loving
r-	Purvahna	Shat	Melancholy and soft
r-	Purvahna	Bhairavi	Tender, peaceful
r-	Aparahna	Shri	Tender, melancholy, calm
r-	Sayam	Puravi	Very tender, prayer
r-	Sayam	Marava	Tender, reluctant
r-	Pradosha	Kalingada	Love, devotion
r--	Prata	Gunakali	Sad, dejected
r--	Prata	Yavanapuri	Intensely sad
r--	Purvahna	Shat	Very sad
r--	Purvahna	Bhupala	Very sad, despair
r--	Sayam	Pilu	Tender, melancholy
S	All	All	Calm, peace, confidence, energy, satisfaction

Endnotes

[1] A.C. Bhaktivedanta Swami Prabhupada, *Srimad-Bhagavatam* 3.12.47 and purport, Bhaktivedanta Book Trust, Los Angeles 1975.

[2] Vanacari, Dasanudas, *The Luna Experiments: Psychophysioloical Effects of Music*. Self-published manuscript, Atlanta, 1972.

[3] Srila Visvanatha Cakravarti Thakura, *Sri-Sri Gurvastaka*, 2. From *Vaisnava Songbook*, Bhaktivedanta Book Trust, Los Angeles 1975.

[4] Krsnadas Kaviraj Gosvami, *Govinda Lilamrta, Nisha Lila, Sargar* (Chapter) 22, oral translation from the original Bengali.

[5] Narahari Cakravarti, *Bhakti-ratnakara*, Fifth Wave, p. 230. Unpublished translation of Bengali Gaudiya Math edition.

[6] reference?

[7] A.C. Bhaktivedanta Swami Prabhupada, *Brahma-samhita* 5.56. Bhaktivedanta Book Trust, Los Angeles 1975.

[8] See Bhag. 3.12.47.

