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Harmonics and pitch organization of the traditional tanbûr

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Abstract. This article examines the principles underlying the pitch system of the traditional tanbûr, a string instrument widely used in Central Asia, particularly in Tajikistan and Uzbekistan. The study aims to identify the mechanisms governing the formation of the instrument's pitch organization. A comparative method is employed, juxtaposing the tones of the tanbûr scale with the harmonics

produced on its melody string, thereby revealing consistent patterns in pitch relationships and specific features of the instrument's tuning. For the first time, the pitch system of the traditional tanbûr is analyzed in relation to its acoustic characteristics and the historical and cultural context of maqâm performance practice. It is demonstrated that the instrument's pitch system has a heptatonic, non-equal-tempered diatonic structure, in which pitch deviations are regulated by stopping the melody string against tightly tied gut frets. Differences between the natural harmonic series and maqâm performance practice are examined, highlighting the flexibility of the instrument in adapting to various modal systems. The findings contribute to a clearer understanding of the principles governing the tanbûr's pitch system from both scientific and practical perspectives, clarify its acoustic nature, and provide a theoretical foundation for further research on traditional musical instruments of Central Asia. The results may be of interest to performers, instrument makers, and scholars in ethnomusicology and musical acoustics.

Keywords: tanbûr, pitch system, acoustics, harmonics, modal system, Shashmaqom, Central Asian musical instruments, ethnomusicology, traditional music

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Этномузыкология

Научная статья

**О гармонике и звукоряде
традиционного танбура**

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Аннотация. В статье детально рассматриваются основы построения звукоряда традиционного танбура, распространенного в странах Центральной Азии, преимущественно в Республиках Таджикистан и Узбекистан. Исследование направлено на выявление закономерностей формирования звуковысотной системы инструмента. В работе применен сравнительный метод сопоставления тонов шкалы танбура с гармониками, формирующимися на его мелодической струне, что позволило выявить точные закономерности высотных отношений и особенности настройки инструмента.

Впервые звукоряд традиционного танбура анализируется во взаимосвязи с его акустическими характеристиками и историко-культурными особенностями исполнения макомов. Установлено, что звукоряд инструмента имеет семиступенную диатоническую структуру, не являющуюся равномерно темперированной, а высотные отклонения звуков регулируются посредством прижатия мелодической струны к высоко навязанным изжилладкам. Описаны различия между натуральным звукорядом и практикой исполнения макомов, что позволяет выявить гибкость традиционного инструмента в адаптации к различным ладовым системам. Результаты исследования позволяют раскрыть логику построения звукоряда танбура с научно-практической точки зрения, уточняют его акустическую природу и дают теоретическую основу для дальнейшего изучения традиционных музыкальных инструментов Центральной Азии. Представленные выводы могут быть полезны как музыкантам и инструменталистам, так и исследователям этномузыкологии и акустики музыкальных инструментов.

Ключевые слова: танбур, звукоряд, акустика, гармоника, ладовая система, Шашмаком, музыкальные инструменты Центральной Азии, этномузыкология, традиционная музыка

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Introduction

The tanbûr is an ancient plucked string chordophone widely distributed across Central Asia and particularly significant in the musical traditions of Tajikistan and Uzbekistan. Like other traditional instruments of the East, it embodies a distinctive pitch organization shaped by stable acoustic principles and centuries of performance practice. One of the central research questions concerns the identification of the mechanisms governing the formation of the instrument's pitch system and its relationship to natural acoustic principles of pitch organization.

The acoustic systems of musical instruments have traditionally been studied within disciplines concerned with the physical nature of sound. This field has been developed in the works of prominent scholars,¹ who have addressed a wide range of issues, including the acoustic foundations of musical performance, the influence of overtones on tuning and timbre, and the physical principles underlying the production of harmonics.

The present study focuses on the relationship between the structure of the instrument's pitch system and the characteristics of its harmonic components. In our previous work, we analyzed the types of tanbûr tuning used in the performance practice of Shashmaqom [1], the order of construction of registers and initial octave modes of this instrument [2], the tuning of the tanbûr scale length, an auditory method used by musicians in performing practice [3], and the connection between the construction canons of the Shashmaqom composition and the pitch system of the tanbûr [4].

The pitch system of the traditional tanbûr can be examined in relation to two principal factors. The first concerns the formation of the natural scale, namely the overtones generated by the sounding of the open melody string and the three

¹ Fletcher, N. H., & Rossing, T. D. (1998). *The physics of musical instruments*. Springer; Helmholtz, H. von. (1954). *On the sensations of tone as a physiological basis for the theory of music*. Dover Publications; Benade, A. H. (1979). *Fundamentals of musical acoustics*. Birkhäuser; Meyer, J. (1972). *Acoustics and musical practice*. Verlag Das Musikinstrument; Bach, M. (1991). *Fingerboards & overtones: Images, foundations and designs of a new approach to cello playing*. Spangenberg.

drone (resonating) strings. The tied frets made of thick gut on the instrument's neck create an unequal diatonic system and allow for pitch variation within a semitone. The drone strings serve to produce pedal tones, emphasizing their importance in shaping the overall sonic color [5, pp. 770–771]. The second factor relates to the characteristics of the repertoire performed on the tanbûr (for example, *Shashmaqom*²), which involves various modal systems and often requires retuning of the instrument. Neglecting these parameters complicates an adequate understanding of traditional tanbûr's pitch system.

Studies devoted to tanbûr performance [8],³ (in English, among others [9; 10]) systematize practical knowledge of the instrument's tuning and usage. These works primarily focus on tuning types, string adjustment, features of the diatonic system, and other structural aspects. However, they remain largely descriptive and tend to reproduce established viewpoints. The acoustic specificity of the tanbûr—its spectral characteristics, resonance–harmonic properties, and timbral features—has not yet been subjected to systematic and comprehensive analysis. Addressing these aspects within the framework of pitch organization underscores the need for further in-depth research and defines the scientific novelty of the present study.

Harmonic Basis of the Tanbûr's Pitch System

The problem of tanbûr tuning systems and their terminology has been addressed in a number of scholarly studies, including some of the earliest publications on the subject [11, p. 13; 12, p. 192; 13, p. 35]. At the same time, this issue was examined in greater detail in our previous work [1], where, alongside the primary

² *Shashmaqom* is the name of an integrated cycle widespread in the musical cultures of Tajikistan and Uzbekistan. *Shashmaqom* consists of six maqâms: *Rost*, *Navo*, *Buzurg*, *Dugoh*, *Segoh*, and *Iroq*. For information on the tuning of the tanbûr in relation to the performance of *Shashmaqom*, see [6; 7].

³ See also Abdukarimov, M. (1997). *Tanbur, sato i setor v muzykal'noi traditsii Uzbekistana i Tadzhikistana* [Tanbur, sato and setor in the musical tradition of Uzbekistan and Tajikistan] (Abstract of Candidate of Sciences dissertation). Tashkent. (In Russ.); Zufarov, A. M. (2025). *Evolyutsiya razvitiya sistemy ladov v makome "Navo"* [The evolution of the modal system in the maqâm "Navo"] (Abstract of Doctor of Philosophy (PhD) dissertation in Art Studies). Tashkent. (In Russ.).

quartal tuning *Buzurg*, artificially constructed systems—such as the quintal tuning *Rost* and the second-based tuning *Navo*—were analyzed. The study demonstrates that the use of these tunings is determined not only by the technical demands of performance practice but also by transformations in the instrument's pitch organization within an alternative intonational–modal paradigm. Their emergence is thus interpreted as a natural stage in the evolution of performance practice, aimed at expanding the acoustic and expressive potential of the tanbûr beyond its inherent system. This process is of particular significance in the context of the development of the Shashmaqom performance tradition, which presupposes variability in tuning systems and their correspondence to different modal–intonational models.

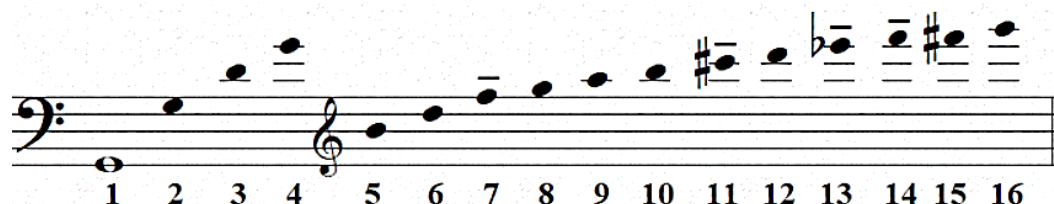
Traditional performers intuitively recognize the importance of the harmonic basis in organizing the tanbûr's pitch system. The tuning process is based on the interaction of two parameters — acoustic and performative.⁴

The natural scale consists of a fundamental tone and its harmonic overtones, each element forming part of a unified harmonic spectrum. The tanbûr, with its open melody and drone strings, derives its distinctive timbre from the interaction between the fundamental tone and the complex array of harmonics produced by string vibration. These overtones enrich the sound, impart brightness, and determine the individuality of timbre even when identical pitches are performed on different instruments. The overtone spectrum of the tanbûr depends on factors such as body construction, materials, and string length and tension, all of which contribute to its characteristic sound.

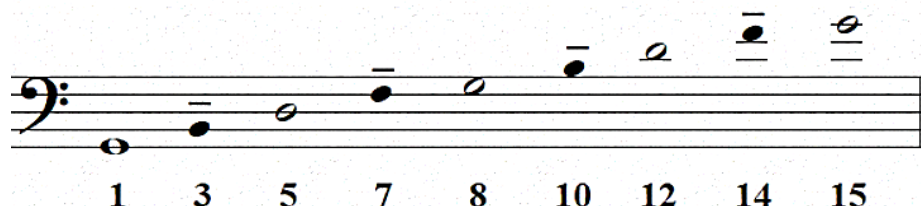
The fundamental tone of the tanbûr's melody string corresponds to the pitch G, generating a natural harmonic series (see *Example 1*).

Some of the overtones generated by the vibration of the tanbûr strings play a particularly significant role; this selectivity is essential in shaping the distinctive structure of the instrument's pitch system. Among these are the pitches G, D, B (natural), and F (see *Example 2*), which are perceived most clearly by the human ear. These tones function as reference points for musicians in the tuning process.

⁴ For the specifics of performance on the Iranian tanbûr see [14], on the Ottoman tanbûr see [10].



Example 1. Natural harmonic series produced by the vibration of the tanbûr's melody string

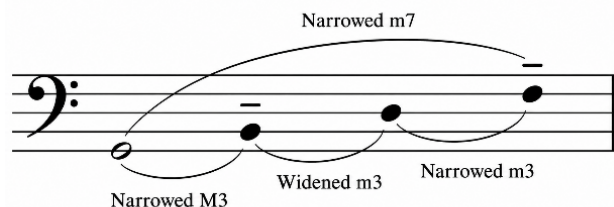


Example 2. Harmonics forming the pitches G, g, g¹; d, d¹; H, h и f, f¹ in the tanbûr scale

In traditional musical practice, the concept of *tabii parda* (*tabû parda*, translated from Tajik as “natural degrees” or “natural tones”) is used to denote the natural steps of the scale. This term refers to frets that appear visually to be evenly spaced along the neck of the tanbûr. In reality, however, they constitute a specific pitch system that does not fully coincide with the natural harmonic series, as it incorporates only a selected set of natural intervals. The selection of these degrees is determined not only by aesthetic and performative considerations but also by the acoustic properties of the overtone series: certain harmonics serve as the basis for the formation of the modal system, defining its characteristic intervallic relationships. Thus, the *tabii parda* system reflects a traditional perception of pitch and ensures the distinctive expressiveness of the tanbûr, while also maintaining practical convenience for tuning and performance by ear.

Some tones of the tanbûr scale correspond to specific degrees of the natural harmonic series, the 7th and the 14th, for example. The analysis of harmonics and intervals within it therefore demonstrates that, despite certain deviations from the complete natural series, the instrument preserves the fundamental principles of harmonic organization. This accounts for the recognizable timbre richness characteristic of the traditional sound of the tanbûr.

As illustrated in *Example 2*, the pitches B and F are slightly lowered relative to G and D. Within this framework, the tones G, D, and the lowered pitches B and F form a harmonic complex spanning the range of a minor seventh. This configuration produces thirds of varying qualities: a slightly narrowed major third (M3), a widened minor third (m3), and a narrowed minor third (m3). The outer tones form a minor seventh (m7), which is likewise slightly narrowed (see *Example 3*).



Example 3. Relationship between overtones
with widened and narrowed intervals

In musical practice, intermediate tones located between the principal intervals were traditionally determined by ear, primarily through the adjustment of frets along the instrument's neck. In this way, they assumed their pitch positions relative to already established harmonic tones. When compared with the equal-tempered system, some of these tones appear either lowered or raised, resulting in the formation of variety of narrowed and widened intervals.

According to the acoustic principles underlying the tanbûr's pitch system, only the octave, the fifth, and the fourth remain acoustically pure intervals, whereas the second, third, sixth, and seventh are realized as either narrowed or widened. This distribution is determined by the specific nature of the instrument's harmonic organization, reflecting the natural laws of string vibration and the corresponding acoustic proportions.

Within this framework, among the seven harmonics occurring within the octave, only G and D, in various combinations, form pure intervals—namely the octave,

the fourth, and the fifth. The remaining tones, including those determined by ear (A, B, E, and F), are tuned slightly lower, whereas the pitch C is, by contrast, slightly raised. As a result, a system of narrowed and widened intervals emerges, a distinctive “natural” pitch organization with unequal temperament.

As an illustration, consider an experimental tanbûr prepared by the author, in which the frets were tuned in accordance with the harmonics of the open melody string, along with additional frets installed on the neck to produce intermediate tones between them. This configuration represents a tanbûr pitch system based on natural intonation within a traditionally unequal temperament (see *Illustration 1*).

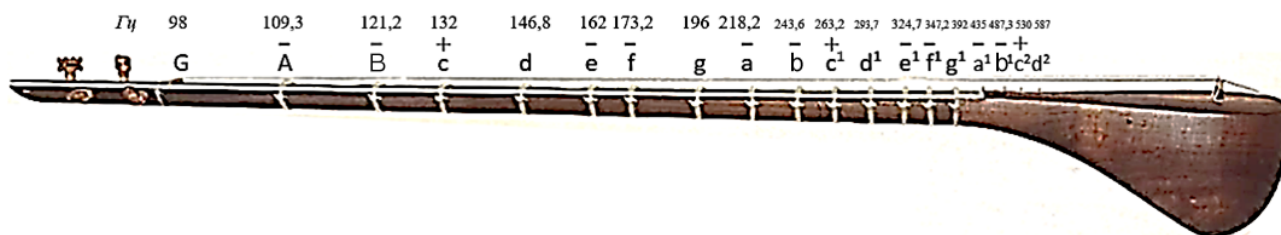


Illustration 1. Pitch system of the tanbûr⁵

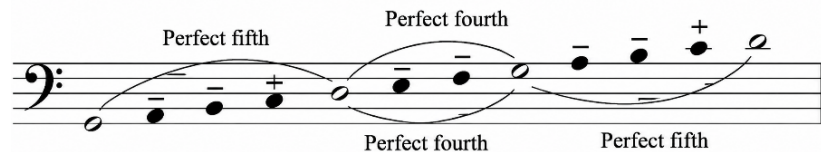
To document the pitch parameters of the scale in the given example, the values of the tones are simultaneously indicated in hertz, allowing for a clear assessment of the degree to which they are lowered or raised relative to the equal-tempered system (*Table 1* — compiled by the author).

Table 1. Comparison of lowered and raised tones of the natural unequal pitch system produced on the tanbûr with the tones of the equal-tempered system

Natural scale produced on tanbûr																		
	G	A	B	c	d	e	f	g	a	b	c¹	d¹	e¹	f¹	g¹	a¹	b¹	c²
Hz	98	109,3	121,2	132	146,8	162	173,2	196	218,2	243,6	263,2	293,7	324,7	347,2	392	435	487,3	530
Fret	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Equally tempered scale																		
	G	A	B	c	d	e	f	g	a	b	c¹	d¹	e¹	f¹	g¹	a¹	b¹	c²
Hz	98	110	123,47	130,81	146,83	164,81	174,61	196	220	246,94	261,63	293,67	329,63	349,23	392	440	493,88	523,25
Difference	0	-0,7	-2,27	+1,10	-0,03	-2,81	-1,41	0	-1,8	-3,34	+2,43	+0,07	-4,93	-2,03	0	-5	-6,59	+6,75

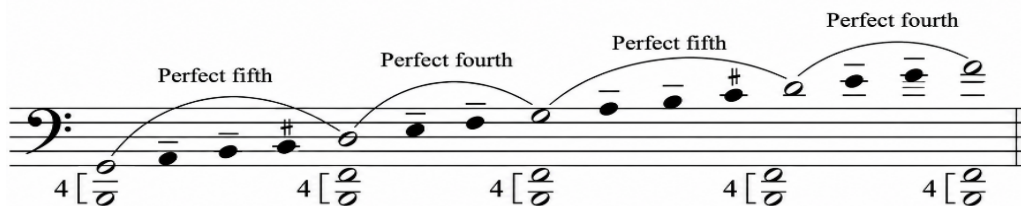
⁵ Illustration compiled by the author.

Pure intervals within a single octave may be formed on the basis of either the fifth–fourth or the fourth–fifth relationship (see *Example 4*).



Example 4. Fifth–fourth and fourth–fifth intervallic relationships in the natural intonation of the tanbûr pitch system

The harmonic organization of the instrument is structured around the relationship between two scale degrees—G and D—and the drone strings. In essence, this system may be described as quartal: the drone strings establish a stable vertical framework based on fourths, while the pitches G and D interact with this framework horizontally across different registers, forming fourth–fifth relationships. In traditional performance practice, this tuning is referred to as *Buzurg* (lit. “great” or “large”). The term denotes the quartal tuning of both the melody and drone strings of the tanbûr (see *Example 5*, compiled by the author).



Example 5. Tanbûr pitch system with natural intonation in quartal tuning, in combination with pure fourth and fifth intervals

Thus, the harmonic structure of the instrument, its system of natural intervals, and the specific characteristics of intermediate tones collectively shape the distinctive sonic character of the tanbûr, ensuring both intonational accuracy and expressive richness in performance practice.

The Pitch System of the Traditional Tanbûr

The melody string of the tanbûr represents the horizontal dimension of the instrument's scale—namely, its pitch organization and limited range. Accordingly, the tuning system of the tanbûr is determined by stepwise movement along the frets in both ascending and descending directions: the number of frets corresponds to the number of scale degrees. Thus, the frets on the neck of the traditional tanbûr—16 primary (*aslparda*) and 4 additional (*khas-parda*)—serve a dual function. On the one hand, they define the instrument's overall range of approximately two and a half to three octaves⁶; on the other hand, they reflect a specific pitch organization—that is, the scale itself [15, p. 27] (*Illustration 2*).

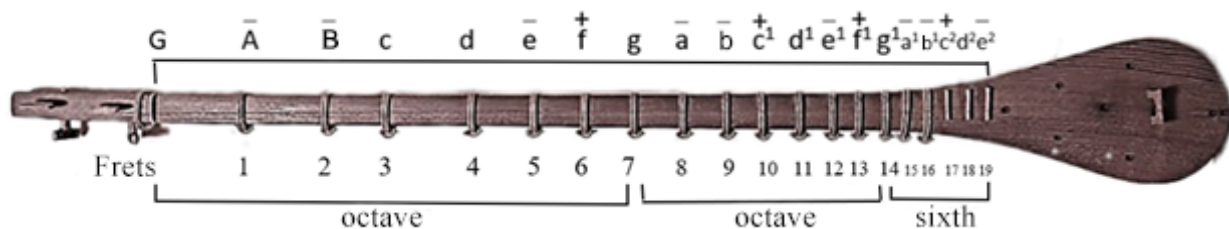


Illustration 2. Range and pitch system of the traditional tanbûr⁷

As can be observed, the frets on the neck of the traditional tanbûr are arranged relatively evenly with respect to one another, with the exception of the third fret. As they approach the body of the instrument, the distances between them gradually decrease. Consequently, it is difficult to determine visually to which tuning system this pitch structure belongs. However, in performance, it becomes evident that the octave comprises seven degrees forming a heptatonic diatonic scale, albeit not based on equal temperament. This structure underlies the distinctive melodic and harmonic expressiveness of the tanbûr.

It is important to emphasize that, alongside the pure intervals of the octave, fifth, and fourth—defined in relation to the reference tones D and G—other intervals

⁶ The lowest pitch is G of the lower octave, and the highest is F₂ of the second octave.

⁷ The authentic traditional tanbûr belonged to the renowned singer and performer of classical *Shashmaqom* music, the People's Artist of Tajikistan Shohnazar Sohibov (1903–1973). The maker of this instrument was Usto Toir (1883–1953) from Bukhara. Notably, for unknown reasons, the final additional fret (*khasparda*) is absent on this tanbûr.

also occur in narrowed or widened forms, including seconds, thirds, fourths, sixths, and sevenths. These arise through the interaction with lowered tones A, B, and E, as well as raised tones F and C. Thus, the diatonic scale of the traditional tanbûr manifests as a distinctive unequal-tempered system. This may be corroborated by examining several traditional tanbûrs associated with prominent masters of the maqâm tradition, including Risqi Rajabi (1887–1977), Rasulqori Mamadaliev (1928–1976), Boboqul Fayzulloev (1899–1964), and Fazliddin Shahobov (1911–1974) (*Illustration 3–6*).⁸

The figures above show that the frets on all variants of the traditional tanbûr are arranged in a broadly similar manner and that, consequently, their pitch systems are based on the same underlying principle. A comparison of these pitch systems with the natural scale suggests the existence of a systematic relationship between them. To verify this hypothesis, we turn to an experimental tanbûr prepared by the author, tuned in accordance with the acoustic



Illustration 3.
Risqi Rajabi



Illustration 4.
Rasulqori Mamadaliev

⁸ All photographic illustrations are taken from various sources, including the personal archives of the performers' relatives and close associates.



Illustration 5. Boboqul Fayzulloev



Illustration 6. Fazliddin Shahobov

properties of the instrument and the pitch organization of a traditional tanbûr associated with the People's Artist of Tajikistan and master Shashmaqom performer Shohnazar Sohibov (Illustration 7–8).

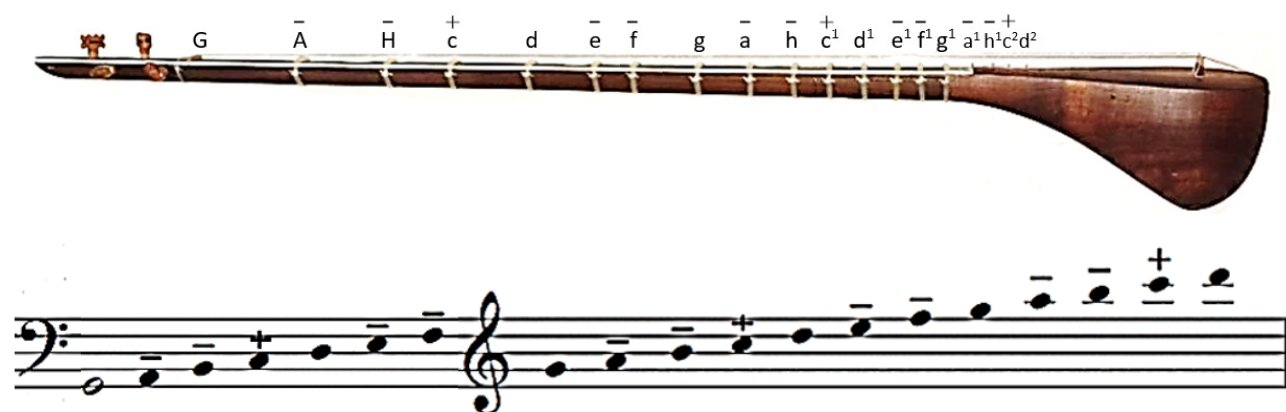


Illustration 7. Pitch system of the experimental tanbûr

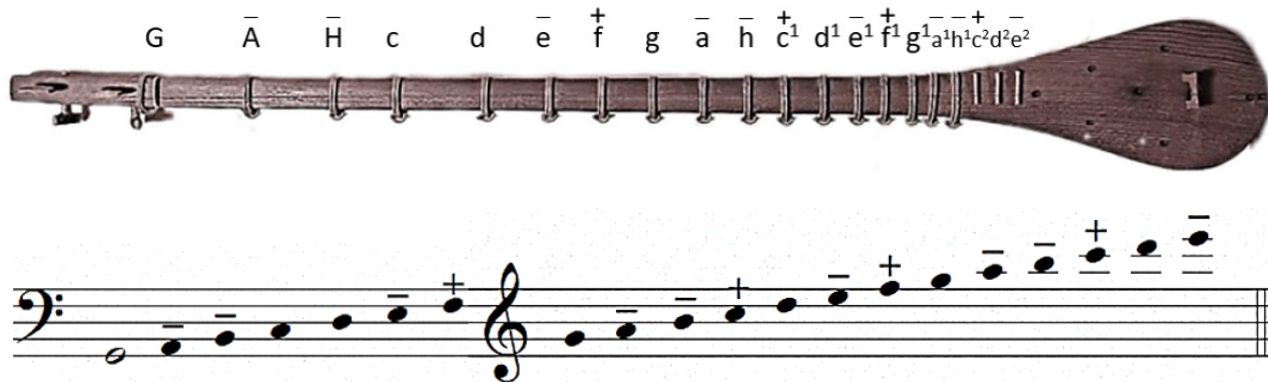


Illustration 8. Pitch system of the traditional tanbûr of Shohnazar Sohibov

A comparison of these pitch systems reveals differences only in the tones C and F of the lower octave, corresponding to the third and sixth frets of the tanbûr. In one case, these frets are positioned lower, whereas in the other they are set higher, resulting in differences in the pitch of the tones produced.

*Tones Produced on the Basis
of the Third and Sixth Frets of the Tanbûr*

The third fret on the neck of the traditional Sohibov tanbûr is, in comparison with the other frets, slightly displaced downward and adjusted to produce the pitch C of the lower octave. In principle, however, it would be expected to lie midway between the second and fourth frets, thereby yielding a naturally raised C of the lower octave (see *Figures 7–8*). In both types of pitch systems, in the higher registers of the tanbûr, the tenth and seventeenth frets are positioned higher and likewise produce slightly raised C in the first and second octaves.⁹

It may be assumed that the principal reason for the displacement of the third fret lies in the introduction of a new harmonic framework. In particular, the adoption of a quintal tuning appears to have necessitated shifting the third fret downward in order to establish C of the lower octave as a central tone of the instrument.

⁹ In one variant of the traditional tanbûr pitch system used by the Shashmaqom master Risqi Rajabi, the raised pitch C is found in all registers of the instrument, including the lower octave. Thus, in *maqâm* performance practice, there are also examples of tanbûrs whose pitch system is constructed as closely as possible to the natural harmonic series.

When the strings are retuned to a fifth, a transformation occurs in the system of principal scale degrees and their interrelationships. The tones C and G acquire the status of structural degrees, on the basis of which, in combination with the drone strings, vertical sonorities are formed. At the same time, the tone D remains the most prominent overtone of the instrument, owing to its resonance with the harmonic partials of the open melody string, and continues to function as a reference tone. Thus, within the quintal tuning system, the tone C assumes a role comparable in importance to that of the degrees forming vertical sonorities.

The sixth fret on the neck of the traditional tanbûr belongs to the category of movable frets, its position depending on the maqâm being performed. This fret may be shifted upward or downward by a semitone, or even by a smaller interval, thereby establishing pitches at specific levels. Its movement operates across three positions—lower, neutral, and upper. The lower position yields F or its lowered variant; the neutral position produces a raised F (i.e., F half-sharp); and the upper position yields a lowered form of F-sharp. In most traditional tanbûrs, including the instrument of Sohibov, the sixth fret is predominantly set in the neutral position, whereas in a natural pitch system it tends to occupy the lower position. The upper position is also actively employed in maqâm performance practice.

As a consequence of lowering or raising the third fret, the tone C of the lower octave, or its raised variant, forms, in relation to the fundamental tone G of the great octave (produced by the open melody string), intervals corresponding to a perfect fourth and an augmented fourth. The sixth movable fret, operating across its three positions (lowered F, raised F, and lowered F-sharp of the lower octave), forms, in combination with the fundamental tone, narrowed and widened variants of the minor seventh, as well as a narrowed major seventh.

Conclusion

The present study demonstrates that the pitch system of the traditional tanbûr is shaped by the combined influence of the instrument's acoustic properties—particularly its harmonic spectrum—and the musical practice of Shashmaqom. This interaction accounts for the internal logic of its pitch organization and the specific features of its sound production, confirming a close relationship between

the structure of the instrument its physical nature, and its musical function. On this basis, the following conclusions may be drawn:

- The harmonics generated by the open melody string of the tanbûr directly influence the organization of its pitch system;
- The pitch system of the traditional tanbûr, formed within the framework of the Shashmaqom classical repertoire, exhibits a natural correspondence with the instrument's acoustic properties;
- Performers and researchers of Shashmaqom should take into account the specific characteristics of this pitch organization in the traditional Bukhara tanbûr in both scholarly and pedagogical contexts.

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