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On the Structural Force of Spatial Movement in Electronic Music —— Taking the Sound Movement Design Practice of the Multidimensional Music Work Galaxy as an Example

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Abstract: As an important means of electronic music creation, the structural force potential of "spatial movement" in music has not been fully explored. Taking the work Galaxy as the research object, this paper analyzes its spatial movement design mechanism of "stage extension - immersive sound field shaping - high-speed traversal - mirror reversal", and discusses the theoretical and practical values of spatial movement as the core structural force.

Keywords: electronic music; spatial movement; structural force; Galaxy; panoramic sound field

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1. Introduction

The innovation of digital technology has propelled electronic music creation from "organization of notational symbols [1]" to "control of sound phenomena [2]", enabling acoustic elements such as timbre, dynamics [3], and space to break through the boundary of "decorative parameters" and gradually become the structural core. However, current research still focuses on spectral development and dynamic tension, while "space" mostly remains at low-level applications such as sound imaging and effector modification, with its potential as a systematic structural force not fully explored. Taking the panoramic multi-dimensional vocal work Galaxy as the analysis object, this paper discusses the theoretical and practical value of spatial movement as the core structural force in electronic music by analyzing the design mechanism of its sound spatial movement. The research will be carried out from three aspects: spatial movement breaking through linear structural thinking, leaping to a structural paradigm, and refining an immersive creative methodology, so as to open up a new dimension for the research on structural forces in electronic music.

2. The theoretical framework of structural force in electronic music

Establishing a structural approach that aligns with the characteristics of electronic music is one of the core propositions in contemporary electronic music composition. Different from traditional composition, the creative paradigm of electronic music essentially represents a profound transformation from "construction of note systems" to "control of sound systems". This difference is concentrated in five core dimensions: the concretization of sound materials[4], the multi-dimensionality of

time and space[5], the technologicalization of creative media, the synaesthesia of perceptual logic, and the co-construction of acoustic elements. Among them, "space" is not only an important acoustic element participating in co-construction but also a core dimension for shaping time and space. Although its application is extensive, it has not been fully exploited.

The application of "space" in current electronic music mostly remains at the technical operation level: firstly, as an acoustic element, it adjusts the left-right, near-far and other attributes of sound through panorama and effect processors; secondly, as a decorative means, it strengthens the sense of acoustic space; or constructs a static sound field or dynamic "special effects" in multichannel systems. As a dimension for shaping time and space, its functions are mainly manifested in: constructing a static multi-dimensional stereo field in a multichannel or ambisonic sound environment, or forming special effect-oriented dynamic auditory sensations by controlling the interaction and movement of sound in a three-dimensional space. However, such applications mostly stay at the parameterized and low-level technical operation level, and have not deeply participated in the overall organization and structural construction of music, let alone formed a systematic core structural force. Some composers have tried to break through this limitation. For example, Stockhausen incorporated the panorama position into the overall sequence in Gesang der Jünglinge, giving "space" the same structural weight as pitch and rhythm[6]; Ahn Seung-pil reconstructed sound particles with spatial vectors through surround sound positioning in Cellular Combinations, forming a topological structure[7].

Galaxy, the analytical object of this paper, also belongs to such explorations. It systematically structures music through the design of sound movement trajectories and the reconstruction of acoustic space, and combines images and performances to convey intentions. The analysis aims to reveal how "spatial movement" becomes the core structural force dominating the work's form.

3. Overview and technical support of Galaxy

3.1. Work overview

Galaxy is a hybrid electronic music work created for panoramic sound, multi-dimensional human voices, and visual images, constructed by a live chorus, panoramic immersive electronic music, three-dimensional visual images, and interactive performances. It premiered at the Ocean of Stars: A Special Concert on Music and Artificial Intelligence during the "EIGHTTH MELODY OF YANGTZE RIVER · World, Famous Music Institution Exchange Performance Season (2024)".

Taking "the universe" as an image, the work explores the deep connection between life and the universe, as well as humanity and technology, through spatial narration of sound and multi-sensory integration. This article focuses on the mechanism analysis of how the sound materials of the work form structural force through movement, only involving composition techniques and music production details related to the arguments when necessary.

3.2. Work structure and narrative context

Galaxy is divided into four movements: Looking Up, The Flow of Stars, Crossing, and Dedication. The performance of the performance art Starry Pursuit serves as a transition between the third and fourth movements, constructing a multi-dimensional artistic expression of "human nature and the universe".

Looking Up opens with a sacred choral chorus, paired with starry sky imagery, outlining humanity's awe of the universe and the starting point of exploration; The Flow of Stars creates the beauty of the universe through flowing vocal sounds and images of nebulae moving through space; in Crossing, images and music together construct an interstellar journey experience, conveying the conflicting tension between "pursuit" and "greed". In the performance art Starry Pursuit, the conductor "plucking stars into their embrace" symbolizes possession, but stands alone on the stage, revealing loneliness. Finally, "scattering stars" metaphorizes "dedication". Dedication uses music and images to flash back, returning to the beginning and completing a "closed loop of time and space".

In Starry Pursuit, the conductor "plucking stars into their embrace" symbolizes possession, but the loneliness

is highlighted as the choir exits the stage. The final act of "scattering stars into the venue" metaphorizes the spiritual sublimation from individual possession to collective sharing, infusing the narrative with the warmth of human nature. The entire work uses dual threads of "spatial displacement" (Earth – Universe) and "psychological displacement" (awe – obsession – reflection – dedication) to ground the cosmic proposition in reflections on the essence of human nature.

3.3. Technical support and immersive experience

The work has achieved the construction of an "audio-visual integrated" immersive environment at the technical level: In terms of audition, the Dolby Atmos 7.1.4 system is adopted to provide technical support[8] for the three-dimensional sound field space. The spatial movement of music materials and dynamic sound effects is highly matched with the video narrative, strengthening the sense of reality of "roaming in the galaxy" (for the speaker layout, please refer to **Figure 1**). In terms of vision, a CAVE immersive display system[9] is built with four LED screens to form a virtual cosmic space surrounded by three-dimensional projections.

Figure 1. CAVE Immersive Display System and Live Choir

4. The deep structure of spatial movement

The immersive experience serves as the explicit narrative device in Galaxy. To enhance this experience, the movement of sound in the acoustic space is endowed with the deep structural function of conveying the work's connotations.

4.1. Extension from real sound field to virtual sound field

The first movement Looking Up completes the transformation of sound from the "real sound field" to the "virtual sound field" through live a cappella chorus and pre-recorded multi-voice chorus. In the first section, the live chant chorus dominates. Initially, the sound concentrates on the stage. After being recorded by stage pickups, the volume gradually increases with the musical development, "quietly extending" to the main PA speakers, forming a weak diffusion from the physical stage to the amplified sound field, resonating with the video's "slow rotation of looking up at the starry sky"[10]. In the second section, real singing is overlapped with pre-recorded audio, and the spatial design shifts to "polyphonic[11] multi-trajectory movement". The male mid-bass melody fixes the front as the base, while the female four-voice parts unfold differentiated movements in an "alternating chase" (see **Figure 2** for details).

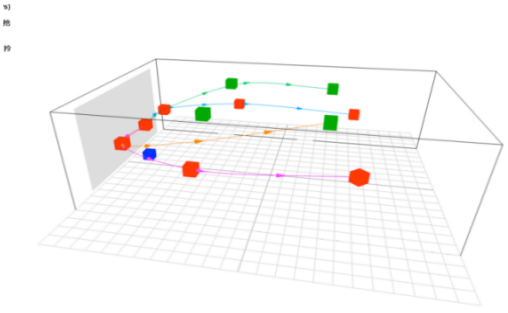

Figure 2. Schematic Diagram of Sound Movement Trajectory in the First Movement

4.2. The multi-layer composite Movement of Sound Shapes an Immersive [12]Channel Sound Field Space

The second movement takes "the Circulation of Star Rivers" as its theme, constructing the immersive feeling of "stacked nebulae" through the spatial flow of multi-sound layers. Among them, the background harmony layer is composed of female multi-voice chorus and bass humai (overtone singing). Each voice part is positioned at different vertical heights (high pitches near the sky, low pitches near the ground), starting from the front position and moving in a circular motion around the entire venue to the right at different speeds (the higher the register, the faster the rotation), forming a "chase-rotating cylindrical sound field". This transforms the static chord padding into a "dynamic sound field space [13]" (see **Figure 3** for details).

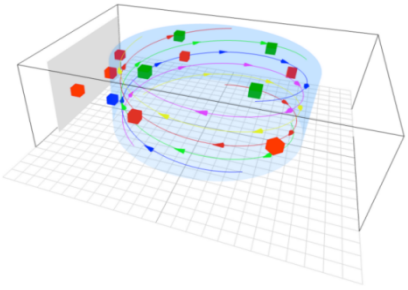

Figure 3. The Sound Movement Trajectory of the Harmonic Layer

The pulsing chant takes two measures as a cyclic unit, with the sound gradually advancing from the front to the rear of the sound field. Coordinating with the visual of "nebulae approaching the audience", it creates a progressive moving experience[14]. The punctual timbre is the short vowel "U" sung by female sopranos, randomly distributed in the sound field to simulate the discrete sensation of "twinkling stars". The composite movement of various sound sound forms and the images together create a strong sense of fluidity and atmosphere.

4.3. High-speed energy transmission and conflict mirroring

Transcendence and Devotion take "interstellar shuttling" and "time reversal" as their explicit narrative contents respectively. The sound motion design emphasizes the high-speed transmission of sound energy and conflict mirroring, with the two movements serving as mirror images of each other[15].

The acoustic forms used in the third movement include powerful choral chord singing, rapid sound-stream chanting, rhythmically modulated bass, coloratura-like motifs, and short modulated vocal effects. Based on their independent movement paths, all sound materials are unified in the overall trend of fast forward-to-backward movement, achieving continuous conduction of sound energy to the rear and creating a strong sense of transcendence.

The fourth movement, Devotion, formally serves as the conflict mirror of the third movement: at the auditory level, all sound materials from the Transcendence segment are reversed (using the Reverse technique), and the spatial movement logic is simultaneously inverted. Sound energy is conducted forward, forming an overall trend of fast backward-to-forward retracing, thus completing the narrative closure of the work.

4.4. The "virtual-real interaction" between performance and sound field

Star Picking is a dramatic segment connecting the "mirror movement" of the third and fourth movements. Centered on real-world performance actions, it constructs a two-way interaction of "real actions – virtual sound field" through the dynamic coordination of the conductor's body movements and sound. Without any video imagery, the sound material uses the high-frequency punctual human voices from the second movement (with top-layer speakers simulating star points). When the conductor performs the "star picking" action, the star points simultaneously contract to the front-center speakers,

creating an auditory illusion of "virtual star points being captured by reality," which is associated with the movement of "holding them in the arms." This paves the way for the subsequent emotional transition. This design breaks through the traditional logic of "sound serving music," transforming virtual sounds into tangible existences that can be touched in reality. It enhances the immersive experience and expands the boundaries of multi-dimensional expression in "performance – sound – space," embodying a typical microcosm of the relationship among "human, sound, and space."

5. Discussion on the structural force of sound movement

As a multi-dimensional electronic music work that focuses on creating an immersive experience, Galaxy uses systematic design of sound movement as the core means to construct its musical structure, which is mainly reflected in three aspects.

First, the overall trend design of sound spatial movement. The work breaks through the limitation that space is only used as parameter modification or special effect application in conventional electronic music, and deeply integrates the overall movement trend of sound into the musical structure and content expression. The four movements form a coherent, unified and logically self-consistent narrative closed loop with the progressive movement trends of "stage spread- immersive shaping - high-speed translating" - mirror reversal", so that the spatial movement leaps from "technical operation" to "structural dominance".

Second, the hierarchical design of sound movement. Under the premise of following the overall trend, the "textured" organization is realized through the movement design of "reaching the same goal by different paths". For example, the "spatial canon" (stratification of path, angle and time difference) of the female vocal part in the first movement, the dynamic sound field with speed difference in the background harmony layer of the second movement, and the composite movement of "main trend - secondary trend - details" in the third and fourth movements not only enrich the auditory perception, but also have the structural function of traditional texture.

Third, the dimensionality-upgrading separation advantage of vocal materials. Due to the narrow range and similar timbre, conventional multi-voice vocals are prone to turbidity. Galaxy uses the three-dimensional sound field of panoramic sound to improve the separation degree of vocal parts in a "dimensionality-upgrading" way, providing possibilities for the construction of complex vocal parts and textures.

6. Conclusion

The creative practice of the panoramic multi-dimensional vocal work Galaxy provides a constructive empirical model for the study of structural forces in electronic music. Through a systematic analysis of its spatial movement design mechanisms, this paper draws the following core conclusions: First, the spatial movement of sound has achieved a leap from "parameter modification" to "structural paradigm". By means of sound field displacement, movement trend construction, cross-modal perceptual collaboration and other strategies, spatial movement has become the core structural force dominating the work's form. Second, the "textural" characteristics of sound movement expand the structural methods of electronic music. Forms such as "spatial canon" and "dynamic sound field" not only follow the overall trend but also adopt hierarchical design, endowing sound movement with the structural functions of traditional textures. Third, the study has refined a quantifiable and reusable methodological approach for immersive audio creation, verifying the value of spatial movement as a "technology-art" bridge in cross-media collaboration.

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