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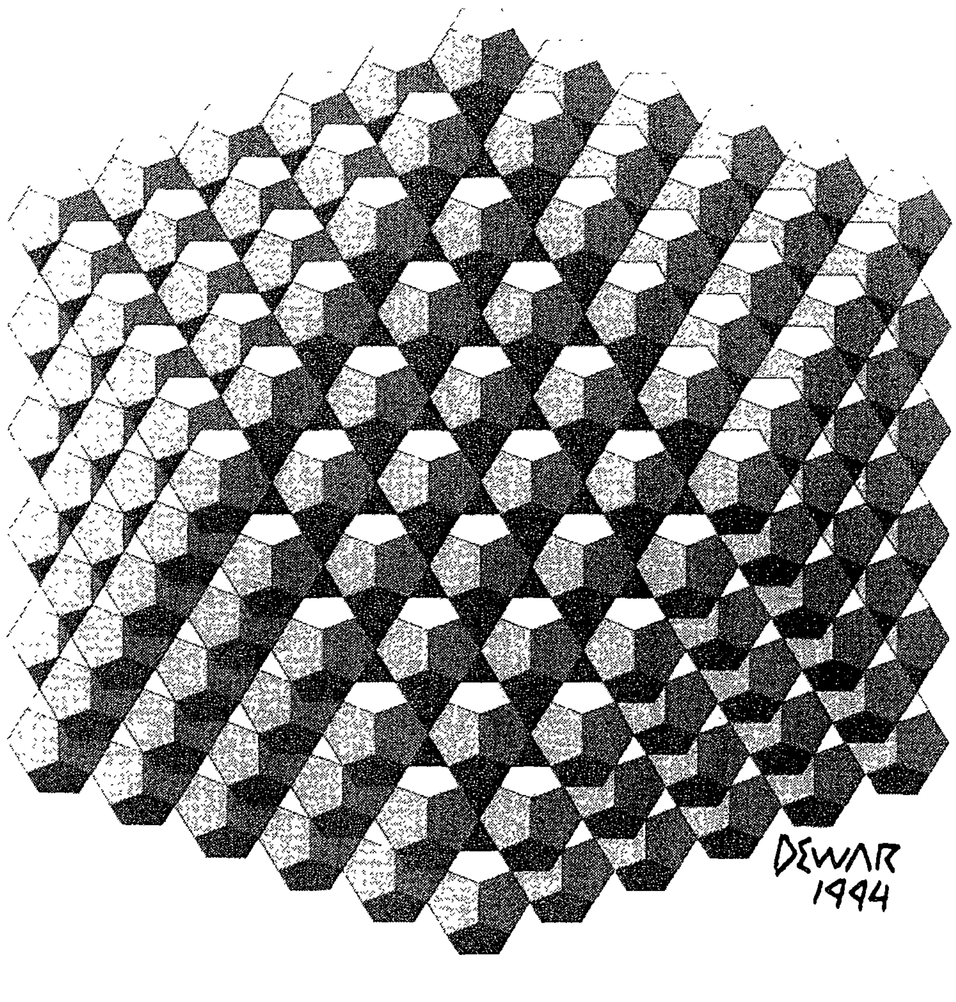

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FRACTAL SYMMETRY/ASYMMETRY IN BARTOK: SPECTROGRAPHIC MODELS

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Recently fractals have brought to the millennia-old universe of symmetry/asymmetry a fresh nuance (Mandelbrot, 1977). Rather than unfolding within the Platonic-Aristotelian framework of identity and regularity, fractal self-similarity unfolds in a universe of constantly changing dimensionality operating over the widest possible range of fluctuations, discontinuities, and differences. The cohabitation of symmetry and asymmetry, of invariance and variance, is now recognized, explored, and enjoyed.

Also new are the views of sonic musical phenomena offered by the spectral analysis of sound spectroscopy. Spectral analysis makes available fresh perceptions at two important levels, the microscopic and telescopic -- levels that until now have been difficult of access for musical understanding. To begin, there is the level of sonic *microstructure*: the teeming overtone detail that Helmholtz first recognized as crucial for the rich, ever-changing coloration of all music (and for spoken language as well). Through spectroscopy the dazzling minutiae of this universe have just now burst into visibility and consciousness in all their overwhelming, fascinating multifariousness, opening up previously unreachable realms to precise, objectively-based analysis. An analytic theory of musical sound (a phonological tone-color theory) and the precise depth analysis of musical performance have been the most important results. At the other end of the scale spectroscopy provides us with vivid images of musical *macrostructure*: a telescopic vision of the whole encompassing design formed by the sum total of sonic elements. These images put the viewer-listener in direct contact with the reality of musical shapes from the smallest to the largest level, offering an integrated view of a scope and detail previously unavailable for musical understanding. As a theoretical proposition let me suggest that understanding of musical macrostructure must derive from and ultimately include musical microstructure, and vice versa.

Having on other occasions focused on the microstructural significance of spectral analysis, especially on tone color understanding (Cogan, 1985), here I will focus principally on the macrostructure: the cumulative design of musical formations (however, see Cogan and Escot, 1976). Our first and principal example will be a late work of Bela Bartok, the "Melodia" movement of the *Sonata for Violin Alone.*

A spectrograph of the entire "Melodia" movement will be shown as Fig. 1. Exx. 1-5 (see following pages) present five detailed spectrographs. Lines drawn on the detailed spectrographs show the principal directional motions of the music in those excerpts. At a glance Ex. 1 reveals the fractal essence of the linear design of the movement's first section. At its largest, the first section unfolds a single wave, or arch, that begins and ends on Bb3, with a midpoint arrival at its apex three octaves higher, Bb6. From the very beginning the gradual ascent is formed of smaller waves, also drawn on Ex. 1. There is the wave of the motivic cells, Ex. 2; and the slightly larger wave of the phrases, Ex 3. As shown in Ex. 3, the wave of the first phrase is formed of three smaller motivic-cell waves. (Musicians will be interested to realize that the motivic-cell waves suggest three different musical language "dialects:" the pentatonic, the octotonic, and the chromatic -- dialects that then are repeatedly juxtaposed and interwoven as the movement unfolds.). Finally, each large phrase of the first section is defined by a tiny closing figure of three notes that is three-times repeated. Ex. 4 shows that this three-note figure is the smallest possible reduction of the generative wave-shaped cell.

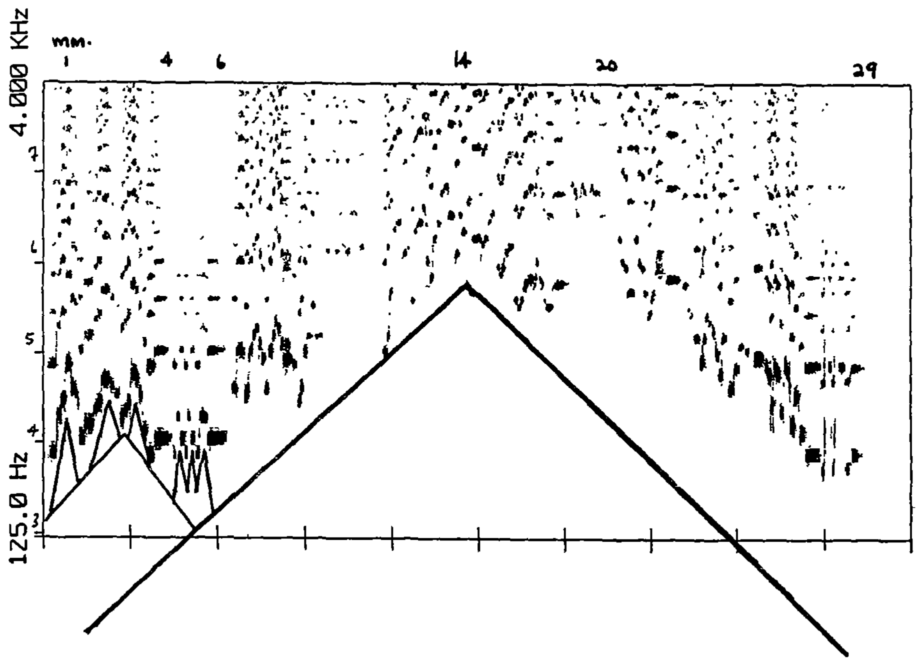
If we now return to Ex. 1, we see how these different multi-dimensional waves combine to form the first phrase, mm. 1-6; and then how they are consistently extended as they gradually and inexorably construct the ascent toward the central apex, as well as the descent from that climactic moment. (The smaller waves are not shown in the line drawing of Ex. 1 for the remainder of the section; they are, however, visible everywhere in the spectrograph.) Each dimensional level of the musical design -- cell, motive, phrase, and section -- fractally reflects the essential generating shape. Furthermore, the shape is regenerated in dimensions of enormously varying size: 3/8/31(or 51)/232 eighth notes. Each of these dimensional relationships and levels, already irrational, is further varied and nuanced as the movement continues. Only with fractal variability of dimensions can one see through this variability to the essential underlying similarity of design; or, put another way, only in this way can all these opposing levels and scales of dimension be revealed as variously-shaded expressions of the same generative shape.

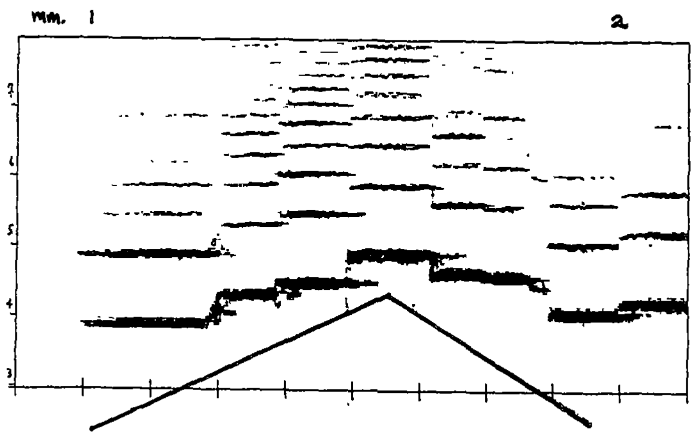
One last example, Ex. 5, shows how the last section is a variation by inversion of the design of the first section. While all of the musical details of the first section pass by, undergoing detailed variation, the total shape of the section is inverted, so that the section and the movement as a whole end in the violin's very highest, most acute registers rather in the dark, grave registers (on the lowest string of the violin) where they began. The design thereby activates the total range of space and colors of the solo instrument. Once again, the generating shape appears in new shades and colors.

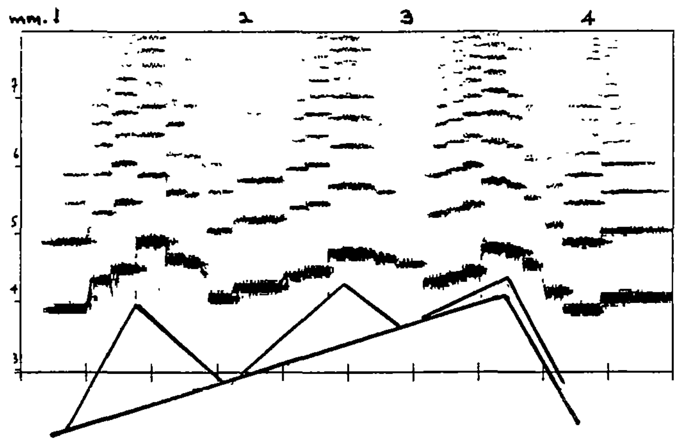
While fractal theory and spectrographic analysis are recent, they cast a revealing light on music of earlier periods as well. Examples from the 12th-century chant composer Hildegard von Bingen (Cogan, 1990) and from J. S. Bach (Cogan, 1994) will be presented to illustrate fractal features of their work. Fractal theory has had an acknowledged impact on recent composers as well. Gyorgy Ligeti (Ligeti, 1988) and the speaker, among many others, have consciously used fractal processes as partial generators of musical works. (Partial because musical works are complex phenomena that can rarely, if ever, be reduced to a single motivation.) In conclusion, an example from a work of the speaker will be presented and examined.

While the essentials of fractal theory -- self-similarity and wide-ranging, irrational variability of dimensions -- have been important factors of musical structures through the ages, it is only with the emergence of fractal theory that these symmetries (or asymmetries if one looks from the perspective of variability) have come clearly and consistently into focus, revealed in the spectrographs we have just seen.

EXX. 1-5 Bartok, "Melodia," Sonata for Solo Violin (first section, mm. 1-29; three excerpts from it; and last section, mm. 49-67)



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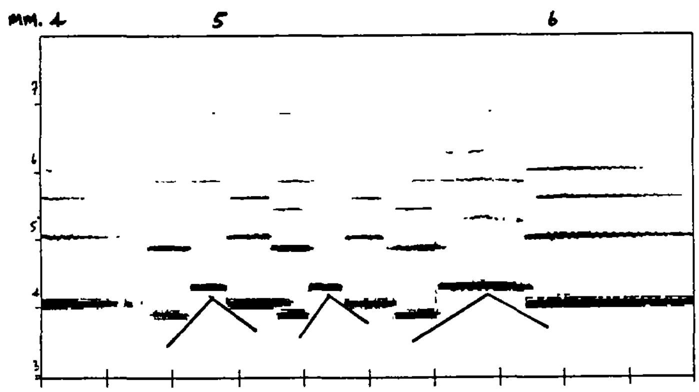
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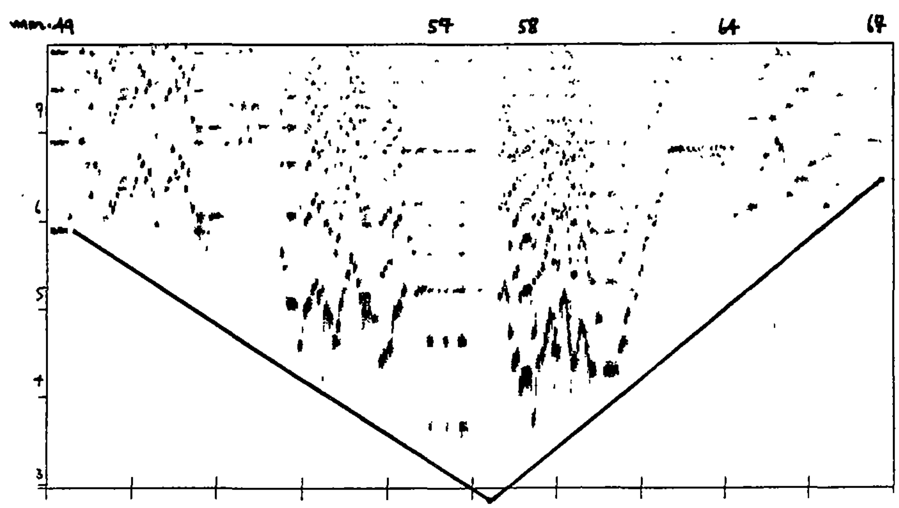
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