Math meets music

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Geometry is the force that shapes both the sound of music and the novel research of Florida State University composer-theorist Clifton Callender, whose work explores and maps the mathematics of musical harmony.

Now, Callender's latest article on that mind-bending research has earned him the inaugural David Kraehenbuehl Prize from the *Journal of* Music *Theory (JMT)*, the oldest and most distinguished music-theory journal now published in the United States.

In its citation of his work, the selection committee sings the praises of its first honoree, noting "Callender develops novel ideas in imaginative ways, harnesses a sizable mathematical apparatus with technical aplomb, and presents his work with exemplary elegance and clarity."

Named for the founding editor of the JMT, the Kraehenbuehl Prize will be awarded biennially to an article judged the journal's best submission from a not-yet-tenured scholar.

The theory described in Callender's Kraehenbuehl Prize-winning paper ("Continuous Harmonic Spaces") complements the "geometric music theory" he formulated at Florida State three years ago in collaboration with researchers from Yale and Princeton universities. The 2008 paper they coauthored, "Generalized Voice-Leading Spaces," was featured in the journal Science.

But while Callender's present work is related to that earlier milestone, it also breaks new ground and draws upon different branches of mathematics.

"For 'Continuous Harmonic Spaces' I used a mathematical technique called the continuous Fourier transform to investigate the aural quality of individual chords and the way in which those qualities differ from one chord to another," said Callender, an associate professor of composition in the Florida State University College of Music. "It is after all a chord's innate sound or 'feel' that makes it perfectly suited for depicting, say, a murderous turning point in a Hitchcock thriller, but not at all appropriate for an uplifting song."

While the language of music theory may sound a little strange to the uninitiated, for Callender those continuous voice-leading and harmonic spaces are inextricably linked to the old, familiar tunes.

"As we know, some chords sound more similar than others," he said. "For instance, while there are several different types of chords in the Beatles' 'All You Need is Love,' all of these chords have a lot in common. Certainly they are more similar to each other than to the bebop-inspired chords of Jimi Hendrix' 'Purple Haze,' or the even more dissimilar dissonant stabs in Bernard Herrmann's score for the 1960 film 'Psycho.'

"Imagine these and other chords as existing in a multi-dimensional harmonic space in which similar-sounding chords are located close together and dissimilar chords are far apart," Callender said. "Music theorists, including my FSU colleague Michael Buchler, have developed ways to map this space and measure the similarity of chords built on a limited number of 'note types,' the twelve notes within a single octave.

"But in 'Continuous Harmonic Spaces' I map all possible chords — including those that do not belong to standard Western tuning because they contain notes that lie in between adjacent keys on the piano. I felt it was essential to do this for two reasons.

"First, because the music of many contemporary composers and of non-Western cultures is not limited to the standard Western tuning," he said.

"And, second, because by looking at the most general case of all possible chords, we can better understand the nature of harmonic spaces and shed light on the relationships and similarities between more common Western chords."

Callender is a composer who practices what he theorizes. The notion of 'continuous spaces' is important in several of his compositions, including "Metamorphoses," in which the rhythms and tempos change in a continuous, gradual manner. And he currently is working on "Spira mirabilis," a set of music canons (or rounds) in which a given melody can be played against itself in an infinite number of ways.

"It is gratifying," he said, "not only to be the first Kraehenbuehl Prize recipient but also to be a part of a community of musician-scholars who are all pursuing such interesting, cutting-edge research at the intersection of music and mathematics."

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