DEALING WITH THE 3RD: ANATOMY OF DISTORTED CHORDS AND SUBSEQUENT COMPOSITIONAL FEATURES OF CLASSIC HEAVY METAL

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Abstract

Because of the use of guitar distortion, chords used in heavy metal are much more complex than the fingered guitar positions would indicate. Due to harmonic partials generated by distortion most chords have a major quality. However, heavy metal is mostly constructed on minor modes regarding the scalar construction. This creates an apparent modal dichotomy between the vertical and the horizontal harmonic construction. This article discusses acoustic characteristics of distorted guitar chords and a variety of compositional strategies that have been used in dealing with the major and minor thirds in "proto" and "classic" heavy metal (ca. 1965-1985).

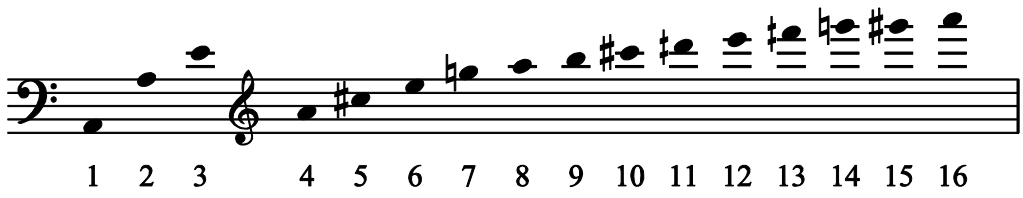
Acoustics of distorted chords

The sound of distorted guitar is much more complex than one would expect on the basis of typical positions played on the guitar. Nonlinear distortion generates harmonic and intermodulation frequency components (e.g. Dutilleux & Zölzer 2002; Bloch 1953; Rossing 1990: 447-448), i.e. distortion amplifies harmonic overtones and creates combination tones.

Harmonic overtones

Musical note is a complex tone containing a root tone and its harmonics. Together these form a harmonic (or, overtone) series of the root tone. Harmonic distortion amplifies harmonic partials, which are multiples of the fundamental frequency, and which are present in all natural tones (see, e.g. Lindley et al. 2003). Example 1 shows the first sixteen harmonic partials of an open A-string played on the guitar (110 Hz).

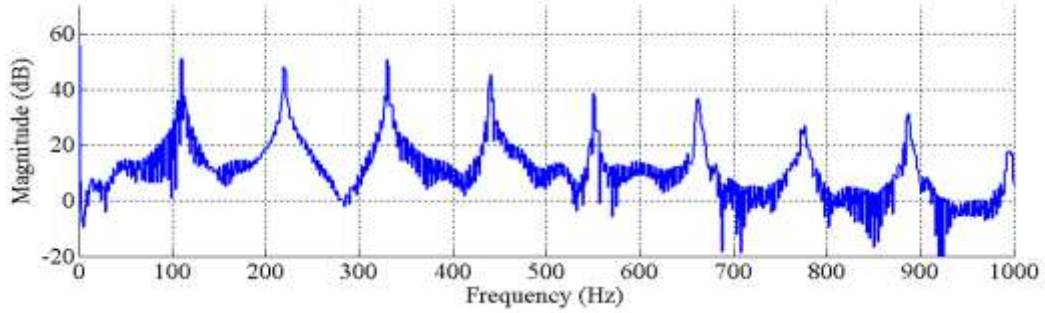
Example 1. The first 16 partials of the harmonic series of A (110 Hz); an approximation in standard music notation.



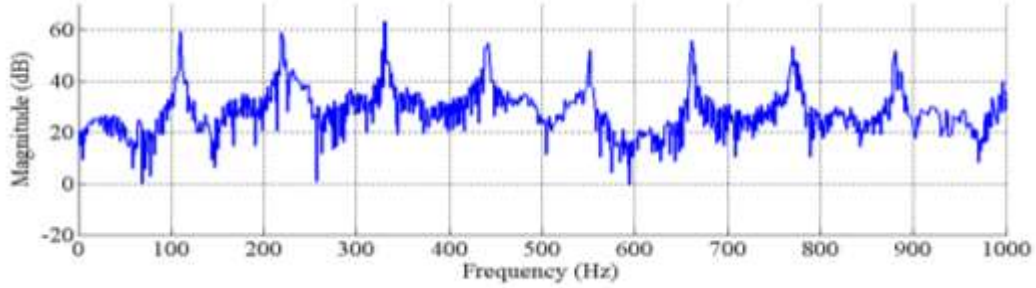
Usually the magnitude of harmonic partials gradually degrease by their number, as shown in Example 2. However, when distortion is used, all the partials

are more or less on the same magnitude level (Example 3). In other words, distortion makes the harmonic series more prominent for a listener's ears. (Lilja 2009: 104-105.) (For the details of the acoustic measuring used in this article, see Penttinen et al. 2009.)

Example 2. Magnitude spectrum of non-distorted guitar A string (110 Hz); the first 9 harmonic partials.



Example 3. Same as Example 2, only with distortion.

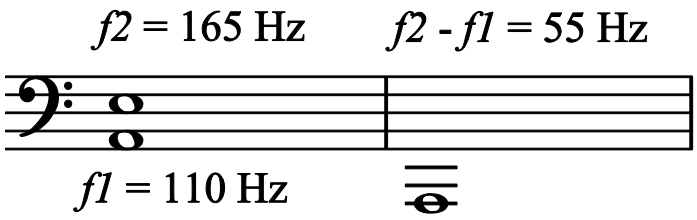


Combination tones

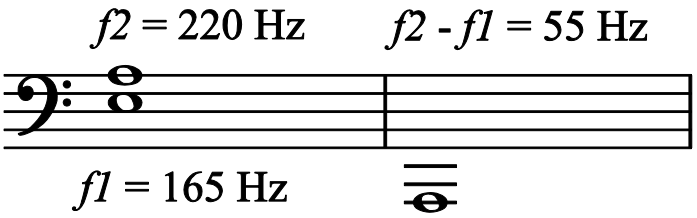
Imagine that you throw a rock in a pool of water and another rock next to it. Waves start to appear around them (an analogue to harmonic series). At some point of time the two patterns of waves collide creating a third pattern of waves that would not been there otherwise. This phenomenon is analogous with sound waves.

Intermodulation distortion between two or more tones generates combination tones. Combination tones of individual frequencies are given by their subtraction (difference tones) and multiplication (summation tones) (e.g. Rossing 1990: 151, 153; Benade 1976: 256-257). For instance, tones *A* (110 Hz) and *e* (165 Hz) (i.e. root tones of an interval of the fifth) produce a difference tone A_1 (55 Hz), which is an octave below the original *A* (Example 4). Rather interestingly, its inversion (the interval of the fourth) produces exactly the same difference tone (Example 5), making it intelligible as to why the fifth and the fourth sound so much alike, especially with distortion. For instance, the famous guitar riff to Deep Purple's "Smoke on the Water" (1972) is played with fourths, yet it sounds like the chord root was not the lowest but the highest note of the chord.

Example 4. Tones A-e *(the interval of the fifth) and their difference tone.*



Example 5. Tones e-a *(the interval of the fourth) and their difference tone.*



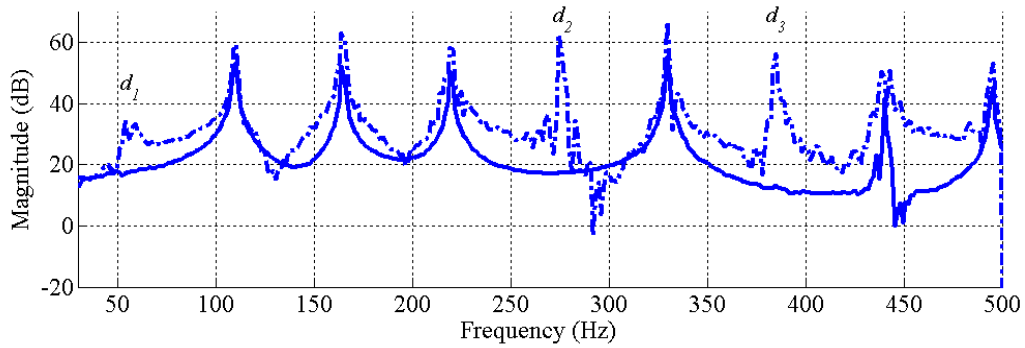
Anatomy of the power chord and other structures

Back to throwing rocks into water. Musical chords contain two or more notes containing a root tone and its harmonic partials. Hence, in chords there are two or more harmonic series sounding together. Not only the root tones discussed above, but other harmonic partials create combination tones as well.

A power chord is a distorted interval of the fifth. The term power chord is sometimes applied to any fifth played with the guitar (e.g. Everett 2000: 330-335), but according to the stand taken here the intervallic formation is not enough. Without distortion the fifth sounds rather plain, whereas the power chord includes a lot of sounding partials (combination tones) not sounding without distortion. For instance, as shown in Example 6, the fifth *A-e* without distortion has only harmonic partials of the root tones.

On the other hand, the same interval with distortion (i.e. power chord A5) has prominent combination tones on 55 Hz (distortion component *d1*), 275 Hz (*d2*) and 345 Hz (*d3*), which approximately equal musical notes that are an octave below the original root (A_1), major third ($c\#^1$) and minor seventh (g^1), respectively. Thus, the power chord is clearly not an open chord – there is substantial major quality in it (with minor seventh and major ninth). (Example 7.) In addition, all the partials fit in to a harmonic series of the difference tone 55 Hz (A_1), which may be called the *distortion fundamental* (Lilja 2009: 112-115).

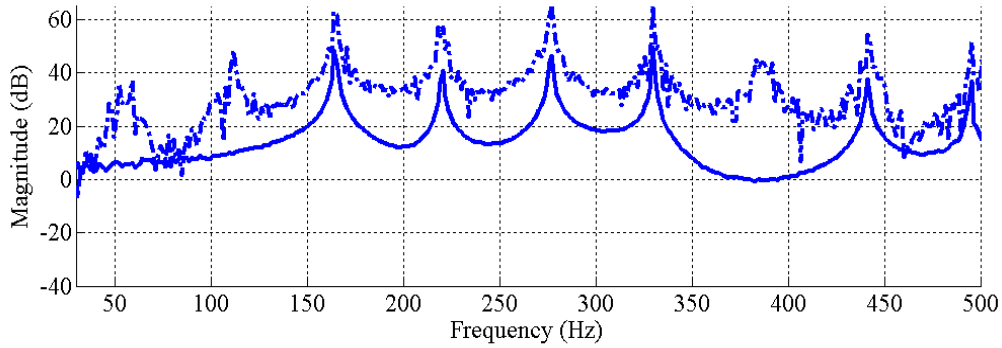
Example 6. Magnitude spectrum of the fifth A-e *on the guitar with (dashed line) and without distortion (solid line).*



Example 7. The first nine sounding partials of the A5 power chord (partials form an A9 chord).

Compared to the power chord, a distorted major triad is somewhat similar in its acoustic construction (Example 8). This similarity makes them aurally almost inseparable (on listening tests conducted on this matter, see Penttinen et al. 2009).

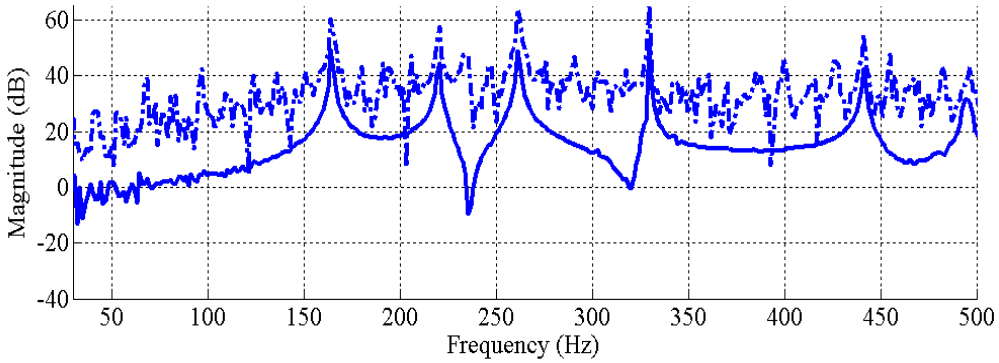
Example 8. Magnitude spectrum of A major triad (position e-a-c#) with (dashed line) and without distortion (solid line).



A distorted minor triad is very different compared to the two (Example 9). Visually this is obvious, aurally even more so. Aural experience is more unclear, rough and dissonant. Whereas the power chord and the major triad fit

more or less neatly to the harmonic series of the distortion fundamental A_1, the minor triad has three different harmonic series clashing with each other, them being those of A, C and F (for further details, see Lilja 2009: 117-119). (For a more detailed discussion on the acoustic structure of distorted chords, see Lilja 2009: 101-122.)

Example 9.Magnitude spectrum of A minor triad (position e-a-c) with (dashed line) and without distortion (solid line).



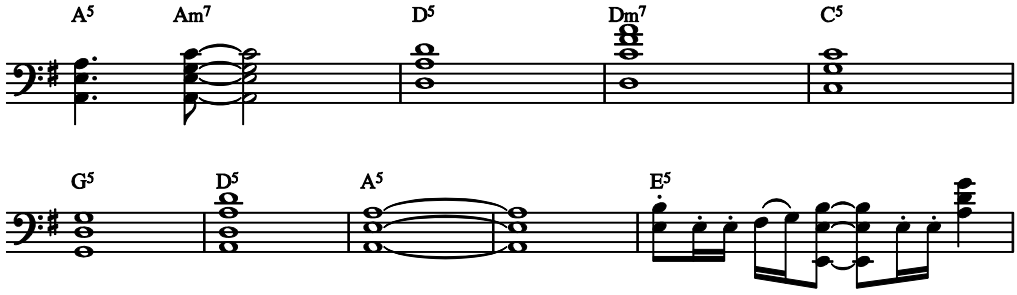
Compositional features – dealing with the 3rd

Acoustics may well explain as to why the minor triad is much avoided in "proto" (ca. 1965-1970) and especially "classic" heavy metal (ca. 1970-1985) and why the power chord is the most popular chord structure. (For a musical genealogy of heavy metal, see Lilja 2009: 29-47.) Musicians have long been aware of the acoustic characteristics of distorted chords. A quote from Pete Townshend, guitar player of The Who, illustrates this: "None of the shapes [i.e. chords] that I play with loud distortion have a 3rd, because you hear the 3rd in the distortion" (Resnicoff 1989: 80).

Chords containing a minor 3rd

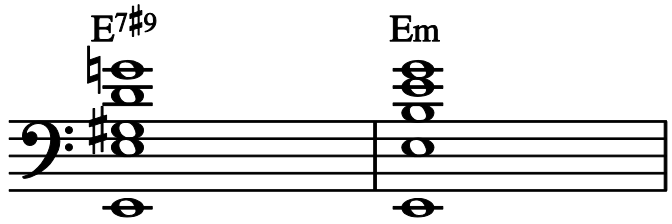
Listening through hundreds of classic heavy metal compositions, mostly of British origin, I have noticed that distorted minor triads (arpeggios excluded) are rare indeed. Chords containing a minor third clearly stand out from their surroundings (i.e. major and power chords) with more dissonance and roughness. One such case is Black Sabbath's "Heaven and Hell" (1980) (Example 10) with its two minor seventh chords.

Example 10. "Heaven and Hell", bridge, ca. [2:16-2:40].



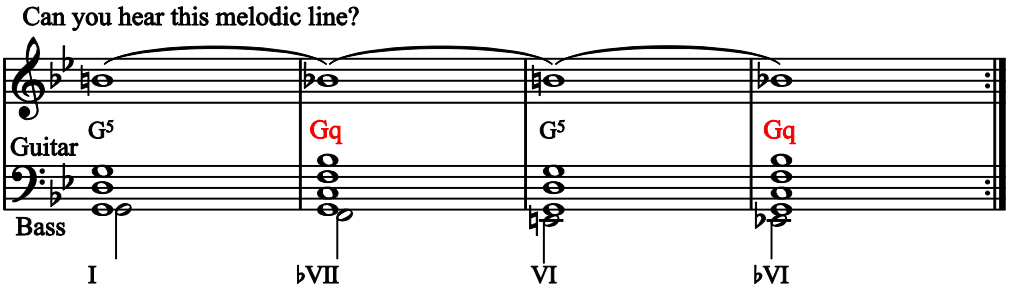
When distorted heavily enough, a minor triad can be aurally inseparable with 7#9, which contains both major and minor thirds. Sometimes this chord is referred to as the "Hendrix chord", since it was, obviously, much exploited by Jimi Hendrix (e.g. "Purple Haze" 1967). Early heavy metal guitarists, such as Ritchie Blackmore and Tony Iommi, adopted this chord for their own use (listen to, e.g. Deep Purple: "No One Came", 1971, ca. [0:08–]; Black Sabbath: "A National Acrobat", 1973, ca. [2:20–]). The first chord of the riff to Black Sabbath's "Supernaut" (1972) can be a bit confusing aurally. The riff is played with heavy distortion and has obviously been multi-tracked. In fact, it is very difficult to say, whether the chord is a minor triad or a 7#9 (Example 11). The reason for this is that with enough distortion the two chords have essentially the same harmonic structure. What is clear is that the minor third has to be fingered; the major third and the minor seventh are in the harmonic structure anyway.

Example 11. Which chord there is in the riff to "Supernaut's" verse [0:20-]?



Black Sabbath's "Black Sabbath" (1970) provides an interesting example of clearly audible harmonic 3rds. At the ending of the piece the guitar alters between the G power chord and a quartal chord on G (*quartal* = stacked fourths rather than thirds). The power chord has an audible harmonic third (not fingered), whereas the quartal chord contains a minor third. A melodic line altering between the major 3rd and the minor 3rd is clearly audible. (Example 12.)

Example 12. "Black Sabbath", outro, ca. [5:58-].



Modes containing a minor 3rd

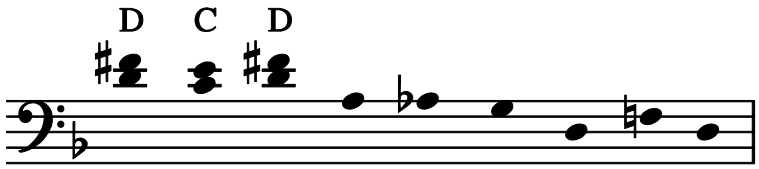
Heavy metal is mainly constructed with minor modes, in other words, on the scales that contain a minor third – the medieval/renaissance dorian, aeolian, prhygian, locrian, various blues modes and various forms of the "euroclassical" minor modes (Lilja 2009: 152-194; for modes in popular music, see Moore 2001: 52-55; for modes in general, see Tagg 2014: 85-149). Table 1 lists some commonly used scales.

Table 1. Commonly used scales and modes.

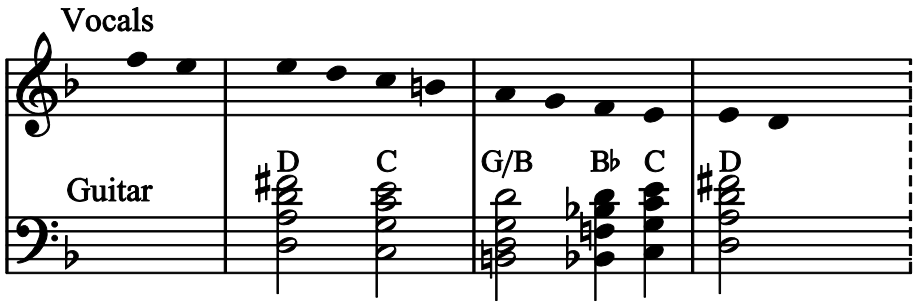
Scale	scale degree						
Ionian (Major)	1	2	3	4	5	6	7
Dorian	1	2	b3	4	5	6	b7
Phrygian	1	b2	b3	4	5	b6	b7
Lydian	1	2	3	#4	5	6	7
Mixolydian	1	2	3	4	5	6	b7
Aeolian ("natural" minor)	1	2	b3	4	5	b6	b7
Locrian	1	b2	b3	4	b5	b6	b7
Harmonic minor	1	2	b3	4	5	b6	7
Melodic minor	1	2	b3	4	5	6	7
Hungarian minor	1	2	b3	#4	5	b6	7
Blues scale (simplified)	1		b3	4/#4	5		b7

Even when a melodic mode would require the use of a minor triad, it is often replaced with a major triad (in proto metal) or a power chord (in classic metal). It seems obvious that the vertical sound of a chord often overruns scalar contents of a mode. Proto metal examples include Cream's "Sunshine of Your Love" (1967, Example 13) and "White Room" (1968, Example 14) and Jimi Hendrix's "Hey Joe" (1966, Example 15), in all of which there are major triads exclusively.

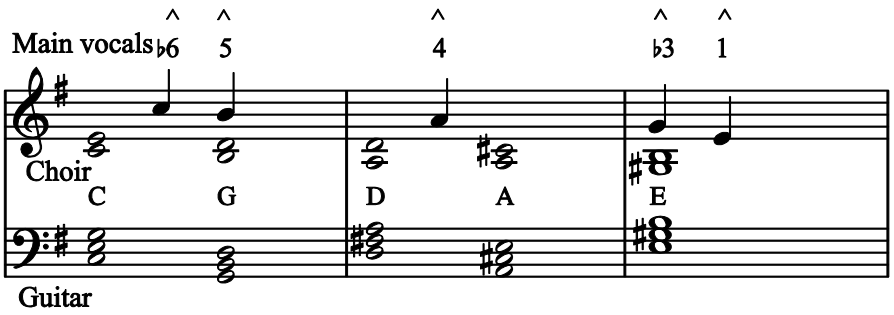
Example 13. D-blues scale riff to"Sunshine of Your Love", reduction.



Example 14. Dorian verse and major triads in "White Room", reduction.

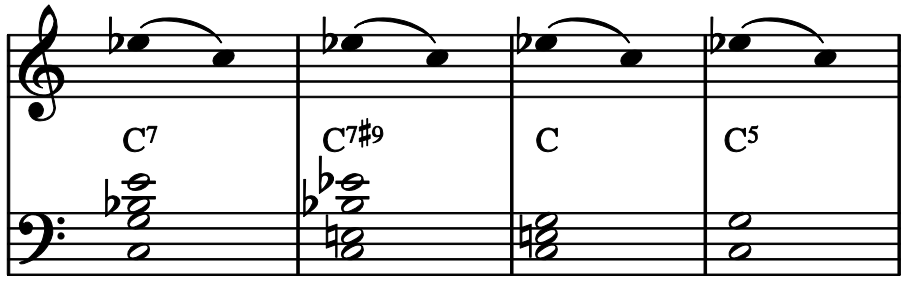


Example 15. E-aeolian/dorian chord progression in "Hey Joe", reduction.



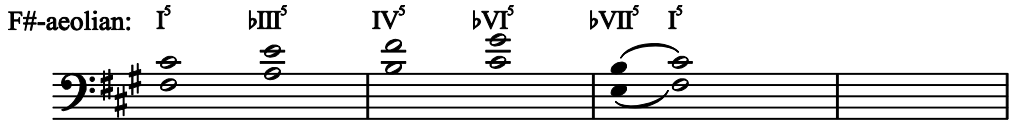
Having a major third in the harmony (i.e. accompanying chords) and a minor third in the melody is nothing new in musical history. Early downhome blues artists often used major type chords to harmonize a minor mode melody. This practice might have very well been assimilated to heavy metal from various types of popular music. Example 16 shows how this has been done by a) Robert Johnson (1936), b) Jimi Hendrix (1967), c) the Beatles (1965) and d) Black Sabbath (1971).

Example 16. Minor third with an accompanying chord in a) "Kind Hearted Woman Blues" [0:12-], b) "Purple Haze" [0:31-], c) "The Night Before" [2:28-], d) "Paranoid" [0:14-].



While distortion gradually increased, some bands exploited dorian/mixolydian chord patterns (such as I–IV–bVII, all major triads) to accompany a bluesy minor mode vocal melody. Cases such as AC/DC's "Highway to Hell" (1979) and Motörhead's "Love Me Like a Reptile" (1980) are illustrative. The classic 1980s bands, such as Iron Maiden, Judas Priest, Ozzy Osbourne and Dio, almost completely abandoned thirds in distorted chords and used power chords instead. However, due to acoustics, in sonic reality the major thirds are inevitably there. For instance, the power chord progression in Ozzy Osbourne's "Rock 'n' Roll Rebel" (1983) follows a much used aeolian pattern (Example 17) (see, Lilja 2009: 187-188). The progression may appear very simple on paper. However, the sonic reality is something different. The chord roots spell out the aeolian scale degrees 1, b3, 4, b6 and b7. On the top of that, the power chords give clearly audible partials on scale degrees 3, 5, 6 and 2 (i.e. the partials forming the major thirds of the chords I, bIII, IV and bVII, respectively). Thus, the audible tonal scale consists of tones 1, 2, b3, 3, 4, 5, b6, 6 and b7 (having the characteristics of aeolian, dorian and mixolydian modes).

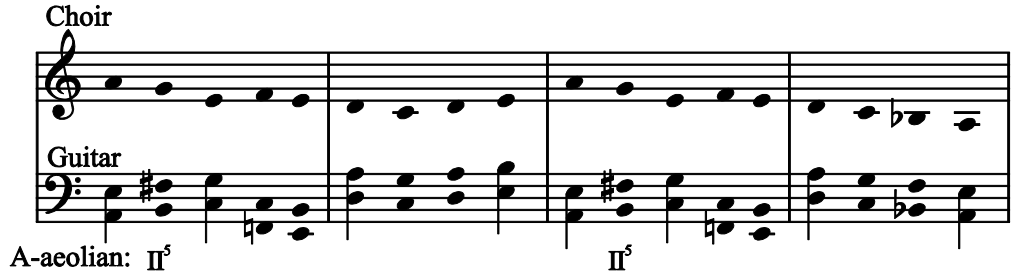
Example 17. "Rock 'n' Roll Rebel", chords in the verse, ca. [0:31-0:45].



It seems evident that many heavy metal power chord progressions are based on chord degrees, which would be major triads in triadic settings. As usual, the progression in "Rock 'n' Roll Rebel" avoids the chords on the natural II, VI and VII degrees (their respective triads would be ii^{b5}, vi and vii^{o}). In this way, both the modal and the acoustic expectations are met in a most satisfactory way. (The inevitable exception to the rule is the chord on I, which is almost impossible to avoid in any kind of tonical music.)

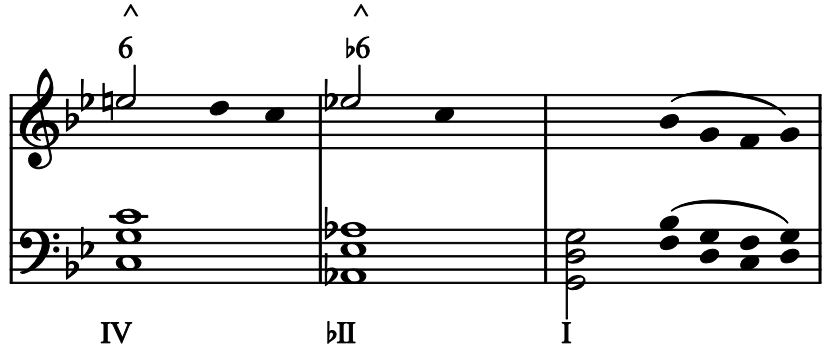
A power chord on II is mainly used as a passing chord in chord melodies, such as in the riffs of Black Sabbath's "Heaven and Hell" (1980) and "Snowblind" (1972) (see, Lilja 2009: 168), and Dio's "Shame on the Night" (1983, Example 18). In such cases, the chord is usually out of the mode, but acoustically solid.

Example 18. "Shame on the Night", outro, ca. [3:22-]. Reduction of the guitar and vocal choir parts.



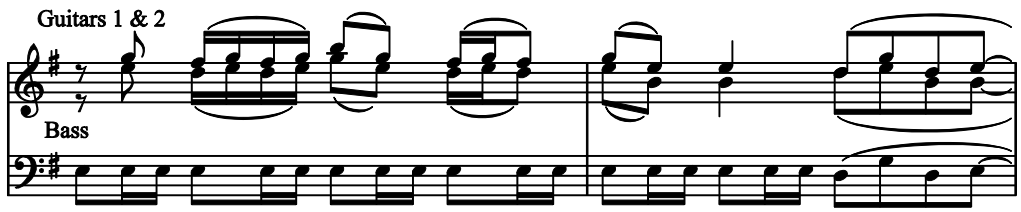
In Deep Purple's "Smoke on the Water" (1972) the vocal melody has a chromatic shift from the dorian 6 to the aeolian 6 (Example 19). This melodic passage that has been widely used since the euroclassics, is traditionally harmonized with IV and iv, respectively. However, Deep Purple chooses to abide with acoustically harmonic structures and uses IV and bII chords, thus avoiding a minor triad quality of the iv. In this way, the melody forms a major third with the IV chord and a perfect fifth with the bII.

Example 19. "Smoke on the Water", chorus.



Although minor triads are rare as full vertical chords, minor thirds abiding by a mode are generally used in vocal melodies and dual guitar harmonization. Iron Maiden's "Trooper" (1983) is illustrative (Example 20).

Example 20. "Trooper", intro [0:12-].



Mixtures of the major and the minor are common not only with individual chords versus melodies, but overall modal contents as well. For instance, Black Sabbath's "Neon Knights" (1980) starts in the mixolydian mode with a melodic suspension 4–3 against the power chord on I. However, the refrain applies phrygian chord degrees bVII, bII and bVI, while the vocal melody has a minor third of the mode. Similar shift from a major mode to a minor can be heard in Iron Maiden's "Murders in the Rue Morgue" (1981) (see, Lilja 2009: 170). It seems evident that in much heavy metal the major and the minor are not treated as polar opposites like in much traditional euroclassical musical material of the so-called common era.

Discussion

The results of the acoustic characters of distorted chords contradict with some of the previous scholarly work. Walser (1993: 43) has argued that combination tones need high volumes to be generated. Berger & Fales (2005: 194) argue that combination tones are psychoacoustic rather than acoustic and would not show in spectrograms. However, the examples presented here clearly show that the combination tones are acoustic (i.e. part of the physical reality rather than imaginary). Furthermore, since the sound pressure level was not a factor in these measurements, loud volume is obviously not needed for combination tones to arise.

Much heavy metal is constructed with minor modes. However, as shown above, the vertical construction of distorted chords is inevitably of major quality. Because of this it may seem that there is a constant modal conflict between the vertical and linear harmony. However, this conflict is a conflict only in a so-called traditional sense. Heavy metal, as well as many other types of popular music, seems to care little about the theoretical dichotomy of the major and the minor. Major and minor are not mutually exclusive, but rather complementary and free to be used for compositional purposes at will. Of course, this dichotomy is rather novel in music history and mostly tied to euroclassical harmonic practices of ca. 1700-1900. Heavy metal practices in this regard actually much resemble compositional practices of the European renaissance polyphony (see, e.g. Merwe 1989: 210-211), in which the vertical and the linear harmony is apparently treated as entities of their own. "The medieval composers down to Sebastian Bach used for their closing chords either exclusively major chords, or doubtful chords without the third" (Helmholtz 1954: 217).

Acknowledgements

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