Musical Relativism

(a cookbook)

by ben glas

Hello there,
welcome to this cookbook.

I hope it tickles your brain and fancy, while inspiring you along your own path.

If you have any questions regarding any of this cookbook, please feel free to email me at

hellobenglas@gmail.com

This work would simply not be possible without the love, patience and editorial proofreading of:

Ma & Pa, Adam Johnson, Andy Fry, Charlie (the Bippy Bandit), Jan Thoben, Hans Peter Kuhn, Lawrence English, Nick Bukea, Linda Kliewer, Douglas Kelly, Keigo Hara, Richard Sanderson, Max Wolf, Patricia Wolf, Sarah Schneider, Knutti and Katha of ohrenhoch!, Anne Bourne, Antonino Modica, Haesoo Jung, Seth Nehil, Ukiah Marcus, Anthony Casey, David Immel & William Raymond Parker.

Thank you

!

Table of contents

Sonic References

If you would like to follow along with the sonic examples, or read this entire cookbook online, please go to

www.thankyouforyourunderstanding.com/cookbook

If you would like to follow along with the PureData examples from each Order, you can access those patches @

https://github.com/tyfyu/pd-patches-for-Musical-Relativism-A-Cookbook-

Introduction:

Historically, an artist's cookbook is an in-depth analysis and divulging of techniques employed during the creative practice of said artist. The medium takes on the format of a traditional cookbook, only in that it mimics its structure of text and practice.

The cookbook, found in most echelons of society (from White Cube Galleries to DIY filmmakers), was a way of sharing practical anecdotes and methodological wisdom, in the hopes of dispersing knowledge to other participants in the field.

The particular hope with this particular cookbook is to give a layperson's primer to ***Musical Relativity*** as an active tool in music, demystifying the concept and its consequences in the process.

The question I beg to beg is how to make a music which reveals this relativistic nature, while both offering an objective sonic experience and freely allowing listeners to find their own selves within the subjective experience of their own interaction.

For the sake of ease and to find a slight bit of grip and friction, I will be making use of the term "***Musical Relativism***". This is not to concretise or reify any theories regarding subjectivity and or objectivity within the realm of music, but rather to point to the open potentials of tone-based interactive music.

What is *Musical Relativism*?

Before I can define the term that haunts this cookbook, I think it best to briefly define the term *relativity*. *Relativity* is defined as

"the absence of standards of absolute and universal application"

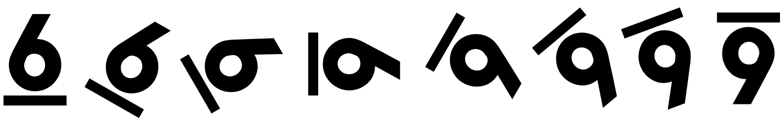
(Thanks Google, Boaz and Westermarck: google.com/search?q=define+relativity)

and, with the tint of physics, as

"the dependence of various physical phenomena on relative motion of the observer and the observed object, especially regarding the nature and behaviour of light, space, time and gravity".

(Ibid)

Admittedly, there are many, many more detailed definitions of this incredibly nuanced, yet pervasive, concept to dive into, as the last century+ has seen many expert digs into its nature, but this one will do for in the here and now. The most important take away from this definition is that our individual perception of a phenomenal event (be it scientific, social or philosophical) depends on our relative positioning to it.



All sound (and vibration) are inherently bound to the laws of general relativity. As we move towards or away from a sound source, we will hear the sound source more loudly and clearly or less and less. Where we are, within the field of a phenomenon's influence, will directly correlate to our qualitative experience of said phenomenon.

Sound, like light, offers an array of subjective points of reference, scattered through the area of its influence. Every objective phenomenon has an array of indeterminate and incalculable subjective perspectives, depending on how we divvy up the surrounding field of influence, of said objective phenomenon (*do you know how many numbers are between 0 and 1?*)

Musical Relativism is the succinctly intentional and practiced use of sonic relativity within the act of composing music and framework of psychoacoustical composition. A musically relativistic composition is one that is composed to offer and encourage many modes of subjective physical interaction on the behalf of the listener.

This cookbook is a practical *hands/ears on* "how-to-guide" on how to tap into this expanded and multidimensional mode of music making, which makes use of didactic examples and listening exercises.

But before we dive into the practical aspect of this cookbook, we'll need to set the stage and introduce some key concepts:

Setting the stage: some key concepts

Spacetime, as described by Albert Einstein, *is a mathematical model that combines the three dimensions of space and one dimension of time into a single four-dimensional manifold.*

(Thanks Wikipedia/
https://en.wikipedia.org/wiki/Spacetime)

Sound as a medium and phenomenon is, by and by, one that occurs in the 4th dimension --> the 4th dimension being that of *time*. The 4th dimension includes the 3rd dimension, which we know to be **space**.

Interference, in physics, *is the net effect of the combination of two or more wave trains* [simple sinusoidal waves] *moving on intersecting or coincident paths. The effect is that of the addition of the amplitudes of the individual waves at each point affected by more than one wave.*

(Thanks Dictionary Britannica/
https://www.britannica.com/science/wave-front)

Sound, like light, fills any enclosed vessel it is projected into. As simple waves interact and overlap with one another in such a space, they will naturally come to a resting point, a natural state of stasis. In such a sonic situation a listener would be able to physically interfere, intercept and move through the presented waves, navigating the peaks, troughs and general physicality of said waves.

With regards to the topic of this cookbook, ***spacetime*** is very much the canvas and backdrop of a relativistic composition, whereas ***interference*** and the listener's physical interaction therewith are its *movements* (pun *somewhat* intended).

X,Y, Z

In the early 1930s stereophonic sound was invented and first utilised (Thank you, Alan Blumlein.) and since the late 1950s it has been the recording industry's standard for producing and playback. This standardisation was (and still is, really) a big and equalising deal, as from then on out there was a standard, a technological guideline to which listeners could hold themselves to.

The industry-push to stereo essentially levelled the playing field for all listeners, this allowed anyone with the means to purchase a stereo set up for their own homes, to hear the music as it was intended to be heard by musicians and producers.

Stereo, although it was inherently successful in its quest to add dynamic dimension to music via the use of two channels, is only the first techno-logical step in providing listeners with a more honed in and realistic aural representation of a captured sonic scene.

Since the acceptance of the stereophonic standard, there have been many variations and approaches to multichannel playback that both the industry and consumers have offered. Some essential examples include the more spatially accurate approach as seen by the initial and subsequent movements of Ambisonics, quadrophonic set ups (4.0) or the familiar 5.1 playback set ups.

These newer additions to the conversation have evolved to break free from the limitations of the Cartesian bound stereo format, in order to achieve a more realistic representation and playback of sound in real (space)time. Researchers and inventors were intent on the progression of sonic technology, so the first logical in breaking free from an X,Y axis was to add Z, or azimuth.

In other words, it would be nearly, if not completely, impossible to realistically capture a sonic scene in a 4 dimensional space and represent it realistically back with a sound system with two main output channels.

A system capable of re-presenting a given sonic scene would have to be able to parrot back a vast field of physical points in spacetime, as not to flatten the sonic scene, thus losing said sonic scene's integrity. There are such systems around (e.g Wavefield Synthesis), but they are hard to come by.

To get closer to a realistic representation of a sonic scene, researchers and artists, technicians and producers added more speakers and channels to the preexisting stereo set up.

This effort led to a series of varied approaches, including the movement of Ambisonics, binaural recording technologies and the wave field synthesis. As it is still a growing field, we are seeing the results of these new approaches sprout and become near ubiquitous realities...

With all of this backdrop in mind, the methodologies described in this here cookbook will lead to a bit of a technological tangent and a hint of friction, so to speak.

The purpose of the techniques in this cookbook lead to a multi-dimensional approach to music, while using any stereo (or mono!) set up, regardless of how many speakers and channels are involved. This will make more sense later on in the practical aspect of this writing and will be especially clear with the sonic examples.

In order to do just that, I have organised the different layers of the forthcoming examples into various **orders**. Each order will include a brief description, a brief sonic snippet and a short exercise for willing participants.

And without further ado, let's dig in:

Ingredients/Technical Requirements

For this the most basic recipe in this cookbook, we'll need these ingredients:

1. A sketch software, for time saving mockups (Max/MSP or PureData);

2. A reliable DAW, one capable of producing pure sinetones (e.g Audacity, Logic, Reaper, etc.);

3. A DAW with an exceptional EQ plugin/ or a VST in your reliable DAW;

4. A reliable set of speakers (mono or stereo- stereo is slightly better, but not necessary);

5. A somewhat open space for movement and playback;

6. A little proprioceptive consciousness and awareness of one's own movements.

Before any down and dirty composing, we need to figure out the basic and foundational maths of our composition. Most importantly is the "*nailing down*" of a tonic and the subsequent partials to come thereafter. I suggest the use of Miller Puckette's PureData (*Vanilla* or **Extended**, both get the job done with ease) or essentially any operable version of MAX/MSP. Additionally, for actual tone generation, I tend to use Audacity (a classic). These of course are just suggestions.

I personally enjoy PD as it is has a very simple interface, I can remember basic commands and it allows me to craft on the go mockups, before I begin generating any tones.

If you're interested in jumping in to PD and or Audacity:
https://puredata.info/downloads
https://www.audacityteam.org/download/

Something to consider when we're in this drafting stage are the relationships between frequency values that we want to work with. If we want to focus on highlighting the inherent relativity and physical navigability of our composition, we will want to pick tones that are either harmonic with one another or different enough in frequency value, as to not "muddy" or complicate the interactive component of our composition.

Let's take a look at how we can draft a mockup and compose a strong foundation for an inherently relativistic piece of music:

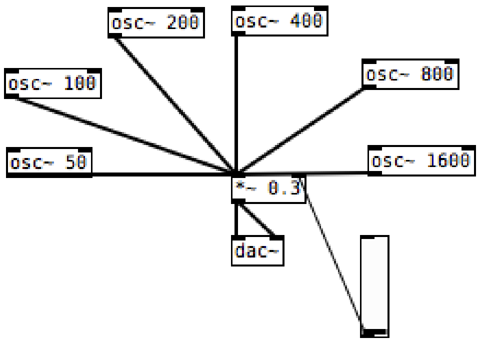
1st order

The first and integral step to beginning a relativistic composition is to select a tonic (or fundamental key, if you so wish and will). This value can basically be anything, as long as there is enough room on the frequency spectrum to expand into.

For example, and for the accompanying composition, I have used 50Hz: it is a low and rich tone, a nicely rounded off number and easy to work with mathematically. A rounded number will also come in handy, in the later stages of the composition if we’re using programs with decimal limitations.

From here, we will want to expand our frequency spectrum. In order to truly promote relativity within the composition, we will need to make sure that there isn’t too much unnecessary beating between our first layer of tones. We will also want the tones to be different enough in value, so we can easily pick them out, while listening. For the sake of these points, we'll use a **2:1 ratio**, which leaves us with:

- 50Hz,
- 100Hz,
- 200Hz,
- 400Hz,
- 800Hz and
- 1600Hz, respectively.



(a mock up "tonal tree" for this 1st order, as generated in PD)

Hands/ ears on exercise #1:

If you're interested in hearing how this first order sounds in space simply play "***Example #1/ 1st Order (Tonic)***" through your speakers at home.

- Be sure to move through your space, in order to get the full effect. It can help to pick a specific spot in space, or even two, to navigate towards, or between.
  - Notice how the sound changes with your movement through the space (and sound).
    - You can try turning your head, from left to right, at various speeds in order to oscillate and perform your hearing.
      - What do you hear?
        - Do your movements become the movements of the piece?

As waves take up physical space, each new wave in the sequence will fit twice into its predecessor. This will amplify the SPL (sound pressure levels) of the various tones and form a matrix of peaks and troughs within the space the piece will eventually be played in.

It is important that this first order is 'static' and comprised of **dry and unmodulated tones**, for two essential reasons:

- the first being that it is the reference tonic and foundation upon which we will build all future orders and it must not get in the way of future developments (it's a very fragile process!).

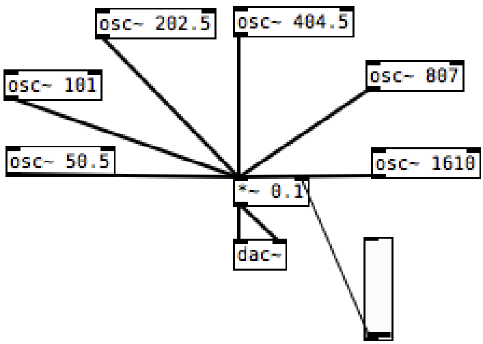
    - The second reason for this first order needing to be static is that it is much, much easier to become aware of the phenomenon of interference and tonal interactivity, if the tones presented are simple and easily traceable and interacted with in space

Now that we have our polyphonic tonic drone, let's complicate things a bit. In the 2nd order we'll add some acoustic beats to the mix , to add the element of polyrhythmic-*ity*:

2nd order

To add acoustic beating to the first order of our composition, we'll need to create a second layer of tones, that quite closely resembles the first. The second order's frequencies are going to be tweaked, in order to create burbly and bubbly pockets of wave swelling. For this composition, I've decided to use these values:

- 50Hz —> 50.5Hz (+0.5Hz)
- 100Hz —> 101Hz (+1Hz)
- 200Hz —> 202.5Hz (+2Hz)
- 400Hz —> 404.5Hz (+4.5Hz)
- 800Hz —> 807Hz (+7Hz)
- 1600Hz —> 1610 Hz (+10Hz)



(mock up for the 2nd order of additive tones)

Notice

the beat values: they are spaced this way to create enough syncopation in oder to give each beat its own space within the composition. If too many amplitudal wave peaks meet at one given point, they'll form a cluster and (subsequently) an amplitudal spike in space.

Syncopating and staggering the beats this way gives each individual line of frequencies and their respective beats their own physical space. In other words, staggering the beats this way will allow the listener to differentiate between different beats and their rhythms more easily.

For the second layer, I also typically decide to decrease the total volume of the layer, as I want the tonic layer to remain exactly that, the foundation. If we were to bring both layers to the same volume, we would loose a certain amount of dimensionality and the piece would become much more “percussive”.

(*For a deeper dive into acoustic beating as a compositional tool, head to page 23*)

Hands/ ears on exercise #2:

Just like in the first exercise, in this second exercise you can physically move through space, as "***Example #2/ 2nd Order (Polyrhythm)***" plays.

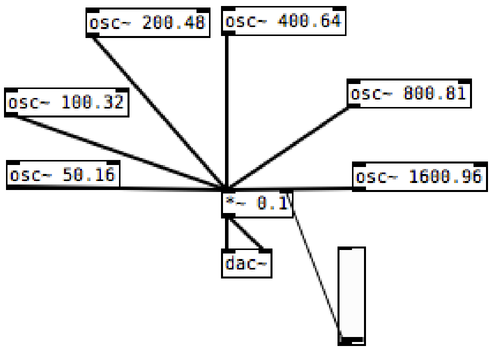
- As in the first exercise, it can help to pick a specific spot in space, or even two, to navigate towards, or between.
    - Be sure to move through your space, in order to get the full effect.
        - You can try walking slowly in a straight line, paying close attention to your own interception and interference with the different acoustic beats in space.
            - Can you navigate the various rhythms in your space?

3rd order

In the third order of this composition, I have added yet another variation of the first order. This third order will be a phasing layer, creating more depth and tonal angles within the composition.

Here's what that looks like:

- 50Hz —> 50.5Hz —> 50.16Hz
- 100Hz —> 101Hz —> 100.32Hz
- 200Hz —> 202.5Hz —> 200.48Hz
- 400Hz —> 404.5Hz —> 400.64Hz
- 800Hz —> 807Hz —> 800.81Hz
- 1600Hz —> 1610 Hz —> 1600.96Hz



(mock up for the 3rd order of additive tones)

As I drafted this piece in PureData, my restrictions within the decimal realm are a bit heavy. Time is nonlinear in this program and measured by each 1000units (1000units = 1 second). Likewise, any full number within a decimal will automatically round up.

Therefore I divided 100 (1 full cycle, within the program) by 6 (the number of oscillators I wished to craft), resulting in ~16.6 and gave each oscillator its own syncopated space within the phasing 100units.

A quagmire/quirk/limitation: the PD program will automatically round the .80 to .8, which results in a phenomenal temporal difference. This is why we have 800.81Hz, instead of 800.80Hz.

A work around to PD's rounding is the use of Audacity or any other program/DAW capable of basic tone generation. The more decimal points, the more nuanced the phasing will ultimately be...

Hands/ ears on exercise #3:

For this exercise, play "***Example #3/ 3rd Order (Phasing)***" in your space.

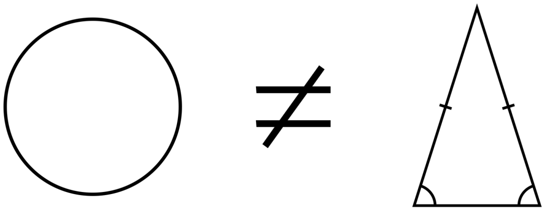
- Notice how the sound changes with your movement **and stasis** throughout the space and sound.
    - You might notice the long winded swelling now present in the mix.
        - Try standing still and listening to the room for a little while. What do you notice?
            - How does the addition of the 3rd Order effect the 1st and 2nd Orders?

4th order

As one of my personal goals in composing is objectifying the nature of objectivity and subjectivity as an interplay in interactive music, the next strata of the composition takes on a different waveform, namely a sawtooth wave.

In classical geometry, a shape's sturdiness is partially contingent upon how many points of potential breakage there are within the shape itself. In a sine wave, there are arguably infinite points of physical breakage, making corporeal interaction therewith quite easy.

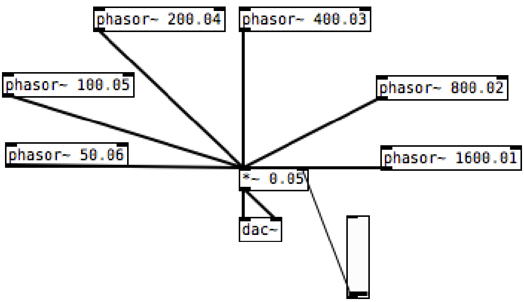
The sawtooth shape (an isosceles triangle) only has three points of breakage and therefore is both less likely to break upon impact or interaction with a body in space, as well as become buried within the various strata that make up the 4th dimensional soundscape.



As there are less points of breakage, the sawtooth wave also retains its harmonic partials to a higher extent, allowing it to truly stick out within the mix of the composition.

Metaphorically and from a physics standpoint, the sawtooth wave is a perfect object to contrast with the soft subjectivity of a sine wave. Instead of producing an oscillator object, we can use a *phasor~* object to produce the sawtooth wave. Its values look like this:

- 50Hz —> 50.5Hz —> 50.16Hz —> (saw) 50.06Hz
- 100Hz —> 101Hz —> 100.32Hz —> (saw) 100.05Hz
- 200Hz —> 202.5Hz —> 200.48Hz —> (saw) 200.04Hz
- 400Hz —> 404.5Hz —> 400.64Hz —> (saw) 400.03Hz
- 800Hz —> 807Hz —> 800.81Hz —> (saw) 800.02Hz
- 1600Hz —> 1610 Hz —> 1600.96Hz —> (saw) 1600.01Hz, respectively.)



(mock up for the 4th order of additive tones)

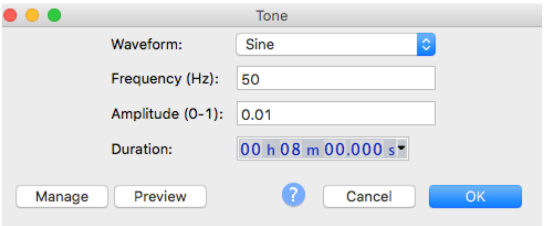
Hands/ ears on exercise #4:

For this next exercise, play "***Example #4/ 4th Order (SAW)***" in your space.

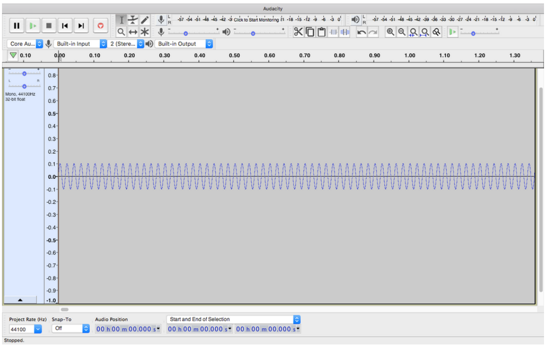
- Do you notice anything different?
    - How does the addition of these new waves effect the space?
        - How are they behaving, when compared to the sine waves?
            - Are they more easily traced?
                - More "objective"?

Now that we have the foundation for a piece prone to musical relativity, we can begin generating the actual content that will ultimately become the composition itself. You of course can use any software you prefer- my bias is towards Audacity: It's *simple*, <u>reliable</u> and **free**.

When generating each tone, we need to pay attention to certain amplitudes. As in most sound recording situations, it is best to leave enough room for later amplification in the editing stages. For this composition, I have opted to generate each tone at Audacity's linear 0.01db. This will be crucial later, as this will also afford us lenient headroom when we begin using equalising tools in the steps to come.

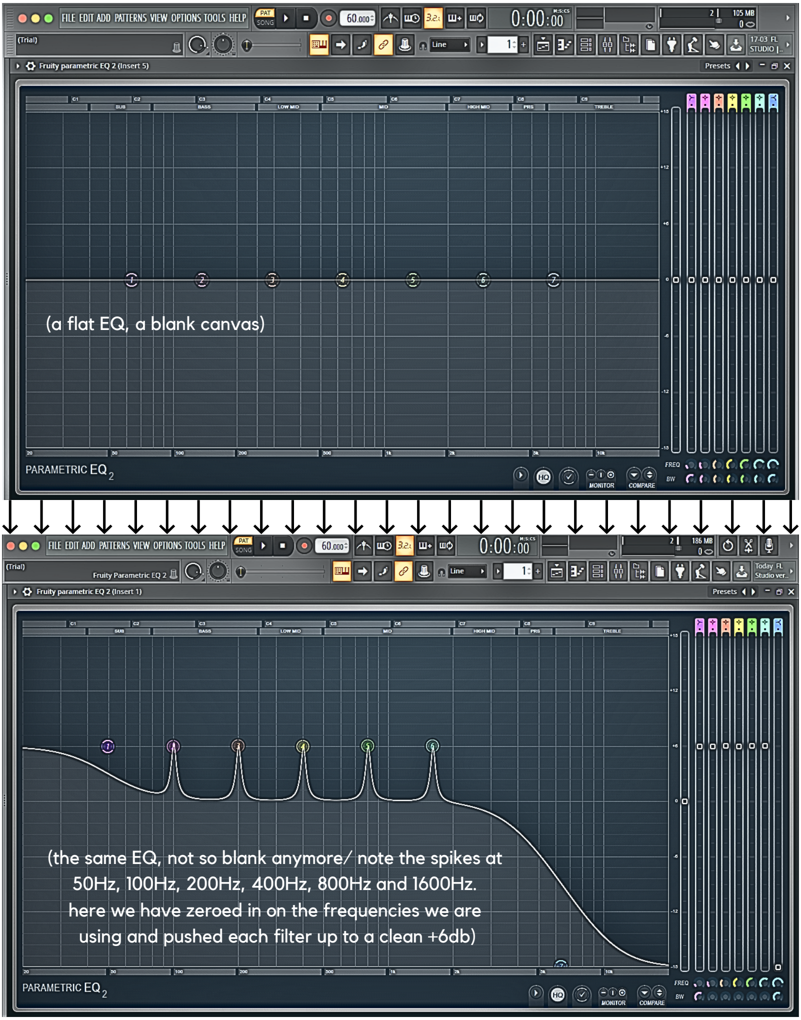


(tone generation in Audacity: rinse and repeat for each new tone)



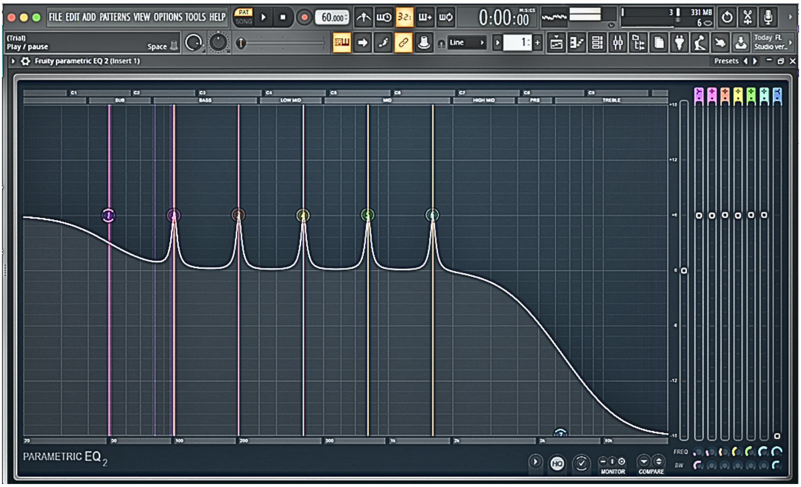
(a newborn tone, in the wild)

Next, we will need to import all the generated tones into your DAW of choosing and equip each track with a single, shared EQ. Best in show would be an EQ with more than sufficient points, as we will need to boost certain signals in the mix, at will:



Now that we have our 1st order and tonic set, we can go about adding in the 2nd, 3rd and 4th orders into our mix, linking them again to the same EQ. As the EQ's settings are specified for the 1st order, this 1st order will stand out most within the mix, but not by much. By focusing the EQ on the 1st order, we can create a dynamic mix and more spatial dimensionality to play with.

After all tracks have been successfully imported and hooked into the EQ, it should look something like this:



Here we can see the active bands, accentuated and amplified by the EQ. Notice how 800Hz is brighter than the other bands? We can attribute this to the harmonic partials stemming from the combination of all previous tones, as 800 is easily divisible by each preceding tone. Luckily, we can simply reduce the respective filter at any stage of this process.

Having completed these steps, we are able to weave more intricate tonal tapestries and compose more complex themes, making for a more dynamic composition. Using these techniques, we can compose musics in most genres, as long as we stick to single frequency waves and boost their amplitudes in spacetime.

We can play with the A.S.D.R of each individual wave track and freely compose arpeggios or fugues or sample various points of our generated tracks. What would a theoretical composition sound like with a few delays? What does an LFO triggered reverb do? How does a flanger effect the piece?

Experimentation is key.

In the case that you do decide to add more intricacies to the composition, beyond the simple foundational steps, it should be said that many effects and or VSTs, as beautifully and dynamic as they are, *may* ultimately distract or fully hinder the relativistic properties implemented in the foundational steps.

One of the reasons this work acts as it does in space, is because the sonic elements that make up the composition are the bare essentials, thus increasing the chances of our own physical interactivity with their unfolding in spacetime.

But *but* <u>but</u>, if we stick to using VSTs or FX that do not compromise the original EQing, the sky is the limit.

Next, we'll look at some more advanced techniques and approaches to the composing process, under musical relativism:

~~~*Superpositioning*~~~

From the Oxford Dictionary Online- "superposition (n.) is the action of placing one thing on or above another, especially so that they coincide." (Thanks again, Google/ google.com/search?q=define+superposition)

The combination of two waves (identical or not) will result in the phenomenon of *interference* and can either cause *constructive interference* (an amplitude increase of both waves) or *deconstructive interference* (an amplitudal decrease of both waves). The placement of the second wave will determine whether the ensuing interference is constructive or deconstructive.

Once we become familiar with this concept, we can weave some pretty fascinating tonal compositions. We can sequence and compose melodies which automate and activate in spacetime, lending a listener quite a few different interactive angles to sift through and to listen from.

The listener will be physically able to interfere with and hear the peaks and troughs of the various tones at various times - making interrelations between tones, whole chords, even whole areas within the space of playback.

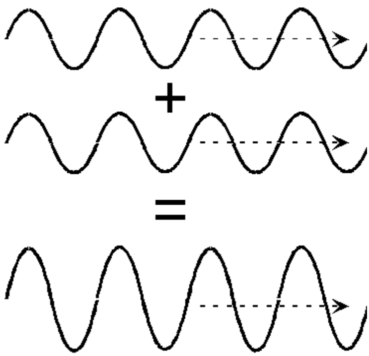
"*Example #5/ Superpositioning (1st Order Re-work)*" shows this all in action.

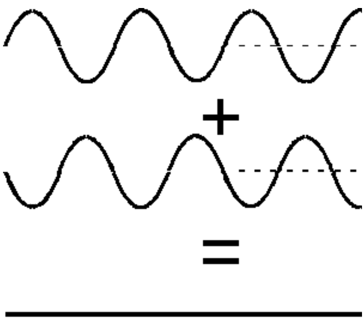
An example of superpositioning could be:

Say we have 100Hz and we want to add a second wave of 100Hz to the original:

Depending on when we decide to place the second wave, it will either amplify, nullify, or slightly phase with the original wave. The combination of the two tones results in a more complex wave.

If we are to add the second 100Hz to the first at an interval of 1 full second, the combined result of both waves will be an amplification of both waves, as both waves and their peaks and troughs will match up exactly, thus amplifying one another and causing constructive interference:





Alternatively, if we are to add the second wave at precisely 0.5 seconds, the second wave will nullify the first wave, leaving us with deconstructive interference.

(Thank you George Gibson and your useful html page/ https://www.phys.uconn.edu/~gibson/Notes/Section5_2/Sec5_2.htm)

Hands/ears on exercise #5:

Superpositioning

To play around with this tonal superpositioning, follow these steps:

1. Import "***Example 1/ 1st Order** (Tonic)*" into a DAW of your choice.

2. Duplicate this track, so that you'll have two identical tracks.

3. Play back the two combined tracks and listen closely.

4. Try moving the second track or delaying its playback, with regards to the first track.

Notice that depending on when you decide to add the second track to the first, the result will either amplify or reduce the combined output of the resultant track.

You can try many different placements of the second track in order to get varying results.

What do you hear?

Playing around with this additive approach can lead to some tonally intricate and sonically interesting results. When we begin to add more tones into the mix, nuanced correlations between tones begin to emerge. It's as if we begin to gain and hear new psychoacoustic insight in the mix, really squeezing the juice out of each tone and its variations.

The results can be melodic and spatially navigable. As new tones enter the mix, they boost or reduce and alter the total tonality of the mix. The same can be said about tones that are ending or leaving the total mix: every little tonal movement has a noticeable effect on the total composition.

Through the repetition of adding duplicate tones on top of one another, we can hear the various angles of the fundamental tone, while also creating more sophisticated timbres. When a tonal sequence is repeated at a specific temporal interval, the tones will naturally mix together and reveal one of myriad possible timbral combinations.

The "*real*" key for this technique, especially when looping: the tones should play for an extended period and not have a short (or non existent) release time/ the tones should be given enough playtime to reveal the phenomenon of interference with the newly added tones. This way our ears can get acquainted and used to the nature of the tones and allows us to pick up even the slightest changes within the mix.

On polyrhythmic approaches

Before I jump into this tangent I want to state that I use this term, polyrhythmic, in a very flexible manner. In “my definition” (let’s get real, it’s an opinion) an acoustic beat is an active signifier of polyrhythmic-ity.

If we define polyrhythm as the combination of 2 or more simple rhythms into one sonic object, then I argue that acoustic beats are simply rudimentary measurements and markers of a simple rhythm.

Moving forward, using the aforementioned methods in this cookbook, we can place acoustic beats within the acoustic space, making for a more dynamic and polyrhythmic experience for listeners.

In the 2nd order of the accompanying composition of this cookbook we added such elements to our fundamental layer. Here a few things to consider when adding acoustic beats, in order to introduce polyrhythm into a composition:

- If we want the presence of acoustic beating to be perceivable and traceable by the listener, we will want to keep the beat values relatively low.
    - Keeping the intervals low will also allow for a larger area of effect, as the the lower the beat interval is, the physically longer the beat itself will be. This will up any chance of the listener being able to experience and trace the acoustic swell in spacetime.
        - Another good reason to keep the beats low in frequency: It's near impossible to track and trace an acoustic beat that is occurring at 40Hz. At ~50Hz the beat itself seems more and more to be an independent tone, veering off from the two tones that gave way to it.
            - To avoid too much constructive interference, the beats should, ideally, be syncopated. When the beats are evenly spaced or share too many common denominators, the speakers will crackle, since these groupings will exert a certain amount of energy on the speaker itself.

How to calculate basic **beating** intervals:

Although this is very simple and perhaps known to some readers, it is important for me to chuck this one breakdown in here.

Without any fluff: to calculate an acoustic beat, we simply subtract the tonic frequency from the secondary frequency. Let's say we want to create an acoustic beat of 1Hz. We start with a tonic tone (eg. 100Hz) and add a secondary tone that is the same Hz value as the tonic plus whatever we want the beating interval to be.

So, let's say we use 100Hz as a tonic and want to produce a 1Hz beat. We would add 101Hz to the preexisting 100Hz. Both of the tracks will amplify the 100Hz aspect of their respective tracks, while leaving us with a resulting in a very low swelling of 1Hz. This swelling will come in the form of a pulse, which interferes with the 100Hz tone.

Or: 100Hz - 101Hz = an acoustic beat of 1Hz

P)))h))a)s(i((n(((g

Akin to the polyrhythmic nature of acoustic beats, a slow phase shift can also be used as a compositional tool, which can make for more dynamic and varied composition.

A **phase**, *in the mechanics of vibrations, is the fraction of a period (i.e., the time required to complete a full cycle) that a point completes after last passing through the reference, or zero, position.* (Thank you again Britannica/ https://www.britannica.com/science/phase-mechanics)

Phasing, in this context (there are many definitions of phasing in the audio world), *is the introduction of constructive or deconstructive interference to a pre-established signal.*

When phasing a signal, we'll begin at the reference point, or 0 degrees, although a full phase consists of 360 degrees. When we add a secondary wave, as we saw in the "*Superpositioning*" section of this cookbook, we have the opportunity to cause constructive or deconstructive interference, depending on what angle of phase we give this second wave. In other words, it takes two signals, in sync or offset, to create a phase-*shift.*

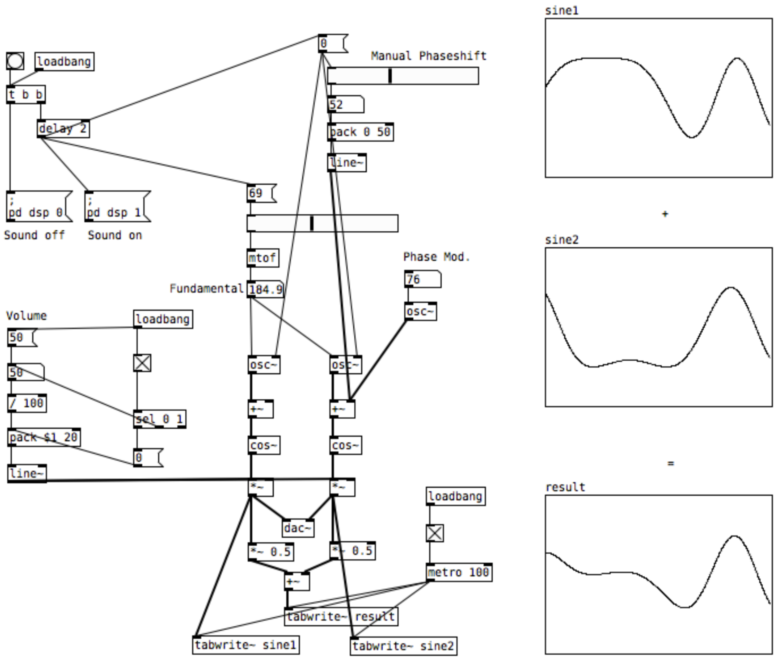
Phasing is a ubiquitous technique in electronic music composition and can be achieved by a wide array of DAW based VSTs or third party purchasable commercial plugins. Using a tone generation tool, such as any DAW based LFO, we can easily generate some tectonic decimal frequencies, which will take full on minutes or even hours to cycle through.

Another approach to phasing is the hands-on use of decimals. Examples of this can be seen previously in orders 2-4. (*In my examples, the decimal values of the additive frequencies are quite low, but we can definitely go lower.*) As stated previously, a phase is one full cycle, or period, of a wave's peak and trough.

Knowing this, I often simply generate new oscillators in PureData, alter their decimal suffixes and let the waves do their thing (old habits die hard).

For example, if I have one oscillator producing 440Hz and another producing 440.5Hz, I will have deconstructive interference, as it off-phase by precisely 180 degrees (***as 1Hz = 1 full cycle and 1/2 of 1Hz is 0.5Hz***).

For the sake of this cookbook and for ease, here is an example of a simple PureData phaser:



The frames on the right show both signals 1 & 2, as well as their combined result. If we change the "Phase Mod.", the phase angle of the second signal will be slightly altered, thus slightly altering the overall output of both signals. We can also use the "Manual Phaseshift" to temporarily phase the main output, much like a classic synth.

This nifty lil patch (Thanks for sharing, Jan Thoben!) is included on the thumb-drive accompanying this cookbook, as well as @ https://github.com/tyfyu/pd-patches-for-Musical-Relativism-A-Cookbook-. You're more than welcome to check it out for yourself, mess around and find out.

Otoacoustics

Other arenas in which this (tonal/musical) relativity take place are unfortunately limited. One shining example to cite is the masterful use of pure sinetones, in oder to induce inner ear distortions, or ***otoacoustic emissions***. First implemented in compositions for public consumption, **Maryanne Amacher** led and paved the way for the use of this extraordinary phenomenon in avant garde compositional practices, carrying an olympic flame of the psychoacoustic music genre.

Otoacoustic emissions are considered to be indicators for healthy inner ear (specifically the cochlea) function. Audiologists will perform a test in which two tones are played into a patient's ear and diagnostically listen back to hear if the inner ear of the patient is emitting an otoacoustic response. If a patient does not warrant or exhibit the emission, a diagnosis can be made as to whether or not the patient has hearing complications or if there is something else the matter with their inner ear.

In other words, a healthy ear will react to the two tones and distort the two signals into an inner ear sonic phenomenon, one that is completely local to the inner ear of the listener.

What’s fascinating is this: each of our ears respond differently to these prompt tones, as everyone’s ear is unique. Our ears are like our fingerprints: not so unique that we can't relate to and empathise with others, yet objectively different enough to warrant biological individuality.

Much like the inherent relativity found in the aforementioned tonal compositions, relativity can also be found within the cochlea of each individual listener.

What’s even more fascinating is that this otoacoustic result needn’t be linked to headphones and can take place spatially, like the other examples in this cookbook. The reason this works is that the tones used to trigger the emission are sinetones and are basically just higher in pitch (although, we could just as easily compose a tonally relativistic piece with high frequencies and sans otoacoustic emissions).

What's *perhaps* even more fascinating is what happens when we combine the concepts of polyrhythm or superpositioning **with** the otoacoustic touch. Some pretty weird stuff can be made, no doubt, and we'll be getting to sample some of those effects soon.

But first:

How to make your inner ear do that funny distortion thing:

1. Find a tonic frequency

(there are many sources and varied findings as to what spectrum of frequencies will work, so you might have to do some research and testing. I have seen mentions of frequencies as low as 500Hz producing results, so your guess is as good as mine. My personal sweetspot-spectrum begins ~ at 800Hz.)

2. Multiply this tonic frequency by any number between **1.20 and 1.23**

(the critical window of otoacoustic emissions within the average ear happen to fall within this range. so, for example, if we take 800Hz to be my tonic, multiply it by **1.22**, we will be given 976Hz as a result/ aka **800** *x* **1.22** = **976.**)

(Thank you Inter Acoustics/ https://www.interacoustics.com/academy/oae-training/otoacoustic-emissions)

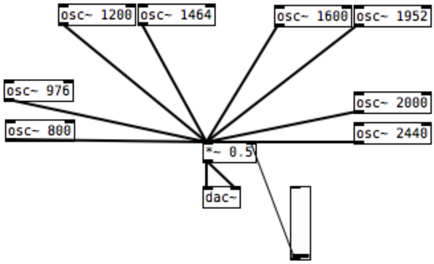
3. Play the tonic frequency and the new frequency back together at a higher db

(again, as there are many sources pointing to different playback levels, you might need to do some testing of your own/ keep in mind that you might need to play the tones back at a ridiculous volume in order to get that distorted result.)

Using this tidbit of knowledge, we can compose a spatially relativistic tonal composition like we did earlier in this book. We can add beats and phasing, making it more dynamic and inherently polyrhythmic. We can add an inner-ear relativism to the preexisting physical relativity of the lower waves.

Here's an example and excerpt of what an otoacoustic mock up could look like:

- 800Hz & 976Hz
- 1200Hz & 1464Hz
- 1600Hz & 1952Hz
- 2000Hz & 2440Hz



To hear what this sounds like, take a listen to "*Example #6/ Otoacoustic (Tonic)*"

Important: note the rather high frequency values listed above.

!

Do take care of your ears, dears.

In the special case of composing with the otoacoustic touch, something sticks out and does so beautifully: typically, when composing a melody, the space between two notes is just as important as the notes themselves (*/there is no up without down*). We pay attention to those silences and give them weight, as they are the contrast to the form and unfolding of a melody.

(In the case of an otoacoustic melody, this is perhaps slightly different, as the effect of the inner ear distortion can only truly occur when the right combination of tones collide and tickle our cochleas. We have to first trigger this sensorial phenomenon, before we shape it into something else. Once it is active, we can play with this inner ear sensation a little more.)

After the creation of an otoacoustic tonic layer, we can begin to utilise techniques previously mentioned in this here cookbook. So, for example (please see *"Example #7/ Otoacoustic Superpositioning (Simple)*") we can layer tracks in a superpositional manner, to derive interesting tonalities and inner ear timbres.

A more complex take (please see *"Example #8/ Otoacoustic Superpositioning (Complex)*") might have us layering different arpeggiated tone combinations upon one another, creating various striations of dissonance and superpositioning rhythms. In this example, we can hear the inner ear distortion itself be treated as an instrument and shaped by various interacting arpeggios, triggering at different speeds, at various times.

The superpositioning in these examples is different than previously mentioned superpositional approaches, as is in these cases the tones have a low or essentially nonexistent release period. This is done to avoid too many high frequencies layering and causing potential harm to the auditory system, of both the listener and my self.

Polyrhythm is also a possibility (please see *"Example #9/ Otoacoustic Polyrhythm"*), as is the phasing variation (please see *"Example #10/ Otoacoustics Spatialized"*) within the context of otoacoustic composing.

These are prime examples of spatialized otoacoustic emissions, allowing for physical movement through the distortion. In this case, the potential emission is treated as a sibling to the acoustic beat: abstractly, yet objectively, measurable in spacetime.

When played at the "correct" volume, we will be able to move from inner-ear-acoustic-beat to inner-ear-acoustic-beat via our own movements through the acoustic space.

S i t e Specificity

Another approach we can take is that of physically measuring a specific acoustic space from which we base our tonic off this initial measurement. Using the objectivity of wavelengths in spacetime, we can compose a contextually objective soundscape of tones- a music for a specific architectural and acoustic space.

Using basic maths (Thank you, Pythagoras) we can figure out the half, quarter or even eighth (or between and beyond, really) point of the initial tonic, crafting an intricate grid of possible interactions in spacetime. Using, once again, that 2:1 ratio, we can place waves within waves and also place nodes of wave interaction throughout spacetime.

If, for example, we have a space that measures 5.7m x 5.7m (an ideal situation, really) we can use this equation*:

λ = v/f,
where **λ** is the wavelength/ *lambda*,
v is 343m/s/ or the general speed of sound and
f is the frequency of the wave itself

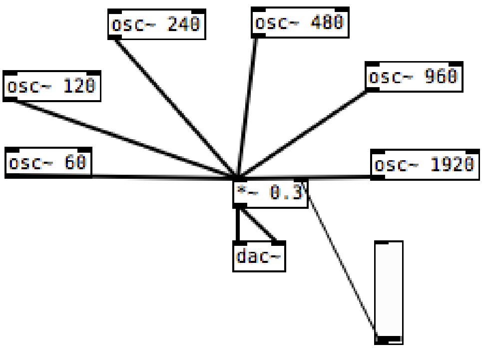
*to figure out that 60Hz fits perfectly within 5.7m/ one full cycle of 60Hz will occupy precisely 5.7m of space.

Using 60Hz as our tonic, we can then begin using the 2:1 ratio to add harmonic (or non-harmonic) frequencies to the mix.

This could (if we're keeping it real simple) look something like this:

- 60Hz
    - 120Hz
        - 240Hz
            - 480Hz
                - 960Hz
                    - 1920Hz

Or:



Of course, if we want to be truly site specific, we'll need to calculate the dimensions of the the speakers themselves and subtract their depth from the initial measurement.

One realistic further step would be to look at the specific speaker model and see if we can obtain blueprints for the speaker, then check to see where the actual transducer and cone of the speaker are situated within the speaker's housing and make that adjustment, getting us even closer to a site specific wave and tonic to base all other tones on.

We can even look into coverage angles (or the angle at which a speaker's output is most prominently perceived), crossover rates (or which cone of a given speaker will produce a specific frequency), as well as a speaker's specific latency.

Following these procedures will ensure a very tight-knit and site specific composition, modelled for a very specific space(time).

Relativism & Individuality

One thing that draws me to compose in this manner, time and time again, is the built in social aspect of these pieces. When cohabiting with an *other* in an acoustic space in which a tonally relativistic composition is playing, our movements or lack thereof have a physical effect on both the acoustic space itself, the perception of the other listener and, subsequently, on the composition itself.

As bodies in space absorb simple phenomena, such as light or sound, our physical presence and interaction with these base phenomena leads to a certain interactive complicity.

Let's say, hypothetically, you and I are in such an acoustic space and there is a gaggle of sinetones present in said space:

If you stand still and I begin to dramatically move through the standing waves within the space, you will be able to hear how my physical body acts as an organically absorbing baffle, in space. You hear the results of my movements, my interaction with tones in spacetime and vice versa. If I swing my limbs and body through the field of sound, I can oscillate the waves and act as a physical filter to the sound before it reaches you and your ears.

With this awareness, we can alter the composition together, through cheeky physical movement in shared spacetime. It's a special scene when listeners become aware of this interaction and begin to, as if they were in any other mundane situation, to perform space, as if it were a stage.

On the Indeterminate

Due to the nature of how interactive these pieces are with moving bodies through the acoustic space, the fact that these compositions warrant the use of an entire acoustic space as a field of tonal possibility and that an active audience, once introduced, warrants organically randomised parameters within a composition, I'd like to think this musical relativism has more than a tinge of indeterminacy.

While, in theory, we can map out and account for each unit of spacetime, we cannot know in advance the movements of an individual listener within the space will be and how their movement will factor into the space via interference.

Here, the indeterminate nature of a relativistic composition may not rely on the method of a composition, but rather how it is perceived within a specific playback context. Moving bodies and physical interaction play a key role in the composition, in the moment.

(**This <u>isn't</u> to say that a seated listening position is a *no-go*:**
it just isn't the only method of consumptive listening.)

What's perhaps more exciting is the newfound indeterminate element within the myriad combinations of various pure tones, varying acoustic spaces and their active listeners.

Taking into account that each acoustic space requires its own particular attributes based on architectural measurements, it's safe to say that a single relativistic composition played in two different acoustic spaces will not only produce different acoustic results, but that the aesthetics of the acoustic space itself will have a different effect upon each listener.

As the acoustic spaces in question are filled with the pure tones presented by this compositional method, the actual physicality of the tones comes into question as well. For example, an acoustic space with hard reflective surfaces might amplify a given tone within a relativistic composition, while subduing others.

The same exact thing might happen due to the physical dimensions of a space as well. It is seemingly impossible to imagine all of the myriad combinations and outcomes between acoustic spaces and a single relativistically oriented composition.

All of this complexity to say something really simple, something we all intuitively know: one cannot have the same exact experience twice. (Thank you, Heraclitus.)

Wrap Up

Somewhat *anticlimactically*, I'll say this: the phenomena described in this cookbook are essentially a combination of a simplification of sonic contents, a perspective shift on how space is used as a tool within the compositional process itself and the subsequent use of an EQ as a compositional tool.

The "*real"* secret behind a relativistic music is the use of single frequency tones and the intentional use of physical space as a compositional tool [and a big nod to discoveries in the fields of phenomenology and physics, especially those findings related to spacetime].

Arguably, part of why these compositions work the way they do is that elongated pure tones are not typically heard in nature, aside from (arguably) whale song or, say, the howling of wolves- but, I'm not sure I would want to be anywhere close enough to hear a wild howling wolf, for personal reasons.

It's the shifting of perspective of how a composition is traditionally composed, a reimagining of a composition's sonic content and how it interacts with spacetime, that eventually allows the listener to have their own internal perspective shift.

The beauty in these processes is not that they are inextricably complex, but rather that they warrant a paradoxical simplicity. This simplistic (but not necessarily easy) inversion from technological complexity to tonal simplicity potentially warrants the inherent focus on space as an integral element of a composition and, consequently, the reintroduction of agency, physical and mental, to the curious listener. As the main parameter of the a relativistic composition needn't be the presently accessible technology, the anchor parameter diffuses and is dispersed to the cognition and physical agency of each listener.

It is my hope that this cookbook serves as an accessible jumping off point for more (*and more and more!*) experiments in the field of multi-dimensional music making and that the concepts and methodologies presented in its pages have yielded phenomenally insightful results when wielded by practicing composers.

Happy composing/exploring/chewing

Thank you for your time, attention, and understanding,
Ben Glas