

# Harmony of the Spheres

Cosmology and number aesthetics in 16th and 20th century music.

Giso Grimm - ORLANDOviols

Contemporary compositions for period instruments are often motivated and based on a carefully considered concept. This marks the first in a series of articles analysing such programmes, as we take a closer look behind the scenes of their concepts, and reasons behind combining contemporary and period performance.

The movements of celestial bodies have long held a particular fascination to mankind. From ancient Greece through to the 16th century, astronomers and philosophers carefully studied the movements of celestial bodies and developed precise models of their trajectories. Based on their observations, scientists believed that all things in the universe, and specifically the sun, the

moon, and the five planets known at that time (Mercury, Venus, Mars, Jupiter and Saturn), moved in universal harmony to each other. From a theological point of view, the world was seen as a huge

divine temple filled with music in the proportions of the celestial spheres. Both the theological and the philosophical concept of celestial relationships was known as the 'Harmony of the Spheres.' In the early 17th century, scientists such as Abraham Bartolus (*Musica Mathematica*, 1614), Athanasius Kircher (*Musurgia universalis*, 1650) and, above all, Johannes Kepler (*Harmonices Mundi*, 1619) devised music theory from the celestial motions.

This fascination with mathematical and astronomical regularities and patterns inspired many composers, most notably during the 16th and the 20th centuries; a time when the aesthetics of numbers and

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omnia (infinita in potentia) permeantes actu: id quod aliter à me non potuit exprimi, quam per continuam seriem Notarum intermedia.



proportions played a large role in the arts, from architecture to music. Although this fascination never completely disappeared, its influence on musical composition played a somewhat reduced role in compositions from the baroque period through until the mid 20th century.

Number aesthetics within musical compositions can be found in various forms; directly in the measure of music, in the number of voices, in the structure of the pieces, and sometimes buried deep in the rules of algorithmic compositions. Numbers of particular interest are three (holy trinity, perfection), four (the four elements earth,

water, air and fire; tetractys), five (pentagram, symmetry in nature), six (hexagram, six cardinal directions, perfect number) and seven (genesis).

Whereas the above mentioned concepts are related to symmetry, proportions and perfection, it is a subtle deviation from this regularity which creates the musical content in the genre of twentieth century 'minimal music.' These alterations can be small changes in the harmony, or temporal shifts in a regular rhythmic pattern, or, even more subtle, the deviation can sometimes be found in the overall structure of a musical work.

A number of pieces following these historical and mathematical concepts have been selected for the concert programme Harmony of

the Spheres: The composers include Giovanni Pierluigi Palestrina, Mr. Picforth, Christopher Tye and Nicholas Stogers from the 16th century, and Arvo Pärt, Steve Reich, Lee Santana and John Cage from the 20th century. In addition to the musical content, the spatial dimension of the underlying concept is emphasised, both by a unique isotropic set-up of the performers around the audience, and the electro-acoustic spatial processing of the historical instruments. (see fig 1.) In a concert, the five musicians are positioned on the corners of a large regular pentagon. Within this pentagon

a '3rd order Ambisonics system' (see fig 2.) is built using ten loudspeakers on a decagon. This system is then used to create a sound field around the audience (who sit within the pentagon formed by the five players), where the perceived location of the instruments can be manipulated by controlling the signal processing, and thus creating a choreography of dynamically moving – or virtually dancing – musicians.

The sound processing and presentation is carefully tuned to the multifaceted sound qualities of the instruments, by applying only

moderate amplification and by choosing distortion-free processing schemes. Psycho-acoustic aspects, such as the breakdown of precedence effect, are accounted for to ensure that the perceived sound is dominated by the digitally processed sounds, and not by the acoustically played instruments.

## The Programme

Musically, the programme *Harmony of the Spheres*, is centred around the piece “*In Nomine*” by Mr Picforth, an unknown Englishman from the 16th century. In this composition each of the five voices represents one of the five planets recognised at that time. Each of these five parts contain a different note value which does not alter throughout the piece. E.g. the first voice has minims throughout, the second has dotted minims throughout, the middle voice has whole notes, the fourth voice has breves, and the bottom voice has dotted whole notes throughout (see below). This

results in a pulse proportion of 12:8:6:3:4. The parts move like the planets on their trajectories; alternating between opposition and conjunction. The tempo proportions correspond to the distance of the planets to the sun: The voices belonging to the inner planets Mercury, Venus and Mars differ by only a crotchet, whereas the outer planets Jupiter and Saturn differ by a minim. Similarly, the

distance between Mars, Jupiter and Saturn is significantly larger than the distance between Mercury, Venus and Mars. The illusion of planets moving on their trajectories is projected into the space of the concert hall. As each planet has its own speed, the music is perceived from ever-changing spatial constellations. The trajectories are modelled after three different systems of celestial mechanics:

**Ambisonics** is a method of approximating a sound field within a number of loudspeakers (surround sound). As oppose to conventional techniques, such as stereo sound, Ambisonics can reproduce complex mixtures of many sources – imagine throwing a stone into a puddle, which will create concentric waves, which could be reproduced with one loudspeaker. Throwing three or more stones at different places into one puddle will show a complex pattern which cannot be created with one or two loudspeakers; multi-channel techniques are needed for this. The spatial precision and size of the usable “sweet spot” when using an Ambisonics system can – roughly spoken – be increased by increasing the number of loudspeakers – this is referred to ‘Higher Order Ambisonics’ (HOA), i.e. 1st order Ambisonics system, 2nd order Ambisonics sstem, 3rd order Ambisonics system etc.]

Fig. 2

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The musical score shows five staves, each representing a planet's voice. The top staff is labeled 'Mercury' and uses minims. The second staff is 'Venus' with dotted minims. The third is 'Mars' with whole notes. The fourth is 'Saturn' with breves. The bottom staff is 'Jupiter' with dotted whole notes. The key signature is one flat (Bb) and the time signature is common time (C).

The five voices of the piece *In Nomine* by Mr. Picforth represent the five planets known at the time of composition.



Sound out my voice!

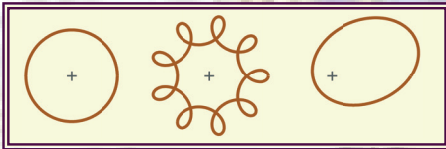
ORLANDOviols' latest CD release. See their website for more details: [www.orlandoviols.de](http://www.orlandoviols.de)

## The Models

1. The first naive system originates from the beginnings of ancient Greek astronomy and became famous again in the middle ages: The planets are mounted on invisible spheres around the earth, thus moving in circles.

2. The second system is attributed to Claudius Ptolemy, and was derived by careful observation of the planets. Although the earth is still thought to be in the centre of the universe, the planets are moving on more complex epicycles.

3. The third system was proclaimed by Johannes Kepler. He found that the planets move on elliptic paths around the sun.



With its extreme regularity, the In Nomine by Mr Picforth is a bridge to the 20th century minimal music. Whereas this 16th century composition is perfectly regular, the subtle deviations from perfection are particularly evident in the opus Violin Phase by Steve Reich, composed in 1967. This piece, originally written for violin and tape recorder or four violins, is played as Viol Phase for five viola da gambas. A short sequence (see Fig 3.), using six different notes, is continually repeated throughout the entire piece. This sequence is initially performed in unison until one player is very gradually to speed up until they are a quaver ahead

of the player who stayed in time with the original motif. These minimal tempo changes, and the resulting time shifts, lead to new melodic motives. Phase shifts are matched with subtle drifts in space, and the odd new motif briefly enters and shines through the basic pattern of the main motif.



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Another minimal composition in this programme is Music for Viols by Lee Santana (composed in 1988). Comprising three movements: Prelude, Chaconne and Postlude, the central chaconne is based on the interval of a third, and a strong homophonic sequence which is built up from stacked fourths and fifths. These elements are experimented with in the form of variations, and the contrast between polyphonic contrapuntal melodies and homophone clusters offers a large spectrum of intensities. The spatial processing aims to emphasise the musical contents: homophony with its grounded character is represented by a very direct static sound, located at the positions of the real musicians, and higher "celestial" melodic motifs are represented by a larger distance from the audience. Quick movements on unsteady trajectories underline

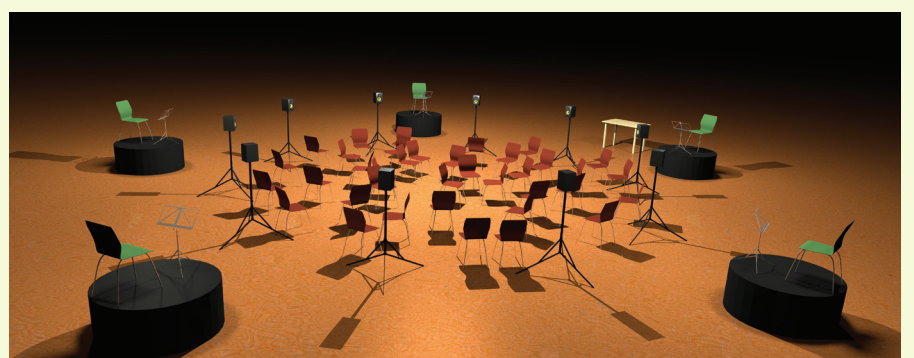
the chaotic climax of the Chaconne. As the piece returns to the calm of the opening Prelude, so too does the choreography of the 'moving' players, as their virtual positions return to their actual ones.

For the spatial processing and monitoring, the sound of the five acoustic instruments is

picked up using closely positioned microphones. These signals are processed on a computer running a Linux workstation, which is optimised for low-delay audio processing. The

## Technical Specifications of the Programme

processed signal rendered in 3rd order Ambisonics format is fed into a decoder for the specific loudspeaker system. Applications which control and create the dynamic spatial configuration have been specifically developed for this concert and have been integrated into a set of open source Ambisonics software such as AmbDec from Fons Adriaensen. Besides the presentation through the loudspeakers, the microphone



Concert setup for the programme Harmony of the Spheres

Fig. 1

Fig. 3

signals are also routed to the musicians for an individual in-ear monitoring mix. This makes it possible for the performers to achieve precise rhythmic control, despite the large distance between them. High quality sound reproduction with a flat frequency response, low distortion and moderate sound levels are essential for this electro-acoustic performance.

The concept of spatial presentation of acoustic instruments in a concert situation – and thus in low delay real-time – is unique. Moreover, this concept can be directly incorporated into new compositions and offers composers a new tool for spatial presentation of period instruments, which, until now, was available only for electronic music.

The ensemble ORLANDOviols is a viol consort, inspired by the historical context of consort music but also open to the sounds of our modern communication society. Although all members are successful as soloists, transparency and communication in polyphonic music and a common consort sound is of greatest importance to ORLANDOviols. The concept and realisation of the audio signal processing has been developed by Giso Grimm, who, besides being a professional



musician, also works as a physicist in the area of hearing aid research, with a focus on algorithm development and low-delay audio processing, at the University of Oldenburg, Germany.

Harmony of the Spheres can be summarised as a concert programme which utilises multi-loudspeaker setups for spatial presentation, to deliver cosmological concepts in music and to achieve a unique listening experience for the audience. The authors believe that with this kind of concert, the audience is offered a spatial approach to the musical content, which is not possible in a traditional set-up of the stage with a frontal presentation. Not only the set-up around the audience, but also the dynamically changing “choreographies” contribute to this perception. Modern technology and inputs from psycho-acoustic research have been considered during the planning and also performance of this programme. The sound processing has been carefully tuned to the period instruments and aims to provide the audience with a concert experience of unprecedented intensity.

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Gemma Hayler: The Virgin and Child with Angels © The National Gallery, London



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