# Lux Aeterna

Patrick Keefe

PREFACE

This work, a setting of the *'Lux Aeterna'* (*'Eternal Light'*) communion antiphon of the Requiem mass, is designed to explore how light and colour might be expressed in music. The premise is to try and realise colour in sound, as interpreted by composers such as Olivier Messiaen, but through an empirical method rather than synesthetic experience. The relationship between colour and sound is most prominently explored in the harmonic language employed. The piece is not in any key in the tonal sense, but rather makes use of certain 'shades'. These are calculated by taking the average frequency in Hz (values taken from Craig F. Bohren (2006) *Fundamentals of Atmospheric Radiation: An Introduction with 400 Problems*) for each of 6 colours of the visible spectrum - Red, Orange, Green, Yellow, Blue, and Purple. These frequencies are divided by 440 Hz (A) in order to give a constant. This is the constant for that particular 'shade', so there is Red-Shade, Orange-Shade, Green-Shade, e.t.c. Dividing the original average frequencies by the constant for each 'shade' gives a hexachord of tones. These tones can then be approximated to the nearest equal-tempered pitch, using values as given by the Physics Department of Michigan Tech University. For instance, Red-Shade contains the pitches A, Bb, B, Db, Eb and F. Thus a 'yellow' note in Green-Shade and a 'yellow' note in Blue-Shade will have different approximate pitches. The purpose of this system is to give the composer a 'palette' of tones he can use. In other words, instead of the colour 'green', for instance, mapping only to a single pitch, it now can be mapped to a set of pitches, from which the composer can select during composition.

To provide a framework for this composition, I have chosen to model the phenomenon of aurorae. Gladimir V.G Baranoski, Justin Wan, Jon G. Rokne and Ian Bell's *Simulating the Dynamics of Auroral Phenomena* (ACM Transactions on Graphics, Vol. 24, No. 1, January 2005) has been invaluable. The different colours of aurorae are produced by solar wind exciting molecules of oxygen and nitrogen in the atmosphere. The most prevalent observable shades are green/blue and red/orange, and these colours differ depending on the type of molecule excited and the height of the molecule when it is excited. Therefore, the main sections of this piece are in a mixture of Orange-Shade and Red-Shade, and Green-Shade and Blue-Shade. The two-stanza text fits this structure, with the first stanza centrally Orange/Red, and the second centrally Green/Blue. The former colours are harder to see, and this has been translated as having a softer dynamic, with the latter colours expressed louder. The dynamic trajectory of this piece is derived from a wave, with pianissimo rising to fortissimo at the centre of the work and returning to pianissimo for the conclusion, in line with the appropriate dynamic for each shade. This is to follow the principle established by NASA's THEMIS mission   the period of oscillation of magnetic field strength of the earth from weakest to strongest to weakest is 6 minutes, which consequently is the work's duration. The climax of the work thus occurs 3 minutes in, when an overlap of auroral colours is imagined. The composer's palette is therefore doubled in size, being able to use pitches from Red-, Orange-, Green-, and Blue-Shades, and increased expressivity is permitted.
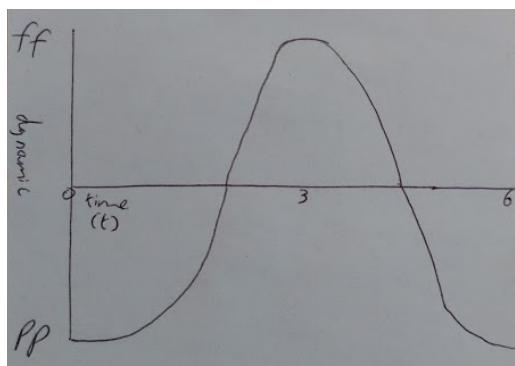
The Baranoski et al. study also finds that aurorae have certain different shapes, two of which, folds and spirals, have been modelled here. The folds are more evident, seen in the rising and falling lines that set the first 'cum sanctis' line. The spiral section has been modelled using the golden spiral, with proportions in line with the Fibbonaci sequence, as demonstrated on the following page.
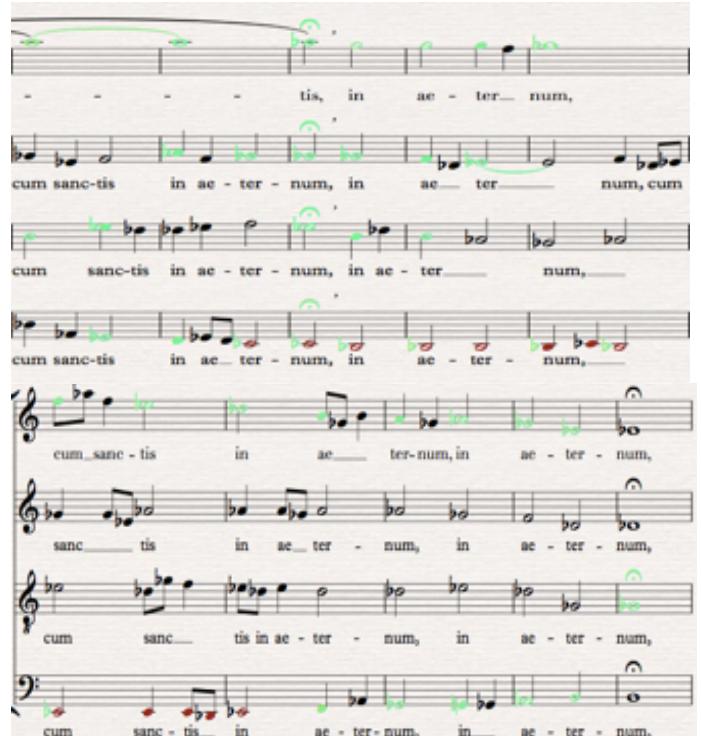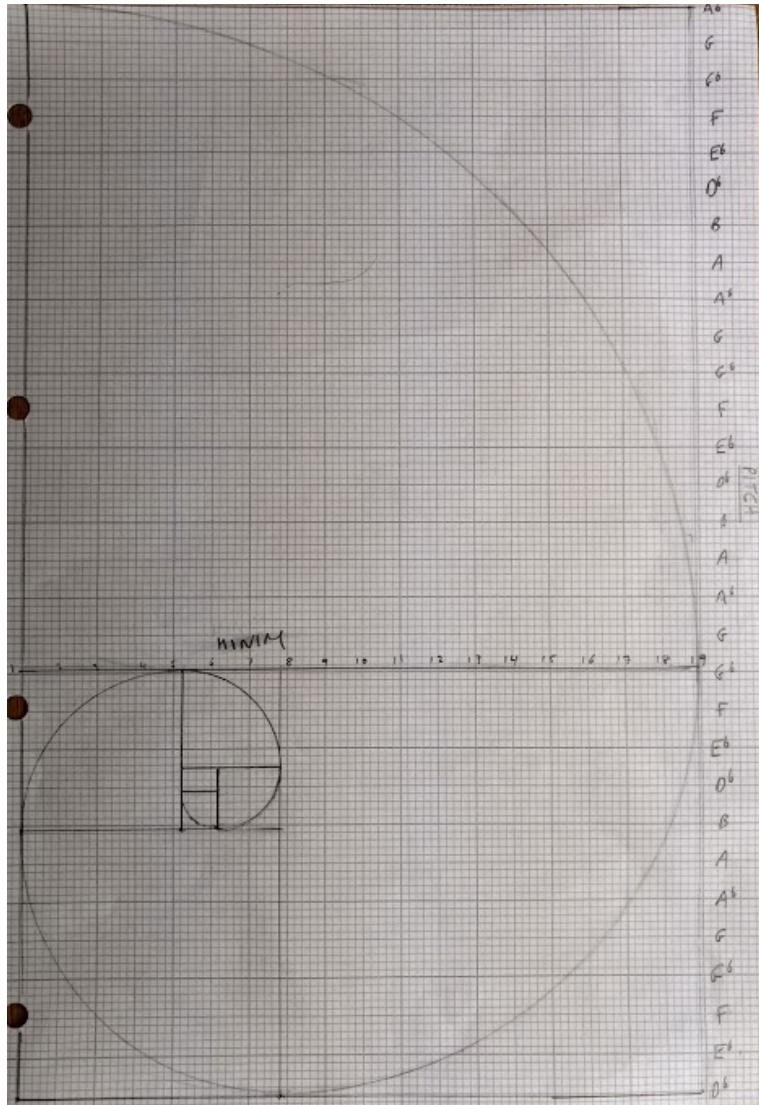
At the required dynamic (forte) a potential range for the voices is conceivably from Db (2) to Ab (5). In Green/Blue compound tuning, there are 8 available pitches (Eb, F, Gb, G, Ab, A, B, Db). Across the desired range, this adds up to 29 available pitches, which form the y-axis of the golden spiral diagram. To find out the x-axis, we must divide by the golden ratio φ, as the start of a number of operations.

$$29 \div \varphi = 17.9229856737 \approx 17.9 \text{ (1. d. p)}$$

The x-axis must therefore be approximately 18 units (in this case centimetres) in length, meaning there are 19 time values, 0-18 inclusive. I decided these units should be minims, as spirals are longer than other auroral shapes. Using these values as a starting point, a golden spiral can be constructed, and the corresponding closest pitch read off for each minim. As shown in the excerpt above (bars 55-64), these values are spread across the SATB voices as they enter, forming a 'spiral matrix', indicated by the green colouring.

The theory behind this piece has been designed with a composer's freedom as its main focus. Instead of creating mathematical certainties that result in a composer inputting values and recording the outcomes, this system imposes creative restraints and scaffolds within which the composer is free to work. The composer is therefore free to express themselves, whilst still being true to the mathematical, scientific or 'natural' conditions they are emulating. General aesthetic inspirations for how I have used my system come from pandiatonic works such Morten Lauridsen's *O Magnum Mysterium* and his own *Lux Aeterna*, Aaron Copland's *Appalachian Spring*, James MacMillan's *Christus Vincit* and Ned Rorem's *String Quartet no. 2*.

Lux aeterna, luceat eis, Domine,
cum sanctis tuis in aeternum,
quia pius es.
Requiem æternam dona eis, Domine;
et lux perpetua luceat eis;
cum Sanctis tuis in aeternum,
quia pius es.

Lux Aeterna

TENOR

(solo)

Lux ae - ter - na, Lu - ce - at e - is Do - mi___ ne.

Lento ♩ = 60

misterioso e affettuoso

1

S — Lux___

A — *pp sotto voce* — Lux ae - ter - na, Lux ae - ter - na___

T — *pp sotto voce* — Lux ae - ter - na, Lux ae - ter - na___

B — *pp sotto voce* — Lux ae - ter - na, Lux ae - ter - na___

5

S — ae - ter - na, Lux ae - ter - na,

A — Lux___ ae - ter - na, Lux ae - ter - na,_

T — Lux___ ae - ter - na, Lu___ ce - at e - is,___

B — Lux___ ae - ter - na, Lux ae - ter - na,_

* This intonation may alternatively be performed by an alto.

18

cum sanc-tis tu_____ is in ae - ter_____ num,

cum sanc - tis tu_____ is in ae - ter - num,

ne, cum sanc-tis in ae - ter - num,_____

ne,

ne, cum sanc-tis - tu____ is_____ in ae_____

21

in ae - ter - num, qui -

in ae - ter_____ num, cum sanc-tis tu_____ is in ae - ter_____num,

in ae-ter_____ num, cum sanc - tis tu____ is in ae - ter_____ num,

ter_____ num,_____ in ae_____ ter____ num,

25

- - a pi_____ us es,

qui_____ a pi - - us es,

qui_____ a pi - - us es,

qui - - a_____ pi - us es,

brilliante

tutti

Lu - ce - at___ e - is, Lu - ce - at___ e - is;

Lu - ce - at e - is, Lu___ ce - at e - is;

Lu - ce - at___ e - is,

Lu - ce - at e - is, Lu - ce - at___ e - is;

Lu - ce - at___ e - is,

Lu - ce - at___ e - is, Lu - ce - at e - is;

magico

sanc - - - - - - - -

cum sanc - tis

cum sanc - tis cum sanc___ tis

cum sanc___ tis

- - - - - - - tis, in ae - ter___

cum sanc - tis in ae - ter - num, in ae___ ter -

cum sanc - tis in ae - ter - num, in ae___ ter -

cum sanc - tis in ae___ ter - num, in ae - ter -

ritmico

Oxford, Christmas 2016