

Scott McLaughlin

## The Dirac Sea: Folds in Continuous Fields

Written for Ilan Volkov and BBC Scottish Symphony Orchestra 2020  
Duration: 20 minutes

## Instrumentation:

1 piccolo  
 2 flute  
 2 oboe  
 1 cor anglais  
 2 clarinet  
 1 bass clarinet  
 2 bassoon  
 1 contrabassoon

4 french horn  
 2 trumpet (plunger mutes)  
 2 trombone (plunger mutes)  
 1 bass trombone (plunger mute)  
 1 tuba

3 bowed cymbal players - all using bass bows and small (20mm) superball mallets  
 (cymbals are anchored in place on weighted stands)

strings 10.10.10.8.6  
 (cellos/bases use special preparations, supplied with score)

## Layout

The three cymbal players are placed front of stage, near to stage-edge and in front of other players.  
 - player 1 in the centre, near the conductor.  
 - players 2 & 3 far left and right of stage respectively.

## Programme notes:

“[all particles] are merely the excitations or fluctuations in completely continuous quantum *fields*. Quantum fields are nothing but matter in constant motion (energy and momentum). They are therefore never ‘nothing’, but more like a completely positive void (the flux of the vacuum itself) or an undulating ocean (appropriately called ‘the Dirac sea’) in which all discrete things are its folded-up bubbles washed ashore, as Carlo Rovelli puts it in *Reality Is Not What it Seems* (2016). Discrete particles, in other words, are folds in continuous fields.  
 [...]”

Lucretius [55BC] put forward the first materialist philosophy of an infinitely continuous nature in constant flux and motion. Things, for Lucretius, are nothing but folds (*duplex*), pleats (*plex*), bubbles or pores (*foramina*) in a single continuous fabric (*textum*) woven by its own undulations. Nature is infinitely turbulent or perturbing, but it also washes ashore, like the birth of Venus, in meta-stable forms [...]”

– Thomas Nail (2019) <https://aeon.co/ideas/is-nature-continuous-or-discrete-how-the-atomist-error-was-born>

## Performance Instructions:

Score in C (picc is 8ve higher than written, contrabass/contrabassoon are 8ve lower)

[Individual parts have more detailed descriptions and instruction.]

### Non-vibrato throughout.

**Intonation:** all instruments sometimes use techniques that may cause notes to go flat, this is fine (desirable even).

**Dynamics:** generally the piece is very quiet, but notes should sound clearly and not break-up (except where requested).

**Repetition and colour:** repeated notes can be varied in colour/intonation to quite radical degrees (at player's discretion).

**Glissandi** should always be smooth and gradual; aim to produce beats with other instruments.

**Articulation/attacks:** I've tried to avoid these in general. Try to make all entries as quiet/smooth as the instrument allows.

Flutes/Oboes:

- **gradual overblow** should gently bring the 1st harmonic into focus, while also trying to keep fundamental and harmonic balanced.

Clarinet:

- **underblown** multiphonics should try to balance both pitches: drop the jaw a little and loosen lip pressure to focus on the lower pitch without losing the upper pitch.

Brass:

- **air sounds**, if possible these should have a hint of pitch.

- **split-tones** should be smooth rather than raucous

Percussion:

- cymbals require both hands to play, so must be firmly secured and weighted to avoid them falling-over from bow pressure.

- cymbals should sound continuously through the bars of wavy-lines, stopping only for notated rests.

- for 'continuous stable pitch', one hand should pinch the cymbal at a marked place while bowing at another marked place.

- bowing should be upbow/downbow at whatever speed and pressure is required to maintain that pitch: multiphonics and other unexpected pitches may occur, this is fine, gently steer the instrument back to the single pitch.

- 'explore near' means to move either the muting or bowing hand in the vicinity of the marked points to find other pitches: usually harmonics/multiphonics of the main pitch. Always long notes; or as long as the cymbal allows.

- 'explore far' means to mute the cymbal in different places, finding a succession of different pitches: always long notes.

- 'free/no-muting' means remove the muting hand, or steady cymbal at the bell. Sound can be more raucous but not excessively so.

- superball mallets must be 20mm (small heads). Larger heads cause too much 'wobble' and don't sustain high pitches.

- superball should be rubbed as continuously as possible about 1cm in from the cymbal edge. Maintain a steady tone but some beats and small deviations are expected. Avoid sudden changes and 'whale sounds'.

Strings:

- generally, each player should bow independently, not as a section.

- some notated harmonics are very difficult; where tiny difference in finger/bow position result in a different harmonic. If you play the wrong harmonic, don't try to fix it, just sustain that one instead. Smooth texture is more important than specific pitch.

- harmonic glissandi shouldn't sound like portamento, but instead bring out individual harmonics as you pass over them.

- long passages are an opportunity to experiment with different colours shifting continuously, just keep the changes smooth.

- bow noise should be smooth, not chaotic: like a grainy vocal 'shhh', not a guttural sound.

- *m.s.p/m.m.s.p* (molto-sul-pont/molto-molto!) should allow some splitting of the sound into upper harmonics. Don't let this get chaotic, keep it smooth.

- *m.m.s.p* (molto-molto-sul-pont) should be as near as possible to playing on the bridge.

String Preparations (cello/bass):

- these plastic 'polo-mint' shapes are inserted between the strings: see parts for position instruction. Different bow positions produce different pitches or harmonics: the left-hand does nothing. Notation is a three-line stave showing bow position between the preparation (bottom line) and the bridge (top line), with the middle line meaning a point approximately equidistant from these. Each note is a single bow (1 upbow OR downbow) so some are longer than others: specific duration here is flexible, use rubato, respond to the sound.

- generally alternate up/down-bows. In some positions up/down-bows will produce different pitches (this is intended).

- generally, a light bow pressure is better here: long and light bowing produces pitches rather than scratchy-tones.

- louder dynamics are better achieved with light and fast bowing than pressure.

- bowing near the preparation (bottom line) often produces a very low and quiet tone, which may need 'pushing out' for more presence.

- the preparations are distributed to maximise different random pitches (as well as the main pitches E and D): if the instrument offers you different pitches, allow them to come out.



The Dirac Sea: Folds in Continuous Fields

Scott McLaughlin

♩ = 54

Piccolo

Flute 1

Flute 2

Oboe 1

Oboe 2

Cor Anglais

Clarinet in B♭ 1

Clarinet in B♭ 2

Bass Clarinet in B♭

Bassoon 1

Bassoon 2

Contrabassoon

Horn in F 1

Horn in F 2

Horn in F 3

Horn in F 4

Trumpet in B♭ 1

Trumpet in B♭ 2

Trombone 1

Trombone 2

Bass Trombone

Tuba

bowed cymbal 1

bowed cymbal 2

bowed cymbal 3

Violin I

Violin II

Viola

Violoncello

Contrabass prep III.IV

Contrabass prep I.II

*ppp* (beating between flutes)

*ppp*

*pp*

*pp*

breath attack

(\*) (no re-attack, hold full duration)

*p*

*mp*

*ppp*

*pp*

breath attack

(no re-attack, hold full duration)

*p*

*mp*

*ppp*

pos.1 continuous stable pitch, no intentional break in sound (until rest bars)

pos.1 continuous stable pitch (as perc.1)

pos.1 continuous stable pitch (as perc.1)

less >>>

>> more

explore near mute-point

explore near mute-point

explore near mute-point

solo, divisi

II bow noise only

III

gently, harmonic emerges

ppp

con sord (glass/metal?)

solo

*pp*

solo, divisi

III bow noise only

IV

gently, harmonic emerges

ppp

Preparations

senza misura: (optional rubato, up to half a bar delay)

*p*

senza misura ends

Div. 8<sup>va</sup> III IV

*ppp* (slow bows with gentle swells)

(\*) pause in b.2 should be about 10 seconds, but depends on how long the trumpets can hold those notes without re-attack.

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Picc. *ppp*

Fl. *ppp*

Fl. *ppp*

Ob. *pp*

Ob. *pp*

C. A. *ppp*

Cl. *pp* *pp* *pp*

Cl. *pp* *pp*

B. Cl. air sound *f*

Bsn.

Bsn.

Cbsn. *ppp*

Hn. 1 air sound *f*

Hn. 2 *less* air sound *f*

Hn. 3 air sound *f*

Hn. 4 air sound *f*

Tpt. 1 air sound *f*

Tpt. 2 air sound *f*

Tbn. air sound *f* plunger *pp*

Tbn. air sound *f* plunger *pp*

B. Tbn. air sound *f*

Tba. air sound *f*

Perc. pos. 1 continuous stable pitch explore near mute-point

Perc. pos. 1 continuous stable pitch explore near mute-point

Perc. pos. 1 continuous stable pitch

Vln. I vibrato (gentle) bow noise with hint of pitch *m.s.p.* *pppp*

Vln. II (as vln I) *m.s.p.* *pppp*

Vla. (as vln I) *m.s.p.* *pppp*

Vc. (as vln I) *m.s.p.* *pppp*

Cb.pIII/IV *m.m.s.p.* bow beside bridge, light/fast *ppp*

Cb.p/II *m.m.s.p.* bow beside bridge, light/fast *ppp*

senza misura: (extreme rubato, up to half a bar silent) preparations *mp*

preparations *mp*

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Picc. *ppp*

Fl. *ppp* very gradual overblow

Fl. *ppp* very gradual overblow

Ob. *ppp* very gradual overblow

Ob. *ppp* very gradual overblow

C. A. *pp*

Cl. *ppp*

Cl. *ppp* -31c 'dark'

B. Cl. *p*

Bsn. *p*

Bsn. *p*

Cbsn. *p* 'dark'

Hn. 1 *ppp* (sim)

Hn. 2 *ppp* (sim)

Hn. 3 *ppp* (sim)

Hn. 4 *ppp* (sim)

Tpt. 1 *p* breath attack *mp*

Tpt. 2 *p* breath attack *mp*

Tbn. *ppp* plunger (sim)

Tbn. *ppp* plunger (sim)

B. Tbn. *p* con sord

Tba. *p* con sord

Perc. *L.v.*

Perc. *L.v.*

Perc. explore near mute-point *L.v.*

Vln. I

Vln. II

Vla. solo  $\phi$  IV = *sul pont* *p* *pp* (upper line) (solo) *pp* (div: half of section free bowing very gradual gliss ad-lib v. slow gliss until B, +/- 1/4 tone, always returning to E) (div: rest of section enters on D) free bowing very gradual gliss

Vc. *pp* (div: half of section free bowing very gradual gliss ad-lib v. slow gliss until B, +/- 1/4 tone, always returning to D)

Cb. p.III/IV *senza misura ends*

Cb. p.I/II

*cresc all until orch*

Picc.

Fl.

Fl.

Ob.

Ob.

C. A.

Cl.

Cl.

B. Cl.

Bsn.

Bsn.

Cbsn.

*ppp* < *p* > (sim)

*ppp* < *p* > (sim)

*pp*

*ppp* (sim)

*ppp* (sim)

Hn. 1

Hn. 2

Hn. 3

Hn. 4

Tpt. 1

Tpt. 2

Tbn.

Tbn.

B. Tbn.

Tba.

different colour/intonation  
each entry (until b.93)

*ppp* (sim) (as Hn. 1)

*ppp* (sim) (as Hn. 1)

*ppp* (sim) (as Hn. 1)

*p* breath attack -31c *mp* *p* breath attack -31c

*p* breath attack *mp* *p* breath attack

Perc.

Perc.

Perc.

Vln. I

Vln. II

Vla.

Vc.

Cb. p.III/IV

Cb. p.I/II

III, muted  
Divisi, free bowing

(very light bow) *ppp*

ad-lib v. slow gliss until B,  
+/- 1/4 tone, always  
returning to E

*m.s.p*

*nat.*

free bowing very gradual gliss  
(div: rest of section enters on E)

*pp*

ad-lib v. slow gliss until B,  
+/- 1/4 tone, always  
returning to E

*m.s.p*



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Picc.

Fl.

Fl.

Ob.

Ob.

C. A.

Cl.

Cl.

B. Cl.

Bsn.

Bsn.

Cbsn.

Hn. 1

Hn. 2

Hn. 3

Hn. 4

Tpt. 1

Tpt. 2

Tbn.

Tbn.

B. Tbn.

Tba.

Perc.

Perc.

Perc.

Vln. I

Vln. II

Vla.

Vc.

Cb. p.III/IV

Cb. p.I/II

Divisi, bow independently muted

ppp (very light slow bow)

p

move slowly between *nat.* and *m.s.p* (sustain 8ve and 12th harmonics when they emerge every few bars (until b.182). Gentle swells to *p* sometimes.)

*m.s.p* *nat.* *m.s.p*

*nat.* *m.s.p* **-> nat** *m.s.p*

95

Picc. *pp* *pp* *pp* *ppp*

Fl. *pp* *ppp* *pp*

Fl. *pp* *ppp* *pp*

Ob. *ppp* *pp* *ppp* *p*

Ob. *ppp* *pp* *ppp*

C.A. *pp* *mp* *ppp* *mp*

Cl. *ppp* *pp*

Cl. *ppp* *pp*

B. Cl. *pp* *pp* *pp* *ppp*

Bsn. *ppp*

Bsn. *ppp*

Cbsn. *pp* *pp*

Hn. 1 *pp* *pp*

Hn. 2

Hn. 3

Hn. 4

Tpt. 1 *mp* *pp* *ppp* breath attack *ppp* attach mute

Tpt. 2 *mp* *pp* *ppp* breath attack *ppp* attach mute

Tbn. *pp* *pp* *pp* *pp* pos. 2

Tbn. *pp* *pp* *pp* *pp* split tone: pos. 3½ pos. 1

B. Tbn. *pp* *pp* *pp* *pp* split tone: pos. 2 pos. 1D

Tba. *pp* *pp* *pp* *pp* split tone: valve 1+2

Perc. Perc. Perc.

Vln. I every 2nd or 3rd bow should be a harmonic of the note you're playing. e.g. touch 3rd/4th/5th (until b.80) *p* (no more harmonics, written pitch only)

Vln. II

Vla. *nat.* *m.s.p*

Vc. *nat.*

Cb. p.III/IV

Cb. p.I/II

more winds to balance horn

110

Picc. *pp* *p*

Fl. *p* *ppp* *ppp*

Fl. *p* *ppp* *ppp*

Ob. *p* *p* *ppp*

Ob. *p* *ppp*

C. A. *mp* *p*

Cl. *p* *p* *p*

Cl. *p* *p* *p*

B. Cl. *p* *pp*

Bsn. *pp*

Bsn. *pp*

Cbsn. *pp*

Hn. 1 *p* (T+1+2) *p* (T+1+2)

Hn. 2 *pp* *pp*

Hn. 3 *pp* *pp*

Hn. 4 *pp* *pp*

Tpt. 1 con sord *ppp* con sord *ppp*

Tpt. 2 con sord *ppp* con sord *ppp*

Tbn. *ppp* con sord *ppp* con sord *ppp*

Tbn. *ppp* con sord *ppp* con sord *ppp*

B. Tbn. con sord *pp* con sord *pp*

Tba. con sord *pp* con sord *pp*

Perc. pos. 1 mostly continuous, sometimes vary bow-speed/pressure *p*

Perc. pos. 1 mostly continuous, sometimes vary bow-speed/pressure *p*

Perc. pos. 1 mostly continuous, sometimes vary bow-speed/pressure *p*

Vln. I (slow ad-lib bowing, intonation should subtly vary across players) *pppp* *pp* *pppp*

Vln. II Div. a 4, con sord I *p* II *p* III *p* IV *p*

Vla. *pp* *p*

Vc. *m.s.p* *pp* *p*

Cb. p.III/IV

Cb. p.I/II

begin to move bow gradually between extremes of pont/tasto. Only shift position between bows. Each player independent.

Picc. *p* *pp*

Fl. *ppp* *ppp*

Fl. *ppp* *ppp* *ppp*

Ob. *ppp*

Ob. *p*

C. A. *p*

Cl. *pp* *p*

Cl. *p* *p*

B. Cl. *pp* *pp*

Bsn. *pp* *pp*

Bsn. *pp* *pp*

Cbsn. *pp* *pp*

Hn. 1 *p* (T+1+2) air sound <f>

Hn. 2 *pp* air sound <f>

Hn. 3 *pp* air sound <f>

Hn. 4 air sound <f>

Tpt. 1 con sord *ppp* air sound <f> air sound <mf>

Tpt. 2 con sord *ppp* air sound <f> air sound <mf>

Tbn. con sord *ppp* air sound <f>

Tbn. con sord *ppp* air sound <f>

B. Tbn. con sord *pp* con sord <f>

Tba. con sord *pp* con sord <f>

Perc. *ppp* *ppp* *ppp* L.v. <p> L.v. <p> L.v. <p>

Vln. I *pp* *pppp* begin dropping out (subtly) by desks, front desk first con sord (glass/metal?) solo #5

Vln. II *p*

Vla. *p*

Vc. preparations senza misura: (extreme rubato, up to half a bar ad libit.) *p* more

Cb. p.III/IV preparations *p*

Cb. p.I/II preparations *p* more



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Picc.

Fl.

Fl.

Ob.

Ob.

C. A.

Cl.

Cl.

B. Cl.

Bsn.

Bsn.

Cbsn.

Hn. 1

Hn. 2

Hn. 3

Hn. 4

Tpt. 1

Tpt. 2

Tbn.

Tbn.

B. Tbn.

Tba.

Perc.

Perc.

Perc.

Vln. I

Vln. II

Vla.

Vc.

Cb. p.III/IV

Cb. p.I/II

pp > < pp > < pp >

pp

pp

pos. 1 continuous stable pitch

pos. 1 continuous stable pitch

5-finger mute, slight *sul pont.*, bow noise only, long slow bows, independent

div. III (keep muting)

div. IV (keep muting)

< mf > p

(as vln. I)

div. III (keep muting)

div. IV (keep muting)

< mf > p

(as vln. I)

div. IV (keep muting)

< mf > p

(not *senza misura*)

(as vln. I) mute across the preparation

IV (keep muting)

< mf > p

(as vln. I) (keep muting)

II (keep muting)

< mf > p

(as vln. I) (keep muting)

III (keep muting)

< mf > p

explore far

explore far

m.s.p

nat.

m.s.p

nat.

m.m.s.p (allow gentle splitting)

m.m.s.p (allow gentle splitting)

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Picc.

Fl.

Fl.

Ob.

Ob.

C. A.

Cl.

Cl.

B. Cl.

Bsn.

Bsn.

Cbsn.

Hn. 1

Hn. 2

Hn. 3

Hn. 4

Tpt. 1

Tpt. 2

Tbn.

Tbn.

B. Tbn.

Tba.

Perc.

Perc.

Perc. explore far

Vln. I

very gradually unmute from noise to harmonic

ppp

p

m.s.p

Vln. II

very gradually unmute from noise to harmonic

ppp

p

m.s.p

Vla.

m.m.s.p (as vc)

mf

ppp

p

Vc.

(allow gentle splitting)

mf

ppp

p

very gradually unmute from noise to pitch

nat.

m.s.p

(allow gentle splitting)

Cb. p.III/IV

mf

mf

p

very gradually unmute from noise to harmonic

Cb. p.I/II

mf

mf

p

m.s.p

(as Cb above)

193

Picc. Fl. Fl. Ob. Ob. C. A. Cl. Cl. B. Cl. Bsn. Bsn. Cbsn.

Hn. 1 Hn. 2 Hn. 3 Hn. 4 Tpt. 1 Tpt. 2 Tbn. Tbn. B. Tbn. Tba.

Perc. Perc. Perc.

Vln. I Vln. II Vla. Vc. Cb. p.III/IV Cb. p.I/II

5-finger mute, slight *sul pont.*, bow noise only, long slow bows, independent

very gradually unmute from noise to harmonic

very gradually unmute from noise to harmonic

very gradually unmute from noise to harmonic

senza misura: (cresc. rubato, up to half bar ad lib)

push up to cymbals' level



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Picc. *pppp*

Fl. *pppp*

Fl. *ppp*

Ob.

Ob.

C. A.

Cl. *pppp*

Cl. *ppp*

B. Cl.

Bsn.

Bsn.

Cbsn.

Hn. 1

Hn. 2

Hn. 3

Hn. 4

Tpt. 1

Tpt. 2

Tbn.

Tbn.

B. Tbn.

Tba.

Perc. explore far

Perc. stable pitch 1

Perc. explore near

Perc. stable pitch 1

Perc. free: no muting

Perc. free: no muting

Perc. free: no muting

Vln. I *m.s.p* very gradually unmute  
div. III from noise to harmonic  
*p*

Vln. II *div.* II very gradually unmute  
IV *m.s.p* from noise to harmonic  
*p*

Vla. *div.* very gradually unmute  
IV from noise to harmonic  
*p*

Vc.

Cb. p.III/IV *m.m.s.p* light bow II  
*ppp*

Cb. p.I/II *m.m.s.p* light bow III  
*ppp*

Picc. Fl. Fl. Ob. Ob. C. A. Cl. Cl. B. Cl. Bsn. Bsn. Cbsn. Hn. 1 Hn. 2 Hn. 3 Hn. 4 Tpt. 1 Tpt. 2 Tbn. Tbn. B. Tbn. Tba. Perc. Perc. Perc. Vln. I Vln. II Vla. Vc. Cb. p.III/IV Cb. p.I/II

Flute turned-out, extremely breathy, only hints of pitch. Breathing where needed. *ppp*

Flute turned-out, extremely breathy, only hints of pitch. Breathing where needed. *ppp*

underblown *ppp* underblown *ppp*

underblown *ppp* underblown *ppp*

*ppp* air *[f]*

*ppp* air *[f]*

*ppp* air *[f]*

*ppp* air *[f]*

*ppp* con sord air *[f]*

*ppp* con sord air *[f]*

*ppp* con sord air *[f]*

*ppp* con sord air *[f]*

*ppp* con sord air *[f]*

*ppp* air *[f]*

*ppp* *[f]*

*ppp* *[f]*

*ppp* *[f]*

*ppp* *[f]*

*ppp* *[f]*

*ppp* *[f]*

so *p*

tacet: take superball

tacet: take superball

edge pitch continuous *p*

edge pitch continuous *p*

edge pitch continuous *p*

superball: edge pitch continuous *p*

preparations senza misura: (centrare rubato, up to half a bar ahead) *pp* *p* *m.m.s.p* *pppp*

preparations senza misura: (centrare rubato, up to half a bar ahead) *p*

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**Woodwinds:**  
Picc.: *ppp*  
Fl. 1: *ppp*  
Fl. 2: *ppp*  
Ob. 1: *ppp*  
Ob. 2: *ppp*  
C. A.: *ppp*  
Cl. 1: *ppp* (underblown), *p*  
Cl. 2: *ppp* (underblown), *p*  
B. Cl.: *ppp*  
Bsn. 1: *ppp*  
Bsn. 2: *ppp*  
Cbsn.: *ppp*

**Brass:**  
Hn. 1-4: *ppp*  
Tpt. 1-2: *ppp*  
Tbn. 1-2: *ppp*  
B. Tbn.: *ppp*  
Tba.: *ppp*

**Strings:**  
Vln. I: *ppp*  
Vln. II: *ppp*  
Vla.: *ppp*  
Vc.: *ppp*  
Cb. p.III/IV: *p*  
Cb. p.I/II: *p*

**Percussion:**  
Perc. 1-3: *L.v.*