Emiliano Imondi

String Qua(ntum)rtet

per Quartetto d'Archi

for String Quartet

(Liberamente ispirato al mondo della Fisica Quantistica)

Freely inspired to the world of Quantum Physics

NOTA DI PROGRAMMA

La composizione è liberamente ispirata al mondo e ai concetti della fisica quantistica in generale e della meccanica quantistica in particolare. Questi principi oltre a ridisegnare la scienza del nostro tempo hanno modellato il pensiero filosofico della società moderna. Il brano è diviso in 9 momenti liberamente correlati alle leggi fondamentali (equazioni matematiche) e al loro contenuto filosofico:

I. Chi Lancia i Dadi?: riferito alla natura probabilistica del mondo quantistico in cui non sempre vale la legge di causa-effetto.

II. Sovrapposizione I: se un sistema può trovarsi in due stati distinti, può trovarsi anche in una qualsiasi loro combinazione lineare (sovrapposizione).

III. Il Paradosso del Gatto: ispirato al paradosso del "Gatto di Schrodinger", un esperimento mentale ideato da Erwin Schrodinger che mette in luce come la natura probabilistica della realtà quantistica e il principio di sovrapposizione portino a manifestazioni bizzarre nella realtà in cui il gatto può essere morto e vivo allo stesso tempo.

IV. L'entanglement e le sue Inquietanti Azioni a Distanza: riferito alla famosa frase di Einstein sullo strano fenomeno della correlazione quantistica in cui due sistemi possono essere "intrecciati" e interagire anche a grande distanza in modo istantaneo violando apparentemente il principio per cui la velocità della luce non può essere superata.

V. Sovrapposizione II: come Sovrapposizione I.

VI. Onde Probabilistiche: ispirato all'equazione di Schrodinger che governa la dinamica (l'evoluzione nel tempo) dei sistemi quantistici definendone le caratteristiche (funzione d'onda) mediante leggi probabilistiche.

VII. Una Strana Dualità: basato sullo strano comportamento ondulatorio-corpuscolare delle particelle elementari espresso dalla legge di De Broglie.

VIII. Figure di Interferenza: rappresentazione musicale del famoso "esperimento della doppia fenditura" che all'inizio del '900 diede il via alla meccanica quantistica facendo scoprire la doppia natura delle particelle subatomiche che al tempo stesso si comportano come onde e come corpuscoli.

IX. Relazioni di Indeterminazione: una mia personale trasposizione musicale del famoso "Principio di Indeterminazione di Heisenberg" che incrinò il sistema scientifico e le sue basi filosofiche mettendo in luce i limiti della fisica dimostrando che è impossibile conoscere contemporaneamente per una particella sia la sua posizione che la sua velocità oppure la sua energia e la sua durata.

PROGRAM NOTE

The piece is freely inspired by the world and concepts of quantum physics in general and quantum mechanic in particular. These concepts, besides redesigning the science of our time, have shaped the philosophical thought of modern society. The piece is divided into 9 moments freely inspired by the fundamental laws (mathematical equations) and their philosophical content:

I. Who Rolls the Dice?*: referred to the probabilistic nature of the quantum world in which the law of cause and effect is not always valid.*

II. Superimposition I*: if a system can be in two distinct states, it can also be in any linear combination of the two states.*

III. The Cat's Paradox*: inspired by the conceptual experiment of "Schrodinger Cat" which highlights how the probabilistic nature of quantum reality and the principle of superimposition lead to bizarre manifestations in macroscopical world in which the cat can be dead and alive at the same time.*

IV. Entanglement and its Spooky Actions at a Distance*: referring to Einstein's famous phrase about the strange phenomenon of quantum correlation in which two systems can be "intertwined" and interact even at great distance in an instantaneous way apparently violating the principle that the speed of light can not be overcome.*

V. Superimposition II*: same as Superimposition I*

VI. Probabilistic Waves*: inspired by the Schrodinger equation that governs the dynamics (the time evolution) of quantum systems by defining their characteristics (wave function) through probabilistic laws.*

VII. A strange Duality*: based on the strange wave-corpuscular behavior of the elementary particles expressed by De Broglie's law.*

VIII. Interference Figures*: my musical representation of the famous "double-slit experiment" which, at the beginning of '900, has started the quantum mechanics making discover the double nature of subatomic particles that at the same time behave like waves and like corpuscles.*

IX. Uncertainty Relations*: my personal musical transposition of the famous "Heisenberg's Uncertainty Principle" which cracked the scientific system and its philosophical bases highlighting the limits of physics showing that it is impossible to know, at the same time for a particle, both its position and its speed or its energy and its duration.*

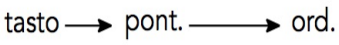
Legenda

1/4 bemolle
1/4 flat

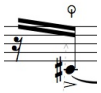
3/4 bemolle
3/4 flat

1/4 diesis
1/4 sharp

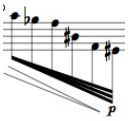
3/4 diesis
3/4 sharp



Muovere l'arco gradualmente dalla tastiera al ponticello e verso la posizione ordinaria
Gradually move the bow from the fingerboard to bridge and to the ordinary position

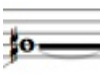


Bartòk Pizzicato (Snap)



Accelerando/Rallentando gradualmente e liberamente
Freely and Gradually Accelerando/Rallentando

Tremolo libero non misurato
Not measured Tremolo



Prolungare il suono per tutta la durata del tratto di unione
Keep the sound for the entire duration of the line

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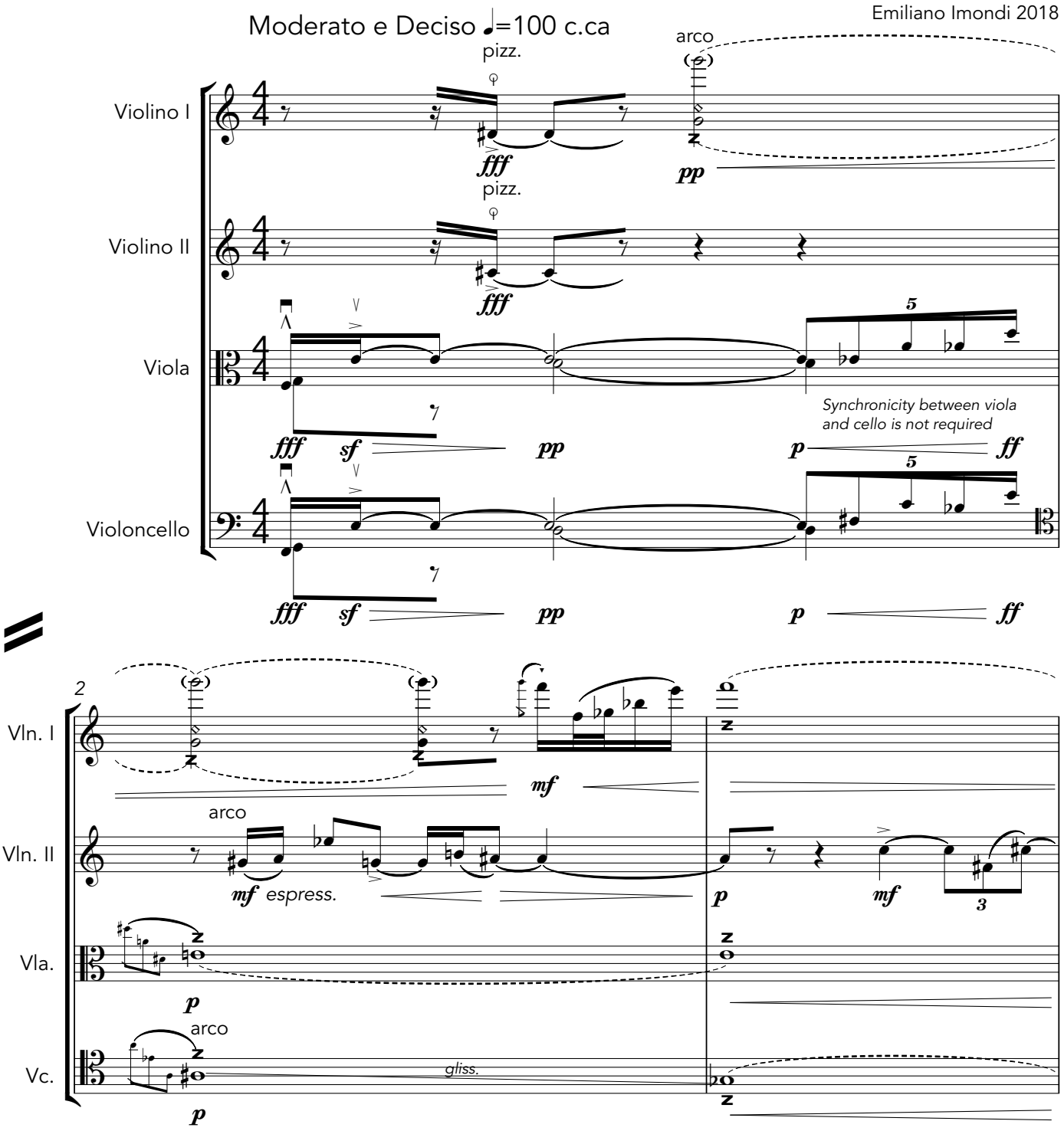
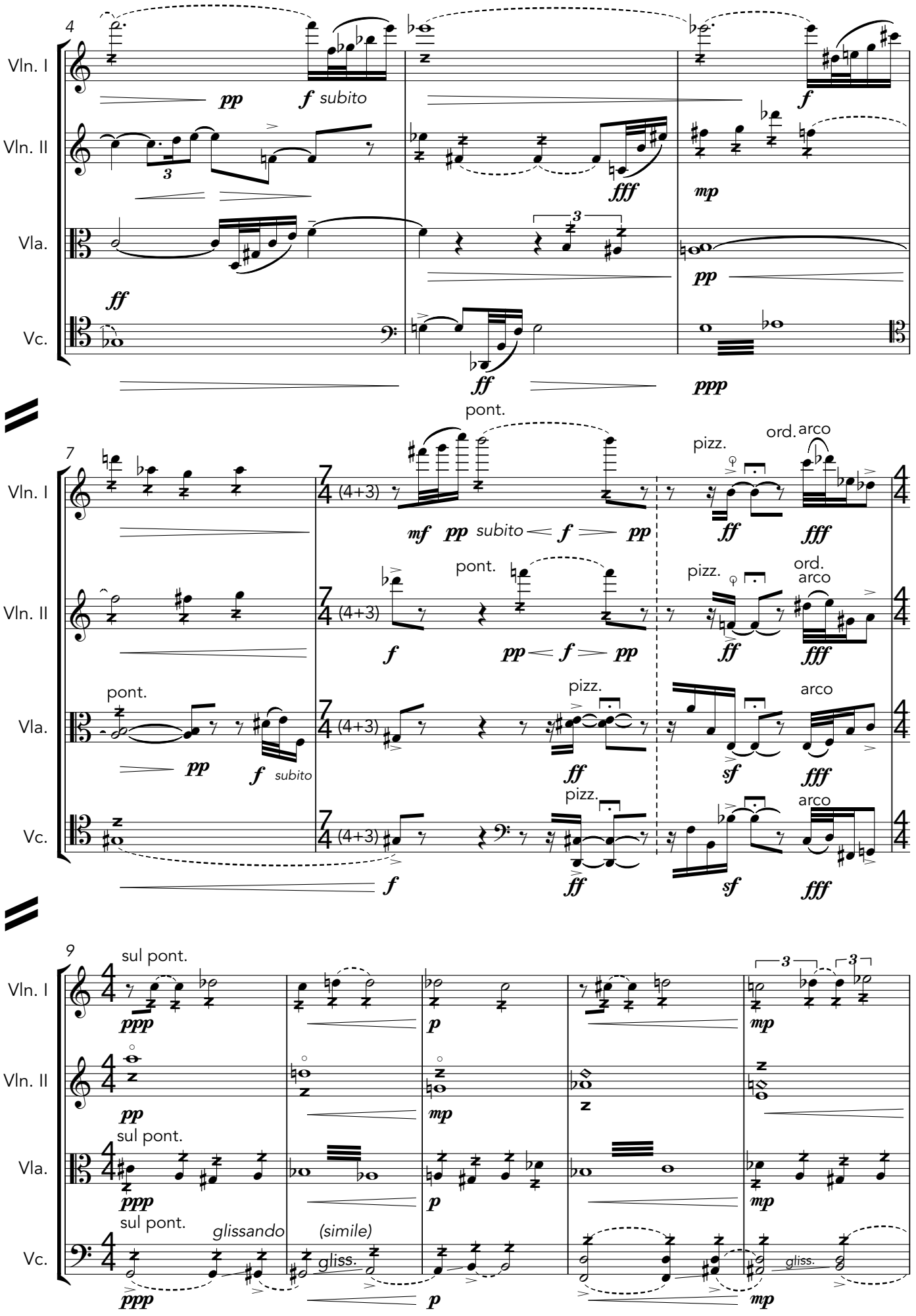
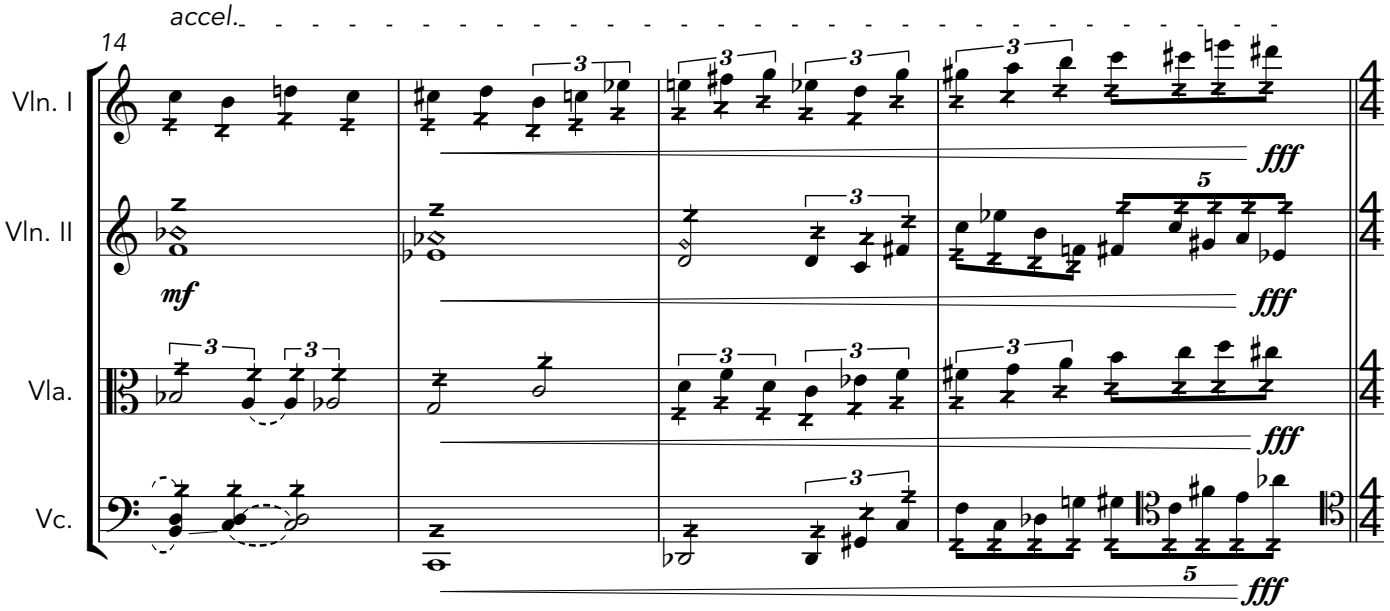
I. Chi Lancia i Dadi?

I. Who Rolls the Dice?



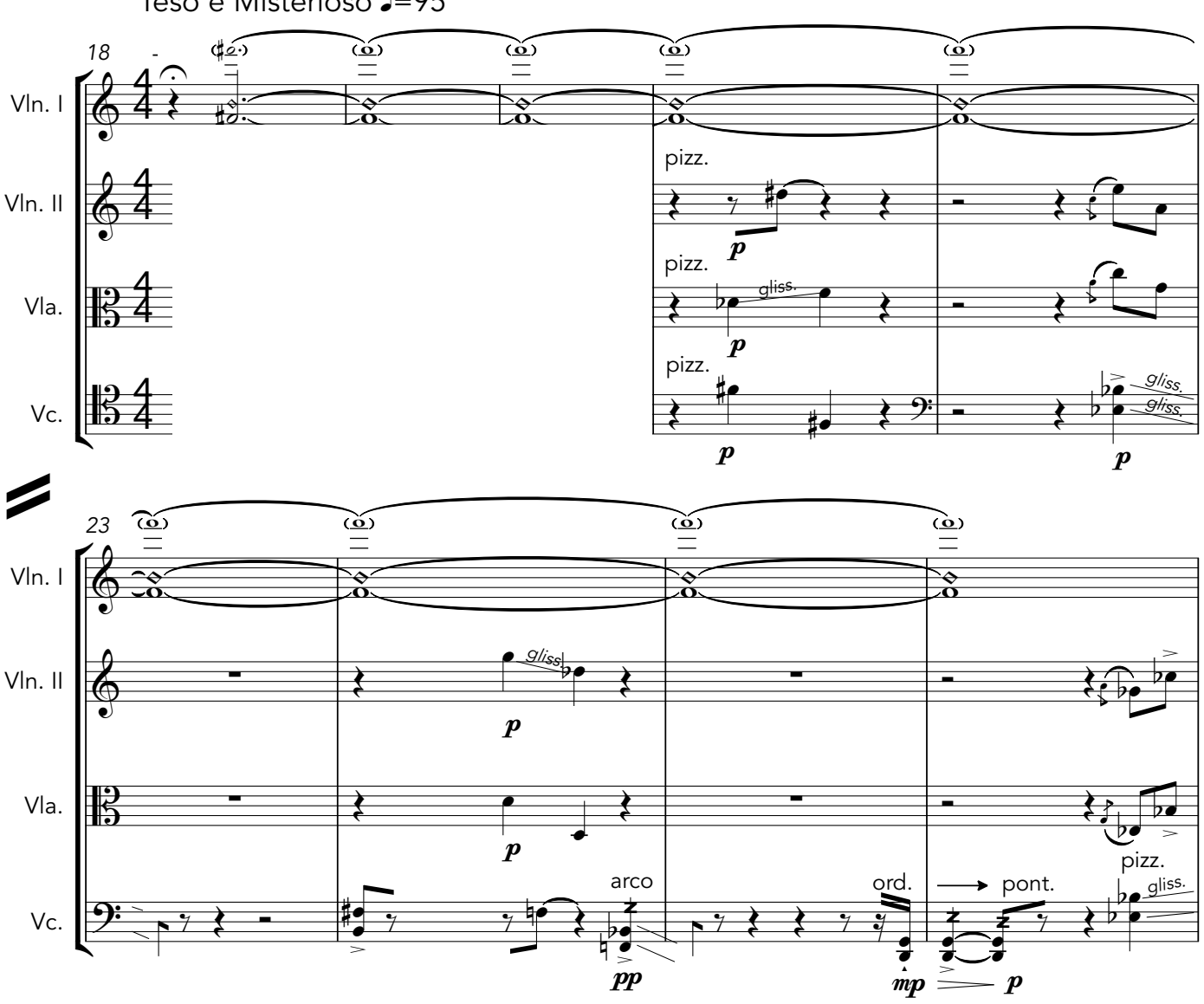

4
Vln. I
Vln. II
Vla.
Vc.
pp
f subito
f
fff
mp
ff
pp
ff
ppp
7
pont.
pizz.
ord. arco
(4+3)
mf pp subito f pp
ff
fff
f
pp f pp
pp
f subito
ff
sf
9
sul pont.
ppp
p
mp
glissando
(simile)
gliss.

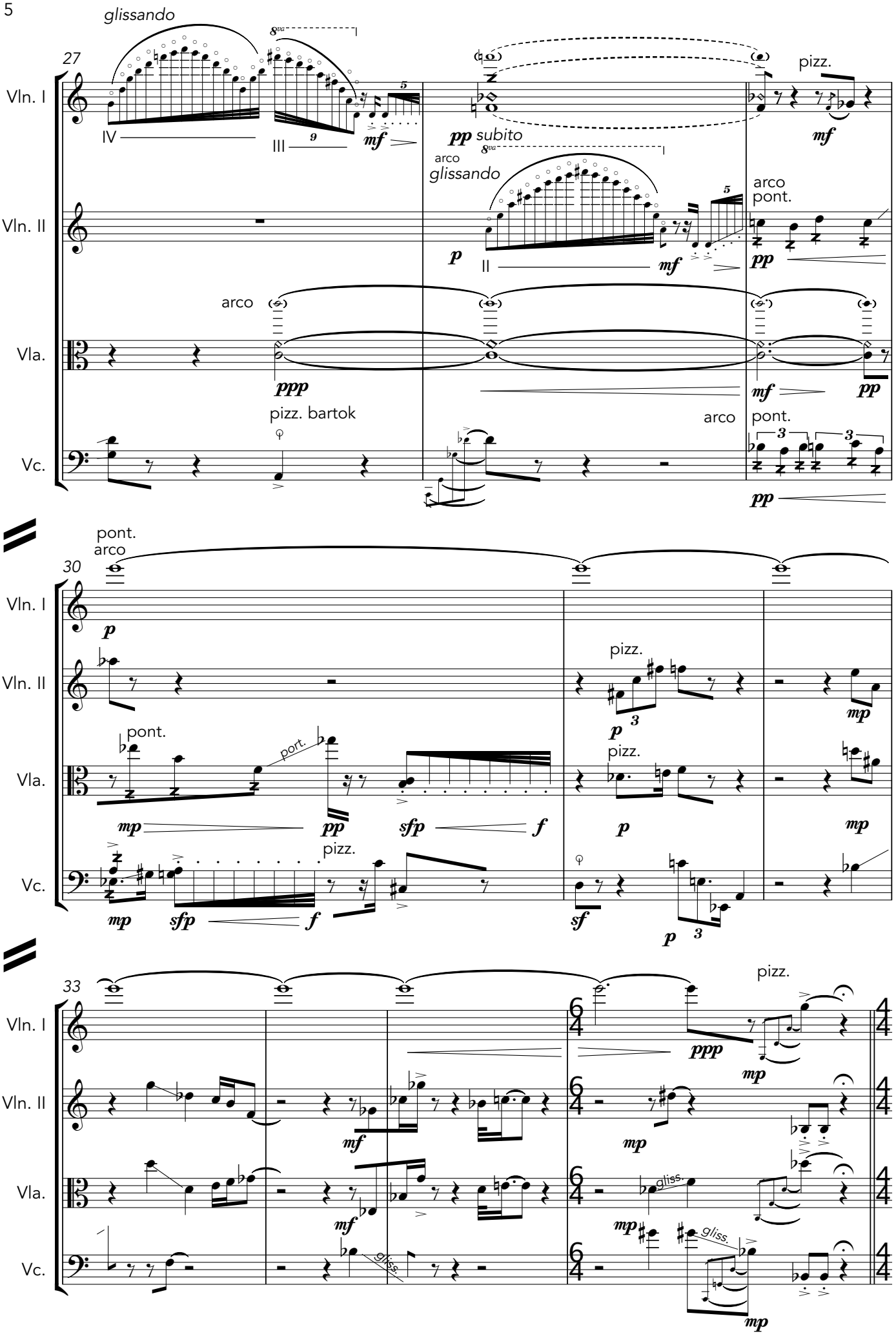


II. Sovrapposizione I

II. Superimposition I

$$\psi = c_1\psi_1 + c_2\psi_2$$

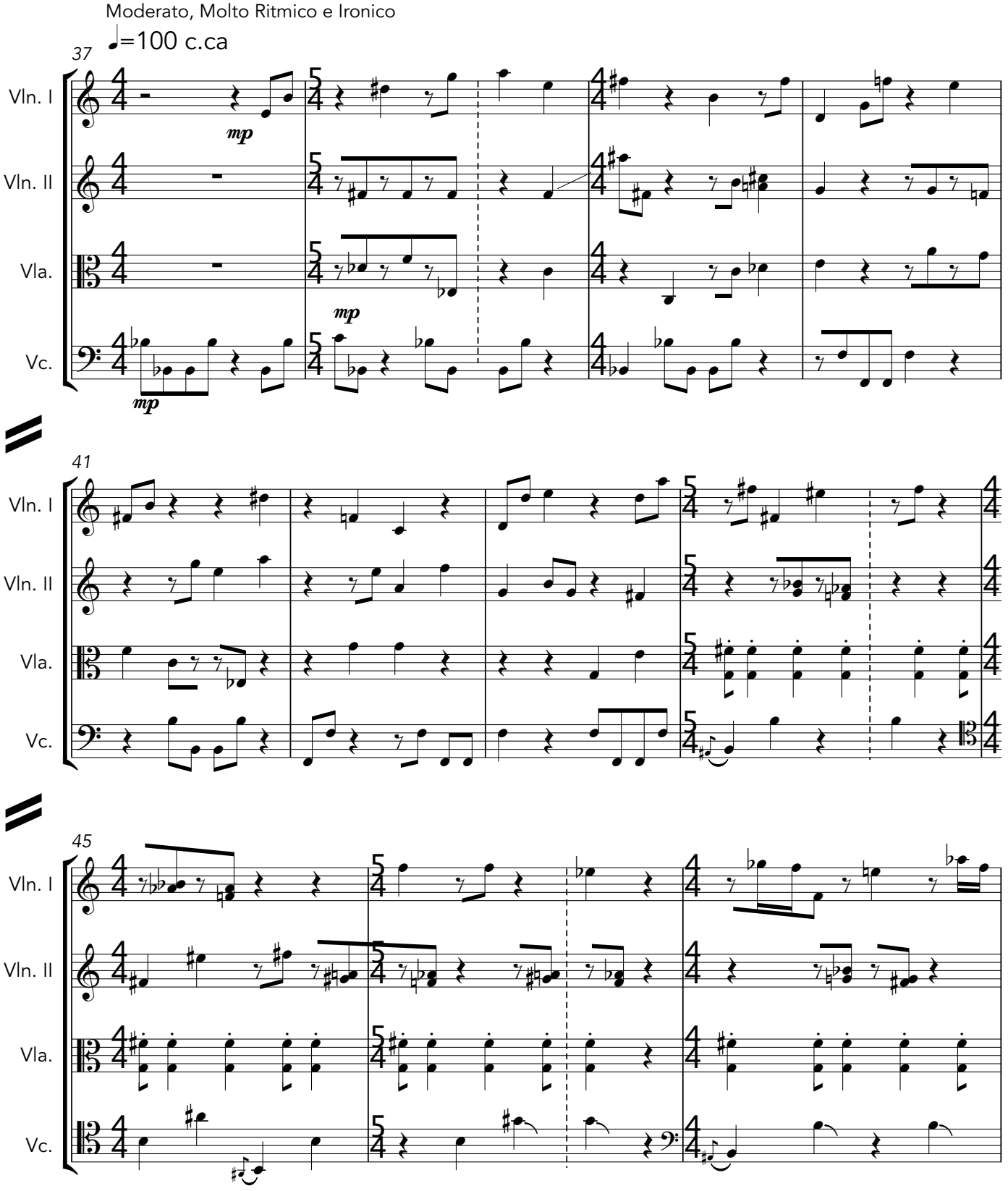


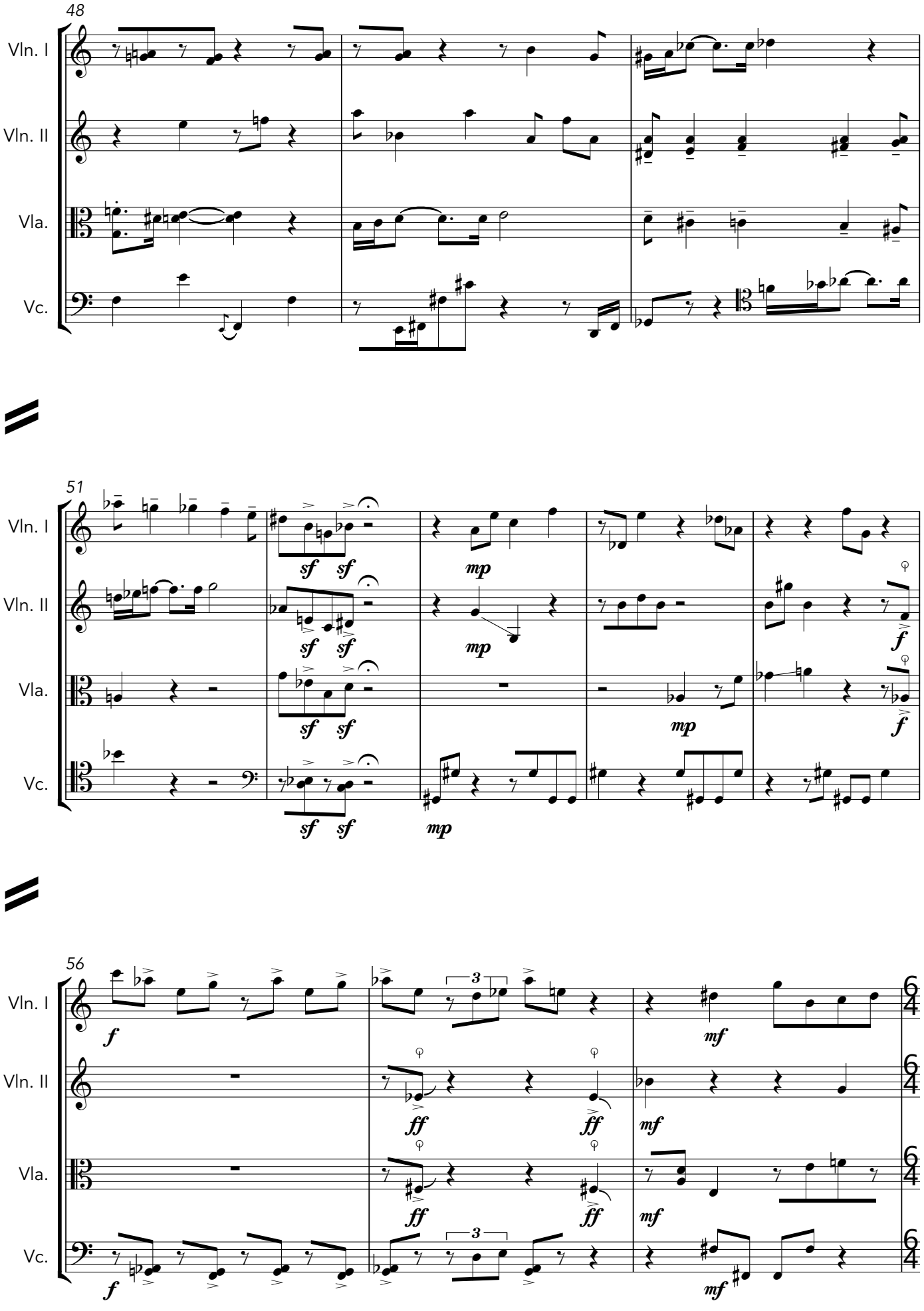

27
glissando
Vln. I
IV
III
mf
pp subito
pizz.
mf
arco
glissando
Vln. II
p
II
mf
arco
pont.
pp
arco
Vla.
ppp
mf
pp
pizz. bartok
arco
pont.
Vc.
pp
30
pont.
arco
Vln. I
p
Vln. II
pizz.
p
mp
pont.
port.
Vla.
mp
pp
sfp
f
pizz.
p
mp
pizz.
Vc.
mp
sfp
f
sf
p
33
pizz.
Vln. I
ppp
mp
Vln. II
mf
mp
Vla.
mf
gliss.
mp
gliss.
Vc.
gliss.
mp

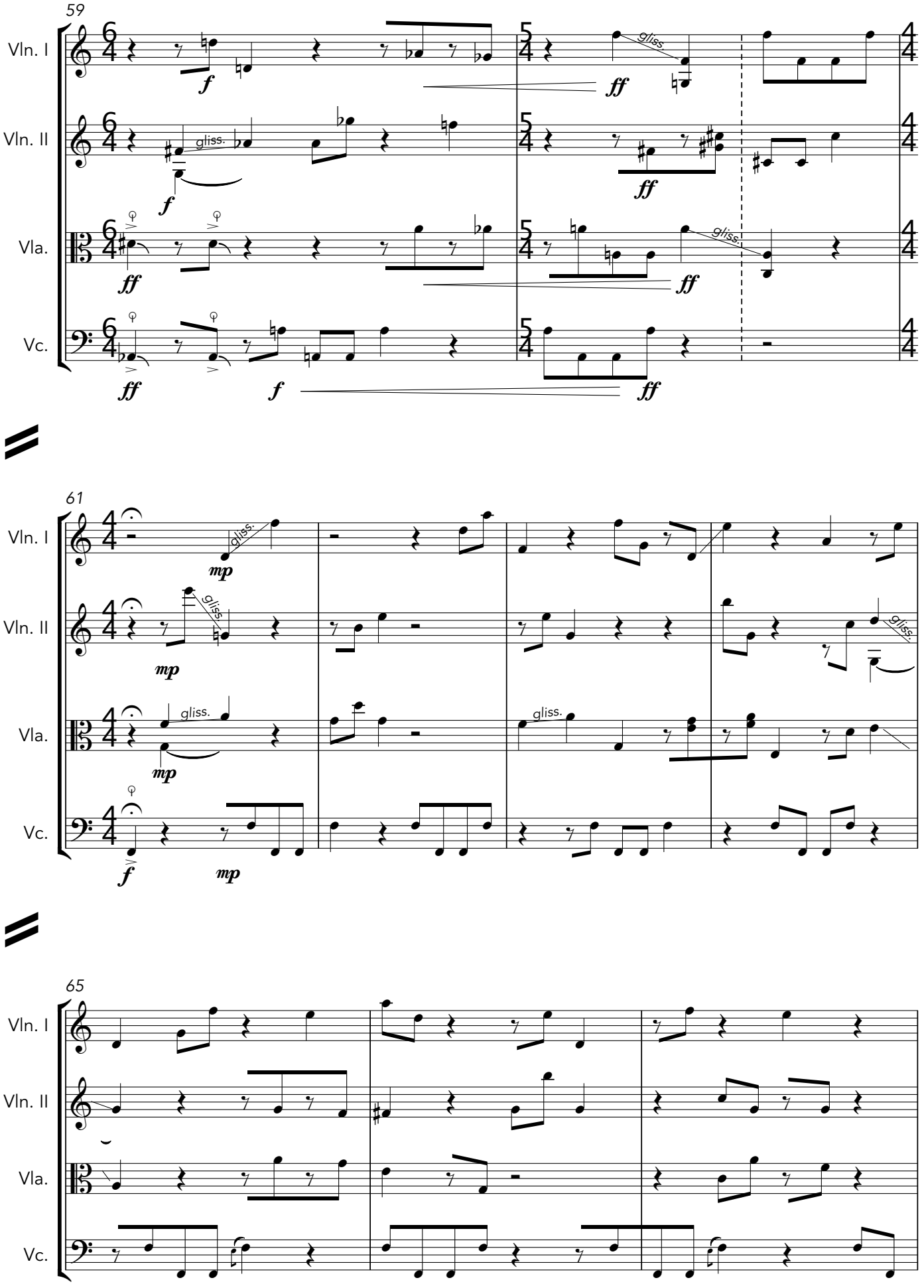
III. Il Paradosso del Gatto

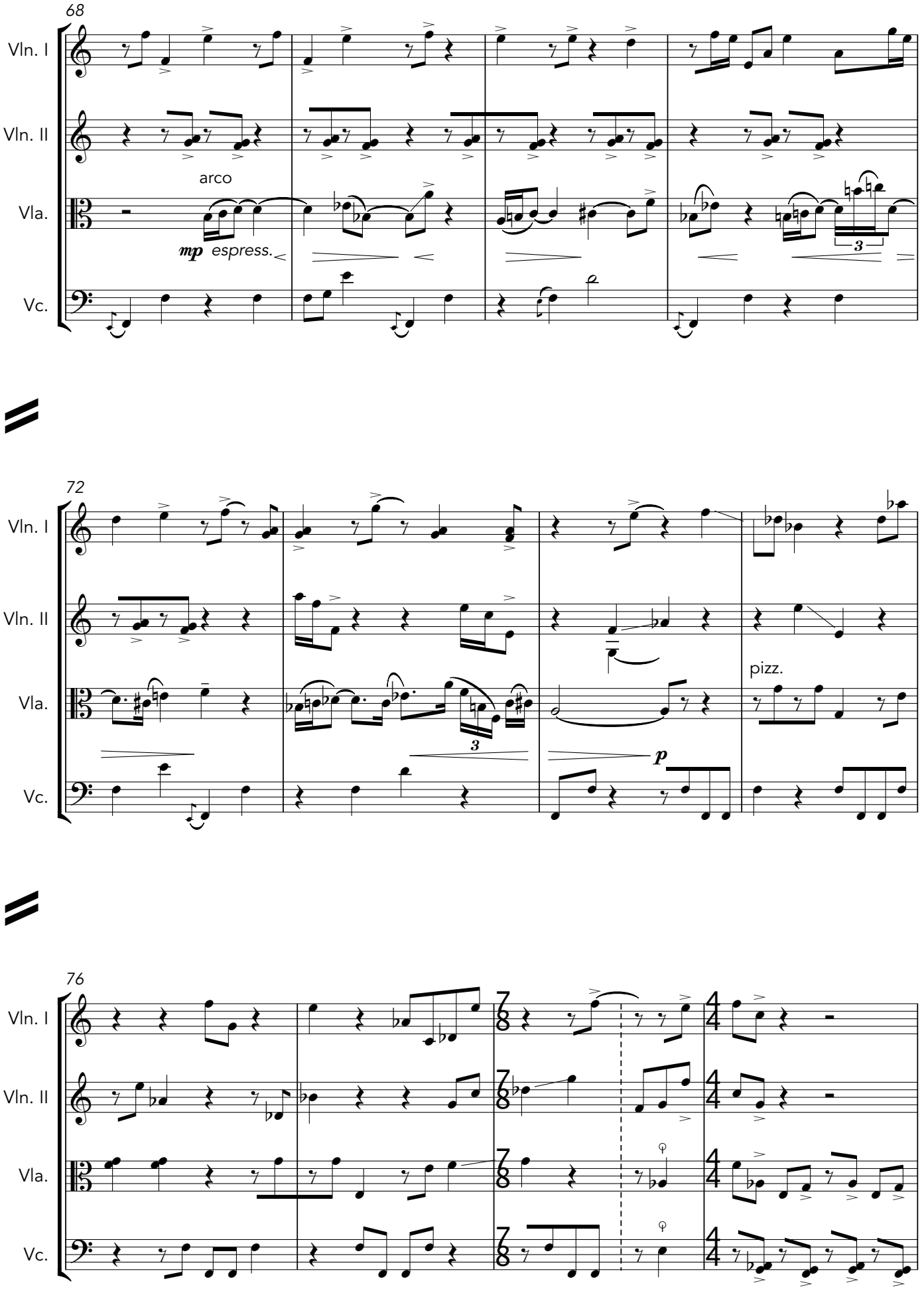
III. The Cat's Paradox

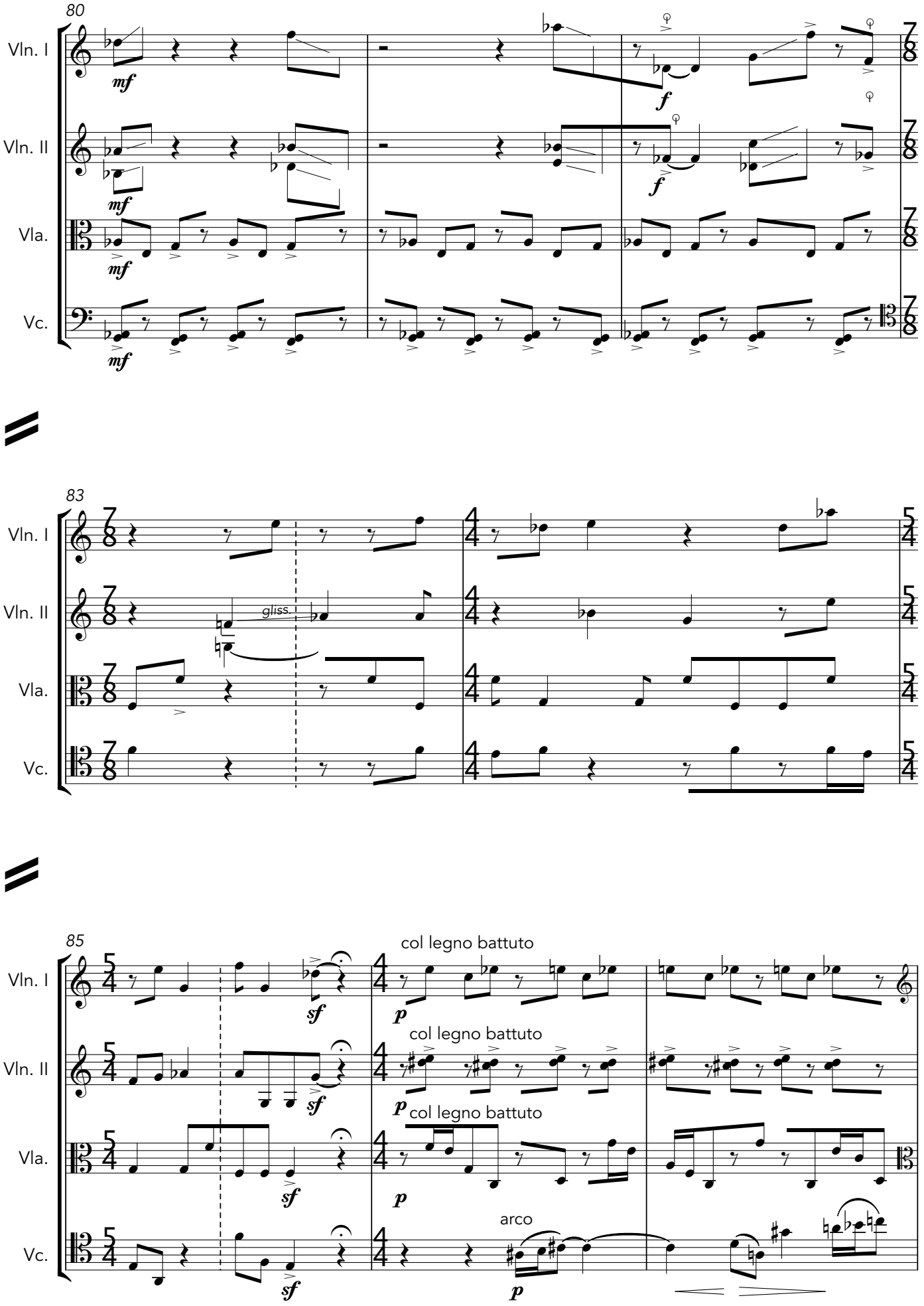
$$|Gatto\rangle = \frac{1}{\sqrt{2}}(|\ Morto\rangle + |\ Vivo\rangle) \qquad |Cat\rangle = \frac{1}{\sqrt{2}}(|\ Dead\rangle + |\ Live\rangle)$$

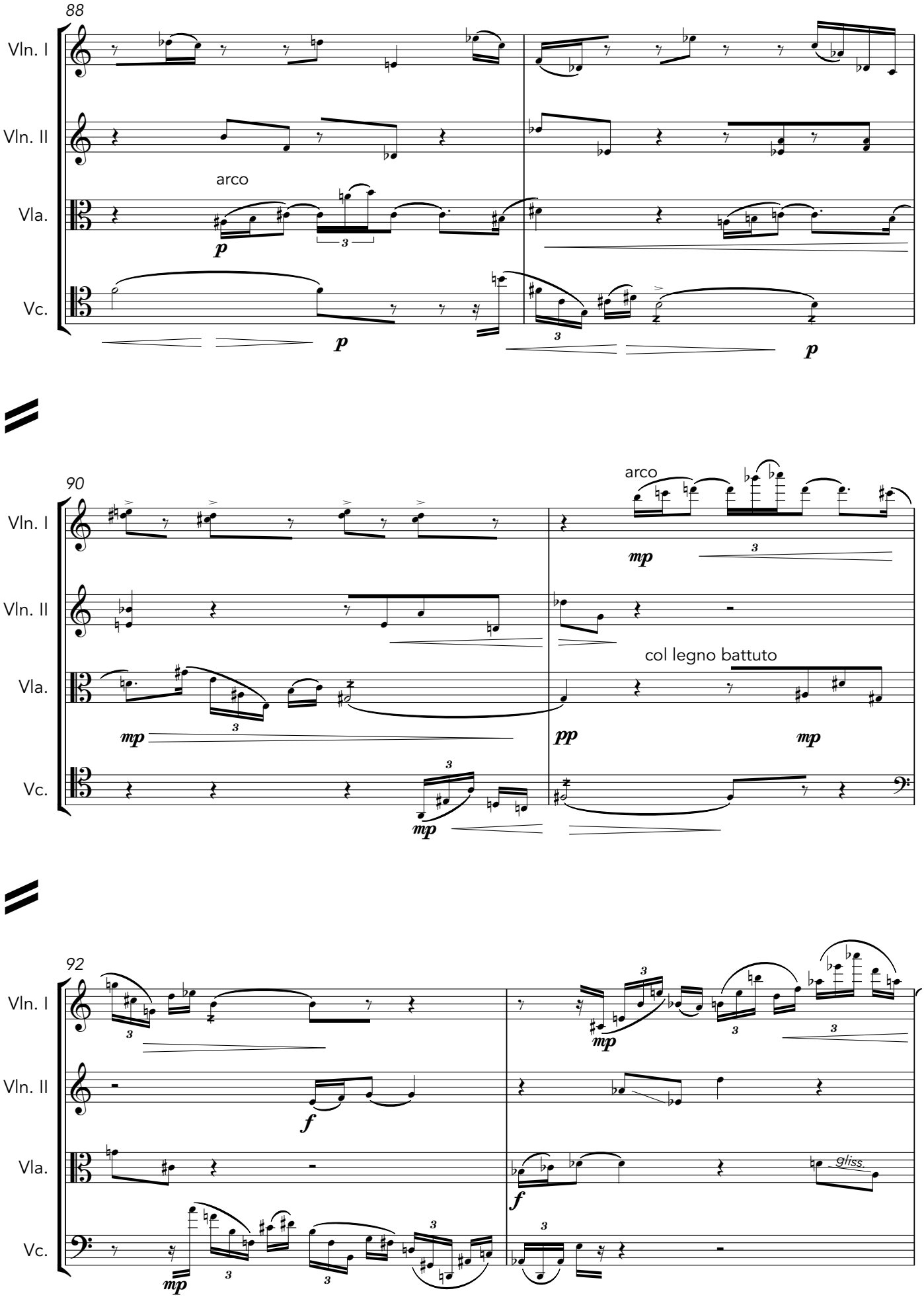


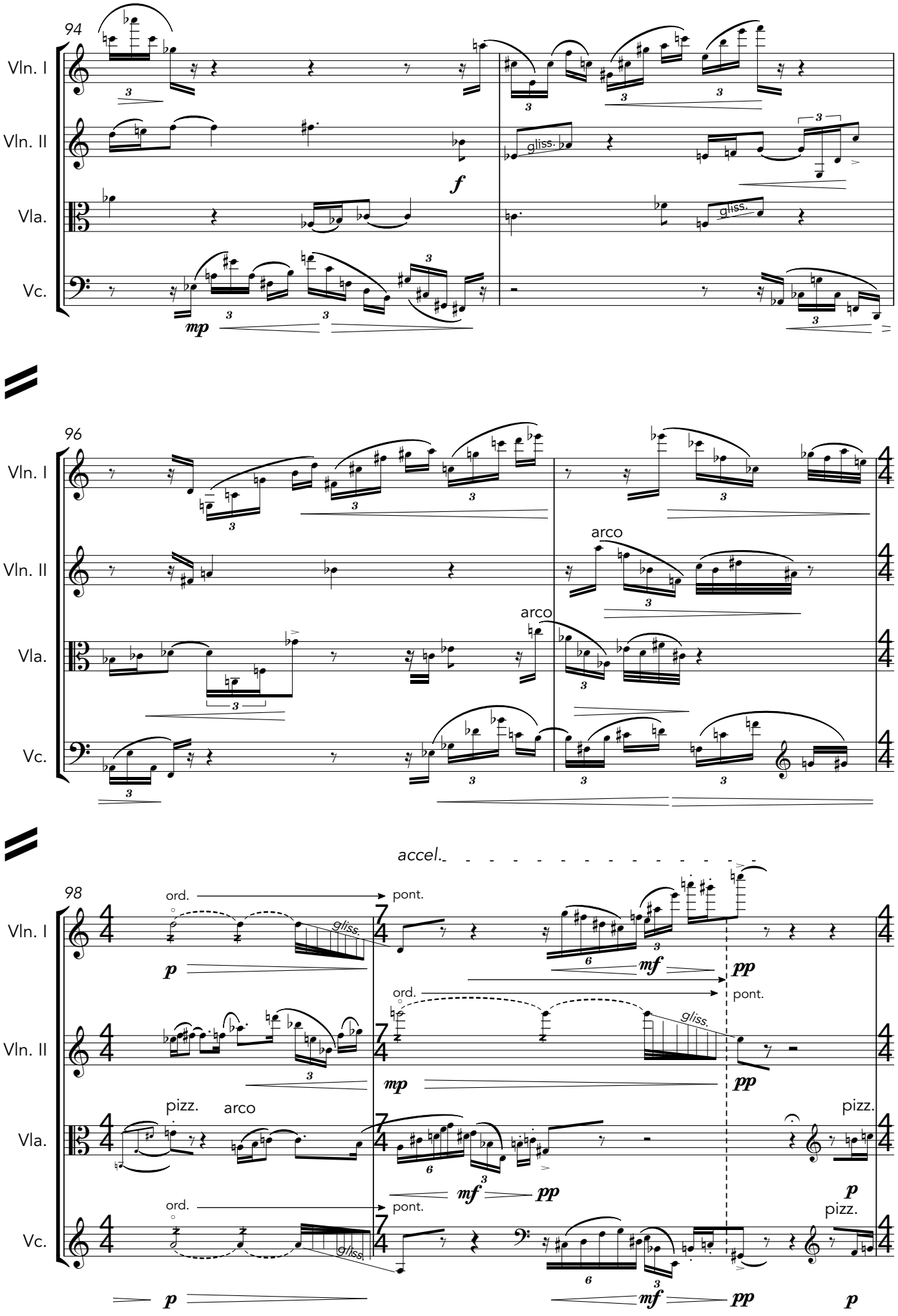

48
Vln. I
Vln. II
Vla.
Vc.
51
sf sf
mp
f
56
ff
mf
3
6/4

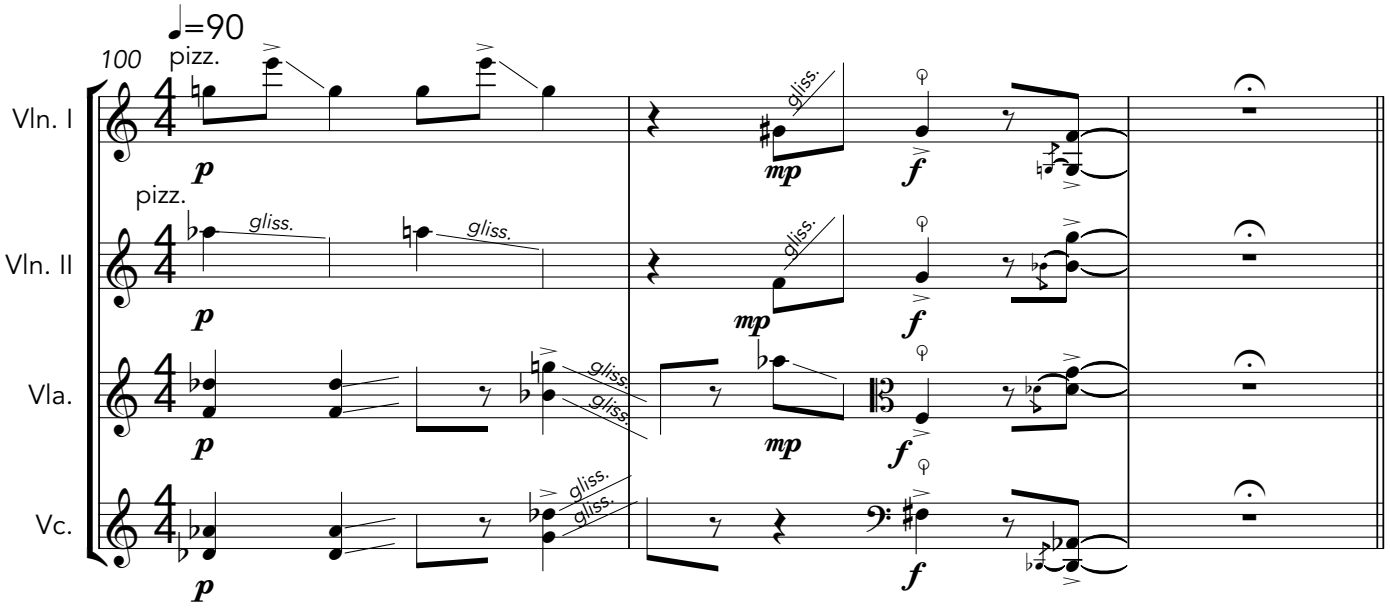

59
Vln. I
Vln. II
Vla.
Vc.
gliss.
61
mp
f
ff


68
Vln. I
Vln. II
arco
Vla.
mp espress.
Vc.
72
Vln. I
Vln. II
Vla.
pizz.
p
Vc.
76
Vln. I
Vln. II
Vla.
Vc.


80
Vln. I
Vln. II
Vla.
Vc.
mf
f
83
gliss
85
col legno battuto
sf
p
arco


88
Vln. I
Vln. II
Vla.
Vc.
arco
p
p
p
90
arco
mp
col legno battuto
pp
mp
mp
92
f
mp
f
gliss.
mp


94
Vln. I
Vln. II
Vla.
Vc.
gliss.
f
mp
96
arco
98
accel.
ord.
pont.
pizz.
mf
pp
p



IV. L'Entanglement e le sue Inquietanti azioni a distanza

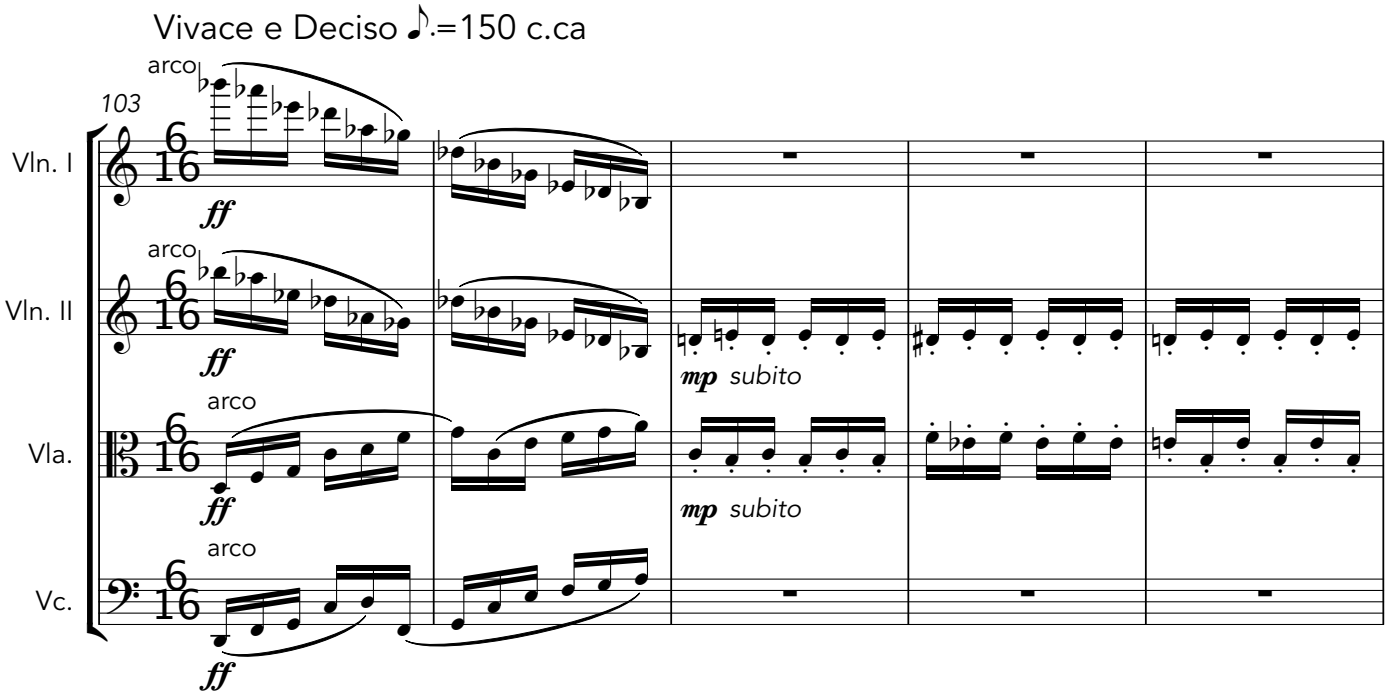
IV. Entanglement and its Spooky Actions at a Distance

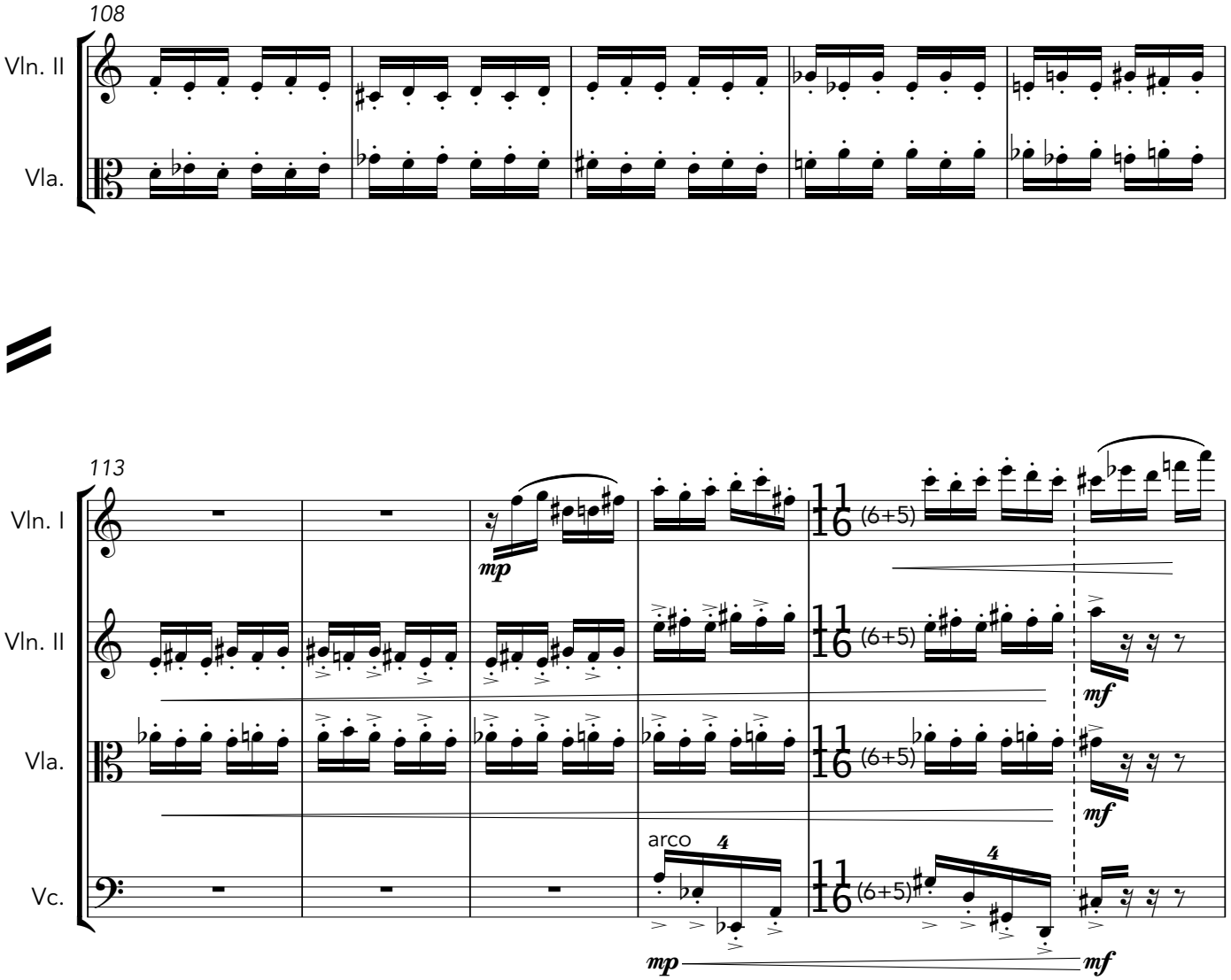
$$|\Phi^+\rangle = \frac{1}{\sqrt{2}}(|0\rangle_A \otimes |0\rangle_B + |1\rangle_A \otimes |1\rangle_B)$$

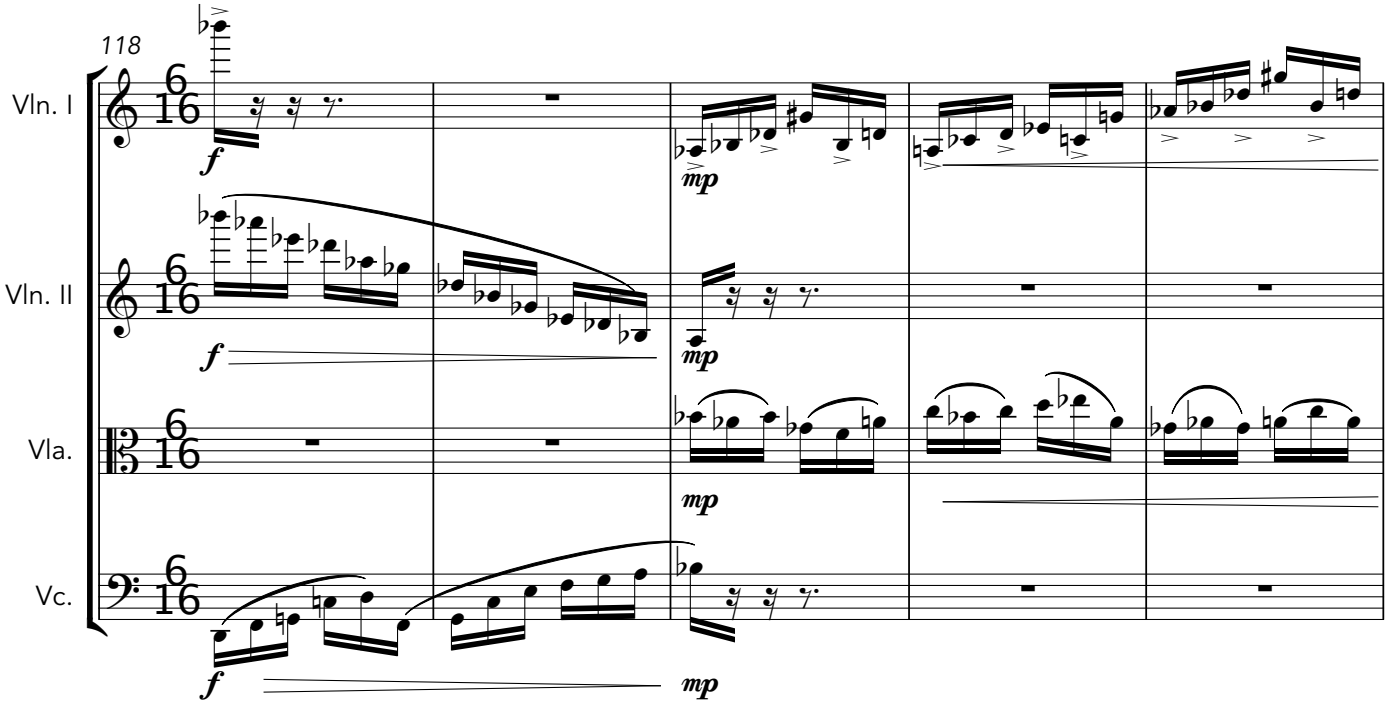
$$|\Phi^-\rangle = \frac{1}{\sqrt{2}}(|0\rangle_A \otimes |0\rangle_B - |1\rangle_A \otimes |1\rangle_B)$$

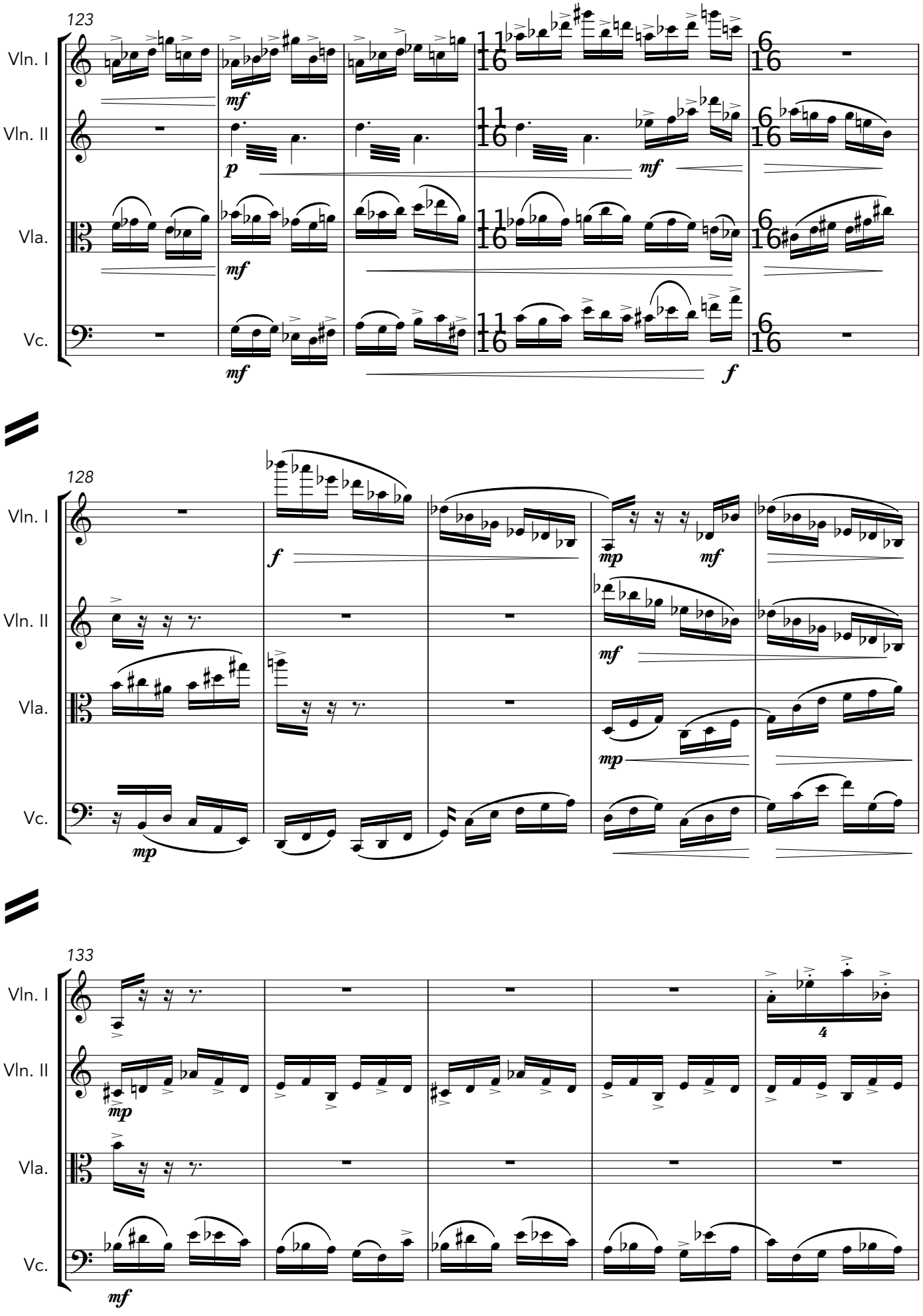
$$|\Psi^+\rangle = \frac{1}{\sqrt{2}}(|0\rangle_A \otimes |1\rangle_B + |1\rangle_A \otimes |0\rangle_B)$$

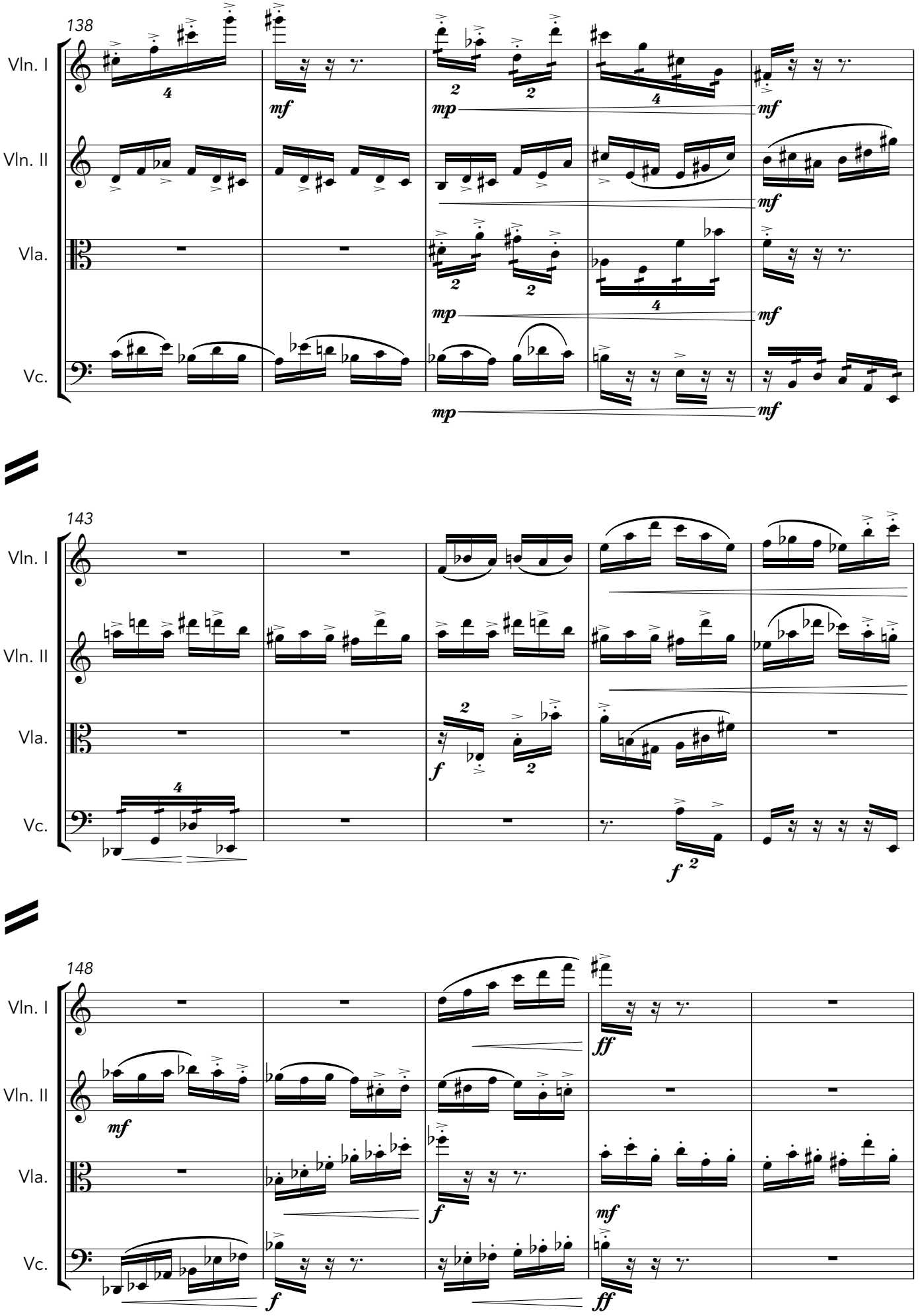
$$|\Psi^-\rangle = \frac{1}{\sqrt{2}}(|0\rangle_A \otimes |1\rangle_B - |1\rangle_A \otimes |0\rangle_B).$$

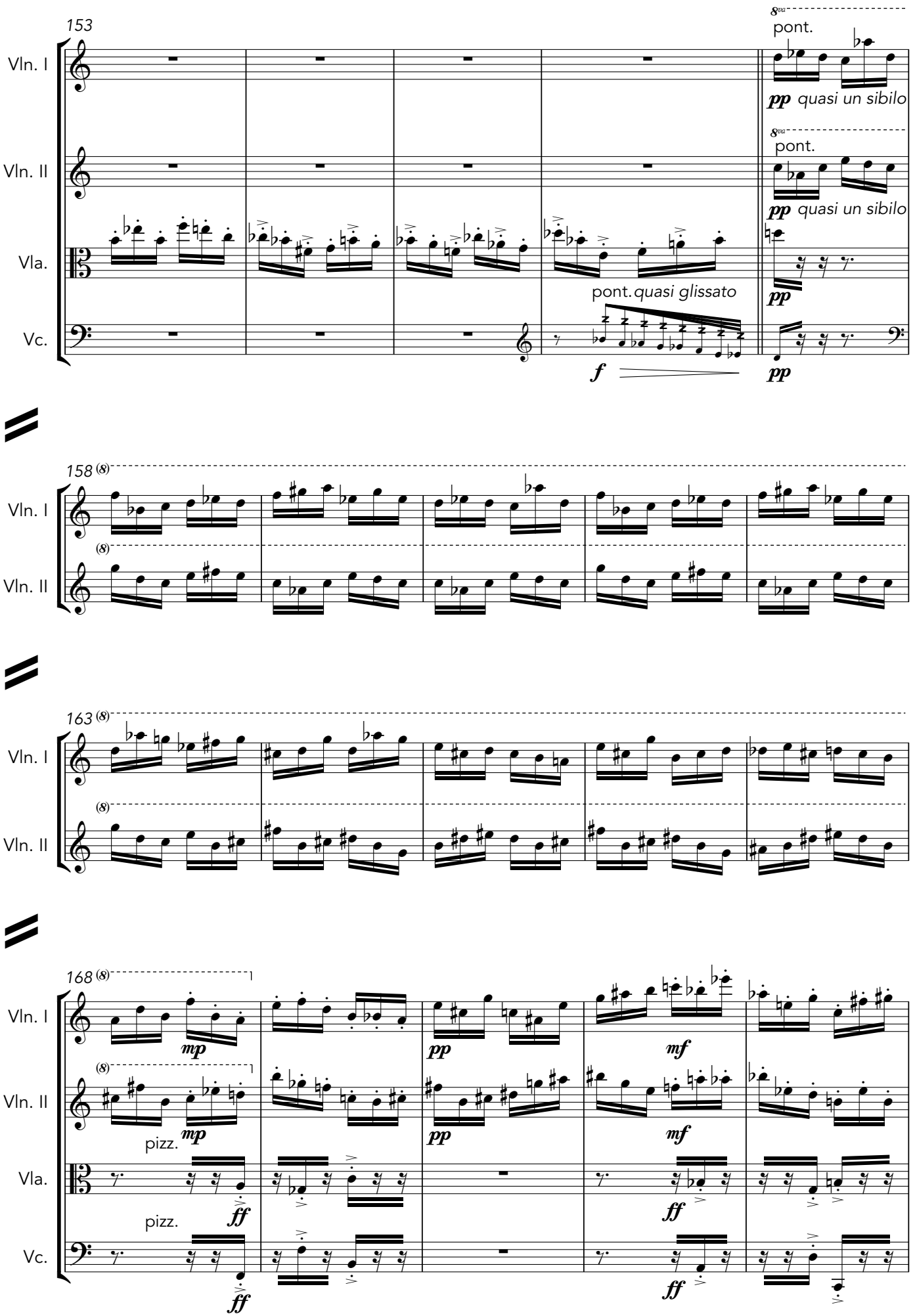


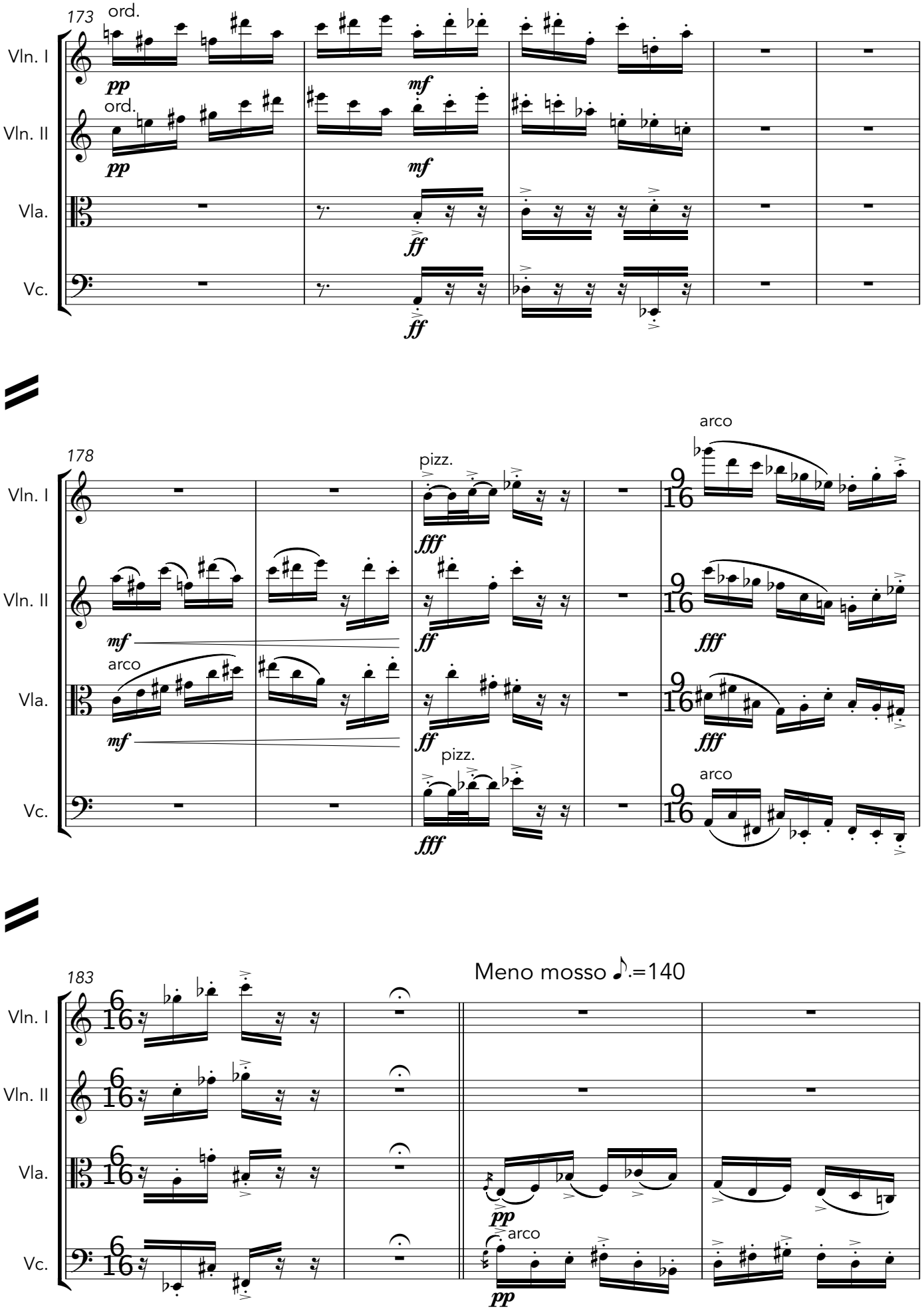

108
Vln. II
Vla.
113
Vln. I
Vln. II
Vla.
Vc.
arco
(6+5)
mp
mf

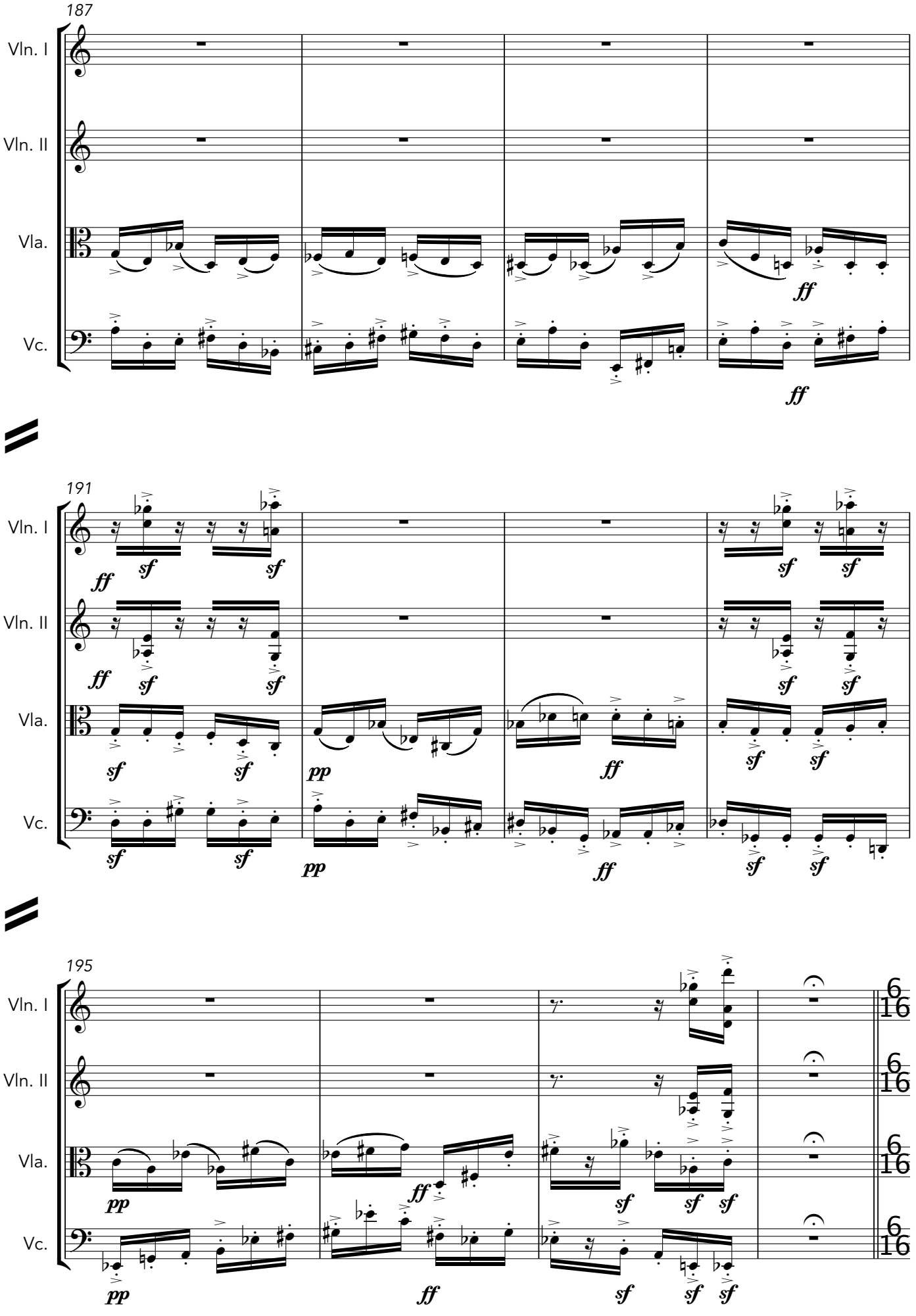

118
Vln. I
Vln. II
Vla.
Vc.
f
mp


123
Vln. I
Vln. II
Vla.
Vc.
mf
p
mf
mf
mf
f
128
Vln. I
Vln. II
Vla.
Vc.
f
mp
mf
mf
mp
mp
133
Vln. I
Vln. II
Vla.
Vc.
mp
4
mf


138
Vln. I
Vln. II
Vla.
Vc.
143
148


153
Vln. I
Vln. II
Vla.
Vc.
8va
pont.
pp quasi un sibilo
8va
pont.
pp quasi un sibilo
pp
pont. quasi glissato
f
pp
158 (8)
Vln. I
(8)
Vln. II
163 (8)
Vln. I
(8)
Vln. II
168 (8)
Vln. I
mp
pp
mf
(8)
Vln. II
mp
pp
mf
pizz.
Vla.
ff
ff
pizz.
Vc.
ff
ff

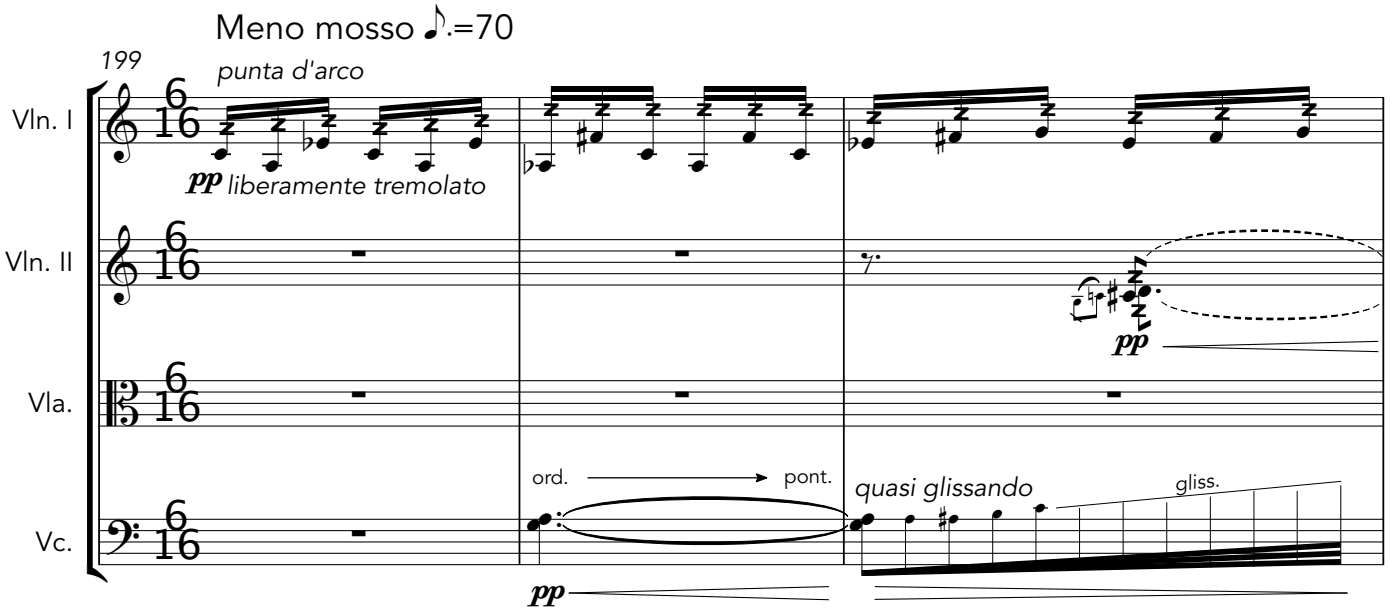

173
ord.
Vln. I
pp
mf
ord.
Vln. II
pp
mf
Vla.
ff
Vc.
ff
178
pizz.
arco
Vln. I
fff
9
16
Vln. II
mf
ff
fff
arco
Vla.
mf
ff
fff
pizz.
Vc.
fff
arco
183
Meno mosso ♪.=140
Vln. I
6
16
Vln. II
Vla.
pp
arco
Vc.
pp

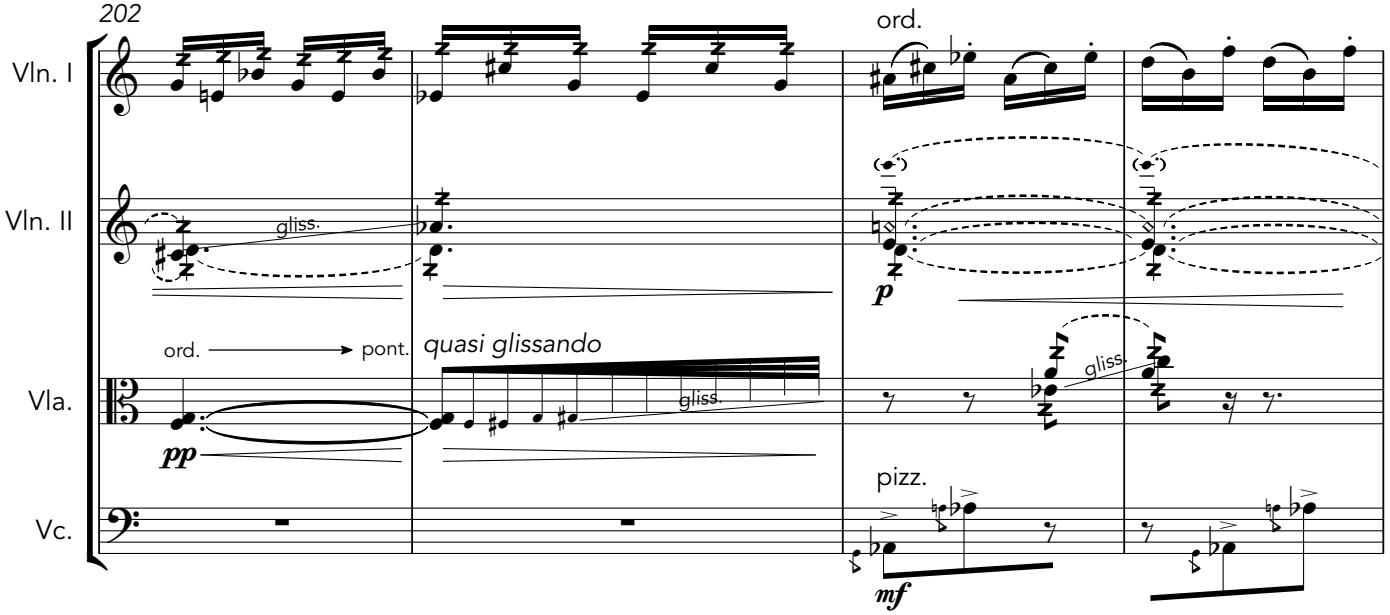

187
Vln. I
Vln. II
Vla.
Vc.
ff
ff
191
Vln. I
Vln. II
Vla.
Vc.
ff
sf
sf
pp
ff
195
Vln. I
Vln. II
Vla.
Vc.
pp
ff
sf
6
16

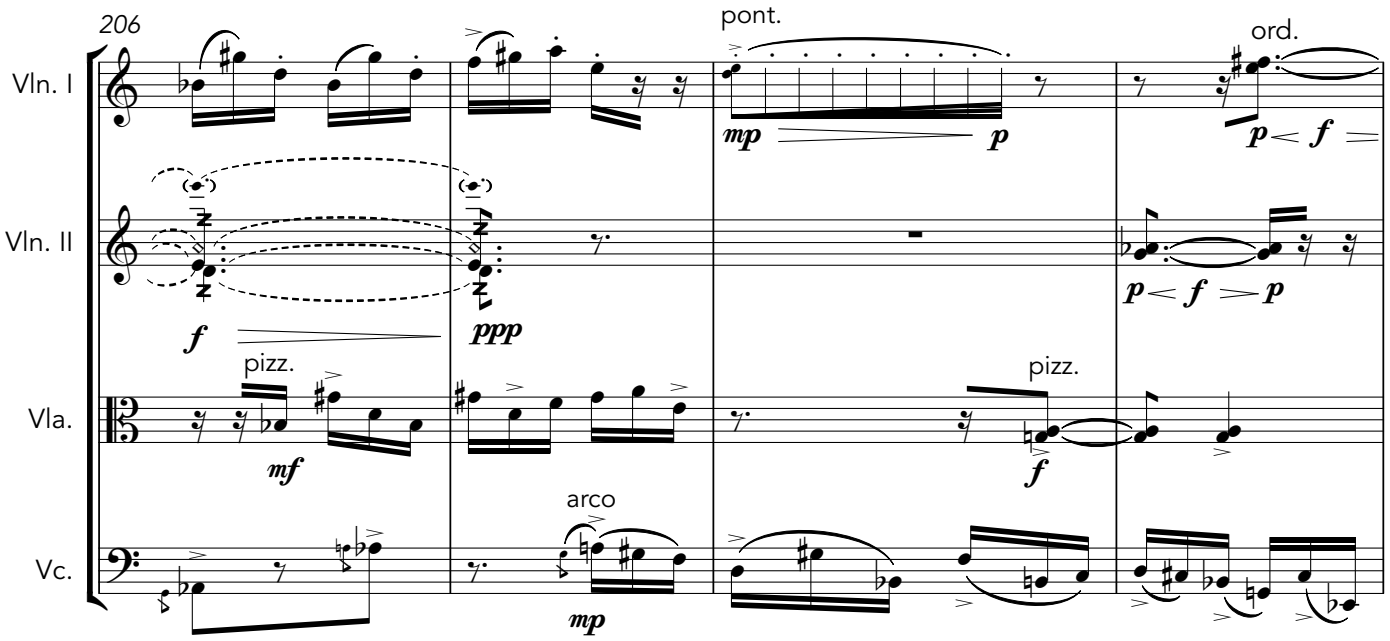
V. Sovrapposizione II

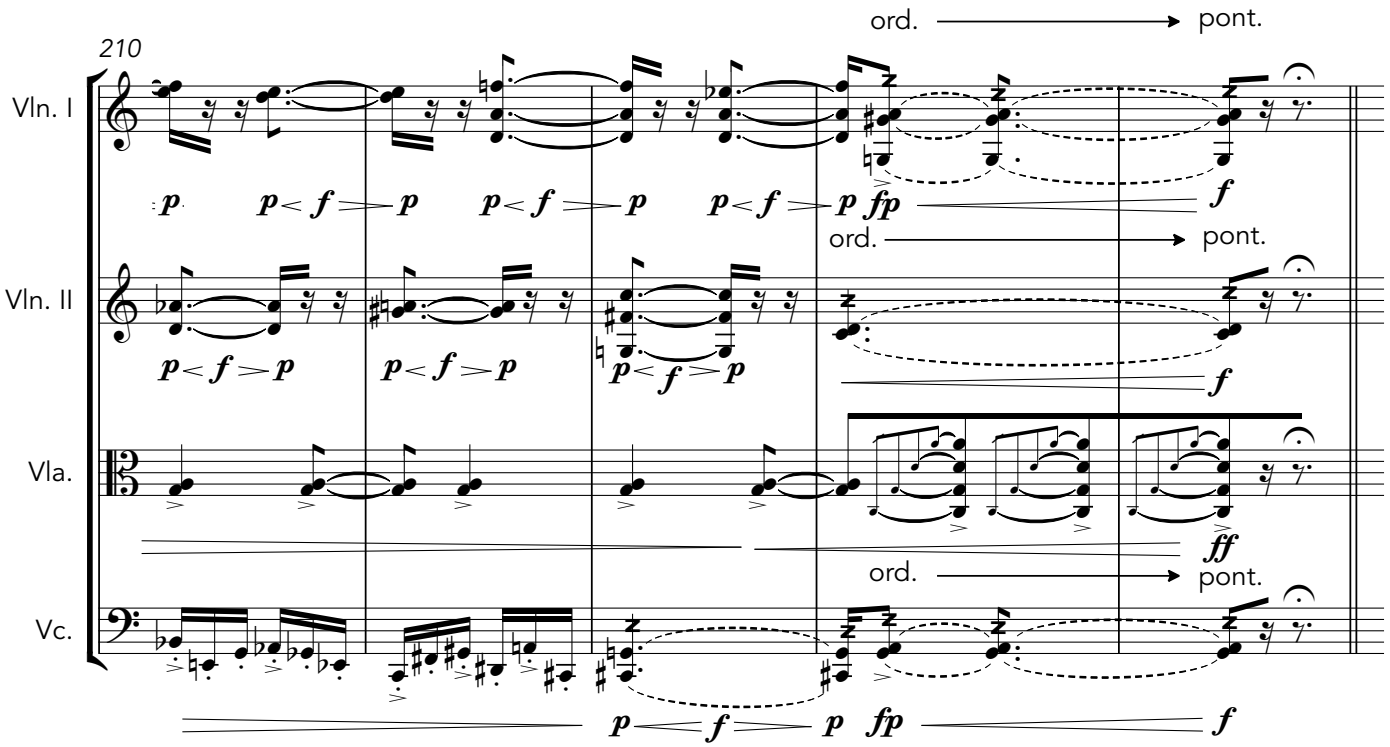
V. Superimposition II

$$\psi = c_1\psi_1 + c_2\psi_2$$






206
Vln. I
Vln. II
Vla.
Vc.
pont.
ord.
pizz.
pizz.
arco


210
Vln. I
Vln. II
Vla.
Vc.
ord.
pont.

VI. Onde Probabilistiche

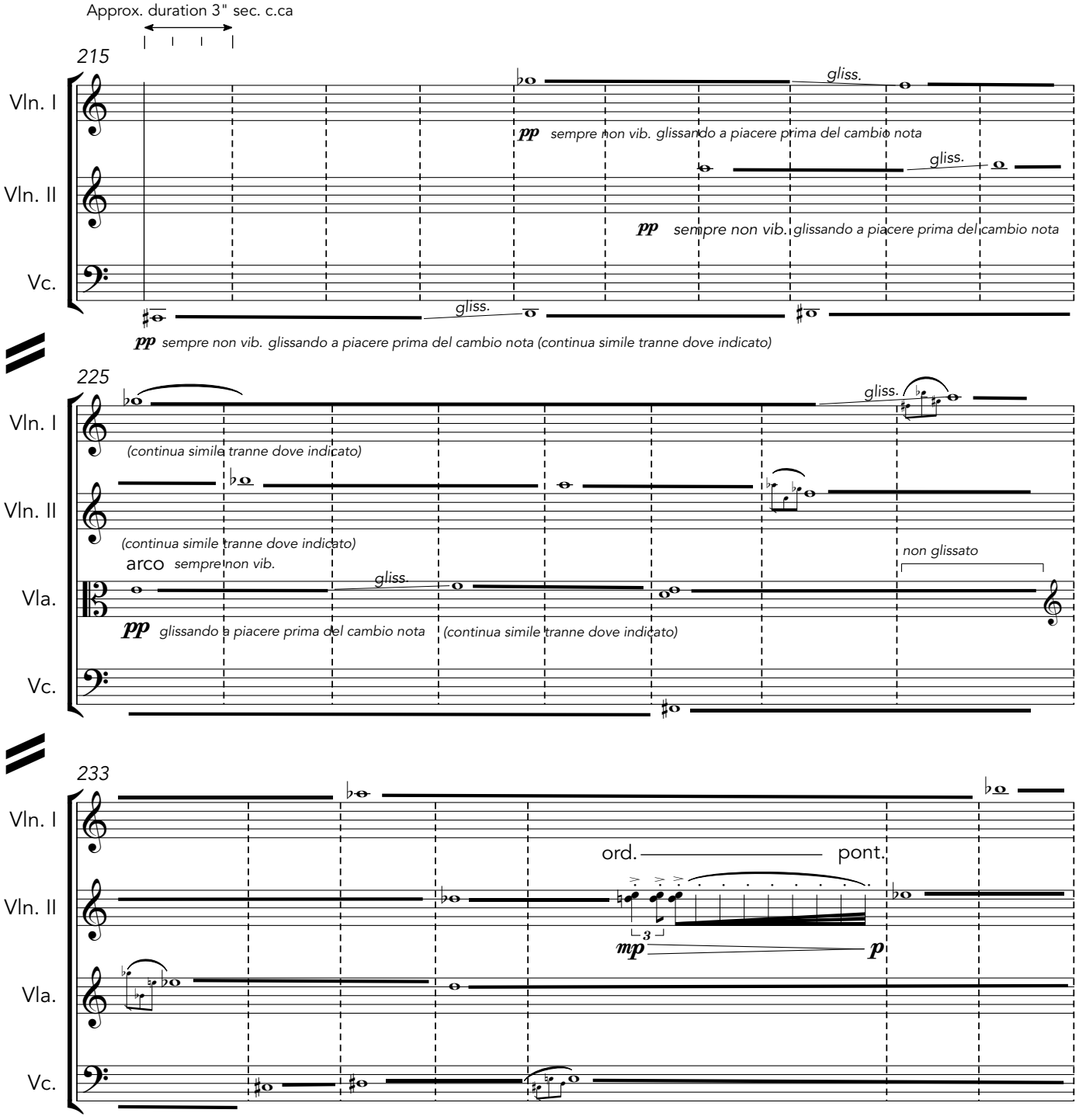
VI. Probabilistic Waves

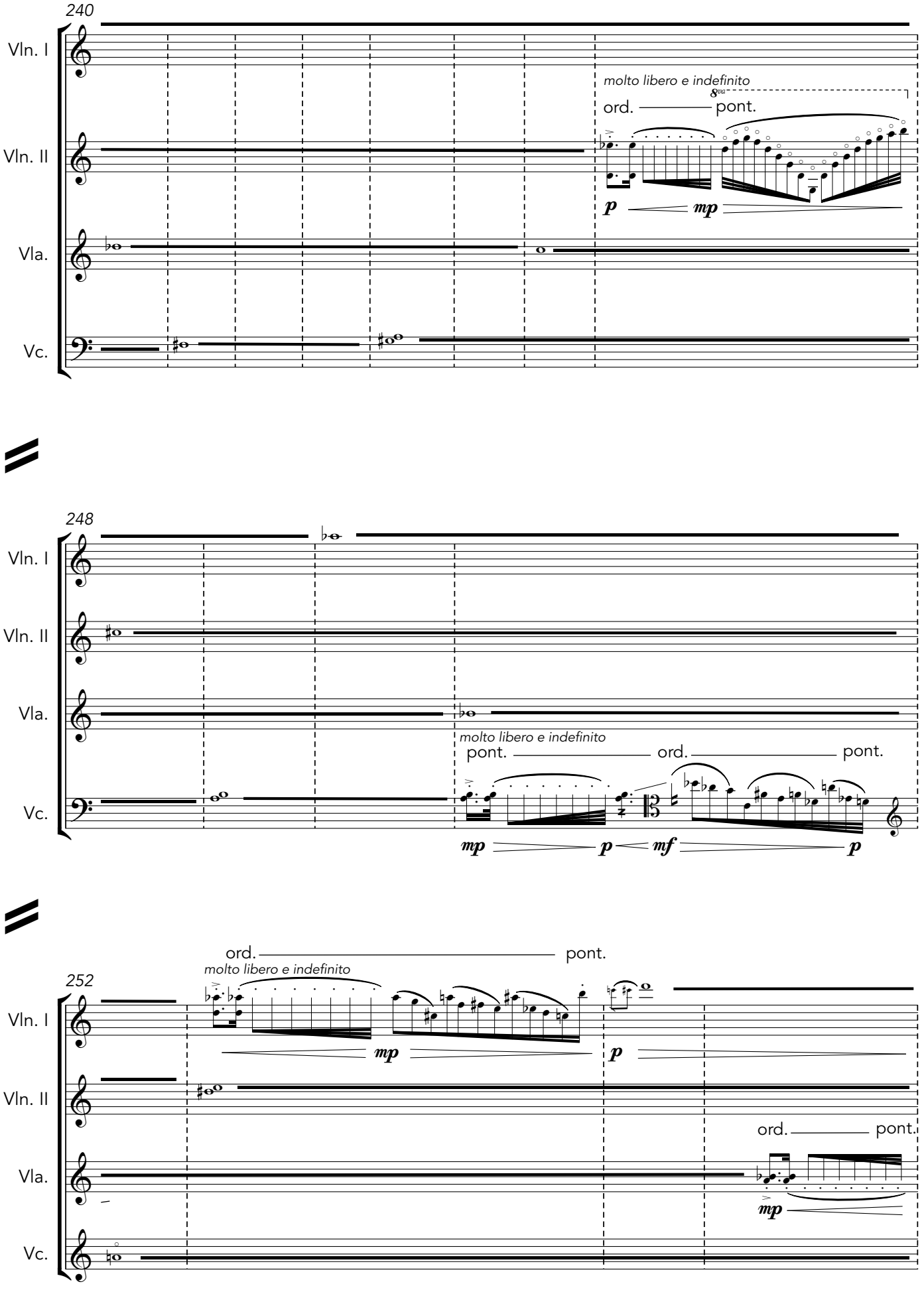
$$i\hbar\frac{\partial}{\partial t}\psi(r,t) = \widehat{H}\psi(r,t)$$

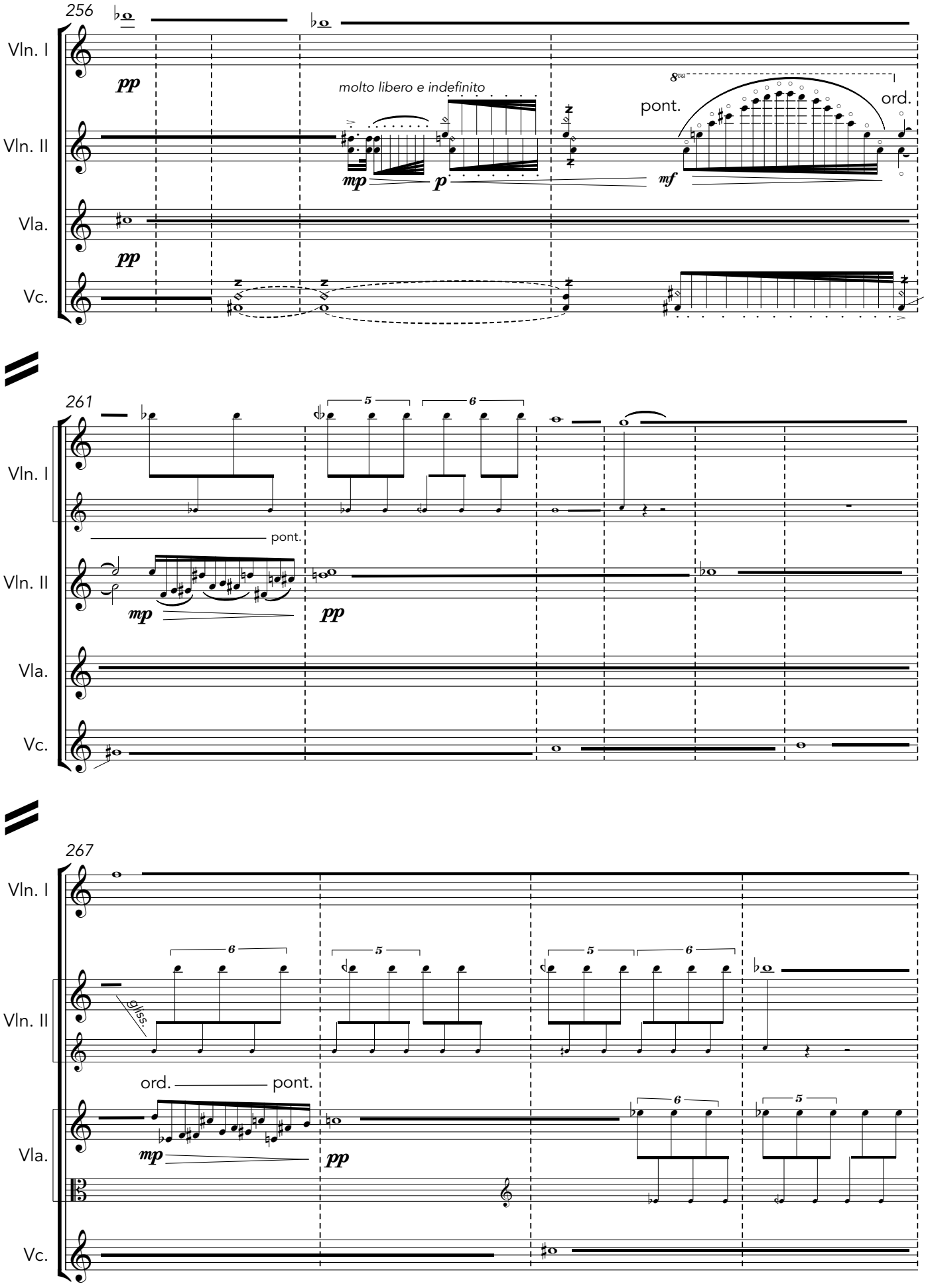
Le linee verticali tratteggiate sono state inserite volutamente per per agevolare la lettura e l'esecuzione dei musicisti fornendo un riferimento di durata approssimativo. Tuttavia l'intera sezione è da intendersi in notazione spaziale, quindi libera e senza tempo.

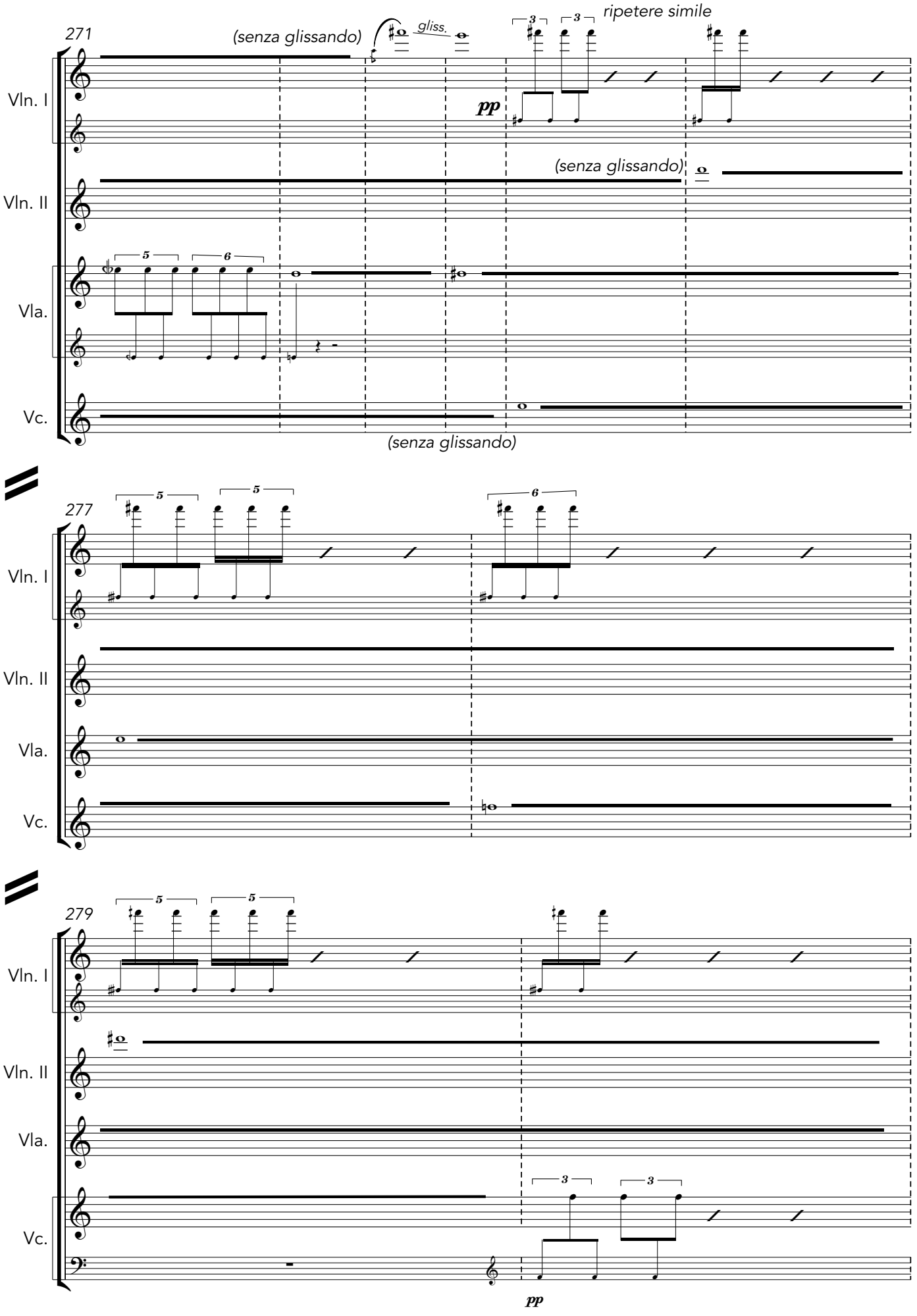
The vertical dotted lines have been inserted intentionally to facilitate the reading and performance of the musicians providing a reference of approximate duration. However, the whole section is to be interpreted as spatial innotation, therefore free and timeless.

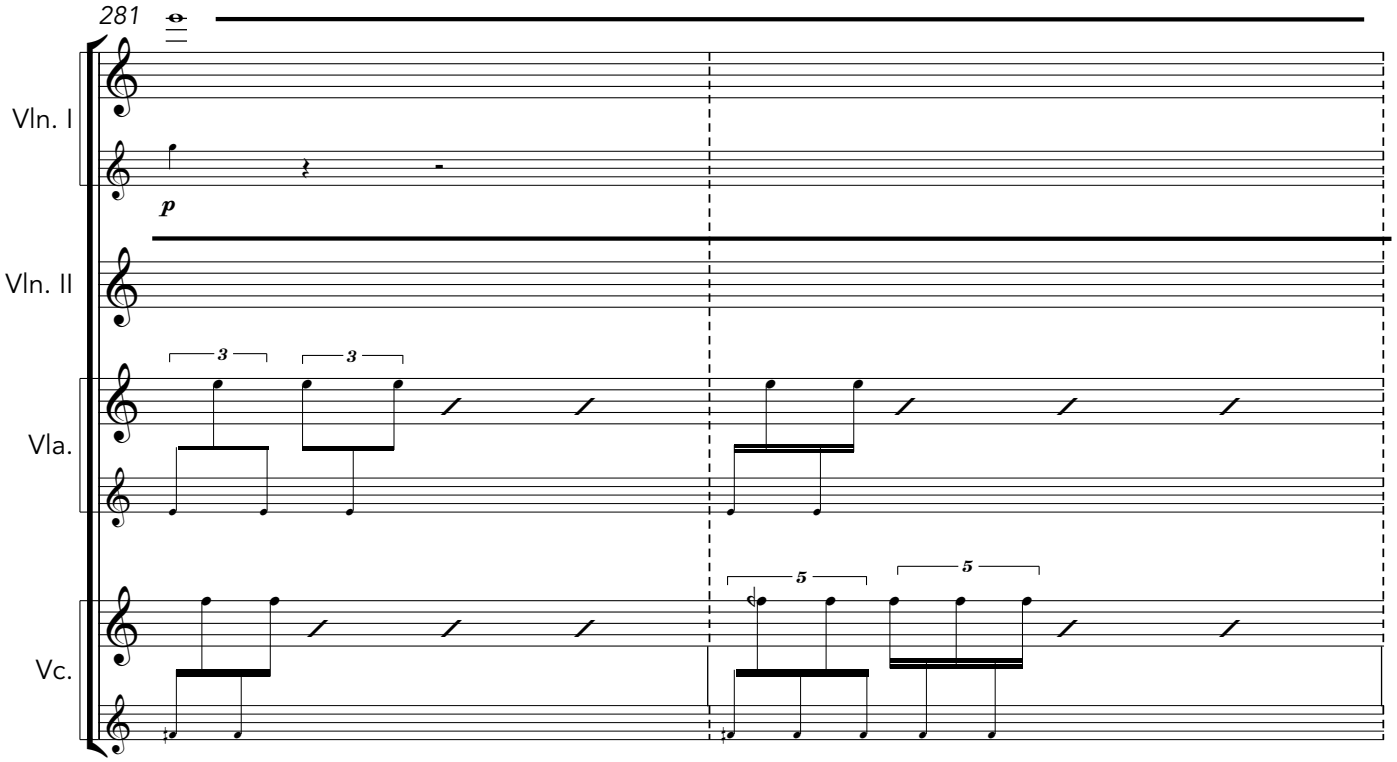
Calmo ma pian piano sempre più intenso come un'onda che cresce
Libero, Senza Tempo (Freely, Whithout Time)

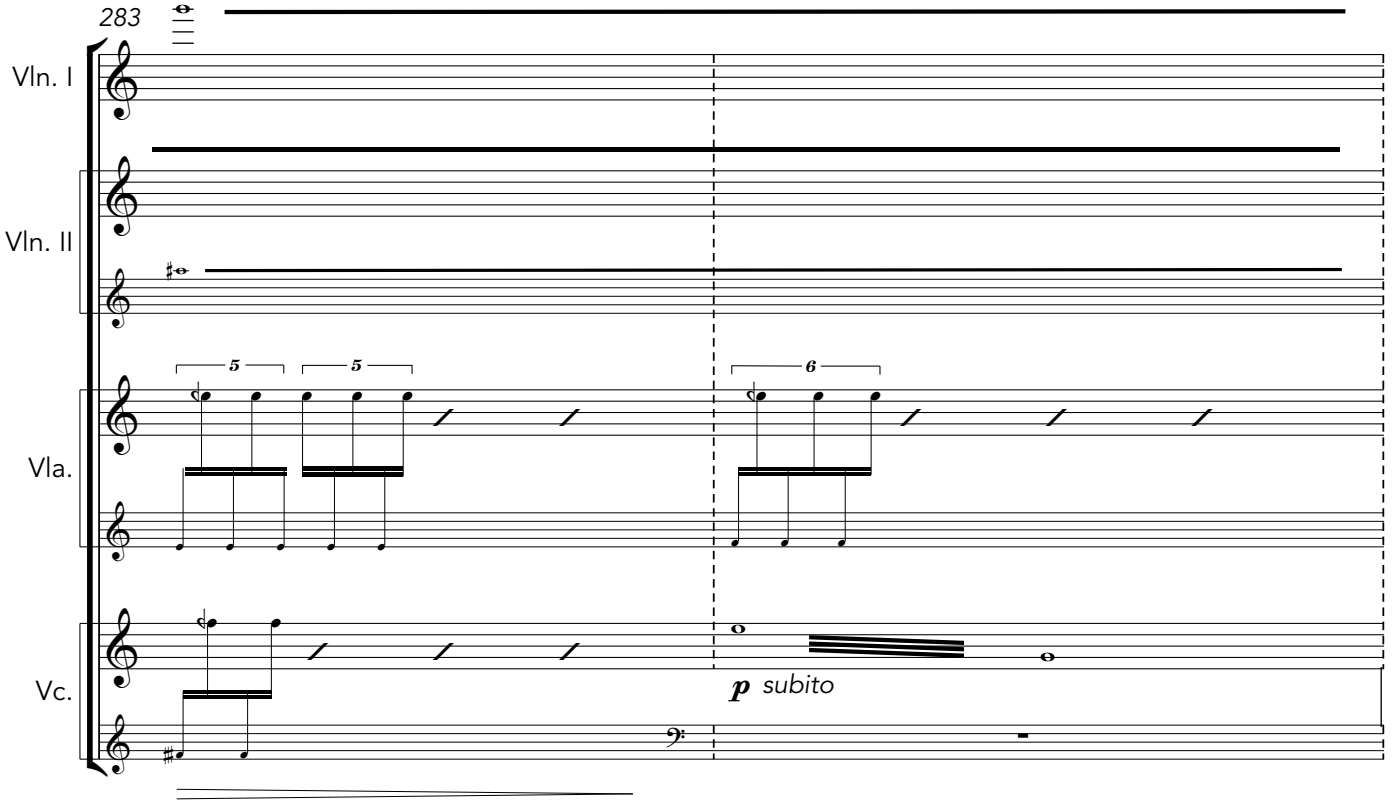


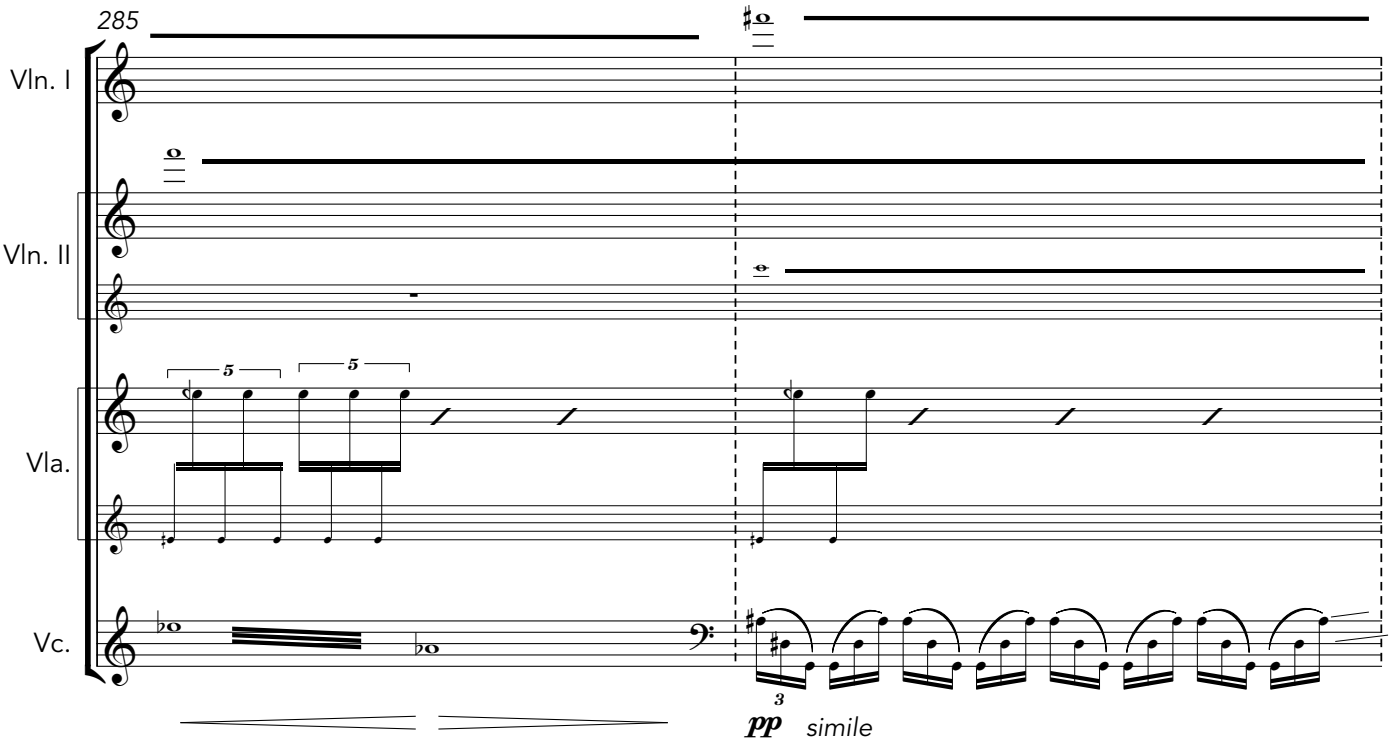

240
Vln. I
Vln. II
Vla.
Vc.
molto libero e indefinito
8va
ord.
pont.
p
mp
248
molto libero e indefinito
pont.
ord.
pont.
mp
p
mf
p
252
ord.
pont.
molto libero e indefinito
mp
p
ord.
pont.
mp

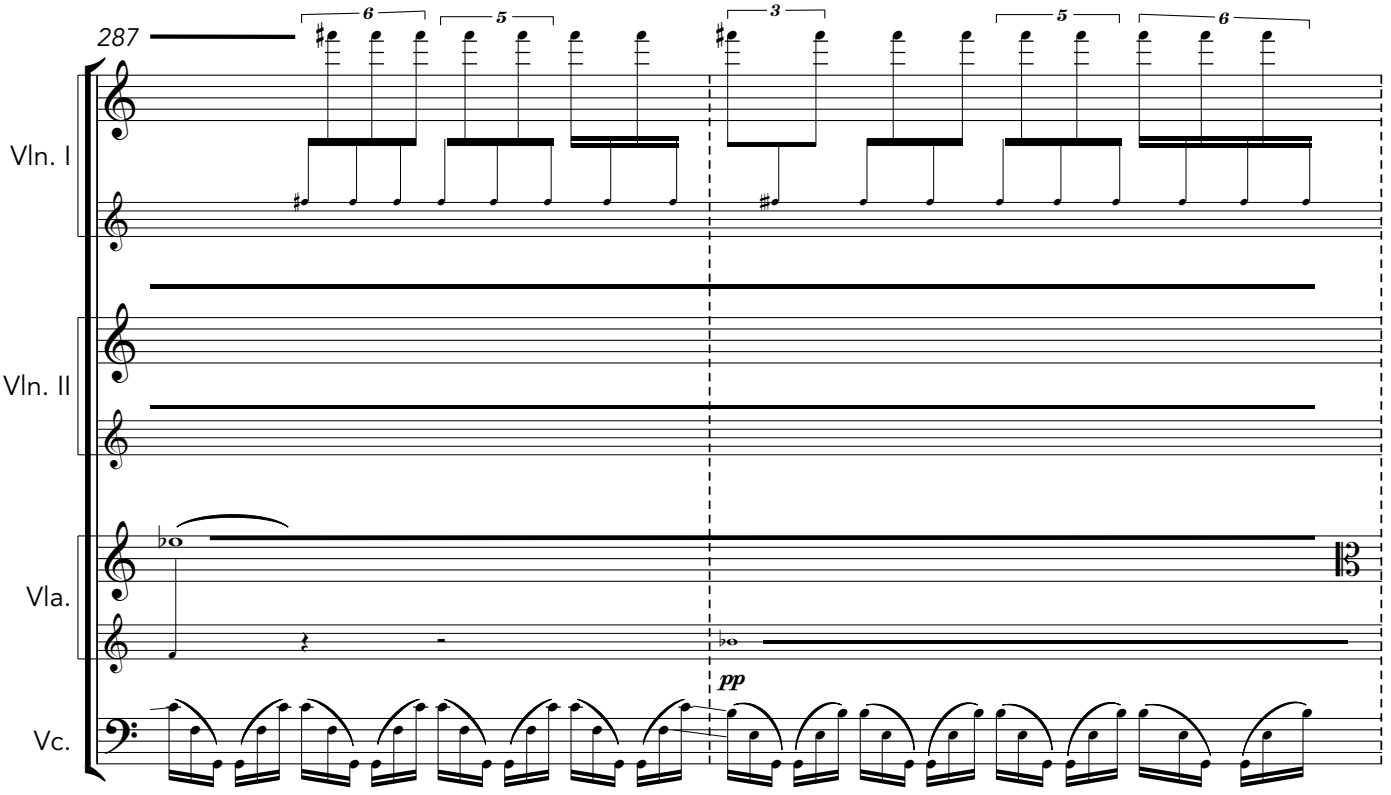

256
Vln. I
Vln. II
Vla.
Vc.
pp
molto libero e indefinito
mp
p
8va
pont.
ord.
mf
pp
261
5
6
pont.
mp
pp
267
6
5
5
6
gliss.
ord.
pont.
mp
pp
6
5

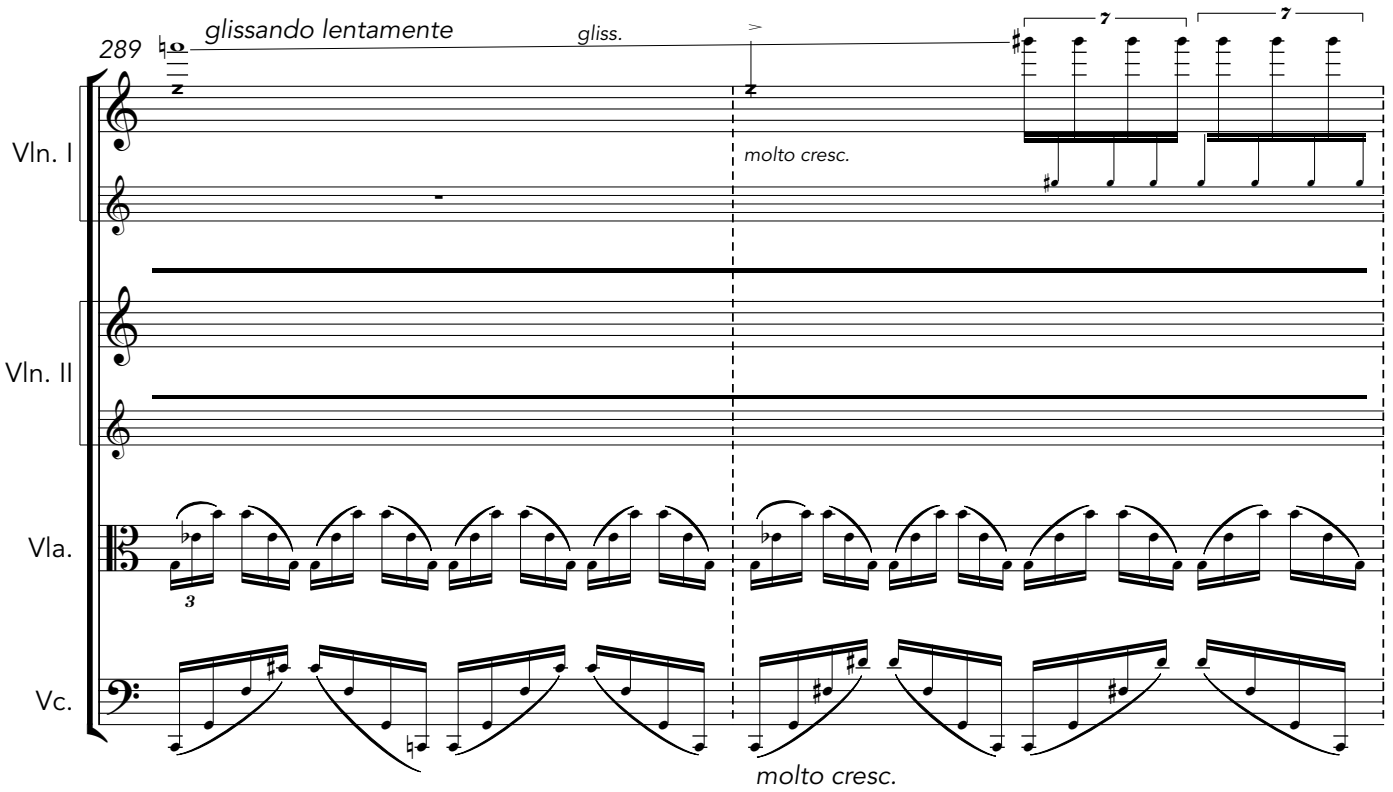

271
(senza glissando)
gliss.
ripetere simile
pp
(senza glissando)
(senza glissando)
Vln. I
Vln. II
Vla.
Vc.
277
279
pp

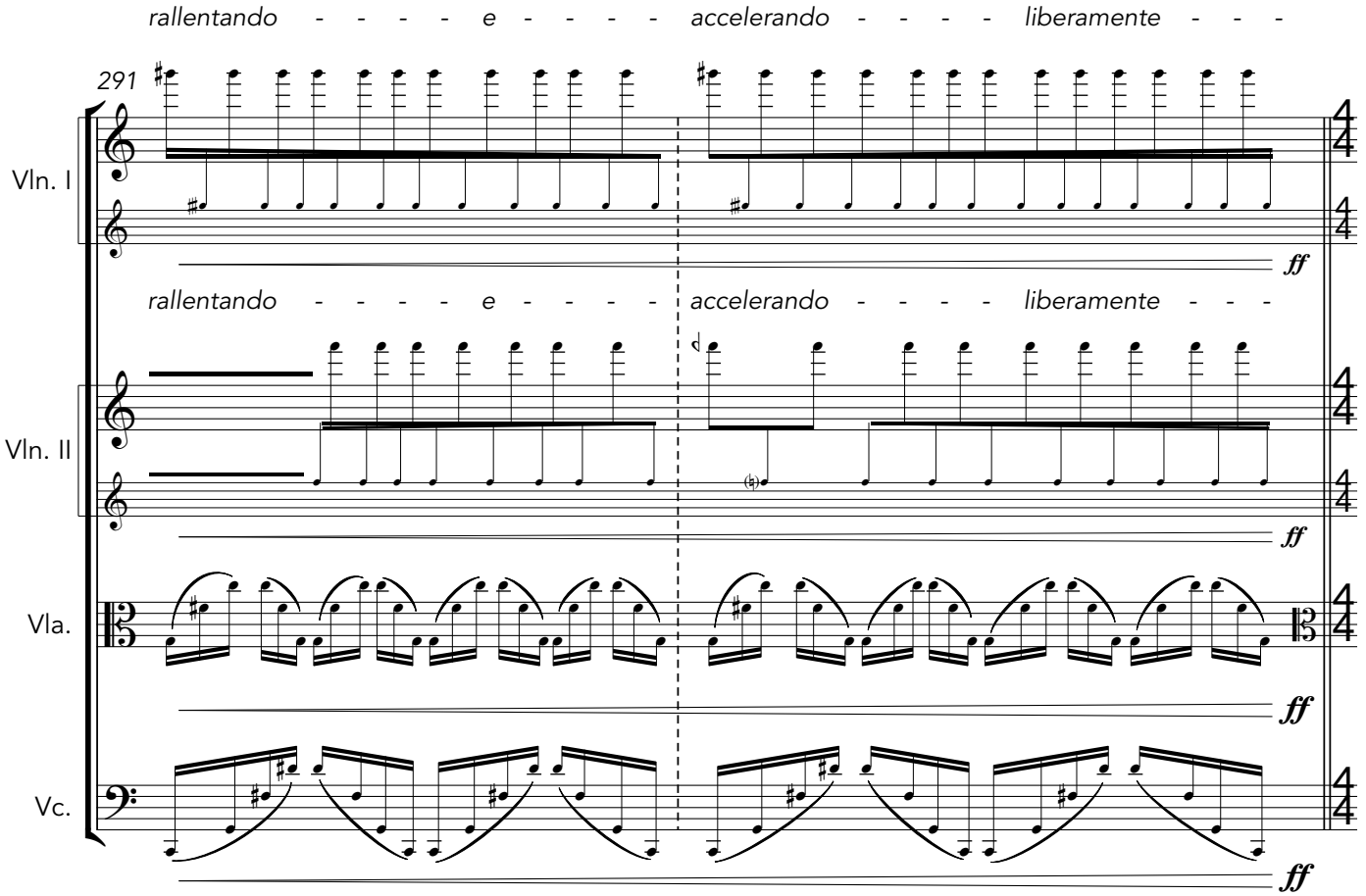

281
Vln. I
Vln. II
Vla.
Vc.
p
3
3
5
5


283
Vln. I
Vln. II
Vla.
Vc.
5
5
6
p subito


285
Vln. I
Vln. II
Vla.
Vc.
5
5
3
pp
simile


287
Vln. I
Vln. II
Vla.
Vc.
6
5
3
5
6
pp


289
glissando lentamente
gliss.
molto cresc.
Vln. I
Vln. II
Vla.
Vc.
molto cresc.

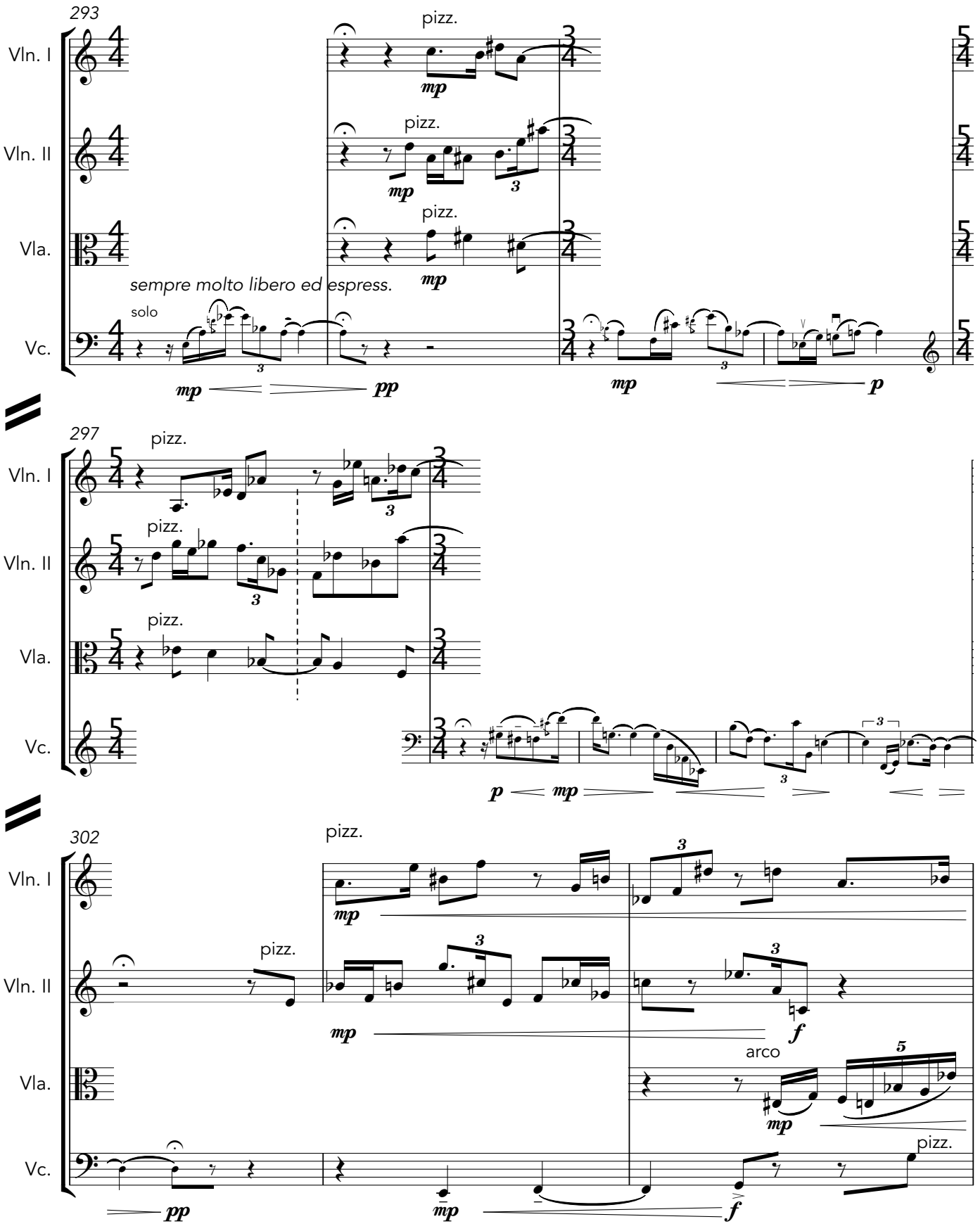

rallentando - - - - - e - - - - - accelerando - - - - - liberamente - - -
291
Vln. I
ff
rallentando - - - - - e - - - - - accelerando - - - - - liberamente - - -
Vln. II
ff
Vla.
ff
Vc.
ff

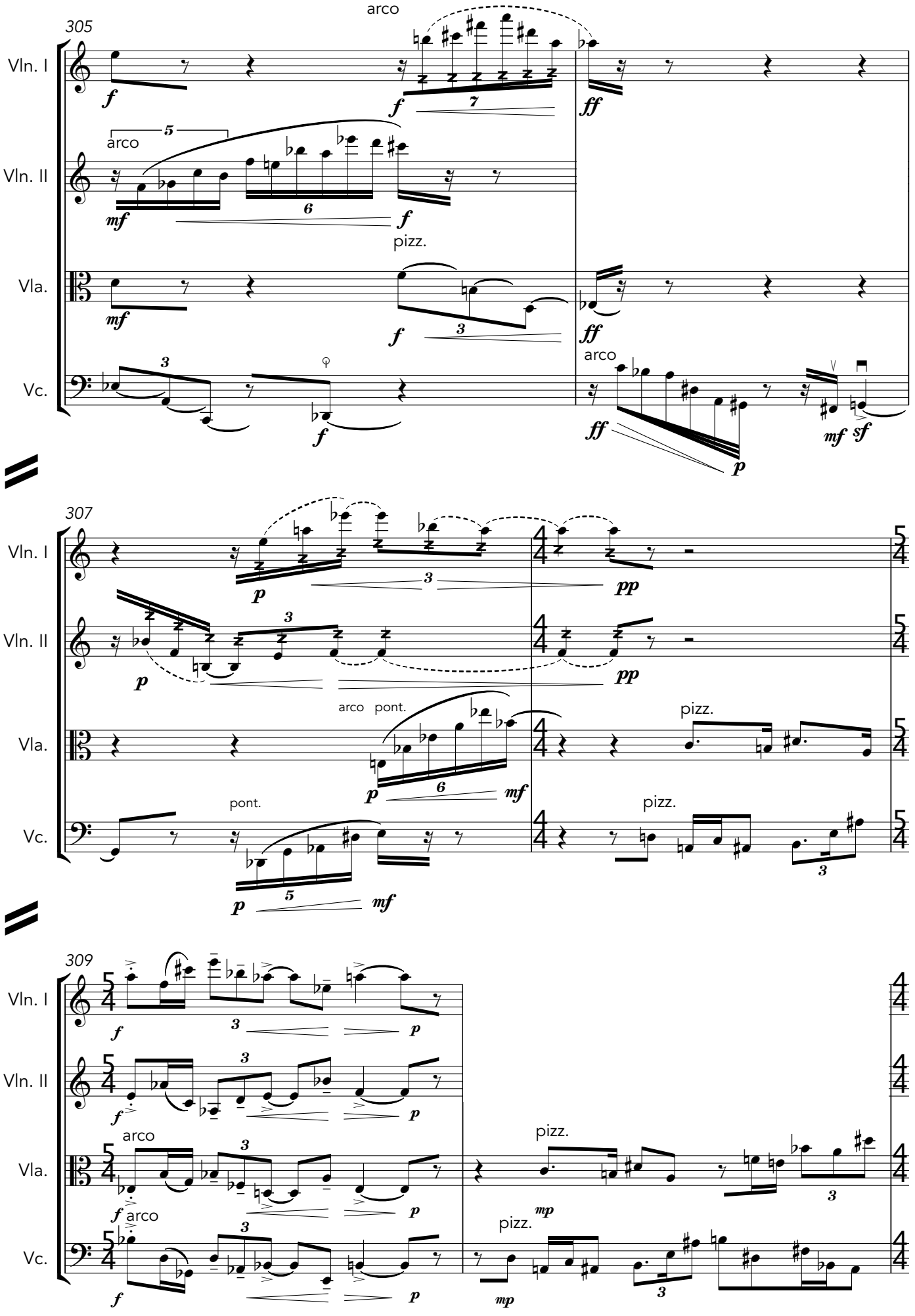
VII. Una Strana Dualità

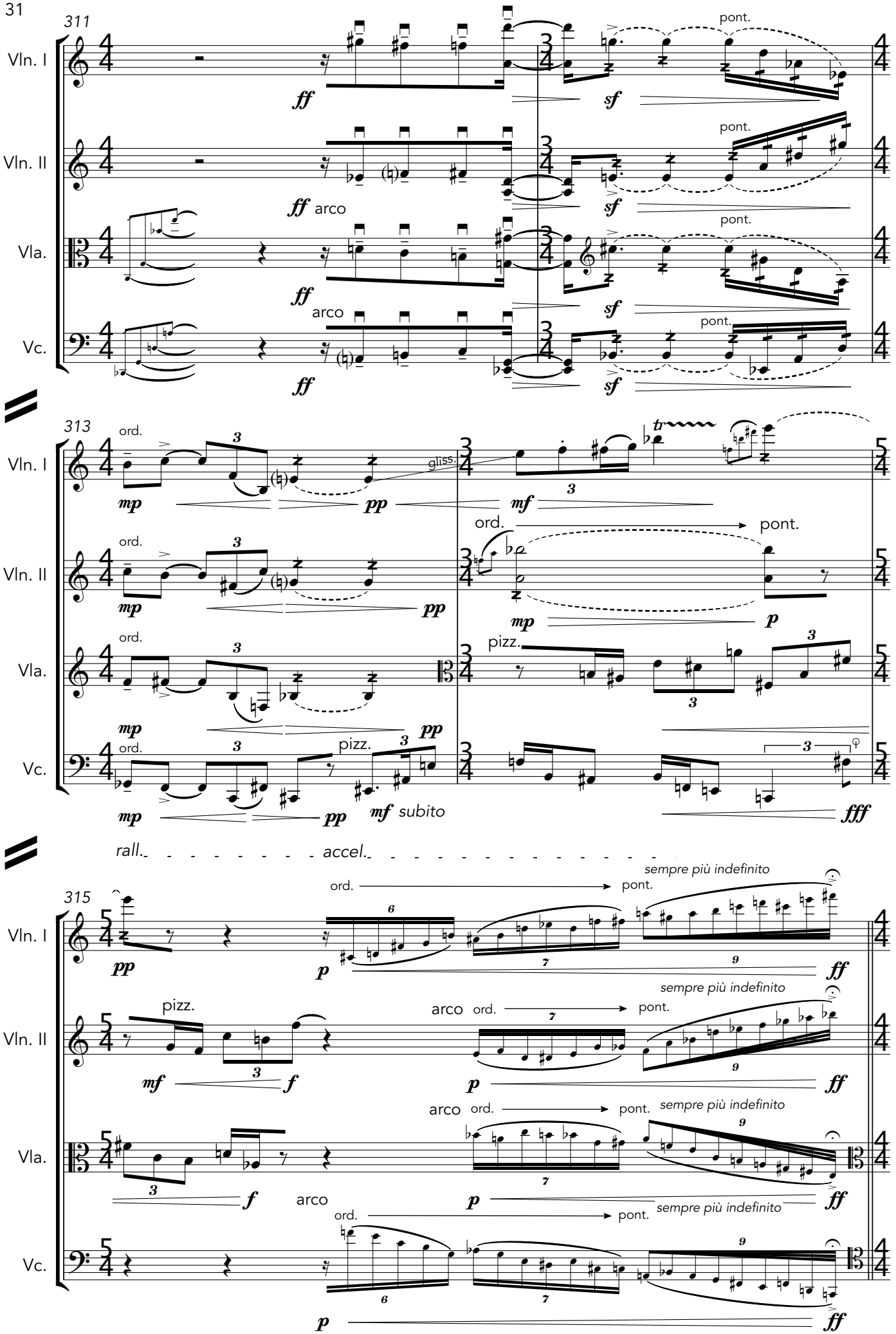
VII. A Strange Duality

$$\lambda = \frac{\mathrm{h}}{\mathrm{m}v}$$

Misterioso ♩=70




305
Vln. I
Vln. II
Vla.
Vc.
arco
pizz.
307
pont.
309
mp


311
Vln. I
Vln. II
Vla.
Vc.
ff
sf
pont.
arco
313
ord.
mp
pp
gliss.
mf
tr
pizz.
mf subito
fff
rall.
accel.
315
sempre più indefinito
f

VIII. Figure di Interferenza

VIII. Interference Figures

$$\sin\theta = m\frac{\lambda}{d} \qquad \sin\theta = \left(m + \frac{1}{2}\right)\frac{\lambda}{d}$$

Ancestrale e arcaico ♩=70

316 solo

Vc. *mp molto espress. e cantabile* *p*

319

Vln. I *mp molto espress. e cantabile*

Vln. II *p* *p* 7

Vla. *mp molto espress. e cantabile*

Vc. *pp* *p* *p* 7

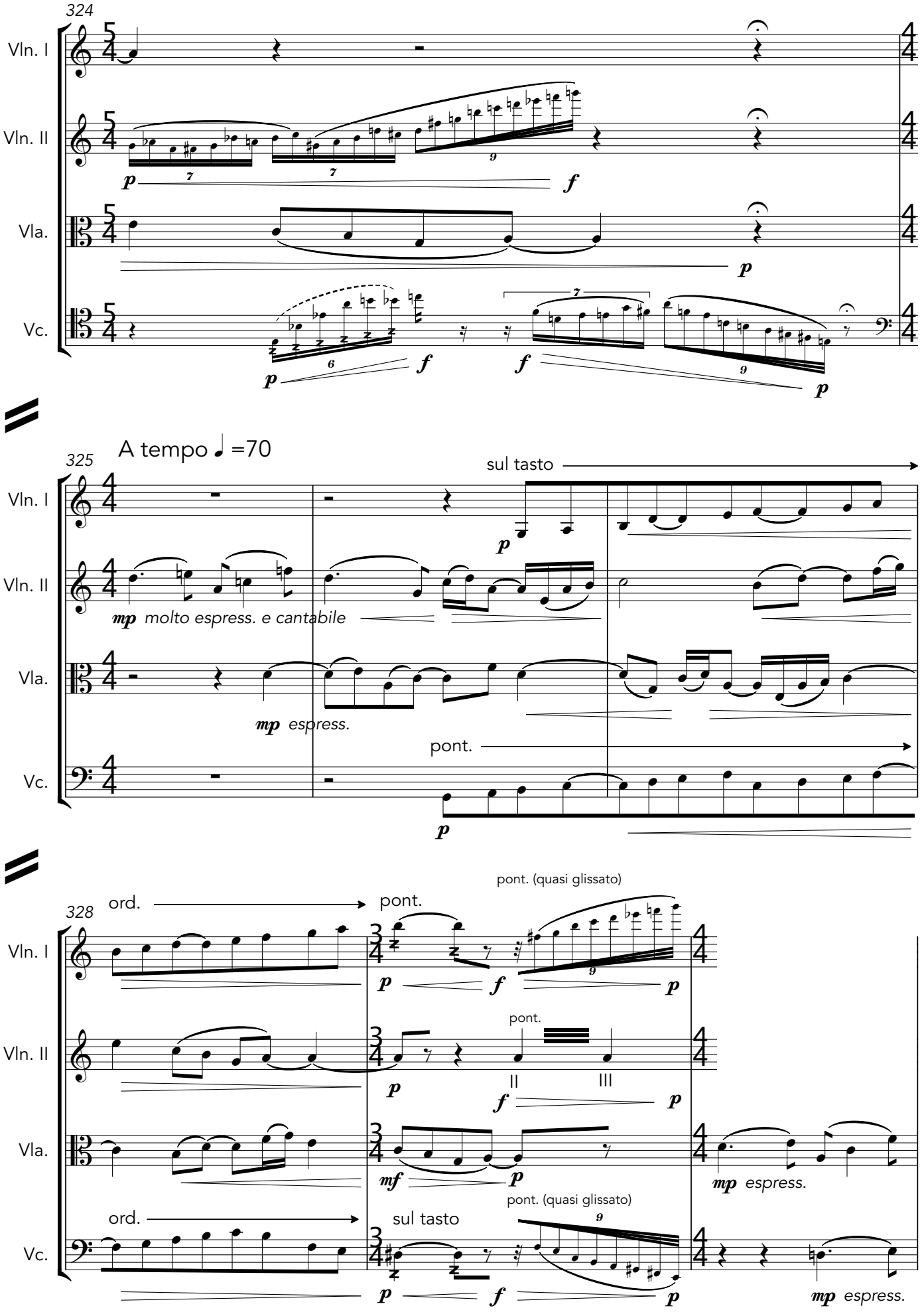
322

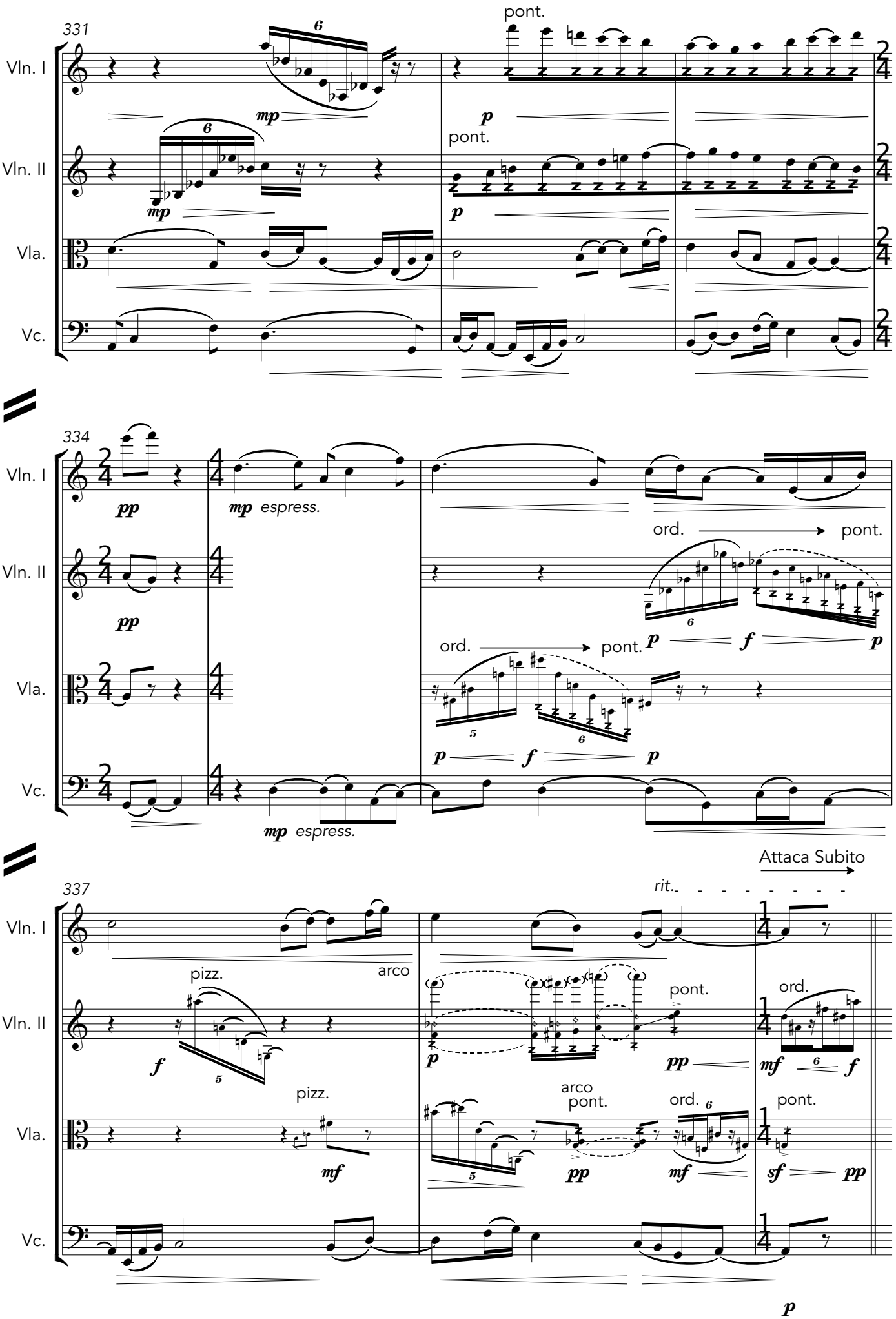
Vln. I

Vln. II *mf* *p* 7 *mf* *mf* 6 *p*

Vla.

Vc. *mf* *p* 7 *f*

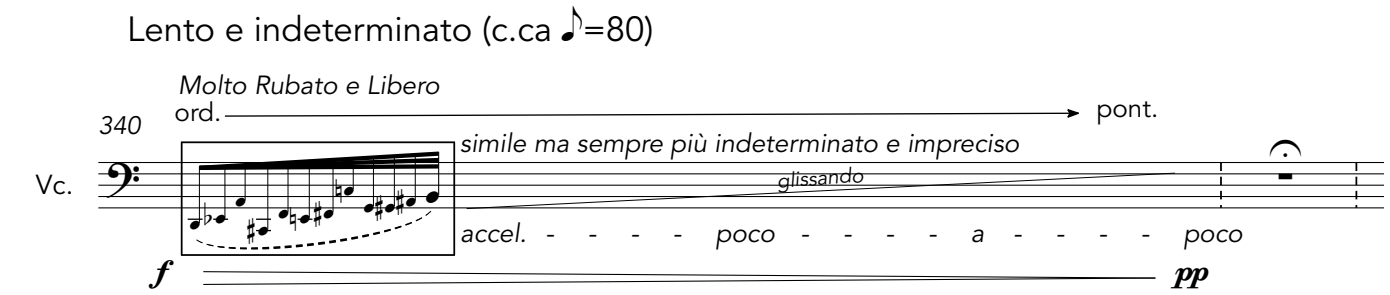

324
Vln. I
Vln. II
Vla.
Vc.
A tempo ♩ =70
325
sul tasto
mp molto espress. e cantabile
mp espress.
pont.
328
ord.
pont.
pont. (quasi glissato)
sul tasto
mf
mp espress.

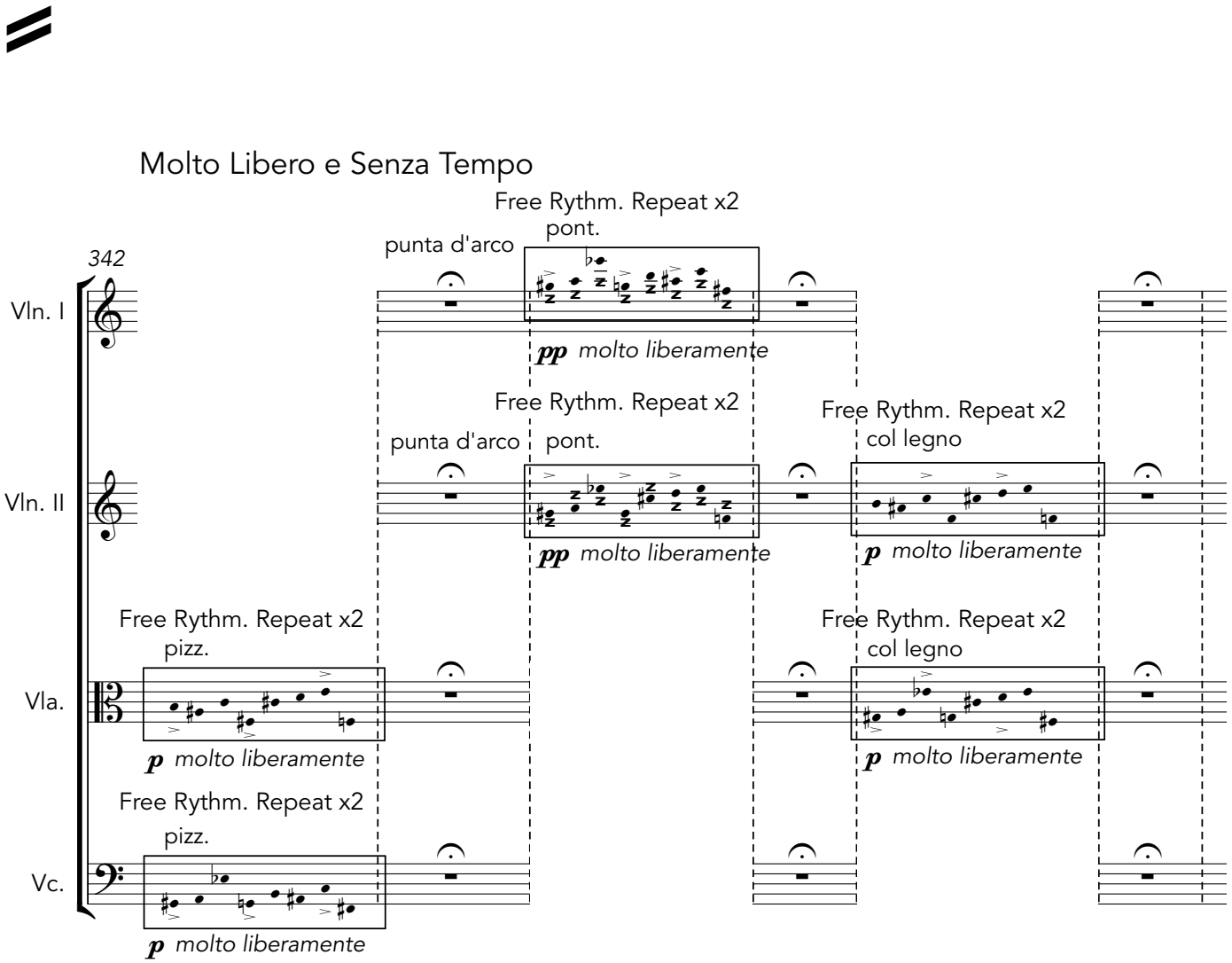

331
Vln. I
Vln. II
Vla.
Vc.
pont.
mp
p
334
pp
mp espress.
ord.
pont.
f
5
6
337
Attaca Subito
rit.
pizz.
arco
mf
sf

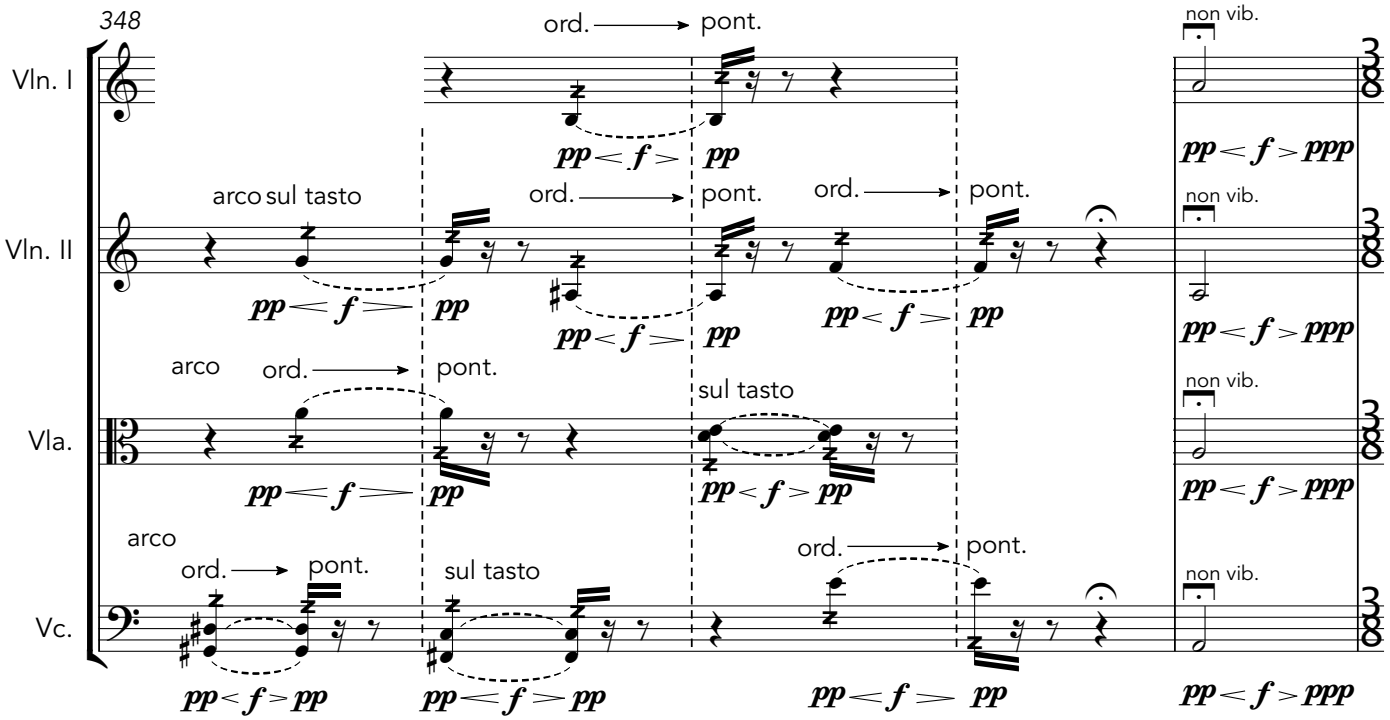
IX. Relazioni di Indeterminazione

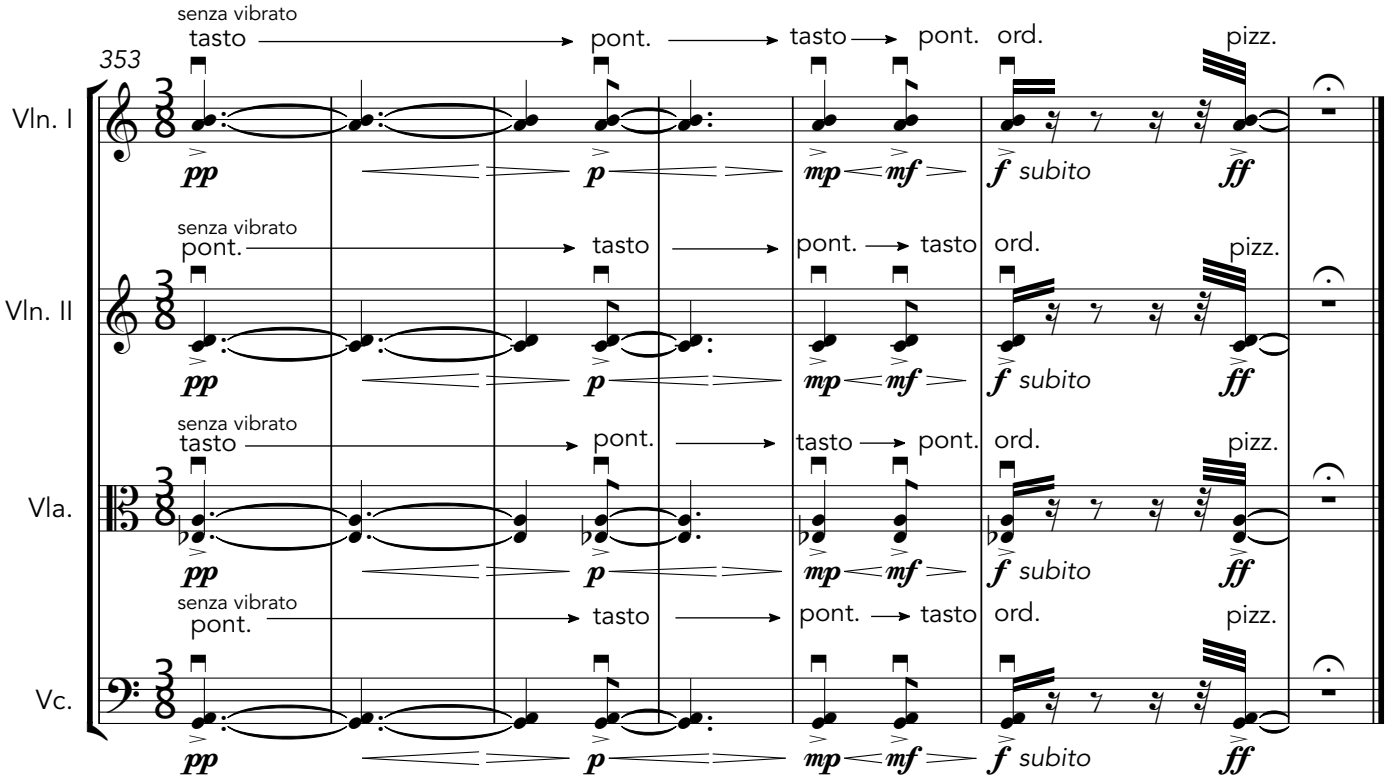
IX. Uncertainty Relations

$$\triangle x \triangle p \geq \frac{\hbar}{2}$$







$$\triangle E \triangle t \geq \frac{\hbar}{2}$$

A tempo ♪=60 c.ca