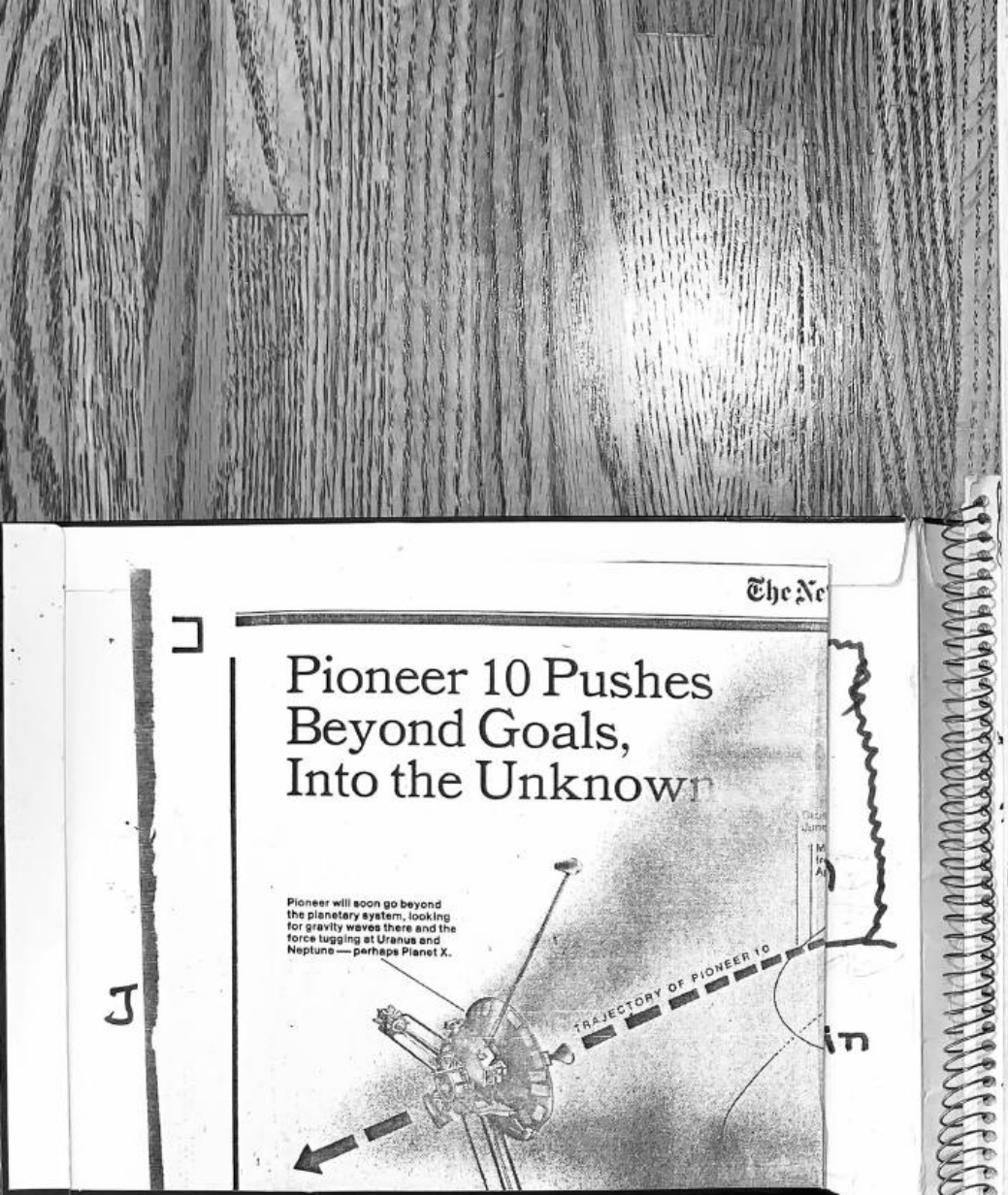


The Ne

Pioneer 10 Pushes Beyond Goals, Into the Unknown

Pioneer will soon go beyond the planetary system, looking for gravity waves there and the force tugging at Uranus and Neptune — perhaps Planet X.

TRAJECTORY OF PIONEER 10

Lento

Flutes
Oboes
Clarinets
Bassoons
Horns
Trumpets
Trombones
Tuba
Percussion
Harp
2nd Harp (Piano)
1st Violin
2nd Violin
Viola
Cello
Bass

1983

ISSM-135

Pioneer 10 Pushes Beyond Goals, Into the UnKnown

[a musical commentary]

Text by John Noble Wilford

Music by Irving Schlein

Instrumentation

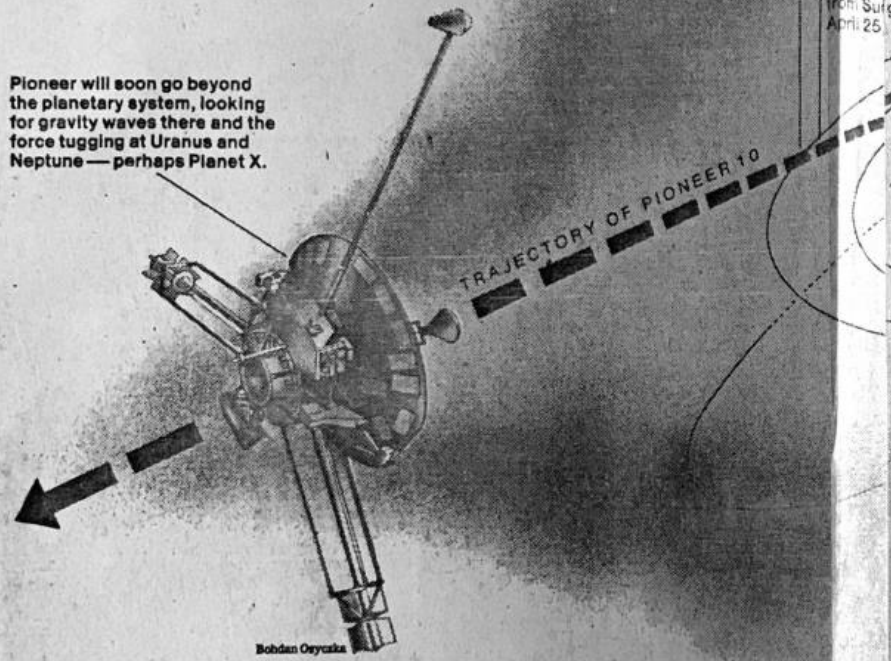
Speaker

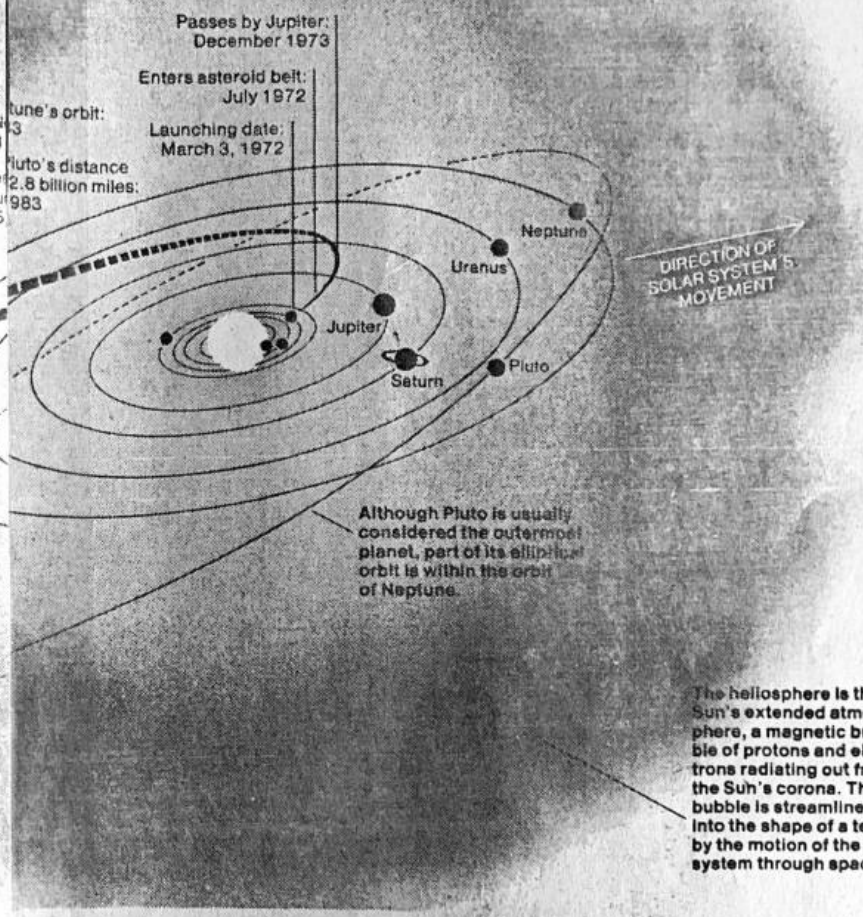
3 Flutes
3 Oboes
3 Clarinets (Bb)
2 Bassoons
4 French Horns (F)
3 Trumpets (Bb)
3 Trombones
1 Tuba
Percussion
2 Harps
Strings
celesta.

Pioneer 10
Pushes Beyond Goals
Into the UnKnown

John Noble Wilford
—and—
Irving Schlein

Pioneer 10 Pushes Beyond Goals, Into the Unknown





Nearing edge of solar system, spacecraft sends whispers of discovery back to Earth.

By JOHN NOBLE WILFORD

OUT there, far, far away where Earth is a mere pinpoint of light and the Sun is a pale disk of diminishing consequence, a hardy little spacecraft cruises on and on into the unexplored. No machine of human design has ever gone so far. Pioneer 10 has traveled to the reaches of Pluto, a distance it achieved yesterday, and is advancing toward the edge of the solar system.

From out there, now 2.7 billion miles away, Pioneer's eight-watt radio transmitter sends faint messages back to Earth every day, whispers of discovery. The transit time of these reports, traveling at the speed of light, is 4 hours and 16 minutes. And by the time the signals arrive at tracking antennas, they have all but vanished, their strength reduced to 20 billionths of a watt.

But scientists with the patience to extract the signals out of the background noise and to decipher their messages are learning for the first time what it is like in the outermost solar system. It is cold and dark and empty, as they knew it must be. A tenuous wind of solar particles, the million-mile-an-hour solar wind, still blows outward. Cosmic rays race inward. A virtual vacuum it may be, but nothingness, it seems, is a relative condition.

If the spacecraft survives long enough and the scientists are clever enough, more exciting discoveries could lie ahead for Pioneer 10. It might be able to detect gravity waves, which have been theorized but have never been observed. It might locate the source of the mysterious force tugging at Uranus and Neptune, a gravitational force suggesting the presence of some as yet unseen object — perhaps the long-sought Planet X or a dim companion star to the Sun. The spacecraft may also function long enough to report back the answer to the question, Where does the solar system end and interstellar space begin?

"We are constantly entering unexplored territory," says Dr. Aaron Barnes, an astrophysicist at the Ames Research Center in Mountain View, Calif., where the Pioneer mission is directed. "We really don't know what we'll learn."

Travel was never more broadening. When Pioneer 10 was launched March 3, 1972, from Cape Canaveral, Fla., no spacecraft had ventured farther than Mars. Pioneer made its way safely through the asteroid belt, a region littered with rocky debris between Mars and Jupiter. It flew within 81,000 miles of Jupiter's cloudtops on Dec. 2, 1973, returning the first close-up images of the Sun's largest planet. The pictures revealed the cyclonic forces of the Great Red Spot roiling Jupiter's dense hydrogen and helium atmosphere. Pioneer made the first detailed observations of Jupiter's powerful radiation belts and discovered that the planet's sphere of magnetic influence extended to the orbit of Saturn, a distance of half a billion miles.

Pioneer had by then accomplished its mission and exceeded its designed 21-month lifetime. The 500-pound craft had been blasted by Jovian radiation and pelted with micrometeoroids. "No one dreamed then we'd still be hearing from Pioneer today," recalls

Continued on Page C8

Pioneer 10 Pushes Beyond Goal, Into the Unknown

Continued From Page C1

Dr. James A. Van Allen of the University of Iowa, one of the mission's scientists.

Still Pioneer kept going, its nine-foot dish antenna always cocked in the direction of Earth. It dutifully kept sending home a travelogue on interplanetary space as it crossed the orbit of Saturn in 1976 and the orbit of Uranus in 1979.

Pioneer 10 had now made believers out of its creators, the engineers for the National Aeronautics and Space Administration and the spacecraft manufacturer, TRW Inc. Like the little engine that could, this was the little spacecraft that could probably push on to the frontier of interstellar space and still be living to tell the tale.

After more than 11 years in flight, according to Richard O. Fimmel, the project manager at NASA's Ames Research Center, all the craft's scientific instruments, except the magnetometer, are working normally. He estimates that deep-space antennas should maintain communications with Pioneer for eight moreyears, out to a distance of five billion miles. That is when the craft's radioisotopic power unit will no longer be generating enough electricity for operations.

Leaving Realm of Known Planets

Right now Pioneer is, in effect, leaving the realm of the known planets. At 5 P.M. yesterday the craft, traveling 30,613 miles an hour, sped farther out than Pluto. It was then almost 2.8 billion miles from the Sun; Earth is 93 million miles away from the Sun. At the time, however, Pluto was on the other side of the Sun.

On June 13, Pioneer's outbound trajectory will cross Neptune's orbit, 2.81 billion miles from the Sun. Normally Pluto is the outermost planet, but because its orbit is highly elliptical, unlike the roughly circular orbits of the other planets, Pluto is now nearer to the Sun than Neptune and will be for the next 17 years.

Each day flight controllers at Ames typically send Pioneer a message when they arrive at work. By quitting time eight and a half hours later, which is the round-trip communications time, they receive Pioneer's reply.

They also receive about 16 hours of scientific data each day from the spacecraft, mainly information defining the extent and behavior of the heliosphere, the Sun's extended atmosphere. Blowing away in all directions from the Sun is the solar wind, an electrically charged gas composed of protons (hydrogen nuclei) and electrons that stream out from the Sun's corona. The wind carries along with it the Sun's magnetic field.

It is as if the Sun is blowing a pressure bubble out into space, a tear-shaped magnetic bubble that acts as a barrier against intrusions by most particles from the interstellar medium. The bubble is streamlined by the motion of the solar system through this interstellar gas. At the solar system's leading edge, so to speak, the bubble is blunted. In the opposite direction, the bubble forms a long tail. Pioneer 10 is traveling down the tail of the heliosphere.

Before Pioneer, some scientists believed the boundary, the heliopause, might be just beyond Jupiter. But the spacecraft is six times that far out and has yet to encounter the boundary.

The spacecraft's instruments indicate the heliosphere "breathes" in and out once every 11-year solar cycle, as reported by Dr. Joan Simpson, a Pioneer experimenter from the University of Chicago. When the Sun is most turbulent, which last occurred in 1980, shock waves from its magnetic storms seem to persist throughout the heliosphere for as long as a year. The effect may be to change the bubble's shape.

Moreover, at the time of maximum solar activity, the bubble seems to be more impervious to cosmic rays from out in the galaxy. Pioneer's detectors found the cosmic-ray particles half as numerous then.

For the rest of Pioneer's working lifetime, scientists will be monitoring the data for signs of the boundary crossing. Scientists are not sure what to expect. Dr. Barnes says Pioneer would probably encounter changes in the outside temperatures and discernible turbulence as the solar wind was buffetod by the incoming interstellar gases. The speed of the solar wind should drop suddenly from supersonic to subsonic. Dr. Van Allen, however, doubts "anything dramatic" will be observed at the heliopause.

Other spacecraft, Voyager 1 and Pioneer 11, may find a sharper boundary. Though not as far from Earth as Pioneer 10, they are traveling in an opposite direction, toward the blunt edge of the bubble. Dr. Edward C. Stone of the California Institute of Technology, Voyager's chief scientist, believes the spacecraft should encounter a kind of bow shock caused by the solar wind slamming into the dominant and relatively stationary interstellar environment. It may even be possible to hear the boundary crossing. Energies produced by the interactions may give off whistling noises that Voyager will radio back to Earth.

Because of its great distance away, Pioneer 10 could give scientists their first evidence of the existence of gravity waves. According to Einstein's General Theory of Relativity, cataclysms in the universe, collapsing or exploding stars, should send waves of gravitational radiation across the galaxies. Dr. John Anderson of the Jet Propulsion Laboratory says that a painstaking analysis of radio transmissions from Pioneer to Earth might reveal the jiggling effects that a gravity wave would have on the craft or Earth itself.

Possible Discovery at the Edge

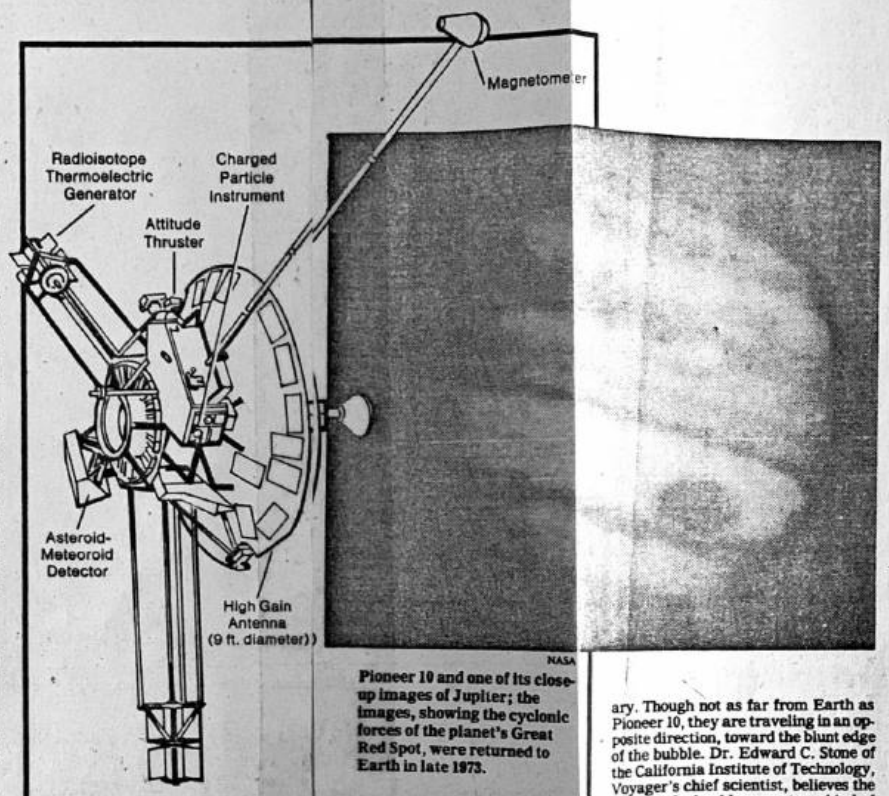
Accordingly, Pioneer 10 may lead scientists to the discovery of some massive object toward the edge of the solar system. It may be, as some astronomers suspect, a "brown dwarf" star, a celestial object that was not quite massive enough for its thermonuclear furnace to ignite. Since most stars are paired, it is not unreasonable to assume that the Sun might have such a dim companion.

Or the force could be from a 10th planet, the long-sought Planet X. Evidence assembled in recent years has led several groups of astronomers to renew the search for a large planet out beyond Pluto and Neptune.

Someday, of course, even the durable Pioneer 10 will lose touch with those who sent it off on its long journey. The little radio that has already transmitted more than 126 billion bits of scientific data will go dead. Sensors will lose sight of the Sun.

Even then, silent and derelict, Pioneer 10 will cruise on and on, the first human artifact to leave the solar system. About once every million years, as nearly as anyone can calculate such things, the craft might expect to come close to another star system. It might then be found by other intelligent beings.

With that eventuality in mind, Pioneer's makers indulged in an act of infinite hubris. They attached a plaque engraved with images of a man and a woman, the location of Earth and some points of basic science — possibly the little spacecraft's ultimate message.



NASA

Pioneer 10 and one of its close-up images of Jupiter; the images, showing the cyclonic forces of the planet's Great Red Spot, were returned to Earth in late 1973.

OUT there, mere pi... disk of ... little spa... unexplored. No m... ...so far. Pioneer ... Pluto a distance ...

Flutes

Oboes

Clarinets

Bassoons

1983

ISSM-135

Horns

Trumpets

Trombones

Tuba

Pioneer 10 Pushes Beyond Goals, Into the UnKnown

[a musical commentary]

Percussion

Text by
John Noble Wilford

Music by
Irving Schlein

Harp

Instrumentation

Speaker

2nd Harp (Piano)

3 Flutes
3 Oboes
3 Clarinets (Bb)
2 Bassoons
4 French Horns (F)
3 Trumpets (Bb)
3 Trombones
1 Tuba
Percussion
2 Harps
Strings
celesta

1st Violin

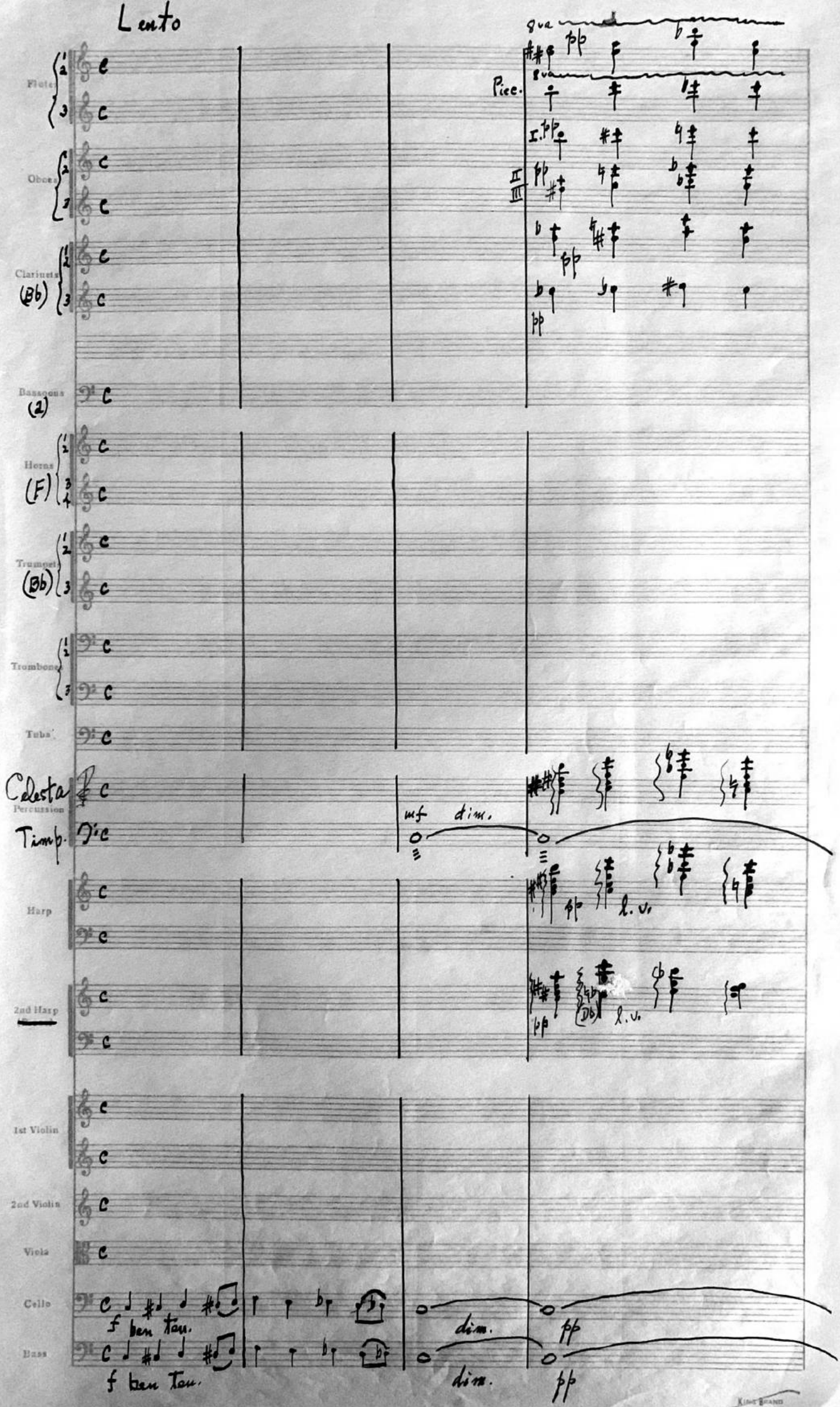
2nd Violin

Viola

Cello

Bass

KING BRAND
1595 B'WAY, N.Y.


Lento
Flute
Oboes
Clarinets (Bb)
Bassoons (2)
Horns (F)
Trumpets (Bb)
Trombones
Tuba
Celesta
Percussion
Timp.
Harp
2nd Harp
1st Violin
2nd Violin
Viola
Cello
Bass
Picc.
8va
mf dim.
l.v.
f ben ten.
dim.
pp

8va

Flutes 1 2 3

Rec.

Change to Fl.

Oboes 1 2 3

Clarinets 1 2 3

Bassoons

Horns 1 2 3 4

Trumpets 1 2 3

Trombones 1 2 B

Tuba

Celesta

Percussion

Timp.

8va

16va

Harp

l.v.

2nd Harp

l.v.

8va

1st Violin

div. à 3

2nd Violin

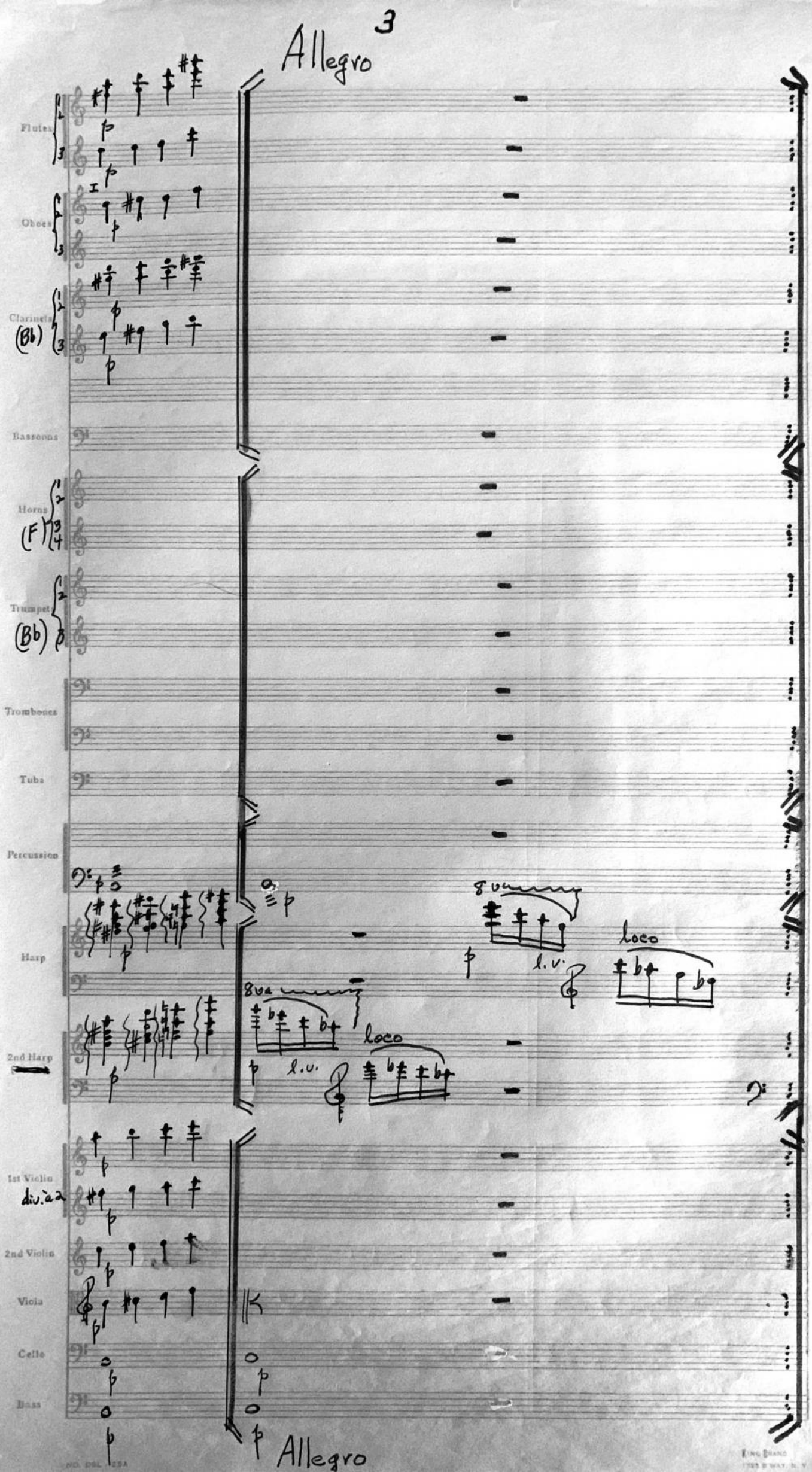
Viola

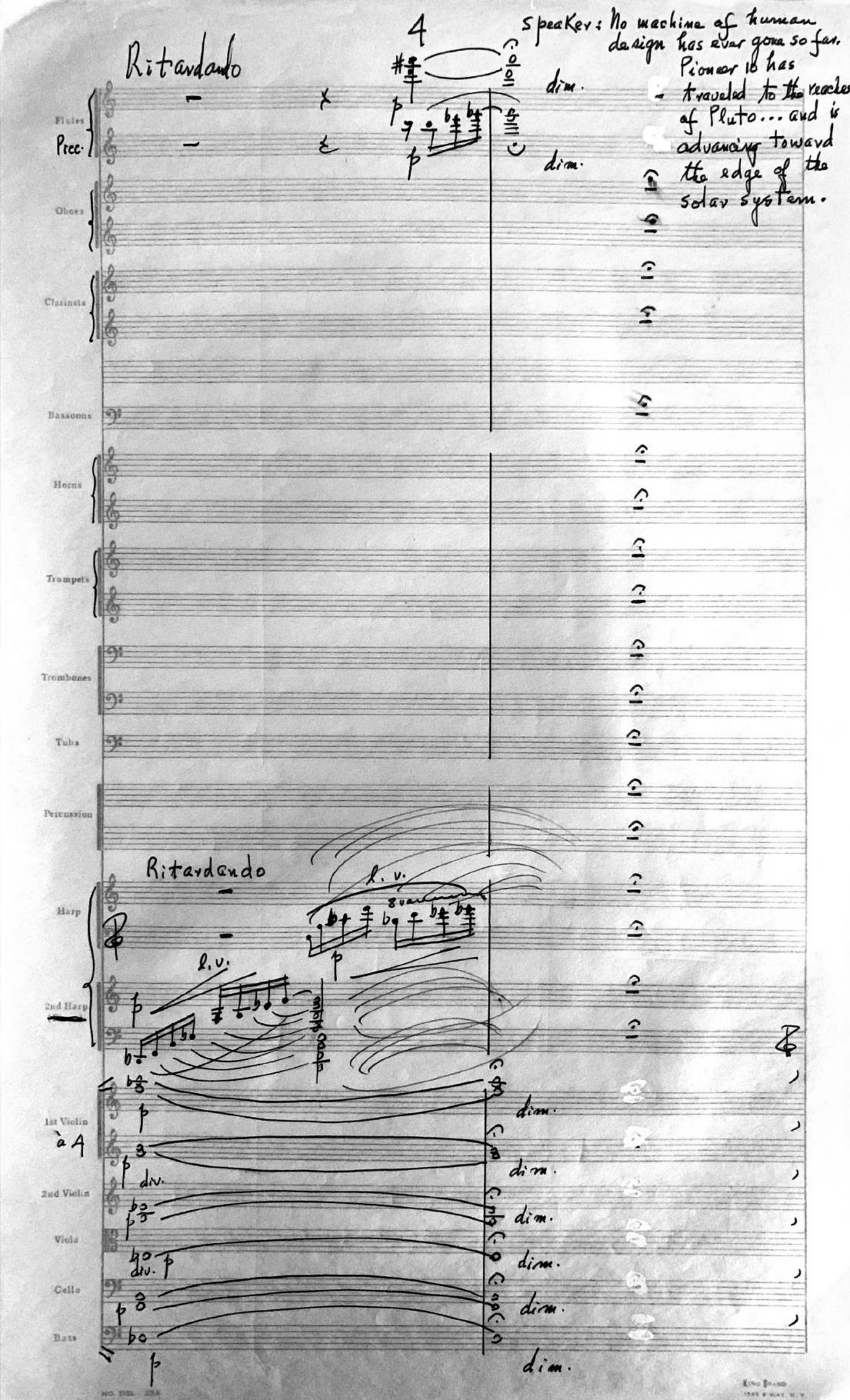
div. à 4

Cello

Bass

Speaker:
Out there, far, far away where Earth is a mere pinpoint of light and the Sun is a pale disk of diminishing consequence, a handful little spacecraft cruises on and on into the unexplored.


Allegro
Flutes
Oboes
Clarinets
(Bb)
Bassoons
Horns
(F)
Trumpet
(Bb)
Trombones
Tuba
Percussion
Harp
2nd Harp
1st Violin
div. à 2
2nd Violin
Viola
Cello
Bass
8va
l.v.
loco
Allegro


Ritardando
4
Speaker: No machine of human design has ever gone so far. Pioneer 10 has traveled to the reaches of Pluto... and is advancing toward the edge of the solar system.
Flutes
Prec.
Oboes
Clarinets
Bassoons
Horns
Trumpets
Trombones
Tuba
Percussion
Ritardando
l. v.
Harp
2nd Harp
1st Violin
à 4
2nd Violin
div.
Viola
Cello
Bass
dim.

5

Repeat

A Tempo

Flutes

Oboes

Clarinets

Bassoons

Horns (F)

Trumpets (B♭)

Trombones

Tuba

Percussion

Harp

2nd Harp

1st Violin

2nd Violin

Viola

Cello

Bass

con sord

8va

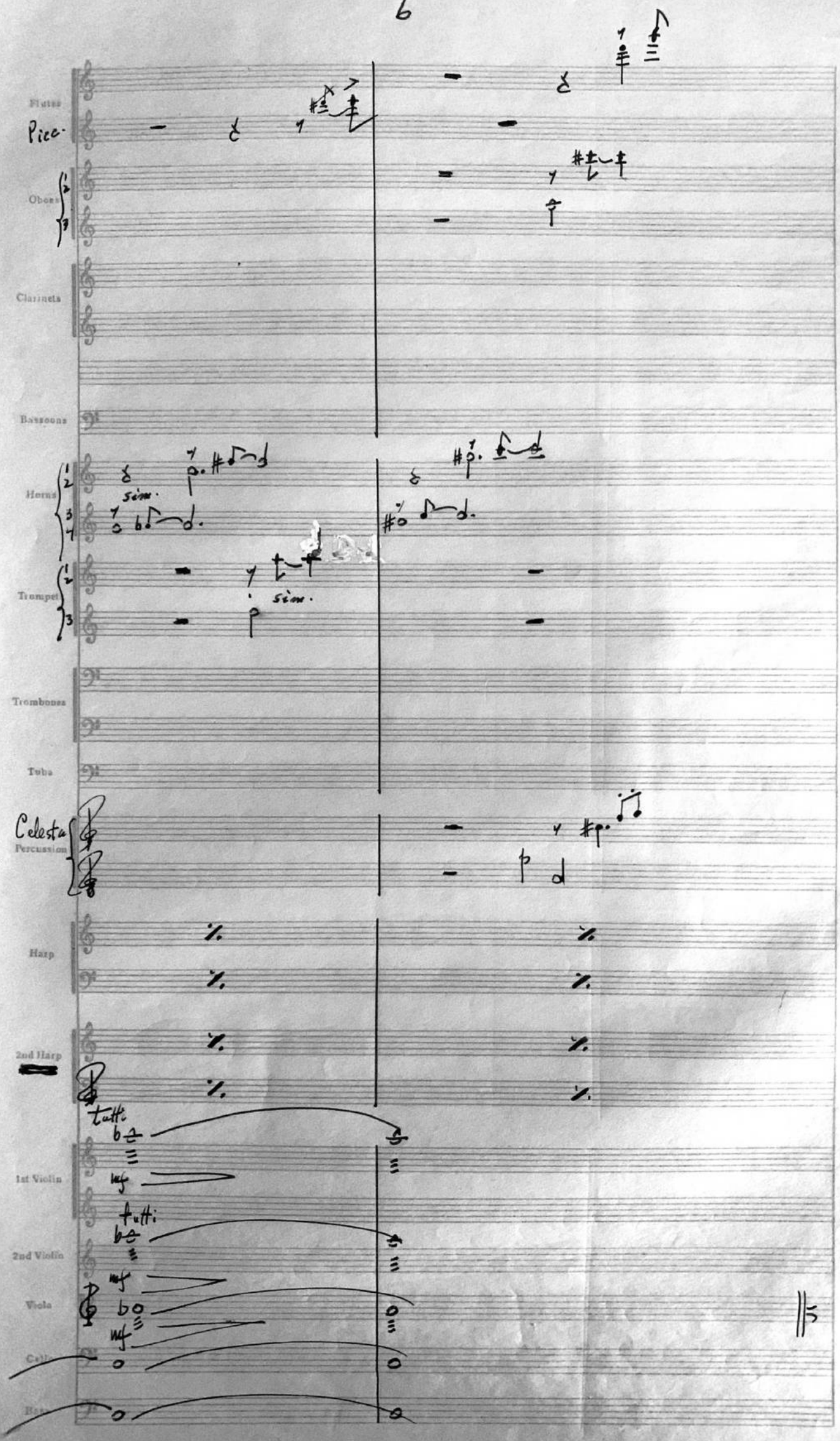
loco

tutti

pp

fp

KING BRAND
1595 B WAY, N. Y.


Flutes
Picc.
Oboes
Clarinets
Bassoons
Horns
sim.
Trumpets
sim.
Trombones
Tuba
Celesta
Percussion
Harp
2nd Harp
tutti
1st Violin
mf
tutti
2nd Violin
mf
Viola
mf
Cello
Bass

7

From out there, now 2.7 billion miles away, Pioneer's eight-watt radio transmitter sends faint messages back to Earth every day, whispers of discovery. The transit time of these reports, traveling at the speed of light, is 4 hours and 16 minutes. And by the time the signals arrive at tracking antennas, they have all but vanished, their strength reduced to 20 billionths of a watt.

Flutes
Picc.
With Flutes
Oboes
Clarinets
Bassoons
Horns
Trumpets
Trombones
Tuba
Celesta
Percussion
Harp
2nd Harp
1st Violin
2nd Violin
Viols
Cello
Bass

Molto meno mosso

But scientists with the patience to extract the signals out of the background noise and to decipher their messages are learning for the first time what it is like in the outermost solar system.

Flutes

Picc.

Oboes

Clarinets

Bassoons

Horns

Trumpets

Trombones

Molto meno mosso

Tuba

Celesta

Percussion

8va

ritenuto

Harp

rit.

2nd Harp

l.v.

rit.

1st Violin

div.

2nd Violin

div.

Viola

div.

Cello

div.

Bass

Molto meno mosso

Lento

It is cold and dark and empty, as they know it must be. A tenuous wind of solar particles, the million-mile-an-hour solar wind, still blows outward. Cosmic rays race inward. A virtual vacuum, it may be, but nothingness, it seems, is a relative condition.

(Repeat under monologue.)

Segue

V.S.

Flutes

Pice.

Oboes

Clarinets (Bb)

Bassoons

Horns

Trumpets

Trombones

Tuba

Celesta

Percussion

Harp

2nd Harp

1st Violin

div.

2nd Violin

tutti

Viola

tutti

Cello

Bass

Lento

If the spacecraft survives long enough and the scientists are clever enough, more exciting discoveries could lie ahead for Pioneer 10. It might be able to detect gravity waves, which have been theorized but have never been observed.

10

Pesante

Flutes

Oboes

Clarinets

Bassoons

Horns

Trumpets

Trombones

Tuba

Percussion

S.D.

Harp

2nd Harp

rec

1st Violin

tutti

2nd Violin

tutti

Viola

div.

Cello

div.

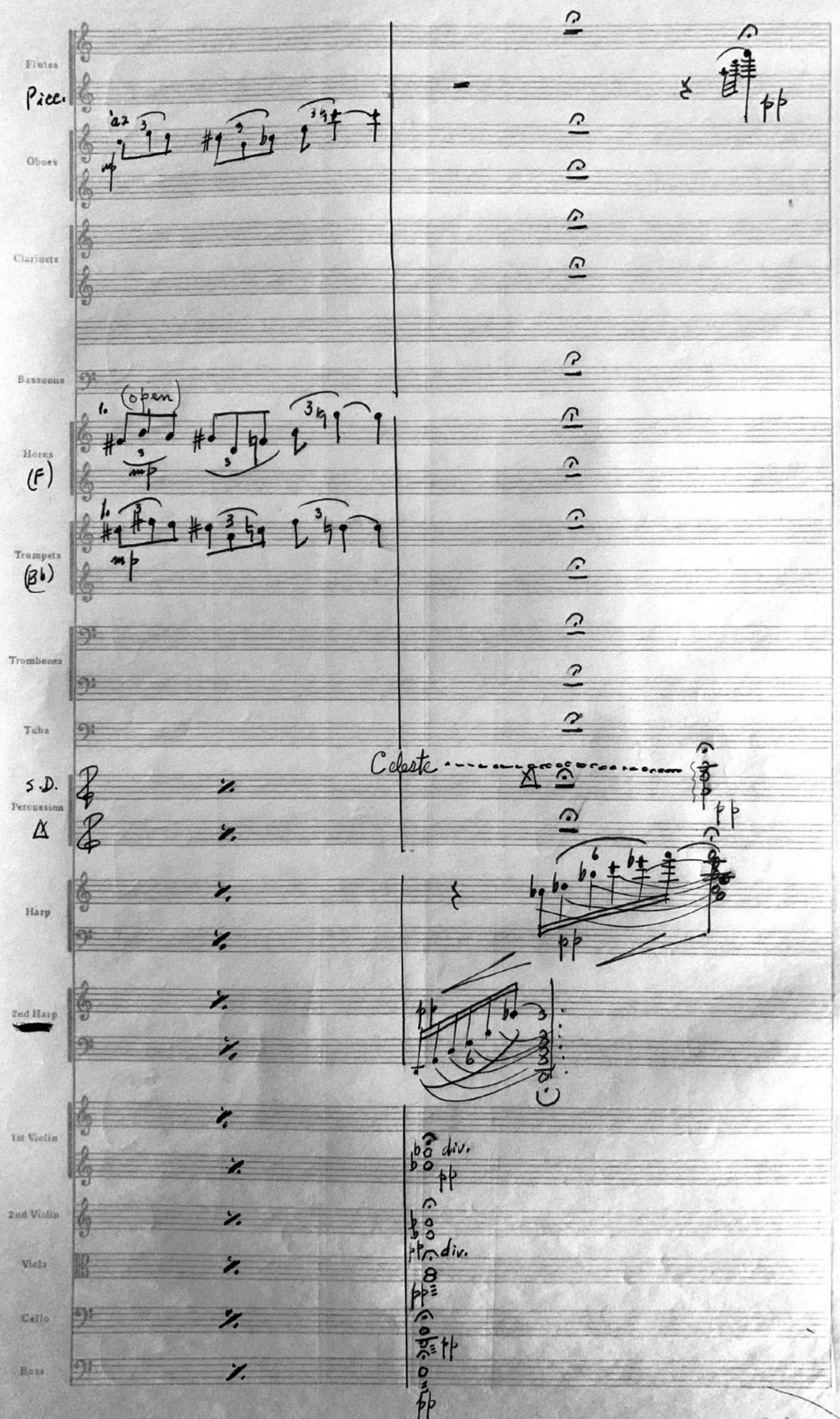
Bass

div.

unis.

tutti

Pesante


Flutes
Picc.
Oboes
a2
Clarinets
Bassoons
Horns
(F)
1.
(open)
Trumpets
(B♭)
Trombones
Tuba
Celeste
S.D.
Percussion
Harp
2nd Harp
1st Violin
div.
2nd Violin
div.
Viola
Cello
Bass

It might locate the source of the mysterious force tugging at Uranus and Neptune, a gravitational force

Maiziale
(4 to the measure)

Flutes
Picc.

Oboes

Clarinets
(Bb)

Bassoons

Horns

Trumpets

Trombones

Tuba

Percussion
Timp.

Harp

2nd Harp

1st Violin
tutti

2nd Violin
tutti

Viola
divisi

Cello

Bass
pizz.

l.v.

sim.

KING BRAND
1595 B'WAY, N. Y.

suggesting the presence of some as yet unseen Object – perhaps the long-sought Planet X or a dim companion star to the Sun.

Change to Fl.

Flutes

Oboes

Clarinet 1 2

Bassoons

Horns 1

con sord.

Trumpets 1 3

con sord.

con sord.

Trombones

Tuba

Percussion

B.D.

Harp

l.v.

2nd Harp

l.v.

1st Violin

div.

2nd Violin

Viola

div.

Cello

sost.

Bass

sost.

Tune to C

poco rit.

Mod^to (in 4)

The space craft may also function long enough to report back

Flutes 1 2 3

Oboes 1 2 B.

Clarinets 1 2 3

Bassoons

unis.

Horns

Trumpets

poco rit.

Trombones

Tuba

Percussion

B.D.

Harp

l.v.

slow gliss.

2nd Harp

poco rit.

1st Violin

div. à 4

2nd Violin

Viola

div. à 3

Cello

Bass

pizz.

poco rit.

pizz.

Mod^to

KING BRAND
1955 B'WAY, N. Y.

the answer to the question, where does the solar system end [15] and interstellar space begin?

à2 marcato

Flutes 2 3

Oboes 2 3

à2

mf

mf

Clarinets 1 2

(Bb)

à2

mf

Bassoons

Horns 1

(F)

mf

Trumpets

Trombones

Tuba

Percussion

B.D.

p

Harp

2nd Harp

[redacted]

1st Violin

unison

mf

2nd Violin

unison

mf

Viola

pizz.

tutti

p

Cello

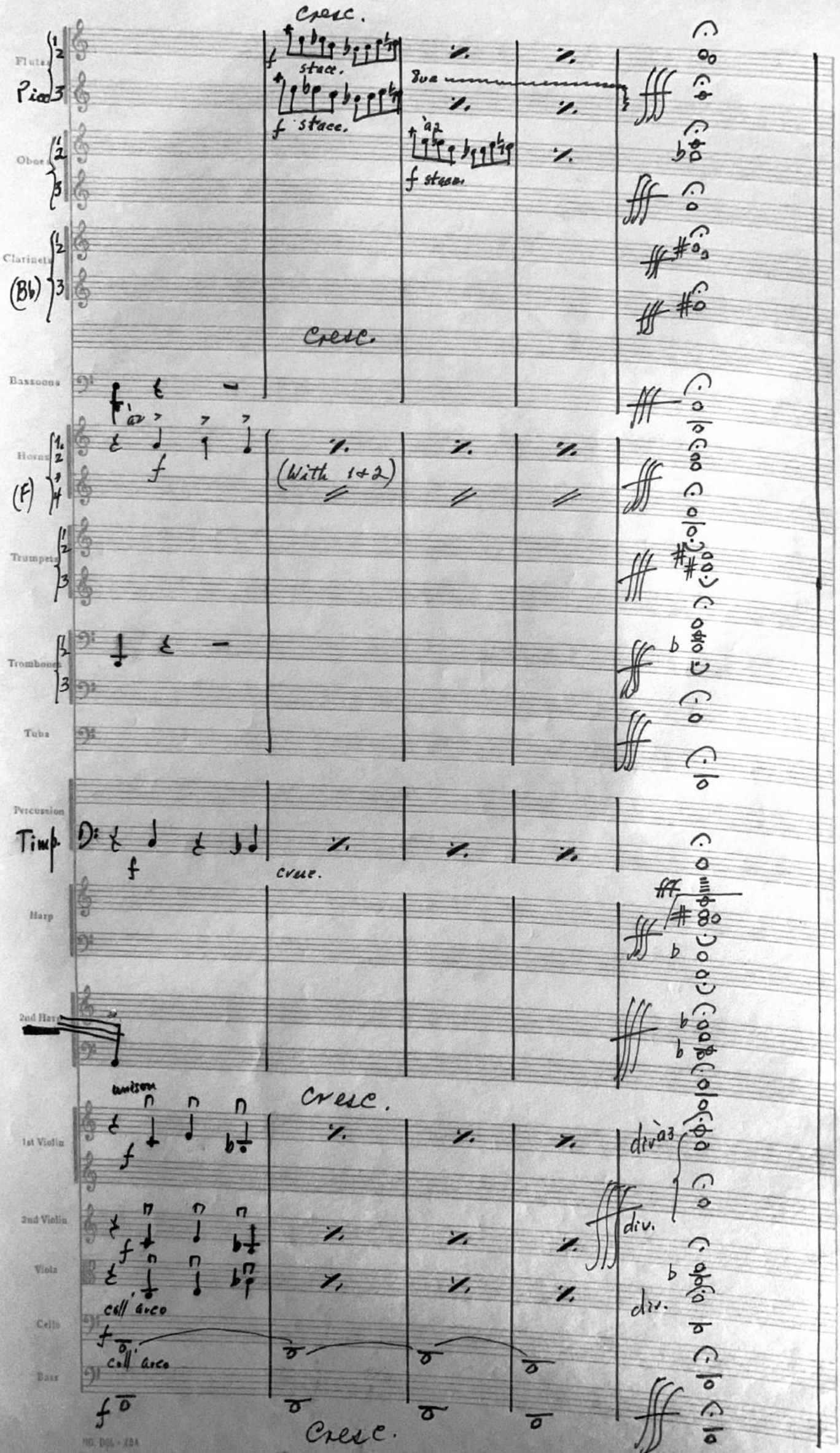
Bass

KING BRAND
1595 B'WAY, N. Y.

16

Flutes
Picc.
1.
Oboes
Clarinets 2 3
Bassoons
Horns
Trumpets
Trombones
Tuba
B.clb
Percussion
B.D.
Harp
2nd Harp
1st Violin
2nd Violin
Viola
Cello
Bass

mf
div.
gliss.


cresc.
Flutes
Picc
f stacc.
8va
f stacc.
à2
f stacc.
Oboes
Clarinets
(Bb)
cresc.
Bassoons
Horns
(F)
(With 1+2)
Trumpets
Trombones
Tuba
Percussion
Timp.
cresc.
Harp
2nd Harp
unison
cresc.
1st Violin
div.
à3
2nd Violin
div.
Viola
div.
Cello
coll' arco
Bass
coll' arco
Cresc.

Marziale (Bright)

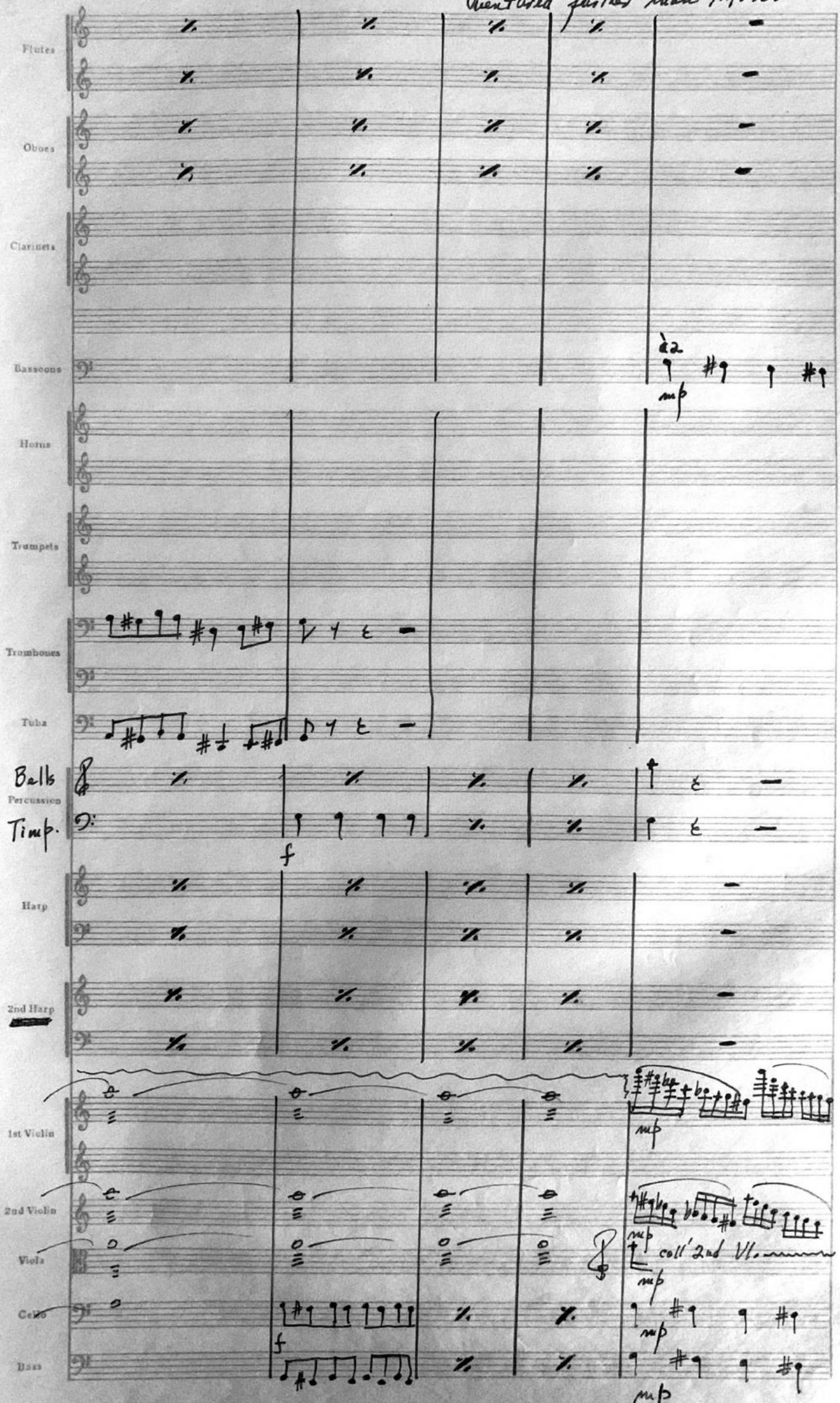
"We are constantly entering unexplored territory. We really don't know what we'll learn," says Dr. Aaron Barnes, an astrophysicist at the Ames Research Center in Mountain View, Calif; where the Pioneer mission is directed.

Flutes 1 2
Pic. 3
Oboes 1 2
Clarinets
Bassoons
Horns
Trumpets
Trombones
Tuba
Bells
Percussion
Harp
2nd Harp
1st Violin
2nd Violin
Viola
Cello
Bass

1. Solo
f Solo
unison

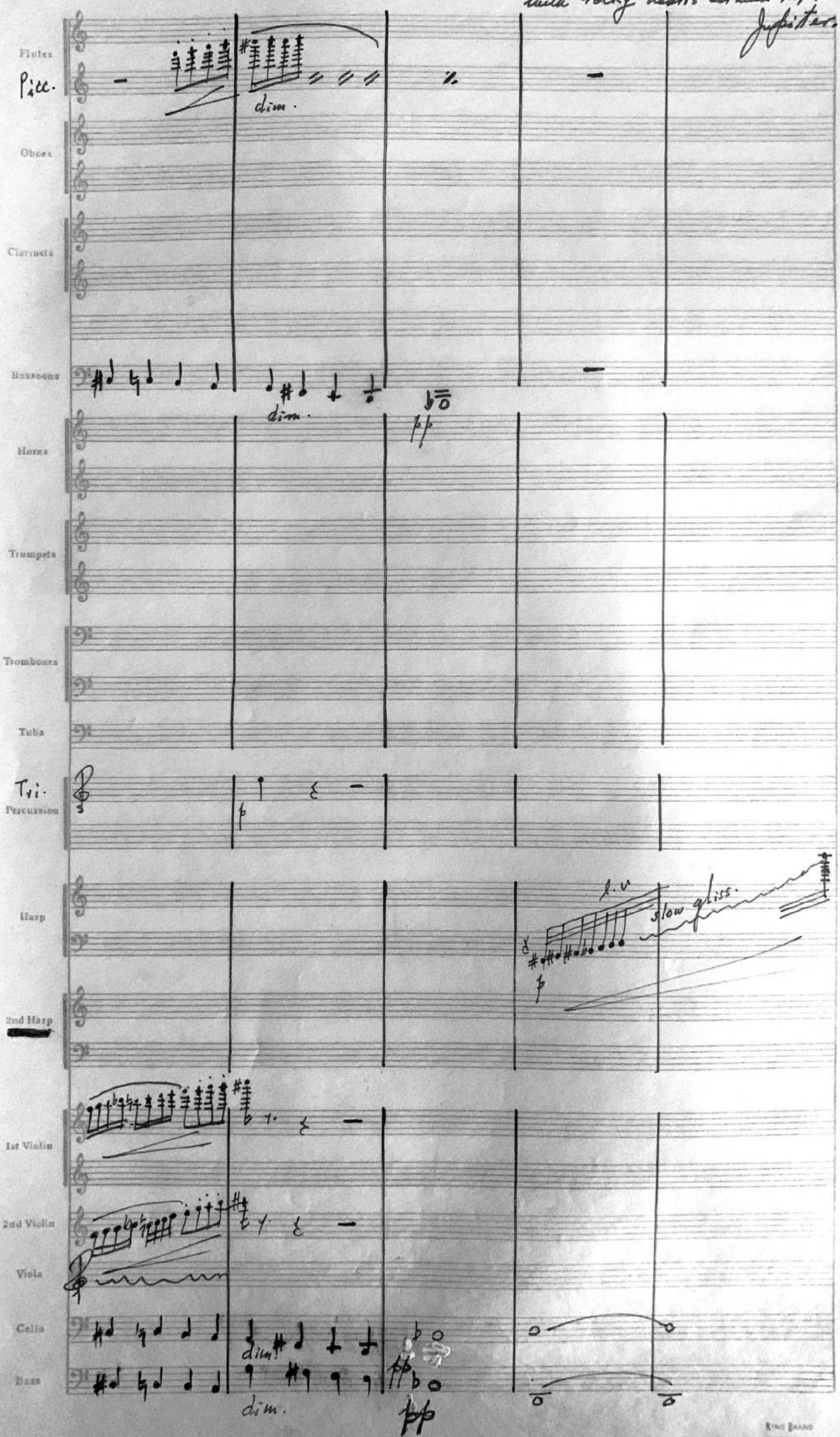
19

Travel was never more broadening. When Pioneer 10 was launched March 3, 1972 from Cape Canaveral Fla. no spacecraft had ventured further than Mars.



20

Pioneer made its way safely through the asteroid belt, a region littered with rocky debris between Mars and Jupiter.



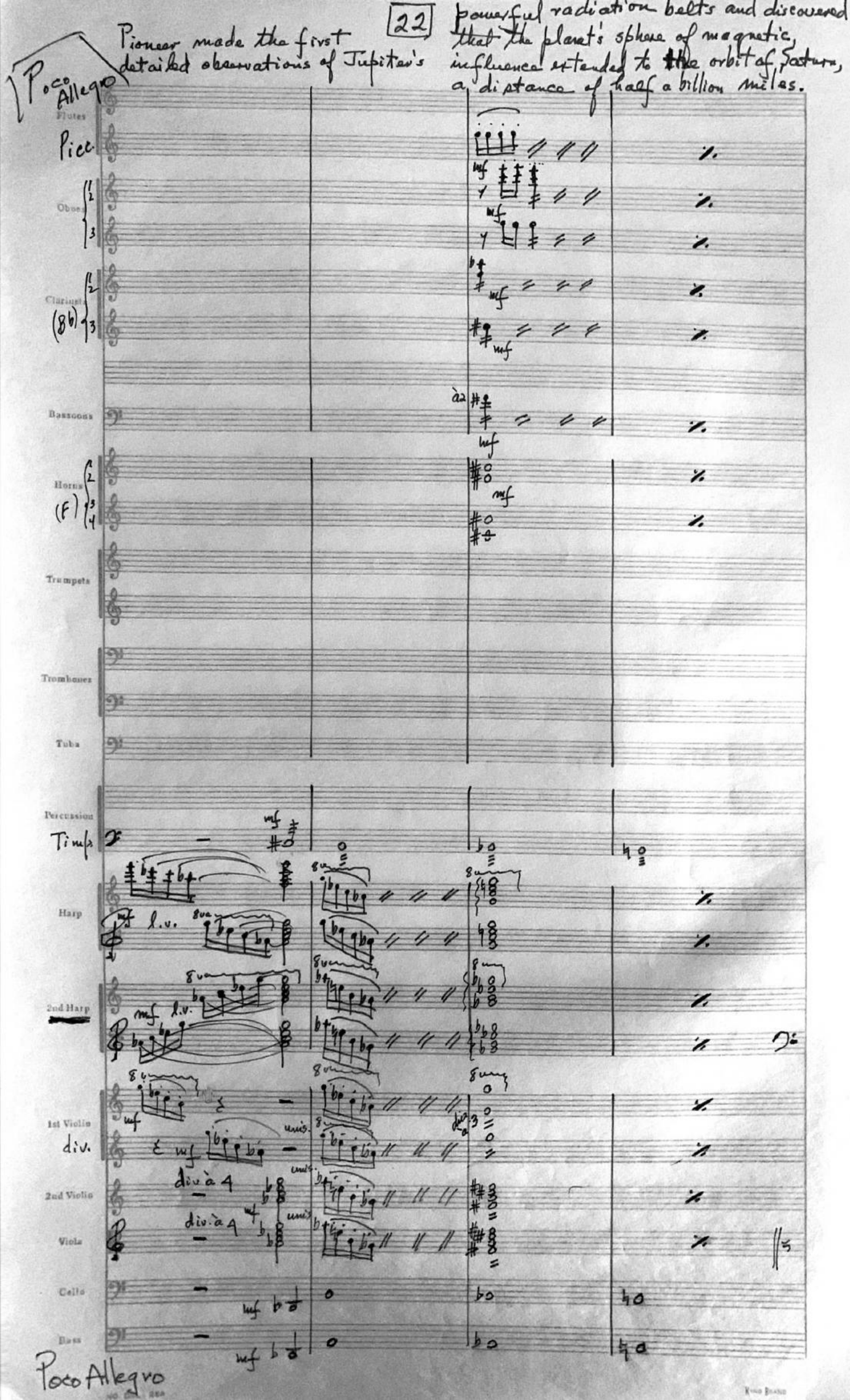
It shows the 81,000 miles of Jupiter's cloud tops on Dec. 2, 1973, showing

The first close-up images of the Giant planet.

The probe revealed the awesome forces of the planet's swirling clouds and

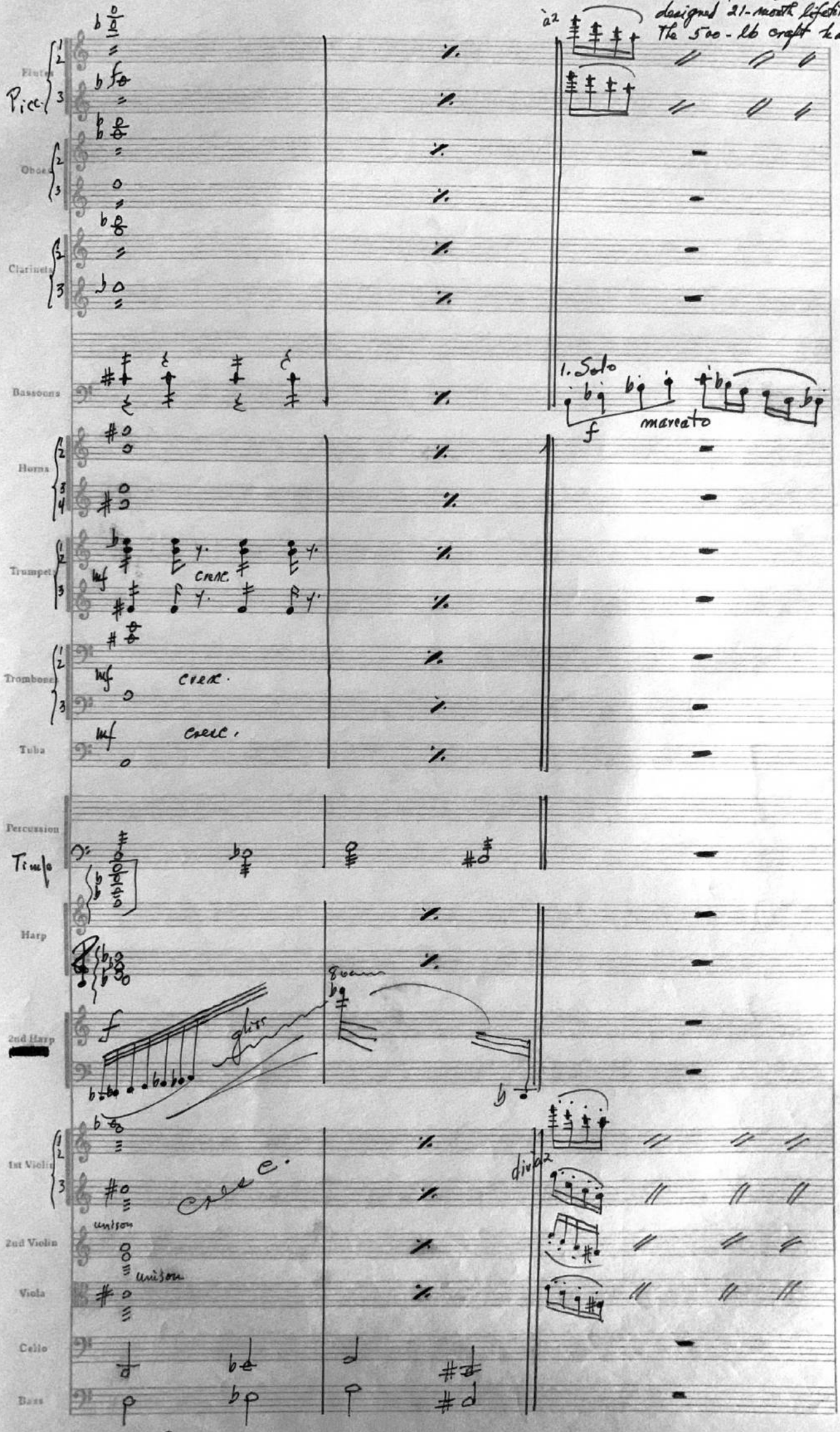
Giant atmosphere.

Pioneer made the first detailed observations of Jupiter's powerful radiation belts and discovered that the planet's sphere of magnetic influence extended to the orbit of Saturn, a distance of half a billion miles.

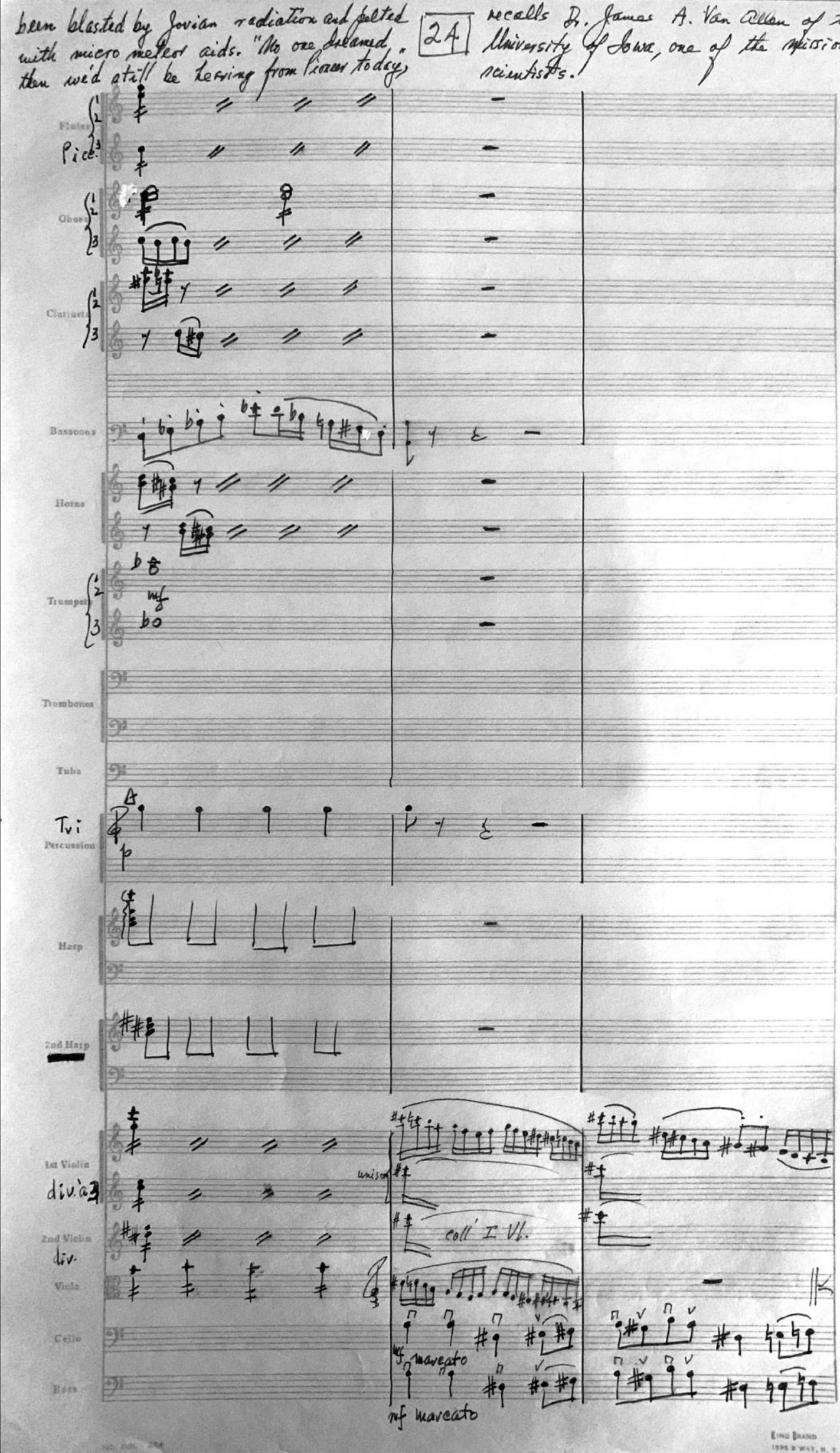


Poco Allegro

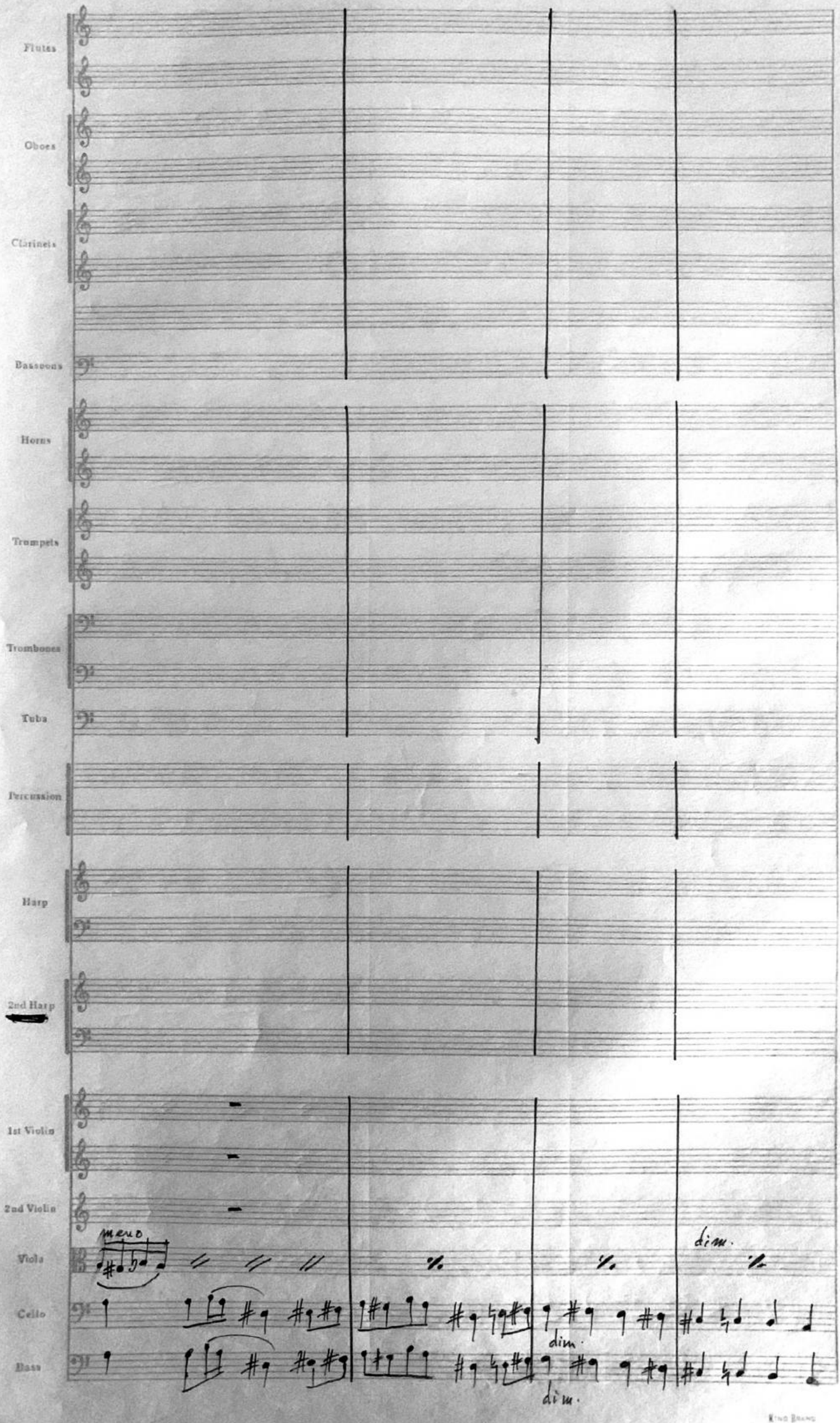
Pioneer had by then accomplished its mission and exceeded its designed 21-month lifetime. The 500-lb craft had



been blasted by Jovian radiation and pelted with micro meteor aids. "No one dreamed then we'd still be hearing from Pioneer today," recalls Dr. James A. Van Allen of the University of Iowa, one of the mission's scientists.

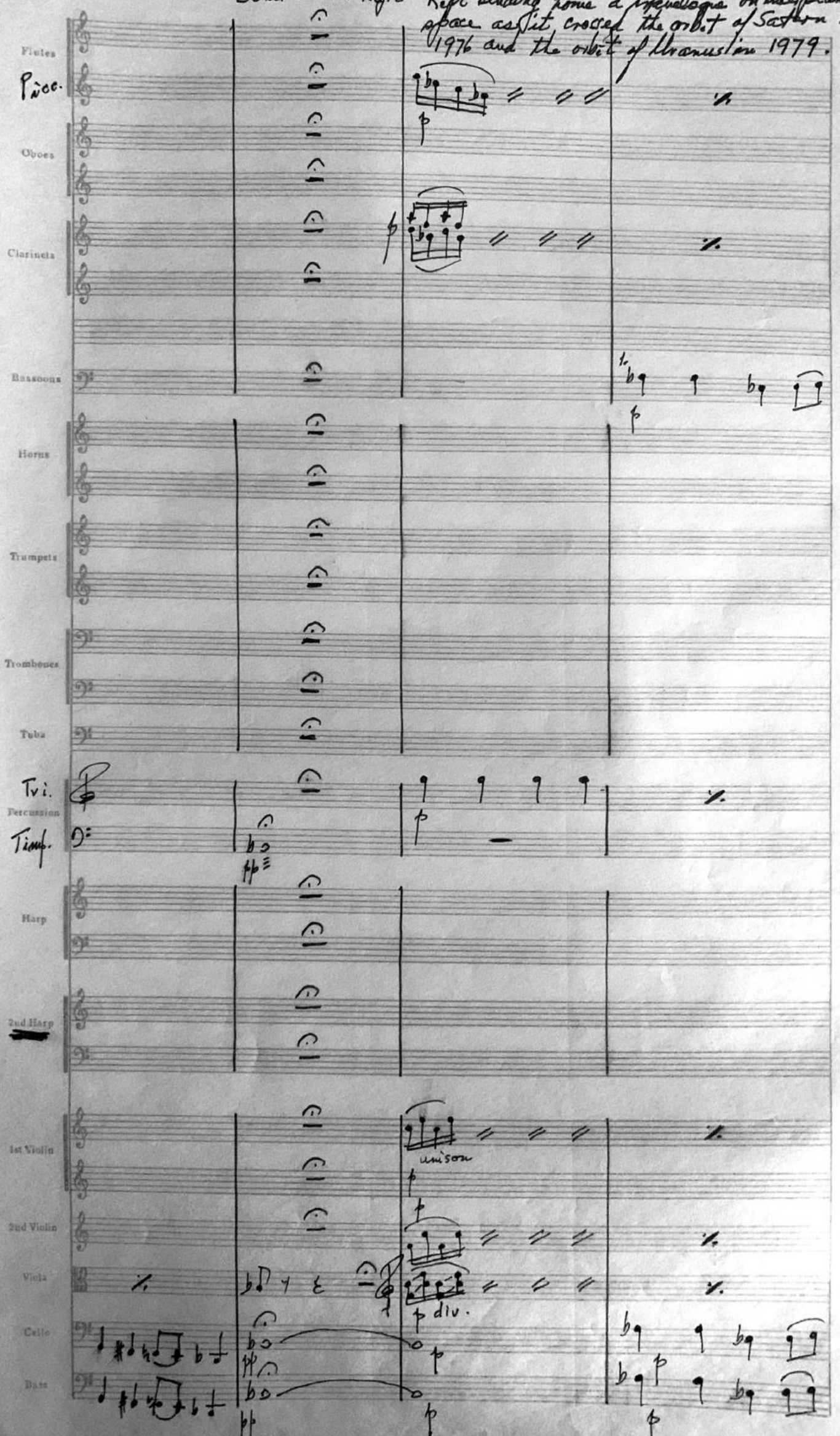


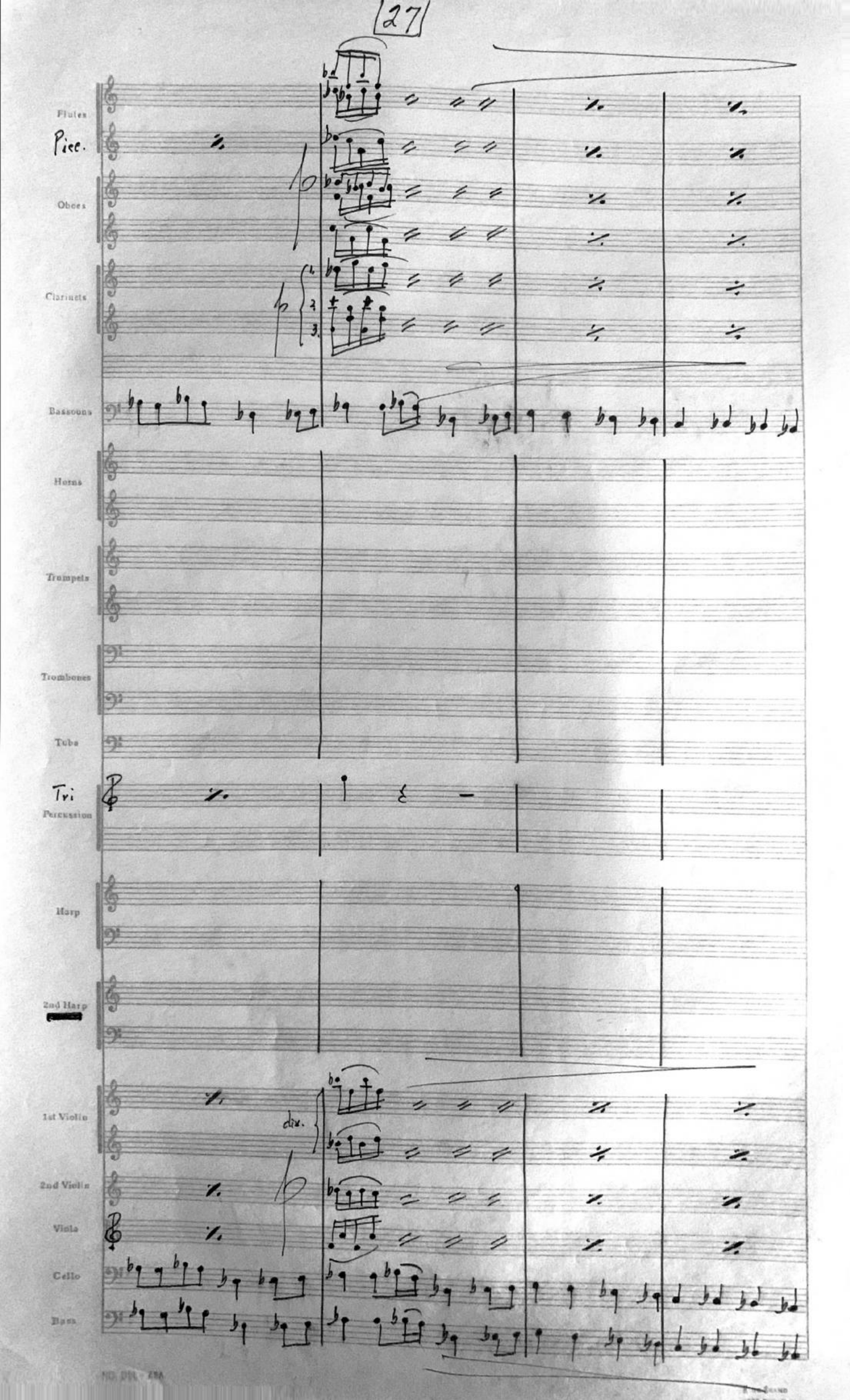
KING BRAND
1595 B'WAY, N. Y.


Flutes
Oboes
Clarinets
Bassoons
Horns
Trumpets
Trombones
Tuba
Percussion
Harp
2nd Harp
1st Violin
2nd Violin
Viola
Cello
Bass
meno
dim.
dim.
dim.

[26]

Still Pioneer Kept going, its nine-foot dish antenna always cocked in the direction of Earth. It dutifully Kept sending home a threnology on interplanetary space as it crossed the orbit of Saturn in 1976 and the orbit of Uranus in 1979.

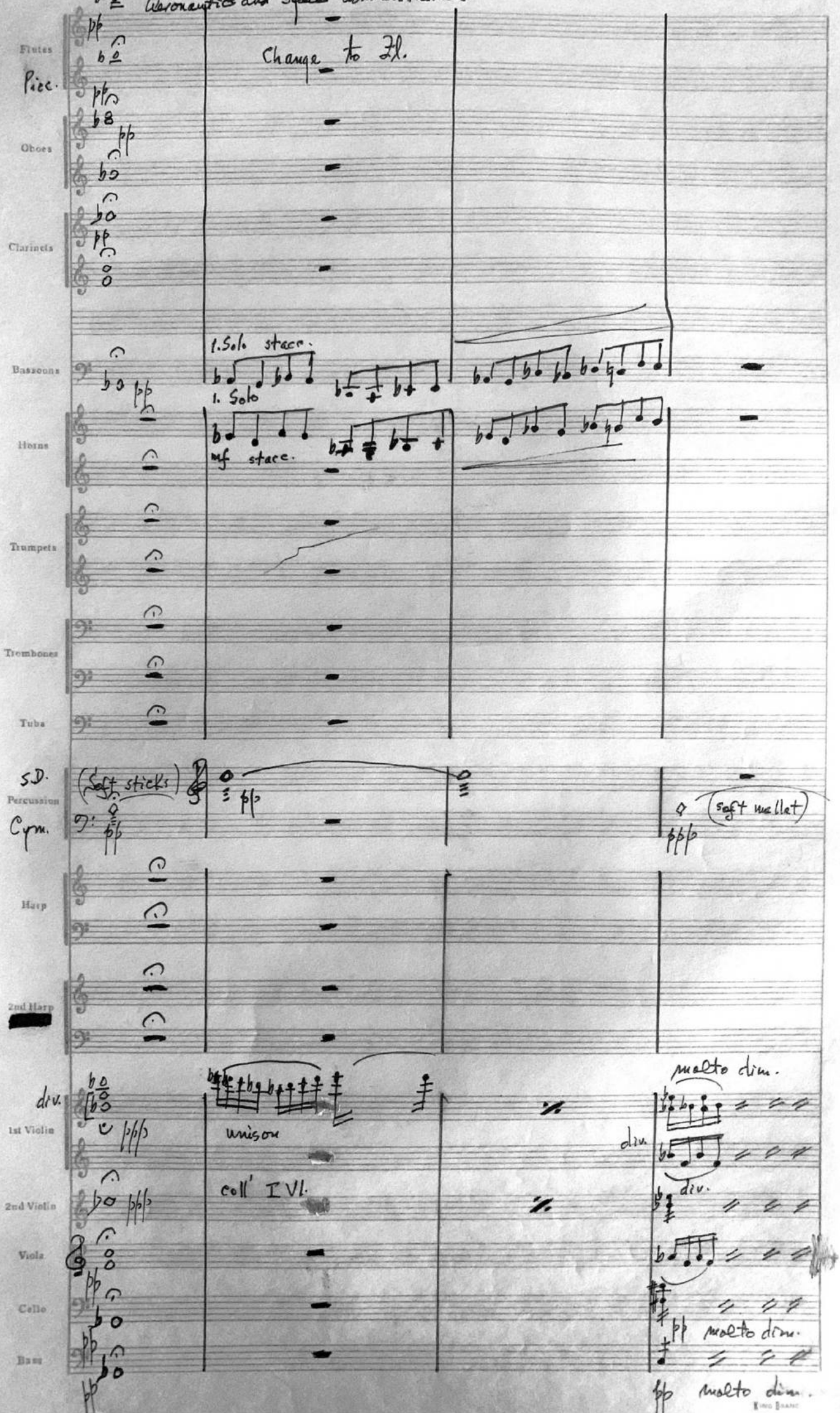


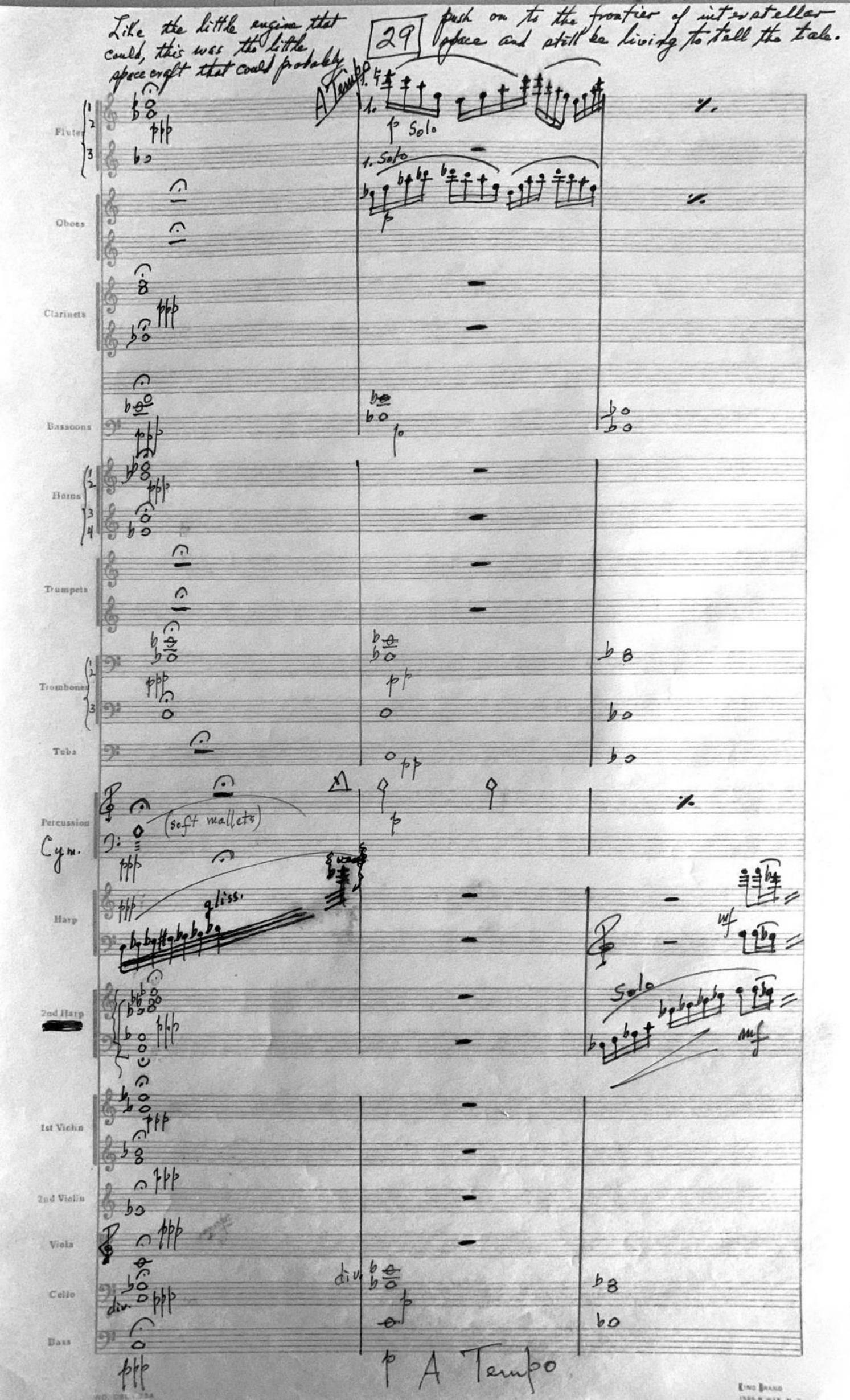

27
Flutes
Picc.
Oboes
Clarinets
Bassoons
Horns
Trumpets
Trombones
Tuba
Tri
Percussion
Harp
2nd Harp
1st Violin
div.
2nd Violin
Viola
Cello
Bass

Pioneer 10 had now made
believers out of its creators, the engineers for the National
Aeronautics and Space Administration

28

and the spacecraft manufacturers
TRW Inc.




Like the little engine that could, this was the little space craft that could probably
29
push on to the frontier of interstellar space and still be living to tell the tale.
A Tempo
Flutes
Oboes
Clarinets
Bassoons
Horns
Trumpets
Trombones
Tuba
Percussion
(soft mallets)
Cym.
Harp
gliss.
2nd Harp
1st Violin
2nd Violin
Viola
Cello
div.
Bass
1. Solo
Solo
mf
A Tempo

à2 After more than 11 years in flight... all the craft's scientific instruments, except the magnetometer, are working normally... deep-space antennas should maintain communication with it for eight more years, out to a distance

Flutes

Oboes

Clarinets

Bassoons

Horns

Trumpets

Trombones

Tuba

Percussion

Harp

2nd Harp

1st Violin

unison

2nd Violin

Viola

div.

Cello

Bass

ben marc.

arco ben marc.

of five billion miles. That is when the crafts radioisotopic power unit shall no longer be generating electricity for operations.

31

A Tempo

Flutes

Oboes

Clarinets

Bassoons

Horns

Trumpets

Rit.

Trombones

Cello.

Tuba

Percussion

Timp.

Harp

2nd Harp

1st Violin

2nd Violin

Viola

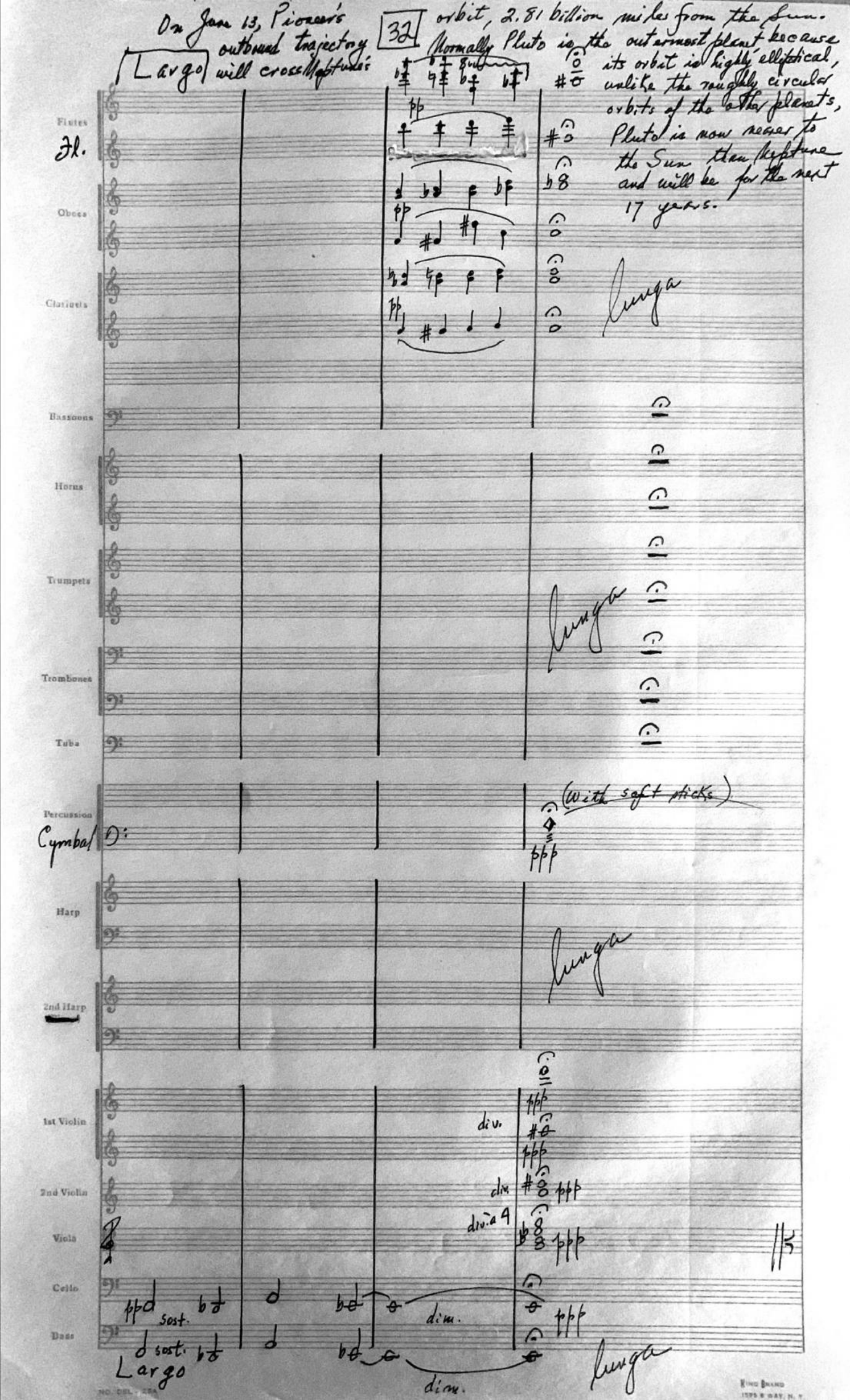
div.

rit.

Cello

Bass

rit.


On June 13, Pioneer's outbound trajectory will cross Neptune's
32
orbit, 2.81 billion miles from the Sun.
Normally Pluto is the outermost planet because its orbit is highly elliptical, unlike the roughly circular orbits of the other planets, Pluto is now nearer to the Sun than Neptune and will be for the next 17 years.
Largo
Flutes
Fl.
Oboes
Clarinets
Bassoons
Horns
Trumpets
Trombones
Tuba
Percussion
Cymbal
(with soft sticks)
Harp
2nd Harp
1st Violin
2nd Violin
Viola
Cello
Bass
div.
sost.
dim.
Largo

Mod^to (poco lento)

Each day flight controllers at Ames typically send Pioneer a message when they arrive at work. By quitting time eight and a half hours later, which is the round-trip communication time, they receive Pioneer's reply.

Flutes

Oboes

Clarinets

Bassoons

Horns

1. Solo espress.

Trumpets

Trombones

Tuba

Percussion

Harp

2nd Harp

unison

1st Violin

espress.

2nd Vl. div.

espress.

Viola

espress.

Cello div.

espress.

Bass

unison

div.

unison

RING BARNE

They also receive about 16 hours of scientific data, each day from the spacecraft, mainly information defining the extent and behavior of the heliosphere, the Sun's extended atmosphere.

Blowing away in all directions from the Sun is the solar wind, an electrically charged gas composed of protons (hydrogen nuclei) and electrons that stream out from the Sun's corona. The wind carries along with the Sun's magnetic field.

Flutes
Oboes
Clarinets
Bassoons
Horns
Trumpets
Trombones
Tuba
Percussion
Harp
2nd Harp
1st Violin
2nd Violin
Viola
Cello
Bass

l.v.
ppp
l.v.
ppp
tam.
ppp
tam.
ppp
tam.
ppp
tam.
ppp
tam.
ppp

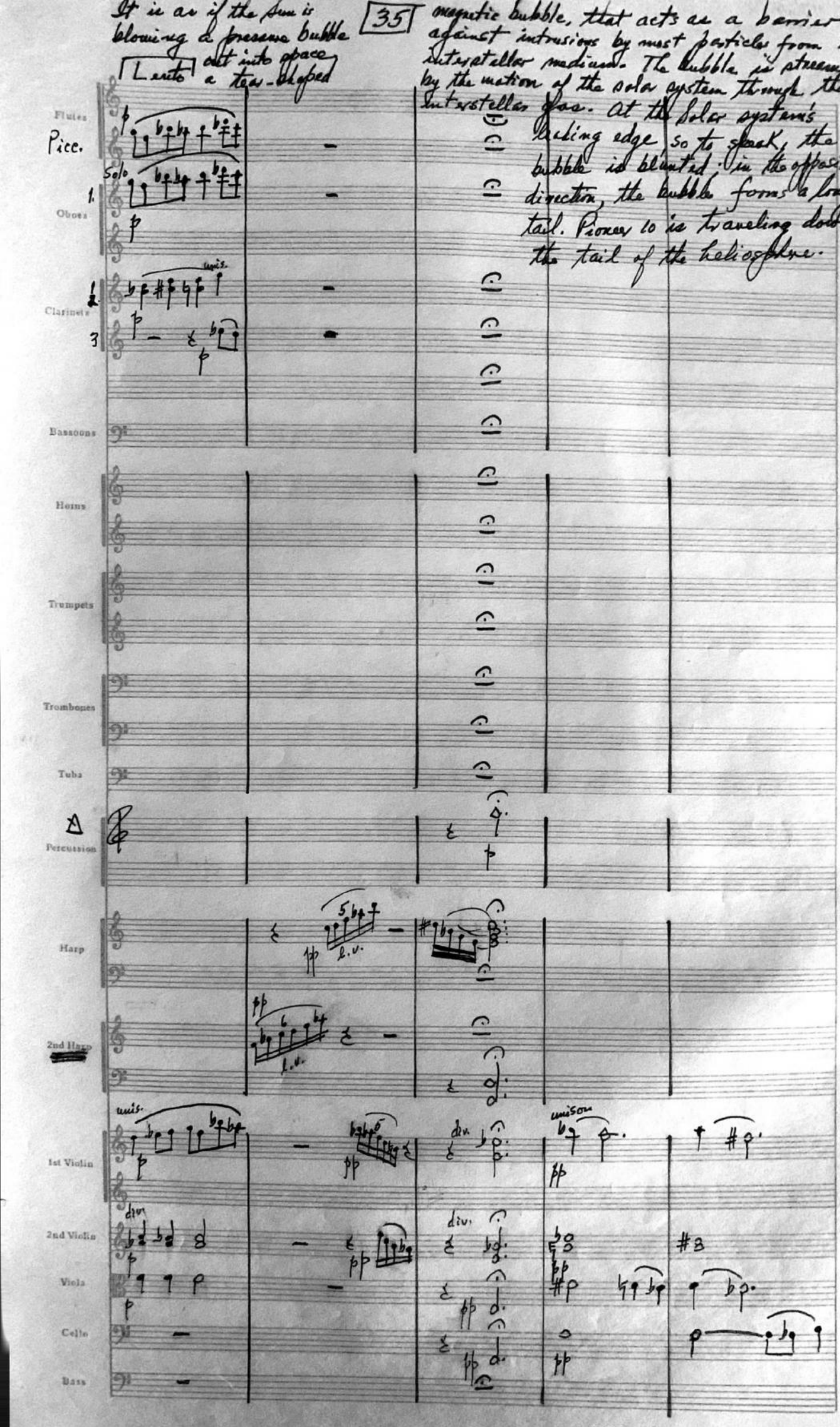
It is as if the Sun is blowing a pressure bubble out into space

35

magnetic bubble, that acts as a barrier against intrusions by most particles from the interstellar medium. The bubble is streamlined by the motion of the solar system through the interstellar gas. At the solar system's leading edge, so to speak, the bubble is bluntest. In the opposite direction, the bubble forms a long tail. Pioneer 10 is traveling down the tail of the heliosphere.

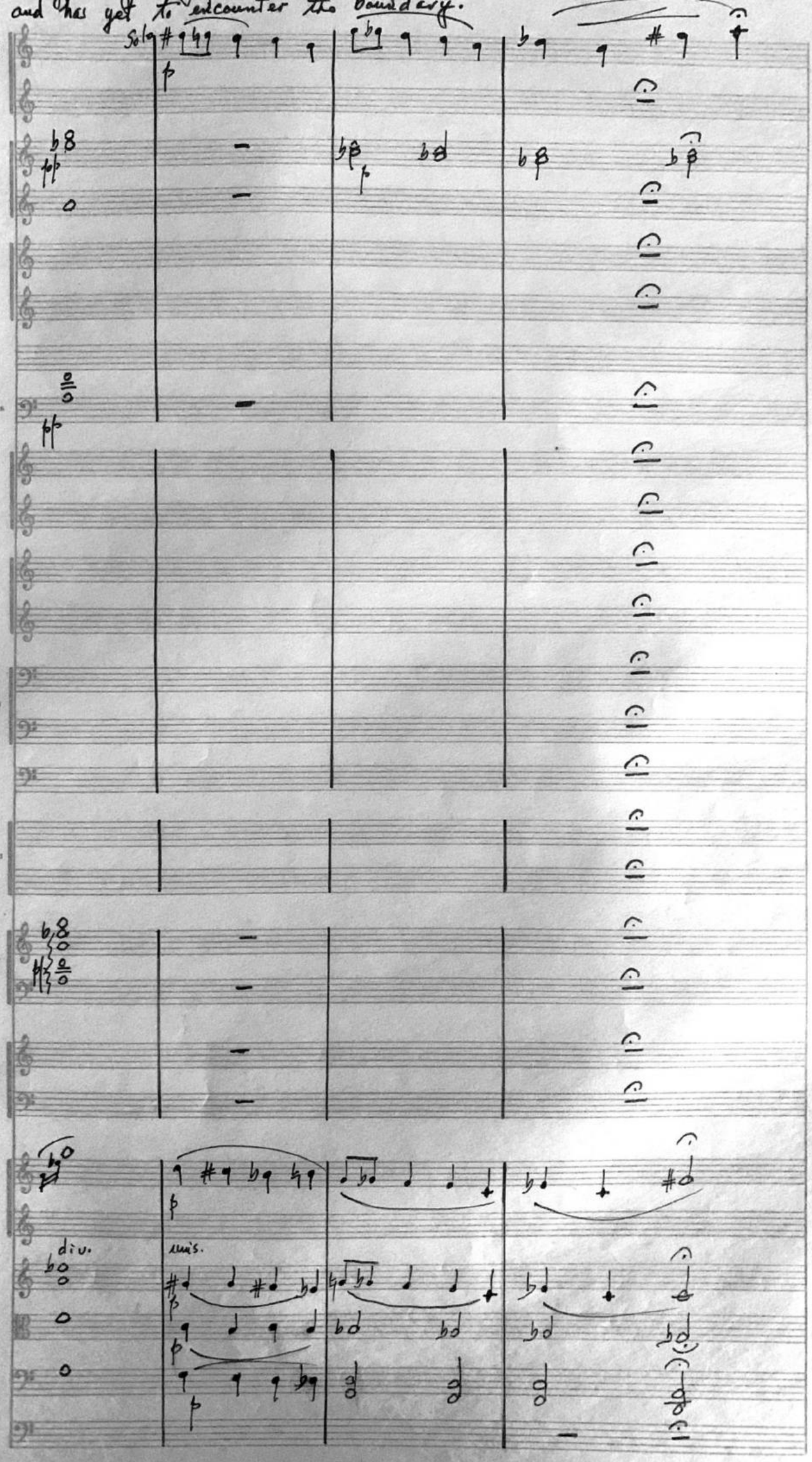
Largo

a tear-shaped



36

Before Pioneer, some scientists believed the boundary, the heliopause, might be just beyond Jupiter. But the spacecraft is six times that far out and has yet to encounter the boundary.



37

The spacecraft's instruments indicate the heliosphere "breathes" in and out every 11-year solar cycle ... When the Sun is most turbulent, which last occurred in 1980, shock waves from its magnetic storms seem to persist throughout the heliosphere, for as long as a year. The effect may be to change the bubble's shape.

Moreover, at the time of maximum solar activity, the bubble seems to be more impervious to cosmic rays from out in the galaxy. Pioneer's detectors found the cosmic-ray particles half as numerous then.

Flutes

Oboes

Clarinets

Bassoons

Horns

Trumpets

Trombones

Tuba

Percussion

Harp

2nd Harp

1st Violin

2nd Violin

Viola

Cello

Bass

Repeat ad lib.

gliss.

mf

8va

mf

gliss.

Repeat ad lib. under dialogue

mf tam.

mf tam.

38

...Pioneer would probably encounter changes in the outside temperatures and discernible turbulence as the solar wind was buffeted by the incoming interstellar gases. The speed of the solar wind should suddenly drop from supersonic to subsonic...

Con Moto

Flutes

Oboes

Clarinets

Bassoons

Horns

Trumpets

Trombones

Tuba

Percussion

B.D.

Harp

2nd Harp

1st Violin

2nd Violin

Violas

Cello

Bass

Repeat

Repeat

2/4 L'istesso Tempo ♩=♩

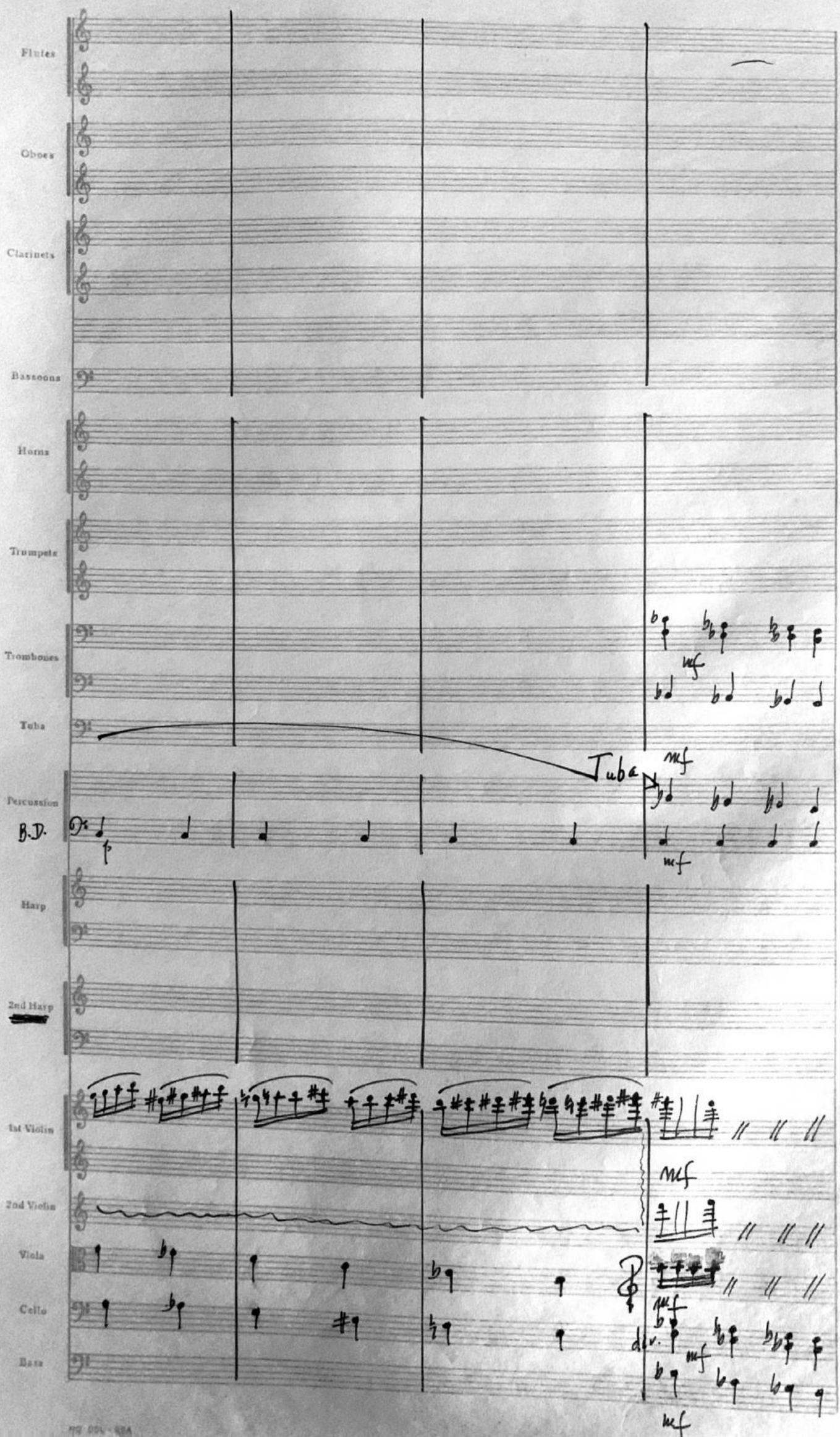
unison

With 1st. Violin

poco cresc.

Con Moto

2/4 ♩=♩ L'istesso Tempo


Flutes
Oboes
Clarinets
Bassoons
Horns
Trumpets
Trombones
Tuba
Percussion
B.D.
Harp
2nd Harp
1st Violin
2nd Violin
Viola
Cello
Bass
Tuba
mf
p
div.

A0

The spacecraft should encounter a kind of bow shock caused by the solar wind slamming into the dominant and relatively stationary interstellar environment. It may even be possible to see the boundary crossing. Energies

(3) Piec.

Flutes 1 2

Oboes

Clarinets

Bassoons

Horns 1 2 3 4

Trumpets

Trombones

Tuba

Percussion

B.D.

Harp

2nd Harp

1st Violin

2nd Violin

Viola

Cello

Bass

a2

marcato

3.

1.

8va

With 1st Violin

pizz.

arco. pizz.

KING BRAND

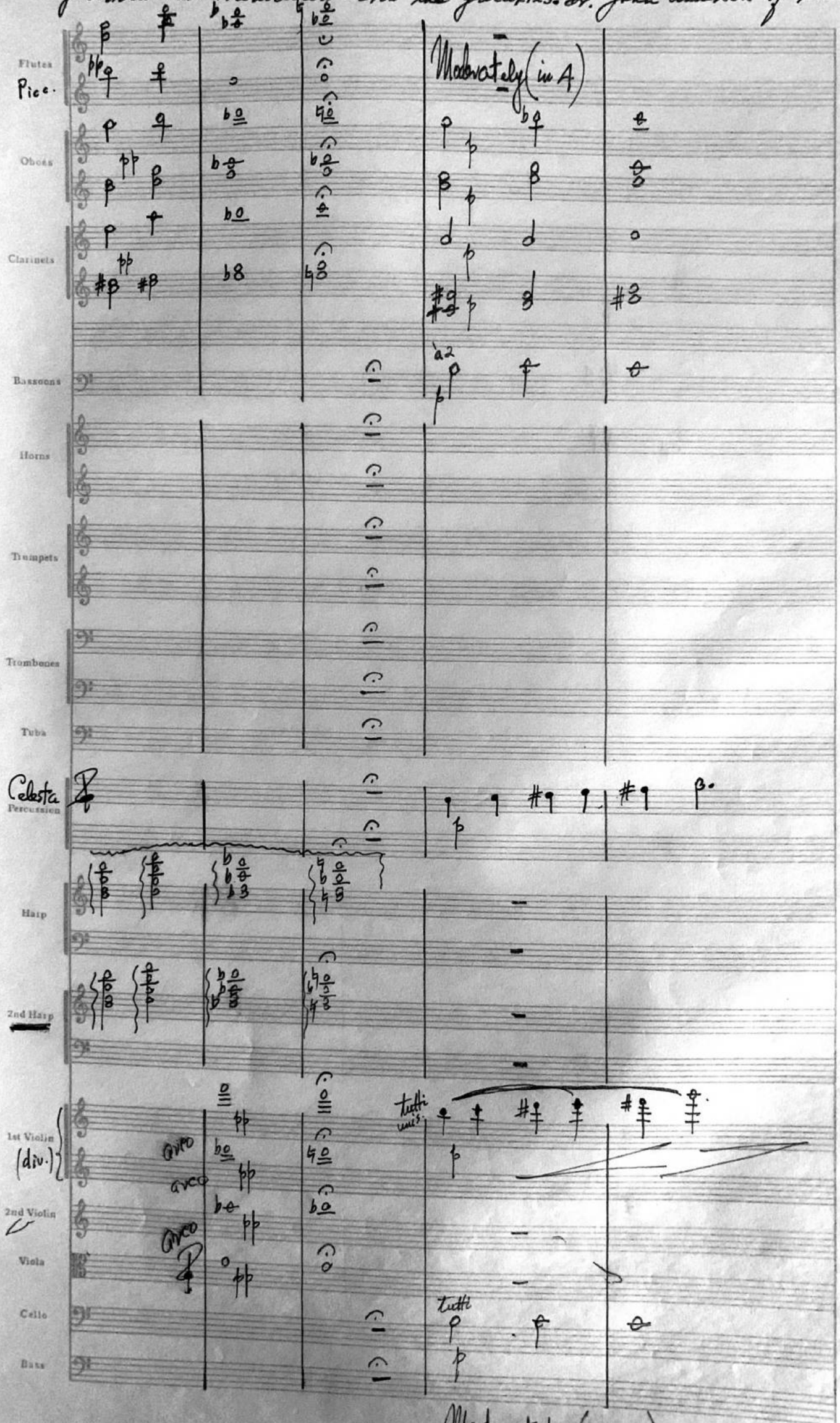
41

produced by the interactions may give off whistling noises that Voyager will radio back to Earth. Because of its great distance away, Pioneer 10 could give scientists their first evidence of the existence of gravity

Flutes
(3) Picc.
1.
Oboes
2
3
1
Clarinets
2
3
Bassoons
Horns
Trumpets
Trombones
Tuba
Percussion
Harp
2nd Harp
1st Violin
2nd Violin
Viola
Cello
Bass

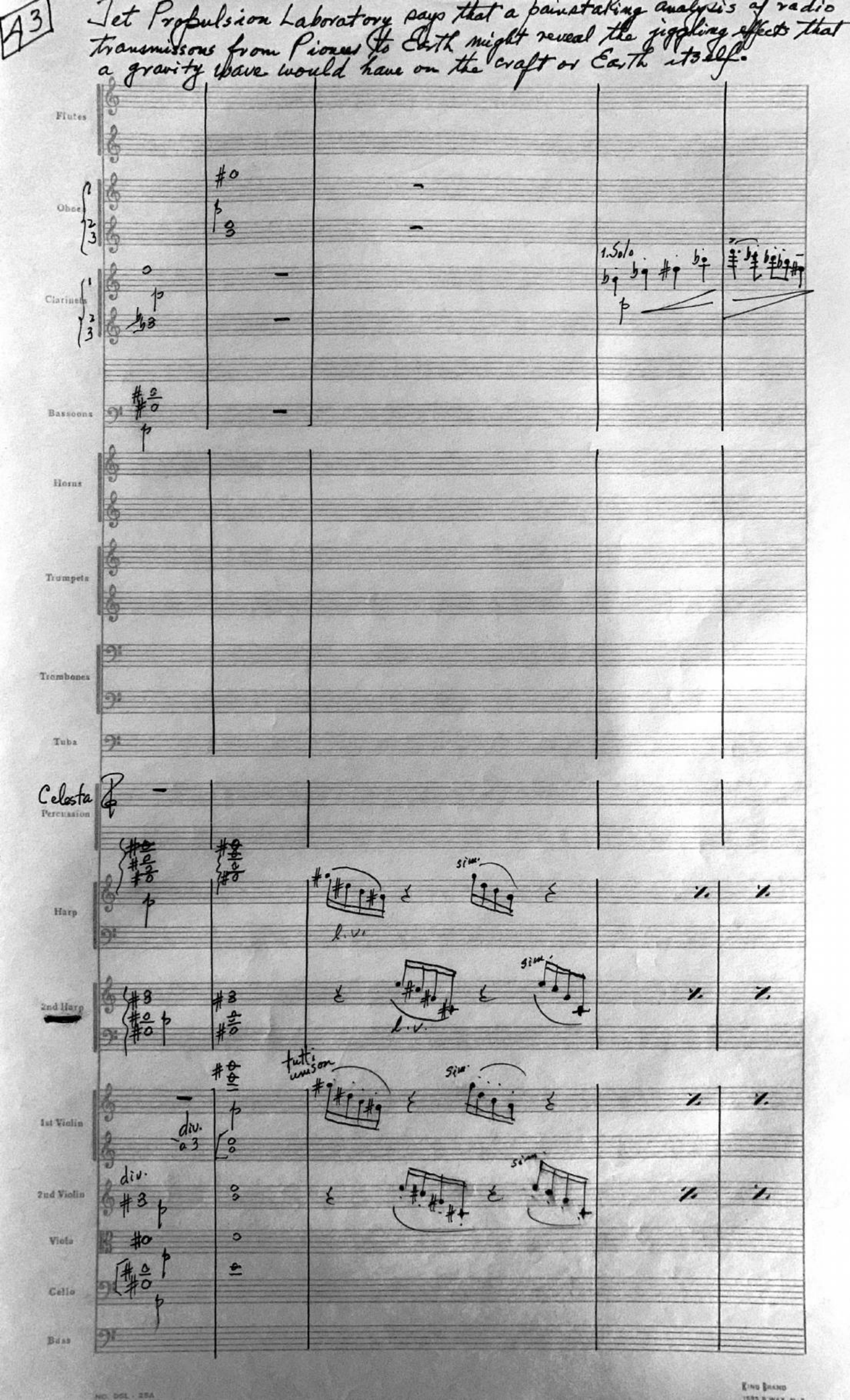
p
dim.
dim.
p dim.
Poco Meno Mosso
mf
8va
pp
pizz
mf

waves. According to Einstein's General Theory of Relativity, cataclysms in the universe, collapsing or exploding stars should send waves of gravitational radiation across the galaxies. Dr. John Anderson of the

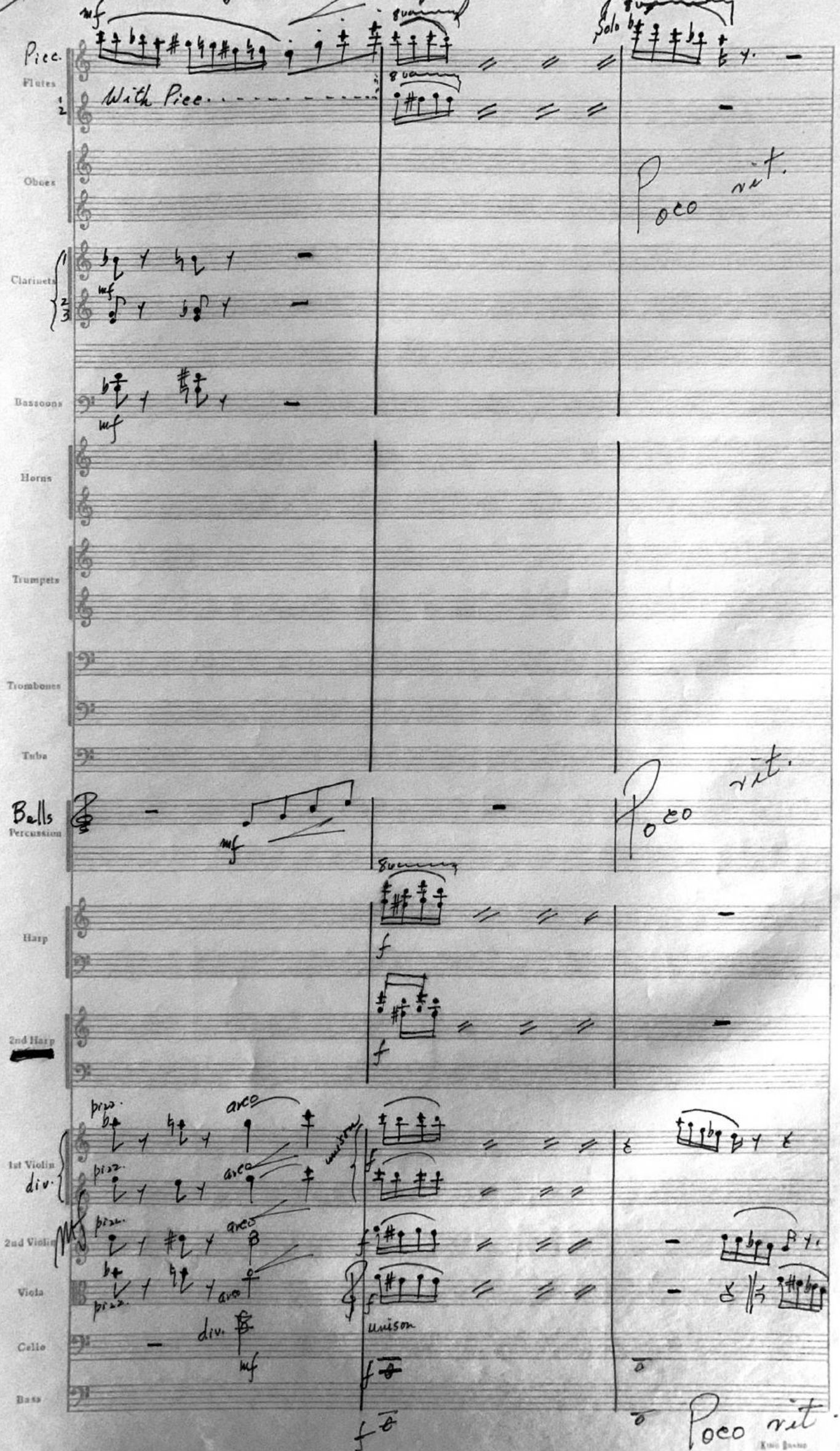


A3

Jet Propulsion Laboratory says that a painstaking analysis of radio transmissons from Pioneer to Earth might reveal the jiggling effects that a gravity wave would have on the craft or Earth itself.



Accordingly, Pioneer 10 may lead scientists to the discovery of some massive object toward the edge of the solar system.



It may be, as some astronomers suspect, a "brown dwarf" star, a celestial object that was not quite massive enough for its thermonuclear furnace to ignite. Since most stars are paired, it is not unreasonable

Moderato (in A)

Flutes
1. Solo
1. espress.

Oboes
1. Solo

Clarinets

Bassoons

Horns

Trumpets

Trombones

Tuba

Percussion

Timp.

Harp
l. v.

2nd Harp

1st Violin
unison

2nd Violin

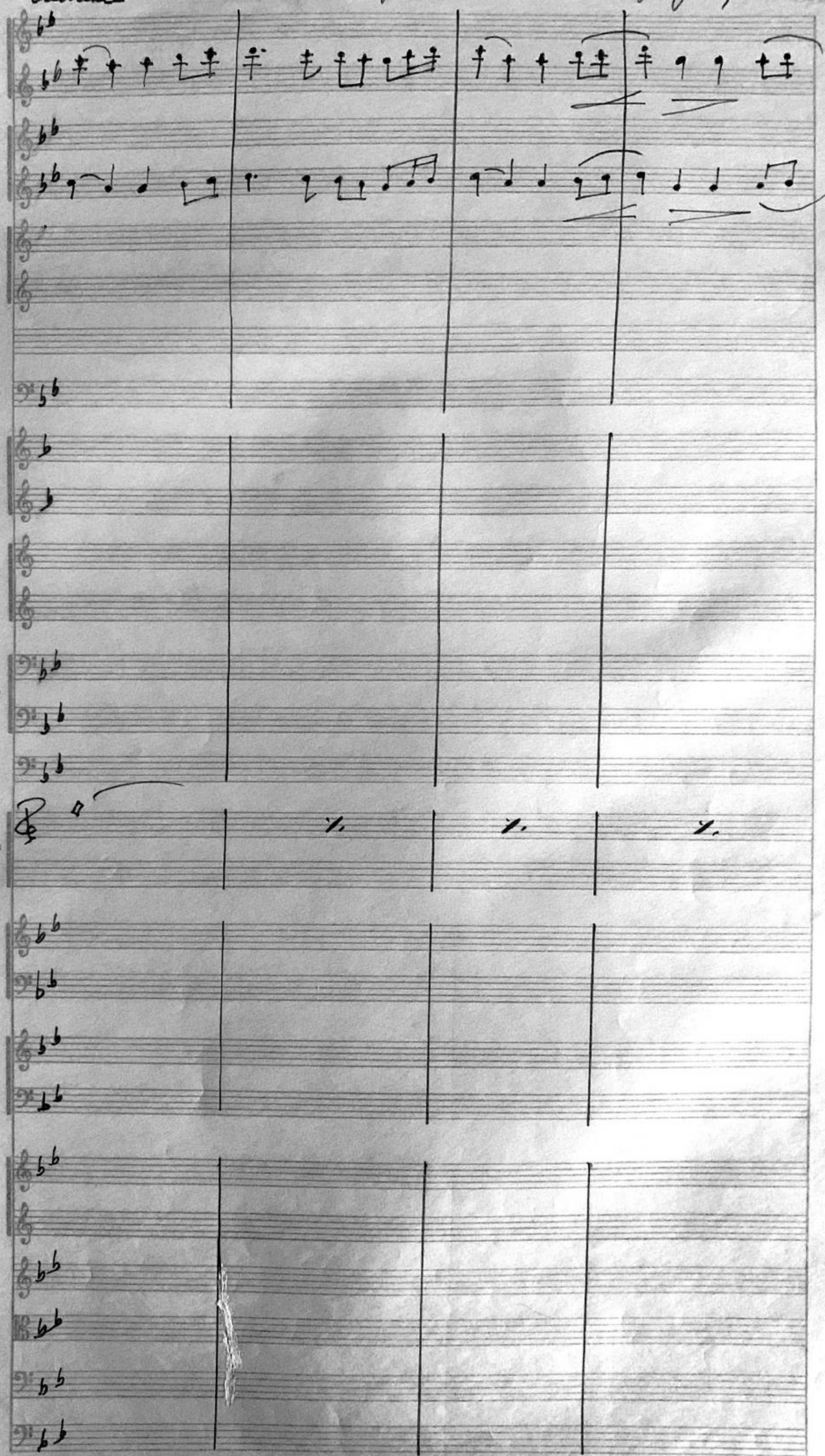
Viola

Cello

Bass

46

to assume that the Sun might have such a dim companion.
Or the force could be from a 10th planet, the long-sought Planet X.
Evidence assembled in recent years has led several groups of astronomers

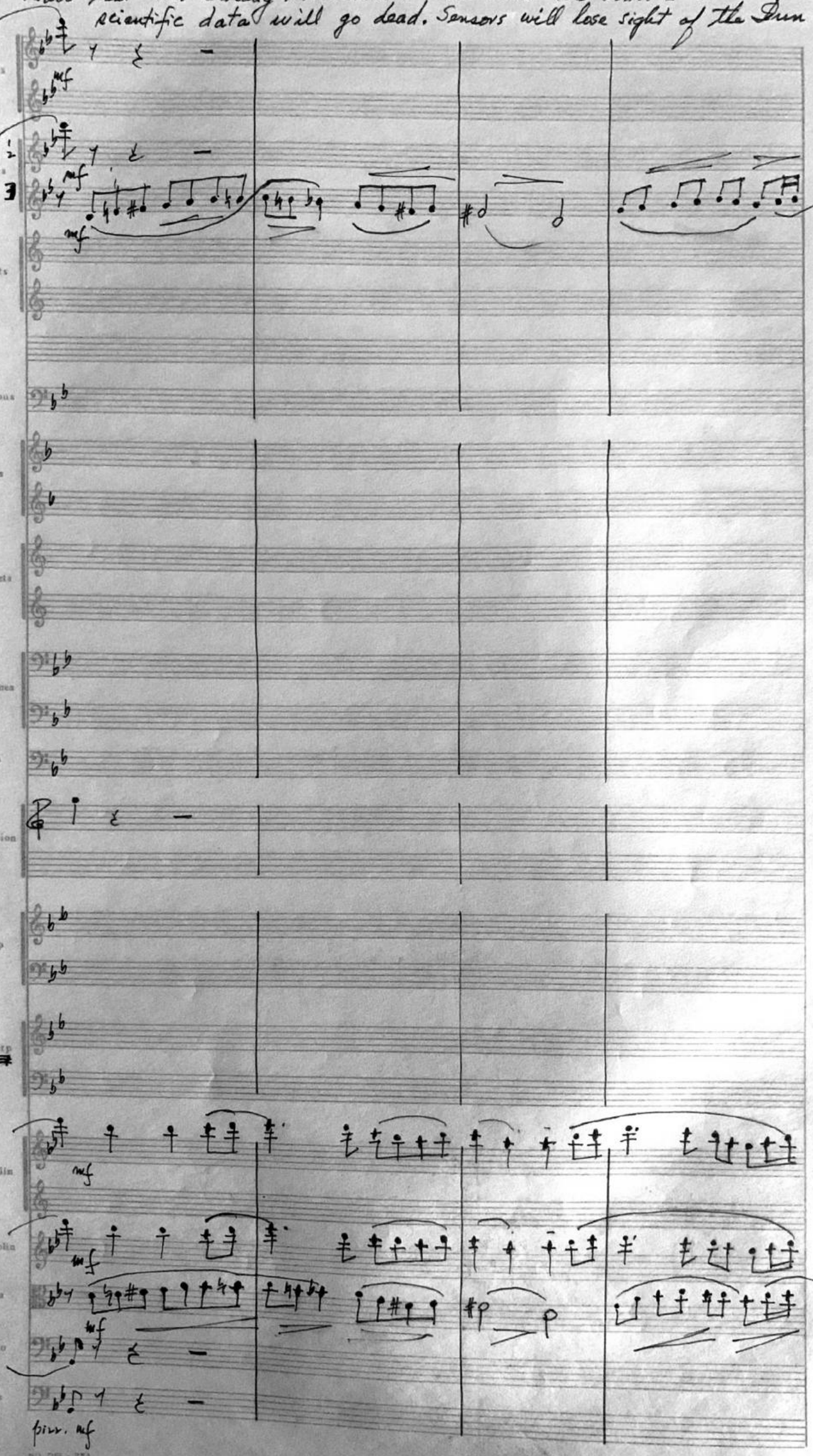


A7 to renew the search for a large planet out beyond Pluto and Neptune. Someday, of course, even the durable Pioneer 10 will lose

Flutes
Oboes
Clarinets
Bassoons
Horns
Trumpets
Trombones
Tuba
Timp
Percussion
Harp
2nd Harp
1st Violin
2nd Violin
Viola
Cello
Bass

à2
cresc.
à2
unis.
unis.

touch with those who sent it off on its long journey. The little radio that has already transmitted more than 126 billion bits of scientific data will go dead. Sensors will lose sight of the Sun.



49

Even then, silent and derelict, Pioneer 10 will cruise on and on, the first human artifact to leave the solar system.

Flutes

Oboes

3

Clarinets

'a2

mf

Bassoons

Horns

Trumpets

Trombones

Tuba

Percussion

Harp

2nd Harp

1st Violin

coll' I VI.

2nd Violin

Viola

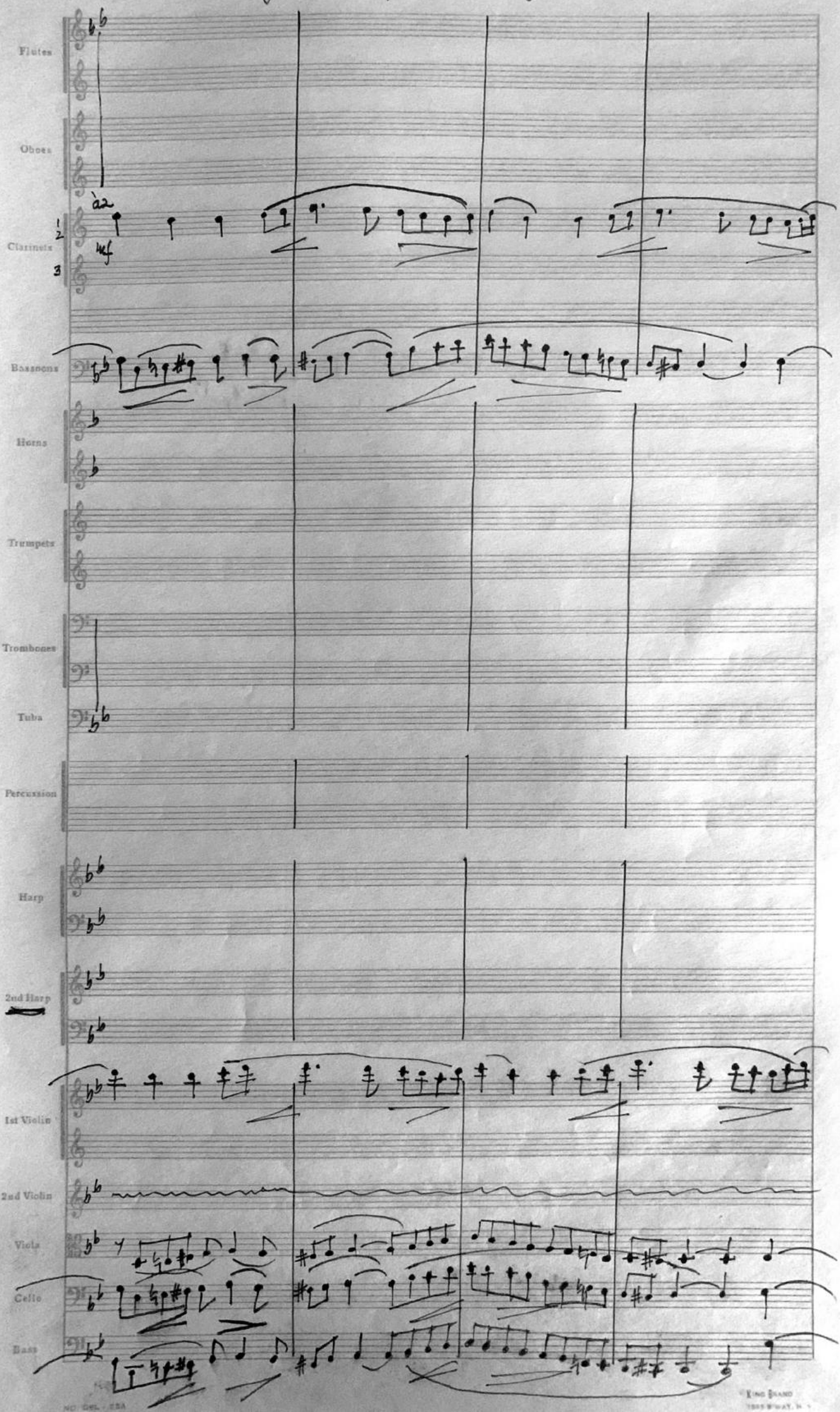
Cello

Bass

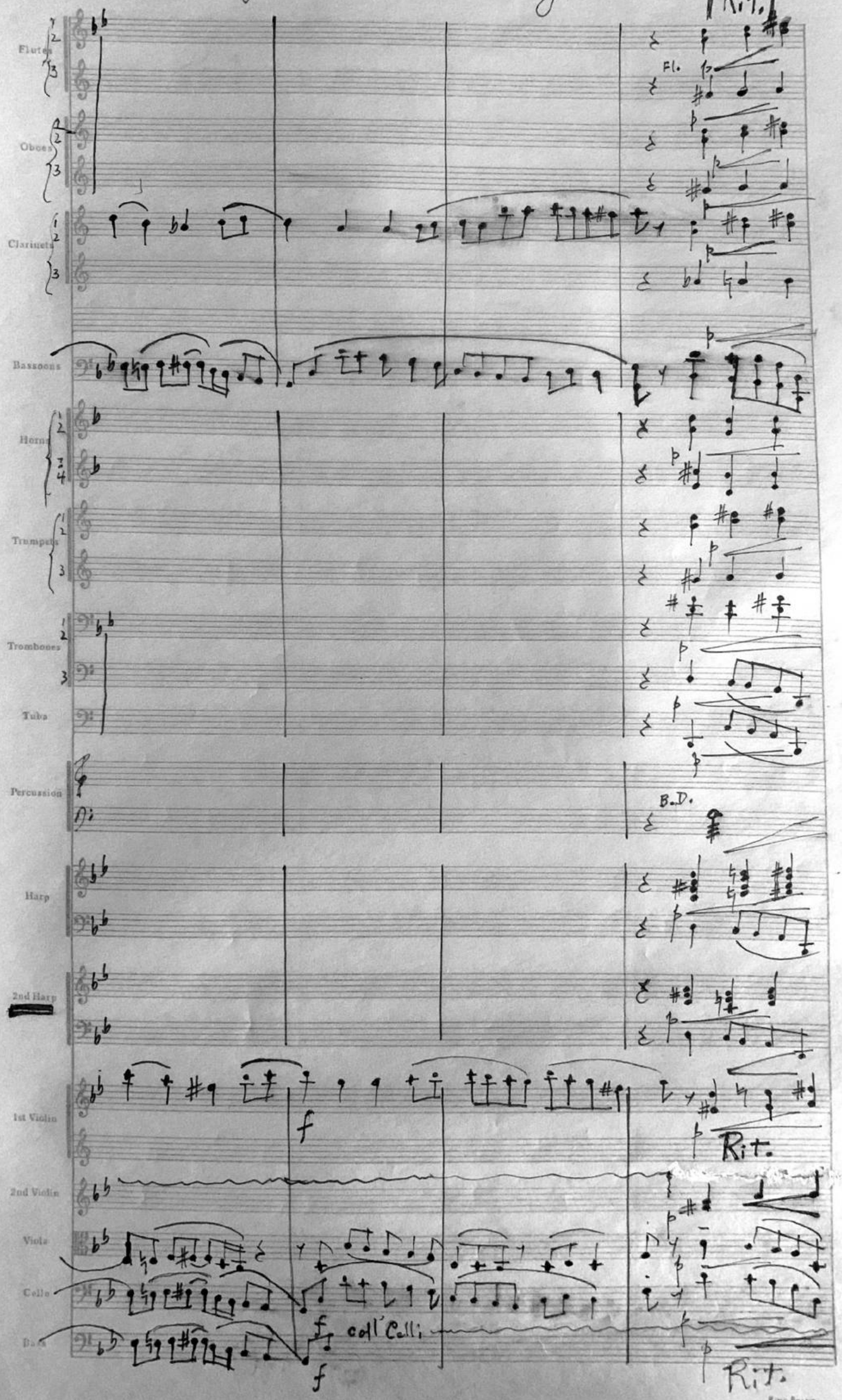
mf

mf

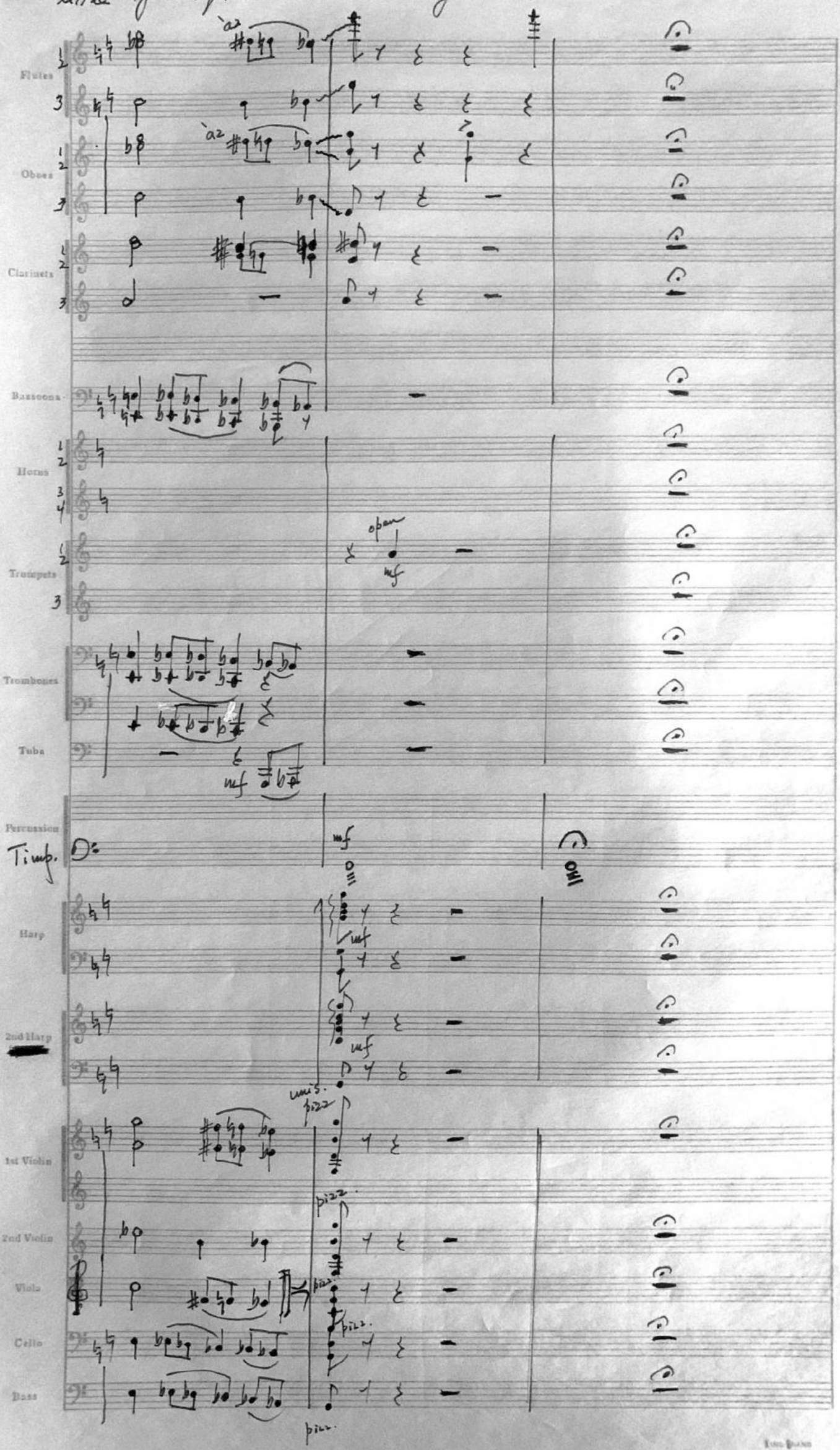
50 About once every million years, as nearly as anyone can calculate such things, the craft might expect to come close to

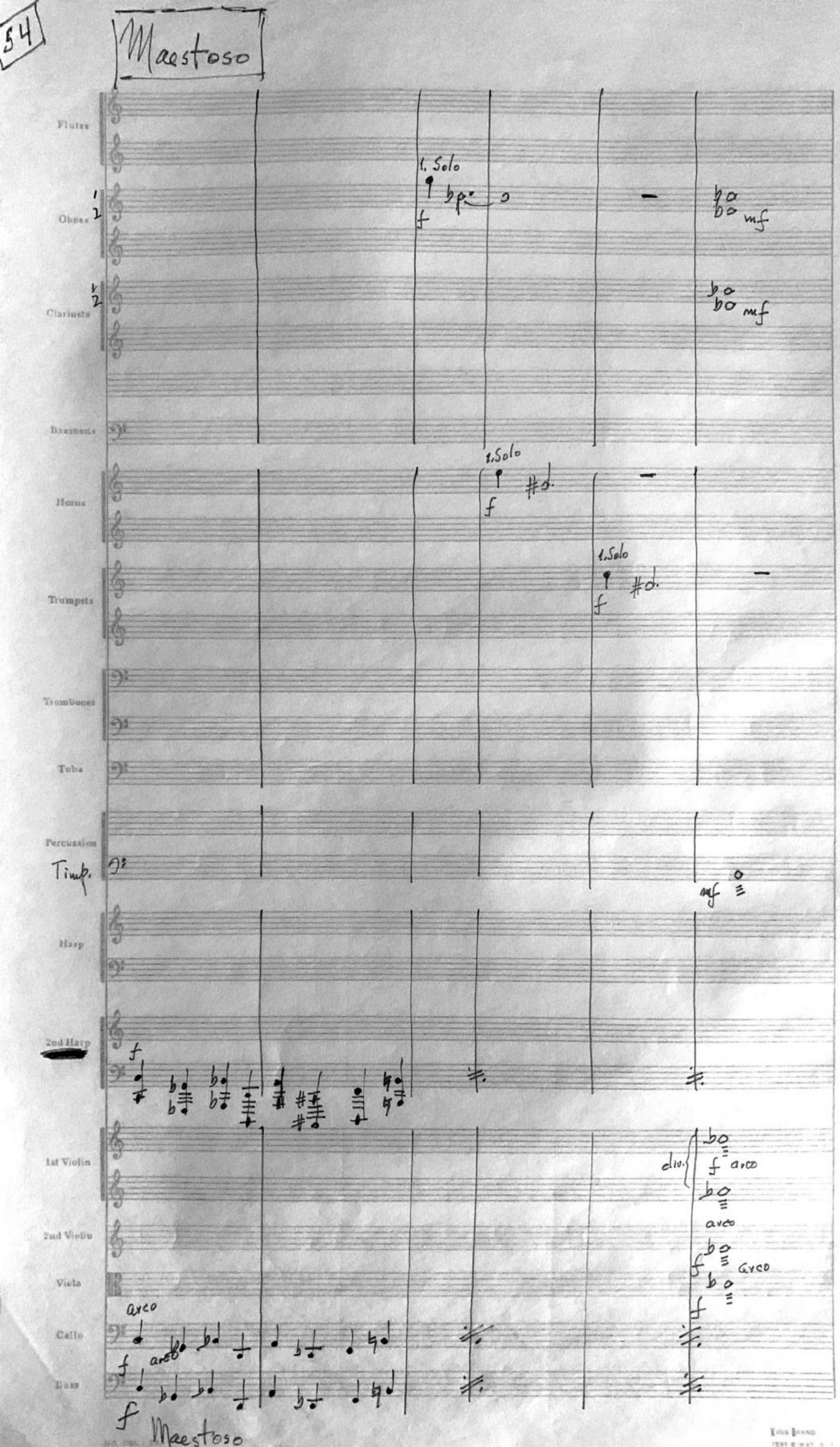


another star system. It might then be found by other intelligent beings. With that eventuality in mind, Pioneer



of Earth and some [illegible] points of basic science — possibly the little spacecraft's ultimate message.




Maestoso
Flutes
Oboes 1 2
Clarinets 1 2
Bassoons
Horns
Trumpets
Trombones
Tuba
Percussion
Timp.
Harp
2nd Harp
1st Violin
2nd Violin
Viola
Cello
Bass
1. Solo
mf
arco
div.
Maestoso

55

Flutes

Oboes

Clarinets

Bassoons

Horns

1. Solo open

mf

Trumpets

Trombones

Tuba

Percussion

Timp.

Harp

2nd Harp

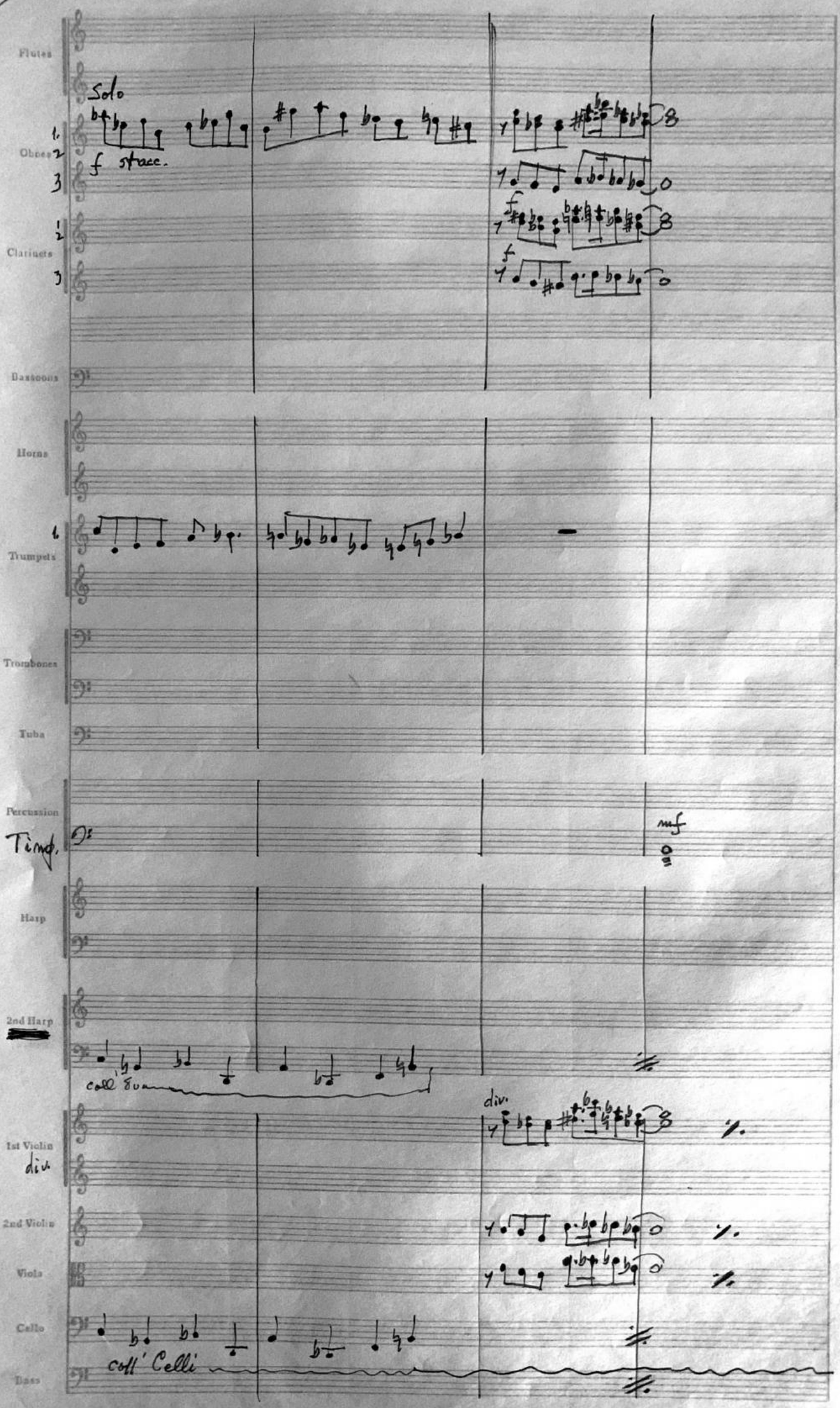
1st Violin

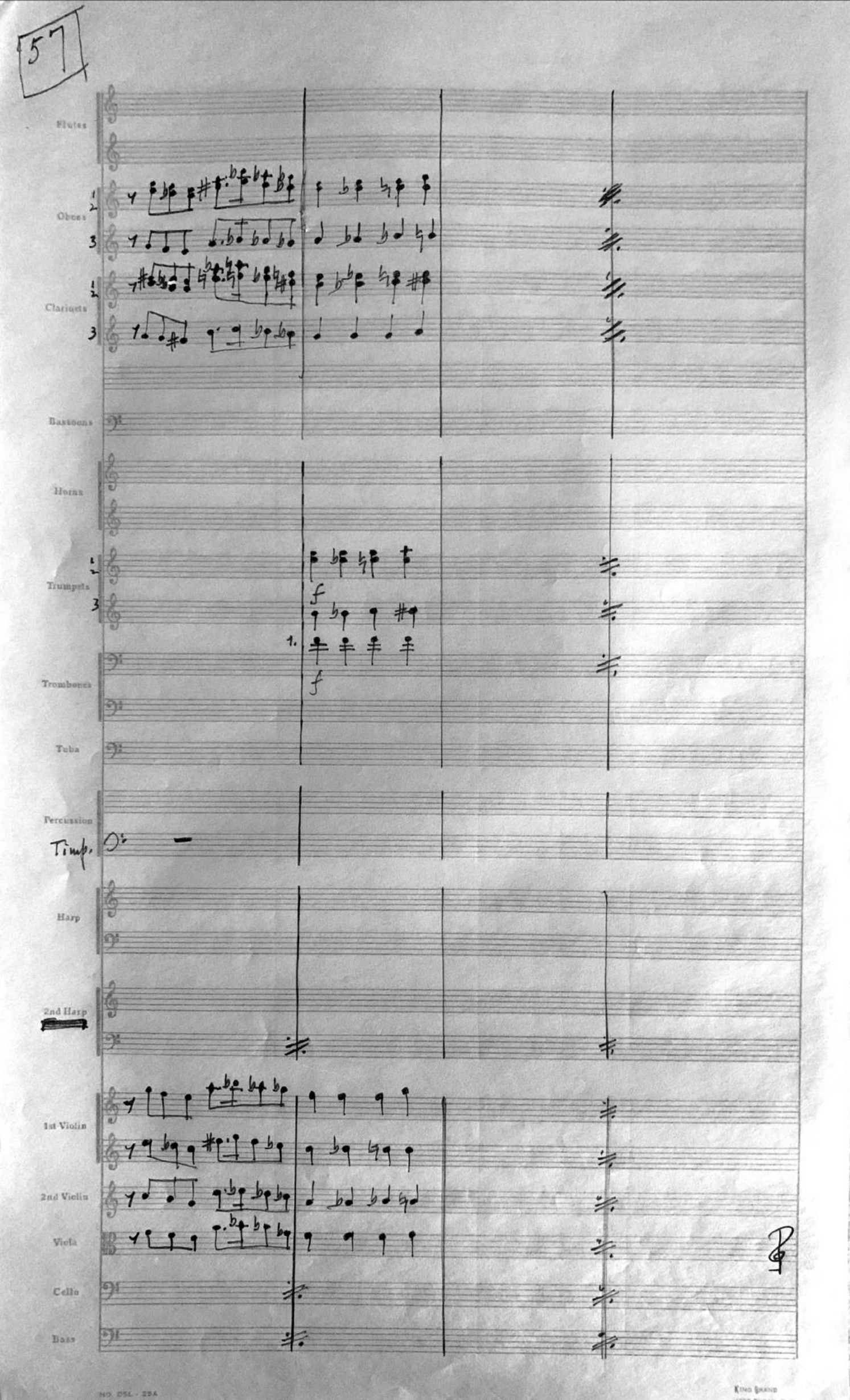
2nd Violin

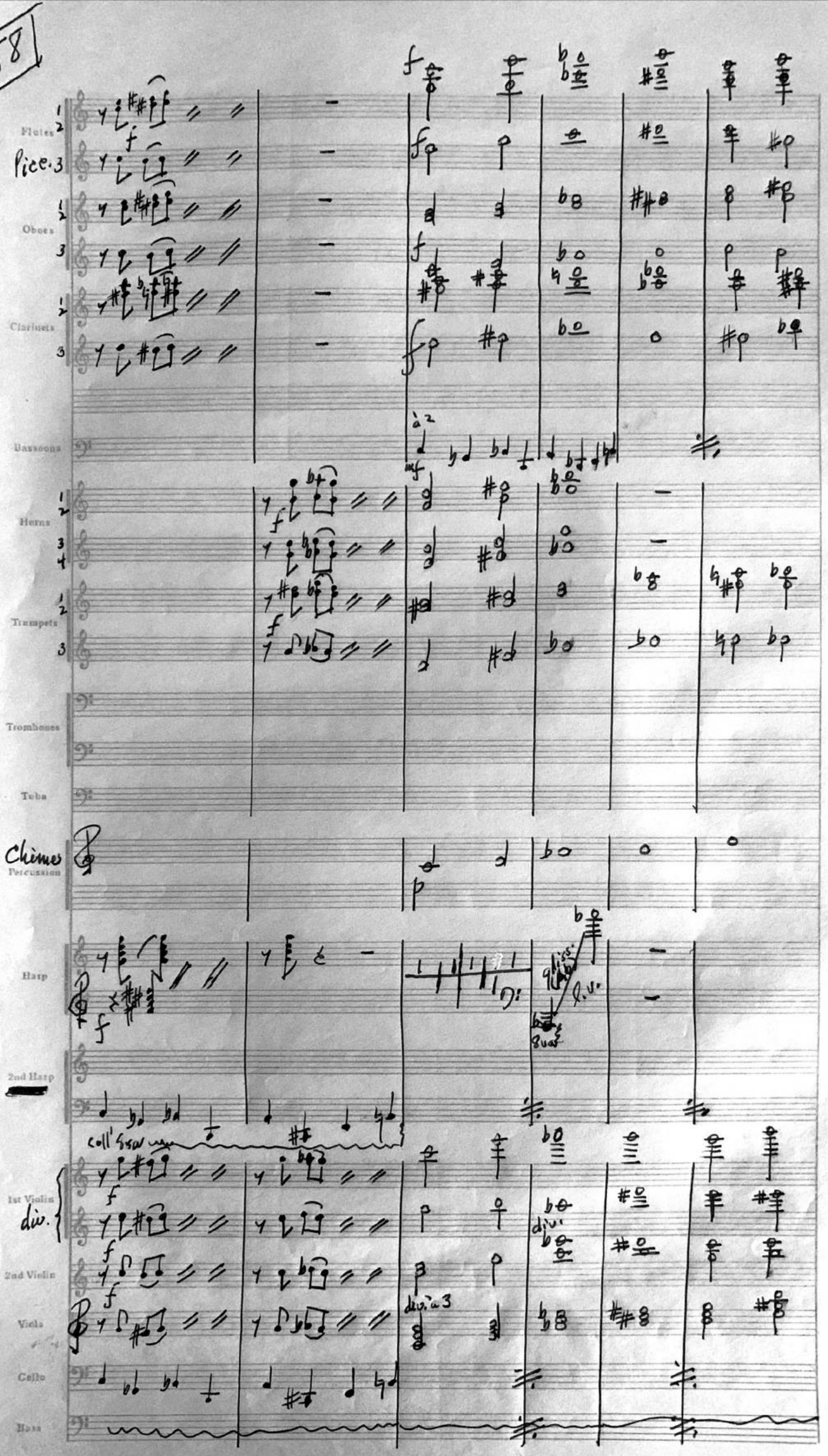
Viola

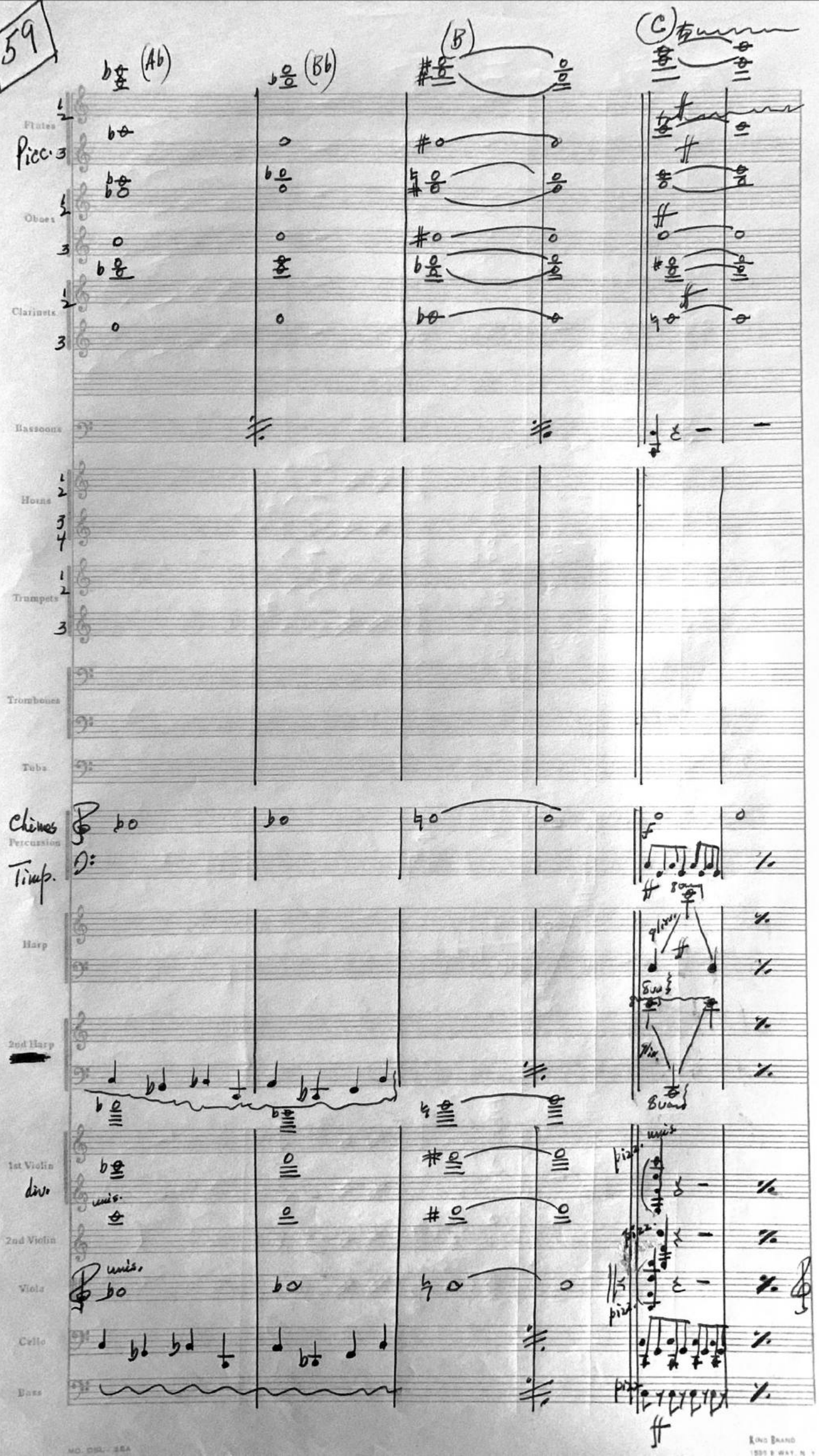
Cello

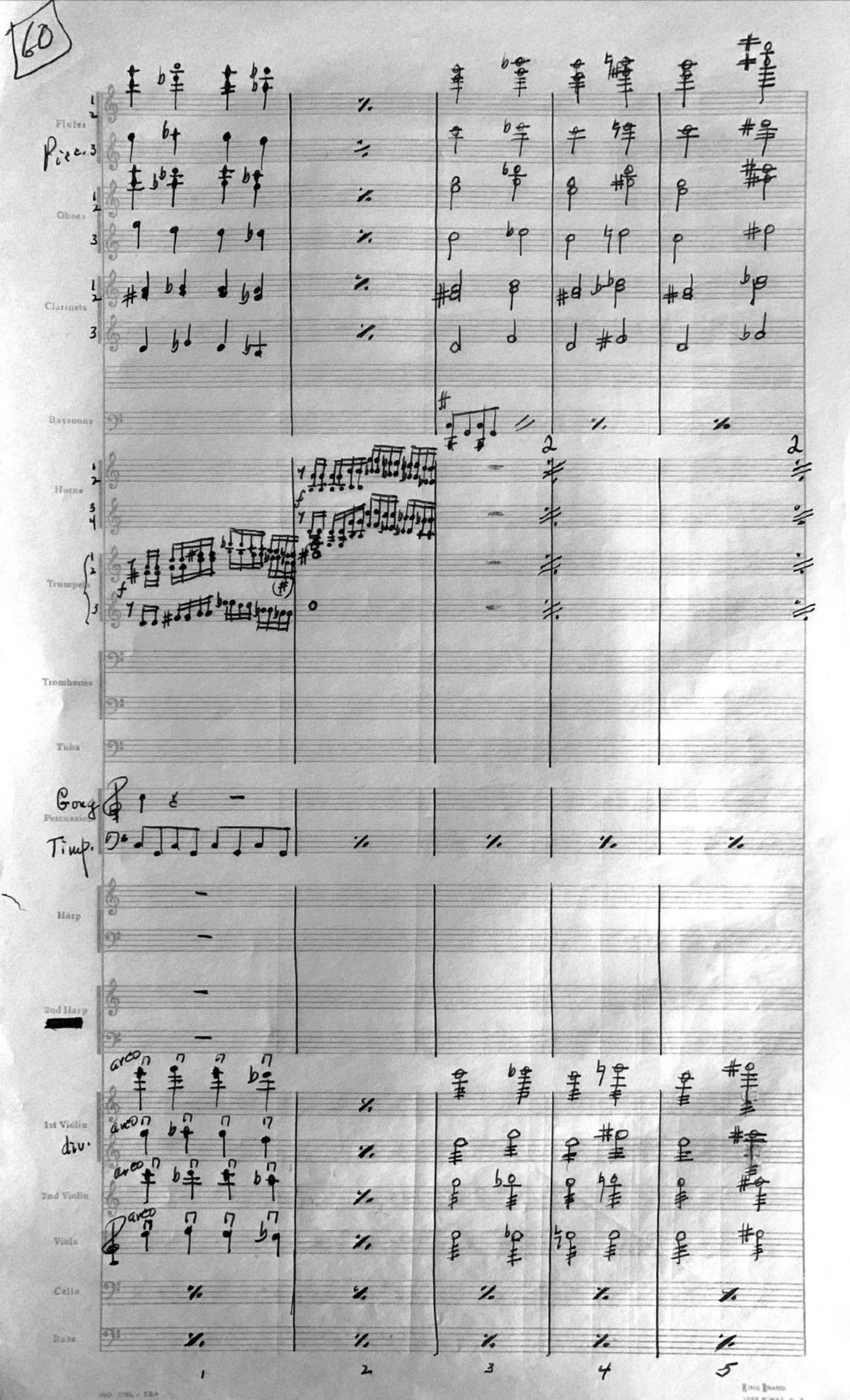
Bass

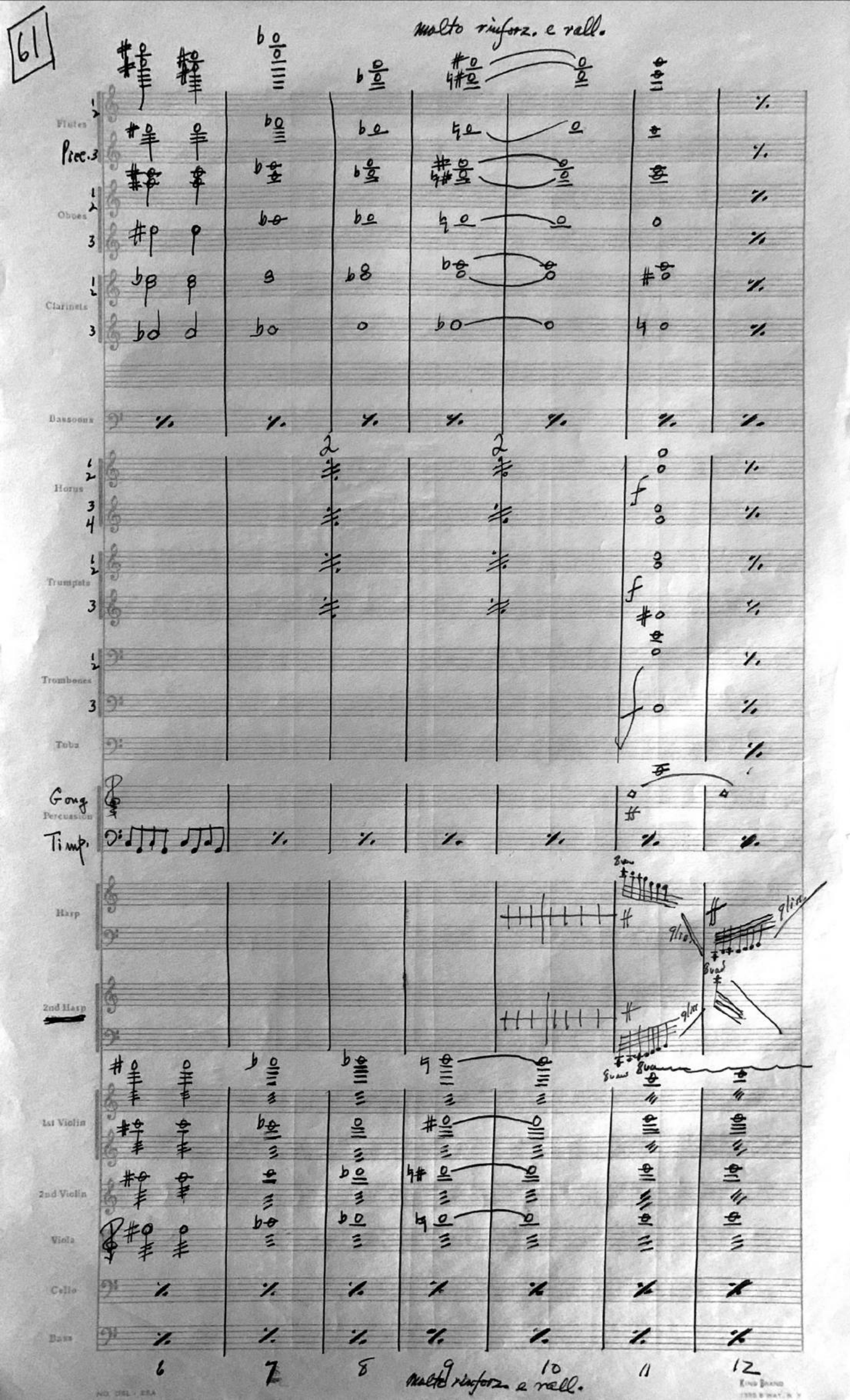

Flutes
Solo
Oboes
1.
2
3
f strace.
Clarinets
1
2
3
f
f
Bassoons
Horns
1
Trumpets
Trombones
Tuba
Percussion
Timp.
mf
Harp
2nd Harp
coll' 8va
1st Violin
div.
div.
2nd Violin
Viola
Cello
coll' Celli
Bass

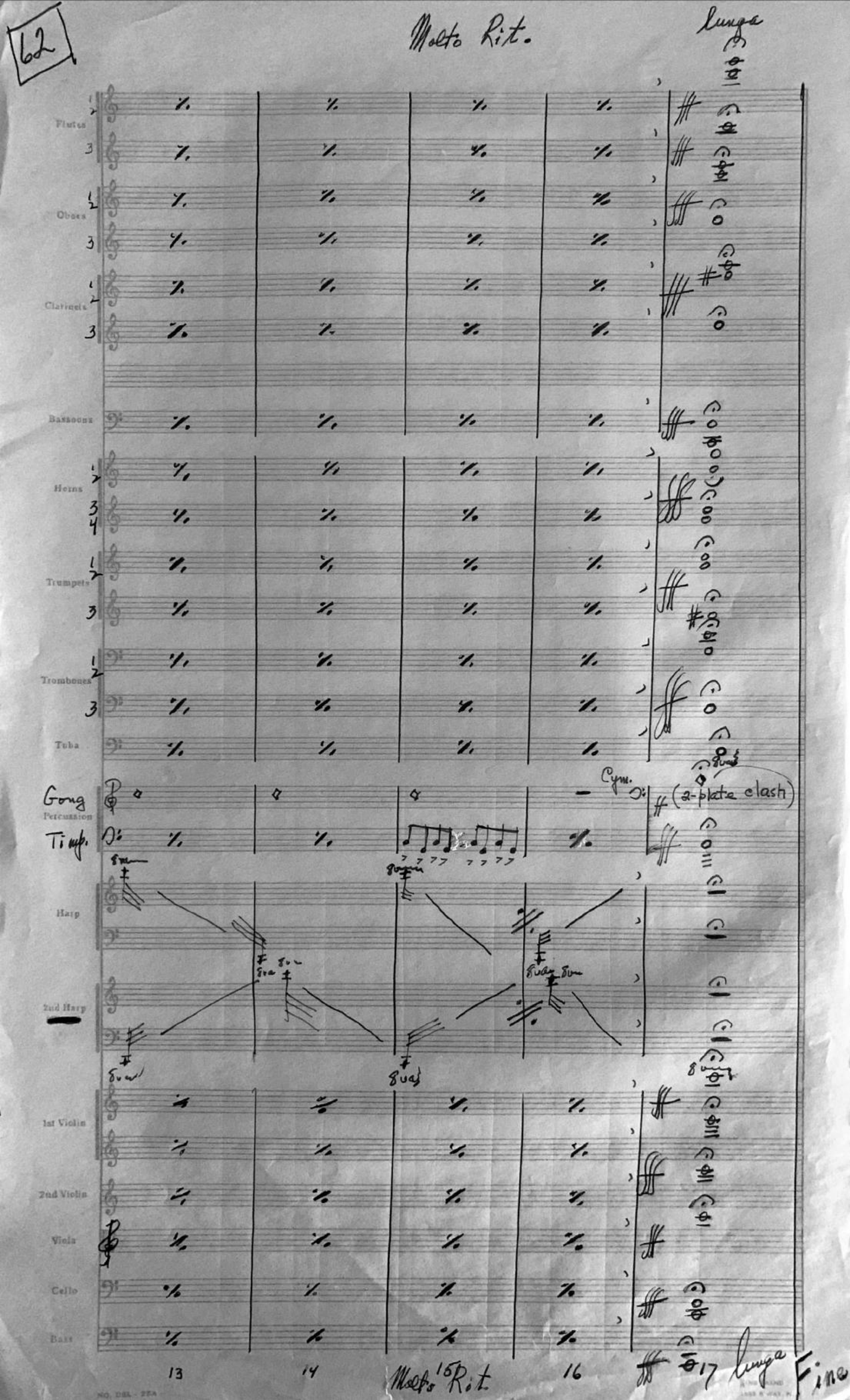

57
Flutes
Oboes
1
2
3
Clarinets
1
2
3
Bassoons
Horns
Trumpets
1
2
3
f
1.
f
Trombones
Tuba
Percussion
Timp.
Harp
2nd Harp
1st Violin
2nd Violin
Viola
Cello
Bass


Flutes
Picc.
Oboes
Clarinets
Bassoons
Horns
Trumpets
Trombones
Tuba
Chimes
Percussion
Harp
2nd Harp
coll'arco
1st Violin
div.
2nd Violin
Viola
Cello
Bass


59
(Ab)
(Bb)
(B)
(C)
Flutes
Picc.
Oboes
Clarinets
Bassoons
Horns
Trumpets
Trombones
Tuba
Chimes
Percussion
Timp.
Harp
2nd Harp
1st Violin
div.
unis.
2nd Violin
Viola
Cello
Bass
pizz.
arco
ff


60
Flutes
Pice. 3
Oboes
Clarinets
Bassoons
Horns
Trumpets
Trombones
Tuba
Gong
Percussion
Timp.
Harp
2nd Harp
1st Violin
div.
2nd Violin
Viola
Cello
Bass
arco
1
2
3
4
5


61
molto rinforz. e rall.
Flutes
Piccs.
Oboes
Clarinets
Bassoons
Horns
Trumpets
Trombones
Tuba
Gong
Percussion
Timp.
Harp
2nd Harp
1st Violin
2nd Violin
Viola
Cello
Bass
molto rinforz. e rall.
6
7
8
9
10
11
12


62
Molto Rit.
lunga
Flutes
Oboes
Clarinets
Bassoons
Horns
Trumpets
Trombones
Tuba
Gong
Percussion
Timp.
Cym.
(2-plate clash)
Harp
2nd Harp
1st Violin
2nd Violin
Viola
Cello
Bass
13
14
Molto Rit.
16
lunga
Fine