

I. BILATERAL SYMMETRY



Retrograde



Inversion

II. TRANSLATORY SYMMETRY

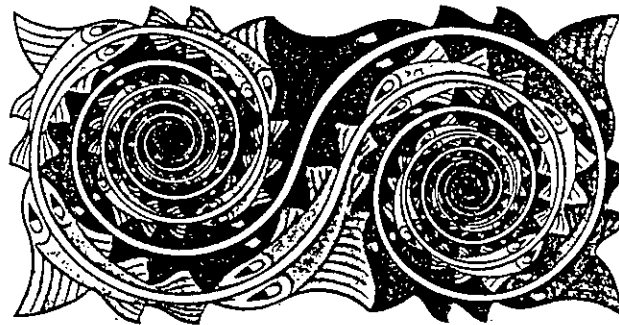


IV. DYNAMIC SYMMETRY

III. ROTATIONAL SYMMETRY



180° Rotation



S-Rotation (Schonberg)



Decreasing Squares



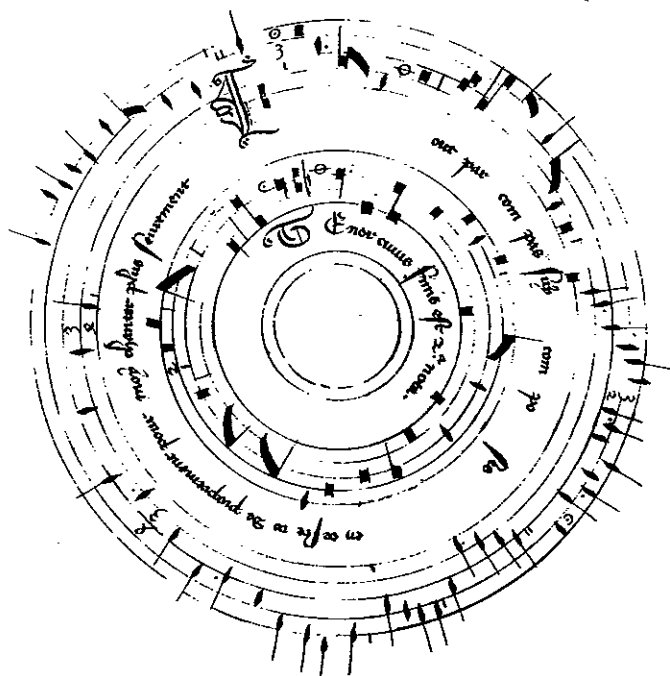
Metamorphic Translations

THE COLLEGIUM MUSICUM

Symmetry and the Arts: The Composer as Geometer

The geometrical mind is not so closely bound to geometry that it cannot be drawn aside and transferred to other departments of knowledge. A work of morality, politics, criticism, perhaps even eloquence, will be more elegant . . . if it is shaped by the hand of geometry.

(Bernard Le Bovier de Fontenelle, *L'Utilité des Mathématiques*)



Circle Canon: *Tout par compas suys composee*, Baude Cordier
(Chantilly MS, early 15th century)

FAIRCHILD CHAPEL

1987

4:30 P.M.

SATURDAY, MAY 2

SUNDAY, MAY 3

PROLEGOMENON: Galileo Galilei, *Il Saggiatore*, 1623

Ben Saferstein, reader

Anyone who wishes to achieve symmetry on a flat surface must take account of three fundamental principles of crystallography: gliding mirror image (REFLEXION); repeated shifting (TRANSLATION); and turning about axes (ROTATION).

(M. C. Escher)

I. BILATERAL SYMMETRY

Bilateral symmetry encompasses figures arranged equivalently on both sides of an axis.

Reflexion is the folding back of a part upon itself.

LONGITUDINAL REFLEXIONS

RETROGRADES—ΣΕΔΑΥΘΟΡΤΕΑ

All that is human must retrograde if it does not advance.

(Edward Gibbon, *Memoirs*)

PROCESSIONAL—TWO CLAUSULAE:

Dominus from the organum *Viderunt omnes*

Perotin

(fl. 1200)

The Lord . . .

Nusmido

Florentine MS, Pluteus 29.1

(13th century)

[The tenor melisma *Dominus* reappears here in retrograde set to *Nusmido*.]

COLLEGIUM

RETROGRADE CANON:

Talent mes prus

Ivrea MS

(14th century)

I. CANON ИОНАЦ | CANON ИОНАЦ
II. CANON ИОНАЦ | CANON ИОНАЦ

[Two voices in strict canon each turn back upon themselves at their midpoints. If the work is performed upon completion in reverse, an exact repetition of the original canon will result but the voices will exchange roles—the follower becoming the leader.]

(The wish has taken hold of me to sing like the cuckoo.)

INSTRUMENTAL ENSEMBLE

READING: Excerpts from *Four Quartets*, T. S. Eliot

From *Burnt Norton*

Bret Battey, reader

From *Little Gidding*

Shoshana Kaminsky, reader

RONDEAU WITH RETROGRADES:

Ma fin est mon commencement

S. RETROGRADE
S. ЭДАΥΘΟΡΤΕΑ
T. CANON ИОНАЦ

Guillaume de Machaut

(c. 1300-1377)

[The second voice is a complete and simultaneous retrograde of the first. The third voice turns back upon itself at its midpoint.]

My end is my beginning and my beginning is my end, and holds truly. My end is my beginning, My third song reverses itself and thus ends. My end is my beginning and my beginning is my end.

Michele Moede, *soprano*

INSTRUMENTAL ENSEMBLE

DIALOGUE PER RECTE ET RETRO: Douglas Hofstadter, *Gödel, Escher, Bach; Crab Canon*

DRAMATIS PERSONAE:

Tortoise: Paul V. Patanella

Achilles: Ben Saferstein

The Crab: Roger Stratton [palindrome by Ben Saferstein]

Crab Canon à 2, J. S. Bach (1685-1750)

INSTRUMENTAL ENSEMBLE

THREE CANONS, ONE AS RETROGRADE:

Magnificat VII toni, Gloria Patri

S. F — r — e — e

S. F O R M U L A - M U L A

A. D O U B L E - - - - -

A. D O U B L E - - -

T. C A N O N S - - - -

T. C A N O N S -

B. A J U M - A J U M R O H

B. F — r — e — e

Sebastián
de Vivanco
(1550-1621)

[Soprano II presents the Tone VII formula as Bass I repeats it simultaneously in retrograde. Alto I and II introduce a separate canon at the unison while Tenors I and II unfold still another canon at the unison.]

Glory to the Father, the Son, and the Holy Ghost.

COLLEGIUM

RETROGRADE CANONS:

Super ut, re, mi, fa, sol, la

I. R E T R O G R A D E

II. E D A Я O O Я T E Я

III. C A N O N I O N A C

Samuel Scheidt
(1587-1654)

[Three 3-voice canons are each constructed in the same manner as Machaut's *Ma fin est mon commencement*.]

Moto contrario continuo à fronte & fine in singulis lineis. Cancer enim cancricat. (The contrary motion continues from beginning to end in all the individual lines; the crab moving ever crabwise.)

INSTRUMENTAL ENSEMBLE

CANON PER RECTE ET RETRO:

Diliges Dominus

Diliges proximum tuum

	PART I	PART II
	S. F O U R -	L E V E L
	A. R E T R O	G R A D E
I.	T. 2 - C H O R U S E S	
	B. 2 - S E C T I O N S	
	S. L E V E L	- R U O F
	A. E D A Я O O Я T E Я	
I I.	T. 2 E S U R	O H C -
	B. 2 I O I T	C E 2 -

William Byrd
(1543-1623)

[A motet for two choruses that is divided into two sections. The voices of Chorus II are complete and simultaneous retrogrades of the corresponding voices in Chorus I. Thus the

second section, which begins at the mid-point of the work, produces a total exchange in reverse order of the melodic contents of both choruses.]

Thou shalt love the Lord thy God with all thy heart and with all thy mind, and with all thy soul, and with all thy strength.

Thou shalt love thy neighbor as thyself.

CHORUS

TRANSVERSE REFLEXIONS

INVERSIONS

INVERSIONS

A novel is a mirror that strolls along a highway.

Now it reflects the blue of the sky;

now the mud puddles underneath.

(Henri Stendahl, *Le Rouge et le Noir*)

Die III. Symphonie aus dem C

Scheidt

[Upright and inverted versions of the subject appear randomly throughout this composition.]

INSTRUMENTAL ENSEMBLE

PERPETUAL MIRROR CANON: S. C A N O $\left[\begin{array}{l} \text{N - C A N O} \\ \text{O И - C V И} \\ \text{A N O N - C} \\ \text{C V И O И -} \end{array} \right]$

So lange Schönheit à 4

Johannes Brahms
(1833-1897)

[A pair of voices introduce the subject and its inversion. They are echoed by a second pair after four measures.]

So long as beauty remains, so long as eyes see on earth, you will not escape love.

Rebekah Edminster, Melinda Matthews, *sopranos*

Catherine Aragon, Emily Greenleaf, *mezzo-sopranos*

PERPETUAL MIRROR CANON:

Canon perpetuus à 2 from The Musical Offering

J. S. Bach

I. C $\left[\begin{array}{l} \text{A N O N - - C V И O И - - C} \\ \text{C V И O И - - C A N O N - -} \end{array} \right]$

II.

B. F

$\left[\text{--- r --- e --- e ---} \right]$

[The subject and its inversion are introduced canonically over a freely moving bass. Upon modulating to the dominant minor, the voices exchange melodic materials. Returning to the original key, they resume again their initial roles. The music is so constructed that the process may be repeated indefinitely.]

INSTRUMENTAL ENSEMBLE

PERPETUAL DOUBLE MIRROR CANON:

Zu Rauch à 4

S. D O $\left[\begin{array}{l} \text{U B L E - D O} \\ \text{- D O И B T E} \\ \text{- C V И O И 2} \\ \text{B. C A N O N S - C A} \end{array} \right]$

Brahms

[Two subjects introduced simultaneously are each answered in inversion after two measures.]

To smoke must turn the sweetness of the earth and also the azure of the heavens.

Shoshana Kaminsky, LeAnne Shoup, *sopranos*
 Peter Goehring, *tenor*, Paul Patanella, *baritone*

II. TRANSLATORY SYMMETRY TRANSLATORY SYMMETRY TRANSLATORY SYMMETRY

*Translation is motion in which all axes of the moving body
 remain parallel to their original position.*

READING: VILLANELLE *If I could Tell You*, W. H. Auden

Peter Goehring, Lisa Murray, *readers*

PERPETUAL 6-IN-1

CANON:

Legitimation als Canon

S.	CANON - CAN	$\left[\begin{array}{c} \text{ON - CAN} \\ \text{NON - CA} \\ \text{- CANON} \\ \text{N - CANO} \\ \text{ANON - C} \\ \text{CANON -} \end{array} \right]$	E
S.	CANON - CA		N
A.	CANON		+D
A.	CANO		I
T.	C		N
B.			G

Arnold
 Schönberg
 (1874-1951)

[The subject is coupled with its exact imitation or translation at the lower fifth. A second pair of translations answers with corresponding pitches after two measures. A third pair follows in the lower octave after two more measures.]

Legitimation as a canon for G. B. Shaw, with admiration on his 70th birthday. In perpetuity, never with a conclusion; the ending is only for an emergency!

Whoever pays honor, must himself possess it, otherwise it is insignificant. Therefore musicians pay homage to honor with the canon, to show through it that they have honor.

CHORUS

3-IN-1 CANON—BALLADE:

Sanz cuer; Amis, dolens; Dame

		I	II
I.	BALLADE -	E - CANON	
II.	B ALLADE - B	- CANON	
III.	BA LLADE - BA	CANON	

Guillaume
 de Machaut
 (c. 1300-1377)

[An extended melody in the form of a *ballade* is here subjected to two translations at the unison.]

(Without heart, I see it . . .

Friends, saddened and discomfited . . .

Lady, through you my senses are restored . . .)

INSTRUMENTAL ENSEMBLE

6-IN-3 CANON:

Kyrie from Missa Ave Sanctissima

I.	THREE
II.	LEVEL
III.	CANON
I.	THREE - -
II.	LEVEL - -
III.	CANON - -

Pierre de la Rue
 (c. 1455-1518)

[Each of the three voices of a first chorus is echoed a fourth higher throughout by the corresponding voice in a second chorus.]

Lord, have mercy upon us. Christ, have mercy upon us. Lord, have mercy upon us.

Suzanne Metz, *soprano* Amy Hansen, *alto*
 Patric Cohen, *tenor* Thomas Hallenbeck, Peter Goehring, Nathan Wilkes, *basses*

CANON:
6 in One

I. C A N O N
 II. C A N O N
 III. C A N O N
 IV. C A N O N
 V. C A N O N
 VI. C A N O N

William Byrd
 (1543-1623)

[An extended canon with translations at the upper and lower octaves and the upper fourth.]

INSTRUMENTAL ENSEMBLE

TWO 2-IN-1 CANONS:
Miserere mihi, Domine

S. F O R M - f—r—e—e F O R M U L A
 A. f—r—e—e F O R M U L A -
 A. f—r—e—e - -
 T. F O R - f—r—e—e C A N O N -
 B. F O R M U L A C A N O N

Byrd

[The portion of the chant formula introduced by the Soprano is answered by the Tenor and then repeated and completed by the Bass. It is then presented in the two upper voices as a canon at the fourth and is accompanied by a second canon at the fourth in the two lower voices.]

Have mercy upon me, O Lord, and harken to my prayer.

CHORUS

FRAGMENTED TRANSLATIONS:

Es wollt' ein Maidlein Wasser hol'n

Ludwig Senfl
 (c. 1486-1543)

[A skillful four-voice work with numerous translations of segments of a popular folk melody.]

A maiden intended to carry some water from a cool fountain.
 She wore a snow-white blouse, through which the sun shone.
 There came a knight riding there;
 "Good day to you, gentle maid! If you will do my will, I
 will take you home with me."
 "I will not submit to your will! I am a maiden already promised.
 The little flowers which grew on the moor were picked for
 me."

Thelonius Griffin, *bass*

KRUMMHORN QUARTET

3-IN-1 AND 2-IN-1 CANONS:
Agnus Dei III from Missa ad fugam

S. C A N O N
 A. C A N O N - -
 A. C A N O N - -
 T. D O U B L E - -
 B. D O U B L E - -

Giovanni da Palestrina
 (c. 1525-1594)

[Palestrina's entire mass is written in canon. The final *Agnus Dei* consists of two separate, but loosely related, sets of exact imitations or translations. A first subject is translated

into a canon at the upper fourth between the two lower voices. A second subject follows in the three upper voices, answered at the unison and upper fourth.]

Lamb of God, who takes away the sins of the world, grant us peace.

CHORUS

III. ROTATIONAL SYMMETRY ROTATIONAL SYMMETRY

*The life of man is a circle from childhood to childhood,
and so it is in everything where power moves.*

(Sioux Indian as told through John Neihardt)

Rotary motion is characterized by movement around an axis, like a wheel.

CIRCLE CANON [cf. Program cover]:

Tout par compas suys composee

Baude Cordier
(fl. 1520)

[A repeating 2-voice canon and an independent tenor melody are notated in the MS as two concentric circles.]

(All by compass am I arranged. All by compass am I composed, fittingly in this rondel. Three times around, put by you, you can chase me merrily, if you sing me with true feeling. All by compass I am arranged, fittingly in this rondel so that you can sing me more accurately.)

INSTRUMENTAL ENSEMBLE

180° ROTATION:

Allegro à 2

R	O	T	A	T	I	O	N	-		-	R	O	T	A	T	I	O	N		
N	O	I	L	V	A	L	O	R	-		-	N	O	I	L	V	A	L	O	R

W. A. Mozart [?]
(1756-1791)

[The rotation is accomplished by a second performer reading simultaneously, from the opposite side of a table, the music of the first. The resulting additional part is thus the original music played upside down and in reverse.]

Amy Hansen, Allen Kastle, *violins*

180° ROTATIONS:

Ein Spruch und zwei variationen à 4

S.	B	I	-	L	E	V	E	L		B	E	L	E	V	E	L	B							
A.	R	O	T	A	T	I	O	N		N	O	I	L	V	A	L	O	R						
T.	N	O	I	L	V	A	L	O	R		R	O	T	A	T	I	O	N						
B.	L	E	V	E	L		B	I	-	L	E	V	E	L		B	I	-	L	E	V	E	L	B

Schönberg

[The score is so constructed that when the Soprano and Alto parts are rotated 180° they provide, with appropriate clefs, simultaneous parts for the Tenor and Bass.]

MAXIM:

Oh don't believe that which you do not know to be worthless! Disdain only that which you undertake!

VARIATION I.

I don't believe that which I know to be of any value until I seek what others hold in esteem.

VARIATION II:

S.	B	I	-	L	E	V	E	L		L	E	V	E	L	-	B	I	B
A.	R	O	T	A	T	I	O	N		N	O	I	L	V	A	L	O	R
T.	R	O	T	A	T	I	O	N		N	O	I	L	V	A	L	O	R
B.	B	I	-	L	E	V	E	L		L	E	V	E	L	-	B	I	B

[In the second variation, the final half of the Soprano is a retrograde of its initial half, and the concluding half of the Alto is a 180° rotation of its first half. The Bass and Tenor,

derived once again by a rotation of the upper lines, now appear respectively as a complete inversion of the Soprano at the lower 12th and an exact imitation of the Alto at the lower 5th.]

I believe only what the majority esteems to be of any value. You try in vain, when they do not support you!

Rebekah Edminster, *soprano* Margaret Bambach, *alto*
Thomas Hallenbeck, Thelonius Griffin, *basses*

CHORUS

180° ROTATION:

Canon für Streichquartett

I.	B	I	-	L	E	V	E	L	AI
II.	R	O	T	A	T	I	O	N	III
III.	N	O	I	L	V	A	L	O	II
IV.	T	E	E	L	-	B	I	I	

Schönberg

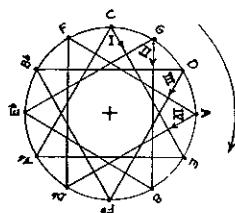
[As in the previous composition, the lower pair of parts are derived from upper pair by giving the score a half turn, applying the appropriate clefs, and reading the result simultaneously from left to right.]

INSTRUMENTAL ENSEMBLE

120° OR TRIANGULAR ROTATIONS:

Perpetual Canon à 4

(Through All Major Keys)



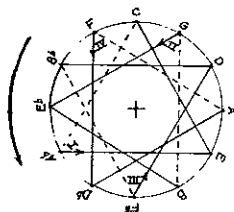
Johann Philipp Kirnberger
(1721-1783)

[A complete circuit of the twelve major keys here consists of three successive rotations of a series of four canonic entries. Within each series, each voice repeats the subject in a key a fifth higher than that of its predecessor. The entire sequence is then rotated a major third higher and repeated. Upon completion of the third rotation all voices should return to their opening pitches an octave higher. Kirnberger, however, reinstitutes the cycle in the original octave. Movements of the voices in the circuit could be represented graphically by four equilateral triangles which combine to form a dodecagon that is circumscribed by the circle of fifths.]

Frederick Lassen, *organist*

120° OR TRIANGULAR ROTATIONS:

Mir lächelt kein Frühling à 4



Johannes Brahms

[The structure of Brahms' work closely resembles Kirnberger's, except that each of the four entries within a single canonic series begins a half-step lower than its predecessor. The entire series is then rotated and repeated a major third lower. Upon completion of the third rotation all voices would return to their initial pitches an octave lower. Brahms, however, terminates his canon after the end of the second rotation. A graphic representation would result in the same configuration as Kirnberger's canon, except that the third sides of all four triangles would remain incomplete.]

The spring no longer smiles for me; the sun no longer shines for me; no flowers bloom for me!

Suzanne Metz, Michele Moede, *sopranos*
Megan Brown, Lisa Murray, *mezzo-sopranos*

READINGS CONCERNING HEXAGONS:

James Gleick, *New York Times*, January, 1987

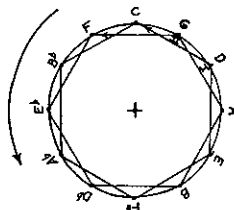
Patric Cohen, *reader*

Henry David Thoreau, *Journal*, January, 1856

Ellen Bradburn, *reader*

60° OR HEXAGONAL ROTATIONS:

Perpetual Canon à 2



Thomas Morley
(1557-1602)

[Morley's duo consists of a canonic sequence in which the answering voice lies a fourth above its antecedent. The entire sequence is then repeated a full step lower and rotated six times to cover a full octave. Each voice thus descends through a separate and complete whole-tone scale. The circuits of the voices could be represented as two independent regular hexagons which combine into a dodecagon that is circumscribed by the circle of fifths.]

INSTRUMENTAL ENSEMBLE

IV. DYNAMIC SYMMETRY

The principle of dynamic symmetry is manifest in shell growth and the leaf distribution in plants . . . The curve of the coil is a logarithmic spiral in which the law of proportion is inherent . . .

(Jay Hambidge, *Dynamic Symmetry in the Greek Vase*)

SERIES OF INCREASING OR DECREASING SQUARES

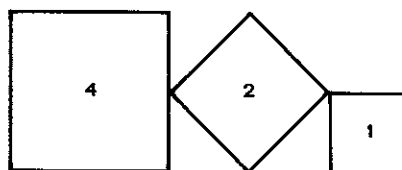
READING: Excerpt from Robert Browning, *The Flight of the Duchess*

[The increasingly frantic efforts of an aging Duchess futilely attempting to beautify herself are matched by an accelerating incidence of rhyme and assonance. Browning's technique closely resembles successive diminutions in musical counterpoint.]

Emily Greenleaf, *reader*

4:2:1 PROPORTION:

Kyrie II from Missa malheur me bat



Jacob Obrecht

[The Soprano presents three successive versions of the same melody. Each repetition moves twice as rapidly as the preceding verison.]

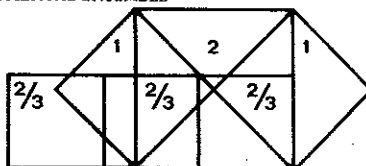
Lord, have mercy upon me.

Rebekah Edminster, *soprano*

INSTRUMENTAL ENSEMBLE

2/3:1:2 [2:3:6] PROPORTION:

Agnus Dei II from Misa L'Homme armé
(*super voces musicales*)



Josquin des Prez
(c. 1440-1521)

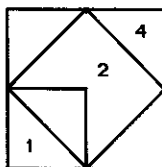
[Three voices are combined to present the same melody simultaneously. The highest voice performs the opening three notes of equal value in the same time span that the lowest voice presents two and the middle voice contributes but one.]

O Lamb of God, have mercy upon us!

Megan Brown, *soprano* Jonathan Brown, *tenor*
Theolonius Griffen, *bass*
INSTRUMENTAL ENSEMBLE

1:2:4 PROPORTION:

Geburtstagskanon für Carl Engel



Schönberg

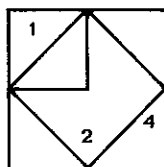
[The composer portrays an elderly musicologist's increasing fatigue by simultaneously repeating the melody of the Bass in each of the two higher voices twice as slowly as in its lower counterpart.]

No man can escape, no man yet remained forever twenty. Suddenly one's sixty and is surprised and is perplexed and asks oneself: What is the matter now? Did I do something wrong? Can I not dance and sing as formerly? Even the music is too fast! I am really out of breath! Should I now sing perhaps only slower voices?

CHORUS

1:2:4 PROPORTION:

Canon



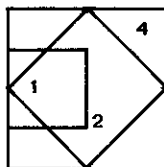
Dr. Cooke
(Prize Model, 1775)

[A duplication of the procedure in Schönberg's canon, except here the sequence is initiated by the highest voice, slowed twice in the lowest voice, and further slowed twice in the middle voice.]

INSTRUMENTAL ENSEMBLE

1:2:4 PROPORTION:

Benedicamus Domino



Sebastián de Vivanco
(1550-1622)

[The melodic material in the Alto is simultaneously duplicated twice as slowly in the Bass and four times as slowly in the Soprano I. The canon is surrounded by free counterpoint in Soprano II and Tenor.]

Let us bless the Lord.

CHORUS

METAMORPHIC TRANSLATIONS metamorphic translations

READING: Metamorphic excerpts from James Joyce, *Ulysses*, *Sirens*

Daniel Judge, Rachel Clapham, *readers*

METAMORPHOSIS OF A 7-NOTE PATTERN:

Fantasia XI à 2

Roland de Lassus

(1532-1594)

[The seven notes introduced by the lower voice are subjected to many transformations, which become increasingly shorter and more fragmented as the work progresses. The metamorphic process recalls that in M.C. Escher prints where an initial pattern is gradually altered until it is transformed into something totally different.]

INSTRUMENTAL ENSEMBLE

METAMORPHOSIS OF A 13-NOTE PATTERN:

Gloria from Missa In manus tuas

Vivanco

[A pitch series, stemming from one of the composer's own motets, recurs throughout in a wide variety of rhythmic patterns in this composition for two choirs. Most of this *Gloria* was believed permanently lost until a print was uncovered in 1978. Our performance probably represents the first since the late 17th century.]

Glory to God in the highest, and on earth peace to men of good will. We praise You. We bless You. We glorify You. We give You thanks in Your great glory. O Lord God, heavenly King, God the Father Almighty.

O Lord Jesus Christ, the only-begotten Son. O Lord God, Lamb of God, Son of the Father: You Who take away the sins of the world, have mercy upon us. You Who take away the sins of the world, receive our prayer. You Who sit on the right hand of the Father, have mercy upon us. For You alone are holy. You alone are the Lord. You alone, O Jesus Christ, are most high. Together with the Holy Spirit in the glory of God the Father. Amen.

COLLEGIUM

* * * * *

RECESSIONAL—PERPETUAL CANON:

Gehn wir in Prater à 3

I. C A $\left[\begin{array}{c} \text{N O N - C A} \\ \text{A N O N - C} \\ \text{C A N O N -} \end{array} \right]$
 II. C
 III.

W. A. Mozart

Let's go to Prater Park; let's go into the crowd; let's go to see Punch. —But Punch is sick and the bear is dead! What does one then do in the crowd there? In the Prater there are only flies and piles of rubbish!

COLLEGIUM

COLLEGIUM MUSICUM

L. D. Nuernberger, *director*

Ben Saferstein, *assistant director*

SINGERS

Catherine Aragon
Margaret Bambach
Brett Battey
Ellen Bradburn
Jonathan Brown
Megan Brown
Patric Cohen
Rebekah Edminster
Peter Goehring
Emily Greeleaf
Thelonius Griffin
Thomas Hallenbeck
Amy Hansen

Sandy Holder
Shoshana Kaminsky
Allen Kastle
Shane Katzman-Rooks
Melinda Matthews
Suzanne Metz
Michele Moede
Lisa Murray
Paul V. Patanella
Ben Saferstein
Clara Shaw
LeAnne Shoup
Roger Stratton

Nathan Wilkes

INSTRUMENTALISTS

Catherine Aragon, *viol*
Margaret Bambach, *recorders*
Greg Bloy, *recorders*
Rachel Clapham, *recorders*
Jonathan Dawe, *krummborn*
Peter Goehring, *recorders, dulcimer*
Emily Greenleaf, *Renaissance flute, vielle, viol*
Thomas Hallenbeck, *viol*
Amy Hansen, *violin*

Robert Igo, *recorders*
Daniel Judge, *recorders, krummborn, Gothic harp*
Allen Kastle, *violin*
Frederick Lassen, *organ, portative*
Paul V. Patanella, *krummborn, sackbut, psaltery*
Jonathan Perry, *recorders*
Ben Saferstein, *lute, Renaissance flute, vielle, viol*
Elizabeth Sharp, *recorder*
Roger Stratton, *Renaissance and Baroque flutes*

Nathan Wilkes, *krummborn, sackbut*