Andrián Pertout

The Elements

for Violin

No. 403

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Composed in May, 2009

Commissioned by American Violinist Piotr Szewczyk

Hommage à Olivier Messiaen (1908-1992)

Winner in the 'Advanced Level' Category of the International Music Prizes
for Excellence in Composition 2009 (Thessaloniki, Greece)

Duration: 4'48"

PROGRAMME NOTES

In his mathematical and geometric treatise *Elements* of circa 300 BC, Greek mathematician Euclid first defined primality (the property of being a prime number, and hence numbers divisible only by themselves and one). According to the preface contained in a new one-volume edition of T.L. Heath's translation of the thirteen books of Euclid's *Elements* published by Green Lion Press, "Euclid's *Elements* has stood for well over two millenia as the exemplar, not just of classical geometry, but of the axiomatic and deductive structure characteristic of all pure mathematics. Its range goes beyond what we think of as geometry, extending to the general theory of proportions, number theory, and an innovative and ingenious treatment of incommensurability." The treatise also explores the close relationship between perfect numbers and Mersenne primes, and the theorem that "if M is a Mersenne prime then $M(M+1)/2$ is a perfect number." Perfect numbers are "numbers that are equal to the sum of their proper divisors, or $2^{n-1}(2^n-1)$," such as the even perfect numbers 6 and 28, because $6=1+2+3$ and $28=1+2+4+7+14$; while a Mersenne prime (in reference to 17th century French monk and mathematician Marin Mersenne [1588-1648] and his 1644 treatise *Cogitata Physica-Mathematica*) is a "prime number that is one less than a power of two, or $M_n=2^n-1$." To date, no odd perfect numbers have ever been discovered, and there is knowledge of only forty-six Mersenne primes, which are suspected of being of an infinite number.

The First 500 Prime Numbers

2	3	5	7	11	13	17	19	23	29	31	37	41	43	47	53	59	61	67	71
73	79	83	89	97	101	103	107	109	113	127	131	137	139	149	151	157	163	167	173
179	181	191	193	197	199	211	223	227	229	233	239	241	251	257	263	269	271	277	281
283	293	307	311	313	317	331	337	347	349	353	359	367	373	379	383	389	397	401	409
419	421	431	433	439	443	449	457	461	463	467	479	487	491	499	503	509	521	523	541
547	557	563	569	571	577	587	593	599	601	607	613	617	619	631	641	643	647	653	659
661	673	677	683	691	701	709	719	727	733	739	743	751	757	761	769	773	787	797	809
811	821	823	827	829	839	853	857	859	863	877	881	883	887	907	911	919	929	937	941
947	953	967	971	977	983	991	997	1009	1013	1019	1021	1031	1033	1039	1049	1051	1061	1063	1069
1087	1091	1093	1097	1103	1109	1117	1123	1129	1151	1153	1163	1171	1181	1187	1193	1201	1213	1217	1223
1229	1231	1237	1249	1259	1277	1279	1283	1289	1291	1297	1301	1303	1307	1319	1321	1327	1361	1367	1373
1381	1399	1409	1423	1427	1429	1433	1439	1447	1451	1453	1459	1471	1481	1483	1487	1489	1493	1499	1511
1523	1531	1543	1549	1553	1559	1567	1571	1579	1583	1597	1601	1607	1609	1613	1619	1621	1627	1637	1657
1663	1667	1669	1693	1697	1699	1709	1721	1723	1733	1741	1747	1753	1759	1777	1783	1787	1789	1801	1811
1823	1831	1847	1861	1867	1871	1873	1877	1879	1889	1901	1907	1913	1931	1933	1949	1951	1973	1979	1987
1993	1997	1999	2003	2011	2017	2027	2029	2039	2053	2063	2069	2081	2083	2087	2089	2099	2111	2113	2129
2131	2137	2141	2143	2153	2161	2179	2203	2207	2213	2221	2237	2239	2243	2251	2267	2269	2273	2281	2287
2293	2297	2309	2311	2333	2339	2341	2347	2351	2357	2371	2377	2381	2383	2389	2393	2399	2411	2417	2423
2437	2441	2447	2459	2467	2473	2477	2503	2521	2531	2539	2543	2549	2551	2557	2579	2591	2593	2609	2617
2621	2633	2647	2657	2659	2663	2671	2677	2683	2687	2689	2693	2699	2707	2711	2713	2719	2729	2731	2741
2749	2753	2767	2777	2789	2791	2797	2801	2803	2819	2833	2837	2843	2851	2857	2861	2879	2887	2897	2903
2909	2917	2927	2939	2953	2957	2963	2969	2971	2999	3001	3011	3019	3023	3037	3041	3049	3061	3067	3079
3083	3089	3109	3119	3121	3137	3163	3167	3169	3181	3187	3191	3203	3209	3217	3221	3229	3251	3253	3257
3259	3271	3299	3301	3307	3313	3319	3323	3329	3331	3343	3347	3359	3361	3371	3373	3389	3391	3407	3413
3433	3449	3457	3461	3463	3467	3469	3491	3499	3511	3517	3527	3529	3533	3539	3541	3547	3557	3559	3571

The First 12 Perfect Numbers

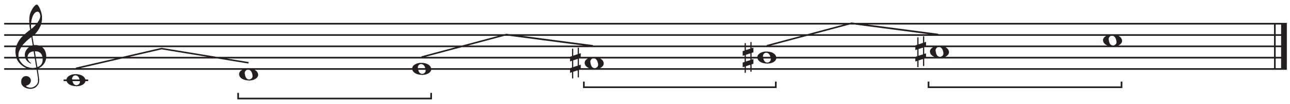
$2^{1}(2^{2}-1)$	6
$2^{2}(2^{3}-1)$	28
$2^{4}(2^{5}-1)$	496
$2^{6}(2^{7}-1)$	8128
$2^{12}(2^{13}-1)$	33550336
$2^{16}(2^{17}-1)$	8589869056
$2^{18}(2^{19}-1)$	137438691328
$2^{30}(2^{31}-1)$	2305843008139952128
$2^{60}(2^{61}-1)$	2658455991569831744654692615953842176
$2^{88}(2^{89}-1)$	191561942608236107294793378084303638130997321548169216
$2^{106}(2^{107}-1)$	13164036458569648337239753460458722910223472318386943117783728128
$2^{126}(2^{127}-1)$	14474011154664524427946373126085988481573677491474835889066354349131199152128

According to Prime Count, "the search for Mersenne primes was revolutionized by the introduction of the electronic digital computer. The first successful identification of a Mersenne prime, M^{521}, by this means was achieved at 10:00 P.M. on January 30, 1952 using the U.S. National Bureau of Standards Western Automatic Computer (SWAC) at the Institute for Numerical Analysis at the University of California, Los Angeles, under the direction of Lehmer, with a computer search program written and run by Prof. R.M. Robinson. It was the first Mersenne prime to be identified in thirty-eight years; the next one, M^{607}, was found by the computer a little less than two hours later. Three more – M^{1279}, M^{2203}, M^{2281} – were found by the same program in the next several months. M^{4253} is the first Mersenne prime that is titanic, M^{44497} is the first gigantic, and $M^{6,972,593}$ was the first megaprime to be discovered, being a prime with at least 1,000,000 digits. All three were the first known prime of any kind of that size." The Great Internet Mersenne Prime Search (GIMPS) was formed in January 1996 by George Woltman to "discover new world-record-size Mersenne primes," and "on August 23rd (2008), a UCLA computer in the GIMPS PrimeNet network discovered the 45th known Mersenne prime, $M^{43,112,609}-1$, a mammoth 12,978,189 digit number."

'The Elements' was commissioned by American violinist Piotr Szewczyk and is a dedication to the late French composer Olivier Messiaen (1908-1992). The title is in reference to Euclid's mathematical and geometric treatise *Elements* of circa 300 BC, and the work serves as an exploration of Messiaen's 'Modes of Limited Transposition' and 'Nonretrogradable Rhythms' within the structural framework of the first 36 prime numbers (2, 3, 5, 7, 11, 13, 17, 19, 23, 29, 31, 37, 41, 43, 47, 53, 59, 61, 67, 71, 73, 79, 83, 89, 97, 101, 103, 107, 109, 113, 127, 131, 137, 139, 149, and 151). Every possible mode is subsequently generated from each of the seven 'Modes of Limited Transposition', producing a collection of twenty-two scales, which are combined to produce one-, two-, three-, and four-octave scales. 'Nonretrogradable Rhythms' are then constructed within the scope of each prime, with each numerical value of a prime allocated a duration of a semiquaver note. The structure of 'The Elements' essentially features seven distinct sections individually dedicated to one of the 'Modes of Limited Transposition' and five unique 'Nonretrogradable Rhythms'; an ornamental rhythmic passage following the termination of each section acting as a type of coda. The ratio of 2:1:2 (equal to ♪+𝅘𝅥𝅯+♪ in the prime number 5) is utilized throughout the rhythmic scheme to delineate a contrasting central region equal to one-fifth of each of the thirty-four quintal palindromes (the primes 2 and 3 unable to yield a palindrome in the context of this scheme).

Olivier Messiaen's Modes of Limited Transposition

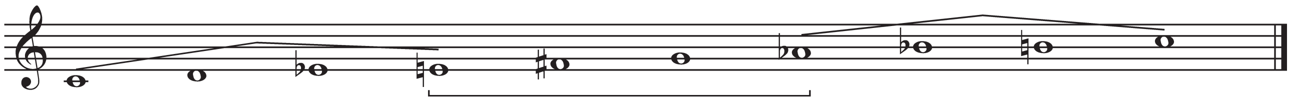
Mode 1 (Whole-Tone Scale)



Mode 2 (Octatonic Minor or Diminished 'Half Step-Whole Step' Scale)

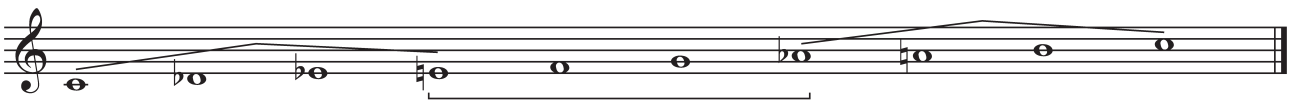
1st Mode Generated from Mode 2 (Octatonic Major or Diminished 'Whole Step-Half Step' Scale)

Mode 3



1st Mode Generated from Mode 3

2nd Mode Generated from Mode 3



Mode 4

1st Mode Generated from Mode 4

2nd Mode Generated from Mode 4

3rd Mode Generated from Mode 4

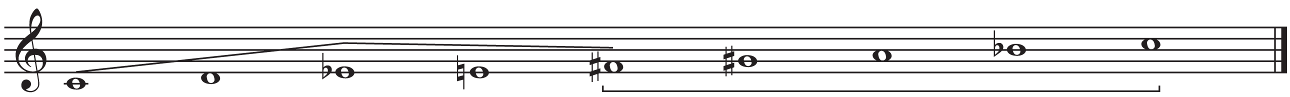
Mode 5

1st Mode Generated from Mode 5

2nd Mode Generated from Mode 5

Mode 6

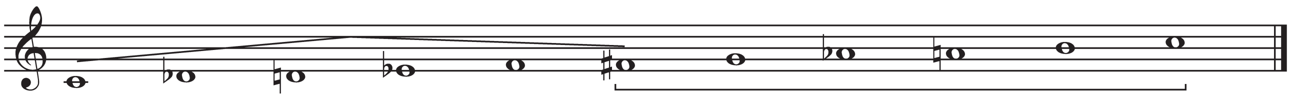
1st Mode Generated from Mode 6



2nd Mode Generated from Mode 6

3rd Mode Generated from Mode 6

Mode 7



1st Mode Generated from Mode 7

2nd Mode Generated from Mode 7

3rd Mode Generated from Mode 7

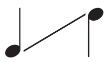
4th Mode Generated from Mode 7

INSTRUMENTATION

Violin

PERFORMANCE NOTES

In this score, accidentals affect only those notes which they immediately precede; accidentals are not repeated on tied notes; and accidentals are not repeated for repeated notes unless one or more different pitches intervene. If a sharp or flat is followed directly by its natural form, a natural is used. Cautionary accidentals or naturals have been used to clarify ambiguities.

	portamento (a smooth and rapid ‘sliding’ between two pitches, executed continuously)
	glissando (a smooth and rapid ‘sliding’ over the keys or strings (so that every individual note is articulated , no matter how rapid the ‘sliding’)
	behind the bridge (play between the bridge and the tailpiece)
	slap strings with palm
+	left-hand pizzicato
	snap pizzicato (Bartók pizzicato)

Hommage à Olivier Messiaen (1908-1992)

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arco
8va
29
1″
sfz mf
32
35
38
41
44
(8va)
al tallone
sul pont.
spiccato (ord.)
f
46
off-the-string
I II I II I II
I II I
II I II
sim.
pizz.
49
arco
8va
1″
sfz mf
52
(8va)


55
58
punta d'arco
saltando
60
martelé
63
punta d'arco
65
saltando
f
67
8va
ff
69
8va
sffz
mf (sub.)
al tallone
72
sul pont.
spiccato (ord.)
f
75
off-the-string
I II I II I II I
I II I II I II I
sim.


78
pizz.
arco (con sordino)
8va
2"
sfz mp
82
85
88
91
sul tasto
1"
col legno battuto (ord.)
94
sul pont.
arco (sul tasto)
ord.
97
sul tasto
100
col legno battuto (ord.)
sul pont.
arco (sul tasto)
ord.
mf
103
8va

106
(8va)
al tallone
sul pont.
spiccato (ord.)
6
6
5
f
109
6
5
5
3
off-the-string
I II I II I II I II I
112
I II I
II I II I II I
sim.
pizz.
3
5
6
3/4 + 3/16 + 1/4
3/4
4/4
115
5
arco (senza sordino)
8va
2"
118
(8va)
sfz mf
121
123
126
129
punta d'arco saltando
6


132
martelé
134
137
punta d'arco
140
saltando
142
f
144
ff
146
8va
sffz
mf (sub.)
149
(8va)
al tallone
sul pont.
spiccato (ord.)
152
f


155
off-the-string
158
sim.
pizz.
160
pp