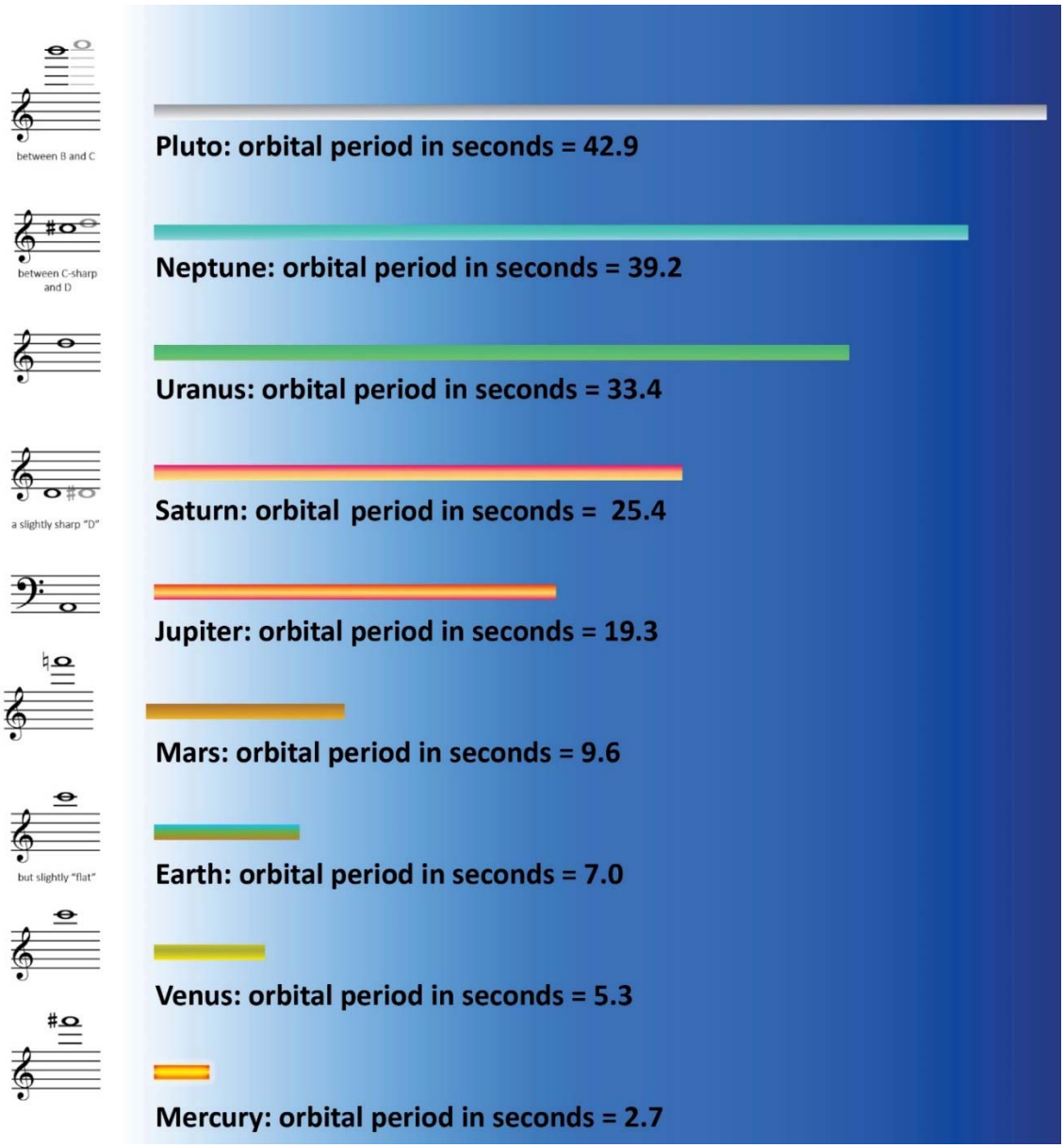
My Not-at-all Musical *Music of the Spheres*

The task of parameterizing planetary attributes[1] to set their relationships to "music" is complicated by the enormous ratios encountered. For example, the ratio of the mass of Jupiter to that of Pluto[2] is 130,000:1. Similarly, Mercury orbits the sun about 1,029 times for each orbit of Pluto. I approached the problem by converting the ratios to logarithms, obtaining ranges that were much more practical.

For this version, I set the pitch of each planet's representative note[3] as a function of its mass relative to Jupiter = A110. The orbital period of Mercury (four beats in 4/4 time; 2.67 seconds at 90 beats per minute) serves as the basis for timing of musical "orbits" in bars (or in seconds). One orbit is defined audibly as one complete cycle of increasing and diminishing amplitude and one complete cycle of rising and falling pitch around the fundamental. To make the range of orbital periods more obvious, I square $\left[1 + log\left({P_n}/{P_{Mercury}}\right)\right]$, where P_n is the planet's orbital period in days). In the case of Pluto, the ratio becomes 16:1, rather than 4:1.



[1] Mass and orbital period are just two of many candidates for musical representation. And neither one was used by Kepler in his *Music of the Spheres*. Kepler also noted that "here the moon also has a place"—but not in my calculations. The sun is a low C drone at about 32 Hz.

[2] For "old time's sake" I include Pluto in my list, fully acknowledging the arguments for demoting it a representative Kuiper Belt object.

[3] I had intended to make the oscillations above and below the fundamental pitch (in "cents") more deterministic (e.g., proportional to mass, to number of moons, to … whatever). However, they are arbitrary and merely reflect the same modulation curves as note amplitudes. If I ever get a handle on the many opcodes available in Csound, perhaps I can come up with results that are far more exact.

A Little Trivia About Planetary Alignment

- According to astronomers (ya know: actual science people), the alignment of the planets has no observable effects on Earth or on us. Sounds good to me.
- The planets never form up in a perfectly straight line. A margin of thirty degrees is about the closest that they get. The last time they all lined up within thirty degrees of each other was in 561 BCE. The next such alignment is forecast for 2,854 CE. That's an interval of 3,415 years.[4] Guess I'll have to miss it.
- Given the wildly atypical orbit of Pluto, it's surprising that they line up at all.
- My "musical" depiction begins with all planets in virtual alignment (disregarding the fade-in and fade-out, that is) and runs for 15.8 minutes or so, equivalent to just over 135 "Earth years."
- This MP3 is 28 MB at 256kbps. At seven seconds per virtual Earth orbit, 3,415 years would play out in about 6.64 hours—a 706 MB MP3. Think I'll give that a pass.

Derivation of Performance Attributes

	MERCURY	VENUS	EARTH	MARS	JUPITER	SATURN	URANUS	NEPTUNE	PLUTO
Mass (10^{24}kg)	0.33	4.87	5.97	0.642	1898	568	86.8	102	0.0146
Orbital Period (days)	88	224.7	365.2	687	4331	10,747	30,589	59,800	90,560
	MERCURY	VENUS	EARTH	MARS	JUPITER	SATURN	URANUS	NEPTUNE	PLUTO

Calculating the fundamental note for each planet as a function of its relative mass, with Jupiter assigned the lowest pitch (110 Hz) and Pluto assigned the highest (about 2 kHz). Note that the ratio of Jupiter's mass to Pluto's (130,000:1) is impractically large for audio, so I used $\log_e$ to scale the various pitches. Note also the large interval between the notes for Jupiter and Saturn (better than a twelfth).

	MERCURY	VENUS	EARTH	MARS	JUPITER	SATURN	URANUS	NEPTUNE	PLUTO
Ratio of Jovian mass to the mass of each planet	5,751.515	389.733	317.923	2,956.386	1.000	3.342	21.866	18.608	130,000.000
$\log_e$ of the above	8.35	5.75	5.56	7.71	0.00	1.16	2.98	2.82	11.36
ratio of logarithm above to that of Pluto (the highest note)	74%	51%	49%	68%	0%	10%	26%	25%	100%
*above ratio of two logarithms x mass of Jupiter in Kg * 10^{24}*	1395	962	929	1288	0	194	497	471	1898
	The quantities above are summed with 110 Hz, the fundamental note for Jupiter. Note that the offset for Jupiter is, naturally enough, zero, and the largest offset in Hz is for Pluto, the least massive "planet."								
add above to 110 Hz (the note for Jupiter)	1505 Hz	1072 Hz	1039 Hz	1398 Hz	110 Hz	304 Hz	607 Hz	581 Hz	2008 Hz
closest frequency to a note in the tempered scale	1480 Hz	1047 Hz	988 Hz	1400 Hz	110 Hz	300 Hz	588 Hz	554 Hz	1988 Hz

[4] These dates from Cornell University: http://curious.astro.cornell.edu/about-us/57-our-solar-system/planets-and-dwarf-planets/orbits/246-when-was-the-last-time-all-9-planets-were-aligned-beginner

Calculating the length of a single cycle of oscillating amplitude and note frequency as a function of orbital period. Note that the actual ratio of Pluto's orbit to Mercury's (1029.1:1) is impractically large for audio, so I used $\log_{10}$ of each ratio.

	MERCURY	VENUS	EARTH	MARS	JUPITER	SATURN	URANUS	NEPTUNE	PLUTO
Ratio to orbital period with respect to Mercury	1	2.553	4.15	7.807	49.216	122.125	347.602	679.545	1029.090
$\log_{10}$ of the above	0	0.407	0.618	0.892	1.692	2.087	2.541	2.832	3.0124
(1 + logarithm above)^2; to make ratios more audible	1	1.98	2.618	3.580	7.249	9.530	12.539	14.684	16.100
"orbits" during one orbit of Pluto	16.10	8.13	6.15	4.50	2.22	1.69	1.29	1.10	1.00
duration of a single orbit in beats, based on 4 beats per single orbit of Mercury	4.00	7.95	10.47	14.32	29.00	38.12	50.16	58.74	64.40
duration of a single orbit in seconds at 90 beats per minute.	2.67	5.30	6.98	9.55	19.33	25.41	33.44	39.16	42.93

JE, 03/08/17