

# BABYLONIAN Tonal System

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April 16, 2016

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## Abstract

Proposal for the BABYLONIAN Tonal System, based on consecutive heptachords.<sup>1</sup>

**Keywords.** Ancient MESOPOTAMIAN music, Old BABYLONIAN music, MESOPOTAMIA, BABYLON, UR, SUMER, AKKADIAN, 1800 BCE to 500 BCE, Sexagesimal arithmetic and numbers, Musical cuneiform tablets, Seven diatonic Heptachords, Tuning system.

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<sup>\*</sup>Initial release of this manuscript: August 22, 2014.

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<sup>‡</sup>Revised version.

<sup>1</sup>Original research, based on [1] and an idea by composer CARL NIELSEN (1865-1931).

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## Part I

# Heptachords and Scales

## 1 Introduction

### 1.1 Heptachords

Table 1: Heptachords

	Heptachord	Pattern	Scales	Symmetric Center
1	<i>išartum</i>	$[1, \frac{1}{2}, 1, 1, 1, \frac{1}{2}]$	2	G
2	<i>embūbum</i>	$[\frac{1}{2}, 1, 1, 1, \frac{1}{2}, 1]$	2	A
3	<i>kitmum</i>	$[1, \frac{1}{2}, 1, 1, \frac{1}{2}, 1]$	2	D
4	<i>pītum</i>	$[\frac{1}{2}, 1, 1, \frac{1}{2}, 1, 1]$	2	E
5	<i>qablītum</i>	$[1, 1, \frac{1}{2}, 1, 1, \frac{1}{2}]$	2	C
6	<i>nīš tuḥrim</i>	$[1, 1, \frac{1}{2}, 1, 1, 1]$	1	F
7	<i>nīd qablim</i>	$[1, 1, 1, \frac{1}{2}, 1, 1]$	1	B

2

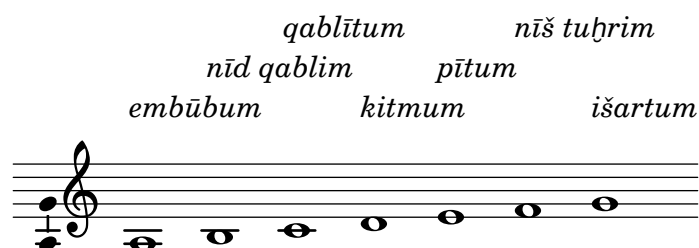


Figure 1: Symmetric Center

<sup>2</sup> Rising Scale.

Table 2: Heptachords II

	Heptachord	Keys per Scale	Key Signature $\Delta$	Sum $\Sigma$
1	<i>išartum</i>	6	2	12
2	<i>embūbum</i>	6	2	12
3	<i>kitmum</i>	6	2	12
4	<i>pītum</i>	6	2	12
5	<i>qablītum</i>	6	2	12
6	<i>nīš tuḫrim</i>	12	5	60
7	<i>nīd qablim</i>	12	5	60

1: 𐎶

2: 𐎶

5: 𐎶

6: 𐎶

12: 𐎶

60: 𐎶 ANU

**Example.** Consecutive Heptachords.<sup>3,4</sup>

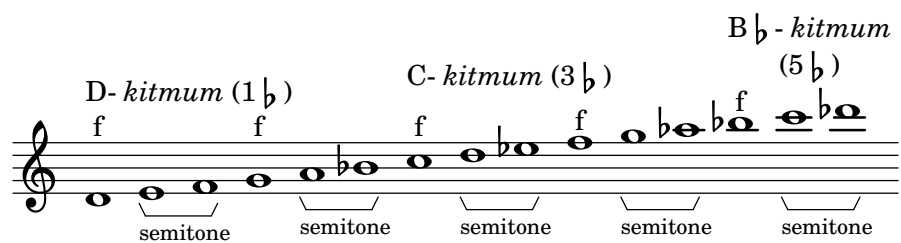


Figure 2: Consecutive *kitmum* Heptachords

<sup>3</sup> From the main theme of CARL NIELSEN *Symphony No. 5* CNW 29 (1922).

<sup>4</sup> Flatward shift for higher pitches.

## 1.2 Scale Range

Table 3: Scale Range

	Heptachord	Center	Semitones	Octaves	$i$ , Cent	Cent per semitone
1	<i>išartum</i>	G	60	5	6000	100
2	<i>embūbum</i>	A	60	5	6000	100
3	<i>kitmum</i>	D	60	5	6000	100
4	<i>pītum</i>	E	60	5	6000	100
5	<i>qablītum</i>	C	60	5	6000	100
6	<i>nīš tuḫrim</i>	F	120	10	12000	100
7	<i>nīd qablim</i>	B	120	10	12000	100

**Definition.** Cent per octave: 1200.

**Definition.** Cent per semitone: 100, Equal temperament (12-TET<sup>5</sup> or 12-EDO<sup>6</sup>).

**Definition.** Scale Range:  $-3000 \dots 0$  (Center)  $\dots +3000$  Cent.<sup>7</sup>

**Theorem.** *The 7 Heptachords of the Babylonian Tonal System are based on an Equal Temperament system.*

<sup>5</sup> Twelve-tone equal temperament.

<sup>6</sup> Equal division of the octave.

<sup>7</sup> Semitone:  $i \leftarrow i + 100$ ,  $i \leftarrow i - 100$ . Whole tone:  $i \leftarrow i + 200$ ,  $i \leftarrow i - 200$ .

### 1.3 Scale Cycle

Table 4: Scale Cycle

	Heptachord	Center	+3000 Cent	−3000 Cent
1	<i>išartum</i>	G	D $\flat$	C $\sharp$
2	<i>embūbum</i>	A	E $\flat$	D $\sharp$
3	<i>kitmum</i>	D	A $\flat$	G $\sharp$
4	<i>pītum</i>	E	B $\flat$	A $\sharp$
5	<i>qablītum</i>	C	G $\flat$	F $\sharp$

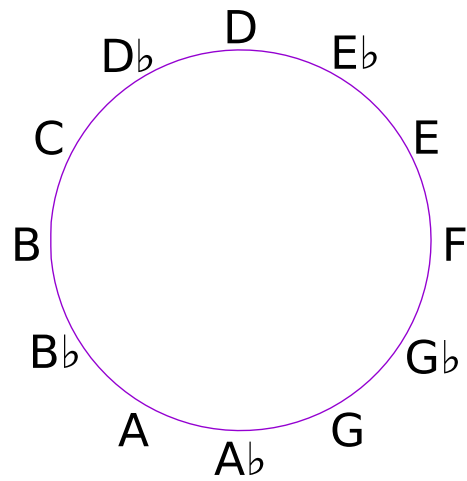


Figure 3: Tone Circle

## 1.4 Tuning

**Conjecture.** *Equal Temperament Tuning Procedure.*

Table 5: Tuning

	Heptachord	Center	$i$ , Cent	$f$ , Hz
1	<i>išartum</i>	G4	+500	
2	<i>embūbum</i>	A3	−500	220
3	<i>kitmum</i>	D4	0	
4	<i>pītum</i>	E4	+200	
5	<i>qablītum</i>	C4	−200	
6	<i>nīš tuḥrim</i>	F4	+300	
7	<i>nād qablim</i>	B3	−300	

8

**Definition.** Tuning Range: −500 ... 0 ... +500 Cent.

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<sup>8</sup> Center in Scientific Pitch Notation.



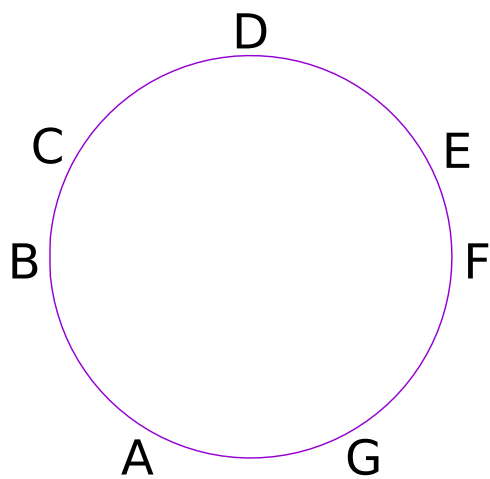


Figure 4: Tuning

## 2 *išartum*

$[1, \frac{1}{2}, 1, 1, 1, \frac{1}{2}]$

### 2.1 Scale 1

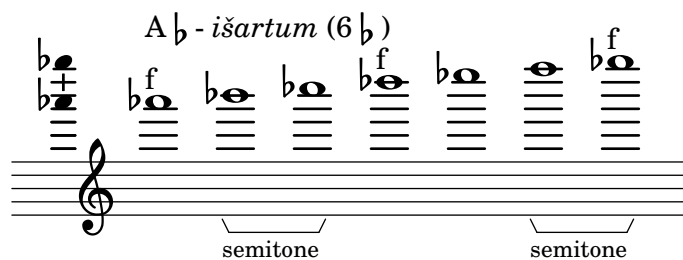


Figure 5: Scale I

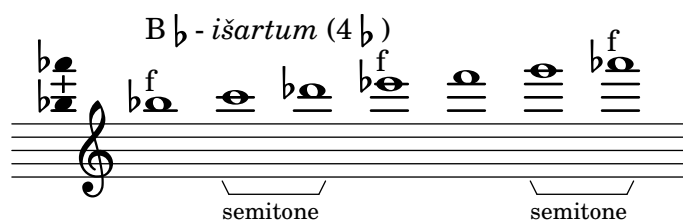


Figure 6: Scale II

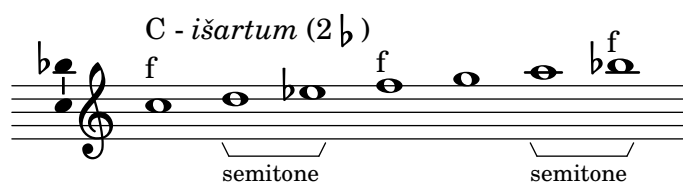


Figure 7: Scale III

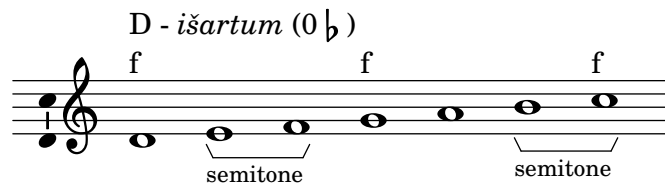


Figure 8: Scale IV

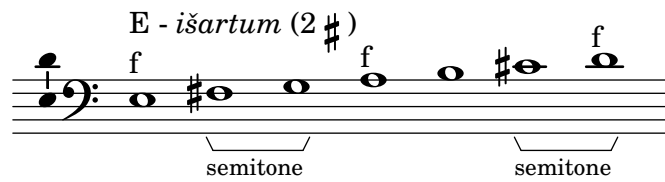


Figure 9: Scale V

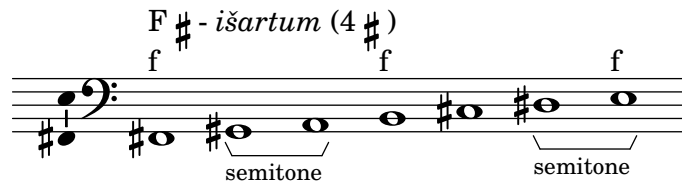


Figure 10: Scale VI

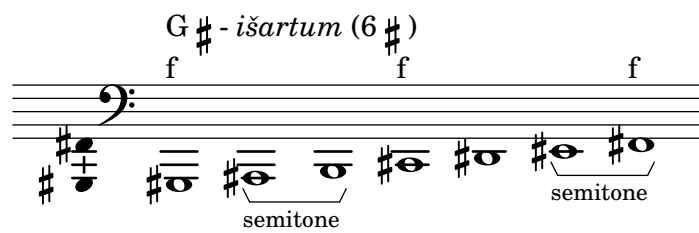


Figure 11: Scale VII

## 2.2 Scale 2

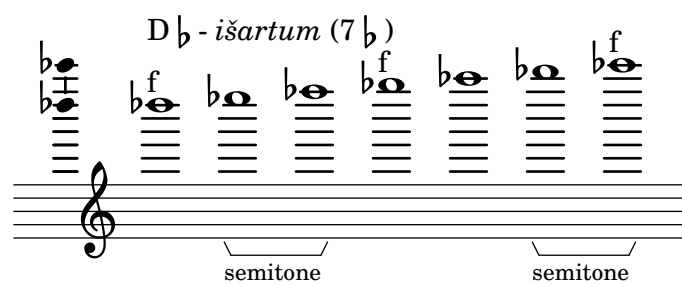


Figure 12: Scale I

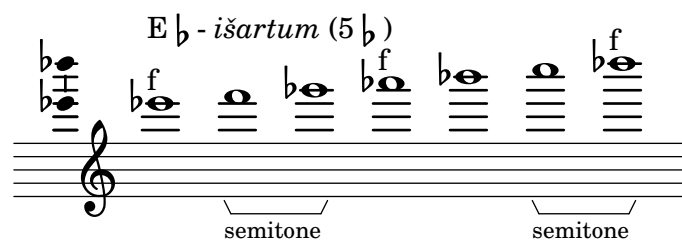


Figure 13: Scale II

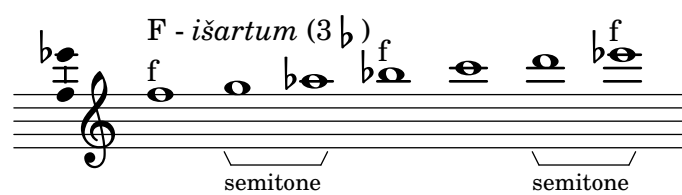


Figure 14: Scale III

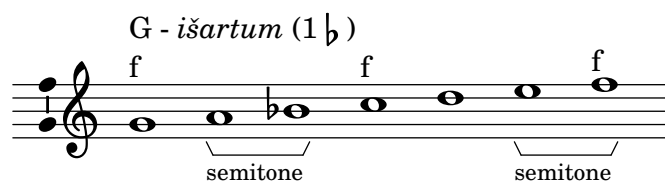


Figure 15: Scale IV

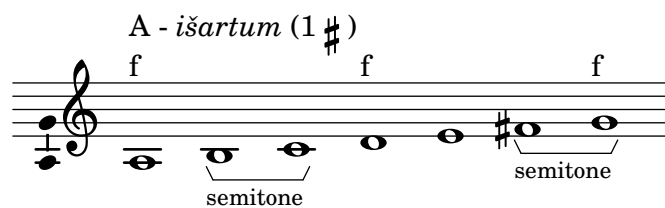


Figure 16: Scale V

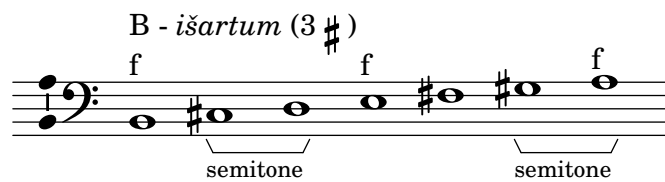


Figure 17: Scale VI

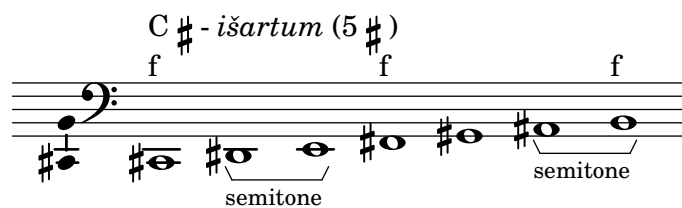


Figure 18: Scale VII

### 3 *embūbum*

$[\frac{1}{2}, 1, 1, 1, \frac{1}{2}, 1]$

#### 3.1 Scale 1

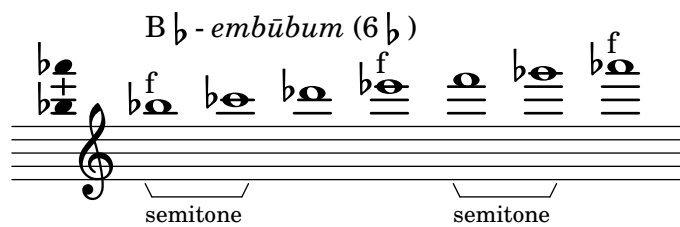


Figure 19: Scale I

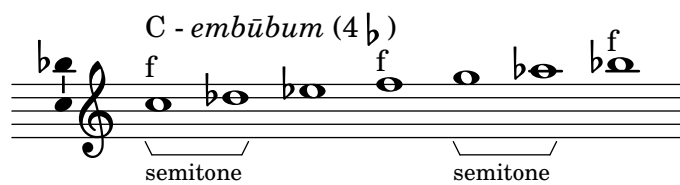


Figure 20: Scale II

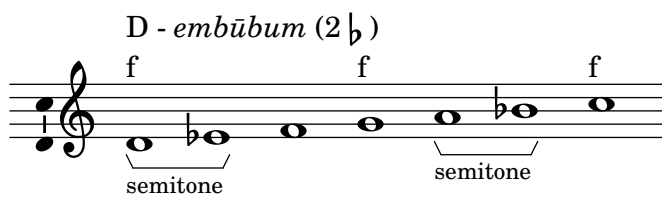


Figure 21: Scale III

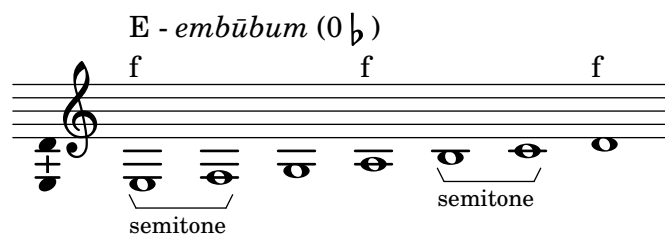


Figure 22: Scale IV

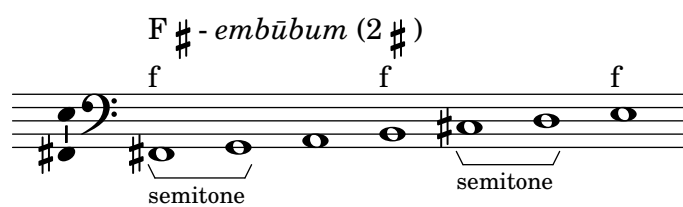


Figure 23: Scale V

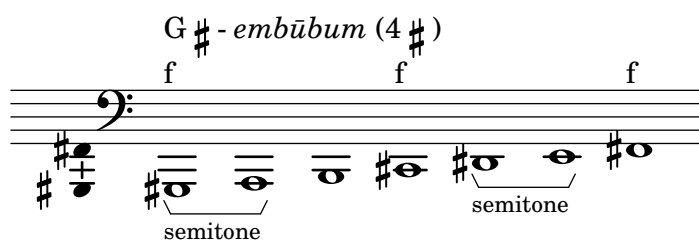


Figure 24: Scale VI

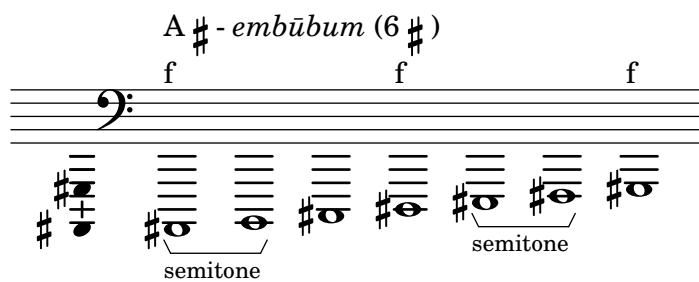


Figure 25: Scale VII

### 3.2 Scale 2

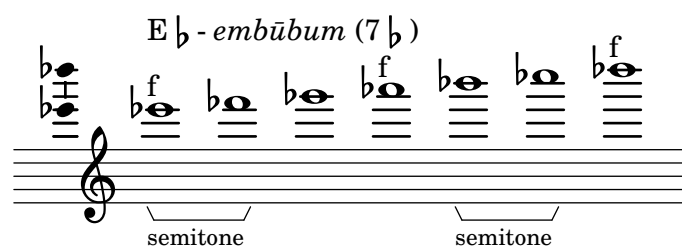


Figure 26: Scale I

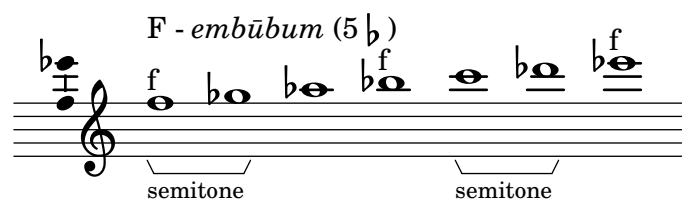


Figure 27: Scale II

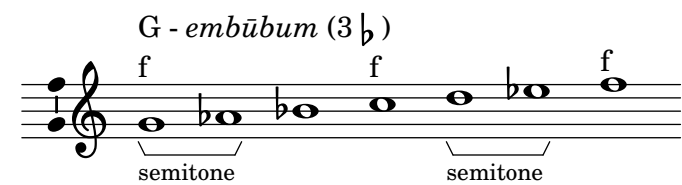


Figure 28: Scale III



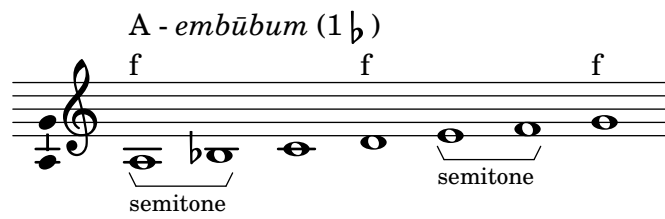


Figure 29: Scale IV

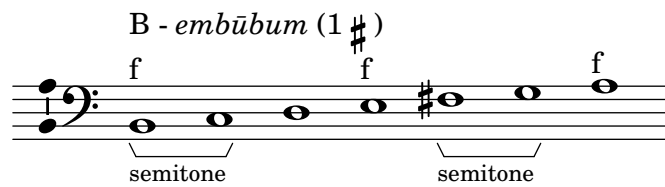


Figure 30: Scale V

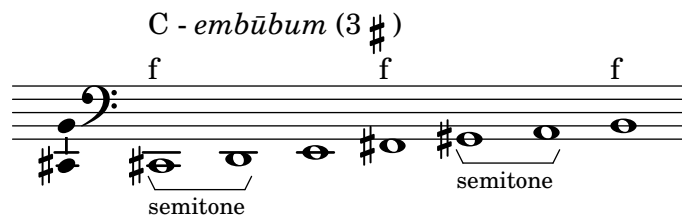


Figure 31: Scale VI

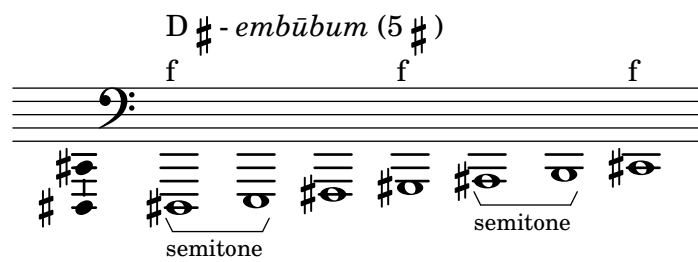


Figure 32: Scale VII

## 4 *kitmum*

$[1, \frac{1}{2}, 1, 1, \frac{1}{2}, 1]$

### 4.1 Scale 1

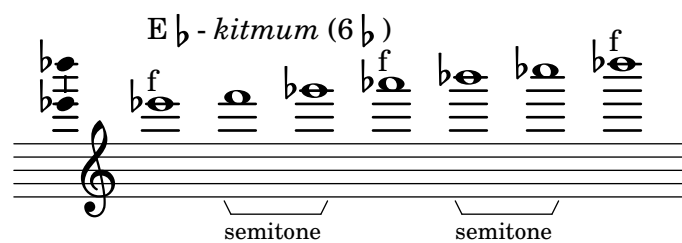


Figure 33: Scale I

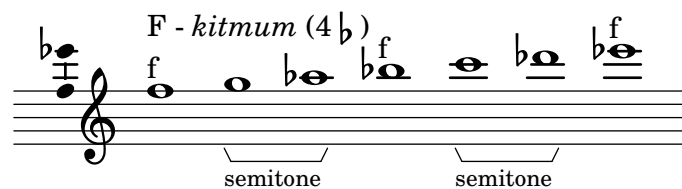


Figure 34: Scale II

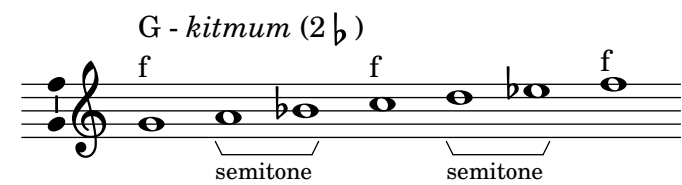


Figure 35: Scale III

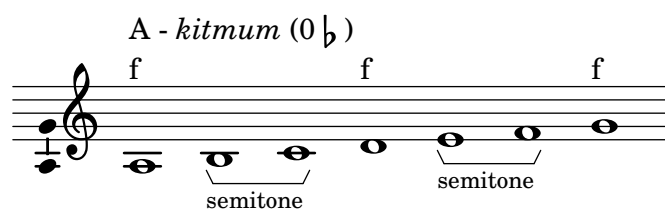


Figure 36: Scale IV

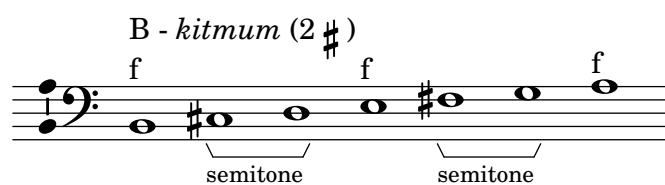


Figure 37: Scale V

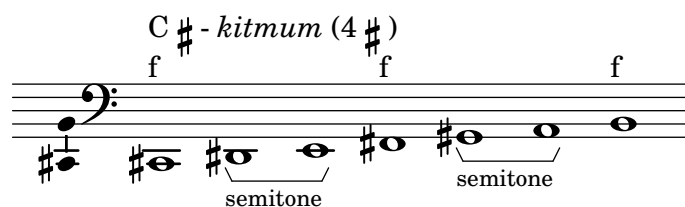


Figure 38: Scale VI

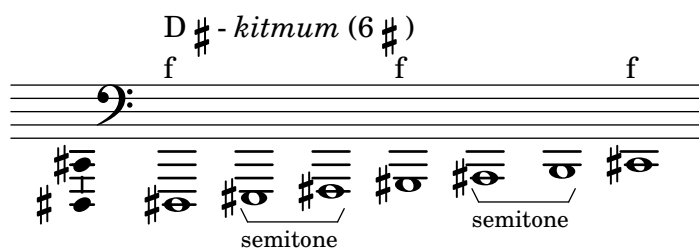


Figure 39: Scale VII

## 4.2 Scale 2

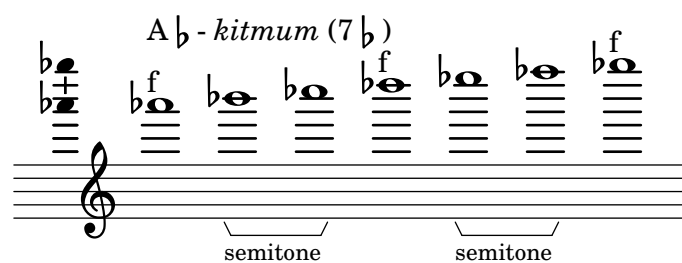


Figure 40: Scale I

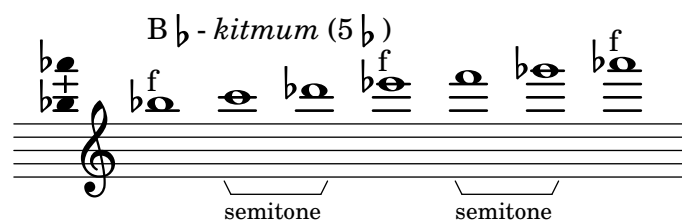


Figure 41: Scale II

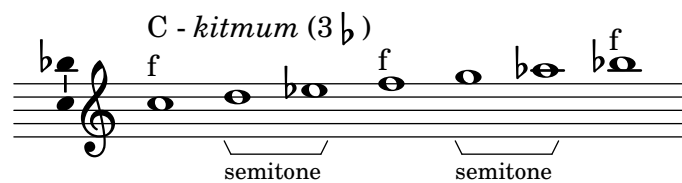


Figure 42: Scale III

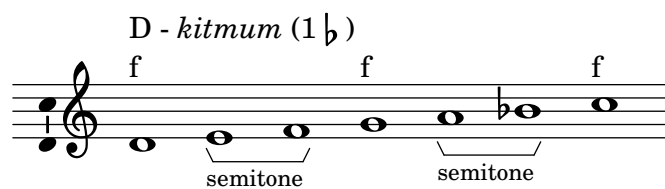


Figure 43: Scale IV

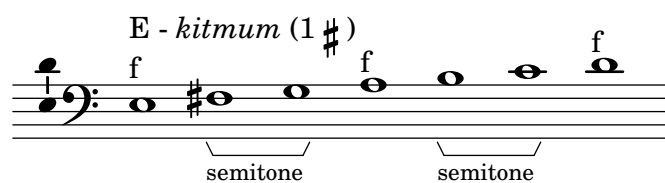


Figure 44: Scale V

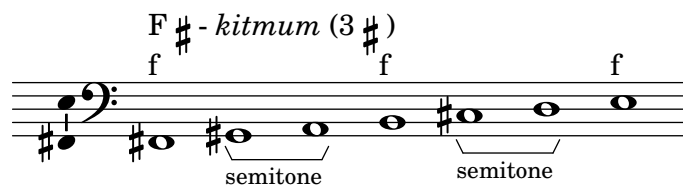


Figure 45: Scale VI

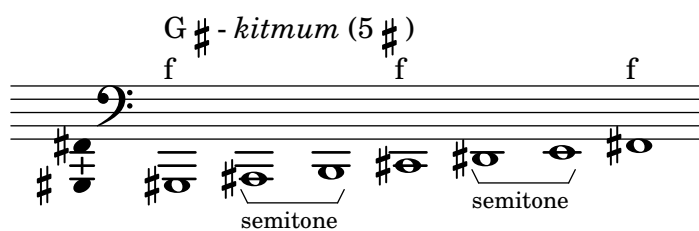


Figure 46: Scale VII

## 5 *pītum*

$[\frac{1}{2}, 1, 1, \frac{1}{2}, 1, 1]$

### 5.1 Scale 1

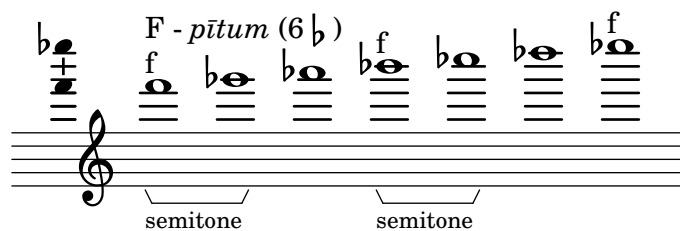


Figure 47: Scale I

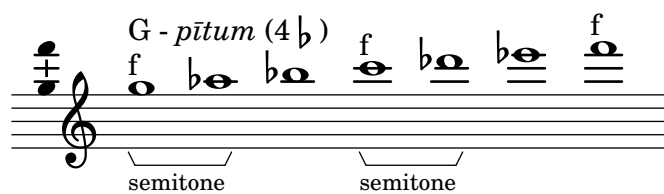


Figure 48: Scale II

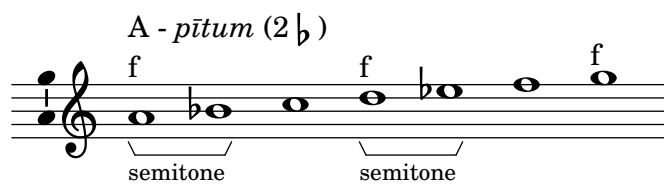


Figure 49: Scale III

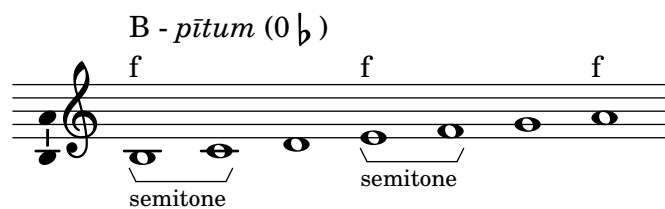


Figure 50: Scale IV

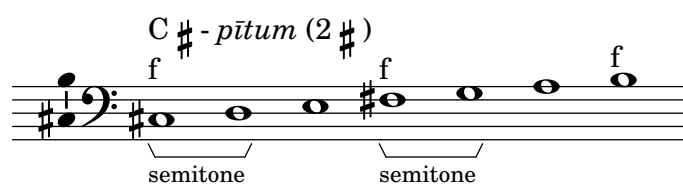


Figure 51: Scale V

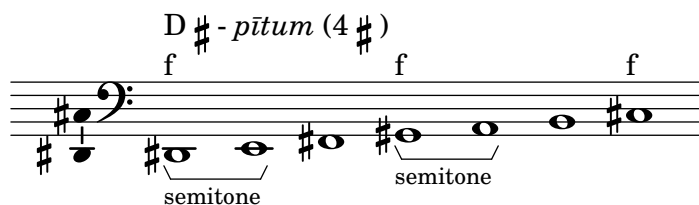


Figure 52: Scale VI

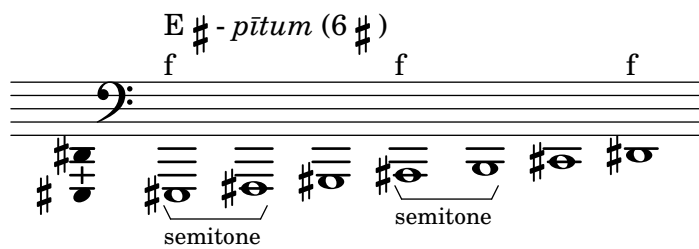


Figure 53: Scale VII

## 5.2 Scale 2

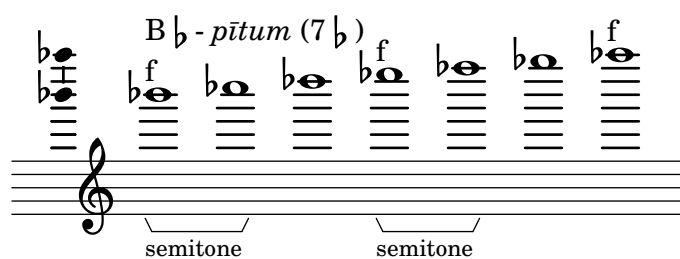


Figure 54: Scale II

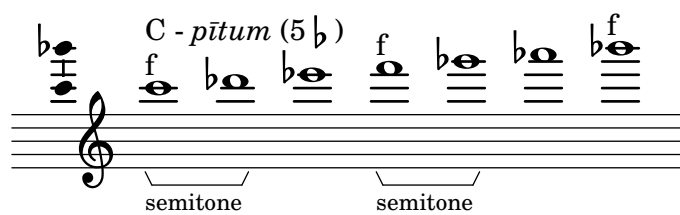


Figure 55: Scale II

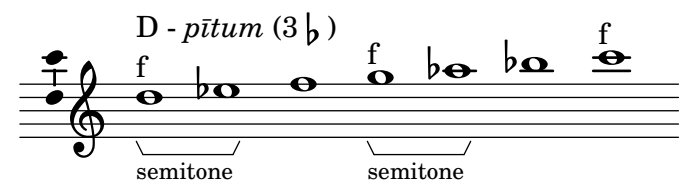


Figure 56: Scale III



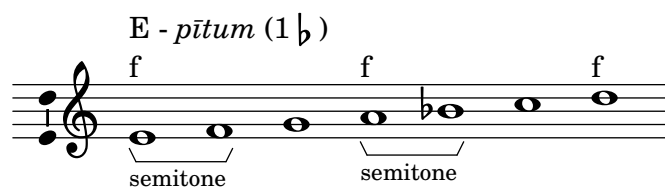


Figure 57: Scale IV

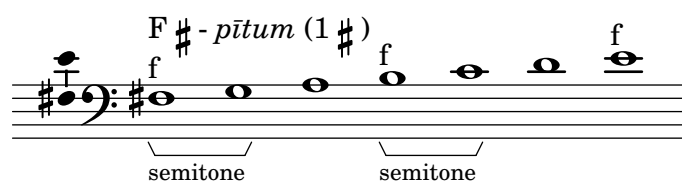


Figure 58: Scale V

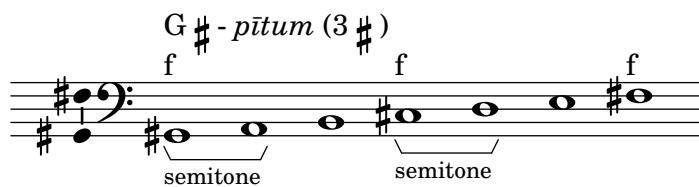


Figure 59: Scale VI

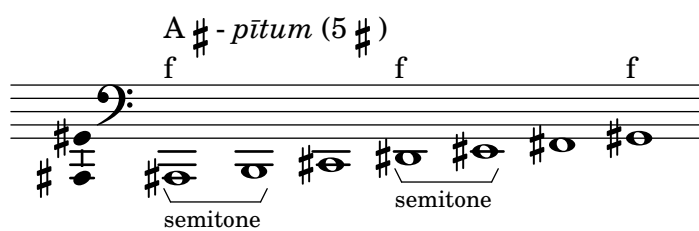


Figure 60: Scale VII

## 6 *qablītum*

$[1, 1, \frac{1}{2}, 1, 1, \frac{1}{2}]$

### 6.1 Scale 1

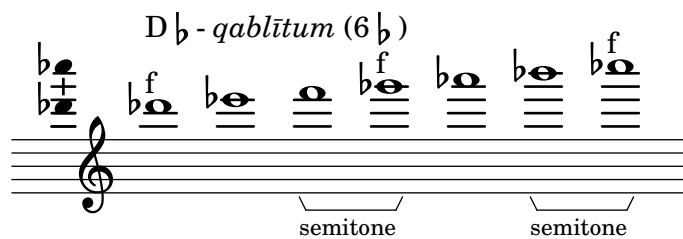


Figure 61: Scale I

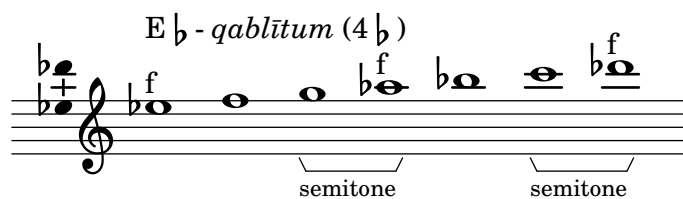


Figure 62: Scale II

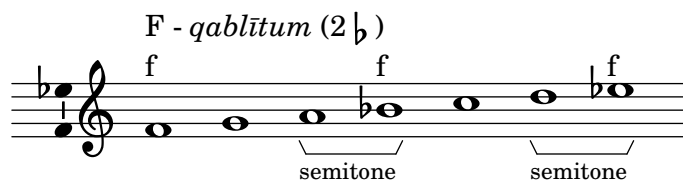


Figure 63: Scale III

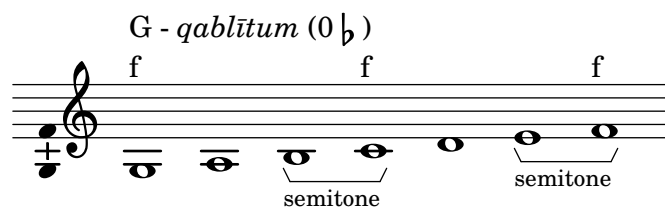


Figure 64: Scale IV

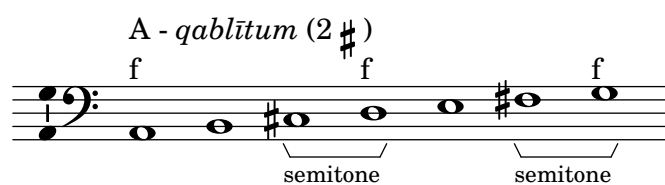


Figure 65: Scale V

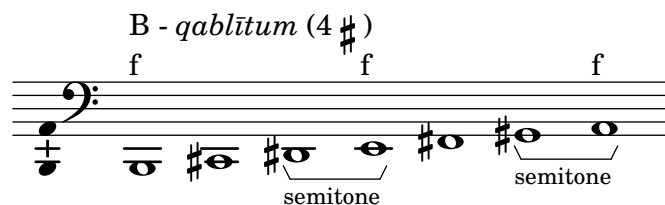


Figure 66: Scale VI

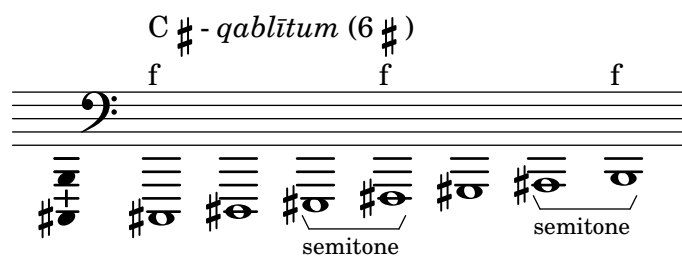


Figure 67: Scale VII

## 6.2 Scale 2

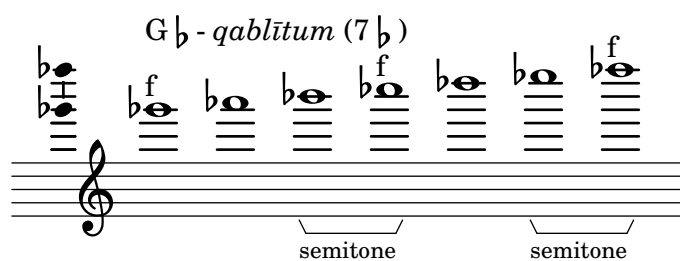


Figure 68: Scale I

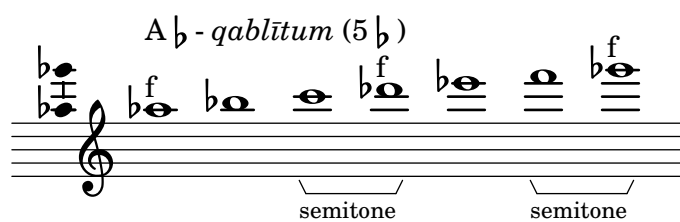


Figure 69: Scale II

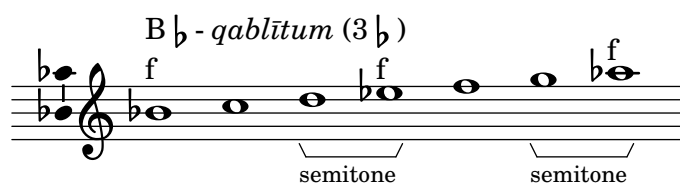


Figure 70: Scale III

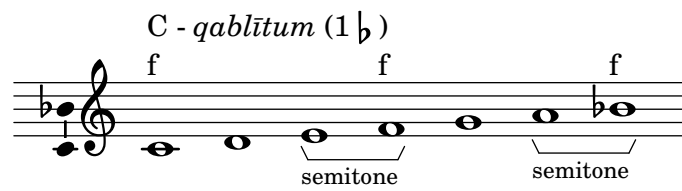


Figure 71: Scale IV

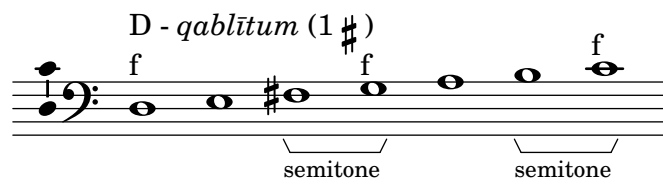


Figure 72: Scale V

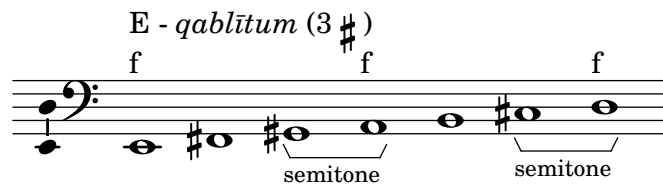


Figure 73: Scale VI

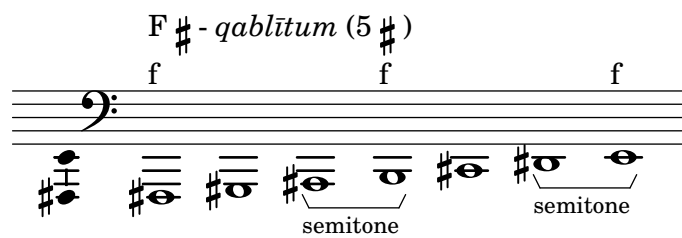


Figure 74: Scale VII

## 7 *nīš tuḥrim*

$[1, 1, \frac{1}{2}, 1, 1, 1]$

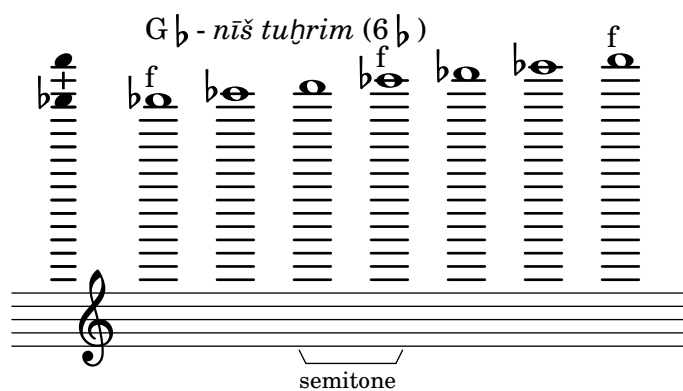


Figure 75: Scale I

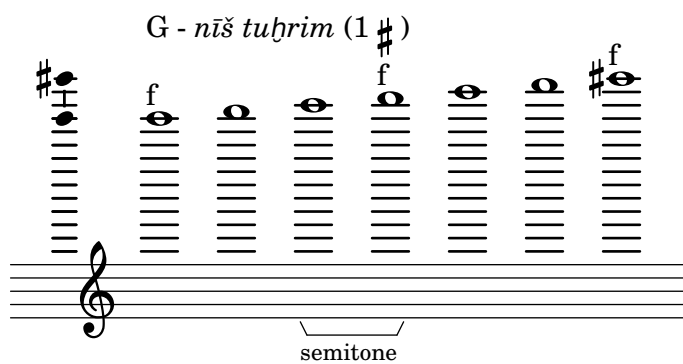


Figure 76: Scale II

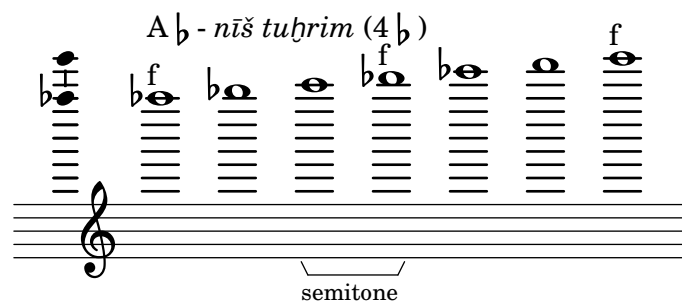


Figure 77: Scale III

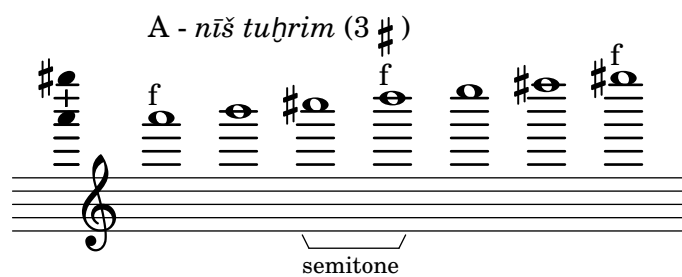


Figure 78: Scale IV

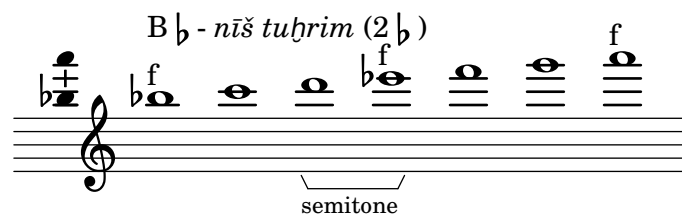


Figure 79: Scale V

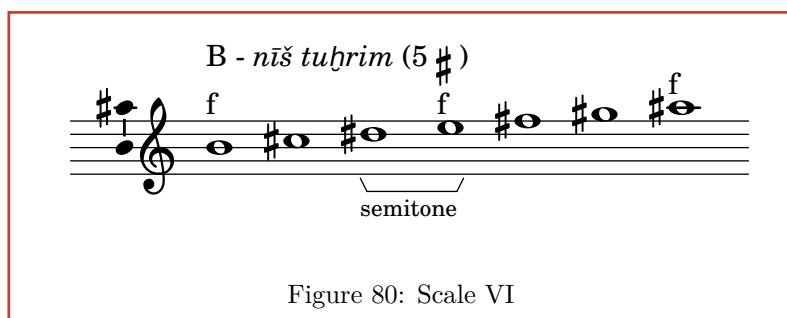


Figure 80: Scale VI

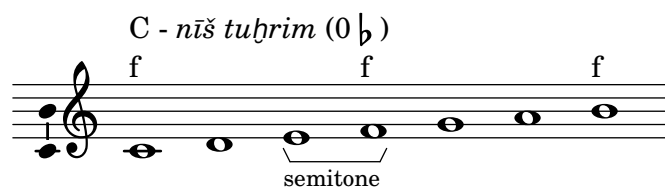


Figure 81: Scale VII

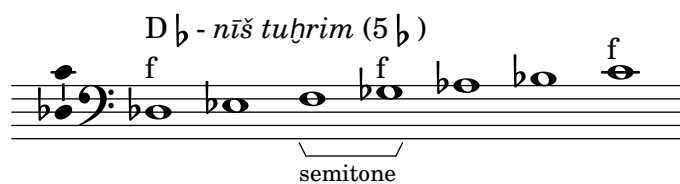


Figure 82: Scale VIII

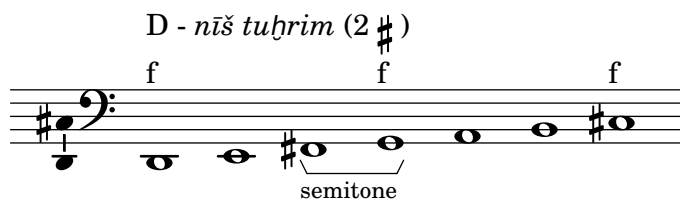


Figure 83: Scale IX

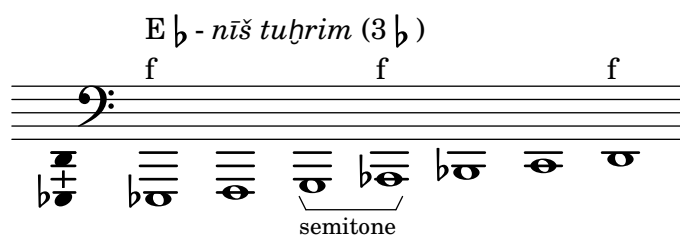


Figure 84: Scale X



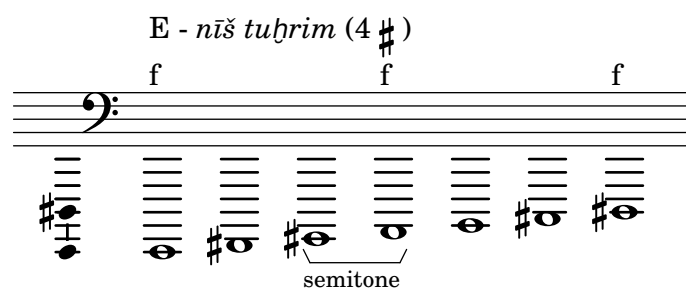


Figure 85: Scale XI

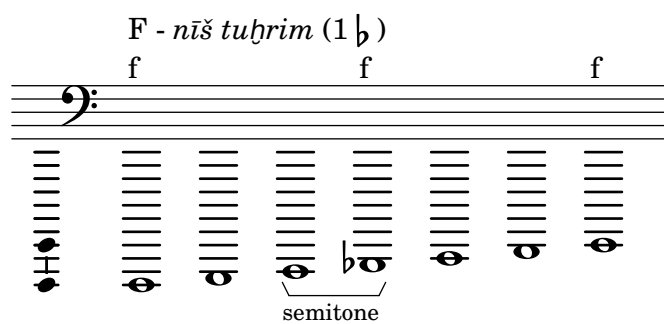


Figure 86: Scale XII

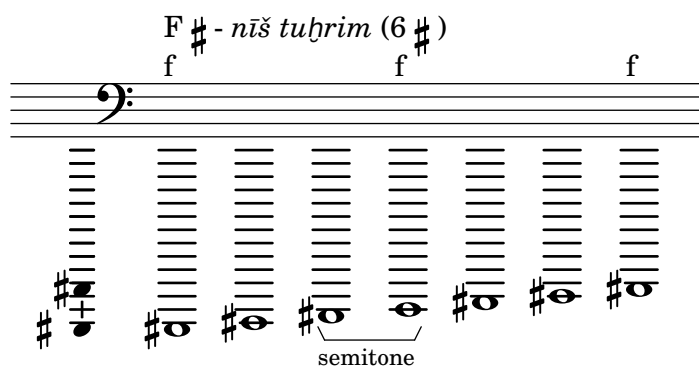


Figure 87: Scale XIII

## 8 *nīd qablim*

$[1, 1, 1, \frac{1}{2}, 1, 1]$

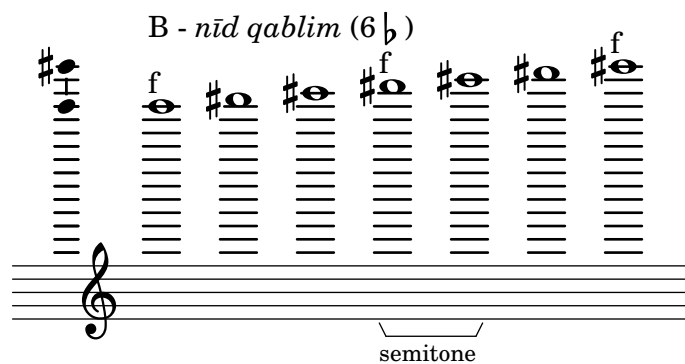


Figure 88: Scale I

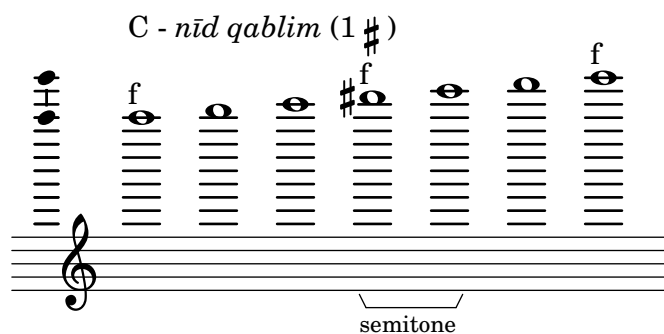


Figure 89: Scale II

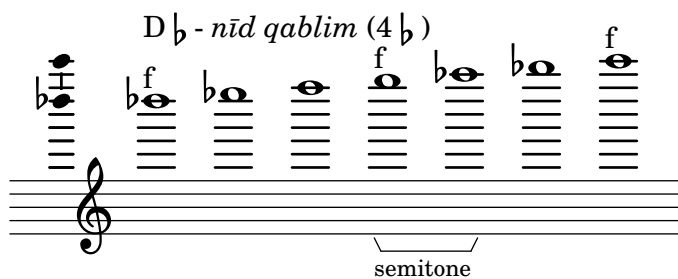


Figure 90: Scale III

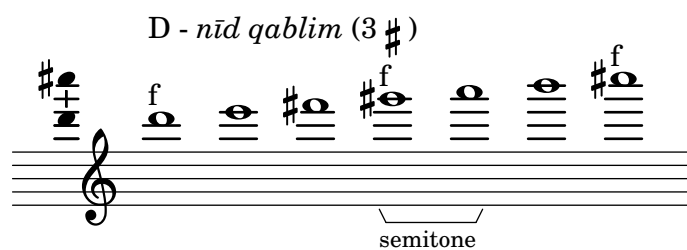


Figure 91: Scale IV

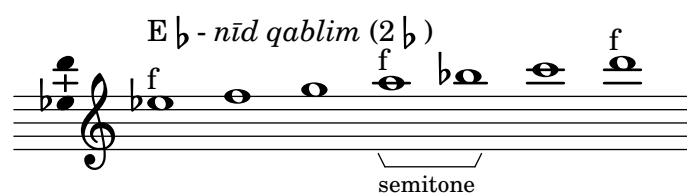


Figure 92: Scale V

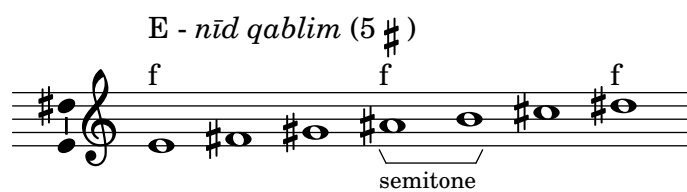


Figure 93: Scale VI

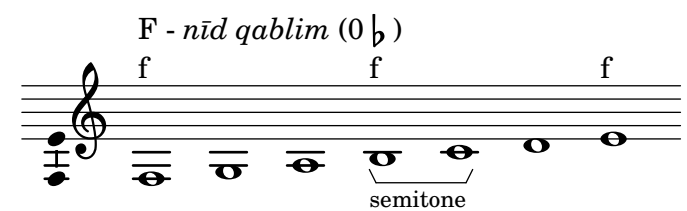


Figure 94: Scale VII

G  $\flat$  - *nīd qablim* (5  $\flat$ )

f f f

semitone

Figure 95: Scale VIII

G - *nīd qablim* (2  $\sharp$ )

f f f

semitone

Figure 96: Scale IX

A  $\flat$  - *nīd qablim* (3  $\flat$ )

f f f

semitone

Figure 97: Scale X

A - *nīd qablim* (4  $\sharp$ )

f f f

semitone

Figure 98: Scale XI

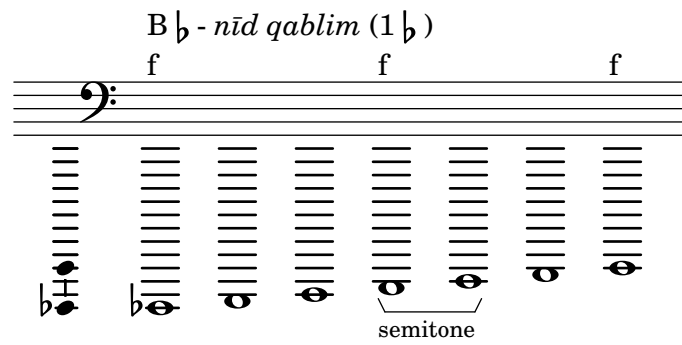


Figure 99: Scale XII

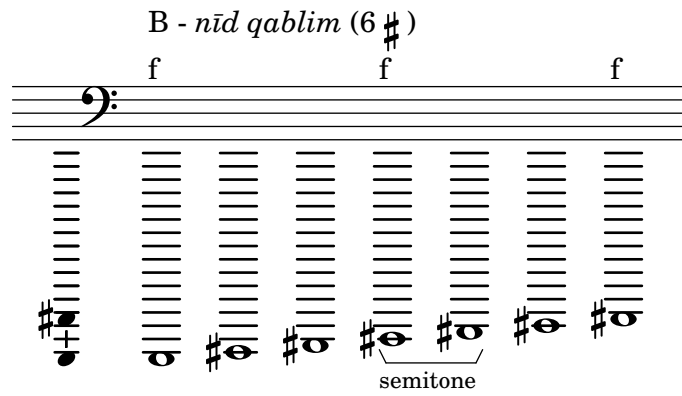


Figure 100: Scale XIII

## References

- [1] Leon Crickmore. New Light on the Babylonian Tonal System. In Richard Dumbrill and Irving Finkel, editors, *ICONEA 2008: Proceedings of the International Conference of Near Eastern Archaeomusicology*, volume 24, pages 11–22. Lulu, 2008. Held at the British Museum, December 4-6. [1](#)

## A Appendix

### A.1 ~~Octatonic~~ Scale

9

#### A.1.1 Scale 1

$[1, \frac{1}{2}, 1, \frac{1}{2}, 1, \frac{1}{2}]$ <sup>10</sup>

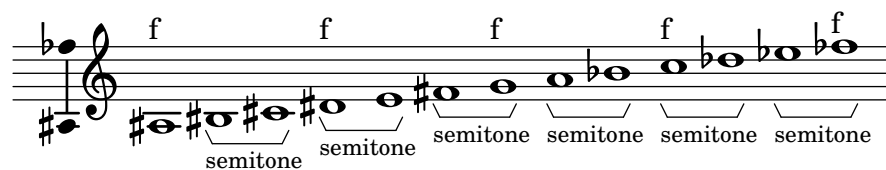


Figure 101: Scale 1, Center G

#### A.1.2 Scale 2

$[\frac{1}{2}, 1, \frac{1}{2}, 1, \frac{1}{2}, 1]$

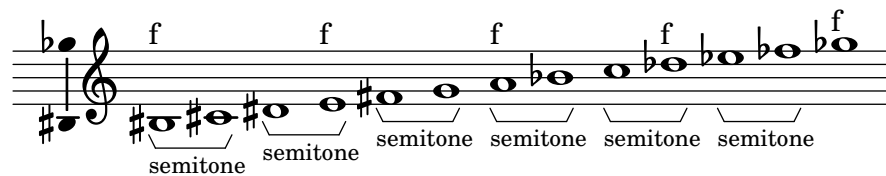


Figure 102: Scale 2, Center A

<sup>9</sup> Derived from CARL NIELSEN *Symphony No. 5* CNW 29.

<sup>10</sup> OLIVIER MESSIAEN's *second mode* of limited transposition.

## A.2 Plots

### A.2.1 Heptachords

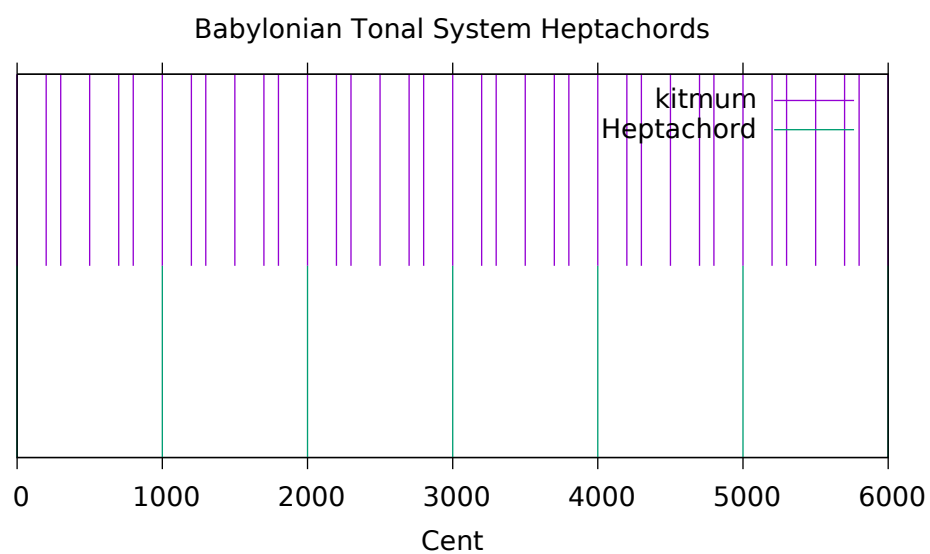


Figure 103: *kitnum* vs. Heptachord



### A.2.2 Octaves

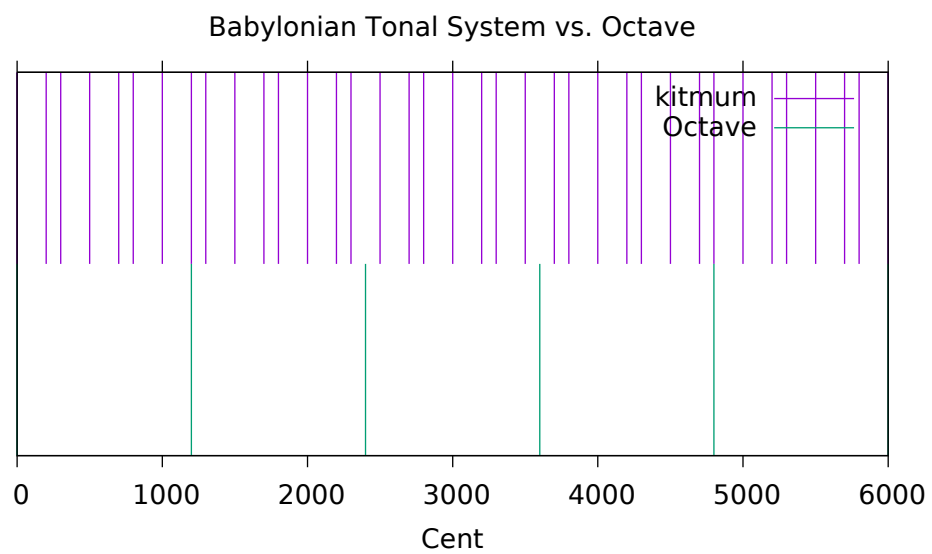


Figure 104: *kitnum* vs. Octave