Musical Acoustics
Harmonic Analysis and Instrument Modeling

Music Technology Laboratory

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Abstract

Computational analysis of musical acoustics including harmonic series, string vibrations, wind instrument resonances, and psychoacoustic phenomena.

1 Introduction

Musical instruments produce sound through vibrating systems generating harmonic spectra.

2 Harmonic Series

$f_n = nf_1$

Figure 1: Harmonic series for 110 Hz fundamental.

3 String Vibration Modes

Figure 2: String vibration mode shapes.

4 Waveform Synthesis

Figure 3: Musical waveform types.

5 Spectral Analysis

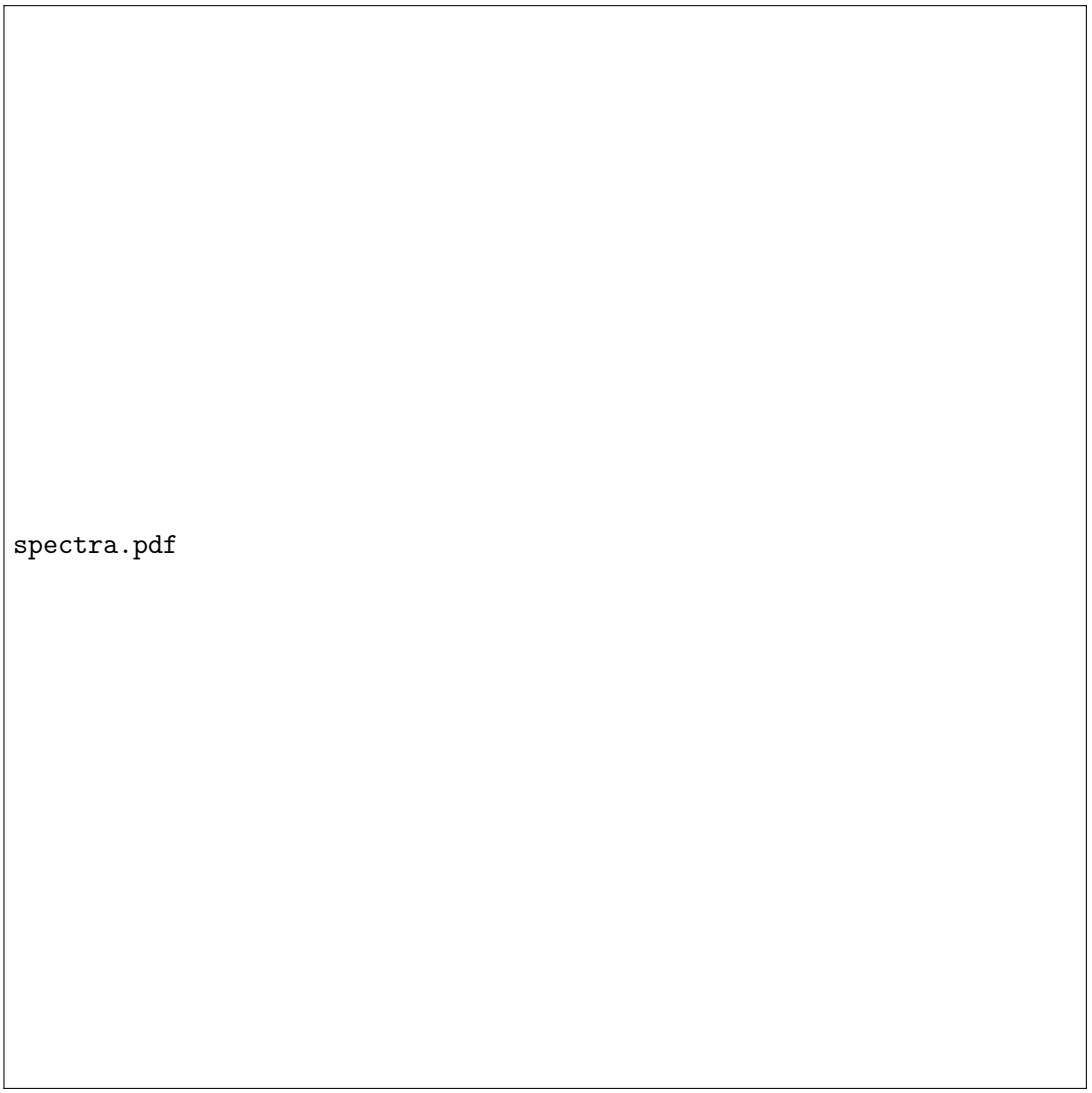

Figure 4: Frequency spectra showing harmonic content.

6 Pipe Resonances

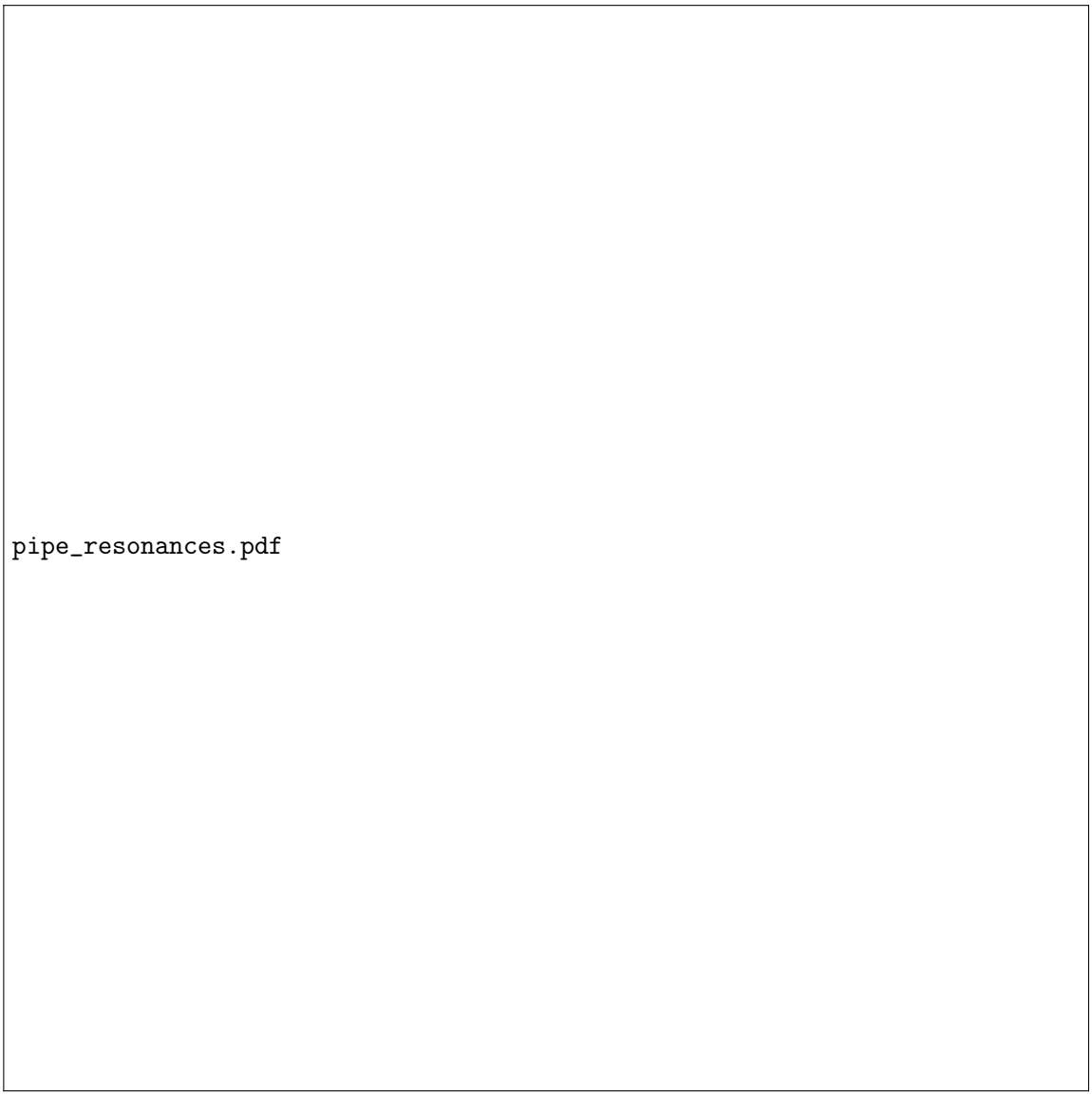

Figure 5: Pipe resonance frequencies.

7 Beating Phenomenon

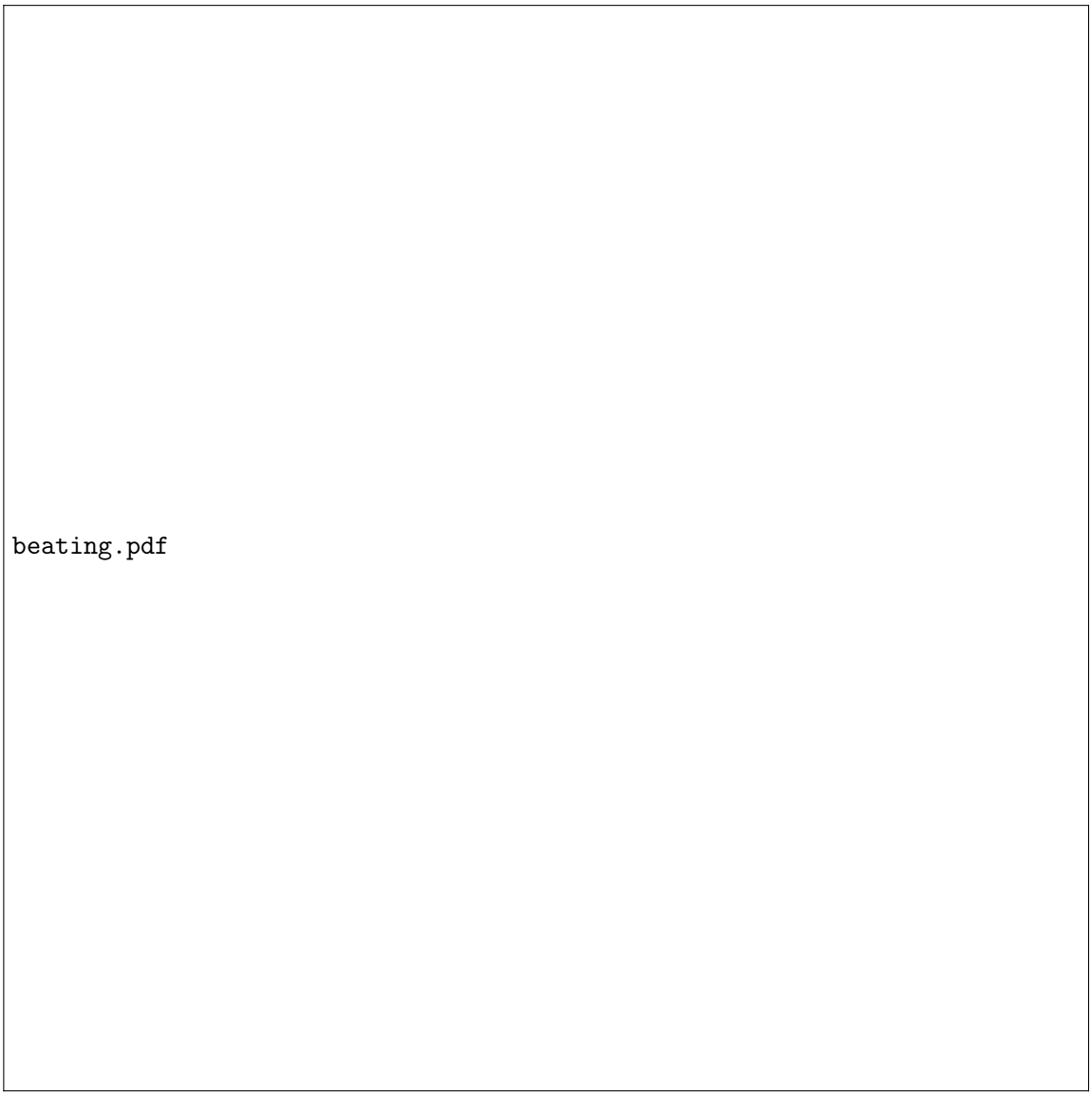

Figure 6: Beating with **??** Hz beat frequency.

8 Tuning Systems

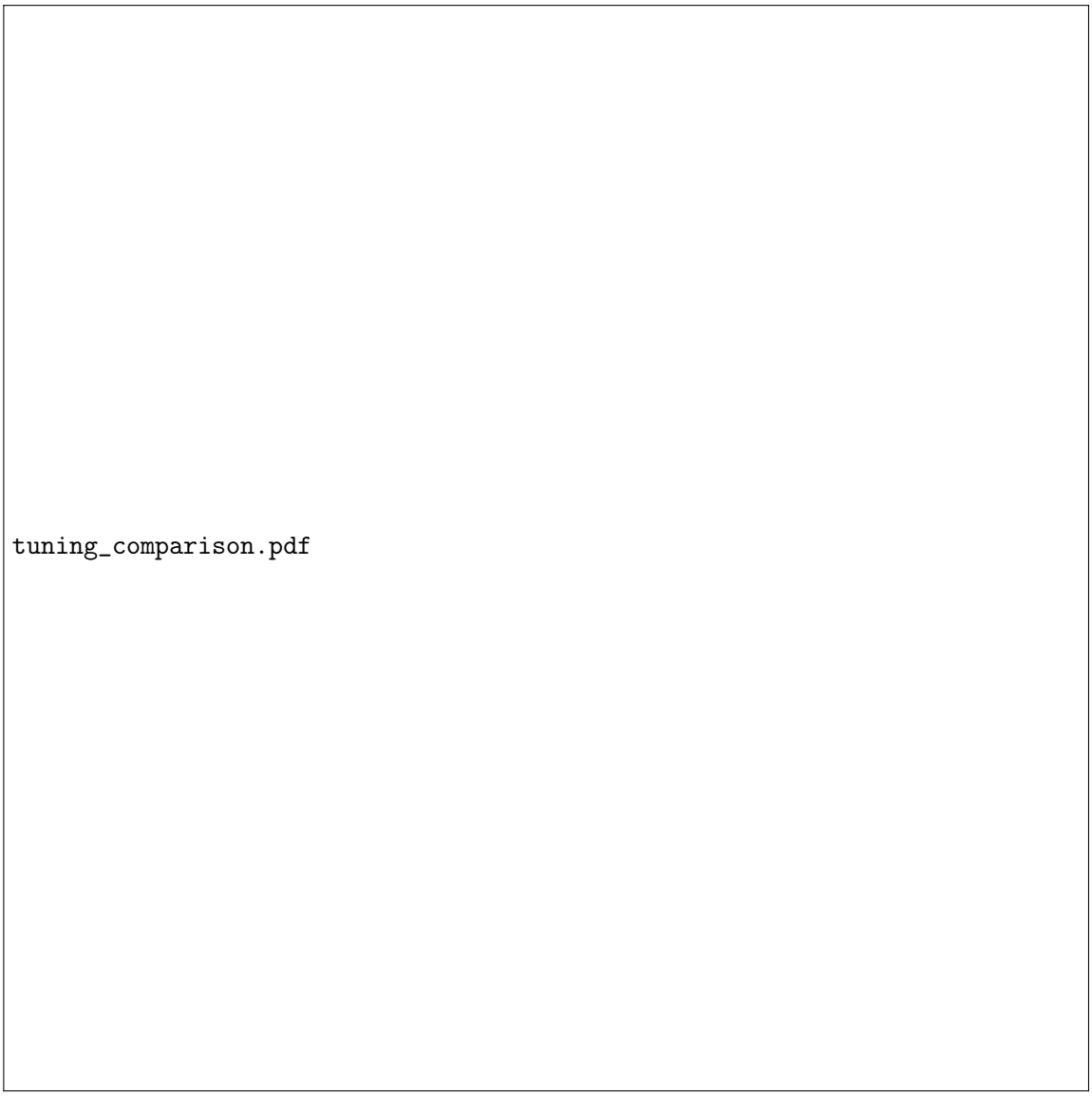

Figure 7: Tuning system comparison.

9 ADSR Envelope

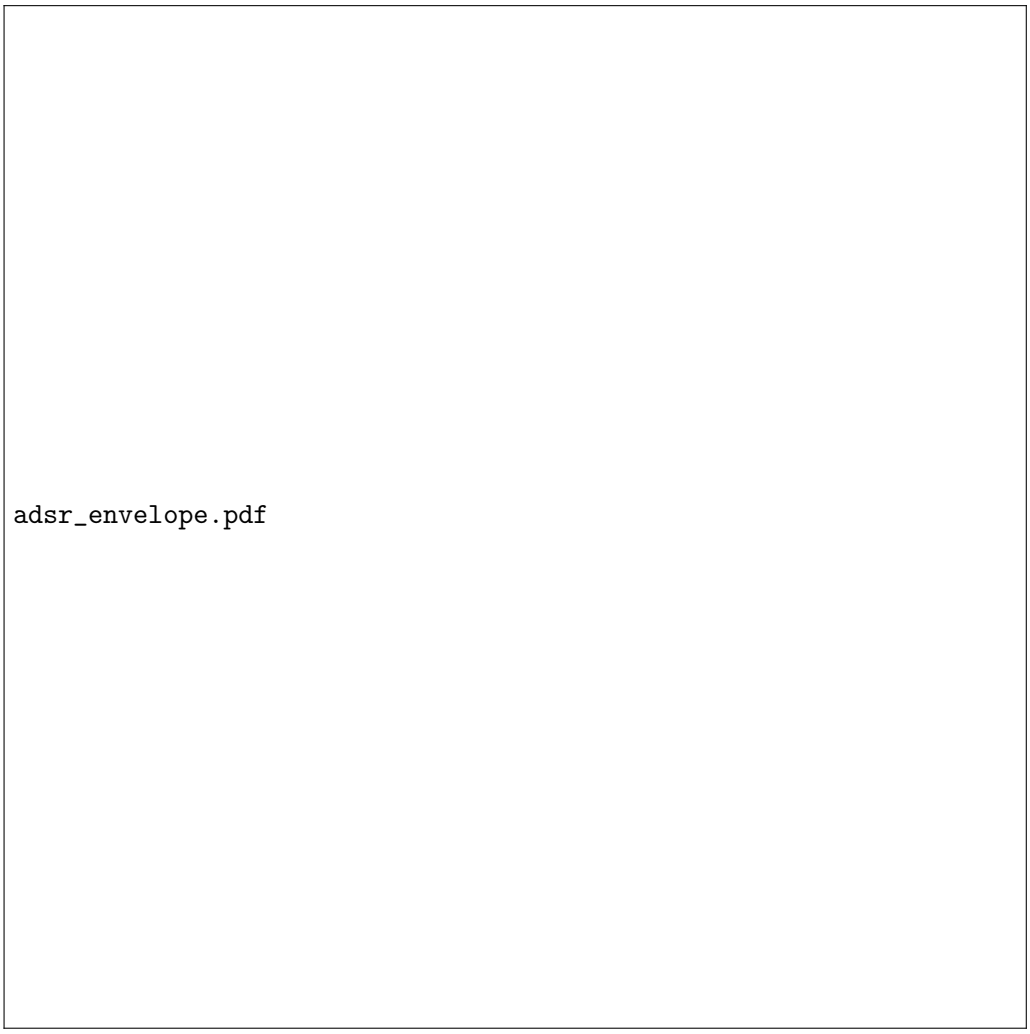

Figure 8: ADSR amplitude envelope.

10 Results

11 Conclusions

This analysis covers fundamental musical acoustics including harmonic generation, vibration modes, and tuning systems.