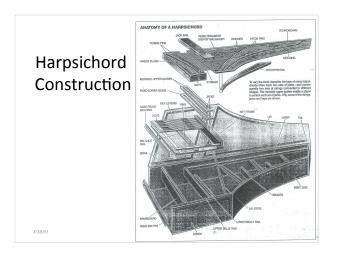
Physics of Musical Sound

Class 16
Class in Wellin Monday
Quiz Wednesday.
NO HOMEWORK next week
Exam after break!

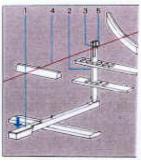
/30/01 Physics 120



Harpsichord



Harpsichord Action



8/30

The Harpsichord

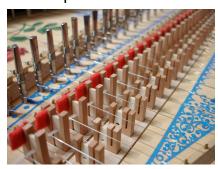
- Wire strings on a wood frame plucked by tiny, sharp quills called Jacks.
- · Classically 4 octave manual
 - May sound 5 octaves due to "short octave"
 - Lowest note 32 times wavelength of highest!
- Wire diameters increase from eg. .008" to 0.024".
 - Usually switch roughly every octave
 - Means low notes don't need to be as much longer
- · No overwound strings.

30/01 Playsic

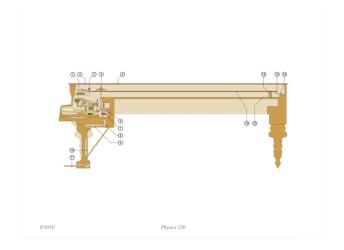
Lautenwerk



Harpsichord Action



8/30/01 Physics 1



The Harpsichord

- Wire strings on a wood frame plucked by tiny, sharp quills called Jacks.
- Scaled at /octave and wire diameters increase from .008" to 0.024".
 - No overwound strings.
- Sound is rich in harmonics and upper partials are strong, especially in the lower notes.

See overall -6B/octave of plucked string

See envelope of spectrum set by plucking point.

Spectrum continues up through complete audio range, no sudden cutoff.

0/01 Physics 120

The Piano

- Bartolomeo Cristofori c. 1700 invented hammer system and gravicembalo a piano e forte
- Strings and sound board like harpsichord but hammer gave control of loudness like clavichord
- Over time increased string thickness and tension to increase loudness but wood limited tensions by warping.
- Alpheus Babcock, 1825, in Boston MA invented cast iron frame, tension greatly increased. Modern piano 30,000-70,000lbs.
- Quite thick strings compared to length, especially in treble.
- Lowest strings overwound with Cu for increased mass, sometimes two overwinds.
- Lowest strings single, many bass double, rest triple strung.
- Soundboard about 3/8" thick, glued up from spruce and braced on back

3/30/01 Physics I.

The Piano

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- Lowest strings single, many bass double, rest triple strung.
- Multiple stringing contributes to longer sustain as strings beat slightly and lower energy transfer.
 Soundboard about 3/8" thick, glued up from spruce and braced on back

8/30/01 Playing 120

Cast Iron Plate

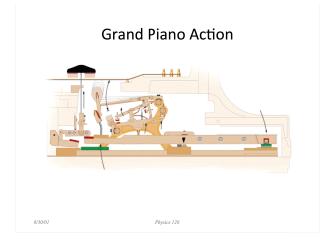


30/01 Physics

The Piano

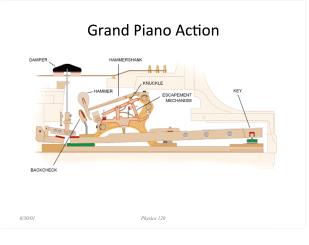
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Physics 120



Piano Strings Physics 120





The Piano Timbre Strings are hammered instead of plucked. Hammer stays in contact with the strings until the string vibration throws it off. This results in a much steeper fall-off of the higher partials.

- The highest notes show the steepest fall off because the hammer stays on the string longer in proportion to the period of the note. In addition to the generally steeper fall in frequency caused by hammering, the spectra show a clear cut-off at the high frequency end due to the damping action of the hammer.
- Especially in the lower notes see strong modulation of spectrum from strike point. Modes with nodes near the strike point are strongly suppressed.
- See non-uniform decay due to triple stringing
- See beating between the individual strings.
- See anharmonicity in the highest strings where stiffness plays the greatest role.