Wine glass oscillations

Warin Poomarin and Ian Jacobs: physics@ KVIS, Rayong, Thailand

The two large wine glasses ring when tapped with almost the same pitch. The initial selection was made by ear and then the FFT spectra were examined.

Fig 1 – two selected wine glasses that ring with the same pitch.

Frequency spectra for both glasses when tapped with a wooden rod are shown in figure 2.

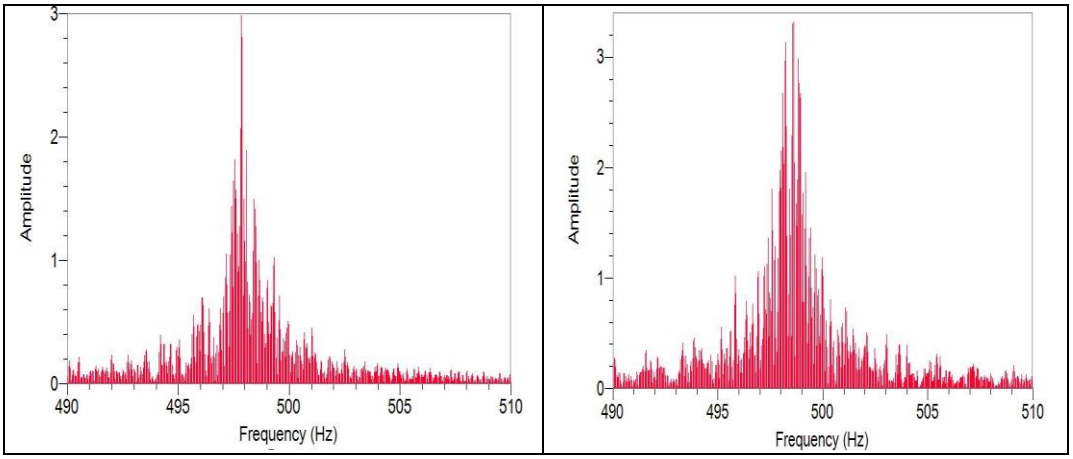

Fig 2 – each glass rings with a fundamental frequency (lowest harmonic) close to 498 Hz.

The glasses will ring if stroked around the rim with a wet finger. The FFT spectra are shown in figures 3 and 4. The two components beat with the beat frequency given by the difference in frequencies.

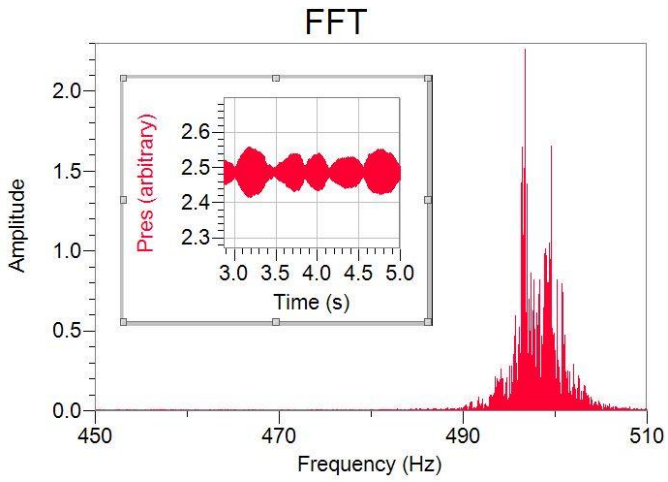

Fig 3 – glass 1 when stroked. The lowest harmonic is split into two components.

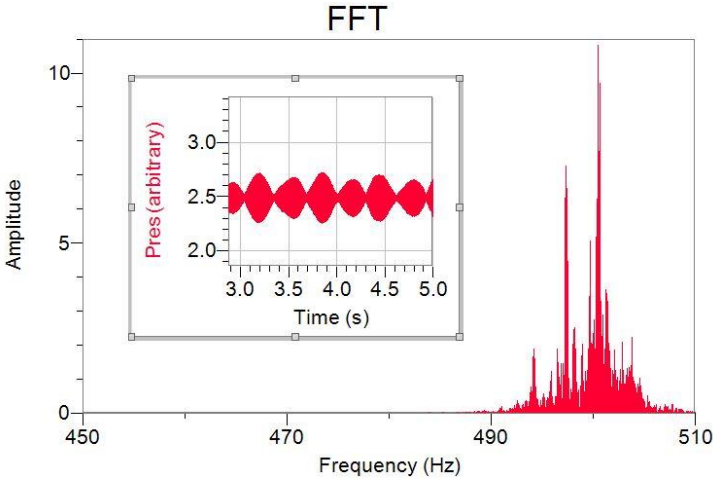

Fig 4 – glass 2 when stroked. The lowest harmonic is split into two components.

The beat frequencies are close to 2.5 Hz for glass 1 (figure 3 inset) and to 3 Hz for glass 2 (figure 4 inset). The beat frequencies match the frequency differences of the two components of the fundamentals.

That the rotating finger acts like an added mass (handle) is seen by comparing figures 3 and 4 with the frequency spectrum of a glass with added mass (figure 5) when tapped with the wooden handle of the rubber hammer.

Fig 5 – wine glass with added mass (one baht coin).

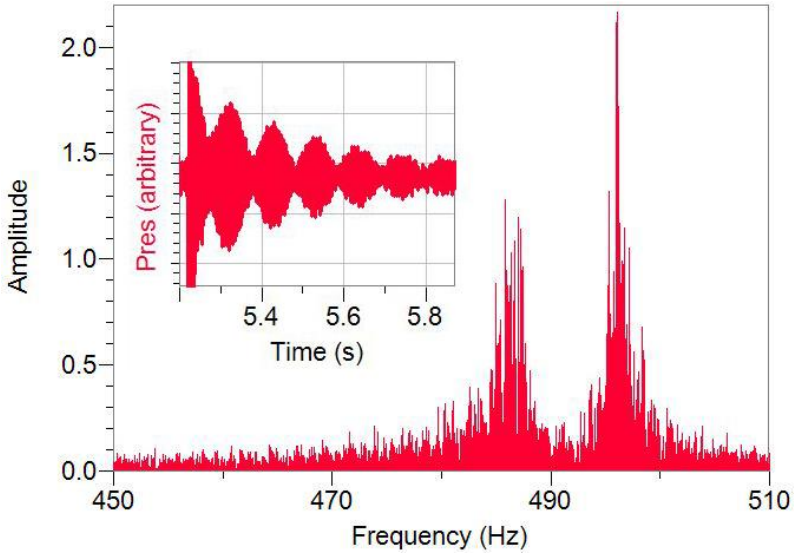

Fig 6 – tapping the weighted glass in figure 5 with the handle of the hammer.

Resonance: a demonstration

The glasses in figure 7 below are close to each other but not touching. The left hand glass is stroked to resonance. Suddenly stopping the ringing with a hand allows the other glass to be heard ringing quietly in a silent room.

For a class demonstration a sliver of bamboo (or a length of wire) can be placed across the top of the right hand glass. When the left hand glass is excited to resonance by stroking the bamboo will move, showing that the untouched glass is also vibrating.

Fig 7 – the right hand glass rings in response to the ringing tones of the left hand glass.

In practice it is often found that one of the two selected glasses drives the other more effectively. The reason for this is seen in figures 8 below.

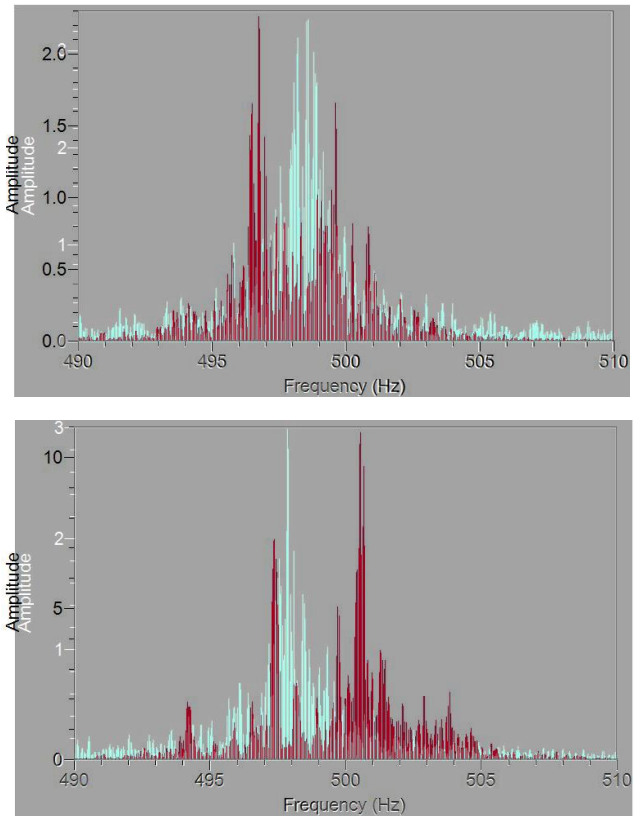

Fig 8 – driving frequencies (red) and the natural frequency of the untouched glass (green)

The lower combination is more effective, having one driving frequency closer to the single natural oscillation frequency of the untouched glass. Adding water to one or both glasses to make the match closer would further increase the energy transfer.