# Characterization of the sound of a violin

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The *quality* of any musical instruments is most often assessed qualitatively. Even the concept of *quality* is ambiguous [1]. Whether an instrument sounds *good* or *bad* is a multi-faceted, difficult question. It can be qualified through the easiness or pleasure an instrumentalist experiences, or, more commonly some not-so-well-defined emotions experienced by the audience, very much influenced by the acoustic characteristics of the room and the performance of the artist! We are interested in the violin, a very rich object of study with many resonators linearly or non-linearly coupled... Although ill expressed, questions on such complex systems composed of dozens of subelements, are exciting for a physicist! [2]

Thanks to piezoelectric ceramics (actuator-sensor), and replacing the bridge by an inertial mass, we are investigating the response function of the *body* of a violin for various frequencies: the *back* and the *front plate* with the air inside, without vibrating the strings (Fig. 1) [3].

**Figure 1.** A very nice Italian violin from the early XVIII$^{\text{th}}$ century, in testing position.

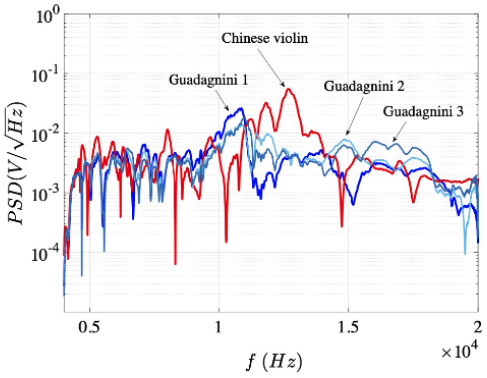


**Figure 2.** Response function of 2 violins, a recent Chinese one (red), and an old Italian one (blue), with 3 slightly distinct positions of the bridge.

Fig. 2 shows that the overall response function of the Chinese violin is much rougher than that of the Italian. Elementary intuition allows to conjecture that an instrument will be all the better if this response function is smooth and flat. Indeed, the old Italian violin *sounds much better* when played! Moreover, by slight changes of the piezo position setting, we evidence dramatic effects on the spectrum (displacements less than .1 mm here). The skill of the Luthier for tuning the bridge and the sound post are essential!

## References

1. Robert M. Pirsig, Zen and the Art of Motorcycle Maintenance: An Inquiry Into Values (1974)
2. Joe Wolfe made major contributions to the acoustics of music and musical instruments: https://www.phys.unsw.edu.au/jw/violintro.html
3. A. Naert, Patent FR20120060891 (2012).