Selected Research Papers by G. Bissinger (content notes; some articles with collaborators)

ARTICLES

- **The Violin Bridge as Filter**, G. Bissinger, J. Acoust. Soc. Am. **120**, 482-491 (2006).
  https://doi.org/10.1121/1.2207576
  By using systematic waist and wing mass trims to modify the bridge rocking frequency the effects on body vibrations and sound radiation were measured, validating the important role of the bridge in setup as a vital and *post*-assembly tunable component of violin sound. Especially note its influence around the rocking frequency.
  Pdf - 1mb

- **Surprising regularity between plate modes 2 and 5 and the B1 corpus modes: Part I**, G. Bissinger, Violin Soc. Am.: VSA Papers **21**, 83-101 (2007).
  The Schleske 1996 experiment where the top and back plates were graduated in stages and the violin assembled and re-tested showed that tuning plates indeed had only a small effect on corpus mode frequencies. However the real lesson from the Schleske experiment was that rib stiffness was dominant factor in determining frequencies for the two 1st corpus bending modes $B1^-$ and $B1^+$. A heuristic model based on the visual mode shape similarities between plate modes #2 and #5 and the B1 modes was developed to approximately subtract out the substantial rib stiffness contributions to the overall corpus bending stiffness. Although the heuristic model predictions in this article were not so good, the plate-B1 link was clear.

  This article provided the first empirical link between free plate tuning of modes #2 and #5 and B1 frequencies, a linkage seen across "good" and "bad" violins, factory-student-unvarnished violins as well as those of reputable modern makers. The expansion of the violin data base and simple trendline fits in EXCEL (see equations below for power-law trend line) now offer a substantial empirical guide to plate tuning effects on the B1 corpus mode frequencies for the violin maker.
  Pdf - 1.1 mb

  - With Δ5-2 = frequency difference between plate modes #5 and #2 and ΔB1 = frequency difference between $B1^+$ and $B1^-$, the present power-law trend line plate-to-B1 frequency equations are:
    $B1^- = 1122 \times \Delta 5\text{-}2^{-0.17}$
    $B1^+ = 187 \times \Delta 5\text{-}2^{0.20}$
    $\Delta B1 = 0.00032 \times \Delta 5\text{-}2^{2.38}$

- **Violin *f*-hole contribution to far-field radiation via patch near-field acoustical holography**, G. Bissinger, E.G. Williams, N. Valdivia, J. Acoust. Soc. Am. **121**, 3899-3906 (2007). https://doi.org/10.1121/1.2722238

  These first ever measurements of *f*-hole-only radiativity for comparison to the *f*-hole+surface total radiativity transformed our understanding of how the violin creates sound; for example, the B1 modes were transformed from surface-only radiators to dominant *f*-hole radiators. Comparing the measured *f*-hole volume flows with B1 volume changes estimated from experimental modal analysis measurements gave good agreement. The two large-volume-change B1 modes are now the “pumps” that drive the internal cavity volume flows that excite A0 *and* A1. A reliable model for B1-driven A0 radiativity can be found in the *dynamic filter model* article of 2012.

- **Structural acoustics of good and bad violins**, G. Bissinger, J. Acoust. Soc. Am. **124**, 1764-1773 (2008). https://doi.org/10.1121/1.2956478

  This paper, summarizing the results of the VIOCADEAS and Strad3D research, examined measured commonalities and differences between “bad”, “good” and 3 old-Italians. There was a significant difference between A0 strength in “bad” and 3 old-Italian violins, with relatively strong A0 being a hallmark of the latter. Comparing measurements of “bad” violins with 3-old-Italians confirmed Saunders 1947 summary comments about what eminent violinists want in their violins (except for “great power”).

  - Note: the very first full vibro-acoustic, CT-scan-based finite element model simulation of a violin (the *Titian* Stradivarius) with cavity mode excitation and radiation for a compliant-wall corpus, required the comprehensive VIOCADEAS vibration-radiation measurements to properly update the solid model [M.A.Pyrkosz, Ph.D dissertation, "Reverse Engineering the Structural and Acoustic Behavior of a Stradivari Violin" (2013). http://digitalcommons.mtu.edu/etds/634]. Even with the best cavity shape presently attainable (via CT scans) and compliant walls, the 288 Hz simulation result was still more than 15 Hz above the experimental A0 (Pyrkosz’ figure 5.20).

- **Parametric plate-bridge dynamic filter model of violin radiativity,** G. Bissinger, J. Acoust. Soc. Am. 132, 465–476 (2012). http://dx.doi.org/10.1121/1.4726010

  The violin’s averaged-over-sphere radiativity profile from the signature modes up to 6 kHz was simulated in the *dynamic filter model*, a composite model that applied a wall-driven, dual-Helmholtz resonator model (dHR) to the playable violin to predict A0 radiativity. (A0 is the sole always-strongly-radiating cavity mode, and one of two major acoustic structures in the open string frequency region seen in the Saunders Loudness Curves modeled in Schelleng’s violin octet scaling.) The dHR model required only measured A0, A1 and B1 frequencies and dampings *plus* B1 radiative strengths to predict A0 radiativity in excellent agreement with experiment. With all other corpus modes now eliminated by various other experiments, the B1 modes have become the sole drivers of A0 radiativity.

  Above the open string region a structural-acoustics-based statistical model was used to incorporate plate tuning – affecting B1 frequencies, total mass, critical frequency and A0-A1 excitation – and bridge tuning – primarily affecting frequencies above 2 kHz in the radiativity profile with relatively minor effects on B1 strengths. Both regions were spliced together in the radiativity trough near 0.7 kHz

- **Model-based auralizations of violin sound trends accompanying plate-bridge tuning or holding,** G. Bissinger and Robert Mores, J. Acoust. Soc. Am. **137**, EL293 (2015). http://dx.doi.org/10.1121/1.4915062

    (Note: this free article is different! To get the sound examples readers will need to go online to download the article itself *and* the **wav** format sound files. To do this just click on the dx.doi.org URL after the article title. The sound examples require good headphones or a sound system to hear effects at low frequencies.)

    The *dynamic filter* model radiativity profile simulations act like a parametric equalizer to filter the bowed string driving force signal run through them, thus creating auralizations of violin sound *trends* as plate and bridge tunings were modified. (The driving force signal was measured with an instrumented bridge.)

Some Bissinger violin URLs

NATURE: http://www.nature.com/news/2008/081002/full/news.2008.1147.html
New York Times: http://www.nytimes.com/2006/11/28/science/28acou.html