Final Voicing Notes

Method of testing guitar resonances with Spectra Plus

A small rare earth magnet is stuck to the guitar with double sided tape at the "semi-sweet" spot. That's a location that excites all the main resonances about equally. A coil stolen from a relay is located directly over the magnet, and is connected to an amplifier. This effectively turns the guitar into a loudspeaker.

The Spectra Plus program contains a signal generator that generates a sine wave signal that can be set to sweep over any given audio range, at whatever speed you choose. I usually set it to cover 50hz to 2500hz in 2 minutes.

The computer audio output goes to the amplifier, which boosts the signal enough to drive the guitar to quite audible levels. As the sweep signal passes through the guitar's various resonances, there is a marked increase in the sound level.

The microphone picks up the sound output from the guitar, and sends it to the computer's audio input. The computer displays a graph of the volume along the vertical axis, and the frequency along the horizontal axis. The result is an acoustical "fingerprint" of that instrument. The resonances displayed on the graph correspond exactly to the patterns that the poppy seeds show.

All guitars have these basic main resonances, though at different frequencies, and sometimes in a different order. ***It's where these resonances are located in the guitar's range, and how strong each is, that determine the "voice" of the guitar.***

Caveat! Main resonances should not fall on a scale note, or be exact multiples of one another, as the soundbox will absorb all the string energy immediately, and the note will be "dead".

Since taping the back on to the sides very closely approximates the finished guitar, it's possible to keep un-taping it, and making adjustments until the resonances are where you want them. Using this method of tracking the effects of brace shaving, and top and back thinning, allows you to adjust the response of the guitar to whatever sound you like.

Where should the resonances be located in the audio spectrum? Ahhh...that's the art of it, isn't it? In general, lower resonances make for a "darker" tone, and higher resonances make for a "brighter" tone.

Caveat #2 The acoustical qualities of the wood you build with place limits on how good the instrument can be. But that's a whole other topic (;->)...

This is the clamping gizmo that I use for holding the guitar at the eleventh fret and the heel of the neck. It's a little fancier than I needed, but I had the carving vise.

I got the horn loudspeaker for driving the guitar at the higher modes, but haven't tried it out yet. I can't get very distinct poppy seed patterns for them, and I'm hoping that the horn will drive them harder.

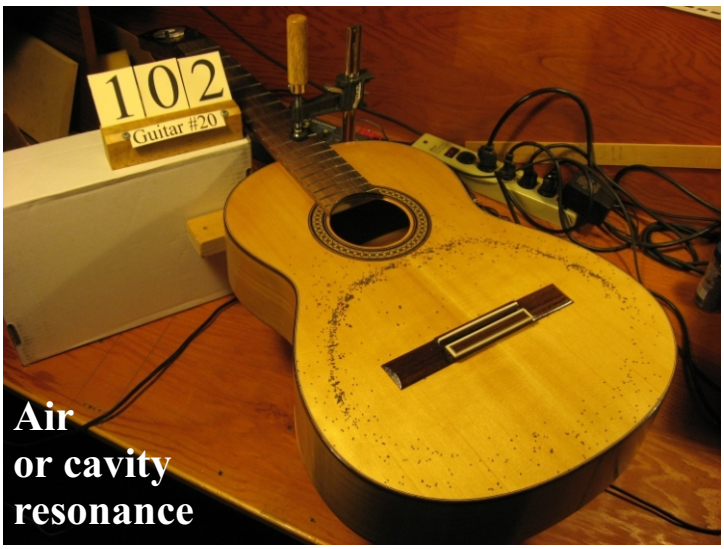
All the modes that you see in the other photos were made using the conventional speaker on the extension lamp frame to the left.

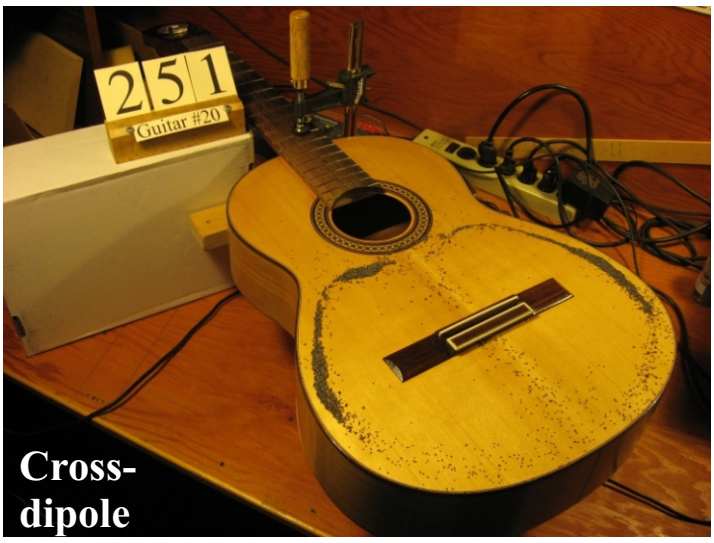
Taping on of back. To remove it from the body, it is only necessary to lift the tabs until the tape is just stuck to the back.

Brian's Guitar # 20

Back taped on--9-14-2009

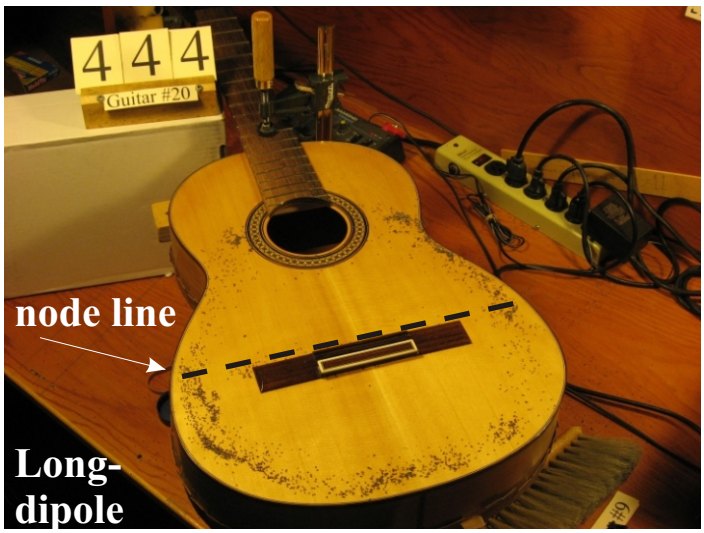
Back glued on--9-16-2009



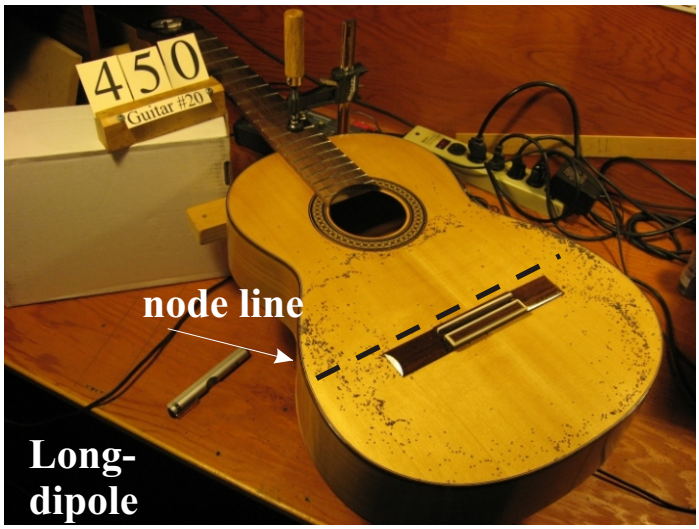


Brian's Guitar # 20

Back taped on--9-14-2009



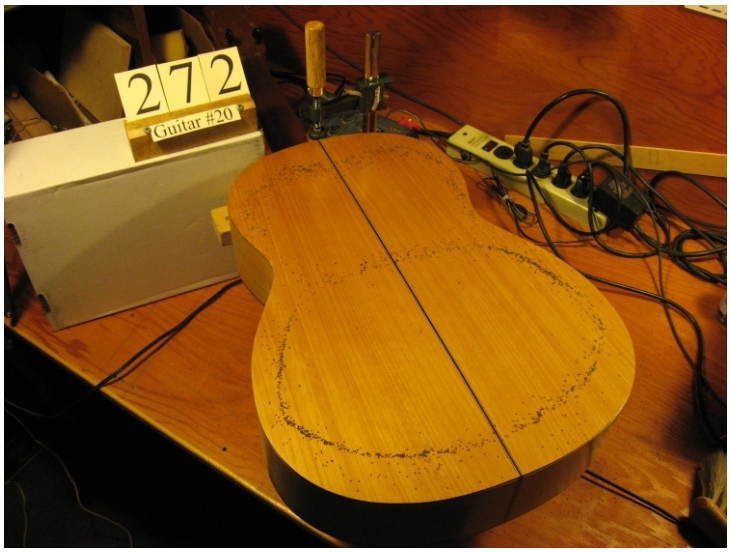
Back glued on--9-16-2009

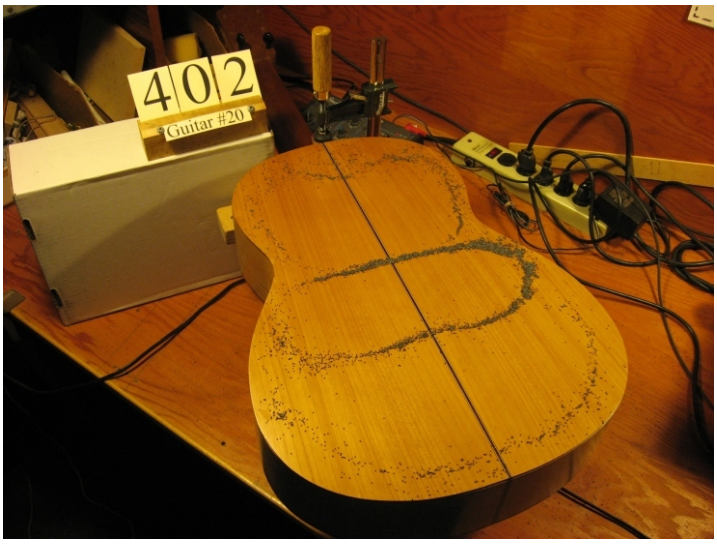


Brian's Guitar # 20--Average increase in frequency of 5%

Back taped on--9-14-2009

Back glued on--9-16-2009





Joel Di Mauro worked with me to build his first guitar, a “larger model” classical with East Indian Rosewood back and sides, and an LS redwood soundboard. To the left is the back that has been removed from the body to give him access to the braces for doing the “final voicing”. The braces are purposely installed a little taller than necessary to allow for trimming.

Taller braces will add to the stiffness of the top and back, so back and top resonances will be a bit higher than desired.

The idea of the slight increase in size of the “larger” model is to have it produce strong bass response, so it gets voiced a half step lower than the “standard” model. The air resonance is moved down to around 90 Hz, which is between F and F# — the second and third frets on the 6th string.

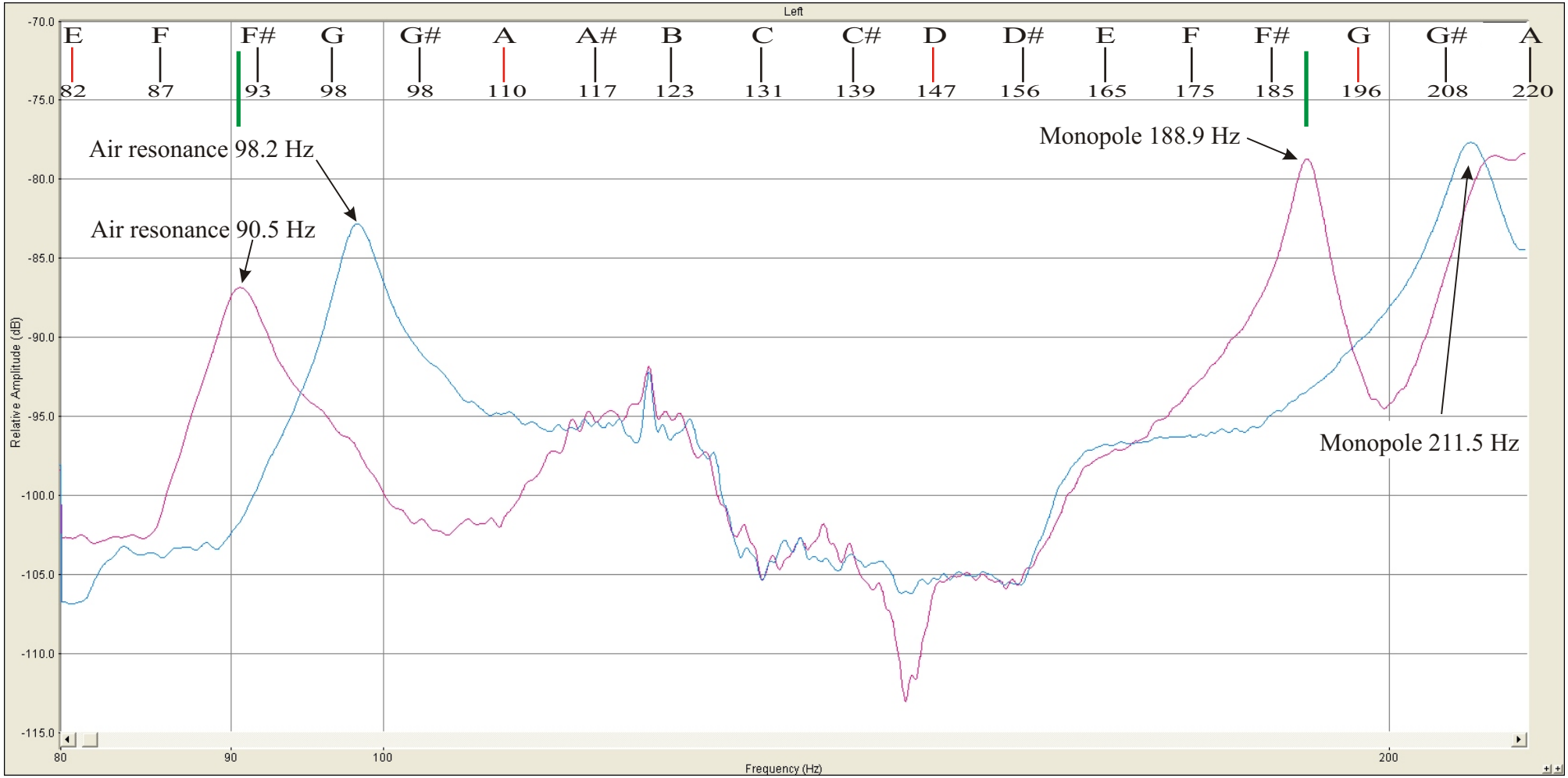
Each time that Joel made a change in the braces, or thickness of the top or back, we re-taped the back onto the body, and ran a “response curve” with the computer. This allowed us to see the effect of what we had done, and track our progress.

Shaving down the fan braces lowers the pitch of both the monopole and the air resonance, but has more effect on the monopole.

Shaving down the main back brace across the lower bout has most of it’s effect on the frequency of the air resonance.

The following two pages show how much the resonances have been moved by the voicing process, and where they ended up in the finished guitar.

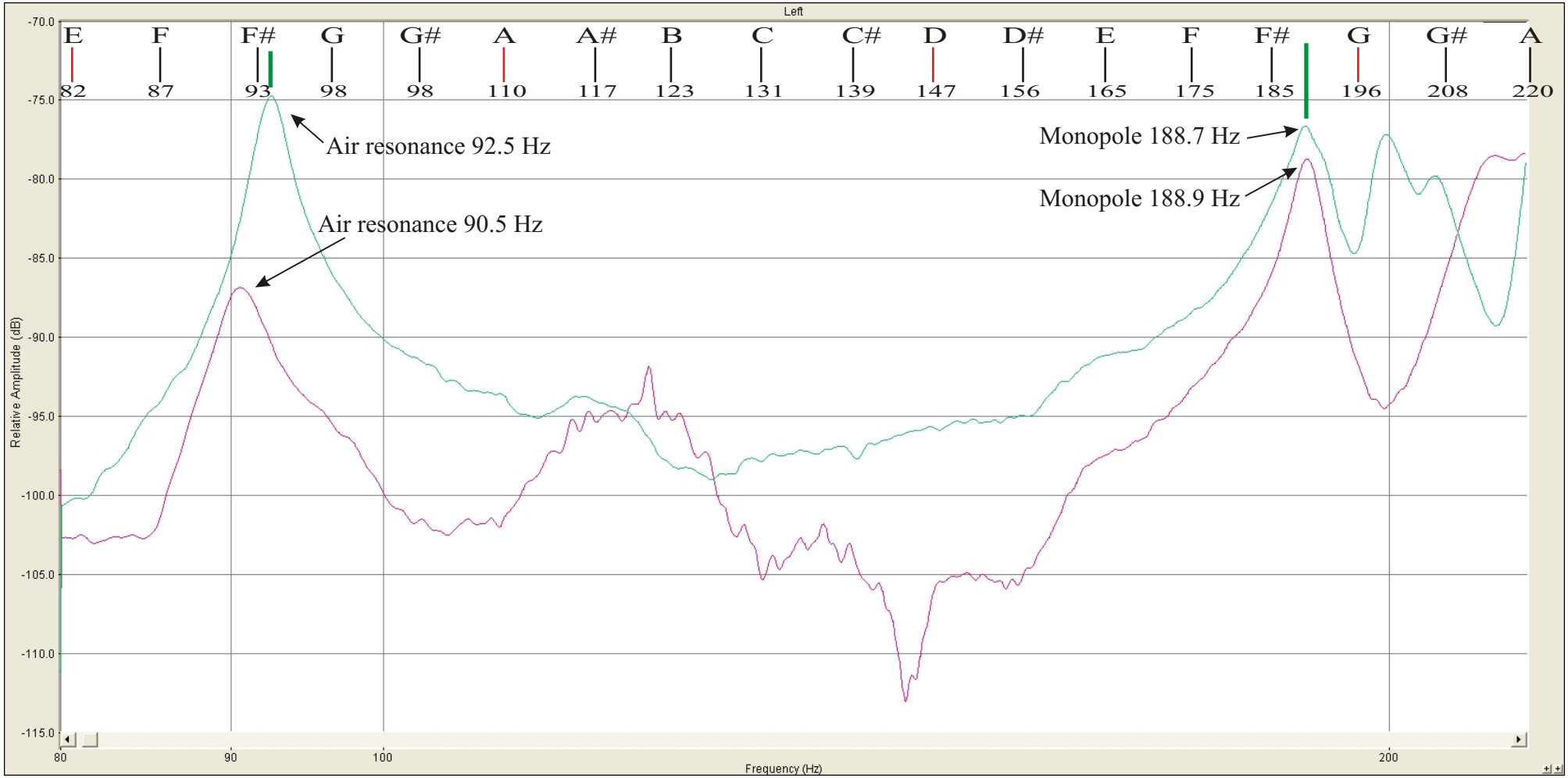
Joel has now made over a dozen guitars!



Final voicing of Joel Di Mauro's #1---Back taped on.

Blue graph is before any changes have been made.

Red graph is after all brace shaving is completed.



Green graph is Joel Di Mauro's #1---Finished guitar, played for 10 months.

Red graph is locations of resonances with back taped on at the end of the voicing process.

When the back was glued on, the air resonance went up 2 Hz, but the monopole has remained virtually unchanged.

So, what about all those other resonances on up the spectrum? Aren't they important too? You bet, and I have changed my bracing pattern to its current form to alter the relative positions and strengths of several of them. But the air resonance (cavity resonance) and monopole go a long way toward determining the character of the "voice" of a guitar.

The best explanation that I have heard of the differences between the "voices" of different guitars came from a professional singer, Warwick Hart. He sings tenor, and can sing a couple of steps higher than a baritone. A baritone can sing a couple of steps lower than he can, but most of the time they are singing the same range of notes. Everyone can hear the differences between them, and just as with guitars, that is due mostly to where their voices resonate best.

A guitar with lower pitched resonances we call "dark", and one with higher pitched resonances we call "bright".

I'm indebted to Ove Cristensen, a Danish researcher who published a seminal article on the subject, "The response of Played Guitars at Middle Frequencies". This was perhaps 40 years ago, and I believe in the journal of the "Catgut Acoustical Society". I can forward a .pdf of it on request.

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