Numerical Simulation of the Production of Pedal Notes in Brass Instruments

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Conical brass instruments, such as saxhorns, show an input impedance with almost harmonically distributed peaks, which allows to play notes whose frequencies approach a harmonic series. Conversely, all brass instruments with a long cylindrical section (notably trumpet and trombone) have their first impedance peak heavily shifted towards low frequencies (38Hz for a trombone instead of 62Hz if the first resonance frequency was belonging to the harmonic series formed by the upper peaks). However, trombonists can play the so-called "pedal note" despite its frequency close to 62Hz, around a minimum of the imput impedance.
Previous publication showed interesting numerical and experimental results when using alternatively a saxophone reed and a brass mouthpiece on both a trombone and a saxhorn.
In this paper, we reproduce numerically and extend these results using Moreesc, a numerical tool based on the modal decomposition of the bore which allows changing parameters during the simulation. By simulating alternately brass mouthpiece and saxophone reed and using modal fits of measured trombone and saxhorn impedances, we examinate this mysterious regime of oscillation. This first allows to check the robustness of this phenomenon regardless of the numerical method. Then, the ability to continuously morph from an impedance to another allows to study the transition between cylindrical and conical instrument's behavior. The influence of the number of modes taken into account is also investigated.