Fundamental Aspects of the Physics of Music

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In this lecture, we delve into the production of musical sounds and their organization into Western musical scales, beginning with an examination of the piano keyboard to establish musical nomenclature. For string instruments, wave motion and standing waves are fundamental, as these principles are universal to all instruments. We then explore the historical development of musical scales, starting with Pythagoras in the sixth century B.C.E., who devised a scale based on eight notes between the tonic and the octave, where the octave's frequency is twice that of the tonic. The other notes in this scale are determined by the consonance between the tonic and the fifth. We introduce the just scale, founded on the consonance between the tonic, the third, and the fifth, followed by the tempered scale with equal intervals.

While the physics of string instruments is often intuitive, understanding wind instruments can be more complex. We explain the basic principles of simple tubes, like flutes and clarinets, which can be open at both ends or closed at one end. Brass instruments, such as trumpets and trombones, involve more advanced concepts and typically play higher harmonics, unlike strings and woodwinds that predominantly play the fundamental harmonic. Throughout the lecture, we use real-world and plastic "toy" instruments to demonstrate these concepts, concluding with a jazz performance to illustrate their application.