A Brief Note on Oscillation

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Opinion Article

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INTRODUCTION

Oscillation is the repeated or periodic variation of some measure around a central value (often a point of equilibrium) or between two or more different states, typically in time. A mechanical oscillation is precisely described by the term vibration. A swinging pendulum and alternating current are two well-known examples of oscillation. Oscillations occur in virtually every field of science, including the beating of the human heart (for circulation), business cycles in economics, predator–prey population cycles in ecology, geothermal geysers in geology, vibration of strings in guitar and other string instruments, periodic firing of nerve cells in the brain, and the periodic swelling of Cepheid variable stars in astronomy.

The most basic mechanical oscillating system is a weight attached to a linear spring that is only affected by weight and tension. An air table or ice surface can be used to approximate such a system. When the spring is static, the system is in an equilibrium state. If the system is shifted out of equilibrium, there is net restoring force acting on the mass, tending to return it to equilibrium. However, in returning the mass to its equilibrium position, it has gained momentum, which keeps it moving beyond that point, establishing a new restoring force in the opposite direction. The point of equilibrium is shifted when a constant force, such as gravity, is introduced into the system. The simple harmonic oscillator mathematically describes systems where the restoring force on a body is directly proportional to its displacement, such as the dynamics of the spring-mass system, and the regular periodic motion is known as simple harmonic motion. Oscillations occur in the spring-mass system because the mass has kinetic energy at the static equilibrium displacement, which is converted into potential energy stored in the spring at the extremes of its path. The spring-mass system exemplifies some common characteristics of oscillation, namely the presence of equilibrium and a restoring force that grows stronger as the system deviates from equilibrium. Thermodynamically, all real-world oscillator systems are irreversible. This means that dissipative processes like friction or electrical resistance are constantly converting some of the energy stored in the oscillator into heat in the environment. This is referred to as damping. Thus, unless there is a net source of energy into the system, oscillations tend to decay over time. The harmonic oscillator's oscillation decay can be used to illustrate the simplest description of this decay process. Furthermore, an oscillating system may be subject to external forces, such as when an AC circuit is connected to an external power source. The oscillation is said to be driven in this case. Energy transfer from the environment can excite some systems. Coupled oscillators are a general term for two related but distinct phenomena. One example is when both oscillations mutually affect each other, resulting in the occurrence of a single, entrained oscillation state in which both oscillate at a compromise frequency. Another example is when an external oscillation affects an internal oscillation but is unaffected by it. In this case, the synchronization regions, known as Arnold Tongues, can lead to highly complex phenomena such as chaotic dynamics.

CONCLUSION

This transfer is most common when systems are embedded in a fluid flow. In aerodynamics, for example, flutter occurs when an arbitrarily small displacement of an aircraft wing (from its equilibrium) causes an increase in the angle of attack of the wing on the air flow and, as a result, an increase in lift coefficient, leading to an even greater displacement. At sufficiently large displacements, the wing stiffness dominates to provide the restoring force that allows an oscillation to occur.