Coupled Oscillations

A simple oscillator has a single, well defined frequency. More complicated systems with more degrees of freedom (e.g. two masses with two springs) will lead to more complex motions. The energy is exchanged between the different oscillators of the system.

Coupling

In order for energy to be exchanged between oscillators, they have to be *coupled*. Depending on the system, there is a variety of possible couplings:

Mechanical: .....

Thermal: .....

Electromagnetic: .....

Natural Oscillations

A coupled oscillation without an energy transfer between the oscillators is called a *natural oscillation,* the corresponding frequency is known as a *natural frequency* or e*igenfrequency*.

It turns out that a system with N coupled oscillators has exactly N natural oscillations.

Example: Natural oscillations of coupled rod pendula (order of increasing frequency).

$N = 3$

1st natural oscillation

2nd natural oscillation

3rd natural oscillation

$N = 4$

1st natural oscillation

2nd natural oscillation

3rd natural oscillation

4th natural oscillation

General Oscillations

Every oscillation of a system of coupled oscillators can be expressed as a superposition of its natural oscillations. The *Fourier transformation* is a mathematical tool enabling the decomposition of a coupled oscillation into its natural oscillations.