Twelve lecture

Parametric oscillation

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Parametric oscillation

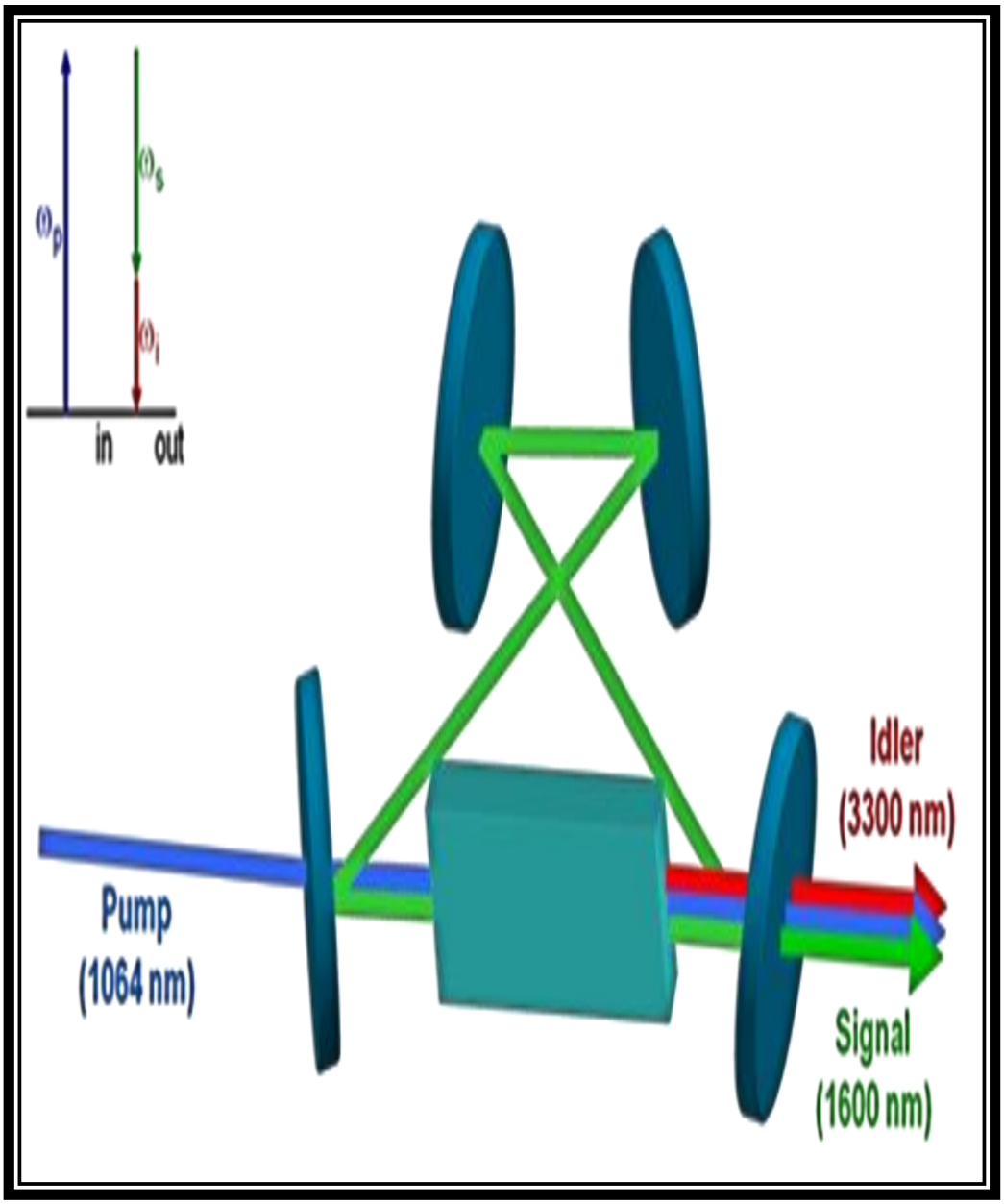
A **parametric oscillator** is a driven harmonic oscillator in which the oscillations are driven by varying some parameter of the system at some frequency, typically different from the natural frequency of the oscillator. A simple example of a parametric oscillator is a child pumping a playground swing by periodically standing and squatting to increase the size of the swing's oscillations.[1][2][3] The child's motions vary the moment of inertia of the swing as a pendulum. The "pump" motions of the child must be at twice the frequency of the swing's oscillations. Examples of parameters that may be varied are the oscillator's resonance frequency and damping .

Parametric oscillators are used in several areas of physics. The classical varactor parametric oscillator consists of a semiconductor varactor diode connected to a resonant circuit or cavity resonator. It is driven by varying the diode's capacitance by applying a varying bias voltage. The circuit that varies the diode's capacitance is called the "pump" or "driver". In microwave electronics, waveguide/YAG-based parametric oscillators operate in the same fashion. Another important example is the optical parametric oscillator, which converts an

input laser light wave into two output waves of lower frequency ( ).

When operated at pump levels below oscillation, the parametric oscillator can amplify a signal, forming a **parametric amplifier** (**paramp**). Varactor parametric amplifiers were developed as low-noise amplifiers in the radio and microwave frequency range. The advantage of a parametric amplifier is that it has much lower noise than an amplifier based on a gain device like a transistor or vacuum tube. This is because in the parametric amplifier a reactance is varied instead of a (noise-producing) resistance. They are used in very low noise radio receivers in radio telescopes and spacecraft communication antennas.[4]

Parametric resonance occurs in a mechanical system when a system is parametrically excited and oscillates at one of its resonant frequencies. Parametric excitation differs from forcing since the action appears as a time varying modification on a system parameter.


ω_p
ω_s
ω_i
in
out
Idler
(3300 nm)
Pump
(1064 nm)
Signal
(1600 nm)