EDITORIAL

Special issue on optical parametric processes

To cite this article: Jeffrey Moses et al 2015 J. Opt. 17 090201

View the article online for updates and enhancements.

Related content

- Surface Acoustic Wave Parametric Oscillation
  Yasuhiko Nakagawa

- Optically pumped coherent mechanical oscillators: the laser rate equation theory and experimental verification
  J B Khurgin, M W Pruessner, T H Stievater et al.

- High-Conversion-Efficiency and Broadband Tunable Femtosecond Noncollinear Optical Parametric Amplifier
  Wei Peng-Fei, Li Chuang, Zhang Chun-Mei et al.

Recent citations

- Notable advances in photonics: the JOPT Highlights of 2016
  Jarlath McKenna

- Distinguished contributions to photonics: the JOPT Highlights of 2015
  Jarlath McKenna
In nonlinear optics, a process is called a **parametric process** if the initial and final quantum states of the system are identical [1]. A **parametric oscillation** refers to the excitation of oscillations in a system by a periodic variation of one parameter of the system itself. Oscillations can be excited parametrically in any oscillatory system, whether mechanical or electric: parametric oscillations are familiar in everyday life, for instance children on a swing can excite parametric oscillations of the swing when they push themselves.

Historically, parametric oscillations were actually first observed in 1831 by Michael Faraday. He identified ‘Faraday waves’ in a liquid as standing-wave patterns that oscillate at half the frequency of the driving force [2]. Later, in 1860 Melde observed parametric oscillations in a string driven by a tuning fork that varied the tension at twice the string’s resonance frequency [3], and Lord Rayleigh was the first scientist to treat parametric oscillations as a general phenomenon [4, 5] at the end of the nineteenth century. In 1892, FitzGerald tried to excite parametric oscillations in an LC circuit by pumping it with a varying inductance provided by a dynamo [6], and parametric oscillations and amplifiers have been exploited for various applications in the radio-frequency and microwave range [7] since then.

The first experimental observation of **optical parametric oscillations** date back to 1965 [8] following a consistent theoretical effort, e.g. [9, 10]. Since then, optical parametric processes and their applications have been investigated in a vast variety of physical systems, from the most application-oriented studies, such as solid-state quantum information, to exploration of the most exotic fundamental physics, such as amplification of quantum vacuum fluctuations [11]. The demonstration of a phase-preserving superconducting parametric amplifier in the microwave range has been recently achieved [12]. Moreover squeezed states of light were generated by degenerate parametric down-conversion in a sub-threshold optical parametric oscillator [13] and the parametric generation and amplification of ultra-cold atom pairs were observed in a Bose–Einstein condensate [14]. Polariton parametric interactions in semiconductor micro-cavities has been studied in the strong exciton–photon coupling regime [15]. Another very interesting recent development obtained by acoustic parametric oscillations in an opto-mechanical oscillator is the phonon lasing [16].

Probably the application of optical parametric processes that has had the greatest impact on technology and scientific discovery has been their role in the development of coherent sources based on optical parametric amplification (OPA), optical parametric oscillation (OPO) and optical parametric chirped-pulse amplification (OPCPA). These coherent sources are designed to drive the next generation of optical technologies and physical interactions. This is a fast growing research field, not only implemented in a broad range of targeted applications, from laser induced fusion to optical amplifiers in an integrated silicon platform, but also with a strong impact in fundamental physics. In particular, these sources of the future pave the way to incredible new scenarios in strong-field physics and
attosecond science and in the exploration of light–matter interactions in extreme and previously inaccessible regimes.

The aim of this Special issue on optical parametric processes is to provide the reader with an overview of some of the most recent and remarkable advancements in this field. A first section is devoted to the scaling of laser sources based on OPA and OPCPA toward longer wavelengths [17–21]. In the second section some aspects related to the increase of energy in OPCPA is investigated [22–25]. The third section presents a few novel and intriguing applications of parametric processes [26–28].

References

[2] Faraday M 1831 On a peculiar class of acoustical figures; and on certain forms assumed by groups of particles upon vibrating elastic surfaces Phil. Trans. R. Soc. Lond. 121 299–340
[5] Lord Rayleigh (Strutt J W) 1887 On the maintenance of vibrations by forces of double frequency, and on the propagation of waves through a medium endowed with a periodic structure Phil. Mag. Ser. 5 24 145–59
