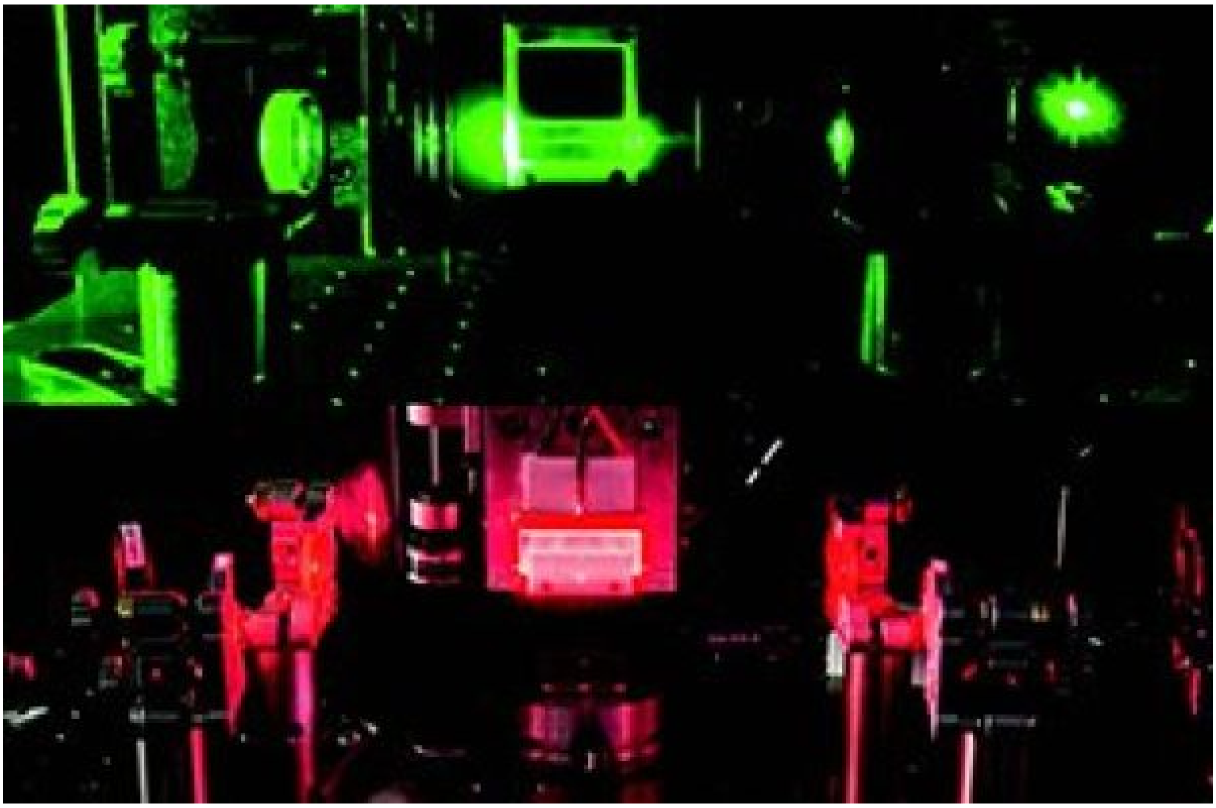

PhD THESIS DEFENSE: Novel Continuous-Wave Infrared Parametric Sources and Noise Analysis of Infrared Upconversion Detectors

ANUJA ARUN PADHEY

June 04, 2020

16:00

ICFO Auditorium and Online (Teams)

Thursday, June 4, 2020, 16:00. Online

ANUJA ARUN PADHEY

Optical Parametric Oscillators

ICFO-The Institute of Photonic Sciences

The ability to manipulate frequency of light, through parametric frequency conversion sources based on ?(2) nonlinear materials, offers an effective route to spectral regions unapproachable by conventional lasers. Most importantly, three-wave mixing processes provide tunable coherent radiation over a broad spectral range. Among the most important tunable devices, narrow linewidth continuous-wave (cw) infrared (IR) optical parametric oscillators (OPOs) are indispensable excitation sources for many applications in molecular spectroscopy and precision metrology. In order to exploit such applications, the development of cw OPOs deploying different wavelength tuning schemes and novel nonlinear materials is highly dezirable, as presented in this thesis. We demonstrated a rapidly tunable cw OPO based on fan-out grating design periodically-poled KTiOPO4 (PPKTP) crystal at room temperature. This approach allows continuous wavelength tuning by avoiding increased thermal fluctuations at higher operating crystal temperatures. The 532 nm-pumped, output-coupled singly-resonant oscillator (OC-SRO) provides widely tunable near-IR radiation across 741-922 nm and 1258-1884 nm, with total output power of 1.65 W. The use of output coupling for the resonating wave reduces thermal loading and enables 30% enhancement in the OPO extraction efficiency over the pure SRO configuration. Towards the goal of developing a next-generation cw source >4 ?m using a new found quasi-phase-matched semiconductor material, orientation-patterned gallium phosphide (OP-GaP), we demonstrated the first realization of a tunable cw mid-IR source based on OP-GaP by exploiting single-pass difference-frequency-generation (DFG) between a Tm-fiber laser at 2010 nm and a home-built OPO based on MgO-doped periodically-poled LiNbO3 (MgO:PPLN) crystal. The DFG source generates up to 43 mW of output power, with >30 mW across 96% of the tuning range 4608-4694 nm, in high beam quality. As the tunable mid-IR sources are making great strides, the availabilityof fast and sensitive mid-IR detectors become equally important. However, the conventional mid-IR detectors demand cryogenic systems for low-noise operation which sets a major drawback as these devices are often bulky and expensive. In this context, the nonlinear frequency upconversion technique has emerged as a promising alternative to the direct detection of mid-IR radiation at room temperature. An upconversion detector (UCD) can be further optimized by identifying and suppressing its noise sources. In order to do so, we experimentally and theoretically investigated noise properties of 1064 nm-pumped single-pass UCD designed for signal detection in telecom and mid-IR range using MgO:PPLN crystals. We studied the dependence of newly discovered SHG (532 nm)-induced spontaneous parametric downconversion (SHG-SPDC) noise intensity on the pump power and crystal temperature, and compared it with the well-known UCD noise source upconverted spontaneous parametric downconversion (USPDC). The measurements deduce that SHG-SPDC must be given a careful consideration since it can act as a dominant noise source under certain operating conditions. However, SHG-SPDC can be avoided by choosing a proper combination of MgO:PPLN grating period,operating temperature, and bandpass filter.

Thursday, June 4, 2020, 16:00. Online

Thesis Advisor: Prof Dr Majid Ebrahim-Zadeh

Hosted by: Prof Dr Majid Ebrahim-Zadeh

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