Bidirectional Flame Lasing

Ding, Pengji; Ruchkina, Maria; Aldén, Marcus; Bood, Joakim

Published in:
Northern Optics & Photonics 2018 12-14 September 2018 Lund University, Lund, Sweden

2018

Document Version:
Publisher's PDF, also known as Version of record

Bidirectional Flame Lasing

*Pengji Ding[1, *], Maria Ruchkina[1], Marcus Aldén[1] and Joakim Bood[1]*

[1]Div. of Combustion Physics, Department of Physics, Lund University, Box 118, SE-221 00 Lund, Sweden
email: pengji.ding@forbrf.lth.se
Telephone: +46767111375

Keywords: Femtosecond; Two-photon excitation; Lasing effect; CH_4/O_2 flame

Abstract
Lasing refers to the generation of highly directional laser-like emission remotely pumped by laser pulses in a medium such as ambient air or a flame. It has been intensively investigated because of its potentials to revolutionize the field of remote sensing. Earlier studies were carried out in flames, where lasing effect has been observed in various radicals, for example H, O, N etc., through two-photon resonant excitation. This scheme was later applied to generate lasing of O and N in ambient air, which can be dramatically improved by predissociation of the air constituents. However, the underlying physical mechanism of two-photon-excited lasing effect is still unsettled although it has been studied for more than one decade. Currently there are three different proposals: (1) Amplified Spontaneous Emission (ASE), in which case population inversion is responsible for optical gain; (2) Superfluorescence (SF), where a macroscopic dipole occurs in the population inverted medium; (3) Both hyper-Raman scattering and four-wave mixing are involved in the generation of lasing emission. Here, we experimentally studied 656 nm lasing emission of atomic hydrogen via two-photon resonant excitation by focusing 125-fs laser pulses of 205-nm wavelength in a methane/oxygen welding flame (see Fig. 1), where hydrogen atoms are naturally present. Lasing occurs in both forward and backward directions, and the forward signal strength is almost one order of magnitude stronger than the backward one. It has been found that the durations of lasing pulses are around 20 ps, and decreases with increasing pump laser energies. Furthermore, the delay of the lasing pulse with respect to the pump pulse decreases with increasing pump energies. These results show high similarities with the behaviors of SF, suggesting that the femtosecond two-photon-excited lasing emission of atomic hydrogen might be SF.

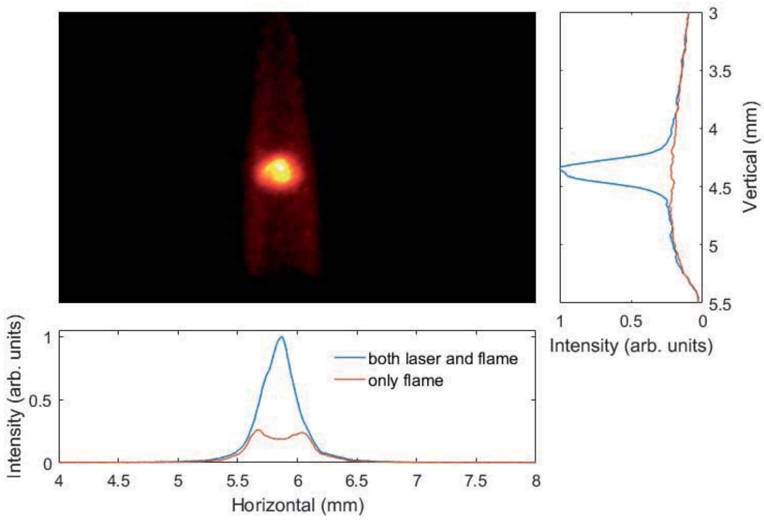

Fig. 1 *Image of backward emission captured by a CCD camera. The orange lines in the profile curves corresponds to chemiluminescence from the flame.*