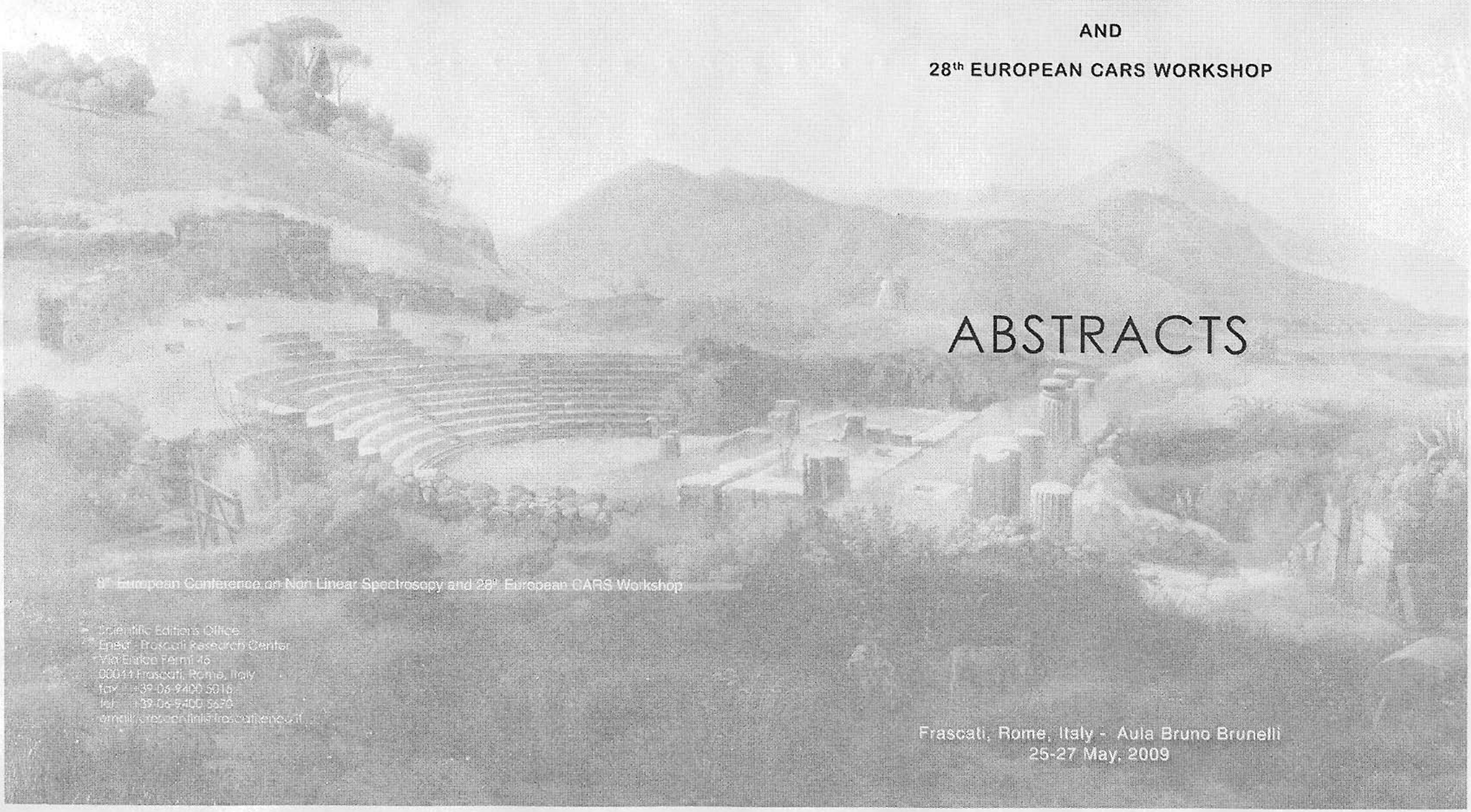

8th EUROPEAN CONFERENCE ON NON LINEAR SPECTROSCOPY

AND

28th EUROPEAN CARS WORKSHOP

ABSTRACTS

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Nonlinear transformations of Short laser Pulses in Photonic Crystal Fibers

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Self-phase modulation (SPM) is a basic mechanism behind the spectral broadening of laser pulses in nonlinear media[1].. In certain regimes, however, SPM can induce an opposite effect, resulting in a spectral narrowing of a laser pulse. This type of spectral transformation, often referred to as spectral compression, is of particular interest for the creation of efficient fiber amplifiers of picosecond[2] pulses and design of telecommunication fiber links. Unlike linear spectral filtering, which rejects frequency components falling outside the selected spectral region, spectral narrowing focuses radiation energy within the required frequency band through nonlinear-optical frequency conversion, thus substantially reducing energy loss. Highly nonlinear photonic-crystal fibers (PCFs) allow an enhancement of spectral narrowing, offering attractive solutions for highresolution multiplex microspectroscopy based on coherent anti-Stokes Raman scattering (CARS) and helping to develop single-fiber-oscillator CARS microscopes.

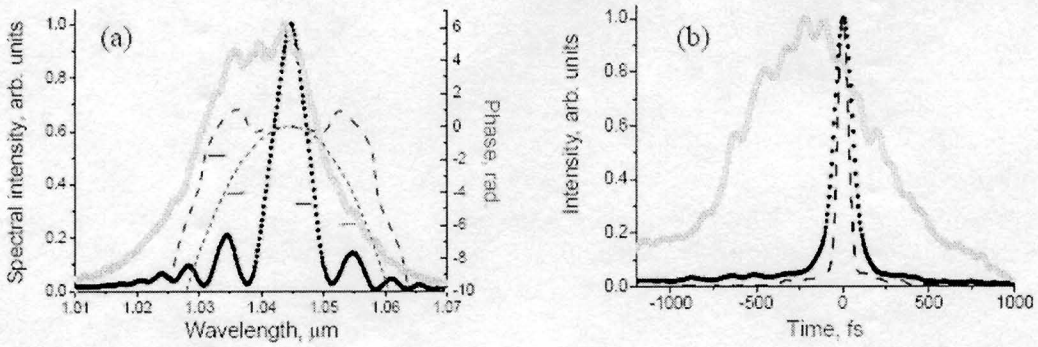

Fig. 1. Results of experiments demonstrating spectral narrowing of chirp-free pulses in a highly nonlinear PCF. (a) The spectrum (circles) and the spectral phase (dashed and dotted lines) of Yb DPSSL pulses transmitted through a 30-cm piece of PCF. The peak power launched into the fiber is 0.35 kW (open circles and the dotted curve) and 1.4 kW (filled circles and the dashed curve). The input pulse width is 50 fs. (b) Temporal envelope of the PCF output for laser pulses with a peak power of 0.35 kW (open circles) and 1.4 kW (filled circles). The dashed line shows a transform limited pulse corresponding to the measured spectrum at the output of the 30-cm PCF.

In present work we demonstrate a spectral narrowing of nearly chirp-free 50-fs pulses delivered by a diode-pumped ytterbium solid-state laser using an anomalously dispersive, highly nonlinear silica PCF as well as a single-mode guiding in a 4-μm-inner-diameter hollow photonic-crystal fiber filled with a highly nonlinear liquid. Strong inertia of optical nonlinearity of the liquid filling the fiber core translates into a pulse-width-dependent red shift of the spectrally broadened fiber output.

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[1] G. P. Agrawal, *Nonlinear Fiber Optics* (Academic, San Diego, 2001).

[2] J. Limpert, T. Gabler, A. Liem, H. Zellmer, and A. Tünnermann, "SPM-induced spectral compression of picosecond pulses in a single-mode Yb-doped fiber amplifier," Appl. Phys. B 74, 2, 191-196 (2002)