SAND95-2849C
CONF-960642--3

Nanosecond, pulsed, frequency-modulated optical parametric oscillator

D. J. Armstrong, W. J. Alford, T. D. Raymond, and A. V. Smith

Dept. 1128, Sandia National Laboratories

Albuquerque, New Mexico 87185-1423

Tel: (505) 844-5810

Abstract: We have seeded a pulsed optical parametric oscillator at the signal wavelength with continuous-wave, frequency-modulated light. This produces frequency modulated pulses with a spectrum that matches the seed. Such a source has applications in speckle reduction and frequency modulated absorption measurements.

This work was supported by the United States Department of Energy under Contract DE-AC04-94AL85000.

Nanosecond, pulsed, frequency-modulated optical parametric oscillator

D. J. Armstrong, W. J. Alford, T. D. Raymond, and A. V. Smith

Dept. 1128, Sandia National Laboratories

Albuquerque, New Mexico 87185-1423

For certain applications, a spectrum comprised of several longitudinal modes from a laser or optical parametric oscillator (OPO) is desirable. For example, a broad spectrum can reduce speckle in remote sensing. One way to achieve this is to allow an OPO to operate on several modes that evolve from quantum noise. Unfortunately, in this case the spectrum fluctuates from pulse to pulse and can be a noise source. An alternative is to seed the OPO on several longitudinal modes simultaneously so the spectrum is broad but does not fluctuate. This can be done by frequency modulating a cw seed laser so the sidebands and carrier all match longitudinal modes of the signal wave in the OPO. Such an FM OPO would also have applications in FM-modulation absorption measurements[1], including remote sensing.

If the seed light is phase modulated with a period equal to the round trip time of the signal wave in the OPO cavity, and the cavity is adjusted to resonate the carrier, all the sidebands are also resonated and are amplified with the same parametric gain as the carrier, assuming the gain bandwidth of the cavity optics and nonlinear crystal are wide compared with the mode spacing. This should lead to an OPO pulse with a spectrum that nearly preserves the frequency modulated seed spectrum. In contrast, the OPO spectrum produced by seeding with an amplitude modulated seed would not mimic the input

because the amplitude modulation of the input seed would be distorted by the nonlinear mixing, by an amount depending on the strength of the pump light.

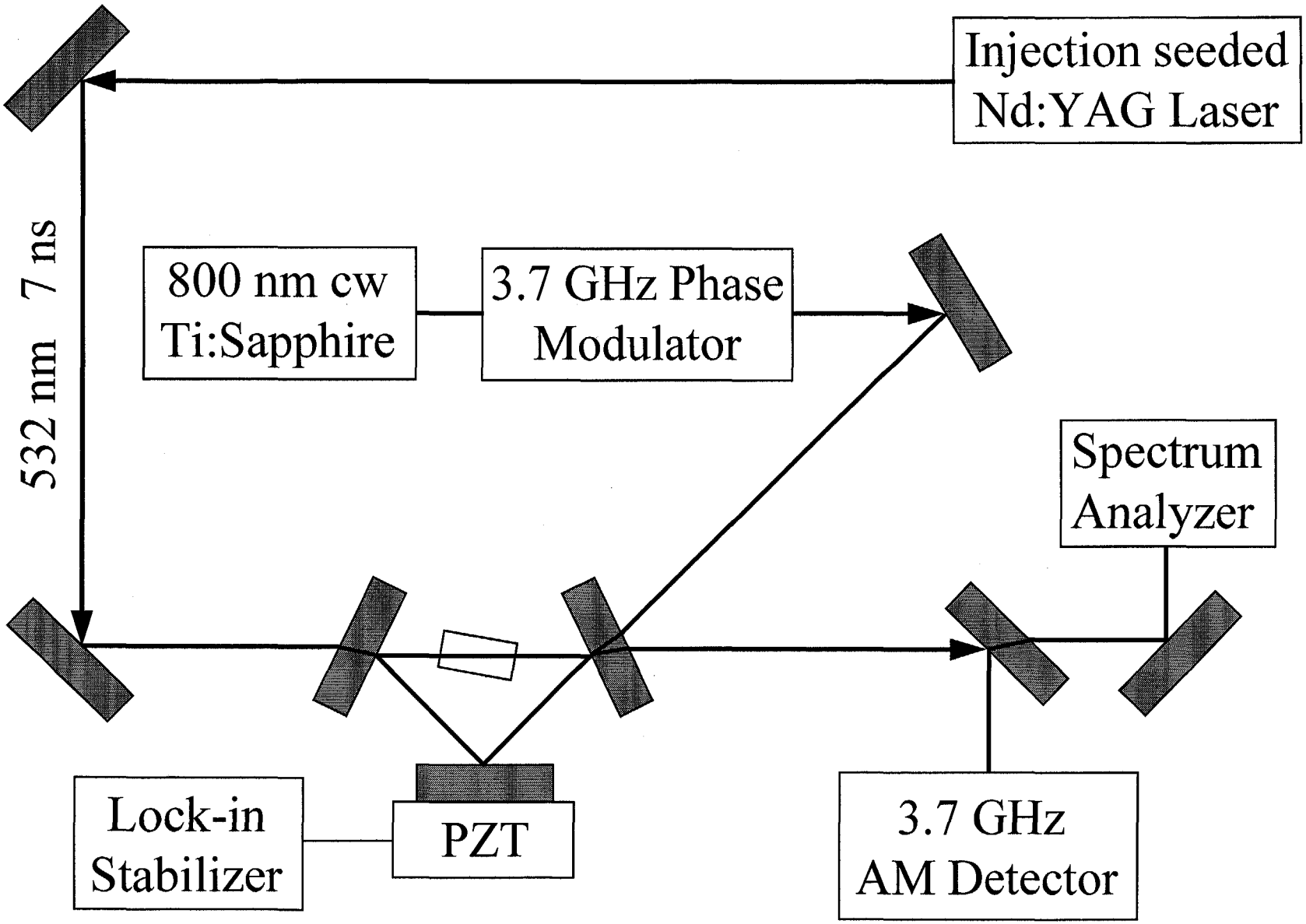
We have demonstrated frequency modulation in a ring-cavity KTP OPO seeded by frequency modulated Ti:SAP light (Fig 1). The singly resonant OPO is pumped by a single-longitudinal-mode 532 nm Nd:YAG light, and the 800 nm signal seed is modulated at 3.7 GHz to match the OPO cavity's free spectral range. Fig. 2 shows a comparison of the input seed spectra and the OPO's pulsed output spectra for FM modulated and unmodulated seeds. We will present a comparison of OPO operation with FM and AM seeds that demonstrates the dramatic difference in spectral properties and pulse profiles for the two modulation types. We will also demonstrate FM modulated absorption measurements made using our FM OPO.

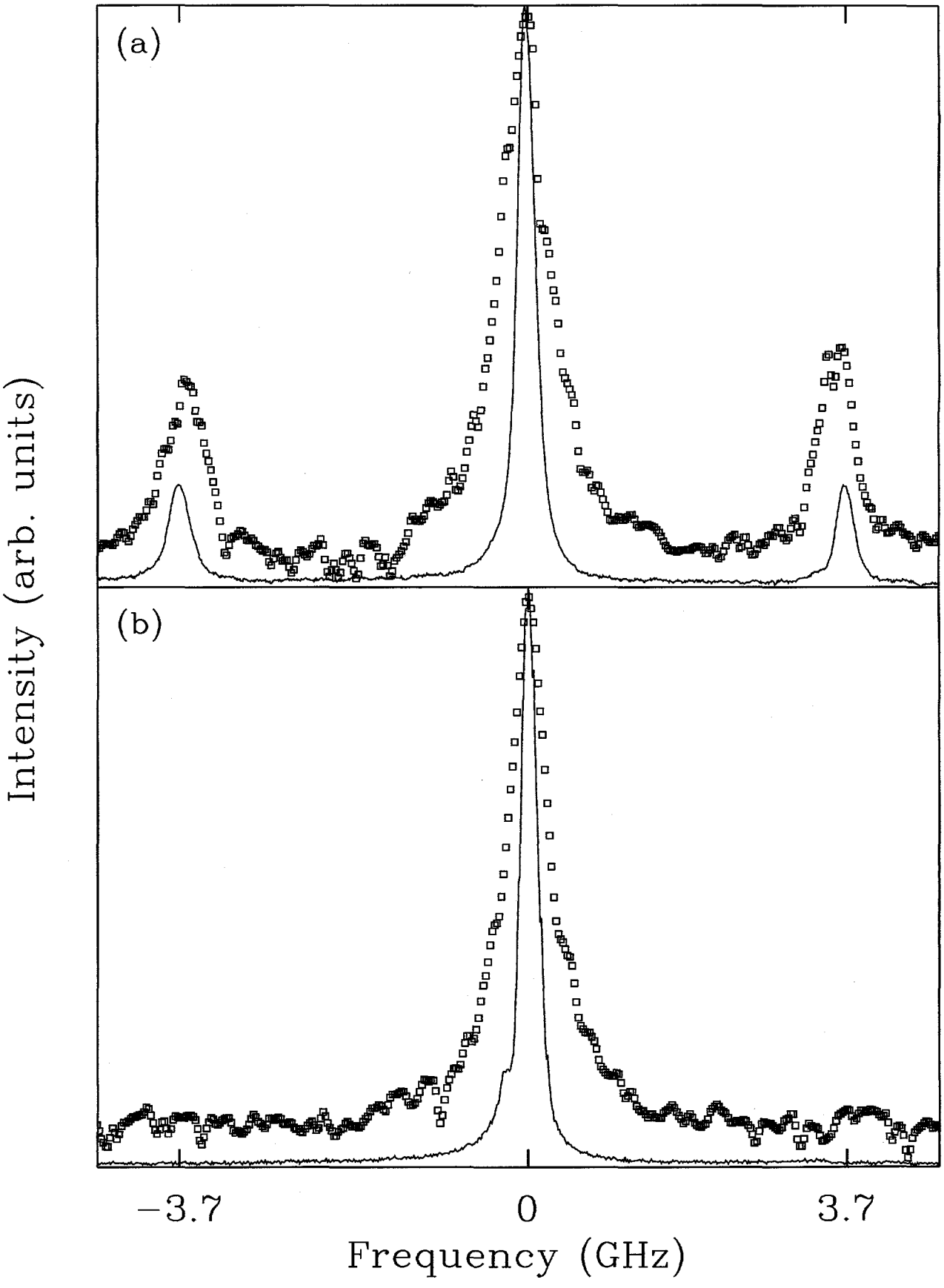
1. T. F. Gallagher, R. Kachru, F. Gounand, G. C. Bjorklund, and W. Lenth, "Frequency-modulation spectroscopy with a pulsed dye laser," Opt. Lett. **7**, 28-30 (1982).

Captions:

Figure 1: Experimental apparatus.

Figure 2: (a) Seed (solid) and OPO (symbols) spectra for frequency modulated seed and (b) same for unmodulated seed.


Injection seeded
Nd:YAG Laser
532 nm 7 ns
800 nm cw
Ti:Sapphire
3.7 GHz Phase
Modulator
Spectrum
Analyzer
Lock-in
Stabilizer
PZT
3.7 GHz
AM Detector


(a)
(b)
Intensity (arb. units)
−3.7
0
3.7
Frequency (GHz)