Review Comments

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Title: Theoretical and experimental investigations of high-power self-mode-locked Pr:YLF visible lasers

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The authors claimed in this manuscript that they observed self-mode-lock oscillation for the first time with a diode-pumped Pr:YLF laser at 522 and 639 nm. The average power of those mode-lock laser was 0.68 and 1.44 W at 522 and 639 nm, respectively. Since mode-locking has been demonstrated for diode-pumped Pr:YLF lasers, so far, only with SESAM and the average output powers were limited to less than 100 mW, this scheme could open up new application with those visible sub-nanosecond laser pulses. The authors speculated the mechanism of the self-starting mode-lock oscillation as the Stark splitting of laser medium induced by laser cavity field, which was reported by Yingxin Bai in 1993 for gas lasers such as HeNe, copper vaper and CuBr, and simulated their experimental spectra with a numerical model. In fact, the authors reported very interesting pulsing phenomena for a diode-pumped Pr:YLF laser. However, since Bai's theory has never applied any solid-state lasers, the author should be more careful to conclude and collect more experimental data to support the authors' conclusion. For example, it is not 100% clear for an argument that the pulsation was rather caused simply by spectral beating among few longitudinal modes. Therefore, I request authors following additional measurements to ensure the author's opinion and conclusion. Also, I recommend to revise the following points before re-review this manuscript.

1. I request the following two measurements.
   (1) The measurement system of the pulse train (30 GHz photodiode and 500 MHz oscilloscope) is sufficient to record the pulse train so that each pulses are distinguished, at least for 83 MHz, but the recorded waveform was a sinusoidal oscillation rather than a “pulse train”. Since the averaged laser power is sufficiently higher at mode-locking, the author can obtain SHG autocorrelation. Discussion about modelock lasers only with RF spectra without optical pulse measurements is out of date. The oscilloscope traces in Fig. 4 cannot avoid the doubt that the pulsation is caused by beating among few longitudinal modes.
   (2) The pulse spectrum should be measured with a single shot using a pair of lens and an etalon. The spectrum in Fig. 3, which was measured with scanning spectrum analyzer with a resolution of 0.08 nm, exhibits many modulated peaks.

2. Following comments are for further revision of the manuscript:

(1) In introduction, they mentioned that the shortest pulse from the Kerr-lens mode-locked Pr:YLF laser was 9.7 and 8.5 ps, at 639 and 607 nm. In fact, Sutherland et al. reported 400-fs mode-locked pulses by a 613-nm Pr:YLF laser pumped by Ar-ion laser.

(2) The authors did not specify the pump diode beam. The beam quality in sagittal and tangential planes should be specified. Moreover, it would be better to clarify the spot size in the two planes in the laser crystal rather than the "average pump sizes." The spot size of cavity mode and mode-matching efficiency should also be described.

(3) In the manuscript, the not-straight output characteristics were explained by increase of the mode volume owing to the second pump diode. But this is not sufficient to explain the characteristics because the slope efficiency was largely improved after the second diode was added. These characteristics may indicate a possibility of multimode operation of the laser due to the lower mode-matching efficiency. Therefore, it would be better to show an output beam profile at the highest pump power.

(4) The authors adopted an uncoated Pr:YLF crystal. In general, any etalon effects caused by intracavity elements (surfaces) should be avoided because it is known to break up mode-locking. The authors need to comment on this point.

(5) In the theoretical discussion, the authors introduced the Gaussian profile temporal intensity modulation as a parameter of modulation pulse width Δt. If such a periodical intensity modulation synchronized with light round trip time is assumed in a model, any lasers will always become to be pulsation. No Stark splitting theory is necessary to predict spectra shown in Fig. 7 (b) with such numerical calculation. How do the authors explain the mode-lock oscillation with the spectrum without dip in the center? In the Bai's theory, he claimed that Stark splitting is necessary to initiate the self-mode-locking. Most important experimental results would be therefore the evidence that the authors obtained laser spectra with relatively big dip in the center. However, the author described that it was seldom case, not a stable condition. The authors should obtain more reliable data.

(6) The author described “the duration of intensity modulation model raised almost 13 times compared with the case without frequency shifts resulted from gain line splitting”. The physical meaning of that intensity modulation duration should be supplied. Why does that longer modulation duration reveal the pulse compression?