ANTICIPATED SYNCHRONIZATION OF DFB LASER WITH PASSIVE DISPERSIVE REFLECTOR

V.Z. Tronciu[1], A.H.Rotaru[2], S. Rusu[1], A. Rusu[1]
[1]Technical University of Moldova
[2]State University of Moldova
tronciu@mail.utm.md

Abstract. *We discuss the phenomena of anticipated synchronization in a DFB lasers with passive dispersive reflector. A rate equation model is proposed. It is shown that the system of two lasers coupled in unidirectional configuration displays, under certain conditions, anticipated synchronization. Finally, the possibility of detection of this phenomenon in experiment is presented.*

Keywords: *anticipated synchronization, DFB laser, passive dispersive reflector*

I. Introduction

During recent years the phenomena of synchronization of different systems has been the subject of significant studies due to its fundamental and applied interests in physical and biological sciences [1]. In the last decade Voss [2] proposed a new scheme of synchronization so called "anticipated synchronization". The idea of anticipated synchronization is that two identical dynamical systems coupled in a master-slave configuration can exhibit anticipated synchronization when the slave system is subject to a delayed self feedback [3]. There have been theoretical predictions of anticipated synchronization in different systems [2-4], and in some cases these predictions have been supported by experimental observation [5]. We believe that passive dispersive reflector lasers (PDRL) [6] could be a good candidacy for observation of anticipated synchronization. In this paper we report studies on the anticipated synchronization of single mode PDRL coupled in master-slave configuration. We start in Section II with a description of the setup and equations. The results of numerical calculations are presented and discussed in Section 3. Conclusions are given in Section 4.

II. Model and equations

The schematic diagram is shown in Figure 1. It consists of two DFB lasers coupled in unidirectional configuration. The slave laser is adjusted to an external optical circuit with a delay time t.

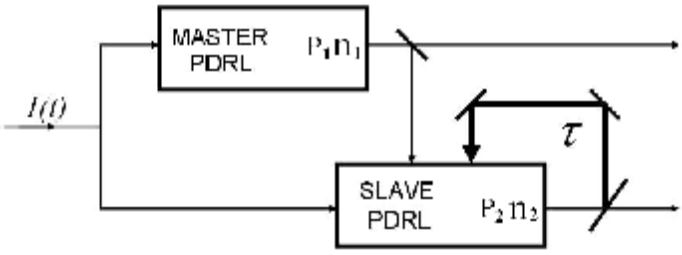

Figure 1. Schematic diagram of two passive dispersive reflector lasers coupled in unidirectional configuration.

We start from the rate equations used in [5] for devices with an active DFB reflector

$$\frac{dP_1}{dt} = TG(n)P_1 + I(t), \qquad \frac{dn_1}{dt} = J - n_1 - (1+n_1)\Gamma(n_1)P_1, \tag{1}$$

$$\frac{dP_2}{dt} = TG(n)P_2 + I(t) + K(P_1(t) - P_2(t-t)), \qquad \frac{dn_2}{dt} = J - n_2 - (1+n_2)\Gamma(n_2)P_2, \tag{2}$$

where T is the ratio between the carrier and photon life times, and J relative excess injection rate.

The rate equations functions $\Gamma(n_i)$ and $G(n_i)$ for $i=1,2$ have the form (for more detail see [5])

$$\Gamma(n_i)=\Gamma_0+\frac{AW^2}{4(n_i-n_0)^2+W^2} \quad \text{and} \quad G(n_i)=n_i+a\,\Delta n\tanh\frac{n_i}{\Delta n} \tag{3}$$

III. Results and discussions

This section concerns the behavior of two lasers coupled in unidirectional configuration as shown in Fig.1

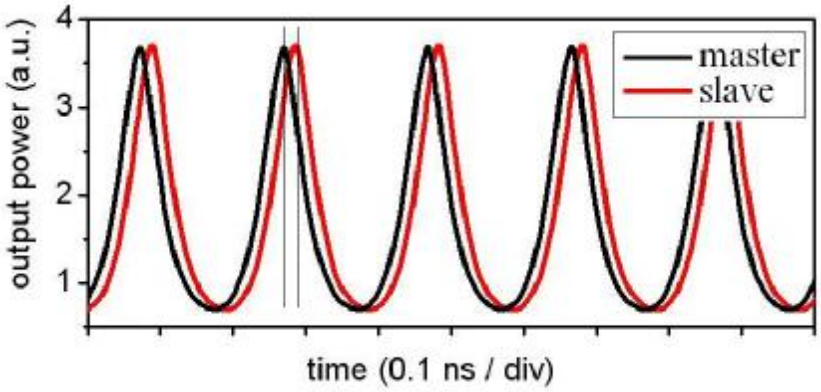

Figure 2. Time traces of the output power for master (black) and slave (red) lasers. The vertical lines show that the slave laser is ahead to the master laser. The parameters are as in [6]

Figure 2 illustrates time traces for master and slave lasers for external-cavity round time $t=0.2$. It can be seen that the slave laser come ahead the master laser with 30 ps. Under these conditions both lasers show the periodic behavior. The parameters of master and slave lasers are equal in the system and we observe the process of synchronization. We mention that the slave laser synchronizes perfectly with the master laser after a short transient. Thus, we observe the phenomenon of anticipated synchronization in PDRLs.

IV. Conclusion

We have studied the regime of anticipated synchronization of coupled DFB lasers with passive dispersive reflector. We have shown that, under appropriate conditions, the slave laser can anticipate the behavior of the master. The authors acknowledge financial support from the project 106b/s of the Technical University of Moldova.

V. References

1. 2003. Pikovsky A, Rosenblum M and Kurths K 2003 *Synchronization: A Universal Concept in Nonlinear Sciences* (Cambridge: Cambridge University Press)

2. H. U. Voss, Phys. Rev. E 61, 5115 (2000); H. U. Voss, Phys. Rev. E 64, 039904(E) (2001); H. U. Voss, Phys. Rev. Lett. 87, 014102 (2001).

3. F.S. Matias, P.V. Carelli, C.R. Mirasso, and M.Copelli Phys. Rev. E 84, 021922 (2011)

4. M. Kostur, et al Phys. Rev. E 72, 036210 (2005), C. Masoller and D. H. Zanette, Physica A 300, 359 (2001).

5. S. Sivaprakasam, et al, Phys. Rev. Lett. 87, 154101 (2001). Y.Liu,et al ,Appl. Phys. Lett. 80, 4306 (2002).

6. V.Z.Tronciu, et al. Optics Comm. 2000, 182, pp. 221-228.