Semiconductor laser amplifiers have been studied extensively due to their potential use in future optical communication systems and optoelectronic integrated circuits (OEICs) [1-2]. However, when a pre-biased SLA is subjected to external optical signals (as in optical communication systems and in OEICs), local carrier density within the active layer of SLA decreases while the refractive index increases accordingly. This results in non-linear behaviour of the device. The non-linear phenomena in a SLA (Fabry-Perot or travelling-wave) may introduce periodic pulsation (or self-sustained pulsation (SSP)), sub-harmonic generation, period doubling, period quadrupling and period tripling; all leading to chaos as a result of time dependant instabilities within the gain medium [3-6]. Chaotic dynamics and SSP have gained considerable importance due to the following reasons:

1. Non-linearities in amplifiers introduce additional cross talk and noise [7] which are the main obstacles to the application of semiconductor lasers in ultra-high frequency regime. They are undesirable in optical communication systems and in OEICs and therefore must be eliminated.

2. Non-linear behaviour and chaotic dynamics of laser based optical systems are the subject of intensive theoretical and experimental investigations because a better understanding of non-linear dynamics allows us to avoid these non-linearities and chaos [8].

3. It has potential applications in the fields of encrypted, synchronised, secure and high speed communication [9-10], linewidth enhancement [11] and ultra-fast and short pulse generating systems [12].

Normally, in a semiconductor laser based system, nonlinearities are not expected due to the fast intraband relaxation rate, but can be achieved by introducing some external effects, such as:

(a) Modulation of the pumping currents [13-14].

(b) Feedback by an external cavity [15].

(c) Injection of external optical signals [16].

In all three approaches, the essential requirement is the existence of two frequencies [17], which characterise the non-linear dynamics of the device. Individually, they assume only one degree of freedom. However, if a source laser and a SLA are coupled to each other, then the injection of the input signal can generate considerable amount of non-linearity in an optical system [18]. In this paper, non-linear dynamics of a semiconductor laser amplifier, subjected to an external input radiation are investigated experimentally by generating self-sustained pulsation. Period doubling route to chaos is demonstrated for the first time. Co-existence of multiple wavelengths satisfying the cavity resonance of the SLA is thought to be the main reason behind the appearance of this behaviour.

Key Words: Semiconductor laser amplifiers, SSP, Chaos, Frustrated instabilities, Coherence collapse

REFERENCES