$$\left(\frac{dN}{dt}\right) = \frac{J}{qd} - \frac{N}{\tau_{sp}} - \frac{c}{\eta n_g}\sum_{m=1}^{M} g_m S_m \tag{2.5}$$

$$\left(\frac{dS_m}{dt}\right) = \frac{\gamma_m}{\tau_{sp}} D_m N + \frac{c}{n_g}\left(g_m - \alpha\right) S_m \tag{2.6}$$

$$g_m = \eta\frac{n_g}{c} A(D_m N - N_0) \tag{2.7}$$

$$\gamma_m = \frac{\eta\lambda_m^2}{4\pi n_r^2 D d} \tag{2.8}$$

$$\alpha = \alpha_0 + \frac{1}{L}\ln(\frac{1}{R}) \tag{2.9}$$

The stimulated emission factor A is defined as

$$A = \frac{\gamma_m}{\eta\tau_{sp}} D L \frac{d}{\eta} \tag{2.10}$$

$$D_m = \frac{\frac{\Delta\lambda_c}{\pi\Delta\lambda_D}}{1 + \left(\frac{\lambda_m - \lambda_0}{\Delta\lambda_D}\right)^2} \tag{2.11}$$

Parameter	Symbol	Typical Value	Unit
Carrier Density	N	-	m^{-3}
Photon Density of m^{th} Mode	S_m	-	m^{-3}
Time Coordinate	t	-	s
Injected Current Density	J	-	$A{\cdot}m^{-3}$
Unit Electron Charge	q	1.602176487×10^{19}	C
Thickness of Active Laser Region	d	0.3	μm
Width of Laser Stripe	D	5	μm
Length of Laser Cavity	L	250	μm
Spontaneous Emission Carrier Lifetime	τ_{sp}	3×10^{-9}	s
Speed of Light	c	3×10^{8}	m/s
Group Index of Laser Medium	n_g	4	-
Refractive Index of Laser Medium	n_r	3.4	-
Mode Confinement Factor	η	0.5	-
Gain Coefficient of m^{th} Mode	g_m	-	Refer to 2.7
Effective Cavity Loss Coefficient	α	-	Refer to 2.9
Reflectivity of Cavity Mirrors	R	0.3	-
Carrier Number Threshold	N_0	8.25×10^{5}	m^{-3}
Loss Coefficient	α_0	2000	m^{-1}
Spontaneous Emission Factor of m^{th} Mode	γ_m	-	Refer to 2.8
Line Shape Factor of Mode Distribution	D_m	-	Refer to 2.11
Stimulated Emission Factor	A	-	Refer to 2.10
Lasing Wavelength at the Peak of Distribution (Central Wavelength)	λ_0	1310	nm
Lasing Wavelength of m^{th} mode	λ_m	-	nm
Wavelength Spacing Between Two Adjacent Mode	$\Delta\lambda_c$	0.845	nm
Effective Gain Spectral Linewidth Parameter	$\Delta\lambda_D$	60	nm

Table 2.1: Definitions and typical values of the rate equation parameters

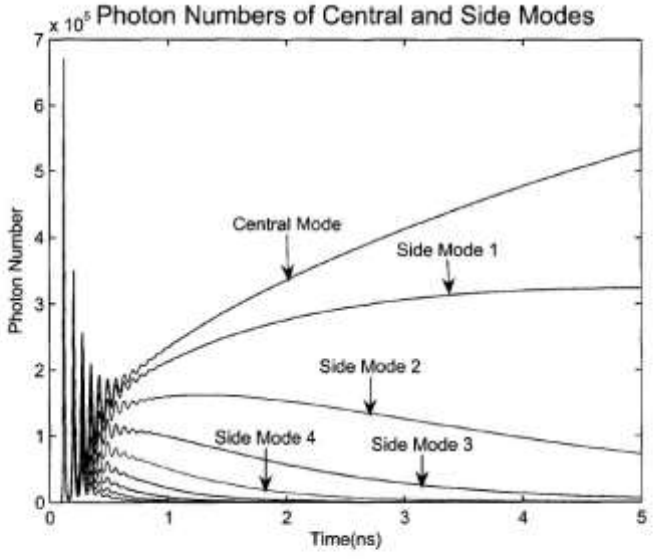

Figure 2.7: Photons numbers for main mode and another 3 side modes when modulation depth $m = 0.01$, with $J_0 = 0.1{\cdot}J_{th}$ and $J_b = 11{\cdot}J_{th}$