List of Figures

1.1 1.2	Phase picture for coherent state and squeezed state.	9 15
2.1	A schematic diagram for the generation of PSDFS (in (a) and (b)) and PADFS (in (c)	
	and (d)). In (a) and (c) ((b) and (d)), single-mode (two-mode) squeezed vacuum is	
	used for generation of the desired state. Here, NLC corresponds to nonlinear crystal	
	and D1 and D2 are photon number resolving detectors	24
2.2	Variation of Mandel Q_M parameter for PADFS (in (a) and (b)) and PSDFS (in (c) and (b)) is a large field of the set of	
	(d)) is snown with displacement parameter α . In (a) and (c), the value of number of photons added/subtracted (i.e., μ or ν) is changed for the same initial Eock state $ 1\rangle$	
	Different initial Fock states $ n\rangle$ are chosen to be displaced in (b) and (d) for the single	
	photon addition/subtraction. The blue curve corresponds to vacuum for $\alpha = 0$ and	
	thus starts from 0 unlike rest of the states which are Fock state $(n \neq 0)$ in the limiting	
	case. Therefore, nonclassicality increases first with increasing α before decreasing	
	as in the rest of the cases	28
2.3	The presence of higher-order antibunching is shown as a function of α for PADFS (in	
	(a)-(c)) and PADFS ((d)-(f)). Specifically, (a) and (d) illustrate comparison between	
	lower- and higher-order antibunching. It should be noted that some of the curves are	
	multiplied by a scaling factor in order to present them in one figure. Figures (b) and	
	(e) show the effect of photon addition/subtraction, and (c) and (i) establish the effect of Eock state chosen to displace in PADES and PSDES respectively. Here, without	
	the loss of generality we have used the notation $W_{\perp}(u, n, l-1)$ ($W_{\perp}(u, v, l-1)$) for	
	nonclassicality in photon added (subtracted) scenarios, and will follow this notation	
	in subsequent figures of this chapter.	29
2.4	Dependence of higher-order sub-Poissonian photon statistics on α for PADFS (in	
	(a)-(c)) and PSDFS ((d)-(f)) is illustrated here. Specifically, (a) and (d) show the	
	increase in depth of nonclassicality witness with order, (b) and (e) depict the effect	
	of photon addition and subtraction, respectively, and (c) and (f) establish the effect	
	of choice of Fock state to be displaced in PADFS and PSDFS, respectively	30
2.5	Illustration of the higher-order squeezing using Hong-Mandel criterion as the func-	
	tion of displacement parameter. In (a) and (d), dependence of the observed nonclas- signification of different orders (l) is shown for DADES and PSDES, respectively, while	
	in (b) and (c), the effect of variation in the number of photon added/subtracted is	
	shown in case of PADES and PSDES respectively. In (c) and (f) the variation due	
	to change in the initial Fock state chosen to be displaced is shown for PADFS and	
	PSDFS, respectively.	31
2.6	Hong-Mandel type higher-order squeezing for PADFS and PSDFS is shown depen-	
	dent on the phase of the displacement parameter $\alpha = \alpha \exp(i\theta)$ in (a) and (b),	
	respectively	32

2.7	Contour plots of the Q function for (a) single photon added displaced Fock $ 1\rangle$ state, (b) two photon added displaced Fock $ 1\rangle$ state, (c) single photon added displaced Fock $ 2\rangle$ state, (d) single photon subtracted displaced Fock $ 1\rangle$ state, (e) two photon subtracted subtracted displaced Fock $ 1\rangle$ state, (f) single photon subtracted displaced Fock $ 2\rangle$ state. In all cases, $\alpha = \sqrt{2} \exp\left(\frac{i\pi}{4}\right)$ is chosen.	33
2.8	Variation of Agarwal-Tara's parameter with α for PADFS and PSDFS is shown in (a)-(b) and (c)-(d), respectively. Specifically, the effect of photon addition/subtraction (in (a) and (c)) and the choice of Fock state ((b) and (d)) on the presence of nonclas-	
	sicality in PADFS and PSDFS is illustrated.	34
2.9	Illustration of the Klyshko's criterion. Variation of $B(m)$ with respect to m (a) and (c) for different values of the number of the photon additon/subtraction for PADFS and PSDFS, respectively; (b) and (d) for different values of the number of the Fock state parameter for PADFS and PSDFS, respectively. Here, we have chosen $\alpha = 1$ in all cases because almost all of the other criteria detected nonclassicality for this choice of α so does the Klyshko's criterion.	35
3.1	Variation of phase distribution function with phase parameter for PADFS with dis- placement parameter $ \alpha = 1$ for different values of photon addition ((a) and (c)) and Fock parameters ((b) and (d)). The phase distribution is shown using both two- dimensional ((a) and (b) with $\theta_2 = 0$) and polar ((c) and (d)) plots. In (c) and (d), $\theta_1 = \frac{n\pi}{2}$ with integer $n \in [0, 3]$ and the legends are some as in (a) and (b) respectively	40
3.2	Variation of phase distribution function with phase parameter for PSDFS with dis- placement parameter $ \alpha = 1$ for different values of photon subtraction ((a) and (c)) and Fock parameters ((b) and (d)). The phase distribution is shown using both two- dimensional ((a) and (b) with $\theta_2 = 0$) and polar ((c) and (d)) plots. In (c) and (d),	40
3.3	$\theta_2 = \frac{n\pi}{2}$ with integer $n \in [0,3]$, and the legends are same as in (a) and (b), respectively. The polar plots for angular Q function for PADFS (in (a) and (b)) and PSDFS (in (c) and (d)) for displacement parameter $ \alpha =1$ and $\theta_2 = \frac{n\pi}{2}$ with integer $n \in [0,3]$ for different values of photon addition/subtraction and Fock parameters. In (a) and (c), for $n = 1$, the smooth (blue), dashed (red), dot-dashed (magenta), and dotted (brown) lines correspond to photon addition/subtracted displaced Fock state, the smooth (blue), dashed (red), dot-dashed (magenta), and dotted (brown) lines correspond to Fock parameter 1, 2, 3, and 4, respectively.	41
3.4	Variation of three phase fluctuation parameters introduced by Carruthers and Ni- eto with the displacement parameter with $\theta_2 = 0$. The values of photon addition (<i>u</i>), subtraction (<i>v</i>), and Fock parameter $n = 1$ are given in the legends. Parameter $U(i,n) \forall i \in \{u,v\}$ also illustrates antibunching in the states for values less than $\frac{1}{2}$.	45
3.5	Variation of phase dispersion for PADFS (in (a) and (b)) and PSDFS (in (c) and (d)) with displacement parameter for an arbitrary θ_2 . Dependence on different values of photon added/subtracted and the initial Fock state $ 1\rangle$ (in (a) and (c)), while on different values of Fock parameter for single photon added/subtracted state (in (b)	1.6
3.6	and (d))	46
	parameters with $u = 1$ and $v = 1$, respectively. In all cases, we have chosen $\alpha = 0.1$.	4/

4.1	For PASDFS the lower-and higher-order antibunching is given as a function of dis-	
	placement parameter α . (a) Lower-order antibunching for different values of param-	
	eters of the state. (b) Higher-order antibunching for particular state. HOSPS for	
	PASDFS for different values of (c) state parameters and (d) order of nonclassicality	52
4.2	Dependence of the Hong-Mandel-type higher-order squeezing witness on displace-	
	ment parameter for (a) different state parameters and (b) order of squeezing. (c)	
	Lower-order squeezing as a function of phase parameter of the state, i.e., phase θ of	
	displacement parameter $\alpha = 1.\exp[\iota\theta]$.	53
43	Illustration of Klyshko's parameter $R(z)$ with respect to the photon number z for	
	different values of state parameters with (a) $\alpha = 0.5$ and (b) $\alpha = 1$.	54
4.4	Nonclassicality reflected through the negative values of (a) Agarwal-Tara's and (b)	υ.
	Vogel's criteria as a function of α or different state parameters	55
45	Polar plot of phase distribution function for PASDES $ w(k, \alpha, \alpha)\rangle$ with respect to	55
ч.5	variation in displacement parameter for (a) $n = 1, k = 2$ and $a = 1, 2$ and 3 rep	
	resented by the smooth (gyan) deshed (magenta) and det deshed (nurnle) lines	
	respectively. (b) $n = 2$, $a = 2$ and $k = 1$, 2, and 3 illustrated by the smooth (aven)	
	respectively, (b) $n = 2$, $q = 2$ and $k = 1, 2$, and 5 industrated by the smooth (cyan), deshed (measure) and det deshed (number) lines, respectively, and (a) $n = 1$ with	
	dashed (magenta), and dot-dashed (purple) miles, respectively, and (c) $n = 1$ with $k = a - 1/2$ and 2 shown by the smooth (syon) dashed (magenta) and dat dashed	
	k = q = 1, 2, and 5 shown by the smooth (cyan), dashed (magenta), and dot-dashed	50
10	(purple) lines, respectively.	30
4.6	variation of phase fluctuation parameter with displacement parameter for various	-
4 7	state parameters in PASDES.	36
4./	<i>Q</i> function for PASDFS $ \Psi(k,q,n,\alpha)\rangle$ with (a) $k = q = n = 1$, (b) $k = 2, q = n = 1$,	
	and (c) $q = 2, k = n = 1$ with $\alpha = \frac{1}{5\sqrt{2}} \exp(i\pi/4)$. (d) Similarly, Q function of	
	PASDFS with $q = 2, k = n = 1$ and $\alpha = \sqrt{2} \exp(i\pi/4)$. Q function for $ \psi(k, q, n, \alpha)\rangle$	
	with (e) $k = q = 1, n = 2$ and (f) $q = 1, k = n = 2$ for $\alpha = \frac{1}{5\sqrt{2}} \exp(i\pi/4)$	58
5.1	Lower- and higher-order antibunching witnesses as functions of displacement param-	
	eter α (for ECS and KS) and probability <i>p</i> (for BS with parameter $M = 10$) for (a)	
	ECS, PAECS and VFECS, (b) BS, PABS and VFBS, and (c) KS, PAKS and VFKS.	
	The quantities shown in all the plots are dimensionless.	66
5.2	Illustration of lower- and higher-order squeezing for (a) BS, PABS and VFBS; (b)	
	KS, PAKS and VFKS at the fixed value of $\chi = 0.02$; (c) KS, VFKS and PAKS as a	
	function of χ with $\alpha = 1$. The negative regions of the curves illustrate the presence	
	of squeezing.	67
5.3	The dependence of HOS witness $(l = 4)$ on Kerr parameter χ and displacement pa-	
	rameters $ \alpha $ and θ for PAKS with (a) $ \alpha = 3$, (b) $\chi = 0.02$, (c) $\theta = 0$	68
5.4	Illustration of HOSPS as a function of displacement parameter α (for ECS and KS)	
	and probability p (for BS) for (a) ECS, (b) BS, and (c) KS and corresponding engi-	
	neered states. HOSPS is not observed in KS.	69
5.5	Illustration of linear entropy for (a) ECS, PAECS and VFECS, (b) BS, PABS and	
	VFBS, (c) KS, PAKS and VFKS with α or p for $\chi = 0.02$. (d) Dependence of	
	nonclassicality in KS, PAKS and VFKS on χ for $\alpha = 1$.	69
5.6	Illustration of linear entropy for (a) KS (b) VFKS (c) PAKS.	71
	1 2	-