Quantitative imaging through scattering wall and fog using statistical analysis and holography

Thesis Submitted in Partial Fulfillment for the

Award of the Degree of

Doctor of Philosophy

By

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2024

Dedicated To My Beloved Parents

“*Everything I am and aspire to become is a reflection of my parents' love, sacrifices, and unwavering support*”

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Declaration by the candidate

I, ***Sourav Chandra***, certify that the work embodied in this thesis is my own bona fide work carried out by me under the supervision of ***Prof. Rakesh Kumar Singh*** and co-supervision of ***Dr. Rajeev Singh*** from ***July 2019*** to ***December 2024***, at the ***Department of Physics***, Indian Institute of Technology (BHU), Varanasi. The matter embodied in this thesis has not been submitted for the award of any other degree/diploma. I declare that I have faithfully acknowledged and given credit to the research workers wherever their works have been cited in my work in this thesis. I further declare that I have not willfully copied any other's work, paragraphs, text, data, results, *etc*., reported in journals, books, magazines, reports dissertations, thesis, *etc*., or available on websites and have not included them in this thesis and have not cited as my work.

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This thesis is dedicated to all those who have faced the storms of life with courage, endured hardships with resilience, and emerged stronger, proving that success is not merely a destination but a journey of perseverance and growth.

"The greater the obstacle, the more glory in overcoming it."
– Molière

Every setback is a setup for a comeback. Each moment of struggle shapes us, each failure teaches us, and each success reminds us of the value of unwavering effort.

"Your present circumstances don't determine where you can go; they merely determine where you start."

– Nido Qubein

To all who dare to dream, work relentlessly, and rise above the challenges life throws at them—this thesis is a tribute to your spirt of perseverance and triumph.

Acknowledgments

"গুরু ব্রহ্মা গুরু বিষ্ণু গুরুদেব মহেশ্বর| গুরু রেব পরং ব্রহ্ম তস্মৈ শ্রী গুরুবে নম: ||"

"Alone we can do so little; together we can do so much."

– Helen Keller

"Gratitude is not only the greatest of virtues, but the parent of all others."

– Marcus Tullius Cicero

Foremost, I am deeply grateful to my research supervisor, ***Prof. Rakesh Kumar Singh****, Department of Physics, IIT (BHU), for his exceptional guidance, continuous encouragement, and invaluable advice throughout my Ph.D. journey. His unwavering belief in the power of hard work has been a profound inspiration for me. The completion of this research work would not have been possible without his support, insightful discussions, feedback on my work, and valuable scientific ideas.*

I also extend my heartfelt gratitude to my co-supervisor, ***Dr. Rajeev Singh****, Department of Physics, IIT (BHU), for his guidance, patience, motivation, and constant encouragement during my research.*

I am extremely thankful to the ***Head of the Department of Physics****, IIT (BHU),* ***Prof. Sandip Chatterjee****, for providing the necessary facilities, as well as my* ***RPEC members****,* ***Dr. Somnath Nag*** *(Department of Physics, IIT (BHU)) and* ***Dr. Ashish Kumar Mishra*** *(School of Materials Science and Technology, IIT (BHU)), for their kind support, inspiration, and insightful suggestions.*

I am immensely thankful to ***Dr. Raj Kumar*** *and* ***Dr. Bhargab Das*** *(CSIR-CSIO, Chandigarh) and* ***Dr. Nandan S. Bisht*** *(Kumaun University, Nainital), for their invaluable support, insightful discussions, and access to lab facilities.*

I would like to express my gratitude to all the faculty members of the Department of Physics, IIT (BHU), for their encouragement and motivation. I also extend my sincere thanks to the non-teaching staff for their selfless assistance and support throughout my Ph.D. journey.

Words are not enough to express my gratitude towards my teachers and mentors who have shaped my career and nurtured my interest in physics and the noble profession of teaching. I am profoundly indebted to ***Anil Kumar Mukhopadhyay Sir****,* ***Ashish Kumar Mukherjee (AKM) Sir****, and* ***Debasis Sarkar Sir*** *for their guidance and encouragement. Their lessons and insights will remain with me forever.*

I am grateful to ***Dr. Lavlesh Pensia*** *and* ***Rajveer Kaur*** *(CSIR-CSIO, Chandigarh),* ***Dr. Vipin Tiwari*** *(University of Tartu, Estonia), and* ***Yukti Pandey*** *(Kumaun University, Nainital), for their unwavering support and help during our collaborative research. I*

truly enjoyed the time spent with them, which was both professionally enriching and personally memorable.

I owe a special debt of gratitude to my senior and mentor, ***Dr. Tushar Sarkar****, who has been like a big brother to me. His unwavering support, guidance, and encouragement have been instrumental in every step of my Ph.D. journey. Without his constant motivation and invaluable advice, this work would not have been possible. I am forever grateful for his mentorship and the pivotal role he played in making this endeavours a success.*

I extend my heartfelt gratitude to my batchmate, lab partner, and close friend, ***Akanksha Gautam****, for her unwavering cooperation and constant support during my toughest times. Her presence and encouragement have been a source of immense strength, and the moments we spent together will always hold a special place in my heart. In a world where people often prioritize their own interests, she has consistently demonstrated selflessness and compassion. I am blessed to have her as a friend, and I will forever cherish her care and support, which have been invaluable throughout this journey.*

This place has given me many sweet and sour memories, and this journey became the most beautiful phase of my academic life because of one of my close friends and lab companion, ***Mohit Rathor****. I will always be grateful to him for his invaluable help and support throughout my research journey. He has been my family away from home, offering kindness, support, and wise counsel in moments of doubt. His friendship and encouragement have been truly inspiring, and I wish him the very best in all his future endeavours.*

I am also thankful to my colleagues and friends from the ***Laboratory of Information Photonics and Optical Metrology, Department of Physics, IIT (BHU)****:* ***Sarita****,* ***Shivam Kumar Chaubey****,* ***Tanushree Karmakar****,* ***Amit Yadav****,* ***Prateek Agrawal****,* ***Ram Pratap****,* ***Ankita Chowdhury****,* ***Neha Choudhary****,* ***Satish****,* ***Arnab Bhattacharyya****, and* ***Munindra Kushwaha****. I would like to thank one of my former labmate, friend* ***Dr. Manisha****. Their camaraderie, support have made my research experience fulfilling, enjoyable, and memorable.*

I would also to express my sincere appreciation to my batchmates and friends, ***Sachin****,* ***Ashish****,* ***Santosh****,* ***Pawan****,* ***Koustubh****,* ***Anuvrat****,* ***Harsh****,* ***Shubham****,* ***Shweta****,* ***Neha****, and* ***Samiksha****, for their lively friendship and continuous support at all stages of my Ph.D. I cherish the moments spent with them. I would also like to thank my former roommate, batchmate,* ***Vivek Chand****, for his support and camaraderie.*

My heartfelt thanks also go to my former HEC group and seniors, ***Saroj Kanta Behera****,* ***Manish Tiwari****,* ***Amit Kumar Ram****,* ***Amit Kumar Singh****, and* ***Mayank Nishant****, for their companionship and joy throughout.*

Special thanks to ***Dr. Supriya Chanda****, my roommate, close friend, and mentor, whose unwavering support and care made this journey much easier. His kindness, unwavering belief in me, and encouragement helped me navigate moments of uncertainty. He has been a pillar of strength and an inspiration throughout this journey.*

*I would also like to express my heartfelt gratitude to one of my dearest friends, **Riya Roy**, for imparting life lessons that I will never forget. The moments I shared with her are cherished memories that will forever hold a special place in my heart. She was there for me during a phase when the future seemed uncertain and always encouraged me to do hardwork towards achieving my dream.*

*Finally, I express my sincere gratitude and love to my beloved parents and family members, who have always believed in me, encouraged me, prayed for me, and stood by me at every moment. I am profoundly indebted to my father, **Shri Dilip Chandra**, my mother, **Smt. Purnima Chandra**, my sister, **Puja Chandra**, my grandmothers, **Seba Paul** and **Kalidasi Chandra**, my uncle, **Mr. Mathur Paul**, and other relatives for their unconditional love, blessings, and unwavering support throughout my academic journey. My parent's blessings, prayers, care, and moral support have been the foundation of my success, and no words can adequately express my gratitude to her. I am deeply grateful to my sister, **Puja**, for single-handedly taking care of our parents in my absence. Without her support and dedication, this journey would not have been possible.*

To all others who contributed to this effort, even if not mentioned here, I deeply appreciate your support and encouragement.

*I would like to acknowledge **IIT (BHU)** and other funding agencies for providing me financial support to do my research, and present my research work in various international conferences.*

*I feel fortunate to have spent this significant time in **Kashi(Banaras)**, surrounded by the campus's beautiful greenery and **Baba Vishwanath's** blessings. The serene environment and spiritual essence of this place have been a source of inspiration and significantly contributed to my personal growth and the depth of my research.*

Lastly, I bow to the Almighty for granting me patience and perseverance to complete this endeavour successfully.

Sincerely

Sourav Chandra

Table of contents

Certificate iii
Declaration by the candidate iv
Copyright transfer certificate v
Acknowledgments vii
Table of contents x
List of figures xii
List of tables xvii
List of abbreviations xviii
Preface xxi
Chapter 1 Introduction 25
1.1 Optical imaging 27
1.2 Quantitative phase imaging 29
1.2.1 Non-iterative phase imaging 30
1.2.1.1 Holography 30
1.2.1.2 Kramers-Kronig (KK) relations 33
1.2.1.3 Transport of Intensity Equation (TIE) 34
1.2.1.4 Wavefront sensing 37
1.2.2 Iterative phase imaging 38
1.2.2.1 Gerchberg-Saxton (GS) algorithm 39
1.2.2.2 Fienup algorithm 41
1.2.2.3 Ptychography 43
1.3 Polarization imaging 45
1.4 Optical imaging with/through randomness 49
1.4.1 Adaptive optics 51
1.4.2 Optical phase conjugation 52
1.4.3 Transmission matrix approach 53
1.4.4 Wavefront shaping 54
1.4.5 Correlation optics 56
1.4.5.1 Intensity autocorrelation 56
1.4.5.2 Non-iterative statistical correlation approach 57
1.4.6 Correlation for polarized light 62
1.4.6.1 Beam Coherence–Polarization (BCP) matrix 63
1.4.6.2 Generalized Stokes Parameters (GSPs) 67
1.4.6.3 Polarization correlation 69
Chapter 2 Statistical analysis of randomness 73
2.1 Introduction 75
2.2 vMF distribution on the Poincaré Sphere 79
2.2.1 Theoretical details 80
2.2.2 Experiment 87
2.2.3 Results and discussions 90
2.3 Poincaré vector correlations 95

2.3.1 Theoretical framework 96
2.3.2 Experimental setup 102
2.3.3 Simulation and experimental results 106
2.4 Conclusion 110
Chapter 3 Imaging through dynamic scattering media 113
3.1 Introduction 115
3.2 Theoretical basis of HBT correlation 118
3.3 Imaging through a dynamic scattering wall 122
3.3.1 Experiment 122
3.3.2 Experimental results 126
3.4 Looking through fog with a high-speed camera 129
3.4.1 Experimental setup and results 130
3.5 Conclusion 133
Chapter 4 New experimental techniques to retrieve coherence and polarization information from randomness 135
4.1 Introduction 137
4.2 Correlation of Stokes fluctuation to measure BCP matrix 140
4.3 Two-shot SPs to measure BCP matrix 148
4.3.1 Experiment 148
4.3.2 Experimental results and discussions 152
4.4 Two-shot SPs to measure BCP matrix 155
4.4.1 Experiment 156
4.4.2 Experimental results and discussions 158
4.5 Single-shot SPs to measure BCP matrix 162
4.5.1 Experiment 163
4.5.2 Experimental results and discussions 164
4.6 Conclusions 171
Chapter 5 Polarimetry with random light 173
5.1 Introduction 175
5.2 Theoretical basis 177
5.3 Experiment 182
5.4 Simulation and experimental results 185
5.5 Conclusion 187
Chapter 6 Conclusion 189
6.1 Summary 191
6.2 Future Work 195
Bibliography 197
List of Publications 217

List of figures

Fig. 1.1 Imaging configuration. 29

Fig. 1.2 Basic geometries for holography. 32

Fig. 1.3 Schematic of experimental setup of phase imaging with KK relations [67]. 34

Fig. 1.4 The optical setup for TIE [74]. 35

Fig. 1.5 Basic principle of phase measurement using Shack-Hartmann wavefront sensor [80]. 38

Fig. 1.6 Schematic diagram of the iterative process of GS algorithm [83]. 41

Fig. 1.7 Schematic diagram of HIO algorithm [84]. 43

Fig. 1.8 Schematic experimental setups for conventional and single-shot ptychography technique. (a) Conventional (b) Single-shot ptychographical setup [109]. 44

Fig. 1.9 SOP representations through polarization ellipse and Poincare sphere [27]. 46

Fig. 1.10 Schematic for the experimental measurement of SPs. 47

Fig. 1.11 Experimental setup for polarimetric imaging with an integrated calibration scheme [139]. 48

Fig. 1.12 Generation of the speckle pattern. 49

Fig. 1.13 Visualization of imaging through different types of random media [142]. 50

Fig. 1.14 A schematic of the AO approach [21]. 52

Fig. 1.15 Schematic of OPC [144]. 53

Fig. 1.16 Experimental setup for the measurement of TM [150]. 54

Fig. 1.17 Illustration of focusing through scattering media by wavefront shaping [149]. 55

Fig. 1.18 Schematic of the memory effect: an incident-tilted source results in the shift of the speckle pattern. 57

Fig. 1.19 Schematic diagram for intensity correlation measurement. 58

Fig. 1.20 Experimental setup for phase imaging through scattering media using correlation holography [186]. 62

Fig. 1.21 Sketch for generation of polarization speckle. Polarization state distribution in part of the speckle is highlighted on the right-hand side. 63

Fig. 1.22 Schematic diagram of intensity correlation of vector field. 65

Fig. 1.23 Experimental setup for imaging polarized source behind the scattering media through BCP matrix measurement [212]. 66

Fig. 1.24 Experimental setup for imaging of polarized source behind the scattering media through GSPs measurements [222]. 68

Fig. 1.25 Schematic diagram for the polarization-resolved HBT experiment. 69

Fig. 1.26 Applications of imaging through randomness using correlation optics. 72

Fig. 1.27 A pictorial overview of the thesis contributions. 72

Fig. 2.1 Experimental setup for polarization speckle for different degrees of spatial polarization fluctuation. Laser: He-Ne laser; MO: Microscope objective; P: Pinhole; HWP: Half-wave plate; BS1, BS2: Beam splitters; PBS1, PBS2: Polarization Beam Splitters; M1, M2, M3, M4: Mirrors; L1, L2, L3, L4, L5: Lenses; GG: Ground glass; CA: Circular Aperture; CCD: Charge-coupled device; Computer. 88

Fig. 2.2 Detailed view of Sagnac geometry for imaging and controlling the overlap of two orthogonally polarized light fields on the ground glass. A red color represents incident diagonally polarized light. Green and pink colors represent two orthogonally polarized light fields, and white represents the overlapping area of two orthogonally polarized light fields. The inset shows experimental geometry for creating three different cases of polarization speckle. 89

Fig. 2.3 Experimentally measured amplitude distribution of horizontal and vertically polarized scattered fields at the CCD plane for three different cases of polarization speckle: (a) full overlap, (b) partial overlap, and (c) full separation. 91

Fig. 2.4 The first row represents the simulation results for polarization speckle with a fully overlapping case: (a) a joint PDF of the vMF distribution on the Poincaré sphere. Histograms represent marginal vMF distribution on the axis of (b) $\tilde{S}_1$ (c) $\tilde{S}_2$ (d) $\tilde{S}_3$. Second row represents corresponding experimental results: (e) a joint PDF of the vMF distribution on the Poincaré sphere; histograms of the marginal vMF distribution on the axis of (f) $\tilde{S}_1$ (g) $\tilde{S}_2$ (h) $\tilde{S}_3$. Analytically evaluated PDF of NSPs $\tilde{S}_1, \tilde{S}_2, \tilde{S}_3$ is represented by pink and blue colors for simulation and experimental results in the first and second row respectively. 93

Fig. 2.5 The first row represents the simulation results for polarization speckle with a partially overlapping case: (a) a joint PDF of the vMF distribution on the Poincaré sphere. Histograms represent marginal vMF distribution on the axis of (b) $\tilde{S}_1$ (c) $\tilde{S}_2$ (d) $\tilde{S}_3$. Second row represents corresponding experimental results: (e) a joint PDF of the vMF distribution on the Poincaré sphere; histograms of the marginal vMF distribution on the axis of (f) $\tilde{S}_1$ (g) $\tilde{S}_2$ (h) $\tilde{S}_3$. Analytically evaluated PDF of NSPs $\tilde{S}_1, \tilde{S}_2, \tilde{S}_3$ is represented by pink and blue colors for simulation and experimental results in the first and second row respectively. 93

Fig. 2.6 The first row represents the simulation results for polarization speckle with a fully separated case: (a) a joint PDF of the vMF distribution on the Poincaré sphere. Histograms represent marginal vMF distribution on the axis of (b) $\tilde{S}_1$ (c) $\tilde{S}_2$ (d) $\tilde{S}_3$. Second row represents corresponding experimental results: (e) a joint PDF of the vMF distribution on the Poincaré sphere; histograms of the marginal vMF distribution on the axis of (f) $\tilde{S}_1$ (g) $\tilde{S}_2$ (h) $\tilde{S}_3$. Analytically evaluated PDF of NSPs $\tilde{S}_1, \tilde{S}_2, \tilde{S}_3$ is represented by pink and blue colors for simulation and experimental results in the first and second row respectively. 94

Fig. 2.7 Space-time distribution of polarization speckles. Points r_1 and r_2 with respect to a centre point 'O' represent two observation points in a time-frozen speckle. 97

Fig. 2.8 Experimental setup for the synthesis of a time-frozen polarization speckle and SPs measurement. Laser: He-Ne laser; HWP: Half-wave plate; CA: Circular Aperture; PBS: Polarization Beam Splitter; M1, M2: Mirrors; L1, L2: Lenses; GG: Ground glass; QWP: Quarter-wave plate; LP: Linear polarizer; CCD: Charge-coupled device. 104

Fig. 2.9 Triangular Sagnac geometry is used to separate two counter-propagating orthogonally polarized components and their images on the GG plane. Yellow and blue colors represent two orthogonally polarized beams after a split from the PBS. A red color represents incident diagonally polarized light. The inset shows three different configurations of the orthogonal polarization components overlap to synthesize the polarization speckle. 104

Fig. 2.10 Panels (a)-(c) represents experimentally measured SPs for three different cases of the polarization speckle (a) full overlap; (b) half overlap; (c) full separation. 105

Fig. 2.11 Panels (a)-(c) and (d)-(f) represent simulation and experimental results of the distribution of normalized polarization correlation function $\gamma_p(\Delta \boldsymbol{r})$ for illuminating beam size 4mm and three different amounts of overlap (a, d) full overlap; (b, e) half overlap; (c, f) full separation. Pixel numbers are given on two axes. 109

Fig. 2.12 Panels (a)-(c) represent profiles of simulation and experimental results of the normalized polarization correlation function $\gamma_p(\Delta \boldsymbol{r})$ along the horizontal axis for illuminating beam size 4mm and three different amounts of overlap (a) full overlap; (b) half overlap; (c) full separation. 110

Fig. 3.1 Propagation from source to observation plane through a dynamic scattering medium. 120

Fig. 3.2 Instantaneous intensity patterns recorded in a lensless configuration through a dynamic scattering medium. 122

Fig. 3.3 Schematic of the optical set-up. BS: beam splitter; L1, L2: lenses; M: mirror; RGG: rotating ground glass; CMOS: complementary metal-oxide semiconductor, PC: personal computer. 124

Fig. 3.4 (a) Representation of cross-covariance process for the dynamically scattered intensity patterns. (b) Cross-covariance of intensity patterns. (c) Fourier spectrum of the cross-covariance. 127

Fig. 3.5 Experimental Results: (a), (b) show the target, and (c), (d) show the corresponding reconstructed amplitude distribution of the ‘ring shaped object’ and ‘HGB’, respectively—scale bar: 2.5 mm. 128

Fig. 3.6 Experimental Results: (a) Fourier spectra of the cross-covariance distributions of the vortex object with TC *l=1*. (fork pattern). Figs. (b), (c) indicates the vortex object's reconstructed amplitude and phase distribution from the inverse Fourier transforms of one of the centrally shifted fork patterns. 129

Fig. 3.7 Conceptual representation of our technique. 130

Fig. 3.8 Schematic of the optical set-up. BS1: beam splitter; L1, L2: lenses; SLM: spatial light modulator; M: mirror; RGG: rotating ground glass; LP: linear polarizer. 131

Fig. 3.9 Experimental Results: (a), (b) show the target, and (c), (d) show the corresponding reconstructed amplitude distribution of the ‘cross’ and ‘letter 2’, respectively. 132

Fig. 4.1 Schematic representation of the generation of vector random field at the far-field by the propagation of vector source through random scattering media. 141

Fig. 4.2 Experimental implementation of the proposed technique. BS: Beam splitter, GG: Ground Glass, L1, L2: Lenses, PA: Pinhole Aperture, LP: Linear polarizer, CCD:

Charge-coupled device, PC: Personal Computer. Labels (1) and (2) denote arm 1 and arm 2, respectively. 152

Fig. 4.3 Digital reconstruction of elements of the BCP matrix from the correlation of fluctuation of SPs. (a) experimentally measured SPs; (b) the correlation of fluctuation of SPs; (c) Fourier spectra of correlation of fluctuation of SPs; (d) In the Fourier spectra, central dc term is digitally suppressed to highlight the spectra and one spectrum is filtered out and shifted to the center (circled by a red circle); (e) reconstructed $W_{pq}^{1}(\Delta \boldsymbol{r})$; FT and IFT are Fourier transform and inverse Fourier transform operations, respectively. 154

Fig. 4.4 Experimental results: (a)-(d) represent amplitude distribution of the elements of the BCP matrix for the vortex with *l*=3. (e)-(h) are the corresponding phase distribution. 155

Fig. 4.5 Experimental implementation of the proposed technique. Laser: He-Ne laser, HWP: Half wave plate, SLM: Spatial light modulator, BS: Beam splitter, RGG: Rotating Ground Glass, L1, L2: Lenses, PA: Pinhole Aperture, LP: Linear polarizer, CCD: Charge-coupled device. Labels (1) and (2) denote arm 1 and arm 2, respectively. 157

Fig. 4.6 Digital reconstruction of elements of the BCP matrix from the correlation of fluctuation of SPs. (a) experimentally measured SPs; (b) the correlation of fluctuation of SPs; (c) Fourier spectra of correlation of fluctuation of SPs; (d) In the Fourier spectra, central DC term is digitally suppressed to highlight the spectra and one spectrum is filtered out and shifted to the center (circled by a red circle); (e) reconstructed $W_{pq}^{1}(\Delta \boldsymbol{r})$; FT and IFT are Fourier transform and inverse Fourier transform operations, respectively. 160

Fig. 4.7 Experimental results: (a)-(d) represent amplitude distribution of the elements of the BCP matrix for the circular aperture of diameter 4mm. (e)-(h) are the corresponding phase distribution. 161

Fig. 4.8 Experimental results: (a)-(d) represent amplitude distribution of the elements of the BCP matrix for the vortex with *l*=1. (e)-(h) are the corresponding phase distribution. 161

Fig. 4.9 (a) Experimental setup. Laser: He-Ne laser, HWP: Half wave plate, SLM: Spatial light modulator, BS: Beam splitter, GG: Ground Glass, L1, L2, L3: Lenses, PA: Pinhole Aperture, CA: Circular Aperture, PBS: Polarizing Beam splitter, M1, M2: Mirrors, CCD: Charge-coupled device. Labels (1) and (2) denote arm 1 and arm 2, respectively. (b) Laboratory picture of the experimental setup. 166

Fig. 4.10 Digital reconstruction process of elements of the BCP matrix from the correlation of fluctuations of the SPs. (a) single-frame intensity recording; (b), (c) calculated SPs from (a); (d) $\left|W_{pq}(\Delta \boldsymbol{r})\right|^{2}$ acquired from the correlation of fluctuation of SPs and represents fringes as indicated in the insets; (e) Fourier spectra of $\left|W_{pq}(\Delta \boldsymbol{r})\right|^{2}$ (f) Selected and centered Fourier spectra (marked by a circle); (g), (h) reconstructed $W_{pq}^{1}(\Delta \boldsymbol{r})$; FT and IFT are Fourier transform and inverse Fourier transform operations, respectively. 169

Fig. 4.11 Modulus square of the elements of the BCP matrix of the coherent summation of vector sources and reference random field at the detector plane. Results in the first row

in Figs (a)-(d) correspond to case 1; the second row in Figs. (e)-(h) present results correspond to case 2; third row in Figs. (i)-(l) present results correspond to case 3. 170

Fig. 4.12 Experimentally recovered complex elements of the BCP matrix for case 1 with circular aperture of diameter 4mm; (a)-(d) represents the amplitude distribution of the elements of the BCP matrix; (e)-(h) are the corresponding phase distributions. 170

Fig. 4.13 Experimentally recovered complex elements of the BCP matrix for case 2 with *l*=2. (a)-(d) represents the amplitude distribution of the elements of the BCP matrix; (e)-(h) are the corresponding phase distributions. 171

Fig. 4.14 Experimentally recovered complex elements of the BCP matrix for case 3 with axicon function. (a)-(d) represents the amplitude distribution of the elements of the BCP matrix; (e)-(h) are the corresponding phase distribution. 171

Fig. 5.1 Conceptual representation of the proposed technique. 178

Fig. 5.2 represent an experimental configuration of the proposed technique. Laser: He-Ne laser, HWP: Half wave plate, BS: Beam splitter, SLM: Spatial light modulator, M1, M2, M3: Mirrors, L1, L2, L3: lenses, GG: Ground glass, CA: Circular Aperture, PBS: Polarizing beam splitter, CCD: Charge-coupled device. Violet dotted line plane is imaged on the CCD. 184

Fig. 5.3 Experimentally measured SPs of the source with different SOP. (a)-(b) shows the SPs for the "star", (e)-(h) represent the SPs for the "plus". Scale bar: 0.5 mm. 186

Fig. 5.4 (a), (b) represents the polarization ellipse plots of experimentally measured SPs for the two sources. 'Blue' and 'cyan' colors depict the orientations of 450 and -450 linearly polarized light, and 'red' and 'green' indicate the orientations of RCP and LCP light. 187

List of tables

Table 2.1 Simulation and experimental results of averaged NSPs, and SDOPs for three different types of overlap. 92

Table 2.2 Simulation and experimental results of spatial mean direction and spatial concentration parameter for three different types of overlap. 95

Table 4.1 Description of different vector sources. 158

Table 4.2 Different vector sources used in this technique. 165

Table 6.1 Comparison table 195

List of abbreviations

Abbreviations	**Description**
2D	Two-dimensional
AO	Adaptive Optics
BCP	Beam Coherence-Polarization
BS	Beam Splitter
CA	Circular Aperture
CCD	Charge-Coupled Device
CDMP	Complex Degree of Mutual Polarization
CGH	Computer-Generated Hologram
CMOS	Complementary Metal Oxide Semiconductor
DH	Digital Holography
DMD	Digital Micromirror Device
FOV	Field Of View
FT	Fourier Tranform
GG	Ground Glass
GS	Gerchberg-Saxton

GSP	Generalized Stokes Parameter
HBT	Hanbury Brown-Twiss
He-Ne	Helium - Neon
HGB	Hollow Gaussian Beam
HIO	Hybrid Input-Output
HWP	Half-Wave Plate
IFT	Inverse Fourier Transform
KK	Kramers-Kronig
L	Lens
LCP	Left-Circularly Polarized
LCVR	Liquid Crystal Variable Retarder
LP	Linear Polarizer
M	Mirror
MDOP	Multi-scale Degree Of Polarization
MO	Microscopic Objective
NLOS	Non-Line-Of-Sight
NSP	Normalized Stokes Parameter
OPC	Optical Phase Conjugation

P	Pinhole
PA	Pinhole Aperture
PBS	Polarization Beam Splitter
PC	Personal Computer
PDF	Probability Density Function
QWP	Quarter-Wave Plate
RCP	Right-Circularly Polarized
RGG	Rotating Ground Glass
SDOP	Spatial Degree Of Polarization
SLM	Spatial Light Modulator
SOP	State Of Polarization
SP	Stokes Parameter
TC	Topological Charge
TIE	Transport of Intensity Equation
TM	Transmission Matrix
vCZ	van-Cittert Zernike
vMF	von Mises-Fisher
WFS	Wavefront Shaping