



















Education

Nanjing University	College of Engineering and Applied Sciences	Nanjing, Jiangsu
Doctor of Philosophy	Optical Engineering	Q.E. – Top 15%  Nonlinear Fourier Optics  – 2025.06
Dissertation: “Analytic 3D vector linear non-uniform & nonlinear Fourier crystal optics in arbitrary $\bar{\epsilon}, \bar{\chi}$ dielectrics” 		
Master’s Studies	Quantum Electronics	Courses Score – 93.5  THz OAM Source  – 2022.06
Northeastern University	School of Physics, College of Science	Shenyang, Liaoning
Bachelor of Science	Applied Physics	GPA Rank – 1/400  DDTank Aimbots  – 2020.06
Thesis: “Research & design of nonlinear holography based on lithium niobate 3D nonlinear photonic crystal”  		
Freshman in College	Science	Sichuan Prov. – Top 2% 3 e-books with C++  2016.09 –

Personal Projects

Three e-books	3 e-books on mathematics, physics, and programming	– 2017.08
	<ul style="list-style-type: none">• Book 1: mathematics, divided into 6 chapters, some intriguing chapters are:<ul style="list-style-type: none">→ Multinomial theorem→ Strive to get the general formula for the n-th derivatives of a composite function $f(g(x))$→ The connection between the sums of certain series and the indefinite integrals of their terms→ Explaining Euler’s formula $a + b - c = n$ through topology→ Retracing the journey of the determinant calculation rules• Book 2: up to 12 programs mainly designed to solve mathematical problems<ul style="list-style-type: none">→ All solutions that meet the criteria of the Faà di Bruno Formula→ Deep recursion algorithms for the aforementioned contexts & the partition numbers→ General solution of a system of multivariable linear equations with given coefficients→ Complete solution to the Double Comb/Ruler problem→ Minimum integer solution of a system of two linear Diophantine equations→ Microstate count of Bose-Einstein systems \in Multinomial theorem’s combinations• Book 3: geometry related<ul style="list-style-type: none">→ Spherical trigonometry→ Special relativity	C++ 

Behind NLAST ¹	0 → 1 : Techniques crafted from scratch in my academic project : NLAST 2022.02 – <ul style="list-style-type: none"> Managed to realize <i>tree</i>-print feature in CMD lines without knowing <i>any tree</i>-packages <ul style="list-style-type: none"> in order to visualize run-time <i>Call Stack</i> with <i>buried checkpoints</i> & display <i>crucial info</i> to understand the <i>hierarchical structure</i> of my code from a more <i>abstract</i> perspective Enabled <i>multi-threads</i> to accelerate <i>for loops</i> in python while preserving the <i>loops' order</i> <ul style="list-style-type: none"> Implemented through utilizing the <i>producer-consumer model</i> (producer = thread pool) Allow users to select which parts of the codes in the <i>for loops</i> to <i>parallelize</i> in CPU Transform <i>multi-layer for loops</i> into <i>nested multi-threads</i>: each thread = a new thread pool Future model will move away from <i>python</i> as the primary language & shift to GPU <ul style="list-style-type: none"> Favoring GPU is driven by “<i>fields</i> in physics = <i>arrays/matrices</i> in math/programs” Haven't decided which to employ: CUDA, Jax, webGL2, webGPU, Mojo or Bend? Developed a log file system to track & record the operating status for debugging <ul style="list-style-type: none"> to output script parameters (<i>**kwargs</i>) for rapid reproducibility of data in the future to store data files & folders, and their metadata for swift data import and reutilization Achieved automatic skipping of functions that return repeated values stored in memory <ul style="list-style-type: none"> via <i>@decorators</i>: let precomputation assess whether to execute the decorated function Wrap <i>matplotlib</i> into <i>plot_1d</i>(, <i>_2d</i>, <i>_3d</i>, <i>.gif</i> ...) for data visualization <ul style="list-style-type: none"> also sped up by customized multi-threading ... Matlab Mathematica JavaScript Python 
LabView Projects	BB84 QKD protocol simulation & distributed optical fiber sensing – 2021.06 <ul style="list-style-type: none"> Verified the information security of photon_polarization_state-related BB84 protocol  Visualized the distribution of anomalies along the fiber optic cable from user data LabView 
Extended 1A2B	A Code-breaking Game - Bulls and cows: Guessing 4 digits → 1-9 digits – 2019.09 <ul style="list-style-type: none"> Hardware - MicroController (C8051F350.h) version of Original 1A2B: Guessing 4 numbers Software - VC++6.0 version of Upgraded 1A2B: Guessing 1-9 numbers Keil.C C++  
DDTank Aimbots	An inverse solving toolkit for a projectile game similar to Angry Birds – 2017.04 <ul style="list-style-type: none"> Established an aerodynamic model with air resistance $\mathbf{R} = -k\mathbf{v}$ for the game DDTank <ul style="list-style-type: none"> by solving $\mathbf{v}' \propto \mathbf{R} + \mathbf{F}$, where driving force \mathbf{F} = gravity \mathbf{G} + wind force \mathbf{W} which lead to the core transcendental equation $1 - e^{kt} + kt = k^2 M(\mathbf{F}; \Delta\mathbf{r}, \hat{\mathbf{v}}_0)$ that can be numerically solved by Newton's method for t with given $k, \mathbf{F}; \Delta\mathbf{r}, \hat{\mathbf{v}}_0$ Finally, for each $\Delta\mathbf{r}, \hat{\mathbf{v}}_0$, one can obtain corresponding initial velocity $v_0(k, \mathbf{F}; t, M)$ <ul style="list-style-type: none"> after k, \mathbf{F} are determined (by the game engine itself) v_0 ends up the very info required to accurately hit an enemy at a distance of $\Delta\mathbf{r}$ from you Software Features: multi-OS/end, multi-hit_mode, multi-trajectory, multi-thread supported <ul style="list-style-type: none"> Multi-OS: classic Web game on Windows, Mobile game on Android & Android Emulator Multi-hit_mode: charge-mode for value v_0, drag_mode (like angry birds) for extended curve Multi-trajectory: predicts up to $6 = (1+2)*2$ trajectories for the player: split 3 + backward 3 Multi-threading: succeeded in coordinating multiple timers to implement multi-threading Capturing game data semi-automatically with computer vision purely <ul style="list-style-type: none"> call findmulticolorEX in dm.dll VBA Excel E4A EPL  

¹ Non-linear Angular Spectrum Theory

- Drawing insights from [PRS.A](#). #M.V.Berry's legacy | [A.O.P.](#) | [A.P.B.](#) | [J.QSRT](#).
- The next generation of this project will come really close to the exact solution
- logging system
 - [J.O.S.A.](#) #Bloembergen's legacy1 | [J.O.](#) | [O.M.](#) | [O.M.](#) | [J.O.](#) | [L.P.R.](#)
 - [JOSA.A.](#) | [O.E.](#) #tightly focus $\bar{\epsilon}$ anisotropy | [Light.Sci.App.](#) | [O.E.](#)

PPT [1](#) [2](#) [3](#) ...

Three Books Closed-form $E_3(\mathbf{r})$ in
$$\left[\nabla^2 + k_3^2 \right] E_3(\mathbf{r}) = -k_{03}^2 \chi(\mathbf{r}) E_1(\mathbf{r}) E_2(\mathbf{r})$$

2022.02 –

- Solving this multivariable/field nonlinear convolution equation on my own
- Strong alternative to Green's Function, pseudo-spectral, split-step Fourier methods
- Developed a log file system to record and output script runtime parameters**kwargs,
 - [P.R.L.](#) #Green | [P.R.L.](#) #experiment #quantum | [P.R.L.](#) #experiment #scatter | [P.R.L.](#)
 - [L.P.R.](#) #SSF #quantum | Matlab #RCWA | [A.P.L.](#) #femtosecond pump
 - [O.L.](#) | [P.R.A.](#)

PPT [1](#) [2](#) [3](#) [4](#) ...

Scientific Activities

- | | | |
|------|---|-------------------------|
| [0] | The 4th Nanjing University Doctoral Interdisciplinary Innovation Forum | Nanjing, Jiangsu |
| | "Analytic vector linear & nonlinear Fourier crystal optics in arbitrary $\bar{\epsilon}$, $\bar{\chi}$ dielectrics" Oral [PPT] | 2024.05.29 |
| [-1] | 2023 CSOE-NJU² Book Club Meeting & Sharing Session | Nanjing, Jiangsu |
| | "A guided tour to Ray & Wave Optics Simulation" Oral [PPT] | 2023.12.09 |
| [-2] | Academic Café Salon of the Research Group | Nanjing, Jiangsu |
| | "Bi-directional notes on Nonlinear Optics in a roam-like app: RoamEdit" Oral [PDF] | 2021.05.21 |

Publications

- | | |
|------|---|
| [0] | P. Chen, X. Xu, T. Wang, C. Zhou, D. Wei, J. Ma, J. Guo, X. Cui, X. Cheng, C. Xie , S. Zhang, S. Zhu, M. Xiao, and Y. Zhang, <i>Laser nanoprinting of 3D nonlinear holograms beyond 25000 pixels-per-inch for inter-wavelength-band information processing</i> , Nature Communications 14 , 5523 (2023) |
| [-1] | J. Guo, Y. Zhang, H. Ye, L. Wang, P. Chen, D. Mao, C. Xie , Z. Chen, X. Wu, M. Xiao, and Y. Zhang, <i>Spatially Structured-Mode Multiplexing Holography for High-Capacity Security Encryption</i> , ACS Photonics 10 , 757–763 (2023) |

Academic Focus

- | | |
|---|-----------|
| Next generation high N.A. 3D vector non-uniform analytic linear & nonlinear Fourier crystal optics | 2024.06 – |
| !Paraxial k_0^ω High N.A. 3D vector non-uniform analytic linear & nonlinear Fourier crystal optics | 2024.03 – |
| Emphasizing G_{xyz}^ω 3D vector non-uniform analytic linear & nonlinear Fourier crystal optics | 2023.12 – |
| Involving $\bar{\chi}_\omega^{(2)}$ anisotropy Vector non-uniform analytic linear & nonlinear Fourier crystal optics | 2023.06 – |
| !Unitary $G_\omega^\pm \Leftarrow$!Hermitian $\bar{\epsilon}_r^\omega \Rightarrow$ Non-uniform analytic linear & nonlinear Fourier crystal optics | 2023.03 – |




² The Nanjing University student branch of the Chinese Society for Optical Engineering

Solution E_{ω}^{\pm} to $(\nabla^2 + k_{\omega\pm}^2)E_{\omega}^{\pm} \propto P_{\omega\pm}^{(2)}$	Analytic linear & nonlinear Fourier crystal optics	2022.09 –
Solution $\mathcal{F}[E_3] = \mathcal{F}[f(\mathcal{F}^{-1}[\cdot])]$ to the Eq. below	Nonlinear angular spectrum theory for SFG	2022.06 –
Solution $\mathcal{F}[E_3] = \iiint \mathcal{F}[\cdot]$ to $(\nabla^2 + k_3^2)E_3(r) \propto P_3^{(2)}(r)$	Nonlinear convolution solution to SFG	2022.03 –
Nonlinear THz LiNbO ₃ -based metasurface	Quit THz project formally COMSOL	– 2022.01
BWOPO + THz optical parametric amplification	Mathematica BookxNote Pro	– 2021.12
THz backward optical parametric oscillator (BWOPO)	Mathematica VBA Excel	– 2021.11
Multi-cycle THz orbital angular momentum (OAM) source	RoamEdit Blender	– 2021.11
Narrow-band THz OAM source via Optical Rectification (OR)	Python Blender	– 2021.10
Electricity $\xrightarrow{\text{produce}}$ Acoustics $\xrightarrow{\text{modulate}}$ Optics	RoamEdit VBA Excel	– 2021.07
Visible Photons $\xrightarrow{\text{SPDC}}$ THz Spectroscopy	BookxNote Pro GeoGebra VBA Excel	– 2021.06
Cavity Phase Matching = Sheet OPO	Paint 3D RoamEdit GeoGebra VBA Excel	– 2021.05
THz Holography via Optical Rectification	Matlab GeoGebra VBA Excel	– 2021.01
Femtosecond laser $\xrightarrow{\text{Optical Rectification}}$ Terahertz (THz)	GeoGebra VBA Excel	– 2020.12
Multicycle THz pulse generation by OR in LiNbO ₃ ... crystals	VBA PowerPoinT	– 2020.10

Honors & Awards

Academia	Doctor’s Qualification Exam (Oral)	Excellent	Top 15%	Nanjing	U.	2024.01
	Bachelor Thesis & Defense	Excellent	1/90	Northeastern	U.	2020.06
Competition	Three Provinces Achievement Expo	Exhibition	Leader	Three	Prov.	2019.10
	“Challenge Cup” Tech Competition	Grand prize	Leader	Liaoning	Prov.	2019.06
Scholarships & Fellowships	Academic Fellowship	1st class	¥40,000	Nanjing	U.	2020-24
	“Jinchuan” Scholarship	1st place	¥5,000	Northeastern	U.	2019.04
	Academic Scholarship	1st place	¥2,000	Northeastern	U.	2018.06
	Entrance Scholarship	3rd place	¥5,000	Leshan No.1 H.S.		2013.09
Honors & Titles	Graduation with Honor	Outstanding		Northeastern	U.	2020.07
	League Member	Excellent		Northeastern	U.	2019.11
	Undergraduate Student	Excellent		Northeastern	U.	2018.12
Memberships	Chinese Society for Optical Engineering	Member		Nanjing	U.	2021-25
	“Qian Sanqiang” Talent Class	Head		I.H.E.P.		2017-20

Research Projects

3D Vector Nonlinear Fourier Crystal Optics	Solving $\left[(\nabla \times)^2 - k_0^2 \bar{\epsilon} \cdot \right] \mathbf{E}(\mathbf{r}) = k_0^2 \bar{\chi} : \mathcal{F}_\omega^{-1} \left[\tilde{\mathbf{E}}_p \tilde{\mathbf{E}}_p \right](\mathbf{r})$ analytically 2023.05 – <ul style="list-style-type: none"> • The first & fastest white box solver ever for this inhomogeneous wave equation <ul style="list-style-type: none"> ◦ or other similar equations, with unprecedented efficiency-accuracy product • No competitors for the time being: other methods or software including <ul style="list-style-type: none"> ◦ k-space RK4, pseudo-spectral, SSF, Green's Function methods, FDTD, COMSOL... • Reproduced well-known papers, all of which provide either zero or wrong theory: <ul style="list-style-type: none"> ◦ Nat.Photo. #proven theoretically wrong by this project #femtosecond pump ◦ O.E.. #Bloembergen's legacy2 #experiment O.M.E.. #z-component ◦ O.E. Q.E.. #high N.A. #$\bar{\chi}$ anisotropy PPT 1 2 3 ... 
Complex Vector Linear Fourier Crystal Optics	Analytic solution $\mathbf{E}(\mathbf{r})$ to $\left[(\nabla \times)^2 - k_0^2 \bar{\epsilon} \cdot \right] \mathbf{E}(\mathbf{r}) = \mathbf{0}$ where $\epsilon_{ij} \in \mathbb{C}$ 2023.02 – <ul style="list-style-type: none"> • Drawing insights from PRS.A. #M.V.Berry's legacy A.O.P. A.P.B. J.QSRT. • The next generation of this project will come really close to the exact solution • Reproduced well-known papers, some are purely experimental (too hard to model): <ul style="list-style-type: none"> ◦ J.O.S.A.. #Bloembergen's legacy1 J.O. O.M. O.M. J.O. L.P.R. ◦ JOSA.A. O.E.. #tightly focus #$\bar{\epsilon}$ anisotropy Light.Sci.App. O.E. PPT 1 2 3 ... 
Real Scalar Nonlinear Fourier Crystal Optics	Closed-form $E_3(\mathbf{r})$ in $\left[\nabla^2 + k_3^2 \right] E_3(\mathbf{r}) = -k_{03}^2 \chi(\mathbf{r}) E_1(\mathbf{r}) E_2(\mathbf{r})$ 2022.02 – <ul style="list-style-type: none"> • Solving this multivariable/field nonlinear convolution equation on my own • Strong alternative to Green's Function, pseudo-spectral, split-step Fourier methods • Reproduced well-known papers & models with maximum accuracy & efficiency: <ul style="list-style-type: none"> ◦ P.R.L.. #Green P.R.L.. #experiment #quantum P.R.L.. #experiment #scatter P.R.L. ◦ L.P.R.. #SSF #quantum Matlab #RCWA A.P.L.. #femtosecond pump ◦ O.L. P.R.A. PPT 1 2 3 4 ... 

Extracurricular Activities

• Member at Some Club <i>Detailed explanation of what you do at this club</i>	2017–Current
• Member at Some Club <i>Detailed explanation of what you do at this club</i>	2016–2017
• Volunteer at Some Event <i>Detailed explanation of what you do in this event</i>	Fall 2019
• Volunteer at Some Event <i>Detailed explanation of what you do in this event</i>	Winter 2015

Skills

- **Skill Group:** List of technologies
- **Skill Group:** List of technologies
- **Skill Group:** List of technologies
- **Skill Group:** List of technologies

Languages

- **Language:** language proficiency level
- **EXAM:** details
- **Language:** language proficiency level
- **Language:** language proficiency level