












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

Behind NLAST¹

0 → 1 : Techniques crafted from scratch in my acedemic project : NLAST 2022.02 –

- Managed to realize *tree*-print feature in CMD lines without knowing *any tree*-packages
 - in order to visualize run-time *Call Stack* with *buried checkpoints* & display *crucial info*
 - to understand the *hierarchical structure* of my code from a more *abstract* perspective
- Enabled *multi-threads* to accelerate *for loops* in python while preserving the *loops’ order*
 - Implemented through utilizing the *producer-consumer model* (producer = thread pool)
 - Allow users to select which parts of the codes in the *for loops* to *parallelize* in CPU
 - Transform *multi-layer for loops* into *nested multi-threads*: each thread = a new thread pool
 - Future model will move away from *python* as the primary language & shift to GPU
 - Favoring GPU is driven by “*fields* in physics = *arrays/matrices* 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
 - to output script parameters (***kwargs*) 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
 - via *@decorators*: let precomputation assess whether to execute the decorated function
- Wrap *matplotlib* into *plot_1d(, _2d, _3d, .gif ...)* for data visualization
 - sped up by customized multi-threading as well ...

Python | SiYuan | Mathematica [repo]

¹ Non-linear Angular Spectrum Theory

- Established an aerodynamic model with air resistance $\mathbf{R} = -k\mathbf{v}$ for the game DDTank
 - 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 $v_0(k, \mathbf{F}; t, M)$
 - 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
 - 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 (using *findmulticolorEX* in dm.dll)
- Achieved automatic skipping of functions that return repeated values stored in memory
 - via *@decorators*: let precomputation assess whether to execute the decorated function
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- Drawing insights from [PR.S.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.](#)
 - [J.O.S.A.A.](#) | [O.E.](#) #tightly focus # \bar{e} anisotropy | [Light.Sci.App.](#) | [O.E.](#)

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**kwarg,
 - 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, *Laser nanoprinting of 3D nonlinear holograms beyond 25000 pixels-per-inch for inter-wavelength-band information processing*, 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, *Spatially Structured-Mode Multiplexing Holography for High-Capacity Security Encryption*, 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 –
- 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 $\mathcal{F}[E_3] = \iiint \text{to } (\nabla^2 + k_3^2) E_3(\mathbf{r}) \propto P_3^{(2)}(\mathbf{r})$ **Nonlinear** convolution solution to SFG  2022.03 –
-  Nonlinear THz LiNbO₃-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

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

🌐 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	<div> <div>Solving</div> <div> $\left[(\nabla \times)^2 - k_0^2 \bar{\epsilon} \right] \mathbf{E}(\mathbf{r}) = k_0^2 \bar{\chi} : \mathcal{F}_\omega^{-1} \left[\tilde{\mathbf{E}}_p \tilde{\mathbf{E}}_p \right] (\mathbf{r})$ </div> <div>analytically</div> </div> <div> <div>2023.05 –</div> <div> <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 </div> <div>PPT 1 2 3 ... </div> </div>
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Complex Vector Linear Fourier Crystal Optics

Analytic solution $E(\mathbf{r})$ to $\left[(\nabla \times)^2 - k_0^2 \bar{\epsilon} \cdot \right] E(\mathbf{r}) = 0$ where $\epsilon_{ij} \in \mathbb{C}$ 2023.02 –


- 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):
 - [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.](#)

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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 –

- 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:
 - [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.](#)

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EXTRACURRICULAR ACTIVITIES

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

SKILLS

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

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