

# Hua-sheng XIE (谢华生)

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2018.02-

Chief Scientist of Fusion Theory and Simulation,

ENN Science and Technology Development Co.,Ltd. [新奥科技发展有限公司 (新奥能源研究院) ]

## Education

- **Postdoc** 2015.10 - 2018.02, School of Physics, Peking University
- **Ph.D.** Plasma Physics, 2015, Zhejiang University  
Thesis: *Numerical Simulations of Micro-turbulence in Tokamak Edge* (Advisor: Yong XIAO)
- **B.S.** Physics, 2010, Zhejiang University  
Thesis: *Study of ES1D Beam-Plasma Interactions* (Advisor: Prof. Liu CHEN)

## Research interests (up to now)

- Compact fusion.
- Fundamental plasma theories (especially, space plasma, astrophysics)
- Algorithms for numerical solutions or simulations of linear and nonlinear plasma problems

- Tokamak physics (Alfvén waves/eigenmodes, ballooning mode, edge, ...)
- Dipole field (space and laboratory, see [gkd](#))

## Publications

1. **H. S. Xie**, Generalized Plasma Dispersion Function: One-solve-all Treatment, Visualizations, and Application to Landau Damping, *Physics of Plasmas*, 2013, **20**, 092125. [13a]
2. **H. S. Xie**, Constant Residual Electrostatic Electron Plasma Mode in Vlasov-Ampere System, *Physics of Plasmas*, 2013, **20**, 112108. [13b]
3. **H. S. Xie**, PDRF: A General Dispersion Relation Solver for Magnetized Multi-fluid Plasma, *Computer Physics Communications*, 2014, **185**, 670-675. [14a]
4. W. Chen, Z. Qiu, X. T. Ding, **H. S. Xie**, L. M. Yu, X. Q. Ji, J. X. Li, Y. G. Li, J. Q. Dong, Z. B. Shi, Y. P. Zhang, J. Y. Cao, X. M. Song, S. D. Song, M. Xu, Q. W. Yang, Yi. Liu, L. W. Yan, X. R. Duan and HL-2A team, Observation and Theory of Nonlinear Mode Couplings between Shear Alfvén Wave and Magnetic Island in Tokamak Plasmas, *EPL*, 2014, **107**, 25001. [14b]
5. **H. S. Xie**, J. Zhu and Z. W. Ma, Darwin Model in Plasma Physics Revisited, *Physica Scripta*, 2014, **89**, 105602. [14c]
6. W. Chen, LiMin Yu, Yi. Liu, X.T. Ding, **H. S. Xie**, J. Zhu, L.M. Yu, X.Q. Ji, J.X. Li, Y.G. Li, D.L. Yu, Z.B. Shi, X.M. Song, J.Y. Cao, S.D. Song, Y.B. Dong, W.L. Zhong, M. Jiang, Z.Y. Cui, Y. Huang, Y. Zhou, J.Q. Dong, M. Xu, F. Xia, L.W. Yan, Q.W. Yang, X.R. Duan and the HL-2A Team, Destabilization of Reversed Shear Alfvén Eigenmodes Driven by Energetic Ions During NBI in HL-2A Plasmas with  $q_{\min} \sim 1$ , *Nuclear Fusion*, 2014, **54**, 104002. [14d]
7. **H. S. Xie** and Y. Xiao, Parallel Equilibrium Current Effect on Existence of Reversed Shear Alfvén Eigenmodes, *Physics of Plasmas*, 2015, **22**, 022518. [15a]
8. **H. S. Xie** and Y. Xiao, Unconventional Ballooning Structures for Toroidal Drift Waves, *Physics of Plasmas*, 2015, **22**, 090703. [15b]
9. **H. S. Xie** and Y. Xiao, PDRK: A General Kinetic Dispersion Relation Solver for Magnetized Plasma, *Plasma Science and Technology*, 2016, **18**, 97. [16a]
10. W. Chen, L. M. Yu, X. T. Ding, **H. S. Xie**, Z. B. Shi, X. Q. Ji, D. L. Yu, Y. P. Zhang, P. W. Shi, Y. G. Li, B. B. Feng, M. Jiang, W. L. Zhong, J. Y. Cao, X. M. Song, M. Xu, Y. H. Xu, L. W. Yan, Yi. Liu, Q. W. Yang, X. R. Duan

- and HL-2A Team, Core-localized Alfvénic Modes Driven by Energetic-ions in the HL-2A NBI Plasmas with Weak Magnetic Shears, *Nuclear Fusion*, 2016, **56**, 036018. [16b]
11. **H. S. Xie** and B. Li, Global Theory to Understand Toroidal Drift Waves in Steep Gradient, *Physics of Plasmas*, 2016, **23**, 082513. [16c]
  12. **H. S. Xie**, Y. Xiao, I. Holod, Z. Lin and E. Belli, Sensitivity of kinetic ballooning mode instability to tokamak equilibrium implementations, *Journal of Plasma Physics*, 2016, **82**, 905820503. [16d]
  13. J. Cheng, J. Q. Dong, L. W. Yan, Z. X. He, **H. S. Xie**, Y. Xiao, K. J. Zhao, Z. H. Huang, J. Q. Xu, L. Liu, Z. B. Shi, W. L. Zhong, D. L. Yu, X. Q. Ji, Y. Huang, X. M. Song, Q. W. Yang, X. T. Ding, X. L. Zou, X. R. Duan and HL-2A Team, Roles of turbulence-induced flows in triggering H-mode at marginal heating power on HL-2A tokamak, *EPL*, 2016, **116**, 15001. [16e]
  14. **H. S. Xie**, Y. Xiao and Z. Lin, New Paradigm for Turbulent Transport Across a Steep Gradient in Toroidal Plasmas, *Physical Review Letters*, 2017, **118**, 095001. [17a]
  15. **H. S. Xie**, Y. Y. Li, Z. X. Lu, W. K. Ou and B. Li, Comparisons and applications of four independent numerical approaches for linear gyrokinetic drift modes, *Physics of Plasmas*, 2017, **24**, 072106. [17b]
  16. **H. S. Xie**, Y. Zhang, Z. C. Huang, W. K. Ou and B. Li, Local gyrokinetic study of electrostatic microinstabilities in dipole plasmas, *Physics of Plasmas*, 2017, **24**, 122115. [17c]
  17. **H. S. Xie**, Z. X. Lu and B. Li, Kinetic ballooning mode under steep gradient: High order eigenstates and mode structure parity transition, *Physics of Plasmas*, 2018, **25**, 072106. [18a]
  18. **H. S. Xie**, BO: A unified tool for plasma waves and instabilities analysis, *Computer Physics Communications*, 2019, **244**, 343–371. [19a]
  19. H. Y. Sun, J. S. Zhao, **H. S. Xie** and D. J. Wu, On Kinetic Instabilities Driven by Ion Temperature Anisotropy and Differential Flow in the Solar Wind, *ApJ*, 2019, 884:44. [19b]
  20. Y. F. Wu, X. Tao, X. Liu, L. J. Chen, **H. S. Xie**, K. J. Liu and R. B. Horne, Particle-in-cell simulation of electron cyclotron harmonic waves driven by a loss cone distribution, *Geophysical Research Letters*, 2020, **47**, e2020GL087649. [20a]

21. Z. W. Yang, Y. D. Liu, S. Matsukiyo, Q. M. Lu, F. Guo, M. Z. Liu, **H. S. Xie**, X. L. Gao and J. Guo, PIC Simulations of Microinstabilities and Waves at Near-Sun Solar Wind Perpendicular Shocks: Predictions for Parker Solar Probe and Solar Orbiter, *The Astrophysical Journal Letters*, 2020, 900:L24. [20b]
22. H. Y. Sun, J. S. Zhao, W. Liu, **H. S. Xie** and D. J. Wu, Electron Temperature Anisotropy and Electron Beam Constraints from Electron Kinetic Instabilities in the Solar Wind, *The Astrophysical Journal*, 2020, 902:59. [20c]
23. C. Shi, J. S. Zhao, H. Y. Sun, C. Y. Huang and **H. S. Xie**, Electromagnetic Emission Driven by Electron Beam Instability in the Jovian Polar Regions, *The Astrophysical Journal*, 2020, 902:151. [20d]
24. S. Y. Sun, X. S. Wei, Z. Lin, P. F. Liu, W. H. Wang and **H. S. Xie**, Verification of local electrostatic gyrokinetic simulation of driftwave instability in field-reversed configuration, *Physics of Plasmas*, 2020, **27**, 112504. [20e]
25. H. J. Ma, **H. S. Xie\***, Y. K. Bai, S. K. Cheng, B. H. Deng, M. Tuszewski, Y. Li, H. Y. Zhao, B. Chen and J. Y. Liu, Two-parameter modified rigid rotor radial equilibrium model for field-reversed configurations, *Nuclear Fusion*, 2021, **61**, 036046. [21a]
26. H. J. Ma, **H. S. Xie\***, B. H. Deng, Y. K. Bai, S. K. Cheng, Y. Li, B. Chen, M. Tuszewski, H. Y. Zhao and J. Y. Liu, A new tool GSEQ-FRC for two-dimensional field-reversed configuration equilibrium, *Nuclear Fusion*, 2021, **61**, 086006. [21b]
27. H. Y. Sun, J. S. Zhao, W. Liu, Y. Voitenko, V. Pierrard, C. Shi, Y. H. Yao, **H. S. Xie**, and D. J. Wu, Electron Heat Flux Instabilities in the Inner Heliosphere: Radial Distribution and Implication on the Evolution of the Electron Velocity Distribution Function, *ApJ Letters*, 2021, 916:L4. [21c]
28. W. Liu, J. S. Zhao, **H. S. Xie**, Y. H. Yao, D. J. Wu and L. C. Lee, Electromagnetic Proton Beam Instabilities in the Inner Heliosphere: Energy Transfer Rate, Radial Distribution, and Effective Excitation, *ApJ*, 2021, 920:158. [21d]
29. D. Guo, **H. S. Xie**, W. Bai, W. J. Liu, Y. K. M. Peng, X. M. Song, R. Y. Tao, Bo Chen, B. Liu, Bin Chen, B. H. Deng, Y. J. Shi, B. S. Yuan, M. S. Liu, and EXL-50 Team, Optical Boundary Reconstruction With Visible Camera in the EXL-50 Spherical Tokamak, *IEEE Transactions on Plasma Science*, 49, 12, 3848, 2021. [21e]
30. J. C. Li, Z. Lin, J. Q. Dong, **H. S. Xie** and S. F. Liu, Microturbulence in edge of a tokamak plasma with medium density and steep temperature gradient, *Plasma Phys. Control. Fusion* 63 (2021) 125005. [21f]

31. J. Q. Cai, **H. S. Xie\***, Y. Li, M. Tuszewski, H. B. Zhou and P. P. Chen, A Study of the Requirements of p-11B Fusion Reactor by Tokamak System Code, *Fusion Science and Technology*, 2022, 78:2, 149-163. [22a]
32. D. Guo, Y. J. Shi, W. J. Liu, Y. Y. Song, T. T. Sun, B. Liu, Y. Y. Li, X. R. Tian, G. S. Zhang, **H. S. Xie**, Y. K. M. Peng, M. S. Liu and EXL-50 team, Experimental study of the characteristics of energetic electrons outside LCFS in EXL-50 spherical torus, *Plasma Phys. Control. Fusion* 64 (2022) 055009. [22b]
33. **H. S. Xie**, D. Banerjee, Y. K. Bai, H. Y. Zhao, J. C. Li, BORAY: A ray tracing code for various magnetized plasma configurations, *Computer Physics Communications* 276 (2022) 108363. [22c]
34. J. S. Zhao, L. C. Lee, **H. S. Xie**, Y. H. Yao<sup>1</sup>, D. J. Wu, Y. Voitenko, and V. Pierrard, Quantifying Wave-Particle Interactions in Collisionless Plasmas: Theory and Its Application to the Alfvén-mode Wave, *The Astrophysical Journal*, 930:95, 2022. [22d]
35. Z. Liang, H. Liu, H. F. Du, B. Chen, Y. M. Yang, **H. S. Xie**, S. Y. Dai and D.Z. Wang, Assessments of the performance of neutral beam injection on the spherical tokamak EXL-50, *Fusion Engineering and Design* 180 (2022) 113189. [22e]
36. D. F. Kong, S. R. Xu, Y. R. Shou, Y. Gao, Z. S. Mei, Z. Pan, Z. P. Liu, Z. X. Cao, Y. L. Liang, Z. Y. Peng, P. J. Wang, D. Luo, Y. Li, Z. Li, **H. S. Xie**, G. Q. Zhang, W. Luo, J. R. Zhao, S. Y. Chen, Y. X. Geng, Y. Y. Zhao, J. M. Xue, X. Q. Yan, and W. J. Ma, Alpha-Particle Generation from H-11B Fusion Initiated by Laser Accelerated Boron Ions, *Laser and Particle Beams*, 2022, 5733475. [22f]
37. D. Banerjee, S. D. Song, **H. S. Xie**, B. Liu, M. Y. Wang, W. J. Liu, B. Chen, L. Han, D. Luo, Y. Y. Song, X. M. Song, M. S. Liu, Y. J. Shi, Y. K. Martin Peng and the EXL-50 team, and Yu. V. Petrov and R. W. Harvey, Investigation of the effectiveness of ‘multi-harmonic’ electron cyclotron current drive in the non inductive EXL-50 ST, *Journal of Physics: Conference Series*, 2397, 1, 012011 (2022). [22g]
38. Y. H. Yao, J. S. Zhao, **H. S. Xie**, W. Liu and D. J. Wu, The Oblique Alfvén Ion Beam Instability in the Earth’s Ion Foreshock, *Research in Astronomy and Astrophysics*, 2022. [22h]

### Submitted or to submit

1. **H. S. Xie**, Y. Xiao, Z. Lin and D. F. Kong, Gyrokinetic Simulations of the HL-2A Tokamak H-mode Edge Turbulence. I. Electrostatic Physics, to submit. [p15f]

2. **H. S. Xie**, R. Denton, J. S. Zhao and W. Liu, BO 2.0: Plasma Wave and Instability Analysis with Enhanced Polarization Calculations, arXiv:2103.16014, 2021.
3. **H. S. Xie**, H. J. Ma and Y. K. Bai, Plasma Waves Accessibility Diagrams: A Tutorial to Include the Fluid and Kinetic Thermal Effects, arXiv:2111.05669, 2021.
4. **H. S. Xie**, M. Z. Tan, D. Luo, Z. Li and B. Liu, Fusion Reactivities with Drift bi-Maxwellian Ion Velocity Distributions, arXiv:2212.01840, 2022.

## Books/Notes

1. **H. S. Xie**, Computational Plasma Physics - Introduction (in Chinese), Science Press, Beijing, 2018, <http://hsxie.me/cppbook/>. 谢华生, 计算等离子体物理导论, 科学出版社, 北京, 2018.
2. 谢华生, 聚变能源研究的零级量, 2022 (待出版), <http://hsxie.me/fusionbook/>.

## Conference contributions

1. **H. S. Xie** and Y. Xiao, Essential Tokamak Geometric Effects for Global Ballooning Mode Study, poster, 23rd ICNSP Conference, Beijing, Sep. 14-16, 2013. Also, 55th Annual Meeting of the APS Division of Plasma Physics, Nov. 11-15, 2013, Denver, Colorado, USA.
2. **H. S. Xie** and Y. Xiao, Gyrokinetic Simulation of HL-2A H-mode Turbulent Transports, poster, 56th Annual Meeting of the APS Division of Plasma Physics, Oct. 27-30, 2014, New Orleans, Louisiana, USA.
3. J. Q. Dong, J. Cheng, L. W. Yan, Z. X. He, K. Itoh, **H. S. Xie**, Y. Xiao, K. J. Zhao, W. Y. Hong, Z. H. Huang, L. Nie, S.-I. Itoh, W. L. Zhong, D. L. Yu, X. Q. Ji, Y. Huang, X. M. Song, Q. W. Yang, X. T. Ding, X. L. Zou, X. R. Duan, Yong Liu and HL-2A Team, Mechanism of Low-intermediate-high Confinement Transitions in Tokamaks, IAEA, 2014.
4. **H. S. Xie** and Y. Xiao, Non-conventional Ballooning Structures for Linear Drift Wave Eigenmode in the Pedestal, poster, International Sherwood Fusion Theory Conference, Mar. 16-18, 2015, New York, USA.
5. **H. S. Xie**, Y. Xiao and Z. Lin, Reverse Trend of Turbulent Transport in Strong Gradient Fusion Plasmas, invited oral, 9th West Lake International Symposium on Plasma Simulation, May. 18-21, 2015, Hangzhou, China.

## Preprint or unrefereed

1. **H. S. Xie**, Pure Monte Carlo Method: a Third Way for Plasma Simulation, arXiv, 1210.2265.
2. **H. S. Xie** and L. Chen, Linear Gyrokinetic Coupling of Firehose and Mirror Modes, arXiv, 1210.4441.

(Selected manuscripts, which are not in final forms.)

## Teaching

1. 2010.09 - 2011.04, Teaching Assistant, Zhejiang University  
Methods of Mathematical Physics (I)(II), for 2nd year undergraduate, major in physics.
2. 2011.02 - 2011.04 & 2012.02 - 2012.04, Teaching Assistant, Zhejiang University  
Introduction to Plasma Physics, for 3rd year undergraduate, major in physics.

## Codes development

1. GPDF, General Plasma Dispersion Function, 2013. Ref: [13a].
2. PDRF, Plasma Dispersion Relation Solver – Fluid version, 2013. Ref: [14a].
3. PDRK/BO, Plasma Dispersion Relation Solver – Kinetic version, 2014. Ref: [16a], [19a].
4. AMC, Alfvén Mode Code, 2013. Ref: [15a].
5. MGK, Multi-approach GyroKinetic code (with Yue-yan LI and Zhi-xin LU), 2016. Ref: [17b].

(Other educational oriented codes: pic1d, vlasov1d, orbitm, mhd2d, transport1d, ...)

See lists: <http://hsxie.me/codes/>

## Others

- Main developer of the IFTS-ZJU new website 'ifts.zju.edu.cn' (2010).
- User of large scale codes GTC (2011 - 2015) and GeFi (2011).
- Main contributor (organizer/speaker) of the IFTS-ZJU Study Group.