

y direction, and they start from $x = 13$. The trapped electrons tend to accumulate to the regions that already have a surplus of electrons (with negative charge density). Then, the transverse undulation in the electron hole becomes more and more pronounced, which results in a self-focusing type of instability.

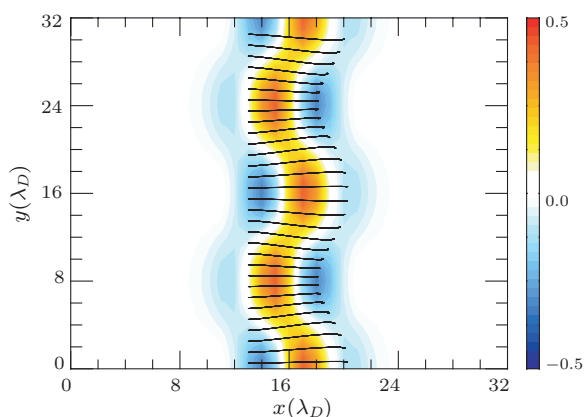


Fig. 2. The typical trajectories of trapped electrons in the electron hole. The charged density ρ is also shown. Initially, these electrons are distributed evenly in the y direction, and they start from $x = 13$. In the figure, the solid lines denote the typical trajectories of trapped electrons, and the color representations denote the charged density ρ . The parameters are $\psi = 0.8$, $\Delta_{\parallel} = 2.0$, $\varepsilon = 0.3$ and $k = 0.39$.

Figure 3 shows the time evolution of the electric field energies E_x^2 and E_y^2 for $v_{\perp Te} = 0.2, 0.5$ and $1.0v_{\parallel Te}$, respectively. The electric field energies are normalized by $n_0 T_{\parallel e} / \varepsilon_0$. In the figure, the increase of the electric field energy E_y^2 means the excitation of the transverse instability in the electron hole, and correspondingly, the electric field energy E_x^2 decreases. Therefore, we can find that with the increase of the electron perpendicular thermal velocity, the transverse instability is difficult to be excited. The transverse instability begins to be excited at about $\omega_{pe} t = 24, 32$, and 40 for $v_{\perp Te} = 0.2, 0.5$ and $1.0v_{\parallel Te}$, respectively, at the same time, E_y^2 attains their maximum values (about 0.00031, 0.00013, and 0.00006, respectively) at $\omega_{pe} t = 45, 65$, and 80.

The reasons for the stabilization of the electron perpendicular thermal velocity to the transverse instability in electron holes can be explained as follows: with the increase of the perpendicular thermal velocity, the diffusion across the background magnetic field also increases. It can prevent the trapped electrons from being focused by the transverse gradients of the potential, and make the electron hole stable. At the same time, as pointed out by Muschitti *et al.*,^[15] the criterion for the transverse instability in electron holes is $v_{\perp Te} \ll \omega_b / k$. In this study, we find that with the increase of the perpendicular thermal velocity $v_{\perp Te}$, the wave numbers k of the transverse insta-

bility decreases. This can be demonstrated in Fig. 4, in which we plot the wave numbers k of the kinked electron holes at different perpendicular thermal velocities. The wave numbers are calculated from the self-consistent PIC simulations without initial perturbations when the kinked electron holes are fully developed. The wave numbers k are inversely proportional to the perpendicular thermal velocity $v_{\perp Te}$ and consistent with the criterion of the transverse instability proposed by Muschitti *et al.*^[15]

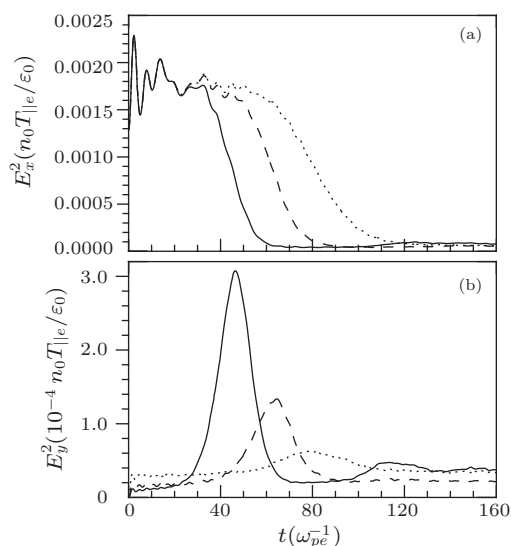


Fig. 3. The time evolution of the electric field energies (a) E_x^2 and (b) E_y^2 for $v_{\perp Te} = 0.2, 0.5$ and $1.0v_{\parallel Te}$, respectively. The solid, dashed, and dotted lines denote $0.2v_{\parallel Te}$, $0.5v_{\parallel Te}$ and $1.0v_{\parallel Te}$, respectively. Here the electric field energies are normalized by $n_0 T_{\parallel e} / \varepsilon$.

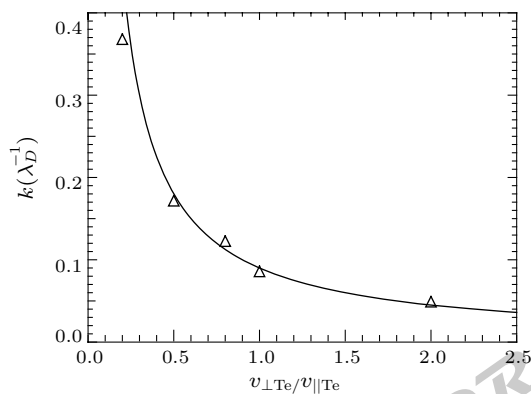


Fig. 4. The wave number k of the kinked electron holes formed due to the transverse instability for $v_{\perp Te} = 0.2, 0.5, 0.8, 1.0, 2.0v_{\parallel Te}$. The triangles are the results from 2D PIC simulations. The solid lines represent the equation $k = a v_{\perp Te}^{-1}$, where $a = 0.09$.

In summary, performing 2D electrostatic PIC simulations we have investigated the transverse instability electron holes in weakly magnetized plasma under different electron perpendicular thermal velocity conditions. Our results show that the transverse instability causes the electron holes to become kinked, and lastly

destroys the electron holes. At the same time, the increase of the electron perpendicular thermal velocity tends to stabilize it, and the corresponding wave numbers decrease. Weibel or whistler instability is also unstable to electron anisotropic temperature.^[21–23] However, its effects are neglected because it is an electromagnetic instability and we use electrostatic PIC simulations in the present study. The interactions between the transverse instability and Weibel instability in electron holes are our investigation in the future.

References

- [1] Ergun R E et al 1998 *Geophys. Res. Lett.* **25** 2041
- [2] Matsumoto H et al 1994 *Geophys. Res. Lett.* **21** 2915
- [3] Bale S D et al 1998 *Geophys. Res. Lett.* **25** 2929
- [4] Mangeney A et al 1999 *Ann. Geophys.* **17** 307
- [5] Cattell C et al 2002 *Geophys. Res. Lett.* **29** 1065
- [6] Pickett J S et al 2004 *Ann. Geophys.* **22** 2525
- [7] Saeki K et al 1979 *Phys. Rev. Lett.* **42** 501
- [8] Sarri G et al 2010 *Phys. Plasmas* **17** 010701
- [9] Bernstein I B et al 1957 *Phys. Rev.* **108** 546
- [10] Schamel H 1986 *Phys. Rep.* **140** 161
- [11] Ng C S and Bhattacharjee A 2005 *Phys. Rev. Lett.* **95** 245004
- [12] Omura Y et al 1994 *Geophys. Res. Lett.* **21** 2923
- [13] Lu Q M et al 2005 *J. Geophys. Res.* **110** A03223
- [14] Lu Q M et al 2005 *Phys. Plasmas* **12** 072903
- [15] Muschietti L et al 2000 *Phys. Rev. Lett.* **85** 94
- [16] Lu Q M et al 2008 *J. Geophys. Res.* **113** A11219
- [17] Franz J R et al 1998 *Geophys. Res. Lett.* **25** 1277
- [18] Decyk V K 1995 *Comput. Phys. Commun.* **87** 87
- [19] Lu Q M and Cai D S 2001 *Comput. Phys. Commun.* **135** 93
- [20] Muschietti L et al 1999 *Geophys. Res. Lett.* **26** 1093
- [21] Weibel E S 1959 *Phys. Rev. Lett.* **2** 83
- [22] Lu Q M et al 2004 *Chin. Phys. Lett.* **21** 129
- [23] Lu Q M, Zhou L H and Wang S 2010 *J. Geophys. Res.* **115** A02213

Chinese Physics Letters

Volume 27 Number 9 2010

GENERAL

- 090201 **New Type Soliton Solutions to Korteweg-de Vries and Benjamin–Bona–Mahony Equations**
LIU Yu
- 090202 **Effect of Geometric Distance on Agreement Dynamics of Naming Game**
HAO Jia-Bo, YANG Han-Xin, LIU Run-Ran, WANG Bing-Hong, ZHANG Zhi-Yuan
- 090203 **An Application of a Generalized Version of the Dressing Method to Integration of a Variable-Coefficient Dirac System**
SU Ting, WANG Zhi-Wei
- 090301 **A New Quantum Key Distribution Scheme Based on Frequency and Time Coding**
ZHU Chang-Hua, PEI Chang-Xing, QUAN Dong-Xiao, GAO Jing-Liang, CHEN Nan, YI Yun-Hui
- 090302 **Wigner Functions for the Bateman System on Noncommutative Phase Space**
HENG Tai-Hua, LIN Bing-Sheng, JING Si-Cong
- 090303 **Testing Evolution Equation for Entanglement of Two-Qubit Systems in Noisy Channels on Ensemble Quantum Computers**
ZHANG Han, LUO Jun, REN Ting-Ting, SUN Xian-Ping
- 090304 **A New Approach for Constructing New Coherent-Entangled State Representations**
MA Shan-Jun, XU Xue-Xiang
- 090305 **From the Thermo Wigner Operator to the Thermo Husimi Operator in Thermo Field Dynamics**
XU Xue-Fen, ZHU Shi-Qun
- 090306 **Entanglement of Superpositions of Orthogonal Maximally Entangled States**
ZHANG Dao-Hua, ZHOU Duan-Lu, FAN Heng
- 090307 **Cryptanalysis and Improvement of Two GHZ-State-Based QSDC Protocols**
GUO Fen-Zhuo, QIN Su-Juan, WEN Qiao-Yan, ZHU Fu-Chen
- 090501 **Analytical Approach to Space- and Time-Fractional Burgers Equations**
Ahmet Yildirim, Syed Tauseef Mohyud-Din
- 090502 **Thermodynamic Performance Characteristics of an Irreversible Micro-Brownian Heat Engine Driven by Temperature Difference**
ZHANG Yan-Ping, HE Ji-Zhou
- 090503 **Chaotic System Identification Based on a Fuzzy Wiener Model with Particle Swarm Optimization**
LI Yong, TANG Ying-Gan
- 090504 **Fast-Scale and Slow-Scale Subharmonic Oscillation of Valley Current-Mode Controlled Buck Converter**
ZHOU Guo-Hua, XU Jian-Ping, BAO Bo-Cheng, ZHANG Fei, LIU Xue-Shan
- 090505 **Bosons or Fermions in 1D Power Potential Trap with Repulsive Delta Function Interaction**
MA Zhong-Qi, C. N. Yang
- 090506 **Stochastic Resonance in a Time-Delayed Bistable System Driven by Square-Wave Signal**
GUO Feng, ZHOU Yu-Rong, ZHANG Yu

NUCLEAR PHYSICS

- 092101 **Effects of Pairing Correlations on Formation of Proton Halo in ${}^9\text{C}$**
HAN Rui, LI Jia-Xing, YAO Jiang-Ming, JI Juan-Xia, WANG Jian-Song, HU Qiang

(Continued on inside back cover)

JUST FOR PHYSICS LETTERS
— CHINESE PHYSICS LETTERS

092501 Elastic Scattering of ${}^6\text{He}+p$ at 82.3 MeV/nucleon

FAISAL Jamil-Qureshi, LOU Jian-Ling, YE Yan-Lin, CAO Zhong-Xin, JIANG Dong-Xing, ZHENG Tao, HUA Hui, LI Zhi-Huan, LI Xiang-Qing, GE Yu-Cheng, PANG Dan-Yang, LI Qi-Te, XIAO Jun, LV Lin-Hui, QIAO Rui, YOU Hai-Bo, CHEN Rui-Jiu, LU Fei, Sakurai H, Otsu H, Nishimura M, Sakaguchi S, Baba H, Togano Y, Yoneda K, LI Chen, WANG Shuo, WANG He, LI Kuo-Ang, Nakamura T, Nakayama Y, Kondo Y, Deguchi S, Satou Y, Tshoo K H

ATOMIC AND MOLECULAR PHYSICS

093301 Dynamics of H_2 in Intense Femtosecond Laser Field

ZHU Jing-Yi, LIU Ben-Kang, WANG Yan-Qiu, HE Hai-Xiang, WANG Li

093401 Rovibrational Formation of Ultracold NaH Molecules Induced by an Ultrashort Laser Pulse

SU Qian-Zhen, YU Jie, NIU Ying-Yu, CONG Shu-Lin

093601 Photoabsorption Spectra of $(\text{SiO}_2)_n$ ($n \leq 5$) Clusters on the Basis of Time-Dependent Density Functional Theory

LIU Dan-Dan, ZHANG Hong

FUNDAMENTAL AREAS OF PHENOMENOLOGY(INCLUDING APPLICATIONS)

094101 Influence of Filling Medium of Holes on the Negative-Index Response of Sandwiched Metamaterials

WANG Xu-Dong, YE Yong-Hong, MA Ji, JIANG Mei-Ping

094102 Detection of Perfect Cloak in Time Domain

SU Yu-Huan, SHI Jin-Wei, LIU Da-He, YANG Guo-Jian

094201 The Axial Spatial Evolution of Optical Field near the Talbot Plane of a Grating

LU Yun-Qing, LI Pei-Li, ZHENG Jia-Jin

094202 Effect of Zeroth-Order beam on Azobenzene Polymer Surface Relief Gratings Fabricated by Phase-Mask Method

WU Wen-Xuan, LUO Yan-Hua, CHENG Xu-Sheng, TIAN Xiu-Jie, QIU Wei-Wei, REN Xi-Feng, ZHU Bing, ZHANG Qi-Jin

094203 Range-Gated Laser Stroboscopic Imaging for Night Remote Surveillance

WANG Xin-Wei, ZHOU Yan, FAN Song-Tao, HE Jun, LIU Yu-Liang

094204 A Two-Stage S-Band Erbium-Doped Fiber Amplifier Based on W-type Erbium-Doped Fiber

DING Lei, JIA Yuan-Yuan, XING Jun-Bo, ZHANG Zhen, SUN Jian-Jun, LU Ke-Cheng

094205 Enhanced Surface-Plasmon-Polariton Interference for Nanolithography by a Micro-Cylinder-Lens Array

LIANG Hui-Min, WANG Jing-Quan, FAN Feng, QIN Ai-Li, ZHANG Chun-Yuan, CHENG Hui

094206 An Experiment for Generating the 14-Tone Stable Carriers Using Recirculating Frequency Shifter

TIAN Feng, ZHANG Xiao-Guang, LI Jian-Ping, XI Li-Xia

094207 Wafer-Level Testable High-Speed Silicon Microring Modulator Integrated with Grating Couplers

XIAO Xi, ZHU Yu, XU Hai-Hua, ZHOU Liang, HU Ying-Tao, LI Zhi-Yong, LI Yun-Tao, YU Yu-De, YU Jin-Zhong

094208 High-Frequency Einstein-Podolsky-Rosen Entanglement via Atomic Memory Effects in Four-Wave Mixing

ZHANG Xue-Hua, HU Xiang-Ming, KONG Ling-Feng, ZHANG Xiu

094209 An Optical Labeling Scheme with Novel DPSK/PPM Orthogonal Modulation

ZHOU Rui, XIN Xiang-Jun, WANG Yong-Jun, ZHANG Zi-Xing, YU Chong-Xiu

094301 Imaging for Borehole Wall by a Cylindrical Linear Phased Array

ZHANG Bi-Xing, SHI Fang-Fang, WU Xian-Mei, GONG Jun-Jie, ZHANG Cheng-Guang

- 094302 **Pharmacokinetic Monitoring of Indocyanine Green for Tumor Detection Using Photoacoustic Imaging**
YANG Si-Hua, YIN Guang-Zhi, XING Da
- 094303 **Effect of Tissue Inhomogeneity on Nonlinear Propagation of Focused Ultrasound**
LIU Zhen-Bo, FAN Ting-Bo, GUO Xia-Sheng, ZHANG Dong
- 094304 **A Spectral Coupled-Mode Formulation for Sound Propagation around Axisymmetric Seamounts**
LUO Wen-Yu, SCHMIDT Henrik
- 094701 **Simulation of Non-Newtonian Blood Flow by Lattice Boltzman Method**
JI Yu-Pin, KANG Xiu-Ying, LIU Da-He
- PHYSICS OF GASES, PLASMAS, AND ELECTRIC DISCHARGES**
- 095201 **Effects of Perpendicular Thermal Velocities on the Transverse Instability in Electron Phase Space Holes**
WU Ming-Yu, WU Hong, LU Quan-Ming, XUE Bing-Sen
- 095202 **K-Shell Spectra from CH-Tamped Aluminum Layers Irradiated with Intense Femtosecond Laser Pulses**
XIONG Gang, ZHAO Yang, SHANG Wan-Li, HU Zhi-Min, ZHU Tuo, WEI Min-Xi, YANG Guo-Hong, ZHANG Ji-Yan, YANG Jia-Min
- CONDENSED MATTER: STRUCTURE, MECHANICAL AND THERMAL PROPERTIES**
- 096101 **Effect of Zn Interstitials on Enhancing Ultraviolet Emission of ZnO Films Deposited by MOCVD**
ZHONG Ze, SUN Li-Jie, CHEN Xiao-Qing, WU Xiao-Peng, FU Zhu-Xi
- 096102 **Condensation Behavior of Ag Aggregates on Liquid Surfaces**
ZHANG Xiao-Fei, ZHANG Chu-Hang, LV Neng, XIE Jian-Ping, YE Gao-Xiang
- 096103 **Small-Angle X-Ray Scattering Study on Nanostructures of Polyimide Films**
LIU Xiao-Xu, YIN Jing-Hua, SUN Dao-Bin, BU Wen-Bin, CHENG Wei-Dong, WU Zhong-Hua
- 096201 **Structural, Electronic and Elastic Properties of Cubic Perovskites SrSnO₃ and SrZrO₃ under Hydrostatic Pressure Effect**
SHI Li-Wei, DUAN Yi-Feng, YANG Xian-Qing, QIN Li-Xia
- 096202 **Preparation of Thermo-Stable Bulk Metallic Glass of Nd₆₀Cu₂₀Ni₁₀Al₁₀ by Rapid Compression**
YUAN Chao-Sheng, LIU Xiu-Ru, SHEN Ru, SUN Zhen-Ya, CHEN Bo, LV Shi-Jie, HE Zhu, HU Yun, HONG Shi-Ming
- 096203 **Collective Modes and Elastic Constants of Liquid Al₈₃Cu₁₇ Binary Alloy**
B. Y. Thakore, S. G. Khambholja, P. H. Suthar, N. K. Bhatt, A. R. Jani
- 096401 **A Three-Component Model Suitable for Natural and Ventilated Cavitation**
JI Bin, LUO Xian-Wu, ZHANG Yao, RAN Hong-Juan, XU Hong-Yuan, WU Yu-Lin
- 096402 **First-Principles Study of the γ Angle Deformation Path in the Wurtzite-to-Rocksalt Phase Transition in Aluminum Nitride**
CAI Ying-Xiang, XU Rui
- 096801 **AFM and XPS Study of Glass Surface Coated with Titania Nanofilms by Sol-Gel Method**
JI Guo-Jun, SHI Zhi-Ming
- CONDENSED MATTER: ELECTRONIC STRUCTURE, ELECTRICAL, MAGNETIC, AND OPTICAL PROPERTIES**
- 097101 **Tuning Bandgap of Si-C Heterofullerene-Based Aantubes by H Adsorption**
LI Ji-Ling, YANG Guo-Wei, ZHAO Ming-Wen, LIU Xiang-Dong, XIA Yue-Yuan
- 097102 **A Density Functional Study of Atomic Carbon Adsorption on δ -Pu(111) Surface**
WEI Hong-Yuan, XIONG Xiao-Ling, SONG Hong-Tao, LUO Shun-Zhong

- 097401 Generation and Quantum Interference of Entangled Electron-Hole Pairs in a Hanbury Brown and Twiss Interferometer**
ZHANG Qing-Yun, WANG Bai-Geng, SHEN Rui, XING Ding-Yu
- 097501 Soft Magnetic Thin Films FeCoHfO for High-Frequency Noise Suppression Applications**
LU Guang-Duo, ZHANG Huai-Wu, TANG Xiao-Li
- 097502 Fabrication, Structural and Magnetic Properties for Aligned MnBi**
LIU Yong-Sheng, ZHANG Jin-Cang, REN Zhong-Ming, GU Min-An, YANG Jing-Jing, CAO Shi-Xun, YANG Zheng-Long
- 097503 Magnetization Switching in a Small Disk with Shape Anisotropy**
LÜ Dong-Li, XU Chen
- 097504 Modulation of Insulator-Metal Transition Temperature by Visible Light in $\text{La}_{7/8}\text{Sr}_{1/8}\text{MnO}_3$ Thin Film**
HU Ling, SUN Yu-Ping, WANG Bo, LUO Xuan, SHENG Zhi-Gao, ZHU Xue-Bin, SONG Wen-Hai, YANG Zhao-Rong, DAI Jian-Ming
- 097505 Structural and Magnetic Properties of $\text{Nd}(\text{Fe},\text{Mo})_{12}\text{N}_x$ Compounds Produced by Strip-Casting Method**
LIU Shun-Quan, HAN Jing-Zhi, WANG Chang-Sheng, YANG Jin-Bo, DU Hong-Lin, YANG Ying-Chang
- 097701 Controllable Ultra Low- k by Via-Typed Air Gap with the Better Design Margin for Logic Devices below 45 nm Node**
CHOI Youn-Ok, KIM Sang-Yong
- 097801 Polymer Light-Emitting Diode Using Conductive Polymer as the Anode Layer**
LIANG Chun-Jun, ZOU Hui, HE Zhi-Qun, ZHANG Chun-Xiu, LI Dan, WANG Yong-Sheng
- CROSS-DISCIPLINARY PHYSICS AND RELATED AREAS OF SCIENCE AND TECHNOLOGY**
- 098101 Light-Induced Agglomeration and Diffusion of Different Particles with Optical Tweezers**
LI Xue-Cong, SUN Xiu-Dong, LIU Hong-Peng, ZHANG Jian-Long
- 098102 Preparation and Characteristics of Nanoscale Diamond-Like Carbon Films for Resistive Memory Applications**
FU Di, XIE Dan, ZHANG Chen-Hui, ZHANG Di, NIU Jie-Bin, QIAN He, LIU Li-Tian
- 098501 Spin Injection from Ferromagnetic Metal Directly into Non-Magnetic Semiconductor under Different Injection Currents**
DENG Ning, TANG Jian-Shi, ZHANG Lei, ZHANG Shu-Chao, CHEN Pei-Yi
- 098502 Wetting Layer Effect on Optical Gain of Strained CdTe/ZnTe Pyramidal Quantum Dots**
Seoung-Hwan Park, Woo-Pyo Hong
- 098701 Synergistic Effect of Auto-Activation and Small RNA Regulation on Gene Expression**
XIONG Li-Ping, MA Yu-Qiang, TANG Lei-Han
- 098901 Phase Transition of the Pair Contact Process Model in a Fragmented Network**
HUA Da-Yin, WANG Lie-Yan
- GEOPHYSICS, ASTRONOMY, AND ASTROPHYSICS**
- 099701 The Surface Gravitational Redshift of a Proto Neutron Star**
ZHAO Xian-Feng

JUST FOR AUTHORS
— CHINESE PHYSICS LETTERS