

# 物 理 学 报

第 72 卷 第 21 期 2023 年 11 月 5 日

## 目 次

### 特邀综述

218701 单分子磁镊旋转操控和基因转录调控动力学 … 张志鹏 刘帅 张玉琼 熊影 韩伟静 陈同生 王爽

### 专题: 磁约束等离子体中的高能粒子

210101 磁约束等离子体中的高能粒子专题编者按 …………… 陈伟 黄娟 仇志勇 万宝年  
综述

215204 EAST 反磁剪切  $q_{\min} \approx 2$  条件下磁流体力学不稳定性及内部输运全物理实验结果简述 ……………  
…………… 徐明 徐立清 赵海林  
李颖颖 钟国强 郝保龙 马瑞瑞 陈伟 刘海庆 徐国盛 胡建生 万宝年 EAST 团队

215207 反磁剪切托卡马克等离子体中低频剪切阿尔芬波的理论研究 …………… 马瑞瑞 陈骝 仇志勇  
研究论文

215201 EAST 上离子回旋波与中性束注入协同加热产生的高能粒子分布及输运研究 ……………  
…………… 张伟 张新军 刘鲁南 朱光辉 杨桦 张华朋 郑艺峰 何开洋 黄娟

215202 负三角形变托卡马克位形下高能离子激发鱼骨模的模拟研究 …………… 任珍珍 申伟

215203 EAST 上中性束注入和离子回旋共振加热下快离子分布函数层析反演 ……………  
…………… 孙延旭 黄娟 高伟 常加峰 张伟 史唱 李云鹤

215205 CFQS 准环对称仿星器低  $\beta$  等离子体中三维磁岛的抑制机制 …………… 苏祥 王先驱 符添 许宇鸿

215206 临界梯度模型的优化及集成模拟中高能粒子模块的搭建 …………… 邹云鹏 陈锡熊 陈伟

215208 HL-2A 装置上电子回旋共振加热沉积位置影响鱼骨模主动控制效果的实验研究 ……………  
…………… 施培万 朱霄龙 陈伟 余鑫 杨曾辰 何小雪 王正涵

215209 CFETR 参数下  $\alpha$  粒子慢化过程的数值模拟 ……………  
…………… 吴相凤 王丰 林展宏 陈罗玉 于召客 吴凯邦 王正涵

215210 托卡马克中低频磁流体不稳定性协同作用引起快粒子输运的混合模拟研究 ……………  
…………… 朱霄龙 陈伟 王丰 王正涵

215211 HL-2A 装置高能离子驱动的比压阿尔芬本征模的扫频行为 ……………  
…………… 侯玉梅 陈伟 邹云鹏 于利明 石中兵 段旭如

215212 HL-2A 装置上成像型中性粒子分析器的物理设计和初步实验结果 ……………  
… 颜筱宇 何小斐 于利明 刘亮 陈伟 石中兵 卢杰 魏会领 韩纪锋 张轶波 钟武律 许敏

215215 EXL-50U 球形环中快离子磁场波纹损失的优化模拟研究 …………… 郝保龙 李颖颖 陈伟 郝广周  
顾翔 孙恬恬 王岬民 董家齐 袁保山 彭元凯 石跃江 谢华生 刘敏胜 ENN TEAM

215216 高能电子激发比压阿尔芬本征模的全域模拟研究 …………… 包健 张文禄 李定

215217 径向电场对离子温度梯度模稳定性的影响 …………… 陈凝飞 魏广宇 仇志勇

### 国防科技大学建校 70 周年专题

214207 基于双光子干涉的量子全息理论框架 …… 徐耀坤 孙仕海 曾瑶源 杨俊刚 盛卫东 刘伟涛

### 总论

210301 读光与读出光子模式腰斑比对腔增强量子存储器恢复效率的影响 ……………  
…………… 范文信 王敏杰 焦浩乐 路迦进 刘海龙 杨智芳 席梦琦 李淑静 王海

## 电磁学、光学、声学、传热学、经典力学和流体动力学

- 214201 相干控制的布洛赫表面波偏振转换 ..... 韦进志 王金浩 陈俊学
- 214202  $\beta$ -Ga<sub>2</sub>O<sub>3</sub> 晶体本征缺陷诱导的宽带超快光生载流子动力学 .....  
..... 王露璇 刘奕彤 史方圆 祁纤雯 沈涵 宋瑛林 方宇
- 214203 H 离子团簇高次谐波平台展宽与团簇膨胀 ..... 张春艳
- 214204 界面材料 PFN-Br 的光放大性质及其在电泵浦有机激光中的应用潜力 .....  
..... 张志远 肖子晗 郝珊 张琪 夏瑞东 彭俊彪
- 214205 基于偏振动力学的全光储备池计算系统 ..... 方撿 钱若兰 王帅
- 214206 基于紫磷增敏的即插即用式双通道光纤表面等离激元共振折射率计 ..... 井建迎  
刘琨 吴张羿 刘玥萌 江俊峰 徐天华 晏伟铖 熊艺扬 战晓寒 肖璐 刘津畅 刘铁根
- 214701 液体中高压脉冲电场产生扩散气泡的规律 ..... 武晓东 陈沿州 韩瑞 郭雨怡 庄杰 石富坤

## 气体、等离子体和放电物理

- 215213 托卡马克边界等离子体中钨杂质运输的多流体及动力学模拟 ... 王福琼 徐颖峰 查学军 钟方川
- 215214 硅原子层刻蚀流程的速率优化 ..... 白胜波 陈志华 张焕好 陈高捷 曹世程 张升博

## 凝聚物质: 结构、力学和热学性质

- 216401 液态 Zr<sub>35</sub>Al<sub>23</sub>Ni<sub>22</sub>Gd<sub>20</sub> 合金的亚稳相分离与双相非晶形成机理 ... 武博文 胡亮 耿德路 魏炳波
- 216701 自旋-轨道耦合玻色爱因斯坦凝聚中多能级绝热消除理论 ..... 袁家望 陈立 张云波

## 凝聚物质: 电子结构、电学、磁学和光学性质

- 217101 载流子阶梯效应调控有机发光二极管三线态激子的解离和散射 .....  
..... 保希 关云霞 李万娇 宋家一 陈丽佳 徐爽 彭柯教 牛连斌
- 217201 Alq<sub>3</sub>/HAT-CN 叠层电致发光器件的激子调控机制探究 .....  
..... 李万娇 关云霞 保希 王成 宋家一 徐爽 彭柯教 陈丽佳 牛连斌
- 217501 基于负载 Fe<sub>3</sub>O<sub>4</sub> 纳米微球的大尺寸单层二维 Ti<sub>3</sub>C<sub>2</sub>T<sub>x</sub> 微波吸收性能 .....  
..... 肖忆瑶 何佳豪 陈南锬 王超 宋宁宁

## 物理学交叉学科及有关科学技术领域

- 218101 基于光声泵浦成像的氧分压测量定量分析 ..... 何霄 肖小舟 何滨 薛平 肖嘉莹
- 218102 准一维层状半导体 Nb<sub>4</sub>P<sub>2</sub>S<sub>21</sub> 单晶的面内光学各向异性 .....  
..... 程秋振 黄引 李玉辉 张凯 冼国裕 刘鹤元 车冰玉  
潘禄禄 韩焯超 祝轲 齐琦 谢耀锋 潘金波 陈海龙 李永峰 郭辉 杨海涛 高鸿钧
- 218901 基于迁移学习的钙钛矿材料带隙预测 ..... 孙涛 袁健美

文章图片的彩色效果详见网刊



扫码阅读  
电子版

# ACTA PHYSICA SINICA

Vol. 72, No. 21, November 5, 2023

## CONTENTS

### INVITED REVIEW

- 218701 Rotation manipulation of single-molecule magnetic trapping and gene transcription regulation dynamics  
*Zhang Zhi-Peng Liu Shuai Zhang Yu-Qiong Xiong Ying Han Wei-Jing Chen Tong-Sheng Wang Shuang*

### SPECIAL TOPIC—Energetic particles in magnetic confinement fusion plasma

- 210101 Preface to the special topic: Energetic particles in magnetic confinement fusion plasma  
*Chen Wei Huang Juan Qiu Zhi-Yong Wan Bao-Nian*

### REVIEW

- 215204 Summary of magnetohydrodynamic instabilities and internal transport barriers under condition of  $q_{\min} \approx 2$  in EAST tokamak  
*Xu Ming Xu Li-Qing Zhao Hai-Lin Li Ying-Ying Zhong Guo-Qiang Hao Bao-Long Ma Rui-Rui Chen Wei Liu Hai-Qing Xu Guo-Sheng Hu Jian-Sheng Wan Bao-Nian the EAST Team*
- 215207 Theoretical studies of low-frequency shear Alfvén waves in reversed shear tokamak plasmas  
*Ma Rui-Rui Chen Liu Qiu Zhi-Yong*

### ARTICLE

- 215201 Investigation of ICRF-NBI synergetic heating induced fast ion distribution and transport in EAST tokamak  
*Zhang Wei Zhang Xin-Jun Liu Lu-Nan Zhu Guang-Hui Yang Hua Zhang Hua-Peng Zheng Yi-Feng He Kai-Yang Huang Juan*
- 215202 Numerical simulations of fishbones driven by fast ions in negative triangularity tokamak  
*Ren Zhen-Zhen Shen Wei*
- 215203 Tomography of fast ion distribution function under neutral beam injection and ion cyclotron resonance heating on EAST  
*Sun Yan-Xu Huang Juan Gao Wei Chang Jia-Feng Zhang Wei Shi Chang Li Yun-He*
- 215205 Suppression mechanism of equilibrium magnetic islands in CFQS low- $\beta$  plasma  
*Su Xiang Wang Xian-Qu Fu Tian Xu Yu-Hong*
- 215206 Improvement of critical gradient model and establishment of an energetic particle module for integrated simulation  
*Zou Yun-Peng Chan Vincent Chen Wei*
- 215208 Effect of deposition location of electron cyclotron resonance heating on active control of fishbone modes in the HL-2A tokamak  
*Shi Pei-Wan Zhu Xiao-Long Chen Wei Yu Xin Yang Zeng-Chen He Xiao-Xue Wang Zheng-Xiong*
- 215209 Numerical simulation of  $\alpha$  particle slowing-down process under CFETR scenario  
*Wu Xiang-Feng Wang Feng Lin Zhan-Hong Chen Luo-Yu Yu Zhao-Ke Wu Kai-Bang Wang Zheng-Xiong*
- 215210 Hybrid numerical simulation on fast particle transport induced by synergistic interaction of low- and medium-frequency magnetohydrodynamic instabilities in tokamak plasma  
*Zhu Xiao-Long Chen Wei Wang Feng Wang Zheng-Xiong*

(Continued)

- 215211 Beta-induced Alfvén eigenmodes with frequency chirping driven by energetic ions in the HL-2A Tokamak  
*Hou Yu-Mei Chen Wei Zou Yun-Peng Yu Li-Ming Shi Zhong-Bing Duan Xu-Ru*
- 215212 Physical design and primary experimental results of imaging neutral particle analyzer on HL-2A tokamak  
*Yan Xiao-Yu He Xiao-Fei Yu Li-Ming Liu Liang Chen Wei Shi Zhong-Bing Lu Jie Wei Hui-Ling Han Ji-Feng Zhang Yi-Po Zhong Wu-Lü Xu Min*
- 215215 Optimizing numerical simulation of beam ion loss due to toroidal field ripple on EXL-50U spherical torus  
*Hao Bao-Long Li Ying-Ying Chen Wei Hao Guang-Zhou Gu Xiang Sun Tian-Tian Wang Yu-Min Dong Jia-Qi Yuan Bao-Shan Peng Yuan-Kai Shi Yue-Jiang Xie Hua-Sheng Liu Min-Sheng ENN TEAM*
- 215216 Global simulations of energetic electron excitation of beta-induced Alfvén eigenmodes  
*Bao Jian Zhang Wen-Lu Li Ding*
- 215217 Effect of radial electric field on ion-temperature gradient driven mode stability  
*Chen Ning-Fei Wei Guang-Yu Qiu Zhi-Yong*

SPECIAL TOPIC—The 70th anniversary of National University of Defense  
Technology

- 214207 General theory of quantum holography based on two-photon Interference  
*Xu Yao-Kun Sun Shi-Hai Zeng Yao-Yuan Yang Jun-Gang Sheng Wei-Dong Liu Wei-Tao*

GENERAL

- 210301 Dependence of retrieval efficiency on waist ratio of read beam to anti-Stokes photon mode in cavity-enhanced quantum memory  
*Fan Wen-Xin Wang Min-Jie Jiao Hao-Le Lu Jia-Jin Liu Hai-Long Yang Zhi-Fang Xi Meng-Qi Li Shu-Jing Wang Hai*

ELECTROMAGNETISM, OPTICS, ACOUSTICS, HEAT TRANSFER,  
CLASSICAL MECHANICS, AND FLUID DYNAMICS

- 214201 Coherent control of polarization transformation of Bloch surface waves  
*Wei Jin-Zhi Wang Jin-Hao Chen Jun-Xue*
- 214202 Broadband ultrafast photogenerated carrier dynamics induced by intrinsic defects in  $\beta$ -Ga<sub>2</sub>O<sub>3</sub>  
*Wang Lu-Xuan Liu Yi-Tong Shi Fang-Yuan Qi Xian-Wen Shen Han Song Ying-Lin Fang Yu*
- 214203 High-order harmonic platform extension and cluster expansion of H ion cluster  
*Zhang Chun-Yan*
- 214204 Optical gain properties of interfacial material PFN-Br and its application potentials in future electrically pumped organic lasers  
*Zhang Zhi-Yuan Xiao Zi-Han Zhu Shan Zhang Qi Xia Rui-Dong Peng Jun-Biao*
- 214205 All-optical reservoir computing system based on polarization dynamics  
*Fang Nian Qian Ruo-Lan Wang Shuai*
- 214206 Violet phosphorus-enhanced plug-and-play double-lane fiber optic surface plasmon resonance refractometer  
*Jing Jian-Ying Liu Kun Wu Zhang-Yi Liu Yue-Meng Jiang Jun-Feng Xu Tian-Hua Yan Wei-Cheng Xiong Yi-Yang Zhan Xiao-Han Xiao Lu Liu Jin-Chang Liu Tie-Gen*
- 214701 Law of diffusion bubbles produced by high-voltage pulsed electric field in liquid  
*Wu Xiao-Dong Chen Yan-Zhou Han Rui Guo Yu-Yi Zhuang Jie Shi Fu-Kun*

PHYSICS OF GASES, PLASMAS, AND ELECTRIC DISCHARGES

- 215213 Multi-fluid and dynamic simulation of tungsten impurity in tokamak boundary plasma  
*Wang Fu-Qiong Xu Ying-Feng Zha Xue-Jun Zhong Fang-Chuan*

(Continued)

- 215214 Rate optimization of atomic layer etching process of silicon  
*Bai Sheng-Bo Chen Zhi-Hua Zhang Huan-Hao Chen Gao-Jie Cao Shi-Cheng Zhang Sheng-Bo*

## CONDENSED MATTER: STRUCTURAL, MECHANICAL, AND THERMAL PROPERTIES

- 216401 Metastable phase separation and duplex metallic glass formation of liquid  $Zr_{35}Al_{23}Ni_{22}Gd_{20}$  alloy  
*Wu Bo-Wen Hu Liang Geng De-Lu Wei Bing-Bo*
- 216701 Adiabatic elimination theory of multi-level system in spin-orbit coupled Bose-Einstein condensate  
*Yuan Jia-Wang Chen Li Zhang Yun-Bo*

## CONDENSED MATTER: ELECTRONIC STRUCTURE, ELECTRICAL, MAGNETIC, AND OPTICAL PROPERTIES

- 217101 Carrier ladder effect regulated dissociation and scattering of triplet excitons in OLED  
*Bao Xi Guan Yun-Xia Li Wan-Jiao Song Jia-Yi Chen Li-Jia Xu Shuang Peng Ke-Ao Niu Lian-Bin*
- 217201 Exciton regulation mechanism of  $Alq_3$ /HAT-CN tandem electroluminescent devices  
*Li Wan-Jiao Guan Yun-Xia Bao Xi Wang Cheng Song Jia-Yi Xu Shuang Peng Ke-Ao Chen Li-Jia Niu Lian-Bin*
- 217501 Enhanced microwave absorption performance of large-sized monolayer two-dimensional  $Ti_3C_2T_x$  based on loaded  $Fe_3O_4$  nanoparticles  
*Xiao Yi-Yao He Jia-Hao Chen Nan-Kun Wang Chao Song Ning-Ning*

## INTERDISCIPLINARY PHYSICS AND RELATED AREAS OF SCIENCE AND TECHNOLOGY

- 218101 Quantitative analysis of oxygen partial pressure measurements based on photoacoustic pump-probe imaging  
*He Xiao Xiao Xiao-Zhou He Bin Xue Ping Xiao Jia-Ying*
- 218102 In-plane optical anisotropy of quasi-one-dimensional layered semiconductor  $Nb_4P_2S_{21}$  single crystal  
*Cheng Qiu-Zhen Huang Yin Li Yu-Hui Zhang Kai Xian Guo-Yu Liu He-Yuan Che Bing-Yu Pan Lu-Lu Han Ye-Chao Zhu Ke Qi Qi Xie Yao-Feng Pan Jin-Bo Chen Hai-Long Li Yong-Feng Guo Hui Yang Hai-Tao Gao Hong-Jun*
- 218901 Band gap prediction of perovskite materials based on transfer learning  
*Sun Tao Yuan Jian-Mei*

Color figures can be viewed in the online issue.



Online issue