

# 物 理 学 报

第 70 卷 第 24 期 2021 年 12 月 20 日

## 目 次

### 专题: 太赫兹生物物理

240101 太赫兹生物物理专题编者按 ..... 施卫 宫玉彬 吴晓君

#### 综述

244303 6G 技术发展愿景与太赫兹通信 ..... 冯伟 韦舒婷 曹俊诚

247802 超材料赋能先进太赫兹生物化学传感检测技术的研究进展 .....  
..... 王玥 崔子健 张晓菊 张达麓 张向 周韬 王暄

248707 红外及太赫兹辐照下细胞膜生物效应的研究进展 ..... 薄文斐 车嵘 孔磊 张明洁 张晓波

240701 太赫兹波生物效应 ..... 彭晓昱 周欢

#### 研究论文

240301 太赫兹波在神经细胞中传输的弱谐振效应 .....  
..... 郭良浩 王少萌 杨利霞 王凯程 马佳路 周俊 宫玉彬

243101 强场太赫兹波作用下氢气分子振动动力学研究 ..... 宁辉 王凯程 王少萌 宫玉彬

243202  $\alpha$ -乳糖水溶液太赫兹吸收光谱实验研究及模拟分析 ..... 侯磊 王俊喃 王磊 施卫

248701 太赫兹波对钾离子通道蛋白二级结构影响的分子动力学模拟 .....  
..... 孙远昆 郭良浩 王凯程 王少萌 宫玉彬

248702 水的氢键网络动力学与其太赫兹频谱的关系 ..... 段铜川 闫韶健 赵妍 孙庭钰 李阳梅 朱智

248703 太赫兹散射式扫描近场光学显微镜中探针与样品互作用及其影响探究 .....  
..... 张倬铖 王月莹 张晓秋艳 张天宇 许星星 赵陶 宫玉彬 魏彦玉 胡旻

248704 太赫兹 GaAs 光电导天线阵列辐射特性 ..... 闫志中 施卫

248705 太赫兹电磁波调控甲烷水合物分解 ..... 朱智 闫韶健 段铜川 赵妍 孙庭钰 李阳梅

248706 COP-PDMS 微流控芯片的制备及在太赫兹对肠道上皮细胞生物效应中的应用 .....  
..... 王澄瑶 李旭 卢晓云

### 总论

240202 受垂直激励和水平约束的单摆系统亚谐共振分岔与混沌 ..... 赵武 张鸿斌 孙超凡 黄丹 范俊锴

240203 最优输运无网格方法及其在液滴表面张力效应模拟中的应用 ..... 周浩 李毅 刘海 陈鸿 任磊生

240302 量子弱测量中纠缠对参数估计精度的影响 ..... 张晓东 於亚飞 张智明

240303 一种基于平衡零差探测技术的平均光子数测量方法 ..... 刘金璐 杨杰 张涛 樊砚 黄伟 徐兵杰

240304 环形泵浦激发下微腔激子极化激元的涡旋叠加态演化分析 .....  
..... 熊振宇 蔡远文 吴昊 刘通 刘政良 任元

240501 一种基于摄动理论的不连续系统 Lyapunov 指数算法 ..... 马召召 杨庆超 周瑞平

### 核物理学

242901 基于载流子猝灭模型的闪烁体发光非线性效应理论分析及实验验证 .....  
..... 魏坤 黑东炜 刘军 徐青 翁秀峰 谭新建

### 原子和分子物理学

243201 同向旋转双色圆偏场中非次序双电离的频率比依赖 ..... 曾雪 苏杰 黄雪飞 庞惠玲 黄诚

## 电磁学、光学、声学、传热学、经典力学和流体动力学

- 244201 基于视觉密码与 QR 码的光学脆弱水印 ..... 周新隆 祝玉鹏 杨栋宇 张峻浩 卢哲 王华英 董昭 柯常军 史祎诗
- 244202 强激光上行大气传输热晕效应导致的光束偏折研究 ... 张建柱 张飞舟 苏华 胡鹏 谢晓钢 罗文
- 244203 基于大气声传播理论的爆炸声源能量估计 ..... 程巍 滕鹏晓 吕君 姬培锋 戴翊靖
- 244204 海洋上空折射率结构常数廓线估算 ..... 徐自强 吴晓庆 许满满 毕翠翠 韩永 邵士勇
- 244301 浅海波导环境不确定性对声源功率估计的影响 ..... 张少东 孙超 谢磊 刘雄厚 王宣
- 244302 一种准零刚度声学超材料板的低频宽频带隔声行为 ..... 胥强荣 沈承 韩峰 卢天健
- 244501 时间尺度上非迁移 Birkhoff 系统的 Mei 对称性定理 ..... 张毅
- 244701 大密度比气泡在含非对称障碍物微通道内的运动行为 ..... 贺传晖 刘高洁 娄钦
- 244702 高超声速 4:1 椭圆锥横流不稳定性实验研究 ..... 郑文鹏 易仕和 牛海波 霍俊杰
- 244703 周期性爆沸诱导的液滴自驱动 ..... 曹春蕾 徐进良 叶文力

## 气体、等离子体和放电物理

- 245201 电子非麦氏分布的二次电子发射磁化鞘层特性 ... 陈龙 孙少娟 姜博瑞 段萍 安宇豪 杨叶慧

## 凝聚物质: 结构、力学和热学性质

- 246301 二维  $XO_2$  ( $X = Ni, Pd, Pt$ ) 弹性、电子结构和热导率 ..... 方文玉 陈粤 叶盼 魏皓然 肖兴林 黎明锴 Ahuja Rajeev 何云斌
- 246401 不同尺寸  $Cu_{64}Zr_{36}$  纳米液滴的快速凝固过程分子动力学模拟 ..... 韦国翠 田泽安

## 凝聚物质: 电子结构、电学、磁学和光学性质

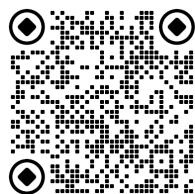
- 247101 非监督学习高维多体波函数矢量轨迹所在低维子空间 ..... 黄志伟 杨宏宇 翟峰 陆肖励 卢军强 吴健
- 247401 过渡金属原子掺杂对二维  $CrBr_3$  电磁学性能的调控 ..... 陈旭凡 杨强 胡小会
- 247501 磁电电压可调电感器的理论设计与可调性优化 ..... 聂长文 吴瀚舟 王书豪 蔡园园 宋树 Sokolov Oleg Bichurin M. I. 汪尧进
- 247502 低温波荡器定向织构 Dy 薄片的磁性能 ..... 何永周 王杰
- 247801 零维  $Sb^{3+}$  掺杂  $Rb_7Bi_3Cl_{16}$  金属卤化物的三重态自陷激子发射 ... 颜俊 王子毅 曾若生 邹炳锁

## 地球物理学、天文学和天体物理学

- 249201 ENSO 气温关联网结构特征差异及成因分析 ... 胡恒儒 龚志强 王健 乔盼节 刘莉 封国林

(卷终)

文章图片的彩色效果详见网刊



扫码阅读  
电子版

# ACTA PHYSICA SINICA

Vol. 70, No. 24, December 20, 2021

## CONTENTS

### SPECIAL TOPIC—Terahertz biophysics

- 240101 Preface to the special topic: Terahertz biophysics  
*Shi Wei Gong Yu-Bing Wu Xiao-Jun*

### REVIEW

- 244303 6G technology development vision and terahertz communication  
*Feng Wei Wei Shu-Ting Cao Jun-Cheng*
- 247802 Research progress of metamaterials powered advanced terahertz biochemical sensing detection techniques  
*Wang Yue Cui Zi-Jian Zhang Xiao-Ju Zhang Da-Chi Zhang Xiang Zhou Tao Wang Xuan*
- 248707 Research progress of biological effects of cell membrane under infrared and terahertz irradiation  
*Bo Wen-Fei Che Rong Kong Lei Zhang Ming-Jie Zhang Xiao-Bo*
- 240701 Biological effects of terahertz waves  
*Peng Xiao-Yu Zhou Huan*

### ARTICLE

- 240301 Weak resonance effects of THz wave transmission in nerve cell  
*Guo Liang-Hao Wang Shao-Meng Yang Li-Xia Wang Kai-Cheng Ma Jia-Lu Zhou Jun Gong Yu-Bin*
- 243101 Vibrational dynamics of hydrogen molecules under intense THz waves  
*Ning Hui Wang Kai-Cheng Wang Shao-Meng Gong Yu-Bin*
- 243202 Experimental study and simulation analysis of terahertz absorption spectra of  $\alpha$ -lactose aqueous solution  
*Hou Lei Wang Jun-Nan Wang Lei Shi Wei*
- 248701 Molecular dynamics simulation of effect of terahertz waves on the secondary structure of potassium channel proteins  
*Sun Yuan-Kun Guo Liang-Hao Wang Kai-Cheng Wang Shao-Meng Gong Yu-Bin*
- 248702 Relationship between hydrogen bond network dynamics of water and its terahertz spectrum  
*Duan Tong-Chuan Yan Shao-Jian Zhao Yan Sun Ting-Yu Li Yang-Mei Zhu Zhi*
- 248703 Tip-sample interactions in terahertz scattering scanning near-field optical microscopy and its influences  
*Zhang Zhuo-Cheng Wang Yue-Ying Zhang Xiao-Qiu-Yan Zhang Tian-Yu Xu Xing-Xing Zhao Tao Gong Yu-Bin Wei Yan-Yu Hu Min*
- 248704 Radiation characteristics of terahertz GaAs photoconductive antenna arrays  
*Yan Zhi-Jin Shi Wei*
- 248705 THz electromagnetic wave regulated dissolution of methane hydrate  
*Zhu Zhi Yan Shao-Jian Duan Tong-Chuan Zhao Yan Sun Ting-Yu Li Yang-Mei*
- 248706 Fabrication of cyclic olefin polymer and polydimethylsiloxane co-bonded microfluidic device and its applications in terahertz biological effects on intestinal cells  
*Wang Cheng-Yao Li Xu Lu Xiao-Yun*

(Continued)

## GENERAL

- 240202 Subharmonic resonance bifurcation and chaos of simple pendulum system with vertical excitation and horizontal constraint  
*Zhao Wu Zhang Hong-Bin Sun Chao-Fan Huang Dan Fan Jun-Kai*
- 240203 Optimized transportation meshfree method and its application in simulating droplet surface tension effect  
*Zhou Hao Li Yi Liu Hai Chen Hong Ren Lei-Sheng*
- 240302 Influence of entanglement on precision of parameter estimation in quantum weak measurement  
*Zhang Xiao-Dong Yu Ya-Fei Zhang Zhi-Ming*
- 240303 An average photon number measurement scheme based on balanced homodyne detection  
*Liu Jin-Lu Yang Jie Zhang Tao Fan Fan Huang Wei Xu Bing-Jie*
- 240304 Analysis for vortex superposition state evolution of microcavity exciton polariton excited by ring-shaped pump  
*Xiong Zhen-Yu Cai Yuan-Wen Wu Hao Liu Tong Liu Zheng-Liang Ren Yuan*
- 240501 Lyapunov exponent algorithm based on perturbation theory for discontinuous systems  
*Ma Zhao-Zhao Yang Qing-Chao Zhou Rui-Ping*

## NUCLEAR PHYSICS

- 242901 Theoretical analysis and experimental verification of scintillator luminescence nonlinearity based on carrier quenching model  
*Wei Kun Hei Dong-Wei Liu Jun Xu Qing Weng Xiu-Feng Tan Xin-Jian*

## ATOMIC AND MOLECULAR PHYSICS

- 243201 Frequency-ratio-dependent ultrafast dynamics in nonsequential double ionization by co-rotating two-color circularly polarized laser fields  
*Zeng Xue Su Jie Huang Xue-Fei Pang Hui-Ling Huang Cheng*

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

- 244201 Optical fragile watermarking based on visual cryptography and QR code  
*Zhou Xin-Long Zhu Yu-Peng Yang Dong-Yu Zhang Jun-Hao Lu Zhe Wang Hua-Ying Dong Zhao Ke Chang-Jun Shi Yi-Shi*
- 244202 Analysis of beam deviation induced by thermal blooming effect when high-energy laser propagating up in atmosphere  
*Zhang Jian-Zhu Zhang Fei-Zhou Su Hua Hu Peng Xie Xiao-Gang Luo Wen*
- 244203 Energy estimation of explosion sound source based on atmospheric sound propagation theory  
*Cheng Wei Teng Peng-Xiao Lü Jun Ji Pei-Feng Dai Yi-Jing*
- 244204 Estimation of  $C_n^2$  profile of troposphere over the sea  
*Xu Zi-Qiang Wu Xiao-Qing Xu Man-Man Bi Cui-Cui Han Yong Shao Shi-Yong*
- 244301 Influence of environmental uncertainty on source power estimation in shallow water waveguide  
*Zhang Shao-Dong Sun Chao Xie Lei Liu Xiong-Hou Wang Xuan*
- 244302 Broadband low-frequency sound insulation performance of quasi-zero stiffness local resonant acoustic metamaterial plate  
*Xu Qiang-Rong Shen Cheng Han Feng Lu Tian-Jian*
- 244501 Mei's symmetry theorems for non-migrated Birkhoffian systems on a time scale  
*Zhang Yi*
- 244701 Behavior of bubble with high density ratio in a microchannel with asymmetric obstacles  
*He Chuan-Hui Liu Gao-Jie Lou Qin*
- 244702 Experimental research on crossflow instability for a hypersonic 4:1 elliptic cone  
*Zheng Wen-Peng Yi Shi-He Niu Hai-Bo Huo Jun-Jie*

(Continued)

- 244703 Self-propulsion droplet induced via periodic explosive boiling  
*Cao Chun-Lei Xu Jin-Liang Ye Wen-Li*

## PHYSICS OF GASES, PLASMAS, AND ELECTRIC DISCHARGES

- 245201 Characteristics of non-Maxwellian magnetized sheath with secondary electron emission  
*Chen Long Sun Shao-Juan Jiang Bo-Rui Duan Ping An Yu-Hao Yang Ye-Hui*

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

- 246301 Elastic constants, electronic structures and thermal conductivity of monolayer  $XO_2$  ( $X = Ni, Pd, Pt$ )  
*Fang Wen-Yu Chen Yue Ye Pan Wei Hao-Ran Xiao Xing-Lin Li Ming-Kai Ahuja Rajeev He Yun-Bin*
- 246401 Molecular dynamics simulation of rapid solidification of  $Cu_{64}Zr_{36}$  nanodrops of different sizes  
*Wei Guo-Cui Tian Ze-An*

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

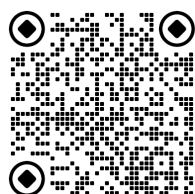
- 247101 Low-dimensional trajectory subspace of high-dimensional many-body wavefunctions by unsupervised learning  
*Huang Zhi-Wei Yang Hong-Yu Zhai Feng Lu Xiao-Li Lu Jun-Qiang Wu Jian*
- 247401 Tunable electronic and magnetic properties of transition-metal atoms doped  $CrBr_3$  monolayer  
*Chen Xu-Fan Yang Qiang Hu Xiao-Hui*
- 247501 Theoretical model and tunability optimization of magnetoelectric voltage tunable inductor  
*Nie Chang-Wen Wu Han-Zhou Wang Shu-Hao Cai Yuan-Yuan Song Shu Sokolov Oleg Bichurin M. I. Wang Yao-Jin*
- 247502 Magnetic properties of directional textured dysprosium foils for cryogenic undulator  
*He Yong-Zhou Wang Jie*
- 247801 Zero-dimensional  $Sb^{3+}$  doped  $Rb_7Bi_3Cl_{16}$  metal halides with triplet self-trapped exciton emission  
*Yan Jun Wang Zi-Yi Zeng Ruo-Sheng Zou Bing-Suo*

## GEOPHYSICS, ASTRONOMY, AND ASTROPHYSICS

- 249201 Analysis of structural differences and causes of ENSO temperature network  
*Hu Heng-Ru Gong Zhi-Qiang Wang Jian Qiao Pan-Jie Liu Li Feng Guo-Lin*

(END OF THE VOLUME)

Color figures can be viewed in the online issue.



Online issue