The 2nd International Mini-Workshop

Gravitational Waves and the Early Universe

第二届“引力波和早期宇宙”国际小型学术研讨会

会议手册

Handbook

Institute of Theoretical Physics, Chinese Academy of Sciences
Center for High Energy Physics, Peking University
中国科学院理论物理研究所/北京大学高能物理研究中心

April 8-11, 2024

International Workshop
Gravitational Waves and the Early Universe

With the detection of gravitational waves from the merger of binary black holes by LIGO, we officially entered the era of gravitational wave cosmology. During the early universe, many interesting physical processes could generate gravitational waves, which were usually associated with new physics beyond the standard model. This opens up a new observational window for humanity to further uncover the origins of the universe and its matter content. These gravitational waves are generated at different epochs and propagate through the cosmic history until the present, which are redshifted to different frequency bands. In the recent future, various gravitational wave detection projects are planned, including CMB-S4, LiteBIRD, BICEP3/Keck Array, AliCPT utilizing the B-mode polarization of the cosmic microwave background radiation; NANOGrav, EPTA, PPTA, CPTA using pulsar timing arrays; LISA, Taiji, TianQin utilizing space-based gravitational wave interferometers; and ET, BBO for ground-based gravitational wave interferometers.

Recently, the NANOGrav, EPTA, and CPTA jointly announced strong evidence for the existence of a nanohertz stochastic gravitational wave background. This has reignited our interest in gravitational waves produced in the early universe.

In order to further advance research in relevant fields, we held the first International Workshop on Gravitational Waves and the Early Universe, which attracted more than 100 scholars from over a dozen domestic and international research institutions and universities. During the three days of the conference, participants engaged in extensive discussions on recent developments in observations and theory.

We are glad to announce that the 2nd International Workshop on Gravitational Waves and the Early Universe will be held from April 8th to 11th, 2024.

Accommodation:

(1) No.1, Zhongguanxinyuan Hotel, Peking University, Beijing 100871, China.

(2) Liaoning Hotel, Jia #2 Bei Si Huan Xi Road, Haidian District, Beijing. 010-62589999

Venue: Jixian Hall, 11th floor, Blg. No.1, Zhongguanxinyuan Hotel, Peking University, Beijing 100871, China.

Schedule: Register on April 8th (Monday). Workshop on April 9th (Tuesday) and 10th (Wednesday). Leave on April 11th (Thursday).

Sponsors: This workshop is sponsored by ITP, CAS, by the Center for High Energy Physics, Peking University, and by the National Key Research and Development Program of China Grant No. 2021YFC2203004.

Organizers:

Bin Chen, Shi Pi

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第二届国际学术研讨会
“引力波和早期宇宙”

中国科学院理论物理研究所及北京大学高能物理研究中心将于 2024 年 4 月 8 日至 11 日在中国科学院理论物理研究所联合举办第二届“引力波和早期宇宙”小型国际学术研讨会。会议网址：https://indico.itp.ac.cn/event/217/。

随着 LIGO 观测到双黑洞合并的引力波，人类正式进入引力波宇宙学时代。在早期宇宙中，很多有趣的物理过程都能产生引力波。它们通常都和超出标准模型的新物理相联系，是人类进一步揭开宇宙起源和物质起源的一个新的观测窗口。这些引力波诞生于宇宙的不同时期，可能出现在许多可探测频段上。未来十几年内将有不同的引力波探测计划进行探测。其中包括间接利用微波背景辐射 B 模偏振的 CMB-S4、LiteBIRD、BICEP3/Keck Array、AliCPT；利用脉冲星测时阵列的 NANOGrav, EPTA, PPTA, CPTA；空间引力波干涉仪的 LISA、太极、天琴；地面引力波探测器的 ET、BBO 等。最近，NANOGrav, EPTA, CPTA 等脉冲星测试阵列观测组同时宣布观测到纳赫兹随机引力波背景存在的强烈证据。这重新燃起了我们对早期宇宙中产生的引力波的兴趣。我们曾于 2023 年 10 月 13 日至 16 日举办了第一届《引力波与早期宇宙》国际研讨会，共吸引了来自国内外十几个科研院所与高校的 100 余名学者参与。在三天的会议期间，参会学者利用 24 场学术报告和自由讨论，充分研讨了早期宇宙和引力波的相关领域的理论和观测问题的近期进展。

为了进一步推进相关领域的研究并促进国内外学者之间的合作与交流，我们将于 2024 年 4 月 9 日至 11 日举办第二届“引力波与早期宇宙”国际研讨会。会议不收注册费，食宿及交通自理。

本次会议由中国科学院理论物理研究所及北京大学高能物理研究中心联合举办，并受到科技部国家重点研发计划“引力波探测”专项项目“宇宙弦等新颖引力波源与随机引力波背景的特征和信号识别研究”(项目号 2021YFC2203004)的资助。

住宿： 北京大学中关新园 (北京市海淀区中关村北大街 126 号 010-62752288)
辽宁大厦 (北京市海淀区北四环西路甲 2 号 010-62589999)
地点：北京大学**中关新园 1 号楼 11 层集贤厅**(北京市海淀区中关村北大街 126 号)
日程：2024 年 4 月 8 日—4 月 11 日
4 月 8 日全天报到 (酒店不设签到处，会议期间在会议室门口签到)
9—10 日两天会议报告，11 日自由讨论、离会
组织者：陈斌，皮石
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倪清容 (niqr@itp.ac.cn,13911992271)
王嘉宁 (wangjianing@itp.ac.cn,18810512717)
会议联系人：皮石(shi.pi@itp.ac.cn,13810683773)

Transportation

Transportation from Beijing Airport to Zhongguanxinyuan Global Village:

PKU is located about 35 km from the Beijing International Airport. It is strongly suggest to take a taxi. You can get a taxi right outside the arrival terminals. Taxies wait there in line. The normal taxi driver will not soliciting business in person at the Airport arrival terminals hall.

(1) By taxi:

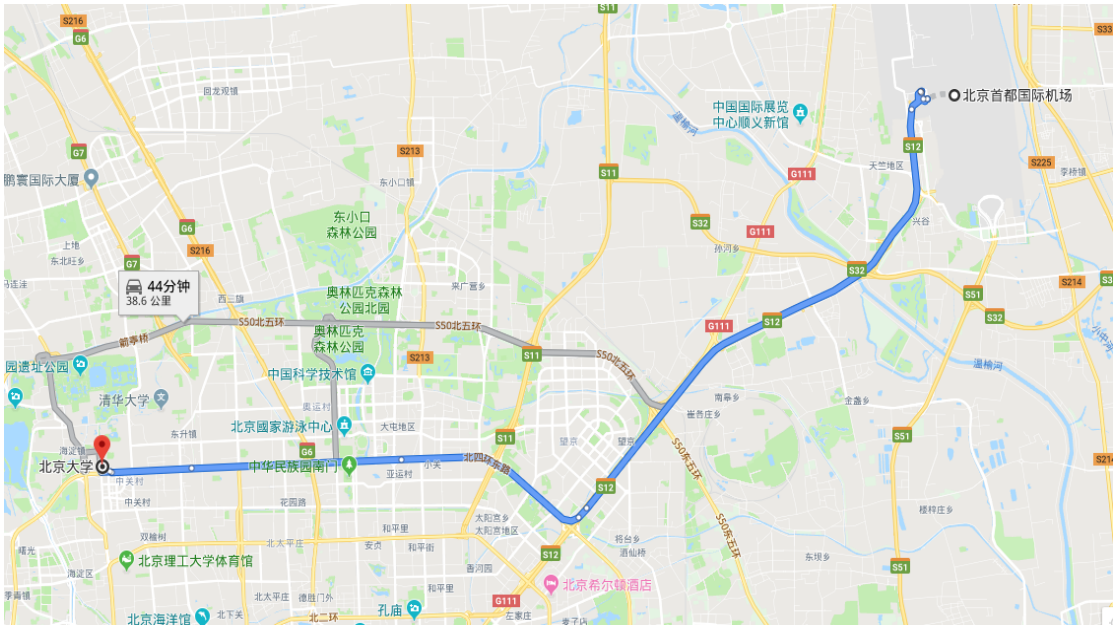
You can get a taxi right outside the arrival terminals. It takes about 40-60 mins from the airport to the No.1 Building Zhongguanxinyuan Global Village PKU. The fare is about 120CNY.

- *If you take taxi, please show this to the taxi drive.*

  请送我到海淀区中关村北大街 126 号的北京大学中关新园 1 号楼

(2) By Subway:

You can take Beijing Subway from the Airport Station to Sanyuanqiao Station, from which transfer to line 10. The direction of line 10 you should choose is Taiyanggong direction. Then make another change from line 10 to line 4 at Haidianhuangzhuang Station, Take the direction to Anheqiaobei and stop off at East Gate of Peking University Station. Take the Port C and then walk about 500 meters, you'll be able to get to the hotel.



Transportation from Beijingsouth Railway Station to Zhongguanxinyuan Global Village:

(1) By taxi:

You can get a taxi right outside the train arrival. It takes about 40mins from the Beijingsouth Railway Station to the No.1 Building Zhongguanxinyuan Global Village PKU. The distance is about 24km.

- *If you take taxi, please show this to the taxi drive.*

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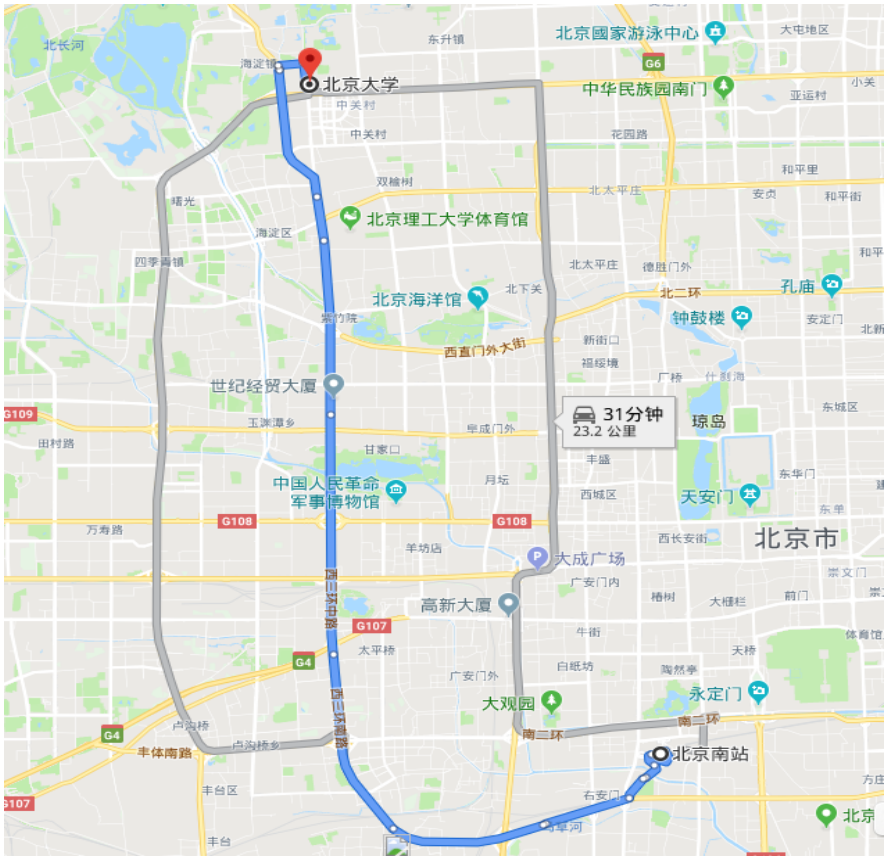
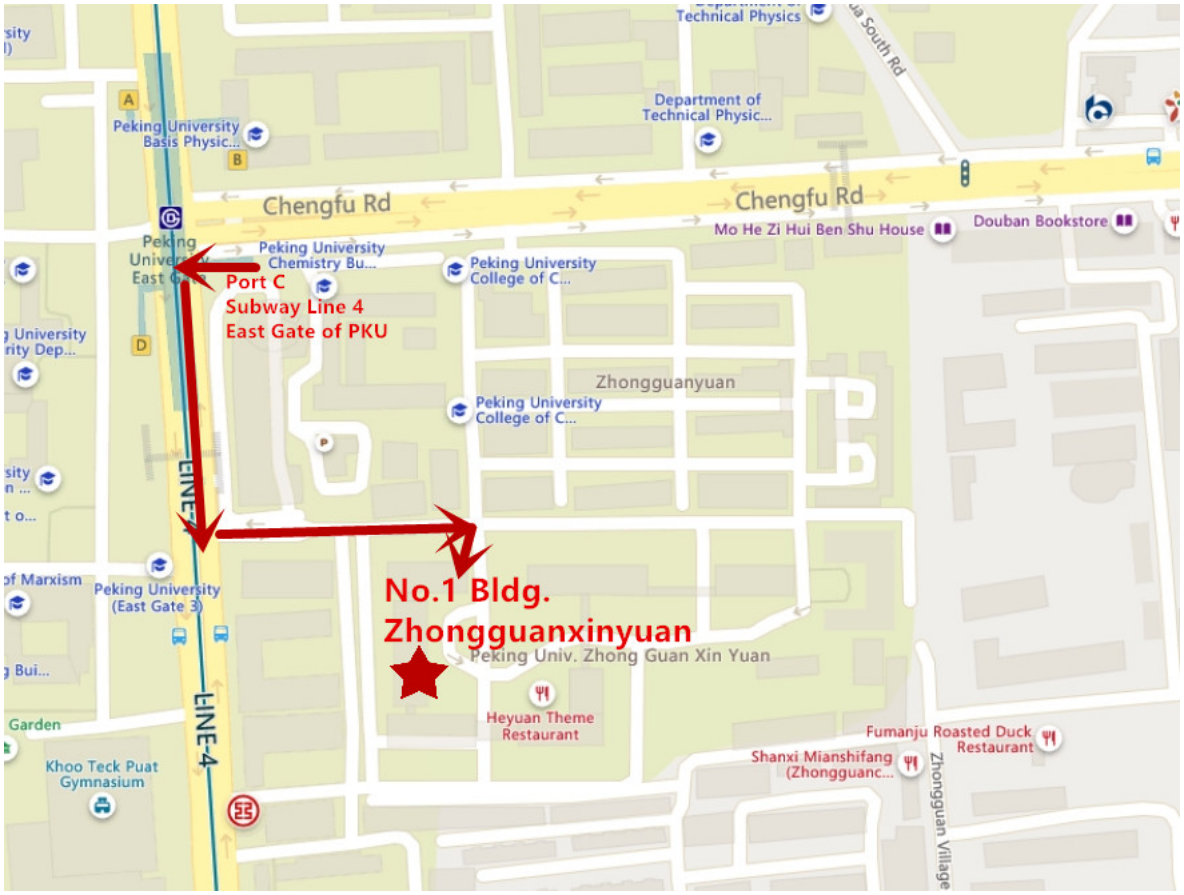
PKU in relation to Beijing South Railway Station




Technical Physics
Department of Technical Physic...
Peking University Basis Physic...
Chengfu Rd
Chengfu Rd
Mo He Zi Hui Ben Shu House
Douban Bookstore
Peking University Chemistry Bu...
Peking University College of C...
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Subway Line 4
East Gate of PKU
Zhongguanyuan
Peking University College of C...
LINE-4
Peking University (East Gate 3)
No.1 Bldg.
Zhongguanxinyuan
Peking Univ. Zhong Guan Xin Yuan
Heyuan Theme Restaurant
Fumanju Roasted Duck Restaurant
Shanxi Mianshifang (Zhongguanc...
Zhongguan Village
Khoo Teck Puat Gymnasium
LINE-4

(2) By Subway:

You can take Line 4 which is to Anheqiaobei direction from Beijingsouth Railway Station to stop off at East Gate of Peking University Station. Take the Port C and then walk about 500 meters, you'll be able to get to the hotel.

Transportation from Beijing Daxing International Airport to Zhongguanxinyuan Global Village:

(1) By taxi:

You can get a taxi right outside the arrival terminals. It takes about 60+ mins from the Daxing airport to the No.1 Building Zhongguanxinyuan Global Village PKU. The fare is about 220CNY.

- *If you take taxi, please show this to the taxi drive.*

  请送我到海淀区中关村北大街 126 号的北京大学中关新园 1 号楼

(2) By Subway:

You can take Beijing Subway DAXING Line from the Airport Station to Caoqiao Station, from which transfer to line 19. The direction of line 19 you should choose is Mudanyuan direction. Then make another change from line 19 to line 10 at Mudanyuan Station.Then

make another change from line 10 to line 4 at Haidianhuangzhuang Station, Take the direction to Anheqiaobei and stop off at East Gate of Peking University Station. Take the Port C and then walk about 500 meters, you'll be able to get to the hotel.

Schedule of the 2nd International Workshop "Gravitational Waves and the Early Universe"
第二届"引力波和早期宇宙"国际小型研讨会日程

4 月 9 日

会议地点：中关新园 1 号楼 11 层集贤厅
Venue: Jixian Hall, 11th floor, No.1 Bldg., Zhongguanxinyuan

Opening 开幕式及特邀报告		**Chair: Yun-Song Piao 朴云松**
Time	**Speaker**	**Title**
9:30	Opening	
9:40-10:30	Misao Sasaki 佐々木節	Primordial Black Holes as a Probe of the Early Universe
10:30-10:50	Tea break and photo 茶歇、合影	

Inflation 暴胀		**Chair: Bin Chen 陈斌**
Time	**Speaker**	**Title**
10:50-11:40	Takahiro Tanaka 田中貴浩	Large gauge transformation, delta-N and IR divergence

11:40- 12:10	Hai-peng An 安海鹏	Consequences of phase transitions happened during inflation
12:10- 13:30	Lunch (2nd floor, Western Restaurant "Time") 午餐（中关新园 1 号楼 2 层时光西餐厅）	

Black Hole 黑洞		**Chair: Jiliang Jing 荆继良**
Time	**Speaker**	**Title**
13:30- 14:20	Shinji Mukohyama 向山信治	Effective field theory of black hole perturbations with timelike scalar
14:20- 14:50	Alexey Koshelev	Black Holes in UV complete infinite derivative gravity - new challenges
14:50- 15:10	Tea break 茶歇	

Dark Matter 暗物质		**Chair:Xian Gao 高显**
Time	**Speaker**	**Title**
15:10- 15:40	Atsushi Naruko 成子篤	Axion Cloud Decay due to the Axion-photon Conversion with Background Magnetic Fields
15:40- 16:10	Kenji Kadota 門田健司	Probes on the Dense Dark Matter Environments Around a Black Hole

16:10- 16:40	Yong Tang 汤勇	Probing Dark Matter with Gravitational-Wave Detectors in Space
16:40- 17:00	Tea break 茶歇	

GW Astronomy 引力波天文		**Chair:Lijing Shao 邵立晶**
Time	**Speaker**	**Title**
17:00- 17:30	Xilong Fan 范锡龙	Using Gravitational Wave Background to probe string cosmology
17:30- 18:00	Ying-li Zhang 章颖理	Mergers of PBH binaries inside Dark Matter Halos
18:00- 20:00	Banquet (2nd floor Guanhu Hall) 晚宴（中关新园 1 号楼 2 层观湖厅）	

4 月 10 日

会议地点：中关新园 1 号楼集贤厅

Venue: Jixian Hall, 11th floor, No.1 Bldg., Zhongguanxinyuan

Modified Gravity 修改引力		**Chair:Renxin Xu 徐仁新**
Time	**Speaker**	**Title**
9:30- 10:20	Masahide Yamaguchi 山口昌英	Trace anomaly in Metric-Affine Gravity
10:20- 10:40	茶歇 Tea break	

GW lensing 引力波透镜		**Chair: Tao Zhu 朱涛**
Time	**Speaker**	**Title**
10:40- 11:30	Teruaki Suyama 须山輝明	Weak lensing of gravitational waves and universal relations
11:30- 12:00	Bin Hu 胡彬	Gravitational wave lensing
12:00- 13:30	Lunch (2nd floor, Western Restaurant “Time”) 午餐（中关新园 1 号楼 2 层，时光西餐厅）	

Tensor Perturbation 张量扰动		**Chair: Junqing Xia 夏俊卿**
Time	**Speaker**	**Title**
13:30- 14:20	Jinn-Ouk Gong 공진욱(孔鎭郁)	Scalar-induced one-loop tensor power spectrum during inflation
14:20- 14:50	Zhiqi Huang 黄志琦	Measuring primordial tensor perturbations with ground-based CMB experiments
14:50- 15:10	Tea break 茶歇	

GW Astronomy 引力波天文		**Chair:Jieci Wang 王接词**
Time	**Speaker**	**Title**
15:10- 15:40	Lei Wu 武雷	Probing Dark Matter Beyond WIMP in terrestrial and astrophysical experiments
15:40- 16:10	Wen-biao Han 韩文标	General formalism for dirty EMRI
16:10- 16:40	Xian Chen 陈弦	(not so) Standard Sirens from Active Galactic Nuclei
16:40- 17:00	Tea break 茶歇	

高阶微扰 Higher-Order Perturbation　　Chair:Yi-fu Cai 蔡一夫		
Time	**Speaker**	**Title**
17:00- 17:30	Zhong-Zhi Xianyu 鲜于中之	Family tree decomposition of cosmological correlators
17:30- 18:00	Bo Wang 王博	2nd-order cosmological perturbations during inflation stage
18:20-	Dinner 晚餐	

4 月 11 日

会议地点：中国科学院理论物理研究所新楼 3 层咖啡厅
Venue: 3rd Floor, New Building, ITP, CAS

	Chair:Misao Sasaki 佐々木節
9:30- 12:00	Free Discussion 自由讨论
12:00- 13:00	Lunch (Cafeteria of CAS Basic Science Campus) 午餐 （中国科学院基础科学园区食堂）
13:00-	Leave 离会

List of Participants

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