

The International School on Crystallographic Groups & Their Representations and the subsequent Workshop on Topological Insulators were held at the International Center for Quantum and Molecular Structure (ICQMS), Shanghai University (SHU), Shanghai, China in July 1-7, 2019.

The summer school was organized by Dr. A. Stroppa (CNR-SPIN), Prof. W. Ren (SHU), Prof. M. I. Aroyo (UPV/EHU). The lecturers were Prof. M. I. Aroyo and Prof. L. Elcoro from (UPV/EHU, Bilbao, Spain), Prof. B. Souvignier (Radboud University, Nijmegen, The Netherlands), Prof. M. Nespolo (Université de Lorraine, Nancy, France), Prof. J. Cano (Stony Brook University, USA), Prof. B. Bradlyn (University of Illinois, USA) and Dr. Zhida Song (Princeton University, USA). There were more than 110 participants from institutions in various countries, including the Institute of Physics, Chinese Academy of Sciences, Institute of High Energy Physics and Fujian Institute of Research on the Structure, National Science and Technology University, Beijing University, Nanjing University, Fudan University, Shanghai Jiaotong University, Zhejiang University, Wuhan University, Huazhong Science and Technology University, Beihang University, Beijing Institute of Technology, Shanghai University, Southern University, Sichuan Normal University, Hunan Normal University, Hebei University, University of Singapore, Seoul National University, University of Vienna, Jawaharlal Nehru Centre for Advanced Scientific Research.



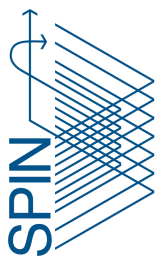
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The summer school opened at 8:15 am on July 1st. Prof. W. Ren, executive director of the ICQMS, introduced the opening ceremony. Prof. X. Wang, Vice President of Shanghai University, delivered a welcome speech. This school provided the crystallographic and group-theoretical background necessary for understanding the application of symmetry methods and techniques in topological quantum systems. The lectures were complemented by exercises to help the participants to get some practical knowledge in crystallographic groups and their representations. Through examples and hands-on sessions, the participants gained experience in the use of the online tools of the Bilbao Crystallographic Server (BCS, <http://www.cryst.ehu.es/>) to solve specific problems related to electronic properties of topological solids. Furthermore, symmetry analyses were applied to identify the problems in solid state physics including the electronic band theory and the recent developments of topological quantum chemistry to classify topological materials. The lectures and exercises of the school focused on the important role of symmetry in the study of modern topological physics and related material science problems.

In the first four days, Prof. Mois Aroyo, Prof. Massimo Nespolo and Prof. Bernd Souvignier introduced the basic knowledge of group theory and matrix representations of symmetry operations and focused on the representations of crystallographic point and space groups. They also introduced the appropriate tools of the BCS server for crystallographic and materials studies. On the fifth and sixth day, Prof. Jennifer Cano, Prof. Barry Bradlyn and Dr. Zhida Song extended the application of symmetry and crystallographic space groups to topology and quantum chemistry. Prof. Jennifer Cano taught the basic concept of band theory in topological insulators while Prof. Barry Bradlyn explained the adiabatic theorem and real space method of topology, the modern theory of polarization, the Berry-Zak phase and the Wannier function method. Dr. Song gave a detailed lecture on the deduction of the quantum spin hall effect in graphene, followed by the introduction of higher order topological insulators and topological phases in bilayer twisted graphene. In order to distinguish various topological materials and to understand the topological band theory, the new BANDREP module of the BCS was introduced to the users. On the last day, Prof. Mois Aroyo and Luis Elcoro introduced magnetic groups and magnetic structures and described the online modules (MAGNEXT and MAXMAGN). The school was successfully concluded at 6 p.m. on July 7th.

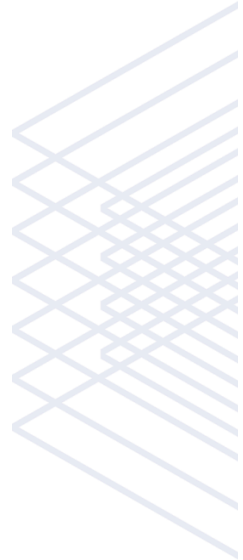


Istituto SPIN
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This summer school has played an active role in promoting the understanding of modern directions in topological physics and as well as to start new collaborations among the participants in condensed matter physics and topological materials. The participants benefited a lot from this school which provided them with a lot of inspiration for future scientific interests in topological materials. The conference was supported by IUCr, CCRS, ICTP, Shanghai University computing center, Koushare academic platform and Hongzhiwei Technology (Shanghai) co. LTD. All the lectures were live broadcasted all around the world on Koushare academic platform, a platform to widely spread science by using new technologies. A total of 9,854 people watched online via this platform.



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