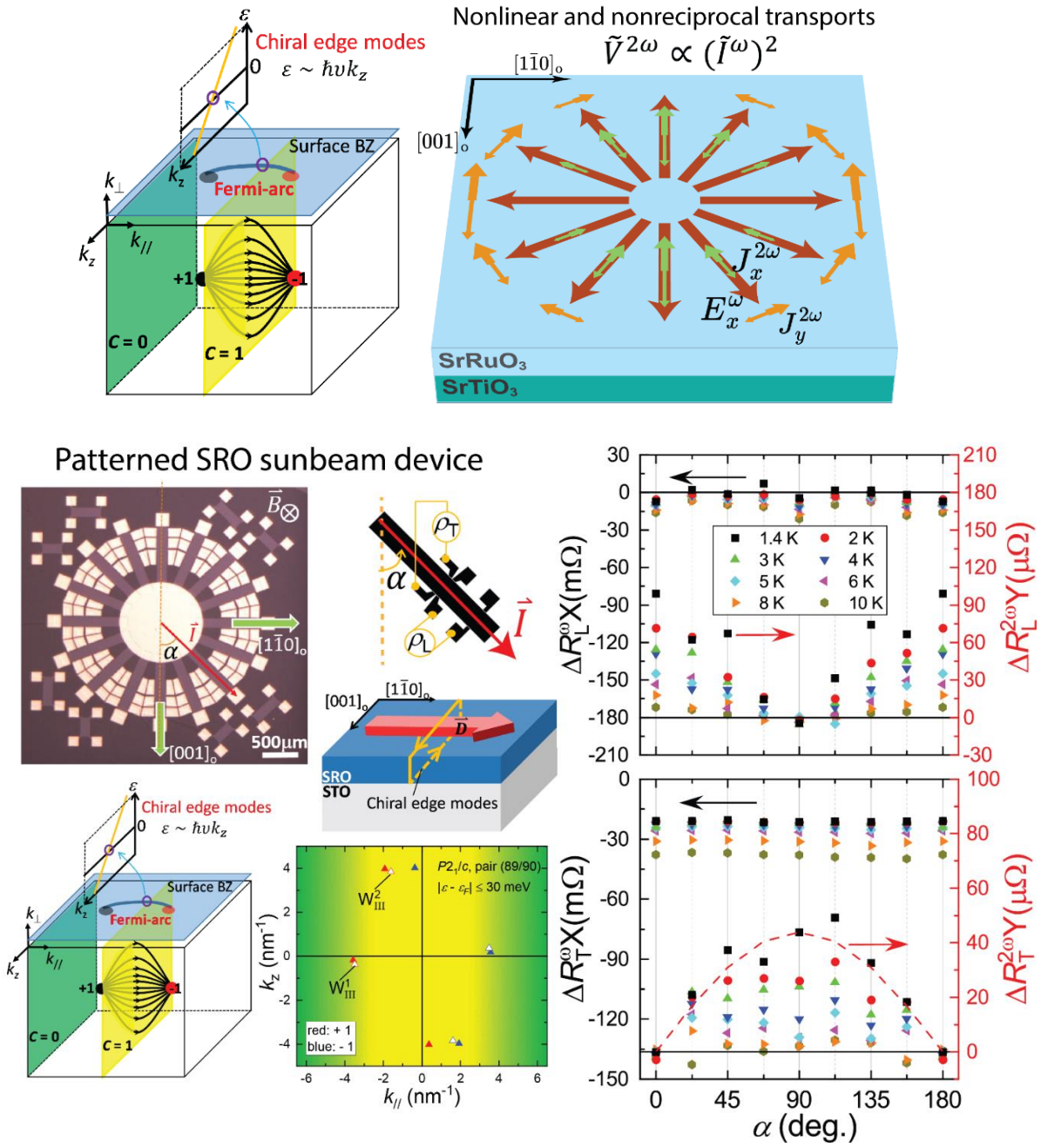
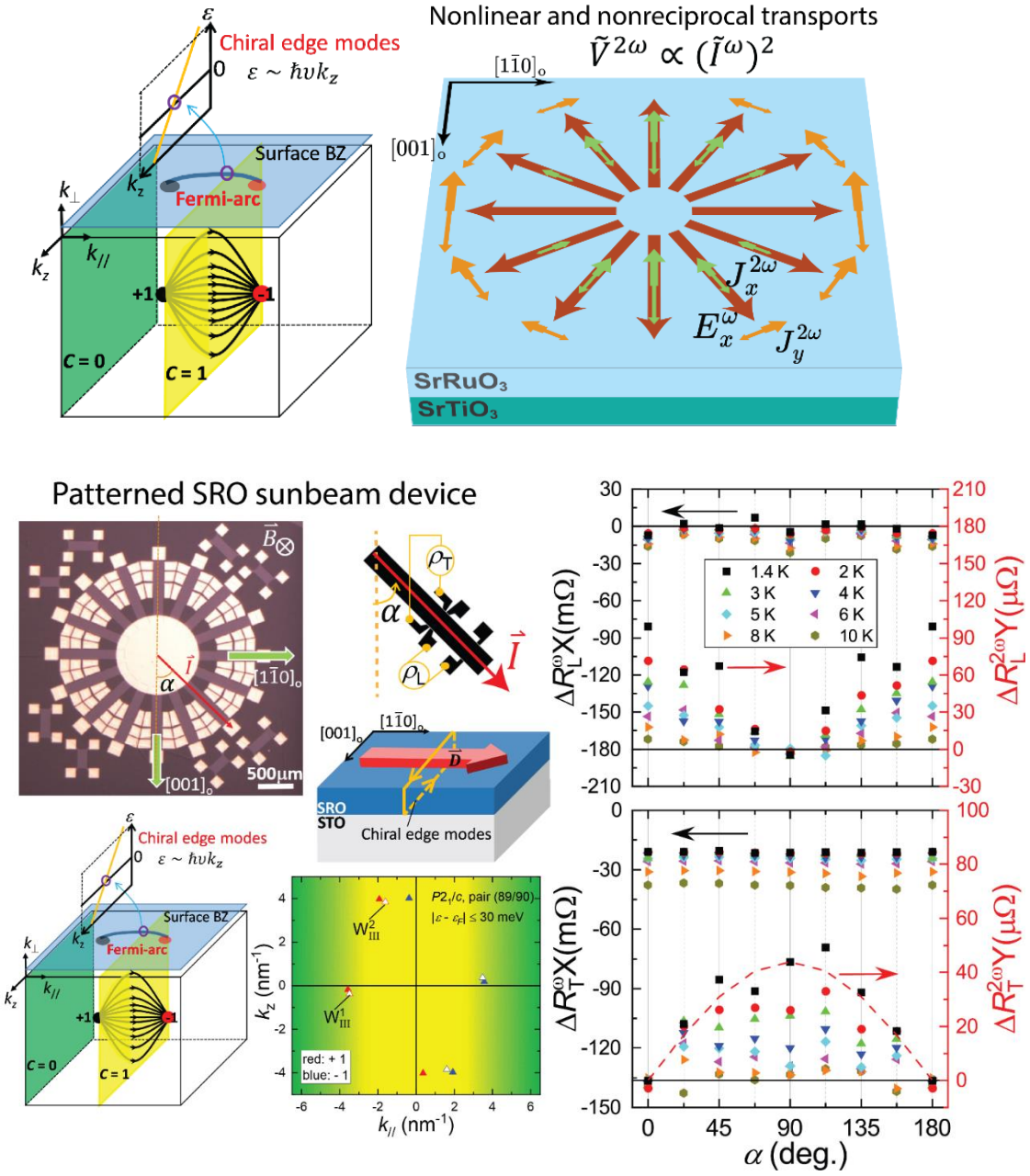


透過非線性和非交互電荷輸運效應揭示拓撲表面態

拓撲物質系統中極具挑戰性的議題之一在於找尋與識別與拓撲表面態有直接關聯的電荷輸運特徵。近期由李偉立博士和郭光宇教授所主導的一項國際合作研究中，在拓撲鐵磁Weyl金屬磊晶薄膜$SrRuO_3$（SRO）中實驗觀察到縱向和橫向輸運通道中巨大的非交互和非線性電荷輸運效應（NRTE）。 結合電子能帶結構計算結果，實驗觀察到的NRTE源自於拓撲Weyl金屬的表面態以及其伴隨的一維度手性邊緣態。 這些研究結果除了強調NRTE 電荷傳輸效應作為鑑別反演對稱性破壞的拓樸表面態的重要性外，亦凸顯拓撲物質在非交互電子元件及非線性光學應用上極具潛力。完整的實驗數據和理論分析已發表在Physical Review X（ https://doi.org/10.1103/PhysRevX.14.011022 ）。 Uddipta Kar、呂倬豪、Akhilesh Singh 和 P.V. Sreenivasa Reddy 為共同第一作者。SRO磊晶薄膜生長、元件製備和低溫輸運測量由本所李偉立博士團隊和台大陳奕君教授團隊進行。 電子能帶結構計算由台大郭光宇教授團隊及紐約州立大學賓漢頓分校李偉正教授團隊進行。 光學二次諧波測量由加州理工學院 David Hsieh 教授的團隊進行的。 SRO 薄膜結構鑑定則由同步輻射中心徐嘉鴻主任團隊進行。



Revealing topological surface states via nonlinear and nonreciprocal transport effects

One of the challenging subjects in topological systems is to identify the charge transport signatures associated with the unusual surface states due to nontrivial band topology. In a recent international collaborating work led by Dr. Wei-Li Lee and Prof. Guang-Yu Guo, an unusual large nonreciprocal and nonlinear charge transport effects (NRTE) in both longitudinal and transverse channels were observed in thin films of topological ferromagnetic Weyl metal SrRuO3 (SRO). These behaviors align with a proposed scenario of an effective Berry curvature dipole originating from Fermi-arc surface states accompanied by 1D chiral edge modes, which is supported by electronic band structure calculations. Our findings not only highlight the significance of NRTE as a charge transport probe for topological surface states with a broken inversion symmetry but also feature potential applications in nonreciprocal electronics and nonlinear optics using topological materials. The complete data and analyses have been recently accepted for publication at Physical Review X (https://doi.org/10.1103/PhysRevX.14.011022).

Uddipta kar, Elisha Lu, Akhilesh Singh and P.V. Sreenivasa Reddy are the co-first authors. The SRO thin film growth, device fabrication and transport measurements were carried out by Dr. Wei-Li Lee's group at IoPAS and Prof. I-Chun Cheng's group at NTU. The electronic band structure calculations were performed by Prof. Guan-Yu Guo's group at NTU and Prof. Wei-Cheng Lee's group at SUNY Binghamton. The optical SHG measurements were performed by Prof. David Hsieh's group at Caltech. The SRO thin film structural characterizations were performed by Director Chia-Hung Hsu's group at NSRRC.