# 北京大学量子材料科学中心

## International Center for Quantum Materials, PKU

## Seminar

# Novel Properties of Single Layers of Transition Metal Dichalcogenides


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**Time: 4:00pm, Jan. 23, 2019 (Wednesday)**

**时间：2019年1月23日 （周三）下午4:00**

**Venue: Room W563, Physics building, Peking University**

**地点：北京大学物理楼，西563会议室**

## Abstract


Films as thin as a single molecular layer can exhibit novel properties that are very different from the bulk counterparts. This talk focuses on two model systems: titanium diselenide ($TiSe_2$) and titanium ditelluride ($TiTe_2$) that exhibit related but very different behaviors. Both materials belong to a vast family of transitional metal dichalcogenides, many of which show charge density wave (CDW) transitions at low temperatures. The CDW order can compete or entangle with other transitions such as superconductivity, and it is a basic phenomenon of great interest in solid state physics. Specifically, $TiSe_2$, with a (2x2x2) CDW transition at TC = 205 K in the bulk, remains a fascinating case; the transition has been attributed variably to excitonic interactions, band-type Jahn-Teller effects, electron-phonon coupling, etc. Our angle-resolved photoemission spectroscopy (ARPES) and x-ray diffraction measurements of the single layer show a (2x2) CDW transition at TC = 232 K, which is surprisingly higher than the bulk TC. The question is, why? Our measurements of the single layer reveal a small absolute band gap at room temperature, which grows wider with decreasing temperature T below TC in accordance with a BCS-like mean-field behavior; the results are well described in terms of band-structure and fluctuation effects. $TiTe_2$, by contrast, is a metal in both the bulk and single-layer forms. Bulk and N-layer $TiTe_2$, with N > 1, show no CDW transitions. Interesting, the single layer (N = 1) shows a (2x2) transition at TC = 92 K; it also exhibits a pseudogap that cannot be explained by any existing model or theory. The singular behavior of single-layer $TiTe_2$ appears to exemplify the emergence of new physics in the 2D limit. In collaboration with P. Chen, C.-Z. Xu, Y. Zhang, S.-K. Mo, Z. Hussain, and A.-V. Fedorov (MBE and photoemission); X.-Y. Fang and Howoong Hong (MBE and x-ray diffraction); Y.-H. Chan and M. Y. Chou (theory); Woei Wu Pai and A. Karn (STM/STS); A. Takayama and S. Hasegawa (4-point probe).


## About the speaker

After receiving a B.S. in physics from the National Taiwan University in 1971, Professor Chiang received his Ph.D. in physics from the University of California, Berkeley in 1978. He joined the Department of Physics at the University of Illinois in 1980 after working as a postdoctoral fellow at the IBM T.J. Watson Research Center. He has done seminal research on the electronic properties, lattice structure, and dynamic behavior of surfaces, interfaces, and ultrathin films. Professor Chiang did pioneering work on the application of angle-resolved and core-level photoemission to surface, thin film, and superlattice research. His honors and awards include IBM Faculty Development Award (1984-85), NSF Presidential Young Investigator Award (1984-89), Xerox Award for Faculty Research (1985), APS Fellow (1986), APS Davisson-Germer Prize (2015), Academician, Academia Sinica, Taiwan (2016)