

物性研究所談話会

標題：Dark-Matter Challenges of the Solid State.

日程：2018年4月12日(木) 午後4時～午後5時

場所：物性研究所本館 6階大講義室 (A632)

講師：Piers Coleman

所属：Center for Materials Theory, Dept Physics and Astronomy, Rutgers University

要旨：

At the turn of the 20th century, physicists faced an uncanny range of unsolved problems: simple questions, such as why hot objects change color, why matter is hard and why the sun keeps on shining, went unanswered. These problems heralded a new era of quantum physics. What was truly remarkable about discovery in this heroic era, was the intertwined nature of research in the lab and in the cosmos: solving superconductivity really did help answer why the sun keeps on shining, while looking at the stars provided clues as to why matter is hard.

The challenges facing us today, epitomized by our failure to quantize gravity and the mysteries of dark matter and energy, are not just problems facing particle physics and astronomy, but problems that challenge physics to its core. What is perhaps less well known, is that physics in the lab and cosmos remain just as intertwined as they were a hundred years ago.

I will talk today about the less well-known dark matter challenges of the solid state, epitomized by the strange metals with linear resistivity that accompany high temperature superconductivity, the recent discovery of insulators with Fermi surfaces and quantum criticality. the solid-state version of a black hole in the phase diagram. The solution of these laboratory-scale problems fundamentally challenge our understanding of emergent quantum matter, and they are no less intertwined with their cosmological counterparts than they were a hundred years ago.

I will highlight three Dark-Matter challenges that have arisen in heavy fermion physics[1-4], emphasizing their connections with other strongly correlated quantum materials and discussing some of our recent theoretical efforts to make progress on them: quantum criticality, hidden order and the possibility of new classes of broken symmetry outside the Hartree-Fock/BCS paradigm and topology, including the mystery of SmB6 and the possibility that this insulator contains a new kind of neutral, yet diamagnetic Fermi surface [5].

- [1] Piers Coleman, “Heavy Fermions and the Kondo Lattice, a 21st Century Perspective”, arXiv: 1509. 05769 (2015).
- [2] Joe Thompson and Zachary Fisk, “Progress in Heavy Fermion Superconductivity: Ce115 and other materials”, J. Phys. Soc. Jpn. **81**, 011002 (2012).
- [3] Philipp Gegenwart, Qimiao Si and Frank Steglich, “Quantum criticality in heavy-fermion metals”, Nature Physics **4**, 186. 197 (2008).
- [4] Maxim Dzero et al, “Topological Kondo Insulators”, arXiv 1506.05635, Ann. Rev. Cond. Matt. Phys., Volume **7**:249-280 (2016).
- [5] B. S. Tan et. al, “Unconventional Fermi surface in an insulating state”, Science **349**, 287-290 (2015).



【講師紹介】

Piers Coleman 教授はこれまで物性物理の分野において様々な潮流を生む概念を提出されてきたことで世界的に知られる理論家である。さらに、東京大学物性研究所も含め世界 20 か国 75 以上の拠点を持つ International Institute for Complex Adaptive Matter(I2CAM)の所長としても活躍されている。一方、アメリカ物理学会と英国物理学会の Fellow であられ、また、これまで様々な若手の学校を開き、次世代の教育にも大きく貢献されている。

標題：平成 30 年度前期客員所員講演会

日程：2018 年 4 月 19 日(木) 午前 10 時～午後 12 時 10 分

場所：物性研究所本館 6 階大講義室 (A632)

- 10:00-10:10 所長挨拶 (森 初果：物性研究所長)
- 10:10-10:40 石井 史之 (金沢大学理工研究域数物科学系)
「第一原理計算によるスピン変換物質デザイン」
- 10:40-11:10 山口 博則 (大阪府立大学理学系研究科)
「有機ラジカル系によって実現する多彩な量子スピンモデルの低温物性」
- 11:10-11:40 撰待 力生 (新潟大学理学部)
「高圧・強磁場下での重い電子系反強磁性体 CePt_2In_7 のメタ磁性の研究」
- 11:40-12:10 松本 祐司 (東北大学大学院工学研究科)
「パルスレーザー堆積法によるナノ構造化機能性酸化物薄膜の創製」