

RCQM Workshop on Strange Metals & Emergent Phases in Materials & Structures – Oct 31-Nov 2, 2022

1. Outcome of the workshop

a. Brief description of the event and science covered:

One focus of the workshop is on the strange metals and their theoretical description. Prominent strange-metal behavior appears in a variety of forms, such as a dynamical Planckian ($\hbar\omega$ over kBT) scaling, a T-linear resistivity and its potential connection with the notion of Planckian dissipation, singularities in thermodynamic quantities and, often, an accompanying “large” to “small” Fermi-surface reconstruction with implications for a localization-delocalization transition. Another focus of the workshop concerns how the amplified quantum fluctuations of strange metals drive the formation of new quantum phases, with unconventional or high-temperature superconductivity being the most prominent candidate.

The workshop brought together key players interested in this overarching subject on a variety of platforms, including:

- Copper- and iron-based high temperature superconductors
- Heavy-fermion metals
- Moiré structures
- Cold atoms
- Broader systems and contexts

List of Sessions:

Heavy fermion strange metals
Moiré and heavy fermions
Cuprate strange metals
Flat band strange metals + Nature Physics
Moiré structures
Ultracold atoms
Heavy fermions and strong correlations
Organic strange metals + Open discussion
Flat bands
Correlated metals across platforms

b. The impact of the meeting:

The workshop had especially strong and positive influence on the junior participants, who have had limited interactions scientifically due to the pandemic. For example, the poster sessions were lively and well attended. The meeting in general served as a good focal point for intensive discussions and exchanges regarding the recent considerable progress on research in strange metals and unconventional superconductivity.

c. The emergence of any potential research collaborations:

There was a lot of cross talks that were instigated between researchers working on different platforms of strange metals. For example, the physics of flat bands from moire, transition metal systems were linked to the physics of strongly correlated bulk materials such as heavy fermions and cuprates.

2. Provide ICAM with a copy of all recordings, multimedia, and photos taken, along with captions including the speakers' name, institution, and brief description of the lecture, to be posted to the ICAM website, Facebook page and YouTube© page:

Monday, October 31, 2022

Session I -- Heavy fermion strange metals

(Chair: Ming Yi, Rice U.)

1. Silke Paschen (TU Vienna, Austria)

Video: Not available.

Description: *Strange metal behavior in heavy fermion compounds*

2. Piers Coleman (Rutgers U.)

Video: Not available.

Description: *Strange metal behavior in a pure ferromagnetic Kondo Lattice*

3. Qimiao Si (Rice U.)

Video: [Haoyu Hu: Quantum Critical Metals: From Loss of Quasiparticles to High-Tc Superconductivity](#)

Description: *Quantum Critical Metals: From Loss of Quasiparticles to High-Tc Superconductivity*

Session II -- Moiré and heavy fermions

(Chair: David Abergel, Nature Physics)

1. Jie Shan (Cornell U.)

Video: Not available.

Description: *Emergence of heavy fermions in a moiré lattice*

2. Ajesh Kumar (MIT)

Video: [Ajesh Kumar: Moire Stimulation of Heavy-fermion Quantum Criticality](#)

Description: *Moiré simulation of heavy-fermion quantum criticality*

3. Blitz poster preview (1 minute per poster)/Lunch and Poster Session I

Video: Not available.

Session III – Cuprate strange metals

(Chair: Meigan Aronson, UBC)

1. Brad Ramshaw (Cornell U.)

Video: Not available.

Description: *Experimental evidence for well-defined quasiparticles with Planckian lifetimes*

2. Subir Sachdev (Harvard U.)

Video: [Subir Sachdev: Strange Metals Strong Correlated Random Interactions](#)

Description: *Strange Metals: Strongly Correlated Quantum Matter with Spatially Random Interactions*

3. Philip Phillips (UIUC)

Video: [Philip Phillips: Strange Metals from Mottness](#)

Description: *Strange Metals and Anomalous Dimensions for Conserved Currents from Noether's Second Theorem*

Session IV – Flat band strange metals + Nature Physics

(Chair: Allan MacDonald, UT Austin)

1. Gabriel Aeppli (PSI/ETH Zürich, Switzerland)
Video: Not available.
Description: *Strange metallicity of a kagomé ferromagnet*

2. Linda Ye (Stanford U.)
Video: Not available.
Description: *A flat band-induced correlated kagome metal*

3. David Abergel (Nature Physics)
Video: [David Abergel: Inside Nature Physics](#)
Description: *Inside Nature Physics*

Tuesday, November 1, 2022

Session V – Moiré structures

(Chair: Hanyu Zhu, Rice U.)

1. Andrea Young (UCSB)
Video: [Andrea Young: Magnetism and superconductivity in crystalline graphite](#)
Description: *Magnetism and superconductivity in crystalline graphite*

2. Emanuel Tutuc (UT Austin)
Video: Not available.
Description: *Interlayer Coherence in Twist-Controlled van der Waals Heterostructures*

3. Andrei Bernevig (Princeton U.)
Video: Not available.
Description: *Interactions in Flat Bands with and without Touching points: Topological Heavy Fermions Beyond Twisted Bilayer Graphene*

Session VI – Ultracold atoms

(Chair: Han Pu, Rice U.)

1. Eugene Demler (ETH Zürich, Switzerland)
Video: Not available.
Description: *Quantum simulators: from the Fermi Hubbard model to quantum assisted NMR inference*

2. Martin Zwierlein (MIT)
Video: [Martin Zwierlein: Fermion pairing and transport in strongly interacting Fermi gases](#)
Description: *Fermion pairing and transport in strongly interacting Fermi gases*

3. Short talk: Sunny Gupta (Lawrence Livermore)

Video: [Sunny Gupta: Designing 1D correlated-electron states by non-Euclidean topography of 2D monolayers](#)

Description: *Designing 1D correlated-electron states by non-Euclidean topography of 2D monolayers*

4. Blitz poster preview (1 minute per poster)/Lunch and Poster Session II

Video: Not available.

Session VII – Heavy fermions and strong correlations

(Chair: Silke Paschen, TU Vienna)

1. Meigan Aronson (UBC, Canada)

Video: [Meigan Aronson: Quantum Critical Points in Ti₄MnBi₂](#)

Description: *Quantum Critical Points in Ti₄MnBi₂*

2. Liyang Chen (Rice U.)

Video: [Liyang Chen: Shot noise indicates the lack of quasiparticles in a strange metal](#)

Description: *Shot noise indicates the lack of quasiparticles in a strange metal*

3. Filip Ronning (LANL)

Video: [Filip Ronning: Developing materials specific tractable Hamiltonians for f-electron systems](#)

Description: *Developing materials specific tractable Hamiltonians for f-electron systems*

Session VIII – Organic strange metals + Open discussion

(Chair: Qimiao Si, Rice U.)

1. Kazushi Kanoda (Tokyo U., Japan)

Video: [Kazushi Kanoda: Quantum criticality and BEC-BCS crossover in a doped spin liquid candidate](#)

Description: *Quantum criticality and BEC-BCS crossover in a doped spin liquid candidate*

2. Open discussion

Video: Not available.

Wednesday, November 2, 2022

Session IX – Flat bands

(Chair: Jun Kono, Rice U.)

1. Pengcheng Dai (Rice U.)

Video: Not available.

Description: *Discovery of charge order in a Kagome lattice antiferromagnet*

2. Elaine Li (UT Austin)

Video: Not available.

Description: *Quantum magnetism of moire Chern bands*

3. Ming Yi (Rice U.)

Video: [Ming Yi: Emergent phases in flat band systems](#)

Description: *Emergent phases in flat band systems*

Session X – Ultracold atoms
(Chair: Kevin Slagle, Rice U.)

1. Randy Hulet (Rice U.)

Video: [Randy Hulet: Spin-Charge Separation with 1D Atomic Fermions](#)

Description: *Spin-Charge Separation with 1D Atomic Fermions*

2. Erich Mueller (Cornell U.)

Video: [Erich Mueller: Quantum Transport in Fermi Hubbard Models](#)

Description: *Quantum Transport in Fermi Hubbard Models*

3. Short talk: Xiaoyu Wang (NHMFL)

Video: [Xiaoyu Wang: Unusual magnetotransport in twisted bilayer graphene from strain-induced open Fermi](#)

Description: *Unusual magnetotransport in twisted bilayer graphene from strain-induced open Fermi surfaces*

4. Short talk: T. C. Wu (Rice U.)

Video: [T.C. Wu: Quantum interference of hydrodynamic modes in the dirty marginal Fermi liquid](#)

Description: *Quantum interference of hydrodynamic modes in the dirty marginal Fermi liquid*

Session XI – Correlated metals across platforms
(Chair: Doug Natelson, Rice U.)

1. Andrew Huxley (U. Edinburgh, U.K.)

Video: [Andrew Huxley: Extended non-fermi liquid phases](#)

Description: *Extended non-fermi liquid phases*

2. Amalia Coldea (Oxford U., U.K.)

Video: Not available.

Description: *Fermi surfaces and quasiparticle effective masses in the high-pressure phase of superconducting iron-chalcogenides, FeSe_{1-x}S_x*

3. Takeshi Kondo (Tokyo U., Japan)

Video: [Takeshi Kondo: Unveiling doped Mott states of high-T_c cuprate superconductors with disorder removed](#)

Description: *Unveiling doped Mott states of high-T_c cuprate superconductors with disorder removed*

4. Peter Abbamonte (UIUC)

Video: [Peter Abbamonte: DeGennes narrowing in the density fluctuation spectrum of a strange metal](#)

Description: *DeGennes narrowing in the density fluctuation spectrum of a strange metal*

Photos



**October 31, 2022
Ramamoorthy Ramesh, Rice University Vice President for Research
Opening Remarks
Bioscience Research Collaborative**



October 31, 2022
Randy Hulet, Fayez Sarofim Professor, Physics and Astronomy (Rice University)
Workshop Introduction
Bioscience Research Collaborative



**October 31, 2022
Poster Presentations
Bioscience Research Collaborative**



**November 1, 2022
Group Photo
Bioscience Research Collaborative**



**November 2, 2022
Break in Duncan Hall**