In a time when the physics community is restricted to online meetings, we fondly remember some of the 2019 ICAM meetings.

Condensed Matter Physics in the Cities 2019

From Mott to Eliashberg: New twists in high-temperature superconductivity and beyond. London and Paris 1-16 July 2019.

Condensed Matter in the Cities 2019 was a two week meeting organized with support from ICAM between the Hubbard Condensed Matter consortium of London and the condensed matter communities of Paris, held from 1-16 July. The first and last week took place at Bedford Square in central London, at Royal Holloway University of London and the Rutherford Appleton laboratory, while the middle week took place at the Ecole de Physique et de Chimie, in Paris. The idea was to bring together the two physics communities within ICAM, for two weeks of discussion about recent developments in our understanding of superconductivity and its interplay with the Mott insulating state. ICAM provided funds to allow students to attend the events and to travel between Paris and London. The university of London provided dormitory accommodation to students. Several of the participants, managed to go to talks in both Paris and London. The meeting was attended by more than 70 participants, with speakers from Japan and China, Europe and North America and students from the UK and France.

Fig. 1. Participants at Condensed Matter in the Cities, outside 10 Bedford Square, in London

Fig. 2a. Participants in Paris outside the Ampitheatre Pierre Giles de Gennes.

Fig. 2b. Kamran Behnia announces the menu, during a lunch break.

Science has always thrived in cities, especially London and Paris. Condensed Matter in the Cities endeavors to capture that ancient relationship, holding a sequence of highly interactive talks and mini-courses in the heart of the city. As part of this two week event, there were two outreach lectures to the general public. Seamus Davis presented an outreach lecture on Quantum Computation at Royal Holloway, University of London.

Fig. 3. Seamus Davis presents an outreach talk on the "Second Quantum Revolution" at Royal Holloway, University of London

Fig. 4. Daniel Bobroff from the Laboratoire Physique des Solides, Orsay, presents an evening lecture on "Les trois plus belles découvertes quanitique" at the Ecole Normal Supérieure.

Daniel Bobroff presented a public lecture on "The three most beautiful discoveries in quantum physics", at the Ecole Normale Superieure in Paris. Both public lectures were very enthusiastically attended, reflecting a deep intrigue about quantum physics, its history and its future applications.

ICAM conferences follow the “Frauenfelder” rules, with at least 30% of the time is devoted to discussion. The idea is to promote interaction and a more dynamic interplay between speaker and audience.

Fig. 5. Top: A lecture at Bedford. Bottom: Kazumasa Miyake and Taka Shibauchi (second row) and Liling Sun, Premi Chandra and Catherine Pepin (first row) at a lecture in the EPSCI, Paris.

An example of this dynamic interplay is captured here: Yuji Matsuda presented new evidence for the existence of Majorana edge modes, from heat conductivity measurements at his lab in Kyoto. An intense discussion between Yuji Matsuda (Kyoto University) and Kamran Behnia (ESPCI) ensued.

Fig. 6. Yuji Matsuda and Kamran Behnia engage in a lively discussion about heat currents in topological materials.

The topics discussed at Condensed Matter in the Cities, 2019 were wide ranging, grouped around a common theme of superconductivity and Mott Insulators. One goal was to finding common ground between the different types of superconductivity, ranging from high temperature cuprate superconductors to low temperature twisted bilayer graphene, and the ultra-low temperature physics of He-3 on graphite discussed by John Saunders (see Fig. 7.).

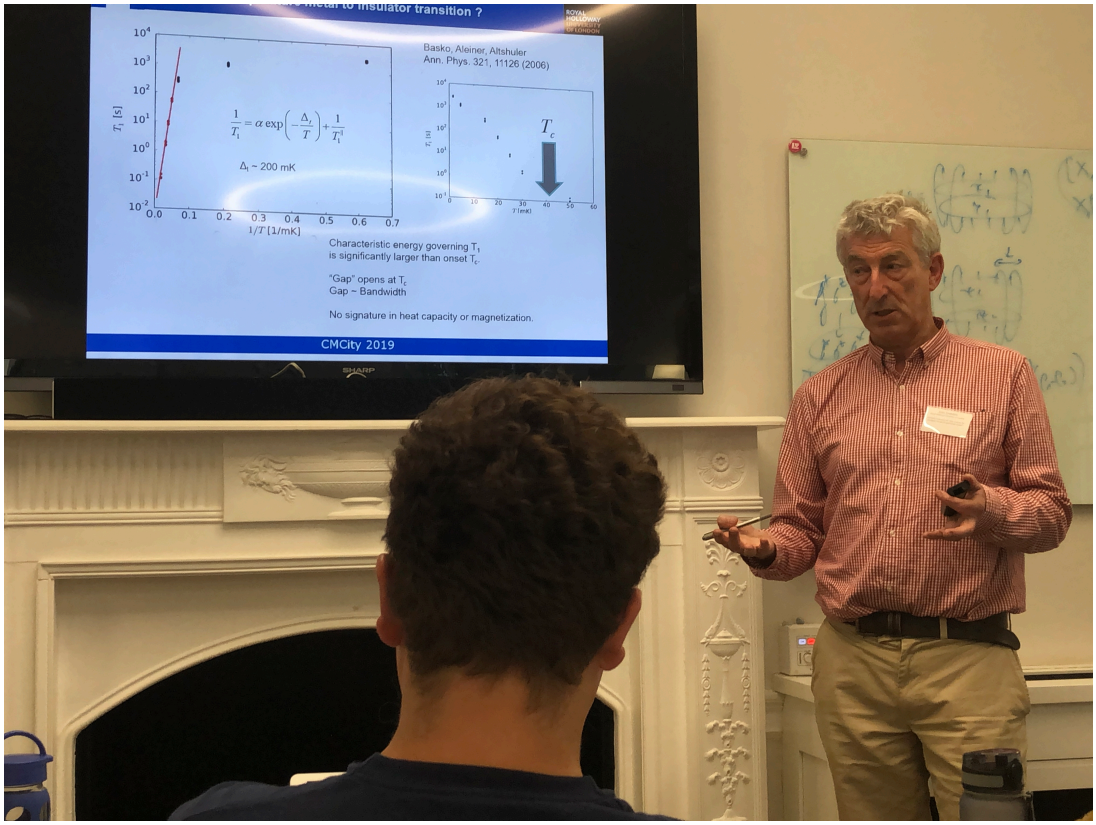

Fig. 7. John Saunders from Royal Holloway, University of London, discusses the Mott transition in single layer He-3 on graphite at 10 Bedford Square in London.

As an example of this commonality, both the cuprate superconductors and the magic angle graphene can be tuned between Mott insulating states and superconducting metallic states (see figure 8.) which also exhibit strange metal behavior, with linear in temperature resistivity that extends to such high temperatures, that the mean-free path of electrons is comparable with their wavelength. What then is the common origin of this physics? The last week of Condensed Matter in the Cities returned to London to follow up this thread as part of an in-depth discussion of twisted bilayer graphene, with discussions led by Allan Macdonald and Dmitri Efetov (see figure 8.) One lasting consensus of the meeting was that strange metallic behavior and its link with Mott physics is clearly an emergent property of electron matter at the brink of localization. The detailed origin and mechanism of this emergence remains a goal that will doubtless be revisited at future ICAM meetings.

Fig. 8. Dmitri Efetov (bottom left) and Alan Macdonald (bottom right) lead a discussion on the unusual superconductivity and insulating behavior of gated twisted bilayer graphene. Above, an intrigued audience watches on.