Discussion Meetings at AIMR/Cambridge Workshop

December 10, 2014

Making report------ blue
Coordinate Group-- red

Group 1: *Mathematics*
Cambridge: Prof. Grimmett, Dr. Kiss and others
AIMR: Prof. Kotani, Prof. Nishiura, Dr. Tanaka and Dr. Miyama

Group 2: *Chemistry*
Cambridge: Dr. Reisner, Dr. Orchard and others
AIMR: Prof. Asao, Prof. Isobe and Dr. Hojo

Group 3: *Functional materials, Sointronics*
Cambridge: Prof. Driscoll, Prof. Mathur, Prof. Blamire and Others
AIMR: Prof. Mizukami, Dr. Hitosugi, Dr. Akagi

Group 4: *Bulk Metallic Glass*
Cambridge : Prof. Greer, Dr. Nachum,, Mr. Sun, Ms. Grize
AIMR: Prof. Louzguine, Dr.Nakayama, Dr. Orava

Group 5: *Topological Insulators*
Cambridge: Dr Saxena
AIMR: Dr. Souma and Prof Tsukada (Dr. Souma)

Group 6; Matallurgy
Cambridge: Dr. Kumar, Prof. Fray, and Prof. Schwandt (Prof. Greer)
AIMR: Prof. Nagasaka

Report of Discussion Meeting –Group 1-

Participants at the meeting: Prof. Grimmett, Prof. Paternain, Dr. Kiss (Cambridge Univ.), Prof. Kotani, Prof. Nishiura, and Dr. Miyama (WPI-AIMR)

Research Topics discussed: Discussion on the future math-material collaboration

Keywords of materials, methods, phenomena and others: Math-material collaboration

We discussed the possibility of collaboration between mathematicians from Cambridge University and researchers from WPI-AIMR. To begin these discussions, we first introduced our strategy for approaching the math-materials science collaboration, as well as our individual activities as mathematicians and theoretical physicists towards a new direction for material science research. In particular, Prof. Kotani suggested an exchange of researchers and students between the two universities, and also organising a joint Cambridge-AIMR workshop. Both Prof. Grimmett and Prof. Paternain agreed on the possibility of a jointly hosted workshop. At the same time, Prof. Grimmett emphasized that the pure mathematics researchers at Cambridge university are working on their own projects, so it could be rather difficult to find a question which both mathematicians and material researchers are directly concerned. As a member of the Interface Unit, I myself (M. Miyama) have come to appreciate the importance of finding mathematically well-posed questions in order to facilitate a collaboration between mathematicians and materials scientists.

After the discussion, we were taken on a laboratory tour of the DAMTP Fluids Laboratory by Prof. Dalziel and Dr. Vriend. We observed the large-scale granular experiments, bubble motion in viscous liquids, and many other interesting phenomena.

Report by Dr. Masamichi J. Miyama (Interface Unit)

Report of Discussion Meeting –Group 2-

Participants at the meeting: Prof. Isobe, Prof. Asao, Prof. Reisner, Dr. Orchard, Dr. Hojo and Others ~20 people.

Research Topics discussed: 1 Carbonaceous Molecular Bearing
2 Self-Assembly and Nanofabrication of Organic-Inorganic hybrid Nanocrystals

Keywords of materials, methods, phenomena and others: Pi-system, Molcecular Bearing, Nanocrystals, Self-assembly, Surface functionalization, metal nanoparticles, Chiral structures.

In this discussion, first, Prof. Isobe and Dr. Hojo gave a presentation of their own research and there were a few discussions on them. Prof. Reisner and his co-worker asked about possibility of two molecular bearing putting together on the same molecular axis on Prof. Isobe's presentation and Prof. Isobe replied that that idea was interesting. Also, Prof. Reisner asked if the size of nanocrsytals can be tunable or not on Dr. Hojo's presentation and Dr. Hojo replied that we could possibly change the size of nanocrystals by adding water but disparsibility of nanocrystals was decreased.
After two presentation and short question time was over, Prof. Isobe left for the airport to leave UK next day. Prof. Asao and Dr. Hojo separately met individual researchers on Cambridge side.
Prof. Asao met with Dr. Jose Souto (Steven Ley group) to discuss Chemical transformations with flow microreactor, Yuang Liu (Andrew Wheatley group) about Fabrication methods of metallic nanoparticles, Jane Lueng and Julien Warnan (Erwin Reisner group) on Surface functionalization of copper oxides.
Dr. Hojo met with Dr. Afu Gumrah Parry (Erwin Reisner group) to discuss a mixture of TiO_2 nanorods (size ~4 nm x 30 nm) and cellulose crystals (4 x 50 nm) to synthesize chiral structures with certain photo-bandgaps. Dr. Hojo also discussed with Prof. Reisner and Dr. Orchard about our ongoing research projects and plans.

Report by Hojo

Report of Discussion Meeting –Group 3-

Participants at the meeting: Driscoll, Moya, Robinson, Blamire, Hitosugi, Akagi, Mizukami

Research Topics discussed: Oxide materials and Spintronics

Keywords of materials, methods, phenomena and others: TiO2, SmSrMnO3, LaCaMnO3, GdN, and Holumium. PLD, ALD, Sputtering. Low temperature transport properties and superconductivity, spin filter type magnetic tunnel junctions.

Hitosugi and Driscoll discussed the oxide materials in her office.

Robinson, Blamire, Akagi, and Mizukami discussed spintronics. First Blamire talked about spin filter magnetic tunnel junction using SmSrMnO3 and GdN. His studies focused on low temperature transport properties. Next Mizukami gave the introduction of his works on magnetic tunnel junctions and spin dynamics. Finally, Robinson talked about superconducting transition temperature modulation in Ferro/Super/Ferro structure by proximity effect.

Moya, Akagi, Hitosugi, and Mizukami discussed magnetic Mn-oxide films. Moya agreed with the collaboration with Mizukami, he will send his sample to Mizukami for measurement of spin dynamics next year.

Report by Mizukami

Report of Discussion Meeting –Group 4-

Participants at the meeting: Prof. Greer, Prof. Louzguine, Prof. Nakayama, Dr. Orava, Mr. Sun

Research Topics discussed: Recent progress on metallic glassess

Keywords of materials, methods, phenomena and others: Metallic glasses, deformation phenomena, Ultrasound spectroscopy, nanoindentation

Discussion meeting of group 4 (Bulk Metallic Glass) was held based on 4 presentations from both Cambridge and Tohoku sides. The main topics of the the presentations are following:

1) Deformation of anisotropic glass is measured by resonance ultrasound spectroscopy and recent results are presented (Mr. Sun).
2) Nanoindentation tests using a spherical indenter is performed on ZrCu-based metallic glasses. There is the indenter size effect where the normalized yield pressure is proportional to the indenter tip diameter (Prof. Greer).
3) Formation and mechanical characterization of metallic glass nanowires are presented. Gas atomization can be used for the production in the large amount of nanowires. The properties of magetoimpedance (CoFe based) and Suzuki cross coupling (Pd based) are investigated (Prof. Nakayama).
4) Vitrification and devitrification processes in metallic glasses and mechanical properties of bulk metallic glassy and double-phase alloys are presented (Prof. Louzguine)

Furthermore, for the future collaborations, the glass forming ability in pure metals are discussed. Fast and slow crystal growth kinetics in glass forming metals would be a key.

Report by Koji S. Nakayama

Report of Discussion Meeting –Group 5-

Participants at the meeting: Dr. Saxena, and his students and postdoc(6)

Research Topics discussed: Exotic superconductor and topological phase

Keywords of materials, methods, phenomena and others: Quantum critical point, Exotic superconductor, topological insulator, topological superconductivity, high-pressure and low-temperature experimental apparatus

1. Search for topological superconductor
   - A family compounds including binary layer of Bi and chalcogen (S,Se,Te) is an interesting field for searching superconductor. If topological insulator (TI) phase is also found by ARPES, such superconductor would be candidate of topological superconductor (TS).

2. Quantum criticality on the border of ferroelectricity
   - Quantum critical point of ferroelectric STO would be a trigger of high-Tc superconductivity. Fermi surface size (carrier density) is important factor and should be observed by ARPES.

3. STO for superconductor-film substrate
   - STO substrate may be a good substrate for growing of high-Tc superconductor film thanks to above mentioned quantum criticality. Topological superconductor could be also found in TI/STO system.

Report by Seigo Souma