# MSc Seminar, Dominik Szombathy

Names of students *

Sári Péter, Horváth Anna, Balázs Péter

Summarize the talk in 5-10 numbered sentences. Some guidance: What is the physical setup presented? What are the control parameters? What are the quantities measured/calculated? Which methods were used? Is this subject particularly interesting or relevant? Why? Do you have any questions? Any comments, suggestions regarding the presentation? *

1. The talk was about the suprconducting properties of bilayer graphene.
2. Superlattices can be created by rotating layers of 2D materials on top of each other.
3. The conductive properties of such bilayer structures can be very different from the properties of the original materal.
4. These properties can be functions of the rotation angle, and other things such as magnetic field.
5. In this case the bilayer graphene showed superconductivity.
6. In the future experiments will be conducted to see the effects of pressure on these properties.

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Gyulai László, Györgypál Zsolt

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1. One of today's most interesting topics is the topic of high temperature superconductors, because we still don't have a working theory to describe these.
2. The superconductivity is explained in the simplest models with the Cooper pairs, which are pairs of electrons bonded together because of the electron-phonon interaction.
3. An interesting realization of this is the so called Magic angle twisted bilayer graphene, which is basically a pair of parallel layers of graphene on each other, but with slightly rotated basis.
4. In this structure one can detect the Moire patterns, which appear because of the rotation (13 nm in size)
5. On a phase diagram (magnetic field - density) one can find superconducting states on different temperatures, even at high ones.
6. This SC material (MATBG) has a higher electron correlation compared to the everyday average SC materials.

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Szilágyi Zsombor, Szabó Zsolt

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1. The talk was about unconventional superconducticity in graphene based systems.
2. Unconventional means that high temperature superconductors were examined.
3. The graphene based system was a magic angle (1,1 degree) twisted bilayer graphene.
4. The material has some desirable properties caused by the Moire patterns emeged due to the magic angle.
5. Resistivity measurements were considered; they were carried out with supercurrents.

The slides featured some nice illustrations on which the phase diagram of the material could be recognized.
The speaker was not bad, although we encourage him to be more confident.

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Szász-Schagrin Dávid, Kovács Panna

Summarize the talk in 5-10 numbered sentences. Some guidance: What is the physical setup presented? What are the control parameters? What are the quantities measured/calculated? Which methods were used? Is this subject particularly interesting or relevant? Why? Do you have any questions? Any comments, suggestions regarding the presentation? *

1. Unconventional superconductivity is such that it can not be described by the means of G-L theory.
2. Among graphene based systems this phenomena can be seen in heavy fermionic materials as well.
3. Instead of achieving 1.1 deg. magic angle, they managed to fabricate two separate devices with 1.05 and 1.16 deg.
4. When the bilayer graphene was twisted in a small angle, a sort of Moire pattern appeared, decreasing the energy barrier for interlayer coupling, which gives rise to SC behaviour.
5. When perpendicular magnetic field was applied, doping densities introduced oscillating effects, which proposed the importance of interlayer interactions and electron correlation.

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Varga Zoltán, Földvári Dominic

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1. The talk was about graphene based systems. The property of superconductivity has been under investigation, which under a critical temperature results in zero resistance. Superconductors are widely used in NMR (MRI) , quantum computing and at particle accelerators.
2. So-called unconventional superconductivity cannot be accounted for using Cooper-pairs, quasi particles and other common theoretical predictions though. In fact orientation of spins could provide with an explanation. Cuprates are a good example for a material baring properties of superconductivity.
3. In reality bilayer graphene is adjusted to have a particular angle between the layers. This is a so-called magic angle resulting in a particular pattern in which electron correlation is higher and interlayer transition can be achieved.
4. Supercurrent measurement techniques could provide a lower-bound for the critical temperature.
5. Applying perpendicular magnetic field can even increase unconventional superconductivity. Moreover it could introduce resistance oscillations.

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Budai Ákos, Tamás Gábor

Summarize the talk in 5-10 numbered sentences. Some guidance: What is the physical setup presented? What are the control parameters? What are the quantities measured/calculated? Which methods were used? Is this subject particularly interesting or relevant? Why? Do you have any questions? Any comments, suggestions regarding the presentation? *

1. Unconventional superconductivity is superconductivity, which BSC and/or Ginzburg-Landau theory can not describe.
2. Experimental setup: magic angle (1.1°) twisted bilayer graphene was fabricated.
3. We can observe moire pattern when we use the magic angle.
4. It was measured that the Fermi temperature for MA-TBG is lower than the typical value.
5. Possible cause of weak superconducting phase is a not negligible inhomogentiy in the superlattice density.
6. The presentation missed coherence and the speaker seemed to be not really well-prepared.
7. We think that the "Thank you for your attention." slide is not particularly useful and the summary slide should be used instead as the last slide.

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Bendeguz Sulyok, Márton Borsi

Summarize the talk in 5-10 numbered sentences. Some guidance: What is the physical setup presented? What are the control parameters? What are the quantities measured/calculated? Which methods were used? Is this subject particularly interesting or relevant? Why? Do you have any questions? Any comments, suggestions regarding the presentation? *

1: Unconventional (high temperature) superconductors cannot be described by either BSC or GL theory as the electrons do not form Cooper-pairs.
2: Heavy fermionic materials, cuprates or graphene based systems can be used to fabricate such unconventional superconductors.
3: In the current experiment two 2D hexagonal graphene layers are twisted by a small angle: 1.05 and 1.16 degrees. The magic angle is 1.1 degree and with 0.2 precision these are good results.
4: On a phase diagram temperature is plotted against superlattice density. On the 1.05 lattice a small weakly superconducting phase can be seen. etween two dome-like superconducting phase and mott-like phase above them. On the 1.16 lattice there is no weakly superconducting phase.
5: On a second phase diagram magnetic field strength is plotted against superlattice density. On the 1.05 lattice at a certain density oscillations in field strength between superconducting phase can be observed.
6: These are to be interpreted as phase-coherent transition in Josephson-junctions.
7: This was modelled by SQuID + GL theory, but the authors sugested that this model does not fully cover the experimental results.
8: As the magnetic field B was increased significantly (~6T) the Mott-like phases were destroyed by the Zeeman field and o ly the metallic and superconducting phases remained.