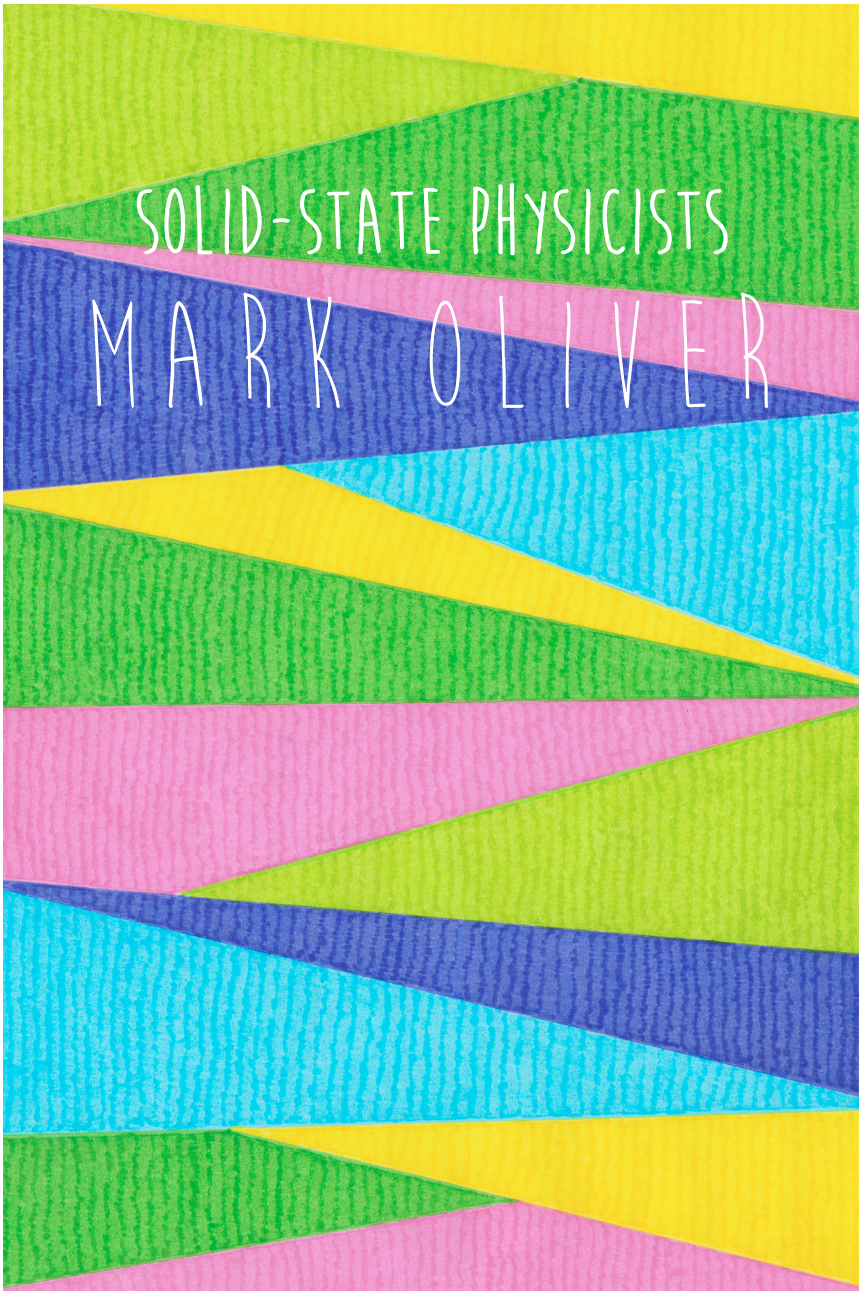
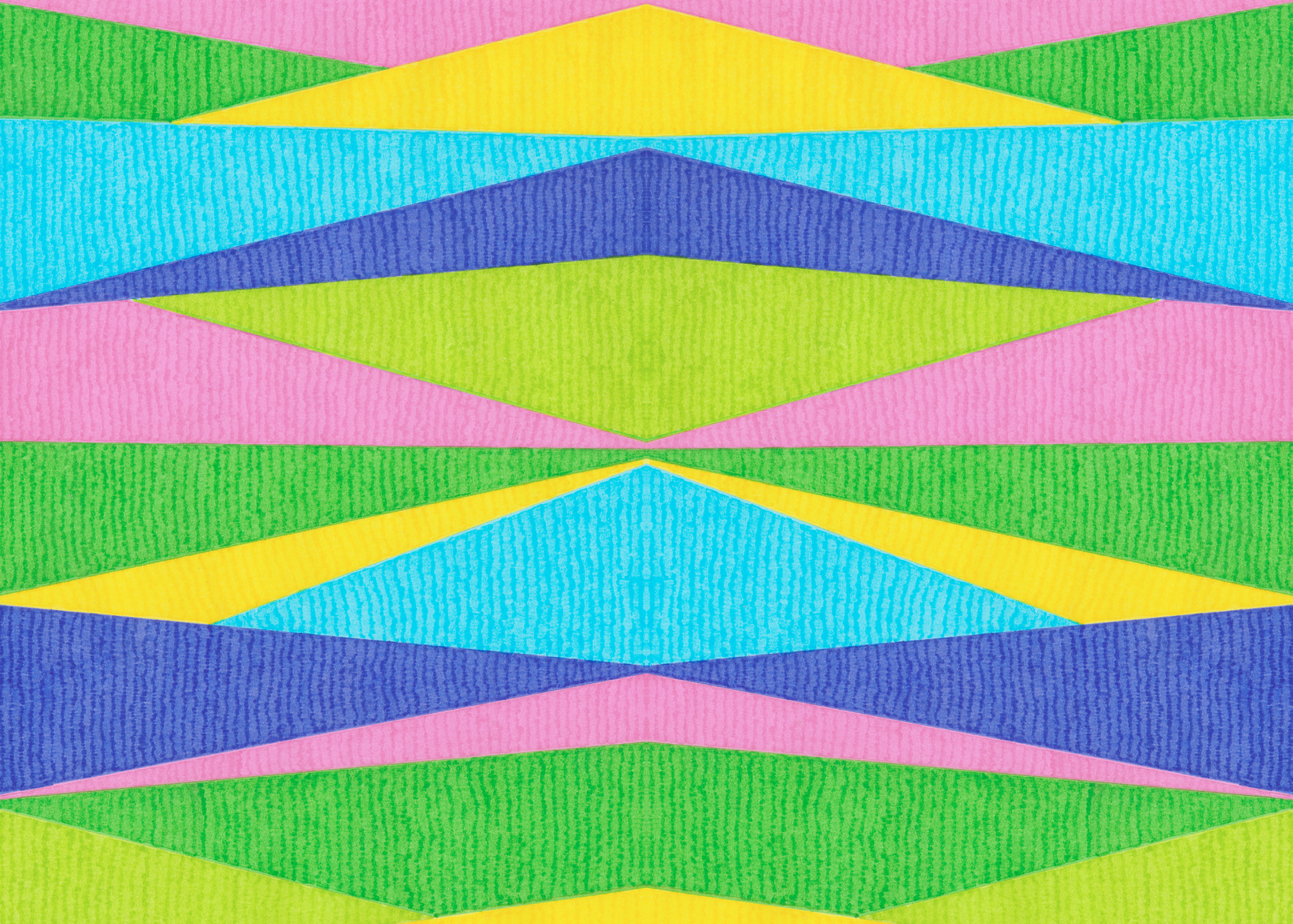
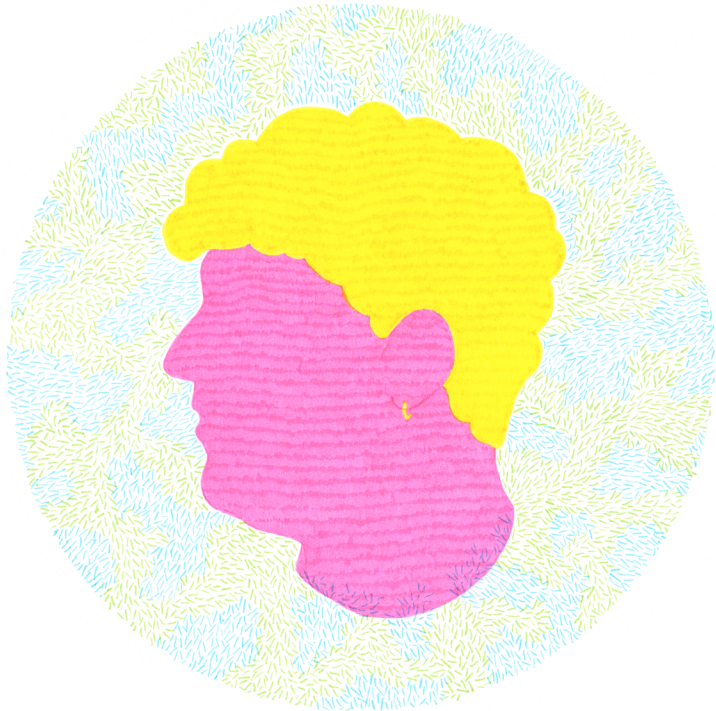

SOLID-STATE PHYSICISTS
MARK OLIVER



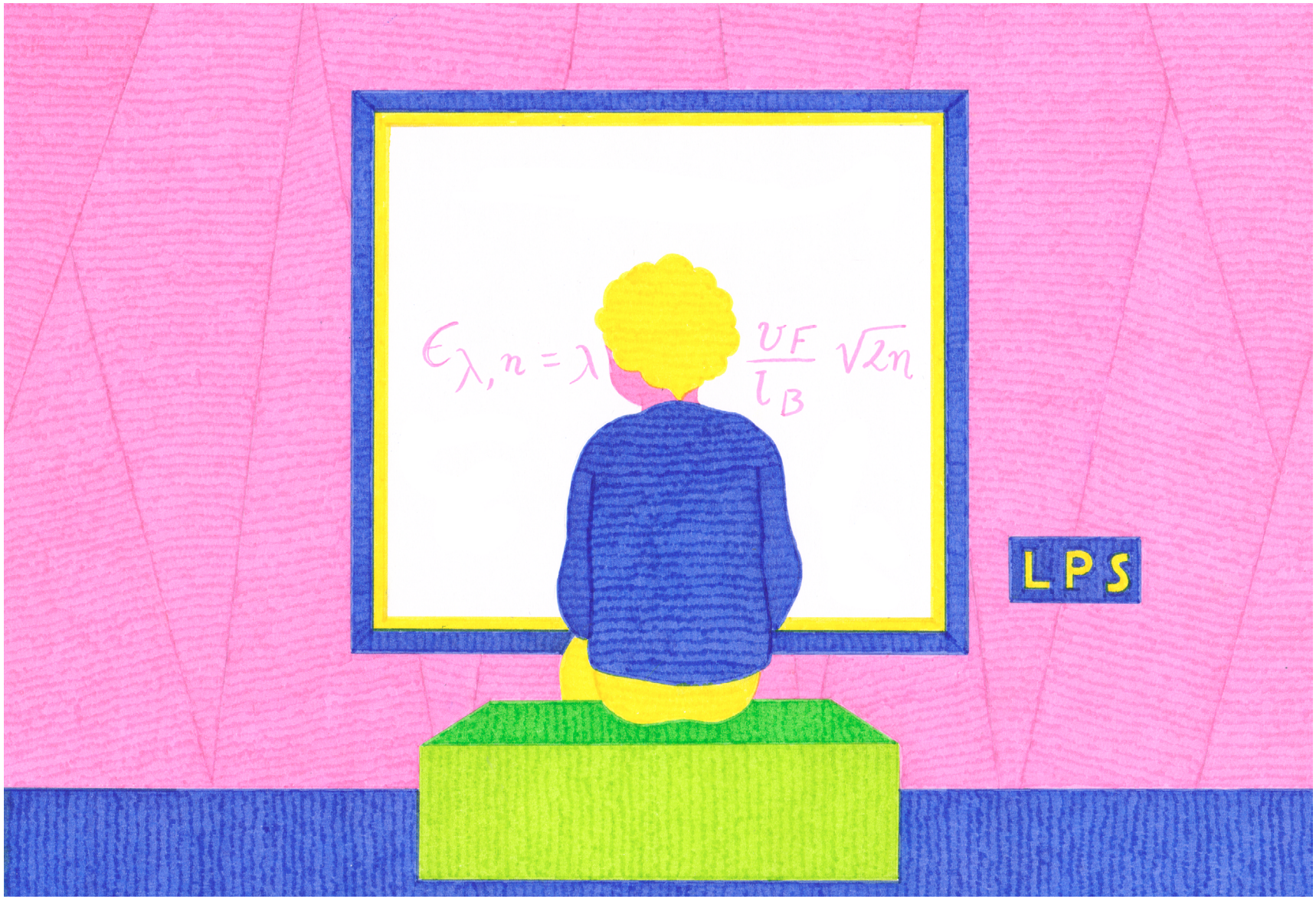
SOLID-STATE PHYSICISTS

MARK OLIVER



THEORETICIAN SPECIALIZED IN GRAPHENE
TEAM : THEORETICIANS
39 YEARS OLD
WORKS ON ELECTRONS IN GRAPHENE

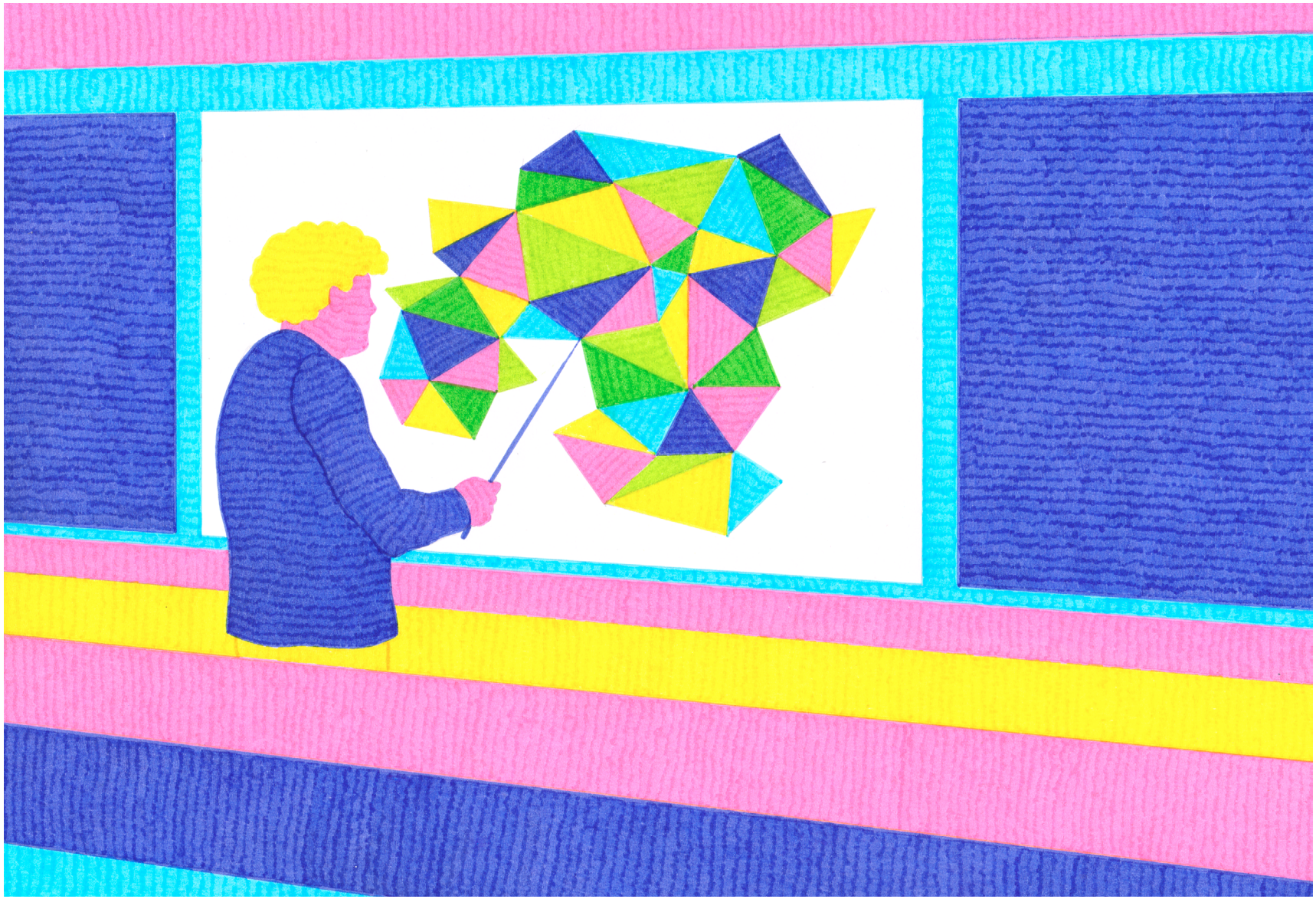
THE FIRST THING I REMEMBER ABOUT THE LABORATORY OF SOLID-STATE PHYSICS (LPS) IS THE HILL IN THE FOREST THAT I HAD TO CLIMB FROM THE RER TRAIN STATION. BECAUSE I NEVER IMAGINED THAT A LAB COULD BE SET UP IN THE MIDDLE OF THE FOREST.



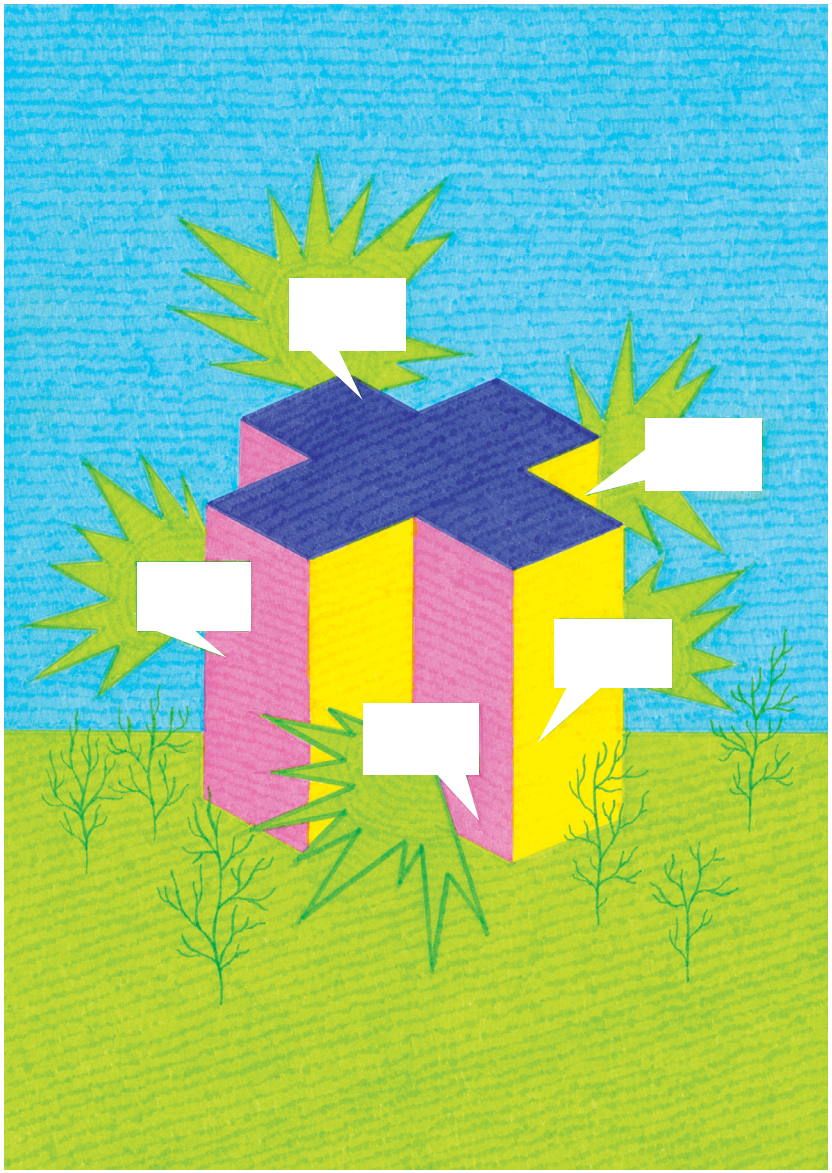
THE WORK OF THEORETICIANS CAN BE COMPARED TO SOME ARTISTIC METHODS, IN THE SENSE THAT OUR PERCEPTION OF PHYSICAL PHENOMENA GOES STRAIGHT TO THE POINT. THE CREATIVITY OF A PHYSICIST MIGHT NOT BE THAT DIFFERENT FROM AN ARTIST'S.

SOME THEORETICIANS TRY TO USE A LANGUAGE THAT IS REALLY CLOSE TO THE EXPERIMENT, AND THEY BELIEVE THAT EVERYBODY CAN UNDERSTAND THEM, ALTHOUGH IT'S NOT ALWAYS THE CASE. OTHER THEORETICIANS WORK ON MORE ABSTRACT THINGS AND USE A LANGUAGE THAT MIGHT BE A LITTLE OBSCURE FOR EXPERIMENTERS.

People have the image of the scientist working alone in his lab (especially in the case of a theoretician), like some sort of secluded genius, but that actually never happens. In order to make progress, we need to discuss with friends and colleagues, and even if we don't always work on the same subject, this kind of discussion is essential to unlock some ideas and of course, to feel less lonely.



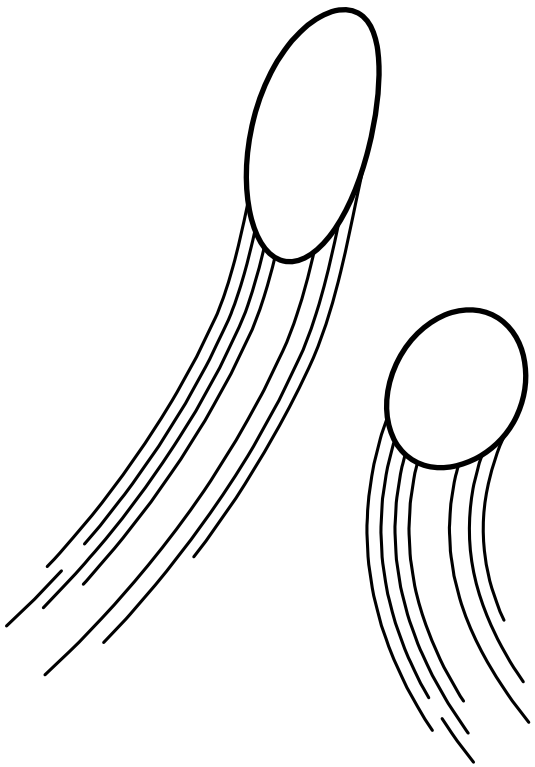
I TEACH AT THE POLYTECHNIC INSTITUTE, AND I BELIEVE THAT IN AN IDEAL WORLD, NOBODY COULD BE A RESEARCHER WITHOUT BEING ALSO A TEACHER. WE NEED TO PASS ON KNOWLEDGE : WE NEED TO HELP STUDENTS WHO WANT TO LEARN. IT SHEDS NEW LIGHT ON OUR WORK, WHICH I THINK IS REALLY IMPORTANT. BUT ABOVE ALL, I AM A RESEARCHER, OF COURSE !



It's sometimes hard to focus on something at the lab, because there is always someone who is going to come and chat with you. When you really need to concentrate, don't go to the lab!

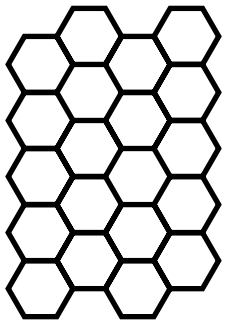
Sometimes, it's easier to work at home, for instance. Theoreticians have the luxury of being able to do that.

QUAND J'EMMÈNE MA FILLE AU TRAVAIL, ELLE ME VOIT PARLER, ÉCHANGER AVEC LES AUTRES CHERCHEURS, SOUVENT AUTOUR DE LA MACHINE A CAFÉ. ELLE NE COMPREND PAS QUE CES ÉCHANGES FONT PARTI DU TRAVAIL DE CHERCHEUR. DONC QUAND ON LUI DEMANDE CE QUE JE FAIS ELLE DIT « PAPA NE TRAVAILLE PAS, IL BOIT DU CAFÉ ET IL DISCUTE ! »

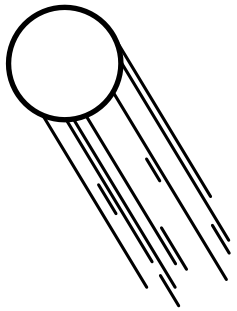


What are you researching?

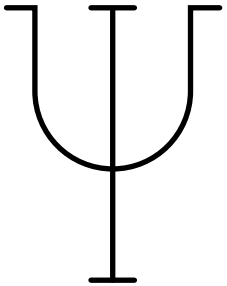
Why do electrons behave so weirdly in graphene? That is the question Mark Oliver is trying to answer.



Graphene



Electrons



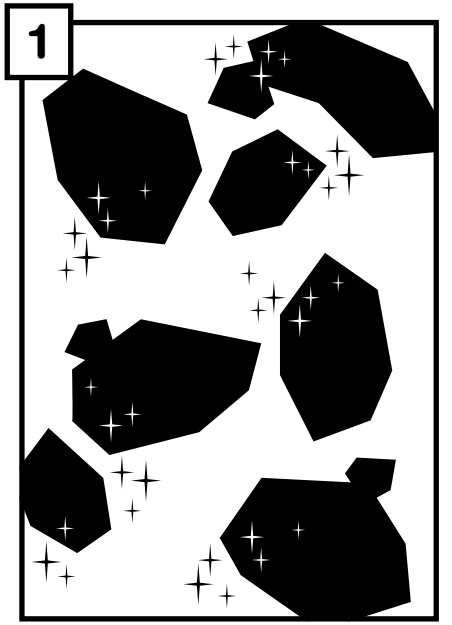
Quantum physics

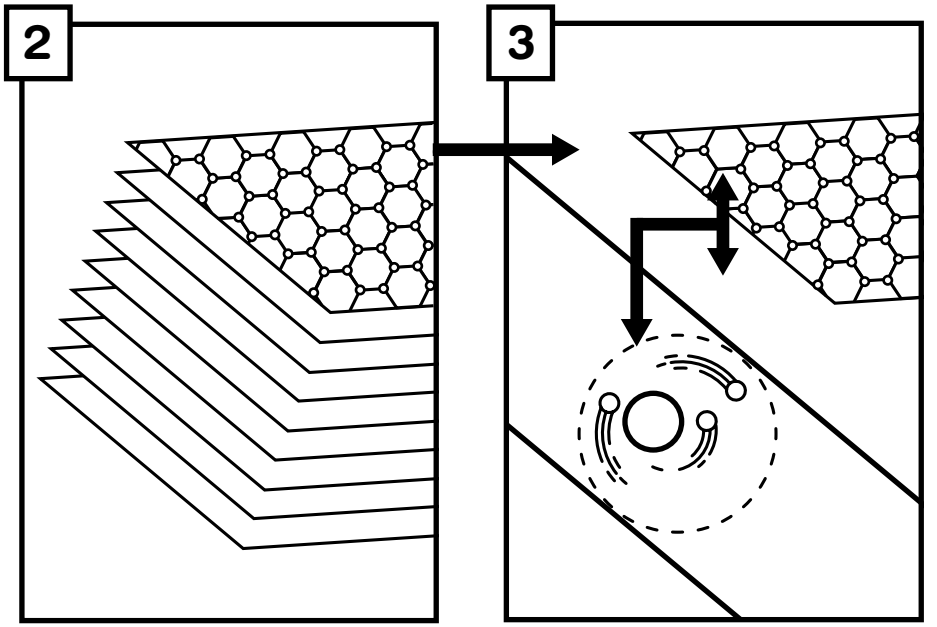
Graphene

1 — In order to make graphene, you need charcoal.

2 — Charcoal, which is also called graphite, is made of layers of carbon atoms arranged in a honeycomb lattice.

3 — Physicists have recently been able to isolate one of these layers, thus creating graphene: a one-atom thick sheet of carbon.

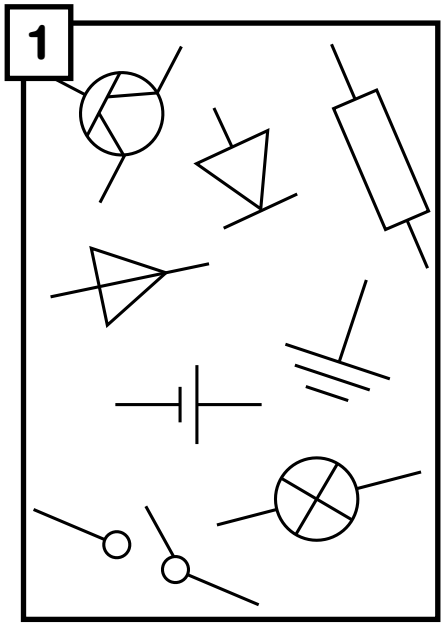




Different conductors

1 — In conventional electronics (in a microprocessor, for instance), we use semiconductors.

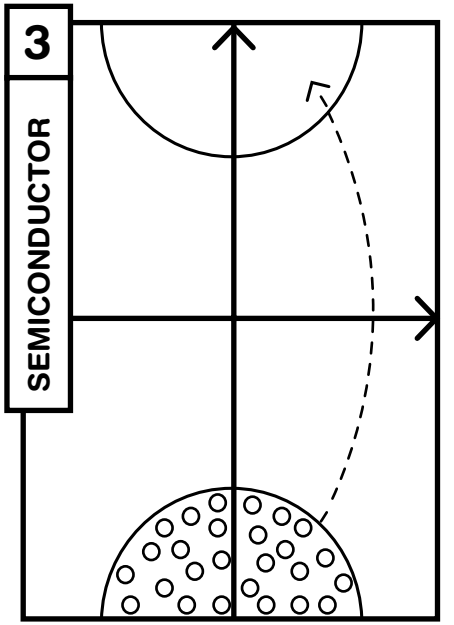
2 — Representation of a simplified semiconductor.

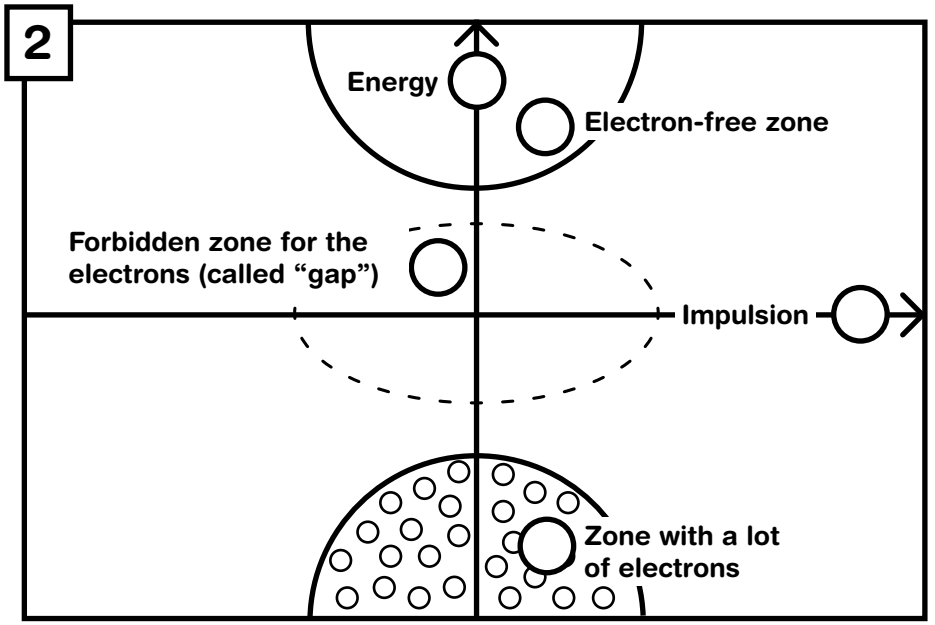


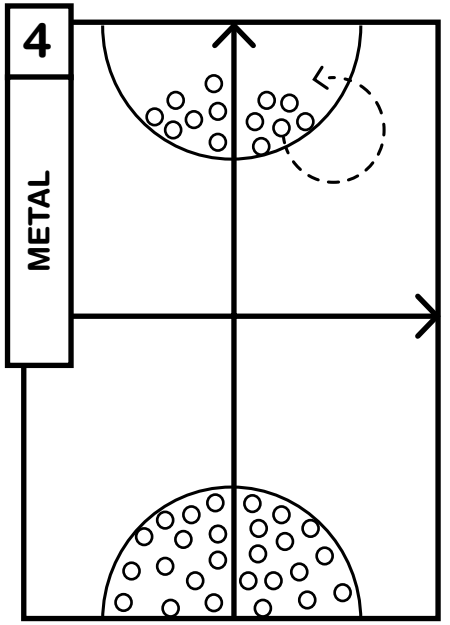
3 — In order for conduction to exist, you have to make the electrons jump towards the top. It is hard because of the forbidden zone (“gap”) which means a semiconductor conducts electricity pretty poorly.

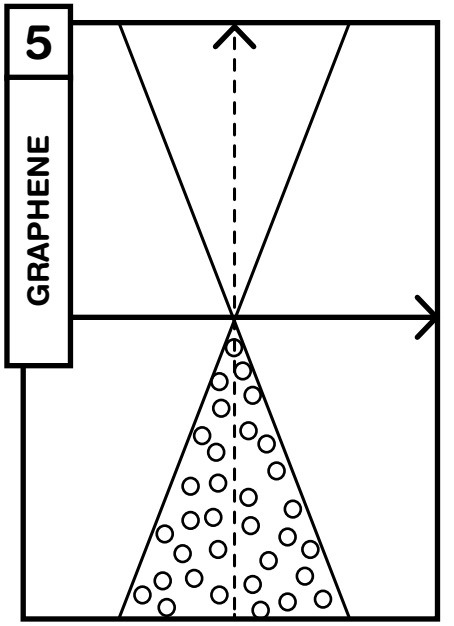
4 — In metal, conduction is easier because some electrons are already present in the upper zone of the conductor.

5 — In graphene, there is no gap, and no electrons in the upper zone either. It is hence neither a semiconductor nor a metal.

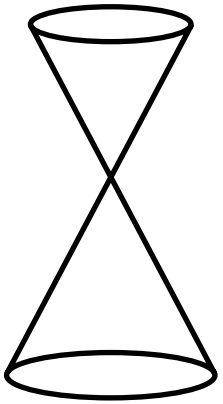








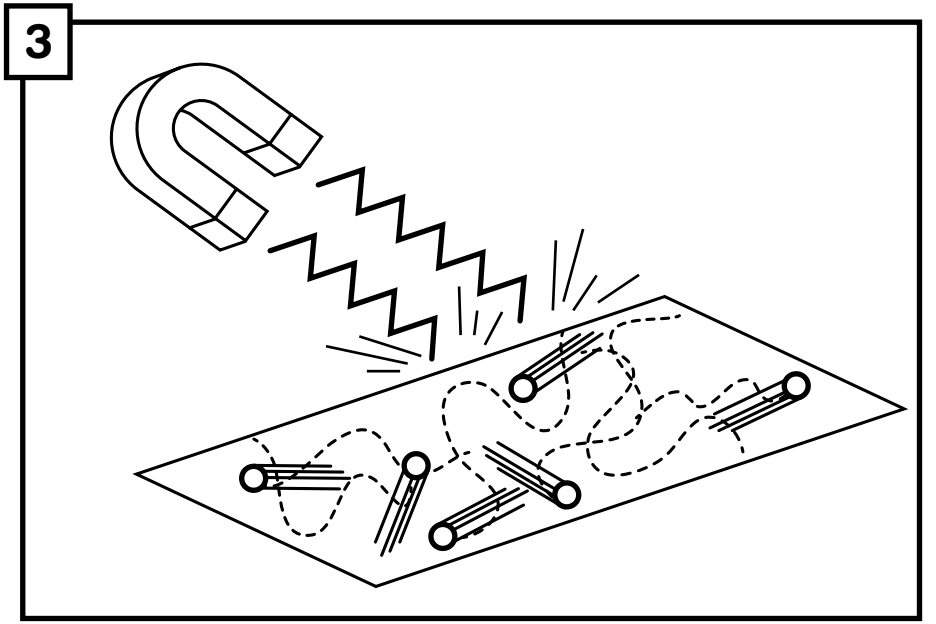
Electrons in graphene

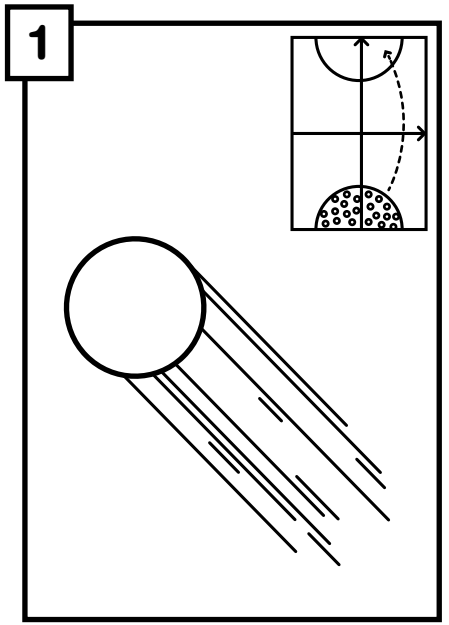


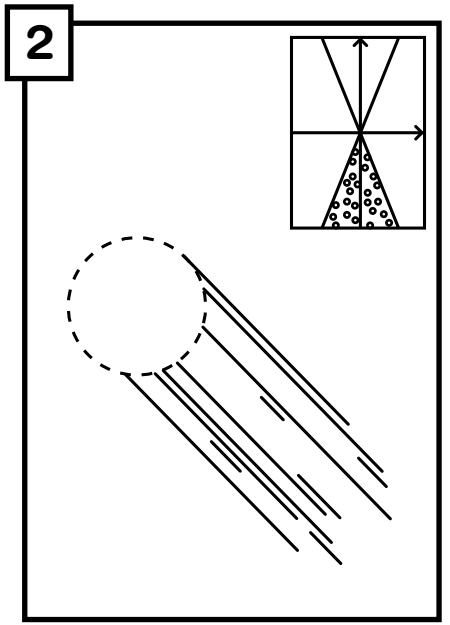
The cross shape is called a "Dirac cone." This structure implies that the electrons behave weirdly.

1 — In a semiconductor or a metal, the electron has a mass and a speed.

2 — In graphene, the electrons behave as if they had no mass! Kind of like photons, the particles of light. Just like light, the electrons obey the laws of relativity.

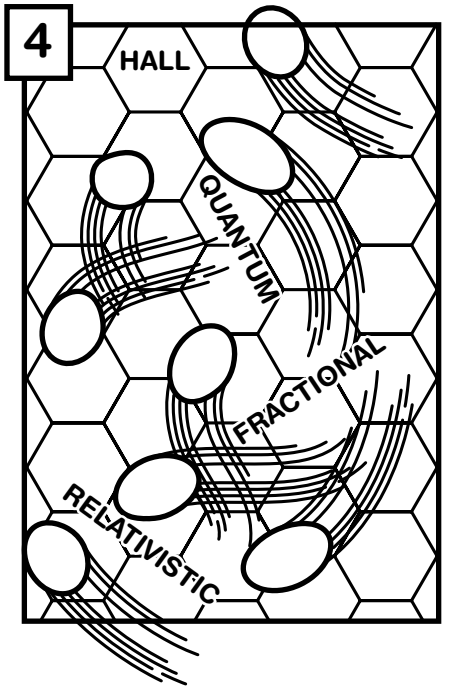


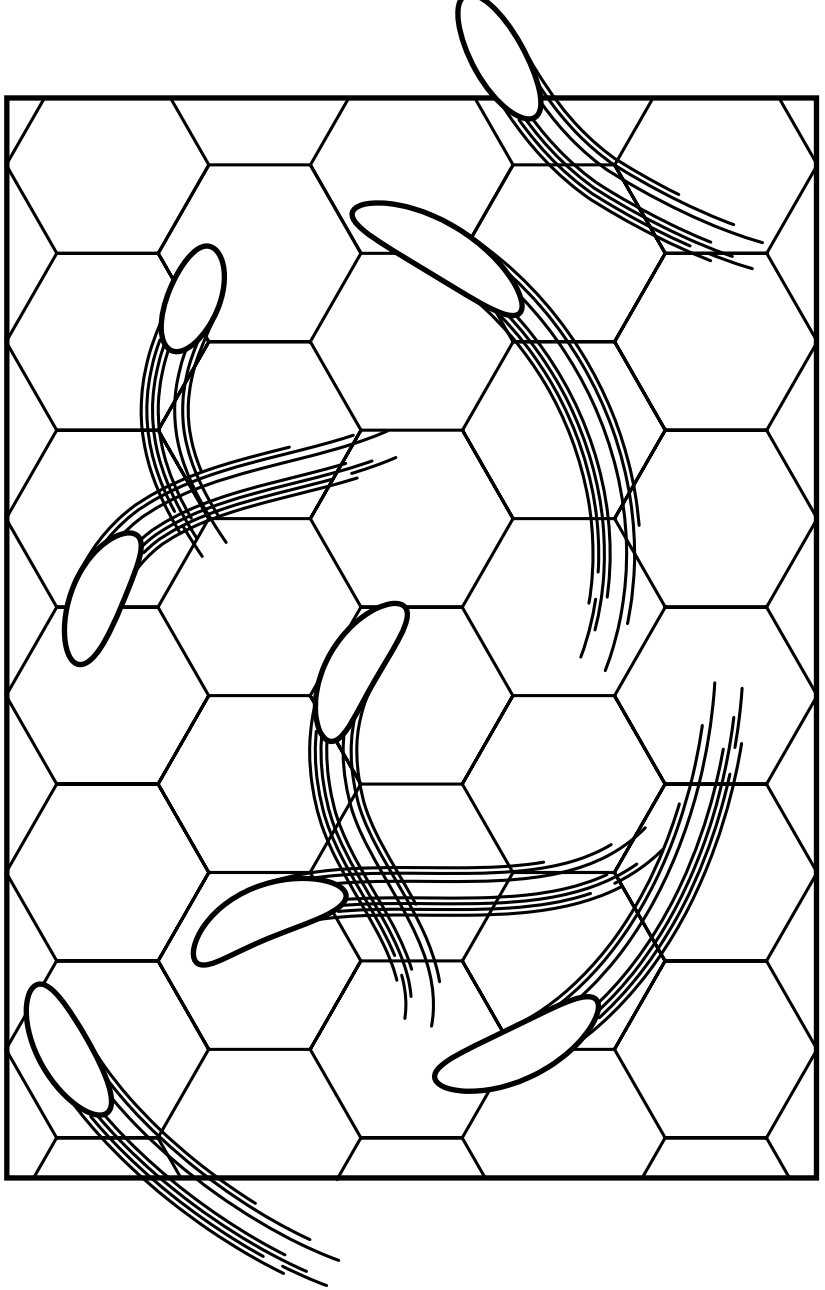


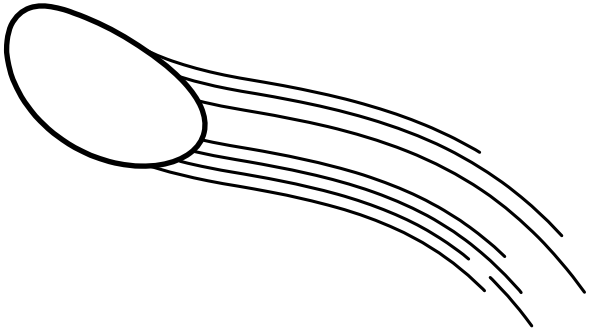


3 — Mark Oliver is interested in these relativistic movements. In order to show their existence, he tries to figure out what happens when he makes the electrons circulate in the graphene while applying a very high magnetic field.

4 — The electrons describe an orbit with very unique properties. This is called the relativistic "fractional quantum Hall effect."







A CREATION BY CHLOÉ PASSAVANT,
AS PART OF HER DSAA SCIENTIFIC ILLUSTRATION DESIGN DEGREE,
WITH THE COOPERATION OF JULIEN BOBROFF (UNIVERSITÉ PARIS-SUD, CNRS)
THIS WORK WAS CONDUCTED AT THE LABORATORY OF SOLID-STATE PHYSICS (LPS)
IN ORSAY, WITH FABRICE BERT, LORÈNE CHAMPIGNY, MARK-OLIVER GOERBIG.
I WOULD LIKE TO THANK THEM FOR TAKING PART IN THAT PROJECT.
TRANSLATION : PIERRE SZCZECINER
WE THANK ICAM-I2CAM FOR THEIR FINANCIAL SUPPORT.
JUNE 2014