

Reimagining physics

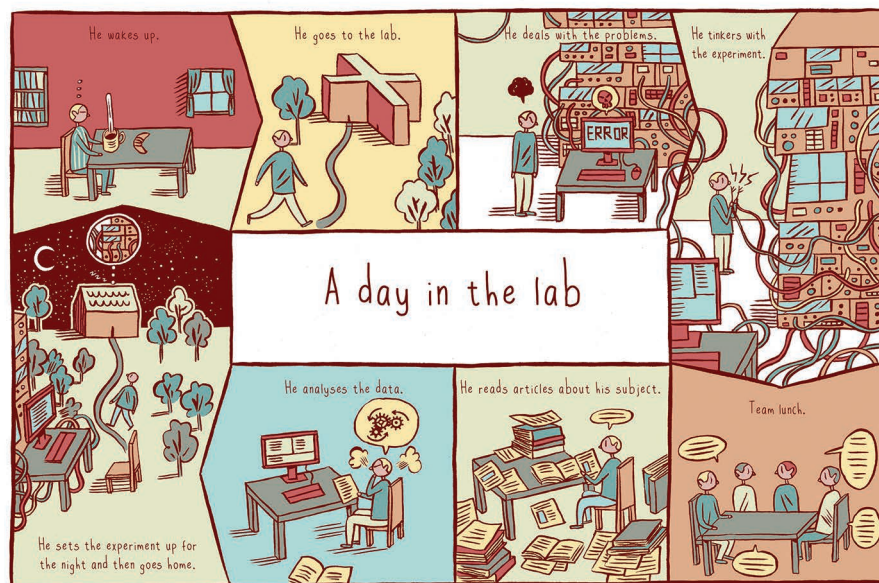
Julien Bobroff describes new ways to popularize fundamental and applied condensed-matter physics.

In our team, condensed-matter physicists collaborate with designers and illustrators to develop new outreach tools about quantum and solid-state physics. Since the beginning of our activities we have focused on both fundamental and applied aspects. When quantum physics was introduced in high schools in France in 2012, we were soon contacted by teachers in need of visual aids to teach quantum phenomena. We created a set of simple animations about basic quantum properties ranging from duality, quantization and spin to decoherence, but we also addressed topics related to active research — for instance, modern microscopy techniques.

These animations were disseminated among the education community, but also through a dedicated website (www.QuantumMadeSimple.com), Wikipedia, YouTube, and through science museums and social networks. The success encountered both on the teaching and outreach sides came as a surprise to us, clearly demonstrating that education and science popularization could benefit a lot from each other. The pedagogy and science at play were acclaimed, but even more were the style, the design and the soundtrack.

Since then, our team has explored new original types of outreach and education tools. Together with a designer we created *The Physics Circus*, in which small wooden birds levitate thanks to superconductivity, but also *The Coldest Book in the World* — an actual book that, when covered with liquid nitrogen, reveals the physics of low temperatures and its history. Working with an illustrator, we developed a series of postcards about recent discoveries such as giant magnetoresistance, topology in solids and graphene. A cartoonist, H. Chochois, stayed in our lab for a few months and drew a series of graphic short stories describing daily life in a physics lab entitled *Embedded with Physicists* (one is pictured). All these projects end up in various media — videos, exhibits, do-it-yourself activities, flyers, posters and postcards — targeting both students and the general public. We make them available in French and English, free to download from our website (www.PhysicsReimagined.com) and to be reused by anyone.

The more than a hundred projects that we worked on over the years showed us several things. Firstly, it seems natural to explain



condensed-matter physics by alluding to potential applications — however, in our experience the public is also fascinated by fundamental aspects. Secondly, the general public is not just interested in the physics but also in the human side of science, the daily life, the methods and the thinking process of physicists. Thirdly, and perhaps most importantly, our field is poorly covered by public media compared with astrophysics or high-energy physics — just compare the impact of the discovery of the Higgs boson to those of the quantum Hall effect, graphene or topological phases of matter. One reason for this may be the fact that condensed-matter physicists usually work in small teams that do not have dedicated public relations or communication services.

This raises the question of how to change the game and make condensed-matter physics and nanoscience more visible and understandable. We propose a simple process for small research teams that could help make a difference. (1) Include popularization activities explicitly when applying for funding through research grants. Outreach projects need much less funding than any physics equipment or post-doc grant — moreover, a strong dissemination program can help a proposal to pass. (2) Don't try to create everything on your own: hire professionals and develop a tight collaboration where you provide them with sound scientific content,

including your recent research. (3) Think about dissemination and sharing. Put your outreach products online and make them free and easy to download and reuse (choose a Creative Commons license for copyrights). If relevant, share it on Wikipedia and do not forget to advertise it through social networks and also traditional media such as magazines, radio and television. Also use your own networks: your colleagues, your students, close-by high schools, local science museums or science fairs. (4) And, finally, try to assess the efficiency of your work through surveys.

Popular science is rarely about condensed-matter physics, and it is our responsibility as a community to improve the situation. Some of us already try to produce small-scale but high-quality resources, but we need more scientists in the game, and a joint effort to share and advertise these resources. It will help rebalance the importance of condensed-matter physics and materials science in the general public's view. Not only will these inputs be valuable for a better dialogue between science and society, but scientists may even get a refreshing view of their own field. □

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