



## Glasses and Friendships: a French–American Scientific Collaboration

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### Remarks from a conversation with Patrick Charbonneau [1], Associate Professor of Chemistry and Physics, Duke University.

The glass problem, which is one of the grand challenges of contemporary physics, aims to understand the origin of rigidity in amorphous materials [2]. Despite decades of work, the various research approaches to glasses have often seemed in vain. My fruitful collaboration with a group of French researchers on this topic is the result of numerous interactions, spread over many years, and facilitated by financial support coming from a variety of sources. A brief summary follows.

During my academic training (Harvard PhD, 2006; Marie-Curie IIF Amolf, 2006-2008) and my first few years at Duke University (where I have worked since 2008), I had the chance to meet a number of French scientists during their visits to the US and at international conferences. These encounters led Pascal Viot [3], then Director of the Laboratoire de Physique Théorique de la Matière Condensée (LPTMC) at Université Pierre et Marie Curie (UPMC), to invite me for a long-term visit to his lab either: i) as a UPMC visiting professor for a month, requiring a complete application, or ii) as a CNRS associated researcher for three months, requiring no application. It was on short notice, so I chose the second option.

Upon my arrival in Paris, in the spring of 2011, I presented a project to Gilles Tarjus [4], CNRS Directeur de Recherche at LPTMC, offering him to partake either as external referee or as collaborator. He chose the latter, and a friendship quickly blossomed from our professional exchanges. A few days later, during a lunch among friends at Arènes de Lutèce, Francesco Zamponi [5], from the CNRS Laboratoire de Physique Théorique of ENS-Paris, offered to collaborate with me on a second project. The following months thus saw the emergence of two particularly novel manuscripts.

In the wake of these advances, the project with Francesco rapidly took off, and our network of collaborators broadened. Our results were exciting, but we were quickly overwhelmed. We needed to hire some help. In 2012, we unsuccessfully requested funding from the Materials World Network program, then sponsored by the US National Science Foundation and the French Agence Nationale pour la Recherche.

Two events saved the day: (i) I was named a fellow of the Sloan Foundation [6], which funded a postdoctoral researcher for one year; (ii) a funding call from PSL Research University, offered Francesco the same opportunity. At the end of 2012, we combined our resources to recruit a young researcher who was put in charge of the back and forth between our two teams. In parallel, Francesco offered me a two-month stay in France: one month as visiting professor at ENS, and another as a guest of Institut Philippe Meyer [7]. Our collaboration had a fresh start!

That's how some remarkable advances took place during 2013-2014. Although the solution to the glass problem was shaping up, sizable obstacles remained and money was once more about to run out.

Fortuitous circumstances again lent us a hand. First, the Simons Foundation [8] announced a call for internal

collaborations in theoretical physics. We gathered a group of thirteen researchers and submitted a pre-proposal, in the fall of 2014. The ambitious scope of our project and the results we already had on hand allowed us to pass through the first round of selection. At the same time, Duke granted me a sabbatical to visit two of the thirteen partners: three months with Ludovic Berthier [9], CNRS Researcher at Laboratoire Charles Coulomb of Université de Montpellier and four months with Giulio Biroli [10] at Institut de Physique Théorique of CEA-Saclay. When we were selected for the second round of the Simons call in the spring of 2015, I was thus at a prime location to facilitate interactions between the French groups and my American colleagues. This French stay also gave me the opportunity to refresh and reenergize my collaboration with Gilles, whose group was unfortunately not part of the thirteen.

Our Simons collaboration was selected for the final interview. The stakes were high: obtaining stable funding to work together toward a solution to the glass problem. By happenstance, I had planned to spend December 2015 in Paris with Francesco, and this visit coincided with the preparation for this last step. Despite the stress at the time, the tight links between some of us enabled us to make the best out of this time.

We got the Simons funding [11]! Since it was announced, in the spring of 2016, our project has been swiftly moving forward, our ambition and energy remaining steady. Moreover, Gilles has become an affiliate of our group. By this victory, we have thus unified two bilateral projects in a single project of international scope, with perennial support. The fabric that enabled us to go through these challenges was woven of the various relationships born of the preceding five years. The journey was challenging at times, encountering some stumbling blocks and requiring many sacrifices. Looking back, success was far from certain, but our passion, our common aspiration and our capacity to accumulate small resources in France and in the United States at key moments have allowed us to stay focused and hopeful.

Thus was born an international scientific collaboration about the glass problem.

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#### Footnotes

- [1] Patrick Charbonneau, Associate Professor of Chemistry and Physics, Duke University: <https://chem.duke.edu/labs/charbonneau>
- [2] American Scientist, Pizza Lunch Podcast, September 2013: <http://www.americanscientist.org/science/pub/through-the-theoretical-glass>
- [3] Pascal Viot, Director of the Laboratoire de Physique Théorique de la Matière Condensée: <http://www.lptl.jussieu.fr/users/viot>
- [4] Gilles Tarjus, CNRS Researcher at LPTMC: <http://www.lptl.jussieu.fr/users/tarjus>
- [5] Francesco Zamponi, CNRS Chargé de Recherche at Laboratoire de Physique Théorique of ENS-Paris: <http://www.phys.ens.fr/~zamponi/>
- [6] Sloan Foundation: <https://sloan.org/fellowships/>
- [7] Institut Philippe Meyer: <https://www.ipm.ens.fr/>
- [8] Simons Foundation: <https://www.simonsfoundation.org/>
- [9] Ludovic Berthier, CNRS Directeur de Recherche at Laboratoire Charles Coulomb of Université de Montpellier: <https://www.coulomb.univ-montp2.fr/perso/ludovic.berthier/>
- [10] Giulio Biroli: [http://ipht.cea.fr/Pisp/giulio.biroli/index\\_en.php](http://ipht.cea.fr/Pisp/giulio.biroli/index_en.php)
- [11] Simons Collaboration on Cracking the Glass Problem: <https://scglass.uchicago.edu/>