

Humboldt Report*

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1 Short report

First and foremost, I wish to thank the Alexander von Humboldt Foundation and Professor Stephan Hartmann for honouring me with the *Friedrich Wilhelm Bessel Research Award* and hosting me at the Munich Center for Mathematical Philosophy (MCMP).

I used the Bessel Award to stay in Munich and to do research in the philosophy of physics at MCMP in the Ludwig-Maximilians-Universität München in the academic year 2021/22. I regard my stay in Munich successful academically and engaging personally.

As for the academic activities, I have published one paper, submitted two other papers during my stay and started writing a fourth one, all related to one of my research topics; I have organized a small workshop on *Physicalism*, I have delivered talks at the Philosophy of Science Colloquium and the Work in Progress Colloquium at MCMP and many other talks at various academic institutions in Germany; I have contributed to MA level teaching and served on the selection committee for an Assistant Professor position at the host institution; and participated at many scientific events organized by the Center.

Beyond the academic life, my family took advantage of the wide range of cultural programs offered by the city, the university, the Regional Humboldt Club, and the *Internationales Begegnungszentrum (IBZ)*, where we stayed. We were all fascinated by the wonderful natural sites of Bavaria.

2 Extended report

Research

During my stay, I pursued research on a number of topics, some of which resulted in a research paper either already submitted or still in preparation.

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In more detail, I completed a paper (together with a young Hungarian colleague) on Einstein's reality criterion which appeared in September, 2021, just at the beginning of my research stay. In the first months of my stay, I have completed and submitted another paper in which a noncontextual, outcome-deterministic ontological model for the Peres-Mermin square was constructed provided the measurements associated with the operators can only be sequentially measured. During the winter, I turned to the analysis of operationalism in quantum mechanics. I completed and submitted a paper in which I show that giving up operational equivalence in quantum mechanics, that is discerning observables represented by the same operator but realized by physically different measurements can lead to ontological models with different causal structure, contextuality, and fine-tuning. Finally, in the spring time, I revisited the problem of ontology of the wave function and investigated the consequences of the PBR theorem to the ensemble interpretation of quantum theory. I also wrote a brief non-academic essay on our experiences in the German high school system.

The published paper and the manuscripts submitted or still under work are the following:

- (2021). M. Gömöri, G. Hofer-Szabó, "On the meaning of EPR's reality criterion," *Synthese*, **199**, 13441-13469.
- (2022). Hofer-Szabó G., "Sequential measurements and the Kochen-Specker arguments,"(submitted).
- (2022). Hofer-Szabó G., "Quantum mechanics without operational equivalence," (submitted).
- (2022). Hofer-Szabó G., "Psi-onticity and ensemble interpretation," (in preparation).
- (2022). Hofer-Szabó G., "A német iskolarendszerrol," ("On the German school system," in Hungarian).

Talks

During my stay, I have delivered a number of talks in Munich and at other departments and centers around Germany and also in Budapest, on topics related to my current research project. I gave a talk at the Philosophy of Science Colloquium at MCMP; at the Work in Progress Colloquium at MCMP; at the New Foundations for Physics seminar at CAS-LMU; at the History and Philosophy of Physics Research Seminar in Bonn; at the Parmenides Center in Pöcking; and also some talks during my short term home visits in Hungary (in Budapest and in Koszeg). I also gave an informal talk at the philosophy of physics group in Wuppertal. During my trips, I had the occasion to exchange ideas with many German colleagues and students.

The title and date of my talks are the following:

- "Between social and classical: contextuality in quantum theory," Parmenides Center for the Conceptual Foundations of Science, Pöcking, Germany, 2022 July.
- "Quantum mechanics without operational equivalence," Work-in-Progress Seminar, Munich Center for Mathematical Philosophy, LMU, Munich, Germany, 2022 May.
- "Sociophysics," Complexity, Culture, Individual Conference, iASK, Koszeg, Hungary, 2022 May.
- "Quantum mechanics without operational equivalence," Early Lunch Philosophy, University of Konstanz, Germany, 2022 April (cancelled due to covid).
- "Two concepts of noncontextuality in quantum mechanics," History and Philosophy of Physics Research Seminar, Lichtenberg Group, University of Bonn, Germany, 2022 April.
- "Quantum mechanics without operational equivalence," Research Seminar, University of Wuppertal, Germany, 2022 April.
- "Contextuality in the natural and social sciences," Institute seminar, Institute of Philosophy, Budapest, Hungary 2022 March.
- "Quantum mechanics without operational equivalence," Logic and Philosophy of Science Seminar, Eötvös University, Budapest, Hungary 2022 February.
- "A dynamical systems approach to causation," Philosophy of Science Seminar, Munich Center for Mathematical Philosophy, LMU, Munich, Germany, 2021 December.
- "Two concepts of noncontextuality in quantum mechanics," New Foundations for Physics, Center for Advanced Studies LMU, Munich, Germany, 2021 November.
- "Quantum and quantum-like," iASK-HAS Conference, Budapest, Hungary, 2021 October.

Workshop

I organized (with the support and help of MCMP and IBZ) a small one-day workshop on *Physicalism* on May 21, 2022 with the aim to bring together researchers from Hungary and Germany and to revisit the problem of physicalism in the philosophy of science. Talks held by speakers of the one research group were commented on by researchers of the other group. The workshop was successful. (The webpage of the workshop is accessible through the web page of MCMP.)

Teaching

I was leading a seminar on July 8, 2022 of the MA course *Philosophy of Time* lead by John Dougherty at MCMP. The topic of the seminar was the Principle of the common cause, a topic which I did research on for many years. The seminar went smoothly and I had a nice discussion with several MA students taking the course.

Other activities at MCMP

I gave a talk on the Work in Progress Seminar series on my paper in preparation "Quantum mechanics without operational equivalence" on May 5, 2022 . The seminar provided useful feedback for future work.

I served on the selection committee for the Assistant Professor position at the Chair of Philosophy of Science in March, 2022.

I was attending the *Philosophy of Physics Reading Group* organized by John Dougherty at MCMP. In the winter term we were reading Craig Callender: *What makes time special?* (Oxford, 2017), in the sommer term Michael Janas, Michael Cuffaro, Michel Janssen: *Understanding Quantum Raffles – Quantum Mechanics on an Informational Approach: Structure and Interpretation* (Springer, 2022). The reading group consisted of 4-5 colleagues and Phd students. We met weekly for one hour during term time. I benefited greatly form the discussions.

I attended the regular seminar series at MCMP (Philosophy of Science Colloquium, Logic Colloquium, Research Seminar in Decision and Action Theory) and attended many of the conferences, workshops and other events organized by the Center (e.g. The Quantum, the Thermal and the Gravitational Reconciled: Physics and Philosophy in the Varied Landscape of the Intersections, Global Structure in Semi-Classical Gravity, Longtermism talk series).

Humboldt events

I attended the Humboldt Annual Meeting in Berlin on June 22-24, 2022. The event was a pleasure from beginning to the end. The Alexander von Humboldt Foundations did a wonderful job in organizing this event and making it possible for more than 600 Humboltianers to meet and exchange ideas. I felt honoured to be invited to the amazing Schloss Bellevue where Bundespresident Frank-Walter Steinmeiner received and addressed the Humboltianers. Similarly, it was an honour to take part at the ceremony and dinner at the Humboldt Carré where the Research Prizes were officially conferred to the grantees. During the receptions, dinners or on the bus trips, I had many occasions to talk to a great number of Humboltianers whom I would otherwise not have got to know. The conversations were all very enriching.

Unfortunately, the Bamberg Symposium for Research Award Winners, originally planned for March 2022 has been postponed to October 2022 due to the pandemy. Since my re-

search term will be expired by October, I am not yet sure whether I will be invited to this occasion.

I regularly attended the events organized by the Regional Humboldt Club. The talks at the Humboldt Salons were fascinating, the get-togethers with wine and cheese helped us to get to know one another. I also attended together with my family a Humboldt excursion to Tutzing in March, 2022. I am very grateful to the local organizers, especially to Evi Vogel and Stephan Recksiegel for their work, steadiness and kindness.

I attended the meeting and ceremony of the Carl Friedrich von Siemens Stiftung at the Nymphenburg Palace on July 25, 2022. I was especially happy that my host, Professor Stephan Hartmann also attended the ceremony. This event was also a nice farewell from Munich since my research stay ended just a couple of days after this event.

Staying at IBZ

I was lucky to be able to rent a nice apartment in the Guesthouse of the *Internationales Begegnungszentrum der Wissenschaft (IBZ)* during my stay in Munich. Located centrally, close to the university and to the Englischer Garten, IBZ facilitated both the participation in the academic life and also provided an easy way to connect with nature. Beyond that, IBZ regularly organized events, talks, music events, Christmas carols, grill party for the tenants. I enjoyed these events and made friends with many of the tenants thanks to these occasions. We also made a daily use of the ping pong table and the treadmill in the Gym of IBZ.

Personal

I stayed in Munich with my family that is with my wife and with three kids. The kids attended a music high school in Munich, picked up a good German, made friends, and benefited a lot from the open-minded, value-based and democratic German high school system. We, parents were also fascinated by the German school system which prompted me to write a short public diary on all the good things our children experienced from their school mates and teachers.

Practically on every weekend we either went either hiking (Zugspitze, Leutaschklamm, Partnachklamm, AlpspiX, Hochkreuz, Teufelstättkopf, Tegernsee, Starnbergersee, Eibsee, Ettal) or cross-country skiing in Sudefeld or sledging at Spitzingsee. We systematically visited a great part of the museums in Munich and the neighborhood (Deutsches Museum, Pinakotheks, Museum Brandhorst, Stadtmuseum, Lenbachhaus, Glyptothek, Antikensammlung, Ägyptischer Sammlung, Mensch und Natur, NS Dokuzentrum, Dachau, Botanischer Garten, Tierpark). We also made three major trips around Germany during the spring and summer, one in Nordrhein-Westfalen, one at the Bodensee and one in Berlin. My whole family had an amazing year in Munich.

I owe a debt of gratitude to many who made our stay in Munich delightful. I would like to thank Frau Mennella and Herr König for doing a wonderful job at IBZ; Antonia Gollwitzer, deputy-director at the Städtisches Luise-Gymnasium who kindly accepted our kids as guest students; Alex Weichselberger and Felix Lieb who trained our sons in football at FT Gern. Above all, however, I wish to thank again the Humboldt Foundation and Professor Stephan Hartmann for this wonderful year.