File *GIF30_05.pdf, 20 August 2015, fwh*

Figures *GIF30EldynFig1.eps, GIF30EldynFig2.eps, GIF30EldynFig3.eps*

Report submitted on 20 August 2015 to GIF Director Tali Rosenbaum, Jerusalem, tali.rosenbaum@gif.org.il

Electrodynamics & all that: a GIF program of Jerusalem–Bremen–Cologne of 2010 to 2014

The scientific exchange between Yakov (Y.) and Friedrich (F.) started in June 1997 with a fierce scientific dispute during the Marcel Grossmann Meeting on General Relativity in Jerusalem. Y. (*1955), who had immigrated from the Soviet Union with his family to Israel in 1992, wrote at that time a thesis under the advice of the mathematics professor Shmuel Kaniel of Hebrew University. F., of age 60 at that time, a gravitational physicist from Cologne/Germany, has had earlier a GIF contract with the late Yuval Ne'eman of Tel Aviv. Y. & F. wrote their first joint paper on electrodynamics in 2003.

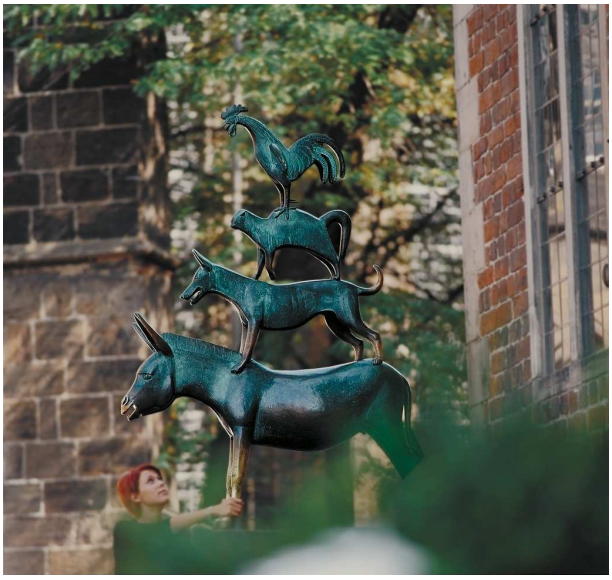

Figure 1: The four PIs (principal investigators) as "Town Musicians of Bremen" (© BTZ, Bremen).

Subsequently, Y. got employed at Jerusalem College of Technology (JCT) and started research with Yaakov (Yaa.), a professor of this college studying various problems in electrodynamics. Yaa. is the first born child of two holocaust survivors. He was first skeptical to join an Israeli-German project, but eventually he hesitantly did so and currently more than appreciates this fruitful collaboration. Indeed, it led to experiments with German partners on fundamental physics at the synchrotrons at DESY (Hamburg, Germany) and ESRF (Grenoble, France).

F. had earlier written papers on electrodynamics with Claus (C.) of Bremen, Germany, see Fig.1. C.—a theoretical physicist—is also involved in such things as in free-fall experiments of Bose-Einstein condensates at the Bremen Drop Tower. In July 2009, C. invited Y. to present a talk on axion modified electrodynamics at the Marcel Grossmann Meeting in Paris. Actually here the idea of a joint electrodynamics project was born. In this way, the four PIs, Yaa., F., C., and Y. came together. Our scientific basis was widened by including local collaborators, namely Tzvi Scarr (Jerusalem), Volker Perlick (Bremen), Yuri N. Obukhov (Moscow and Cologne), and Alberto Favaro (London and Cologne), see Fig.2.

During this project we intensely worked on the foundation, the structure, and the implications of electrodynamics. Though Maxwell's equations governing electrodynamics are known for 150 years, not

Figure 2: The Electrodynamics PIs at their 4th GIF Workshop in June 2014 in Jerusalem. From the right: Y. Friedman, M. Land, J. M. Steiner (Rector JCT), F. W. Hehl, V. Perlick, C. Laemmerzahl, T. Scarr, Y. Itin.

everything is known about the full variety of phenomena related to the electromagnetic field. Accordingly, we worked on the signature of spacetime as interrelated to the Lenz rule of electrodynamics, the Maxwell equations in generalized metrical theories, on the kinematics of covariant uniform acceleration, on the energy and momentum distributions and their fluxes in electromagnetic fields in interaction with matter, on nematic liquid crystals in interaction with electromagnetic fields, on the self-force in nonlinear Bopp-Podolsky electrodynamics, just to mention a few of our results.

The four of us (and our respective collaborators) have fairly diverse opinions on politics, society, religion, and philosophy. In spite (or because) of all of this, we pushed our scientific program jointly and with joy and we all had eventually the feeling that we could successfully contribute good results to electrodynamics and could foster a good mutual understanding between Israel and Germany. By the way, the Israeli partner town of Bremen is Haifa, that of Cologne Tel-Aviv-Yafo.

We very much profited from our mutual visits and we think that the personal and cultural exchanges are most important for science in particular and the relations between Israel and Germany in general. We appreciate the support of GIF and we hope that this institution will have a bright future.

In August2015: Yaakov Friedman, Friedrich W. Hehl, Yakov Itin, Claus Laemmerzahl

Responsible for the text: Friedrich W. Hehl, email: hehl@thp.uni-koeln.de, *please no changes without permission!* Fig.2 with better resolution is available on demand (Y. Friedman). p.t.o.

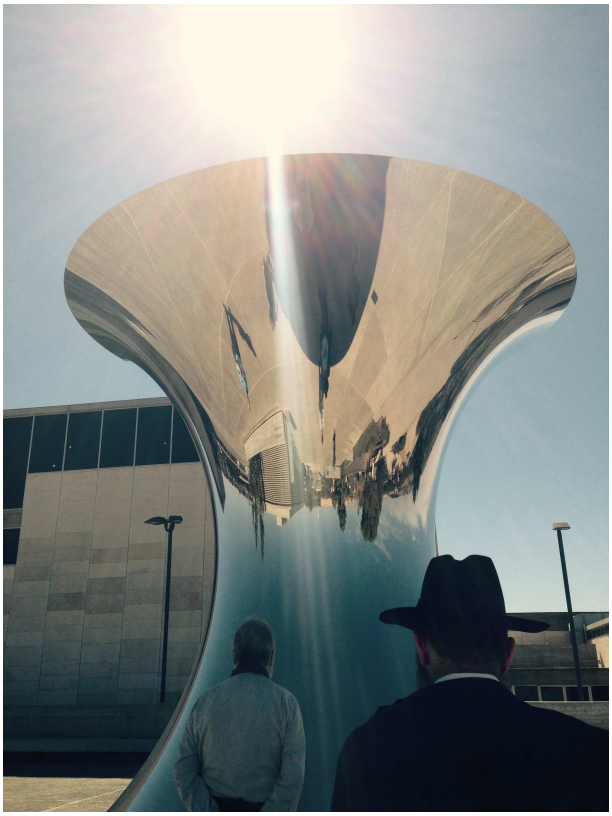

Figure 3: Two of the PIs contemplating the beauty of curved spacetime in the Israel Museum at Jerusalem.