SPECIAL ISSUE ON THE THEORY AND APPLICATION OF ANALYTIC AND ALGEBRAIC METHODS IN PHYSICS

(preface)

Miloslav Znojil,
Nuclear Physics Institute ASCR,
250 68 Řež, Czech Republic

The "Entente Cordiale" as signed by UK and France in April 1904 may be perceived as a climax and as a legal reflection of the peaceful co-existence and collaboration which lasted since the end of the Napoleon's fury. Once one tries to find a parallel in the recent history of science, what comes to one's mind is an apparently peaceful co-existence of mathematics and physics.

A deeper scrutiny of the possible parallels reveals that the piecefulness of the latter co-existence is also rarely just for free. It only too often requires nontrivial efforts on both sides [1]. Usually, what is achieved is a more or less reasonable compromise between a frequent weakness of the rigorous background of models and methods in physics and an equally frequent lack of a satisfactory motivation of only too many studies of structures in the contemporary algebra and analysis.

In the history of mathematics and physics a very good illustrative example of an interference between conflict and collaboration may be provided by the recent growth of popularity of the so called PT-symmetric non-Hermitian candidates $H \neq H^\dagger$ for physical quantum Hamiltonians. In the community of physicists, these operators were quickly and enthusiastically accepted as a potential background of building new phenomenological models (one can recall, e.g., the invited talk by C. M. Bender to the Group 24 conference in Paris in 2002 [2]).

In contrast reminding us slightly, in the above-mentioned context, of the highly deplorable philosophical misunderstandings behind the Napoleonic Wars, the mathematicians remained sceptical. In the language of mathematics, the latter operators were immediately identified as a mere well known and not too interesting special class of operators which are self-adjoint in an *ad hoc* Krein space $\mathcal{K}$.

A certain related "Entente-Cordiale-like" series of agreements between mathematicians and physicists on PT symmetry may be documented by the emergence of the series of International Workshops on Pseudo-Hermitian Hamiltonians in Quantum Physics (PHHQP, [3]) in 2003. The proceedings of several meetings of this series were also published in Czechoslovak Journal of Physics.

Two things happened after the extension of the thematic scope of the latter series of conferences which left the Czech territory as early as in 2004. Firstly, the Czechoslovak Journal of Physics ceased to exist and its specific and traditional role of a proceedings-supporting medium has inadvertently been lost. Secondly, another, still mathematics-plus-physics-oriented new series of conferences emerged [4] and survived as one to be organized in Prague. Under the new name "Analytic and algebraic methods in physics" (AAMP) this slightly younger series of meetings in Villa Lanna both weakened its umbilical-cord connection to PT symmetry and, simultaneously, it re-strengthened the direct communication between the generic mathematicians and physicists.

In the new setting, the role of a specific Czech proceedings-supporting medium seems to be taken over by Acta Polytechnica (cf., e.g., a few details in [5]). In parallel, the steady growth of status and impact of Acta Polytechnica seems to have opened a possibility of making its individual issues better organized, say, as dedicated to certain subsets of problems which could play a truly innovative role in a domain of overlap (if non-empty) between mathematics and physics.

In the present issue of Acta Polytechnica the Editors decided to support such an experiment with a printed (plus electronic, web-accessible) medium which would offer a combined sample of

results presented during *several* international conferences taking place, say, within a given year. Unexpectedly, the editorial "affirmative-action-like" support and encouragement of the participants in the eleventh "local" Villa Lanna AAMP XI meeting (October 30th - November 1st, 2013) proved too strong. So efficient that just very limited space was left to the "more slowly reacting" participants of the complementary PHHQP XII meeting (July 2nd - 6th, 2013, Koç University, Istanbul [6]).

We must admit that our experiment with superproceedings did not work, at the first try at least. Thus, the present preface still has to remain, in the first approximation, just the preface which will pay attention, predominantly, to the AAMP XI meeting in Prague (see [7] for full details).

In particular, we shall still provide here just the November photo of (an incomplete set of) participants (see Fig. 1), accompanied merely by a very brief account of the range of the talks as delivered in Prague. Still, before we mention the scientific highlights let us just repeat that the service-style as well as the capacity of Villa Lanna seems to be, in some sense, optimal. This time, 38 participants from 19 countries (of 5 continents!) just fitted the space and time of the meeting.

A similar diversity also concerns the headings of the twelve separate sections which covered the subjects ranging from the slightly prevailing above-mentioned PT symmetry (in sections I, III, VI and IX) and from a slightly subdominant theoretical physics (cf. sections II, X and XII), via several disciplines in between mathematics and physics (cf. section V: "quantum scattering", or sections VII and VIII: "quantum models" and "quantization techniques"), up to the purely mathematical sections devoted to the singular interactions and to the applied functional analysis (section XI) and/or to the advanced descriptions of the purely algebraic formalism of the so called effect algebras (section IV).

Several speakers offered just a review of their recent results (to be, or being published elsewhere: the most extensive and ambitious samples of the use of this strategy were the comprehensive talks by Robin Hudson (on product-limit integrals) or Ingrid Rotter (on exceptional points), or the Teoman Turgut's talk on his "recently rejected results" (on Bose-Einstein condensates – the subject covered also by Günter Wunner or Holger Cartarius)). Naturally, some of these speakers did not feel urged to repeat the job, for Acta, once more (for example, the Peter Prešnajders' results on non-commutative coordinates were just very recently published). Others presented their unfinished results of high quality – alas, also these oral presentations were not yet available for publication before our submission deadlines. The third general category of speakers appeared too busy with their administrative and/or teaching duties. The traditional autumn timing of the AAMP XI meeting did not leave any space for an additional active conversion of their talks into full (and, as we all know, twice refereed) papers for our special issue.

Due to all of these reasons, the last (and also very brief) part of this preface intends to offer just a rough overview and orientation of the readers of Acta in the AAMP talks and results which will *not* be published in this proceedings-like issue.

In a preamble we must state that virtually all of the lectures would deserve a separate mention. We are not going to do that, making just a random selection of a few samples. Thus, the criteria are more or less stochastic and, in addition, strongly personal. Moreover, using an alphabetic ordering of the speakers, it is truly difficult to omit mentioning the very first Ambichl's talk at a compariatively disproportionate length. Not only because he arrived (from Vienna) just for his own talk and not only because he spoke under a truly strong flu. On the challenging, physically and phenomenologically important subject which was first presented during PHHQP XI in Paris and which connects, in a virtually mysterious manner, the eigenvalues of Hamiltonians with those of the S-matrices.

Certainly, the similar attention cannot be paid to all of the subsequent and equally exciting talks. Irrespectively of the distance of their home Universities (below see the sample of work by Francesco M. Fernández from La Plata, etc) and moving too slowly over the alphabet: Fabio Bagarello spoke on the metric-unboundedness problem, using a strictly mathematical approach and language – a few parallel studies of the similar and related problems were also reported by David Krejčiřík and Petr Siegl. Etc.

Even if we completely skip the talks which were converted into the written contributions (to

Acta or elsewhere) and even if we skip all of the progress reports (also to be sought elsewhere: typically, the progress in PT symmetry represented here by the introductory talk by Kwang Shin and by the Radek Novák's report on the slightly more complicated spatial structures may be followed via the Daniel Hook's dedicated webpage [8]), we may only very briefly try to attract attention here, say, to the Jakubsky's results on nanotubes, to the amazing historical comments on ambiguity of Lagrangeans (by Peter Leach), to the traditionally innovative observations by Ali Mostafazadeh (on the transfer matrices and inverse scattering and on all that this time), to the Nikitin's way of dealing with the spin in superintegrable models or to the Bagchi's approach to the variable-mass systems, etc.

Among the most amazing results of the meeting the auditorium found an innovative and pioneering approach to the physics as well as mathematics of chaos (M. Howard Lee), the very promising analyticity-based rigorous approach to scattering theory (by S. Kuzhel) as well as the newest results on bridges between pure algebra and quantum physics (J. Janda, J. Paseka and G. Lévai). In these and similar talks, perhaps, the interdisciplinary and cross-disciplinary flavor of the AAMP XI meeting was the strongest. Still, this being said, the most lasting impact of the meeting may be expected to lie in the mutual inspiration between people doing mathematical methods and people doing phenomenological physics. We believe that our special issue will also offer a sufficiently representative sample of such a, hopefully, bidirectional inspiration.

Reference

[1] P. Kurka, A. Matoušek and B. Velický, *Spor o matematizaci světa*. Pavel Mervart, Prague, 2011 (in Czech). ISBN: 978-80-7645-012-03, EAN: 9788074650123

[2] http://phhqp11.in2p3.fr/Home.html

[3] http://gemma.ujf.cas.cz/∼znojil/conf/index.html

[4] http://gemma.ujf.cas.cz/∼znojil/conf/mikroindex.html

[5] http://gemma.ujf.cas.cz/∼znojil/conf/proceedaamp.html

[6] http://home.ku.edu.tr/∼amostafazadeh/workshop_2012/index.htm

[7] http://gemma.ujf.cas.cz/∼znojil/conf/micromeetingjedenact.html

[8] http://ptsymmetry.net