Weyl Prize and Wigner Medal Ceremony

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Abstract. An integral part of the International Colloquia on Group Theoretical Methods in Physics (ICGTMP) is the award ceremony of the Weyl Prize and Wigner Medal.

The Hermann Weyl prize is awarded biannually and is presented to the awardee(s) at the ICGTMP. The first Hermann Weyl Prize was awarded in 2002 at the 24th ICGTMP in Paris. Its purpose is to provide recognition to young scientists who have performed original work of significant scientific quality in the area of understanding physics through symmetries. To be eligible for the Hermann Weyl prize, the candidate should be either under thirty-five years of age, or be within five years of having received the doctoral degree, at the time of the deadline of the application. Their contributions shall be in one or more of the following fields: group theory, development of new mathematical tools for the description of physical phenomena, interpretation of experimental results, formulation of general laws based on symmetries.

The Wigner Medal is a distinction designed to recognize outstanding contributions to the understanding of physics through group theory. It is also awarded every two years. The Wigner Medal is administered by The Group Theory and Fundamental Physics Foundation, a publicly supported international organization. The Medal was first awarded in 1978 to Eugene Wigner and Valentine Bargmann at the Integrative Conference on Group Theory and Mathematical Physics (7th ICGTMP in Austin).

The ceremony took place in the Bethlehem Chapel, the ceremonial hall of the Czech Technical University in Prague, on July 12th, 2018. The Hermann Weyl Prize was presented by Professor Mariano A. del Olmo, the Chairman of the Standing Committee of the ICGTMP. The Wigner Medal was presented by Professor Piotr Kielanowski, representing The Group Theory and Fundamental Physics Foundation on behalf of its Chairman, Professor Arno R. Bohm. Laudationes for both awards were read by Professor Luc Vinet, the director of the Centre de Recherches Mathématiques (Montréal) and the chair of Weyl Prize 2018 Selection Committee. Both Laudationes and the Acceptation Speech of the Wigner Medal Laureate are reproduced below.

Address of Mariano A. del Olmo

Ladies and Gentlemen,
Dear Friends,

On behalf of the Standing Committee of the International Colloquium on Group Theoretical Methods in Physics I am please to present the Herman Weyl Prize.

The Hermann Weyl Prize was created 18 years ago by the Standing Committee of the ICGTMP under the initiative of H.D. Doebner, chairman of the Standing Committee at that time. The aim of the Prize is the recognition of young scientists who have outstanding research in understanding physics through symmetries.

The Hermann Weyl Prize consists of a certificate citing the accomplishments of the recipient, prize money of US$ 500 and allowance toward attendance the ICGTMP at which the award is presented.

The previous winners of the Weyl Prize are:

Edward Frenkel (2002), Nikita A. Nekrasov (2004), Boyko Bakalov (2006), Mohammad M. Sheikh-Jabbari (2008), Giulio Chiribella (2010), Razvan Gurau (2012), Yuji Tachikawa (2014) and Vasily Pestun (2016).

The Selection Committee of the Weyl Prize 2018 was formed by Luc Vinet (Chair, University of Montreal, Canada), María Antonia Lledó (Valencia University, Spain), Mohammad M. Sheikh-Jabbari (IPM, Tehran, Iran), Nedialka I. Stoylova (INRNE, Bulgarian Academy of Sciences, Sofia, Bulgaria) and Francesco Toppan (CBPF, Rio de Janeiro, Brazil).

The Standing Committee of the ICGTMP provided 18 nominees. For the first time, since it was established, the Weyl Prize 2018 was awarded jointly to two young scientists.

I would like to thank in public the members of the Selection Committee for his outstanding work done to select the awardees.

The Selection Committee decided unanimously to award the Hermann Weyl Prize 2018 to

Simon Caron-Huot

McGill University, Montreal, Canada

In recognition of seminal contributions in the areas of scattering amplitudes in gauge theories and conformal bootstrap, examples are: the generalization to general helicities of the amplitude/Wilson loop duality and the analog of the Froissart-Gribov formula in conformal field theory.

and

David Simmons-Duffin

California Institute of Technology, Pasadena, USA

In recognition of breakthroughs in the analytical and numerical development of the conformal bootstrap method and its applications, in particular to the understanding of the critical point of the 3D Ising model.

Presidential Table of the Weyl Prize and Wigner Medal Ceremonies: Luc Vinet (Chair of the 2018 Weyl Selection Committee), Piotr Kielanowski (Scientific Secretary of the Group Theory and Fundamental Physics Foundation), Mariano A. del Olmo (Chairman of the Standing Committee of the ICGTMP) and Igor Jex (Dean of the Faculty of Nuclear Sciences and Physical Engineering of the Czech Technical University in Prague)

Laudatio of the 2018 Weyl Prize Winners (by L. Vinet)

Dean Jex, Chairman Del Olmo, Dear Giulio Chiribella, former Weyl prize recipient,
Dear colleagues and distinguished guests,
Dear Simon,

As Chair of the Weyl prize selection committee and on behalf of my fellow committee members: María A. Lledo, Shahin Sheikh-Jabbari, Neli Stoilova and Francesco Toppan, I have the great pleasure of introducing to you the 2018 winners of the Weyl prize which is awarded as you were told, to outstanding young scientists who have performed work of great significance in theoretical physics from a symmetry perspective.

The task of the committee was made particularly difficult this year as a record number of remarkable candidates have been proposed. I would thus first wish to congratulate all the nominees for their accomplishments as well as their nominators for offering the praise and recognition that these young researchers deserve. Ultimately though, two extraordinary individuals stood out in the eyes of the committee members who could not collectively bring themselves to prefer one to the other: if you allow me this pun, they were bootstrapping one another! Given also as I just alluded that there was strong commonality in their work, unanimously, the committee decided to recommend that the prize be awarded to both Simon Caron-Huot and David Simmons-Duffin.

Unfortunately, David could not join us tonight. I will hence introduce him first and save Simon for last.

- As of last year, **David Simmons-Duffin** is an Assistant Professor at Caltech. Prior to this appointment, he obtained his PhD in theoretical physics from Harvard under the supervision of Lisa Randall and has been a member of the Institute for Advanced Study in

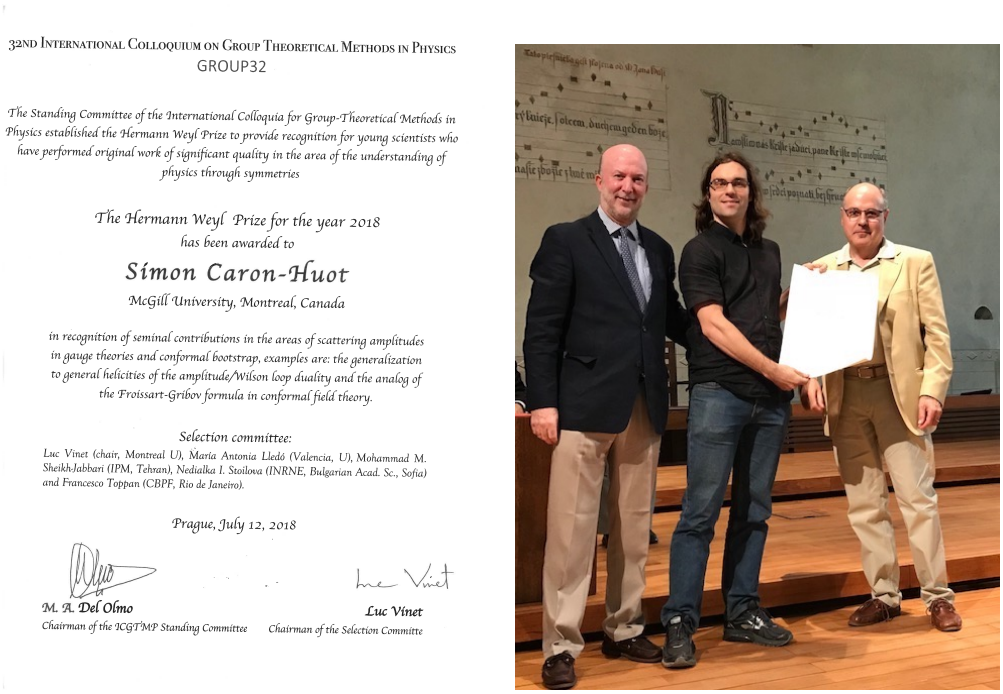
Princeton. A high-energy theorist by training, David Simmons-Duffin works on the interface with statistical and condensed matter physics. He is a key player in the ongoing revival of the conformal bootstrap program.
Progress with this program required advancing the knowledge of conformal blocks and the development of efficient numerical techniques and David much contributed to both these areas. This made Riccardo Rattazzi write in his letter of support and I quote: (...) without David's contribution, the conformal bootstrap program would not nearly be at its present level of development. Of note is the clever semidefinite linear programming formulation of the bootstrap that he developed and which has become a method of choice in the field. This paved the way to what is up to now David's most spectacular work, namely the study of the 3d Ising model using conformal bootstrap which Simon Caron-Huot kindly explained to us in his beautiful lecture this morning. In this respect, Slava Rychkov wrote: "(The) findings are nothing short of sensational (...) the 3d Ising model CFT is the only unitary theory which has one $\mathbb{Z}_2$–even and one $\mathbb{Z}_2$–odd relevant operator. (This result) gives the tantalizing hope that the 3d CFT may one day be solved completely".

The citation for the award reads as follows:

The 2018 Hermann Weyl Prize is awarded to David Simmons-Duffin for breakthroughs in the analytical and numerical development of the conformal bootstrap method and its applications, in particular to the understanding of the critical point of the 3D Ising model.

Ladies and gentlemen, I invite you to offer a round of applause as an expression of your congratulations.

- **Simon Caron-Huot** is since 2016 an Assistant Professor in Physics at McGill University in Montreal. Before that, he held a similar position at the Niels Bohr Institute in Copenhagen after being a Member of the Institute for Advanced Study in Princeton for 5 years. He obtained his PhD from McGill University under the supervision of Guy Moore in the field of the quark-gluon plasma.
Since his days at the IAS, Simon has been interested in the mathematical structure of scattering amplitudes particularly in planar $N = 4$ super Yang-Mills theory and he has obtained results that have left the greatest experts in awe. In his letter of nomination, to give a hint of Simon's genius as he puts it, Lance Dixon tells the story of when to ask feedback, he sent to Simon a paper on the self-crossing limit of Wilson loops in planar $N = 4$ super Yang-Mills theory only to see Simon extend within a week to arbitrary order, the results up to 8 loops that had taken Lance's group many weeks of hard technical work to achieve.
The letter of Nima Arkani-Hamed from the IAS is simply glowing and raves about the various accomplishments of Simon Caron-Huot, those include extending the loop from trees method beyond one-loop; contributing centrally to the determination of the all-loop integrand for planar $N = 4$ SYM; extending the Wilson-loop amplitude to general helicities; explaining how the dual conformal symmetry of $N = 4$ SYM generalizes the Runge-Lenz symmetry of the Kepler problem; and on and on. He gave us a nice overview of some of these results in his talk.
In his letter of support Edward Witten uses a recent paper of Simon Caron-Huot entitled Analyticity in Spin in Conformal Theories to illustrate that Simon is an expert on both modern and old approaches who can juxtapose the two to obtain startling results. In this paper, Simon obtained a formula that extends to conformal field theory the Froissart-Gribov representation of massive four-particle scattering amplitudes. This formula which was the object of the second part of his talk, has attracted a lot of interest: it gives a powerful way



32ND INTERNATIONAL COLLOQUIUM ON GROUP THEORETICAL METHODS IN PHYSICS
GROUP32

The Standing Committee of the International Colloquia for Group-Theoretical Methods in Physics established the Hermann Weyl Prize to provide recognition for young scientists who have performed original work of significant quality in the area of the understanding of physics through symmetries

The Hermann Weyl Prize for the year 2018
has been awarded to

Simon Caron-Huot

McGill University, Montreal, Canada

in recognition of seminal contributions in the areas of scattering amplitudes in gauge theories and conformal bootstrap, examples are: the generalization to general helicities of the amplitude/Wilson loop duality and the analog of the Froissart-Gribov formula in conformal field theory.

Selection committee:
Luc Vinet (chair, Montreal U), Maria Antonia Lledó (Valencia, U), Mohammad M. Sheikh-Jabbari (IPM, Tehran), Nedialka I. Stoilova (INRNE, Bulgarian Acad. Sc., Sofia) and Francesco Toppan (CBPF, Rio de Janeiro).

Prague, July 12, 2018

M. A. Del Olmo
Chairman of the ICGTMP Standing Committee

Luc Vinet
Chairman of the Selection Committe

The 2018 Herman Weyl Prize Certificate (left) and Luc Vinet, Simon Carot-Huot (2018 Herman Weyl Prize Awarde) and Mariano A del Olmo (right)

to understand some conformal bootstrap results; also, it provides a natural framework for relations that arise in the Sachdev-Ye-Kitaev model of quantum holography.
Moreover, this formula gives a nice link between our two 2018 Weyl prize recipients. Let me in this respect, quote Witten who writes: I have actually been quite interested in Caron-Huot's formula and recently, David Simmons-Duffin, Douglas Stanford and I have written a paper proposing an alternative derivation of it. There could hardly be better praise.

The citation in this case reads:

The 2018 Hermann Weyl Prize is awarded to Simon Caron-Huot in recognition of seminal contributions in the areas of scattering amplitudes in gauge theories and conformal bootstrap, examples are: the generalization to general helicities of the amplitude/Wilson loop duality and the analog of the Froissart-Gribov formula in conformal field theory.

Address of Piotr Kielanowski

Ladies and Gentlemen,
Dear Friends,

I am honored to address such a distinguished audience in this chapel, whose history traces back 600 years and where Jan Hus performed various rites and participated in meetings.

Today, we are celebrating the Wigner Medal Award that was established exactly 40 years ago. Here is a brief history.

In 1978 the Group Theory Colloquium was organized at the University of Texas at Austin and the organizer was Professor Arno Bohm. During the Colloquium he wanted to honor Eugene Wigner for his great contributions in the study of symmetries in physics and also to recognize new contributions in the same field.

To honor Eugene Wigner with the Medal with his name was simple, but not easy to obtain Wigner's approval and secure the support of the scientific community. Invaluable help was provided by John Archibald Wheeler, Wigner's close friend from Princeton. John Wheeler in 1976, at age of 65, retired from Princeton and accepted an offer from the University of Texas at Austin, where he stayed next 10 years.

John Wheeler was an extraordinary person. He may be the only physicist, who was the Ph.D. adviser of the two Nobel Prize winners. He loved teaching and he loved helping people, so he provided expertise and moral support to his young colleague, office neighbor and friend, Arno Bohm, in establishing the Wigner Medal. To ensure the future and continuity, the Wigner Medal is administered by the Group Theory and Fundamental Physics Foundation. Its Chairman from the very beginning has been Arno Bohm who is unable to come to Prague. He sends his best wishes of success.

Let me state that the Wigner Medal has been always awarded during the Group Theory Colloquia and **the purpose of the Wigner Medal is to recognize the outstanding contributions to the understanding of physics through group theory.**

To conclude let me thank, in the name of the Foundation, the members of the Wigner's Medal Selection Committee: Professors José Fernando Cariñena, Luiz Davidovich, Victor Dodonov and above all the chairman, Jean-Pierre Gazeau for their work during the selection of the winner of the 2018 Wigner Medal and let me announce that the winner of the 2018 Wigner Medal is Professor

Pavel Winternitz

from the Montréal University, who received the Medal *for seminal work on symmetries of differential and difference equations and for inspiring a young generation of physicists.*

Congratulations — Gratulujeme

Laudatio of Pavel Winternitz, 2018 Wigner Medal recipient (by L. Vinet)

Dean Jex, Chairman Del Olmo, Professors Kac and Iachello, former Wigner medal recipients,
Dear colleagues,
Dear Milada, family members and friends of the recipient and
Dear Pavel,

I have known Pavel for 45 years, that is since 1973. At the time, I was looking for a supervisor when I was told that a great theoretical physicist had arrived in Montreal a year before actually to work at the CRM, a research institute that I did not know about. Needless to say, that

The obverse and the reverse of the Wigner Medal

Luc Vinet, Pavel Winternitz and Piotr Kielanowski

following up on this has been, next to marrying my wife, one of the best decisions of my life. Pavel has been a truly inspiring mentor, a real friend and a highly influential colleague who is making everyone proud to know him. I mention this to let you all appreciate, how thrilled I was when Pavel came to my office recently to tell me that he had been awarded the Wigner medal and how honored I feel that he has asked me to do this laudatio.

Pavel's first paper was published in 1960 and since then, for more than 58 years now, with a passion that never weakens, he is building a most impressive body of work, made out of various threads and whose impact keeps growing. Last, I looked, there were 430 titles with Pavel as author ... and counting. Quite telling also is the fact that Pavel has an immense network of collaborators around the world; this shows that there are a lot of people eager to work with him

and that he is extremely generous with his ideas and energy. Among these collaborators there are some with whom he has worked for many years and there are also the numerous young and now not so young people like me, that he has trained. And then, there is the impact that he has had in Montreal, his adopted town, and on the CRM while remaining mindful of his homeland. In the little time I have, I will try to illustrate or paraphrase Pavels accomplishments on these fronts but first, I wish to put a disclaimer to Pavel on the one hand, because it will be impossible to do him justice, and to all his friends here on the other hand, because I will necessarily omit some of you who are very dear to Pavel and I apologize for that.

Pavel was brought up in the great tradition of the Fock and Landau Russian schools. After his MSc in Leningrad, Pavel moved to Dubna to do his PhD with Ya. A. Smorodinsky, an illustrious student of Landau. In his contribution to the volume in honor of Smorodinsky, Pavel attributes to the influence of his mentor his interest in phenomenology as well as in mathematical physics. Therein are indeed the roots of his exploration of polarization phenomenology and complete nucleon-nucleon scattering experiments, questions that he kept working on well into the 1990s, in particular with his friend experimentalist František Lehár in Saclay with whom he had climbed the Lenin peak. Some of his most cited papers are actually in this area. At the same time, in the wake of a seminal paper by Smorodinsky and Vilenkin, Pavel undertook a large program based on the representation theory of Lie groups of physical relevance, in particular of the Lorentz group, with an eye to their applications. This formed the backdrop for his celebrated two-variable expansions of scattering amplitudes which incorporate partial wave analysis, Regge pole and eikonal expansions. I remember that Pavel was still pursuing this program when he arrived in Montreal. His first postdoctoral fellow at the CRM, Ernie Kalnins got involved into that. I think it is fair to say that it is because of Jiří Patera, another illustrious Canadian/Czech mathematical physicist, that Pavel came to Montreal. Indeed, Jiří had been a postdoc in Montreal. Knowing the place, he came to the CRM soon after its creation in 1968 – 50 years ago – and then sent the right signals to Pavel. These two have had an extraordinary collaboration that involved numerous distinguished colleagues such as Marcos Moshinsky and Hans Zassenhaus, only to name two. Let me mention for instance the huge task they undertook and carried out, of classifying the subgroup structures of the groups of physical interest, a study which culminated with the analysis in this respect of the conformal group. I might mention that the Chairman of the Standing Committee of this conference series Mariano Del Olmo has been involved in parts of this program. A recent outcome of this broad undertaking is the publication of a book that Pavel wrote in collaboration with Libor Šnobl from the Czech Technical University in Prague, former postdoc of Pavel and our MC tonight. The book is entitled Classification and Identification of Lie Algebras and Pavel referred to it in his talk. One day Pavel confided that he felt he had waited too long to write books, I replied to him that he will have more time for these sorts of things when he retires! Anyhow, you must know Libor that Pavel is delighted with this opus.

While still in Dubna, in 1965, together with Smorodinsky, Uhlíř and Friš, Pavel wrote a little paper entitled Symmetry groups in classical and quantum mechanics. This paper has already been mentioned may times during the conference. Building on the observations that Pauli, Fock and Fradkin had made on the known Coulomb and oscillator systems, this remarkable article truly launched the study of superintegrable models. It brought up a potential now known as the Smorodinsky-Winternitz potential. Here I can fortunately rely on the beautiful talk of Kolya Reshetikhin who recalled a few days ago in his plenary talk, the essence of Pavel's foundational paper and concluded by expressing the view that this field of superintegrability opened by Pavel, is likely to keep bringing beautiful findings. Will you mind if I reveal Pavel, that you once told me that little were you suspecting back when you did that work, that it would have such an impact.

In 1973, because of the presence of Pavel at the CRM, Willard Miller Jr, an already

distinguished expert on Lie theory and special functions came to Montreal to spend his sabbatical. Recall that Ernie Kalnins was there as a postdoc. The connection made in this little paper of Pavel, between separation of variables and the existence of a constant of motion that is quadratic in the momenta proved to be the spark that initiated the intense and on-going collaboration between Willard and Ernie which led in particular to a remarkable series of papers on Lie theory and separation of variables and is now focused on superintegrability per se. This prolific matching of Willard and Ernie is also a feather in the hat of Pavel.

In 1979, Pavel spent a sabbatical in Paris with the clear intent of launching new research directions. With my PhD almost complete, I had the good fortune of accompanying him during that stay and to abuse the hospitality of Milada and Pavel countless times using regularly their couch in Gif when it was too late to get back to the Cit Universitaire. I also fondly remember memorable ski excursions in the French Alps. Anyhow, this is when the involvement of Pavel in nonlinear integrable systems began while he was pursuing his research on NN scattering. You will have by now appreciated that everything he touches turns into gold; this was certainly no exception and led to strikingly fruitful programs. A first important series of publications initiated with Bob Anderson and John Harnad concerned the identification of nonlinear ODEs with superposition formulas. Another major undertaking initiated in the late 80s has to do with the determination of Lie point symmetries of nonlinear differential equations like those of the KP hierarchy and the application of these symmetries to dimensional reduction. Here Pavel's results on subgroup classification were essential and found beautiful uses. He has at the time contributed to the creation of very practical codes to perform these tasks as well as for doing the Painlevé analysis of ODEs. In the midst of these efforts Pavel started to work with Decio Levi who has become over the years one of his main collaborators. Together they introduced the important concept of conditional symmetry that is widely used. In the mid 90s, they began looking at the continuous symmetries of discrete equations and at symmetry preserving discretization of differential equations. Again, this is proving extremely fertile and is still being actively developed by Pavel as we could appreciate in the lovely talk he delivered earlier today. As a matter of fact, some twenty years ago, Decio, Pavel and I started a conference series known as SIDE in the general area of difference equations that is ongoing and quite vibrant.

Relentlessly, bringing in more and more collaborators and students, Pavel remains very busy enlarging these avenues I have evoked, often connecting them in startling ways and opening also new cross streets. Amazingly he does not stop finding gold. At this point, I am afraid Pavel the audience might be getting overwhelmed even by this limited covering of your remarkable accomplishments and Libor is looking at his watch. However, I would not want to end this much-abridged presentation of your scientific work, without mentioning as an example of the nuggets you unearthed recently, the bomb you dropped in 2009 on the superintegrability area that you created way back as was said. That bomb is not TNT but goes under the name TTW with the first two letters standing for your student Tremblay and for Turbiner. For those who were looking elsewhere, this paper radically extended the class of known superintegrable models by correctly conjecturing the superintegrability of an infinite family of models with constants of motion of arbitrary order in momenta (up to then very few systems of order greater than two were known). This has given an enormous impetus to superintegrability studies that Pavel among others is currently pursuing. If you are curious, I recommend the recent review he has written with Willard Miller and Sarah Post who has been a student of Willard and a CRM postdoc.

Clearly, there is a lot of great stuff we owe to Pavel. It would however be short-sighted to view our debt to him exclusively in terms of the scientific advances he produced, since Pavel in many ways, has also created conditions for colleagues to thrive. Take for instance this very conference series which started thanks to the inspiration of Henri Bacry and Aloyso Janner and oscillated for its first four years between Marseille and Niejmegen. It is because Jiří and Pavel

proposed that it be held in Montreal, which happened in 1976, if the ICGTMP has really taken off and has become the truly international and dynamical series it is today.

On the home front, it is largely thanks to both of them, if the CRM which is celebrating this year its 50th anniversary is enjoying the enviable reputation it has internationally. Pavel and Jiří have put the nascent CRM on the map, they brought with them the high scientific tradition in which they trained and obviously their immense talent, they have been highly creative and hard-working and have been exceptional role models, they have attracted experts from all over to Montreal, run great seminars, organized numerous international meetings and have been fantastic colleagues. They have established the mathematical physics school of the CRM and made it possible for younger people such as Simon Caron-Huot to brilliantly carry the flag with them now. Our deepest appreciation Pavel for this legacy.

All the while, when it became possible, Pavel and Jiří have developed ties and collaborations with people and institutions here in Prague. This has further extended the impact of their work with the added benefit of building a well-travelled bridge between Montreal and Prague, something else we owe to them. It is hence fantastic that the circumstances are such that Pavel is receiving this Wigner medal here in Prague, it is obviously highly meaningful and emotional and I wish to thank Igor Jex, Čestmír Burdík and Libor Šnobl and the Czech Technical University for making this ceremony so nice.

Being awarded the Wigner medal is a high honor and it could not have been attributed to a better person than Pavel Winternitz: a man of great scientific distinction, a family man, a man of high moral values and culture, a man faithful in friendship – in short, a special human being. I am so happy for you Pavel, you are making Dubna, Prague and Montreal very proud, please receive my warmest congratulations.

Acceptation Speech by 2018 Wigner Medal Laureate, Prof. Pavel Winternitz

My first reaction to hearing that I was selected to receive the Wigner Medal was total disbelief. I heard it as a recorded message on my telephone when I returned to my office in Montreal after a brief trip to Miami. The recording was left by Arno Bohm, the Chairman of the International Selection Committee who thought that I had already heard about the award from someone else. Anyway, now I believe it, though I am still overwhelmed by the award and by finding myself on the same list as such scientists as Wigner, Bargmann, Gelfand, Michel, Neeman, Gursey, Iachello, Moshinsky, Kac, Moody, O'Raifeartaigh, Kostant and many others, whose work I had always admired.

The award for me is a great honour and a great pleasure, enhanced by the fact that this celebration is in Prague, my native city (though I spent only about 9 years of my life residing in Prague, as opposed to 46 years in Montreal).

I am very grateful to those who proposed me and those on the Selection Committee who voted for me.

The award made me look back at the body of my work and to see what survived the test of time. Also to look at my long list of collaborators, those who educated me, those I worked with over the years, my students, postdocs and other collaborators. The list is long, since I have been at it for a long time, since 1960: 58 years. Luckily the Web of Science is of great help in such an enterprise.

My MSc. degree was written under the guidance of G.F. Drukaryev in Saint Petersburg (then Leningrad) on polarization phenomena in elementary particle scattering. My PhD supervisor was Ya.A. Smorodinsky at the Joint Institute for Nuclear Research in Dubna. Ironically, I came to Dubna after 3 years at the Nuclear Research Institute in Rez, Czechoslovakia to work in a field that Smorodinsky and his group had essentially created: nucleon-nucleon scattering


Pavel Winternitz (2018 Wigner Medal recipient) delivering his acceptation speech (left) and with his wife Milada Winterniz (right)

phenomenology and the complete reconstruction of the scattering matrix from experimental data. However, his interests had shifted towards mathematical physics, more specifically applications of group theory in physics. Still more specifically representations of the Lorentz group realized in different bases, harmonic analysis on the Lorentz group and its homogeneous spaces.

I was greatly influenced by Smorodinsky and my stay in Dubna. Among the things that I learned from him are that if you are doing mathematical physics you must use real cutting edge mathematics. If you are doing phenomenology, you must have real back and forward interactions with experimentalists.

Many of my collaborations that started in Dubna continued after I emigrated in 1968, or were restarted in 1990 after the Velvet Revolution in then Czechoslovakia.

Much of my recent work was in two fields: superintegrability and continuous symmetries of discrete equations; and discretisation of differential equations preserving their Lie point symmetries. Let me just mention a few fields I feel that I contributed to (one of the criteria being that at least one of the articles has more than 100 citations according to the Web of Science).

(i) Superintegrability in classical and quantum mechanics: The theory of Hamiltonian systems that have more integrals of motion than degrees of freedom. My interest in this field was sparked by lectures on quantum mechanics that Drukaryev gave while I was an undergraduate in Leningrad. They concerned Pauli's , Fock's and Bargmann's $O(4)$ symmetries of the hydrogen atom. With Ya.A. Smorodinsky, I. Friš, M. Uhlíř, and others we started a systematic search for superintegrable systems in 2 and 3 dimensions. In 3 papers we found infinite families of such systems, now called Smorodinsky-Winternitz potentials and still very much alive. Further infinite families together with results on the connection between superintegrability and exact solvability were presented in 3 more recent articles sometimes referred to as TTW. One of the T's is A. Turbiner, the other either F. Tremblay or P. Tempesta. About 30 of the talks at this conference Group 32 in Prague were devoted to superintegrability. Soliton theory can be viewed as the theory of infinite dimensional

superintegrable systems.

(ii) Classification of the subalgebras of Lie algebras, two-variable expansions of scattering amplitudes, separation of variables, special function as basis functions for group representations. My involvement in this field also started in Dubna (work with I. Friš on subalgebras of $o(3,1)$). Later it continued with Ya.A. Smorodinsky and M. Sheftel and concerned relativistic expansions of scattering amplitudes. This work was continued in Dublin and at the Rutherford High Physics Laboratory (with L. O'Raifeartaigh and P. Pajas), in Pittsburgh (with J. Belinfante, and N. Macfadyen) and finally Montreal in a series of articles with J. Patera, R.T. Sharp, H. Zassenhaus, V. Hussin, W. Miller Jr, E. Kalnins, M.A. del Olmo, M.A. Rodríguez, L. Gagnon, Z. Thomova and others.

(iii) Nucleon-Nucleon Scattering Formalism. Work started in Dubna (with F. Lehar and Z. Janout). It continued in Montreal and Saclay (Quebec-France collaboration: J. Patera + P. Winternitz + L. Vinet + P. Lafrance & J. Bystrický + F. Lehar + F. Perrot and others). The other cycles of papers were started and brought to fruition in Montreal (where I arrived in 1972 and felt more at home than anywhere else).

(iv) Lie point symmetries of differential, difference and differential delay equations. My main collaborators were V. Dorodnitsyn, A.M. Grundland, F. Gungor, J. Harnad, R. Kozlov, L. Martina, D. Levi, M.A. Rodríguez, and many others.

(v) Classification and recognition of Lie algebras. Book with L. Šnobl based on work with L. Šnobl, H. Zassenhaus, J.F. Ndogmo, J. Rubin, S. Tremblay, Z. Thomova and E. Kalnins.

(vi) Nonlinear ODEs with superposition formulas. (S. Shnider, R.L. Anderson, J. Harnad, V. Hussin, M.A. del Olmo, M.A. Rodríguez, Z. Thomova and others.)

Most recent work:

(i) Book with Libor Šnobl. Started when he was a postdoc in Montreal. Finished when he was a "docent" (associate professor) and Vice Dean at the Czech Technical University in Prague.

(ii) Superintegrability with higher order integrals of motion. Exotic potentials expressed in terms of Painlevé transcendents. My collaborators were all younger or much younger than me: S. Gravel, I. Marquette, M. Sajedi, A.M. Escobar-Ruiz, I. Yurdusen, I. Abouamal and S. Post.

(iii) Superintegrability with vector potentials or particles with spin. L. Šnobl, A. Marchesiello, I. Yurdusen and D. Riglioni,

(iv) Series of articles on Lie symmetry methods for difference equations hopefully to culminate in a book by D. Levi, R. Yamilov and myself.

My most frequent collaborators according to Web of Science are: Decio Levi (42 joint articles), Jiří Patera (32), František Lehar (20), Hans Zassenhaus (16), Michel Grundland (14), Miguel Angel Rodríguez (13) and John Harnad (11).

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Finally I will reveal the secret of scientific longevity: collaborate with people who are smarter than you and from some point on also younger than you.