Diákalkotások

2021 tavaszán magyar és svéd tudósok felfedezték az Odderont.

Zsóri Georgina Anna 10. A osztályos tanuló angol nyelvű interjút készített a kutatócsoport tagjaival és a vezetőjével.

Gratulálunk ehhez a komoly munkához!

- https://medium.com/…/interview-with-the-research-group…
- https://medium.com/…/an-odd-interview-about-the-odderon…
- Interview with the research group that discovered the odderon
- Interviewees: Tamás Csörgő, Tamás Novák, András Ster, István Szanyi, Roman Pasechnik, interview conducted by Georgina Anna Zsóri 10. A
- Interview with the research group that discovered the odderon
- Interviewees: Tamás Csörgő, Tamás Novák, András Ster, István Szanyi, Roman Pasechnik, interview conducted by Georgina Anna Zsóri

From left to right: István Szanyi, Tamás Csörgő, Georgina Anna Zsóri, Tamás Novák and András Ster at the Researcher's Night, MATE Károly Róbert Campus, on September 24, 2021 **Please tell us the story: what was your most interesting story during this discovery research?**

Professor Tamás Csörgő

Tamás Csörgő:

-For me, perhaps the most interesting part was that a good idea, implemented by a highly motivated and devoted team, may compensate for a lack of financial resources. Albert Szent-Györgyi noted this before: "Discovery consists of seeing what everybody has seen, but thinking what nobody has thought."

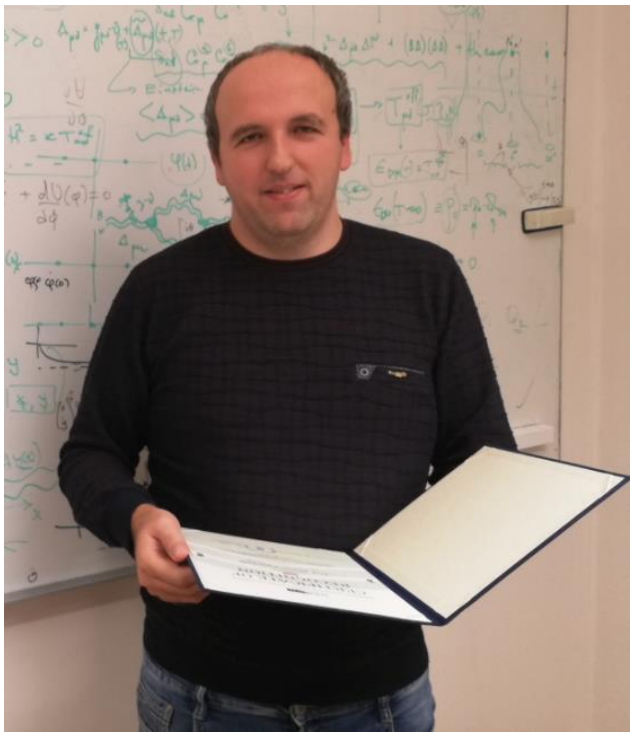
Dr. Tamás Novák

Tamás Novák:

Finding out a new idea and starting to analyze it together always affects me like an adrenaline rush. How true that was also when working on odderon. It feels amazing to think back on this idea like a seed, which we saw growing and blossoming.

András Ster
András Ster:
The good team work.

István Szanyi
István Szanyi:
For me the whole research process was exciting. It was an uplifting feeling to become a part of a real discovery research in particle physics. It was also really interesting to learn the steps of the rigorous statistical analysis which must be carried out in order to announce a discovery that is an observation of a signal with a statistical significance of at least five sigmas.



Prof. Roman Pasechnik, a docent at the University of Lund, Lund, Sweden, on the occasion of the 7th Day of Femtoscopy in October 2021, holding in his hands his Certificate for the Discovery of the Odderon, as published in EPJ C in February 2021.

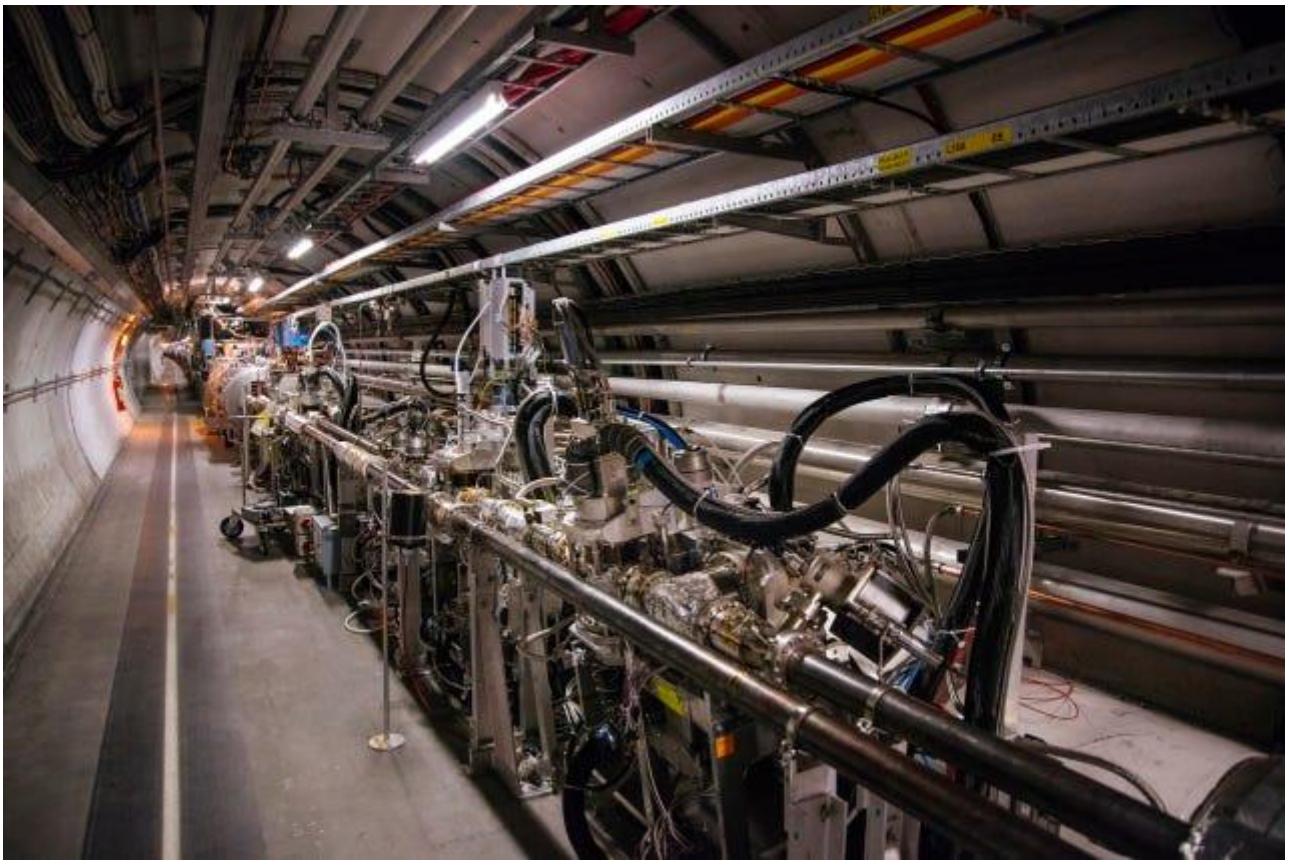
Roman Pasechnik:

-The discovery of a new composite particle of QCD, the Odderon, and retrieving non-trivial information about it right from the experimental data has been driving my curiosity and interest since the beginning of our project. This is an important milestone in particle physics, in general, and in understanding the structure of the QCD theory in the non-perturbative domain, in particular. Besides, working as a member of our amazing team of experts has been enjoyable and rewarding in many ways.

-What prompted the search for odderon? How did you join this project?

Tamás Csörgő:

-Professor László Jenkovszky, an external member of the Hungarian Academy of Sciences from Kyiv, Ukraine, called our attention to this long-standing problem. We have published our first paper on the search for odderon in 2015 together with András Ster and him, where we have noted that the data from the LHC accelerator at CERN and the Tevatron accelerator at Fermilab may turn out to be decisive concerning the question of the existence of the odderon. Between 2015 and 2021 we have published further studies that examined qualitative signals of the odderon exchange in elastic proton-proton and proton-antiproton collisions at the TeV energy scale, however, we had to wait until 2021 to turn these qualitative signals to a quantitative, discovery level, refereed and published paper.



TOTEM experiment in the LHC tunnel

Tamás Novák:
-Some years ago I attended the lecture of Professor Jenkovszky about odderon. At that time I did not even suspect I would be part of the team discovering odderon once. I was invited by Tamás Csörgő and joined the research group a little bit later. This proved to be a good decision, later on, I am thankful for the invitation.
András Ster:
-Already, in 2015-en with Prof. László Jenkovszky, we published an article on this question, but not as fully as now.
István Szanyi:
-I joined the odderon discovery research at the beginning of my master studies under Tamás Csörgő's supervision. Back then I already had two years of experience in this research field from my work during my bachelor studies and my activities in Scientific Students' Associations ("TDK"). I spent one year only doing purely model-dependent analysis in the framework of the Real Extended Bialas-Bzdak model, then I also joined the model-independent Odderon discovery research.
Roman Pasechnik:
-The search for the odderon has been going on for decades. However, only recently, with the appearance of high-precision TOTEM data from the LHC in the TeV energy domain, and with the development of novel statistical approaches to the data analysis by our team (also within the joint effort by the TOTEM and D0 collaborations), it became possible to extract and quantify relevant differences between proton-proton and proton-antiproton elastic scattering. I joined this project and the team of excellent researchers, led by Prof. T. Csörgő, having a strong incentive to make use of elastic scattering data as a clean probe for

understanding the QCD dynamics at long distances. Our combined expertise and ideas have borne fruit proving our collaboration has been successful.

-What is the significance of the discovery of odderon in physics and society

Tamás Csörgő:

-In physics, the discovery of odderon exchange implies that a new family of strongly interacting particles is found and now the members of this family can be individually produced and studied. Thus the search for various gluonic bound states, that contain an odd number of gluons, has been re-started. These states can be directly produced and their decays are observed in so-called central exclusive processes at the LHC accelerator at CERN.

In society, the discovery of odderon exchange gives a reason for all to rejoice and to be happy: We have managed to extend the boundaries of knowledge for all.

Tamás Novák:

-We discovered new gluon-rings, with an interesting feature of containing an odd number of gluons. Having found this example implies that there must exist even more of this. This discovery will not be perceptible for society for long. Basic research always matures over time, we can learn more about its practical relevance later on.

The Dø experiment at Fermilab's former Tevatron collider.

András Ster:

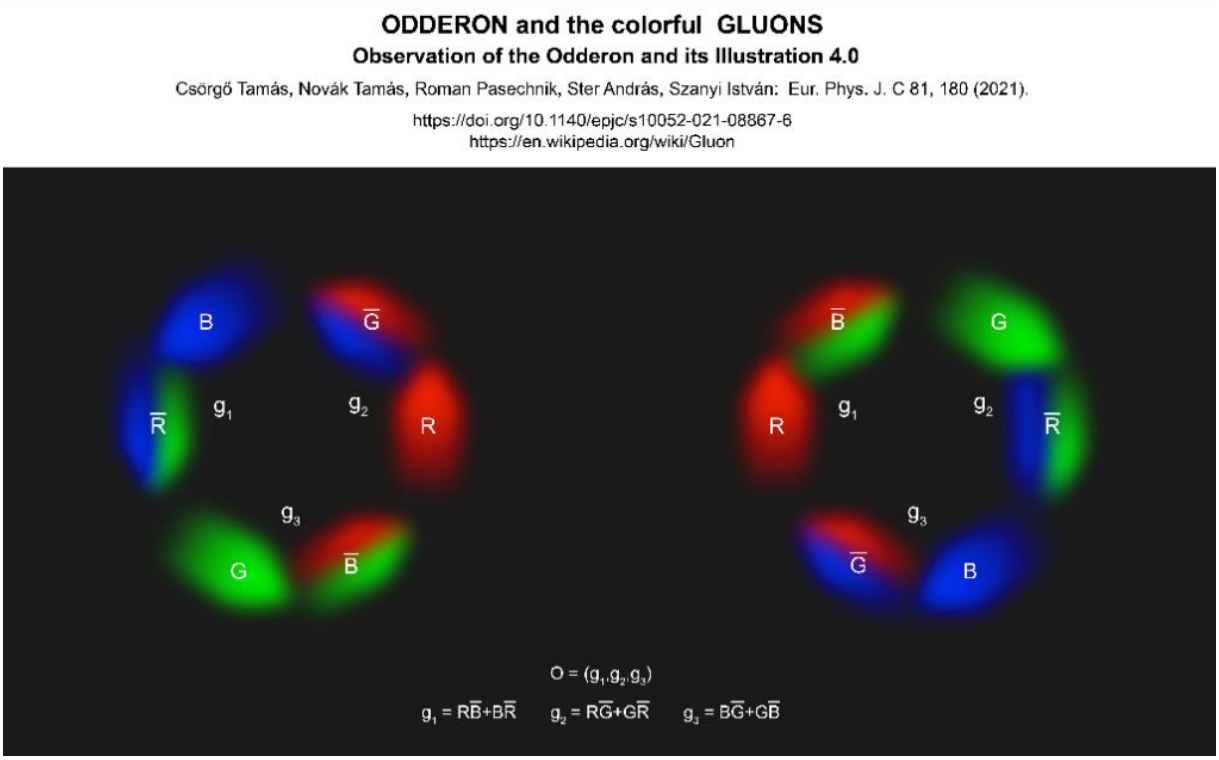
-Proving the small difference between matter and antimatter. Everything that helps us to know our world better is beneficial for our society.

István Szanyi:

-The discovery of the odderon is a very important result in physics. This is the first experimental evidence for the existence of composed colour-neutral particles composed of an odd number of colour-charged gluons. The odderon is not only one particle but a family of particles composed of three, five, seven and so on, that is an odd number of gluons. The discovery induced further research aiming at the exploration of the properties of the odderon. The odderon search is a part of basic physics research with the primary aim to more deeply and widely understand how Nature including the whole Universe works. Although the discovery of the odderon does not contribute to the development and improvement of technical devices used in everyday life, it provides very important new knowledge about the properties of one of the four fundamental interactions of nature, the strong interaction. This way our result is a step forward for all of humanity.

Roman Pasechnik:

-Not sure about the immediate benefits to society from the odderon discovery, but making significant advances in fundamental physics, in general, play an important role in expanding humans' comprehension of reality and pushing the frontiers of our understanding of the Universe we live to a new level. Being predicted by the QCD theory a long ago, the odderon discovery certainly signifies the correctness of our current theoretical knowledge and approaches we employ in the study of strong interactions.



Observation of the odderon and its illustration

-What were the difficulties and obstacles on the road to discovery?

Tamás Csörgő:

-To stay on the human level, even in the middle of the research and funding difficulties.

Tamás Novák:

-The essence of the research was comparing two data sets. However, the measuring techniques of the data were quite different, which made it very difficult for us to get them synchronised. For this, a good idea, as well as a comprehensive calculation were needed, which have to stand the tests of time and professional challenges.

András Ster:

-Finding the correct physical and mathematical methods for the study. Here, we several times ran in the wrong direction.

István Szanyi:

-The first difficulty in the research was to find and develop the methods which could be used to show the signal of the odderon. Before the announcement of the discovery in particle physics a rigorous statistical analysis must be carried out which is an activity demanding very special care. Every measurement has uncertainty. A precise statistical analysis requires that these uncertainties must be considered appropriately. The experimental data used in our research were measured by different experimental collaborations and/or the measurements were carried out at different data-taking periods and the uncertainties were not handled in the same way in all of the cases. Although in the end, we could overcome these difficulties, during the analysis it caused complications.

Roman Pasechnik:

-The biggest challenge was to develop novel comprehensive analysis techniques that enabled us to directly compare data to data without resorting to any model and to make all the numerical results and checks consistent. There were also certain political issues when it came to the priority of such an analysis, causing sometimes a strong repelling of our ideas and approaches by certain members of the experimental community. That has created some obstacles and it took some time to get around those.

-What is the next step in research after such a large-scale discovery?

Tamás Csörgő:

-Taking a little bit of rest.

Tamás Novák:

-Meanwhile, new measurement data is available already, which would also be worth analysing. It would be great to learn more about the features of the newly discovered particle. Also, new theories could be worked out and tested by using the data.

András Ster:

-Every discovery must be followed by further confirming and more detailed investigations**.**

István Szanyi:

-Of course, the research work has not come to an end. After our odderon discovery, our attention turns to the exploration of the properties of the odderon and its detailed role in elastic proton-proton and proton-antiproton scattering. The proton-proton and proton-antiproton scattering data where the odderon plays a non-negligible role are not fully understood in the framework of the present models. In the future, we want to develop a

model which can explain all the available experimental data not only qualitatively but also quantitatively.
Roman Pasechnik:
-There are many ideas and certain developments that already exist towards a better understanding of the data and physics behind our discovery. We should get together again and discuss our next steps and make a concrete plan for the coming months.
What was your contribution to the discovery of the odderon?

Tamás Csörgő:
-My main contribution was the idea that led to success, as well as the organisation and the quality control of the research was my contribution.

Tamás Novák:
-I mentioned the difficult calculations we needed for comparing the data. We were aware of having discovered something great. We knew we must not go wrong, therefore we kept checking ourselves all the time. One of my tasks was to perform these corroborating calculations
András Ster:
-Developing the investigation methods and carrying out the complicated calculations correctly.
István Szanyi:
-I mainly did the calculations for the model-dependent odderon discovery research. Later on, I also joined the model-independent analysis and I investigated the validity range of our model-independent method using theoretical modelling which provided important results concerning the applicability of our method to show the signal of the odderon.

Roman Pasechnik:
-I took part in all relevant discussions, contributed to the development of certain parts of the analysis at its early stages and understanding of the intermediate and final results. We tried several different approaches and then converged on the most robust one.
-What was the most exciting part of the discovery for you?
Tamás Csörgő:
-Two parts were most exciting: First, we obtained the final statistical significance, 6.26 sigma, and found that it is well above the discovery threshold, 5 sigmas. Second, the schedule of the publication, where the three main time-stamps were the date of submission, the date of acceptance and the date of publication. Our paper was the first in each of these three time-stamps. However, when the international press release was organized, our press release was on March 8, 2021, and it was followed by a press release at CERN on March 9, 2021. So only one day advantage remained out of the one year advantage that we had when our manuscript was submitted for publication. It was a great happiness to learn that we were able to be the first even with the international press release.

Tamás Novák:
-The publication of the results was very challenging as there was huge competition for that. Finally, we were the first to publish our results. We had to prove our right against journal editors, but in the end, there were no more counterarguments: our article was published.
András Ster:

-The most exciting moment was when we got the final results for the discovery.
István Szanyi:
-For me the whole research process was exciting. It was an uplifting feeling to become a part of real discovery research in particle physics. It was also really interesting to learn the steps of the rigorous statistical analysis which must be carried out to announce a discovery that is an observation of a signal with a statistical significance of at least five sigmas.
Roman Pasechnik:
-Being part of such a major discovery is a reward on its own. Working in an atmosphere full of new ideas within a team of active researchers is another exciting part of it. Also, making use of the experimental data to extract new knowledge in a statistically significant manner is very exciting by itself.

What was expected and unexpected during the research project?

Tamás Csörgő:
-I have expected many of the funding difficulties and a great amount of work. I did not expect that the discovery of the odderon would become a physics highlight of 2021 at CERN and I did not expect that CORDIS, the science portal of the European Commission, would consider our results as a new milestone in particle physics.
Tamás Novák:
-It was to be expected — because all indications were that — there would be an Odderon signal. However, it was unexpected how difficult it was to achieve this.

András Ster:
-It was evident from the beginning that we face a very complex task, which can be completed with well-harmonised teamwork, only. It was unexpected how difficult the job was, how many things we had to pay attention to.

István Szanyi:
-The qualitative investigation of proton-proton and proton-antiproton experimental data showed indication for an existing odderon contribution. When we started the quantitative, rigorous statistical analysis we did not know what we would get at the end, if the indication would be justified or not. Thus our final result, an odderon signal with a discovery level statistical significance was not completely unexpected but it was uncertain until the end of the analysis.

Roman Pasechnik:
There were lots of unexpected and difficult obstacles on our way, on both the methodological and on the technical sides of the analysis, as well as in relationship with our experimental colleagues and in getting our results published. It was also unexpected that we could reach such a high statistical significance of the odderon signature given rather high experimental uncertainties in certain cases, particularly, when it comes to the violation of the scaling property of elastic scattering.

More from Georgina Zsori