ODD DISCOVERY of the ODDERON

PRESS RELEASE

An Odd New Result of Hungarian and Swedish Researchers:
Discovery of a long awaited but totally surprising new particle, the Odderon

48 years after the first prediction, after a long lasting and intense international competition, four Hungarian physicists and their Swedish colleauge published, for the first time, decisive evidence for the existence of an elusive new particle, the so-called Odderon. This result implies the existence of several, other, new kind of strongly interacting particle states, too. The discovery of the Odderon has just been published in the respected European Physical Journal, EPJ C.

``*This result seems to be particularly important: as far as we know, this is a totally unexpected and surprizing discovery, based on recent measurements at the CERN LHC accelerator. Our result may open a new chapter in the study of strong interactions,"* – according to **Tamás Csörgő, a physicist, Member of the Academy of Europe** (London), who heads the Hungarian team from the Wigner Reserch Center for Physics, Budapest and the MATE Institute of Technology, Gyöngyös, Hungary.

``*The Odderon discovery marks an important milestone in our understanding of the deep mysteries of the strong interactions"* – added **Roman Pasechnik, senior lecturer, docent at the University of Lund, Lund, Sweden**, who acted as the corresponding author of the publication.

The observation of the Odderon

The possible existence of the Odderon was proposed in 1973 by L. Lukaszuk and B. Nicolescu, based on theoretical considerations. However, physicists had to wait 48 years, untill 2021, before finding experimental evidence for the existence of the Odderon. In a tight, global competition, a team consisting of four Hungarian and a Swedish researchers published evidence for the observation of the Odderon.This team has re-analyzed previously published experimental data by the TOTEM and the D0 Collaborations. They have utilized a new and innovative method, invented by the Hungarian team, to winnow down the wealth of these data to the Odderon signal.

The TOTEM experiment at the CERN LHC accelerator joined efforts with the D0 experiment at the Tevatron accelerator in the US and submitted for a publication a manuscript, co-authored by 463 scientists, that finds evidence for the Odderon signal based on new experimental data. This paper utilized manpower and financial resources that were well beyond the reach of the Hungarian and Swedish team. This manuscript is currently under anonymous peer-review in a prestigeous physics journal, but it has not yet been published.

``*The goal of fundamental research is not to make profit, but to reach a deeper level of understanding of the world that surrounds us, and to bring new relationships to light. These results close a scientific question that has been open for 48 years. They imply a small but significant difference in the interaction of matter and antimatter, within the otherwise well-known Standard Model of particle physics"*- explained **Tamás Novák, PhD, associate professor of the MATE Institute of Technology, Gyöngyös, Hungary.**

What is the Odderon and what is the significance of its discovery?

According to modern physics, all the interactions are mediated by exchanges of messanger particles. For example, the well known electromagnetism can be described by the exchanges of photons, quanta of light. ``*Due to Odderon exchange, a small difference appears between elastic proton-proton and elastic proton-antiproton collisions. For the first time, this difference has been quantified in a published paper precisely enough to match the strict scientific criteria needed for a discovery in particle physics,"* – said **András Ster, a physicist from the Wigner Research Centre for Physics, Budapest, Hungary** .

In elastic collisions, particles exchange energy and momenta without changing their identity. To illustrate this process, we may use the example of selling a car: Before the deal, Peter has the car, Paul has the money. After the deal, Peter has the money and Paul has the car. If the car is bought by Anti-Paul, who has to borrow the money, a small difference appears. After the deal, Peter will have the same amount of money as in the previous example and Anti-Paul will have the same car. The difference between these two kind of deals is the interest, that Anti-Paul has to pay for his credit. In this illustrative example, Peter and Paul represent the two colliding protons, Anti-Paul illustrates the anti-protons. The money and the car represent the exchanged energy and momenta, and the difference between the two kind of deals, the interest payed for the credit line of Anti-Paul corresponds to the Odderon-exchange. Without the Odderon-exchange the process of elastic proton-proton and elastic proton-antiproton collisions would be identical at the enormous TeV energy scales that

characterize these collisions at the LHC and the Tevatron accelerators. Thus the existence of the Odderon violates one of the symmetries of particle physics.

``*Out of light, one cannot make matter, bound states, little rings of light, as light is not self-interacting. However, the messenger particles of the strong interactions, the gluons are self-interacting and our result indicates that it is possible to make small, locally colored but overall white rings out of them. According to our results, not only an even but also an odd number of gluons may form such a ring. It is possible to discover it from Hungary, too, not only from Budapest, but even from the Hungarian countryside and from Ukraine. One needs at least three, odd number of gluons to do this*" – explained **I. Szanyi, PhD student at the Eötvös University, Budapest, Hungary, and young researcher at the Wigner Research Centre for Physics, Budapest, Hungary** who received his BSc from the Uzhgorod National University of Ukraine.

Last, but not least, **the collaborative partnership with the Tevatron experiment D0 and the CERN LHC experiment TOTEM has to be emphasized**. In this aspect, it is important to stress **that the main conclusion, the discovery of the Odderon is the same** in both scientific manuscripts. Indeed, it seems that a new chapter is being opened in the field of the strong interactions, due to the **nearly simultaneous discovery of the Odderon by several teams**.

We may hope, that the publication of the discovery of the Odderon brings not only a deeper level of understanding of a long lasting scientific problem, but also a little bit of satisfaction and happiness for the tax-payers and organizations that fund science all over the world.

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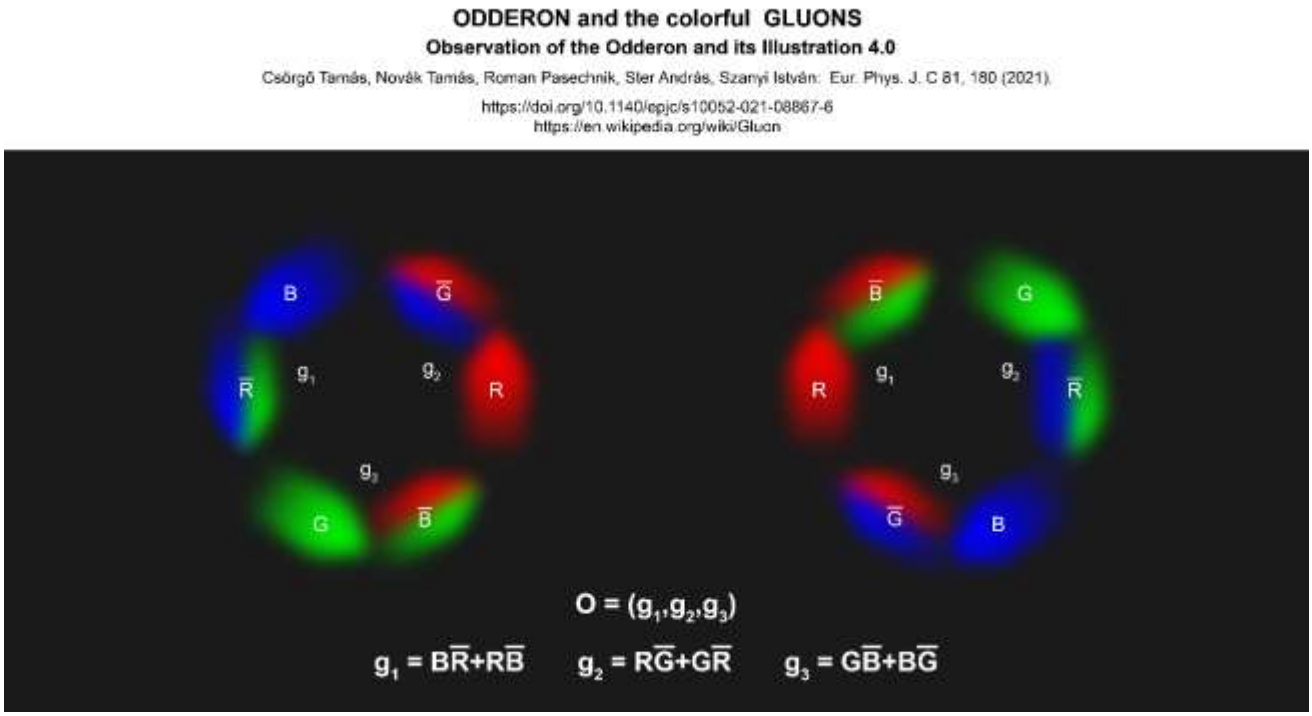

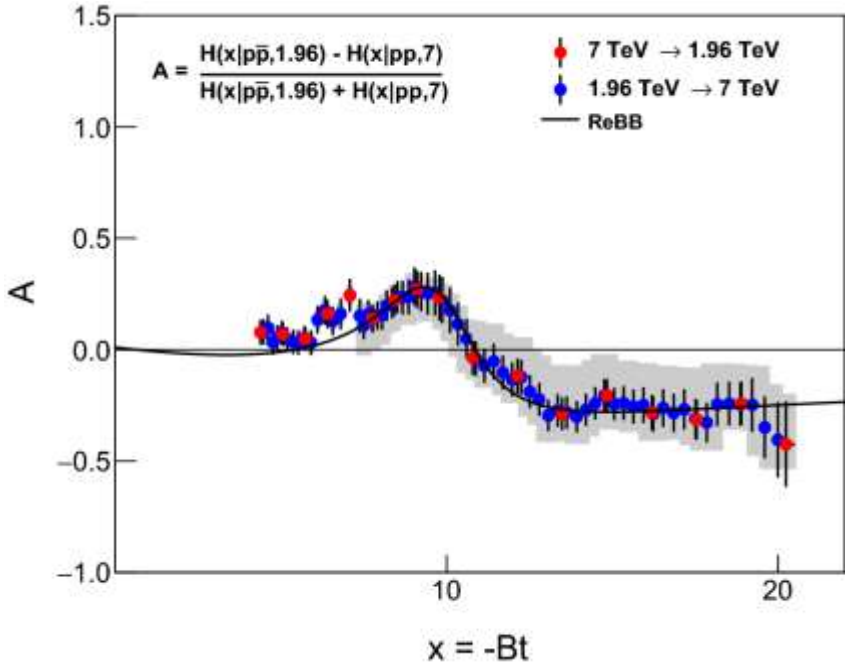

``*We may visualize the Odderon, as a locally colorful, overall white ring of at least three, odd number of gluons. The characteristic size of this ring is a femtometer, that is* 10^{-15} *m, corresponding to one part in thousand times million times million subdivisions of a meter. It is one of the reasons why the Odderon was so elusive and its observation so difficult"*– emphasized Tamás Csörgő, a physicist, Member of Academia Europaea.

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Acknowledgments:

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Video recorded presentation of the Odderon related results at the Zimányi Winter School on Relativistic Heavy Ion Collisions, Budapest, Hungary, December 7-11, 2020:

- **T. Csörgő***: Observation of a crossing-odd component in elastic pp and pbarp collisions at TeV energies:* **https://youtu.be/ilzL5vdcfnM?t=169s**
- **F. Nemes:** *Recent Results from TOTEM – Status of the joint D0-TOTEM analysis* **https://youtu.be/ilzL5vdcfnM?t=1915**
- **Ch. Royon:** *Soft and Hard Diffraction and Photon Exchange Processes at LHC* **https://youtu.be/I3GRX1zNDUc?t=34**
- **T. Novák***: Detailing the Odderon Effect:* https://youtu.be/ilzL5vdcfnM?t=4871
- **A. Ster***: Scaling properties of elastic pp and pbarp collisions, H(x) and A(x) comparisons:* **https://youtu.be/ilzL5vdcfnM?t=3167**
- **I. Szanyi***: Observation of the Odderon based on the Bialas-Bzdak model:* **https://youtu.be/Xlexq3AFdcQ?t=1472**

References to scientific publications:

[1] L. Lukaszuk and B. Nicolescu:
A Possible interpretation of pp rising total cross-sections
Lett. Nuovo Cim. **8** (1973) 405-413

[2] TOTEM Collaboration: G. Antchev, ... M. Csanád, T. Csörgő, T. Novák, F. Nemes, J. Sziklai ... (75 társszerző):
Elastic differential cross-section dσ/dt at sqrt(s)=2.76 { TeV} and implications on the existence of a colourless C-odd three-gluon compound state
Eur.Phys.J.C 80 (2020) 2, 91, e-Print: 1812.08610 [hep-ex]

[3] Csörgő, T., Novák, T., Pasechnik, R. Ster, A. and Szanyi, I:
Evidence of Odderon-exchange from scaling properties of elastic scattering at TeV energies.
Eur. Phys. J. C **81,** 180 (2021). https://doi.org/10.1140/epjc/s10052-021-08867-6
submitted for a publication: December 29, 2019
accepted for a publication: January 12, 2021
published on February 23, 2021

[4] Csörgő, T., Novák, T., Pasechnik, R. Ster, A and Szanyi, I:
Proton Holography -- Discovering Odderon from Scaling Properties of Elastic Scattering
Proc. ISMD 2019, Santa Fe, NM, USA, *EPJ Web Conf.* 235 (2020) 06002
e-Print: 2004.07095 [hep-ph] (conference proceedings)

[5] D0 and TOTEM Collaborations • V.M. Abazov (Dubna, JINR) et al. (463 szerző)
Comparison of pp and p\bar{p} differential elastic cross sections and observation of the exchange of a colorless C-odd gluonic compound
e-Print: 2012.03981 [hep-ex] (*manuscript submitted for a publication*)

[6] Csörgő, T., Novák, T., Pasechnik, R. Ster, A and Szanyi, I:
Scaling of high-energy elastic scattering and the observation of Odderon
e-Print: 2004.07318 [hep-ph] (*manuscript submitted for a publication*)

[7] Csörgő, T. and Szanyi, I:
Observation of Odderon Effects at LHC energies - A Real Extended Bialas-Bzdak Model Study
e-Print: 2005.14319 [hep-ph] (*manuscript submitted for a publication*)

[8] A. Ster, L. Jenkovszky and T. Csörgő:
Extracting the Odderon from pp and pbarp scattering data
Phys.Rev.D 91 (2015) 7, 074018, e-Print: 1501.03860 [hep-ph]

Earlier news in English on new possibilities for the observation of the Odderon:

2017: TOTEM experimental results and the first signs of the Odderon

The possibility of the observation of the Odderon was raised in the following publications of the CERN LHC experiment TOTEM. At the time of the 2017 press release from the Kansas University (US), these results were still preliminary, but by now the scientific papers are published results, that passed the anonymous peer review process. Both TOTEM papers were published in the prestigeous European Physics Journal C:

CERN-EP-2017-321:
TOTEM Collaboration: G. Antchev et al, 87 co-authors**:**
First measurement of elastic, inelastic and total cross-section at sqrt{s}=13 TeV by TOTEM and overview of cross-section data at LHC energies
Submitted for a publication: December 17, 2017
Published: *Eur.Phys.J.C* 79 (2019) 2, 103
e-Print: 1712.06153 [hep-ex]

CERN-EP-2017-335:
TOTEM Collaboration: G. Antchev et al, 95 co-authors
First determination of the ρ parameter at sqrt{s}=13 TeV: probing the existence of a colourless C-odd three-gluon compound state
Published for a publication: December 16, 2017
Published: *Eur.Phys.J.C* 79 (2019) 9, 785
e-Print: 1812.04732 [hep-ex]
DOI: 10.1140/epjc/s10052-019-7223-4
Report number: CERN-EP-2017-335-v3

Appended please find a collection of the Odderon-related news, based on the above two publications and the 2017 press release of the Kansas University.

The ***possibility*** of the discovery of the Odderon was also translated to several languages in 2017-18, among others to Finnish, Japanese, Russian and Turkish, but these news items are not included below. At present, in the beginning of 2021, we can finally speak about evidence and discovery of the Odderon. The list of earlier news records are added below, for the sake of completeness, as a background material.

- Brookhaven National Laboratory, US [workshop]
- CERN [CH] [article, published]
- dailyhunt.in
- earth.com
- earth-chronicles.com
- Gizmodo [Australia] [interview, published]
- Gizmodo [US] [interview, published]
- IFL science.com
- INFN [Italy] [article, published, press-released]
- Kansas University [US] [article, published]
- Newsweek.com
- P.Mechanics Vermont [US] [interview, published]
- Phys.org [UK] [article, published]
- SCI news
- Tomsk University [Russia] [english, published]

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