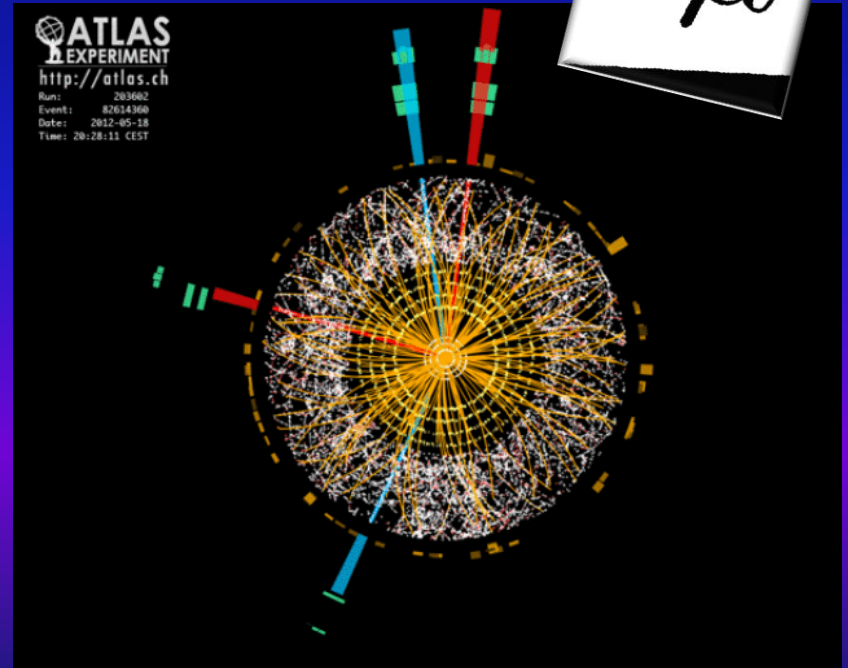
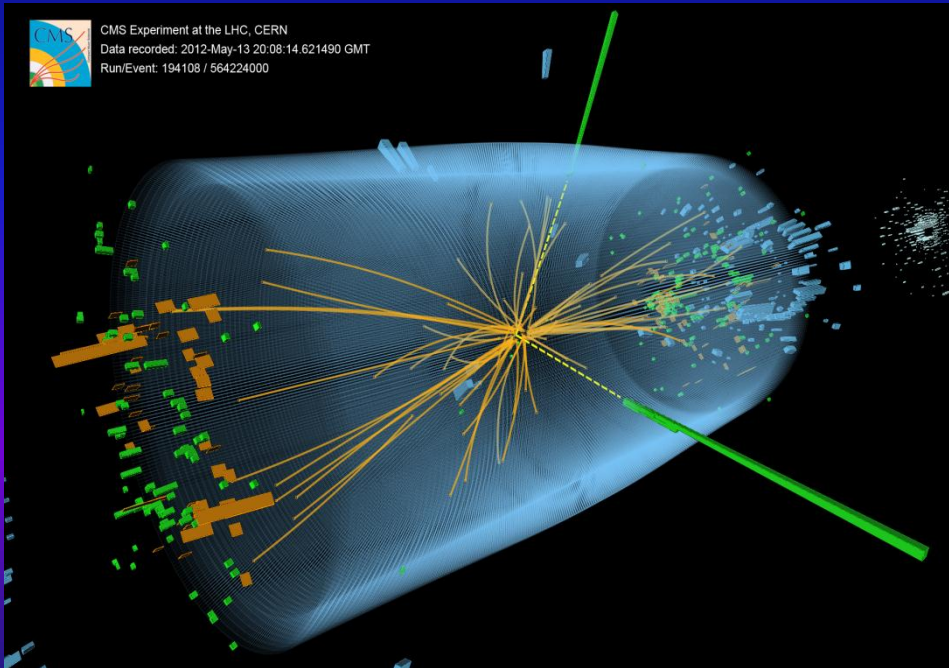
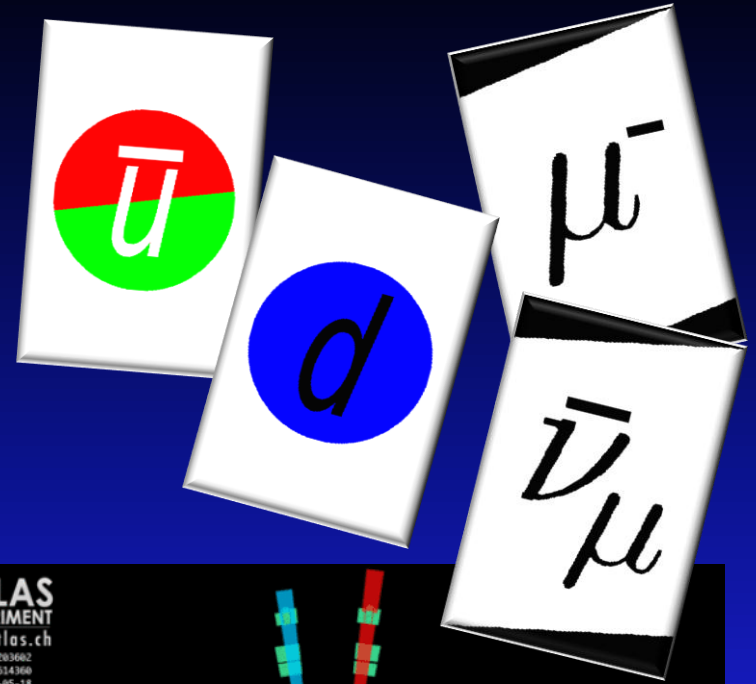


# HIGGS BOSON – ON YOUR OWN

T. Csörgő

Wigner RCP, Budapest, Hungary

csorgo.tamas @ wigner.mta.hu

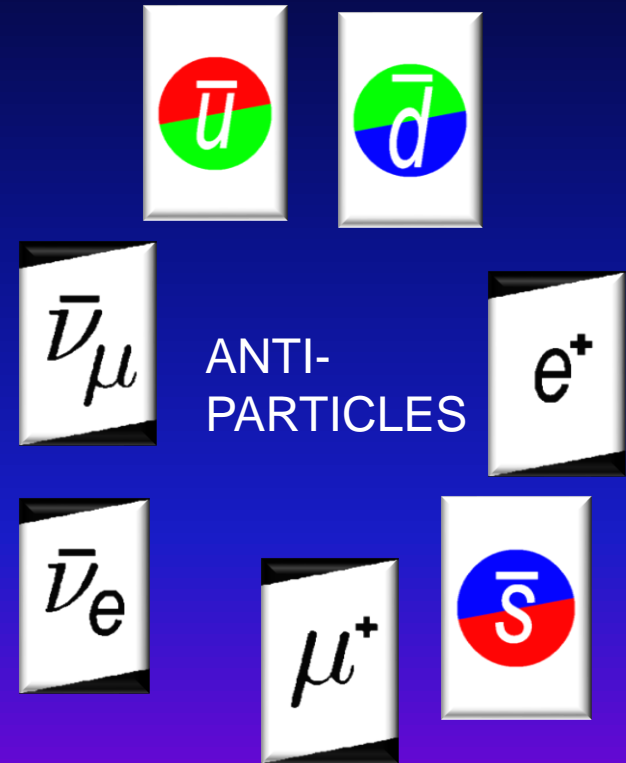


# ELEMENTARY PARTICLES - PLAYFULLY

**Fermions**

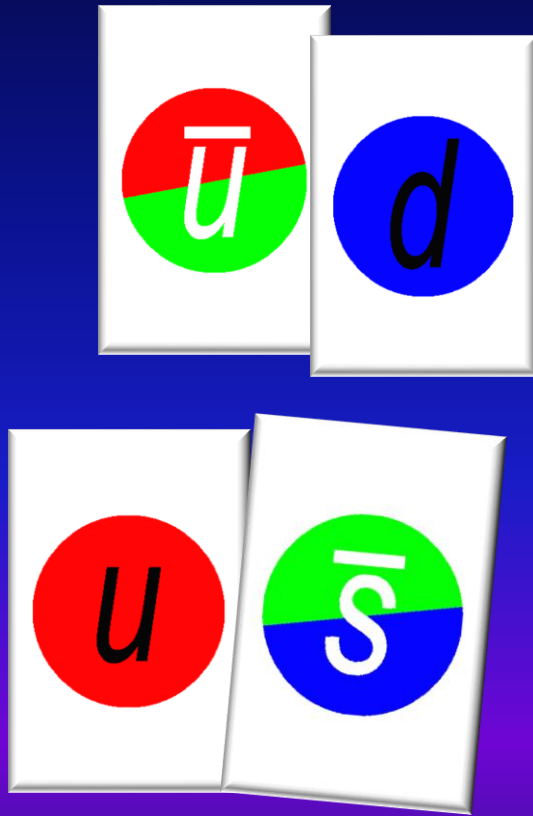
	 $u$ 1.27 GeV $\frac{2}{3}$ $\frac{1}{2}$	 $c$ charm 171.2 GeV $\frac{2}{3}$ $\frac{1}{2}$	 $t$ top 171.2 GeV $\frac{2}{3}$ $\frac{1}{2}$	 $\gamma$ photon 0 0 1
Quarks	 $d$	 $s$	 $b$ bottom 4.2 GeV $-\frac{1}{3}$ $\frac{1}{2}$	 $g$ gluon 0 0 1
	 $\nu_e$	 $\nu_\mu$	 $\nu_\tau$ tau neutrino $< 15.5$ MeV 0 $\frac{1}{2}$	 $Z^0$ weak force 91.2 GeV 0 1
Leptons	 $e^-$	 $\mu^-$	 $\tau$ tau 1.777 GeV $-1$ $\frac{1}{2}$	 $W^\pm$ weak force 80.4 GeV $\pm 1$ 1

Bosons (Forces)

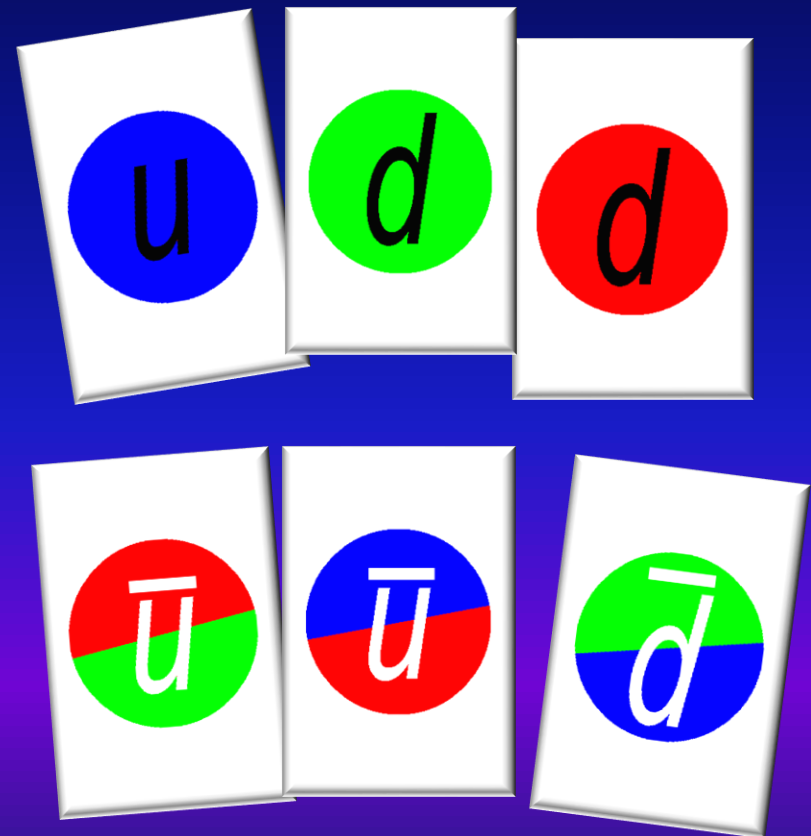


# SU(3) COLOR vs OPTICAL COLOR

Mesons



Baryons



# CARD GAME WITH PARTICLES

**66 cards, 4 games:**

- ANTI
- Let us detect!
- Quark Matter
- Cosmic Showers

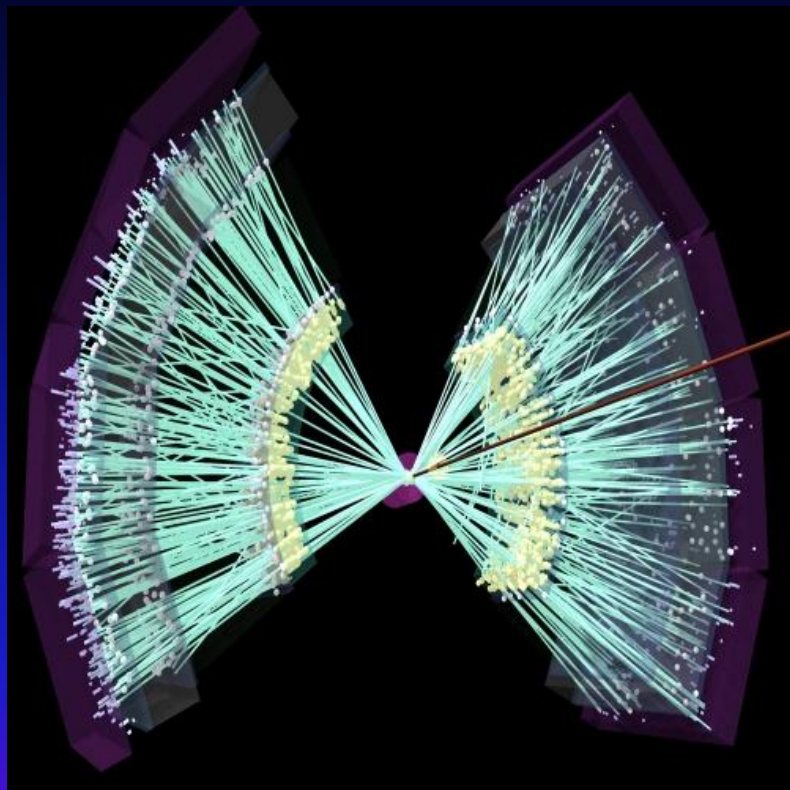
**Published as an e-book**

**„Meet the Scientist“**

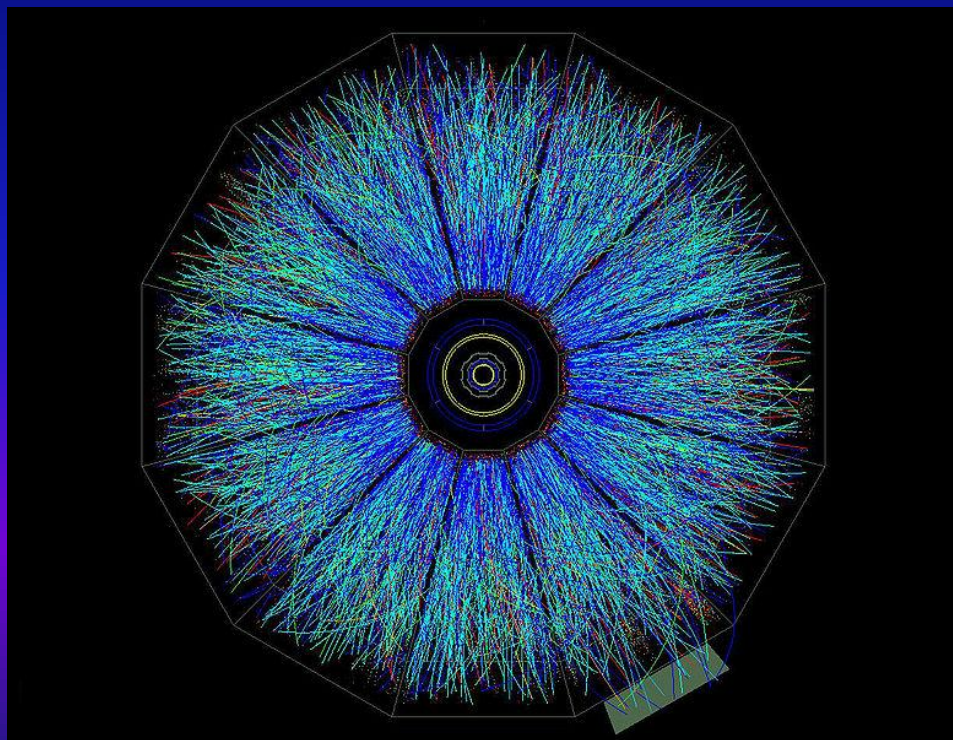
<http://www.lulu.com/>



# QUARK MATTER - EXPERIMENTALLY

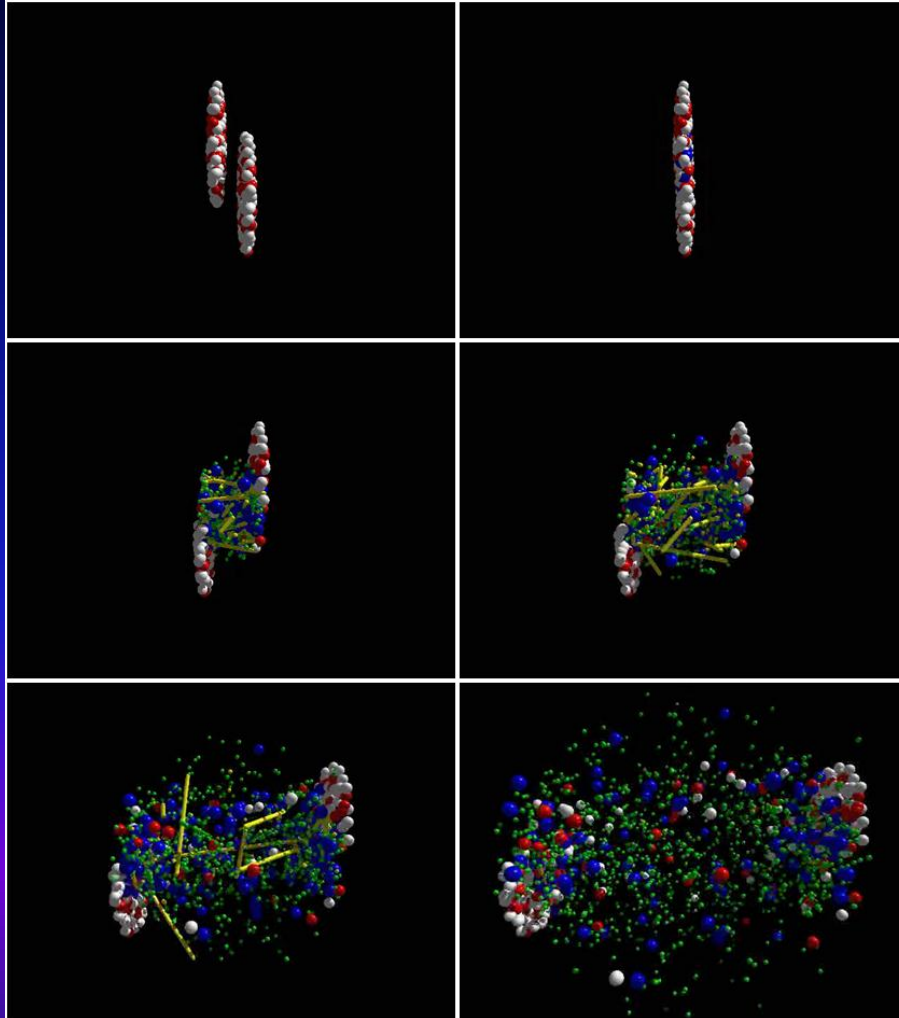


sQGP, the perfect fluid of quarks was discovered in the US in PHENIX and STAR, at the Relativistic Heavy Ion Collider (RHIC) at Brookhaven National Laboratory (BNL)



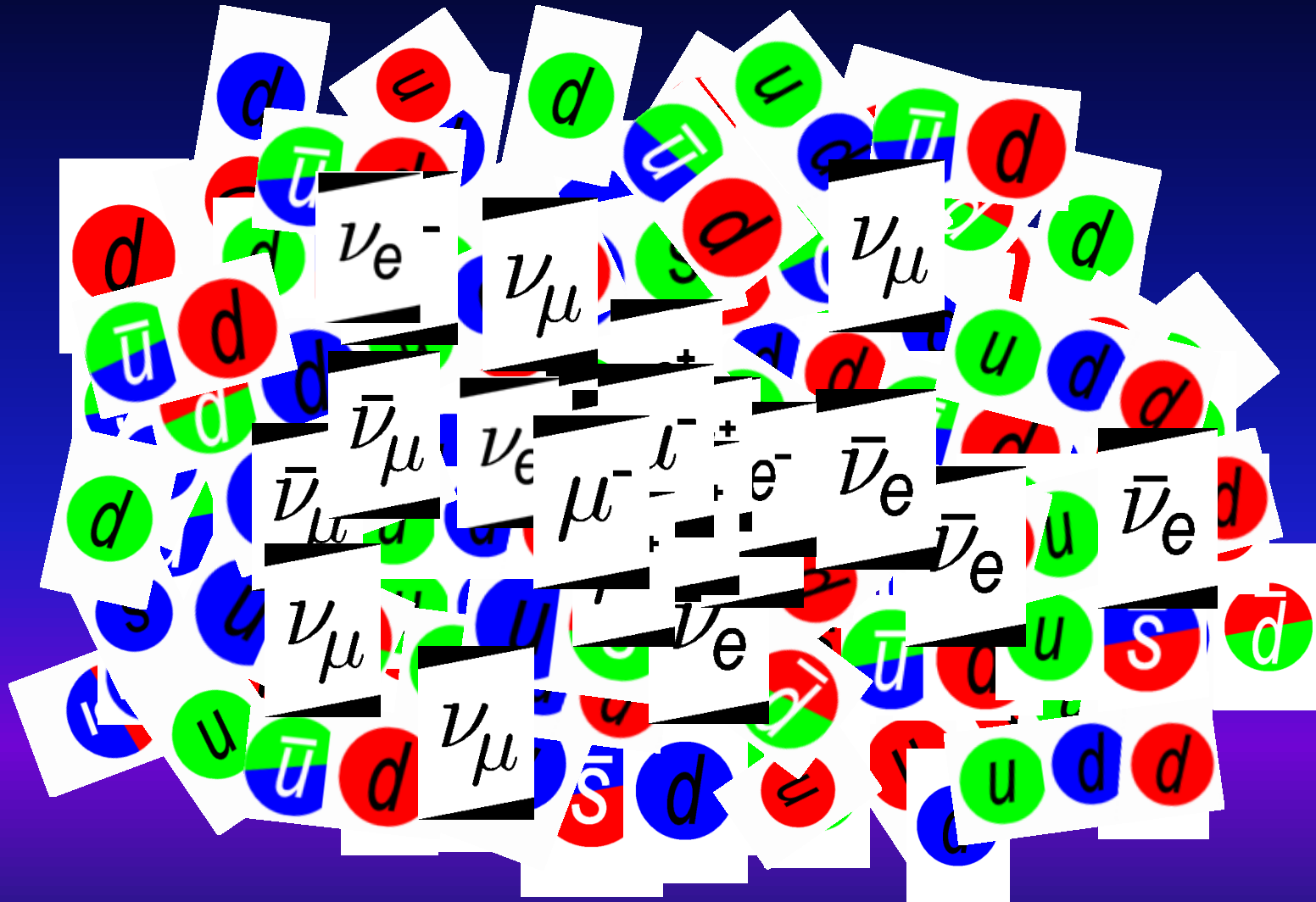
The RHIC discovery of sQGP has been confirmed by the ALICE, ALTAS and CMS experiments at CERN LHC.

# QUARK MATTER - THEORETICALLY



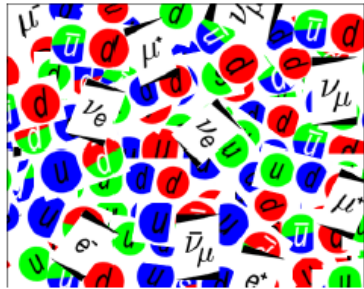
Simulation of Au+Au collisions at RHIC. In energetic collisions of Au ions a strongly interacting quark-gluon plasma is created, with surprising properties: the perfect fluid of quarks was discovered in the US at the Relativistic Heavy Ion Collider (RHIC) at Brookhaven National Laboratory (BNL) and confirmed in the ALICE, ATLAS and CMS experiments at LHC (CERN, Geneva, Switzerland).

# QUARK MATTER - PLAYFULLY



# RÉSZECSKÉS KÁRTYAJÁTÉK

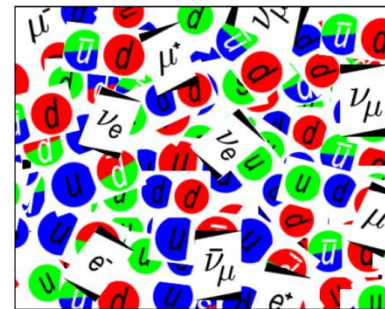
ELEMI RÉSZECSKÉK JÁTÉKOSAN



Csörgő Judit  
Török Csaba  
Csörgő Tamás

# QUARK MATTER CARD GAME

ELEMENTARY PARTICLES ON YOUR OWN



Judit Csörgő  
Csaba Török  
Tamás Csörgő



# International coverage, some examples

## SUBATOMIC SHUFFLE

Prefer particle physics to poker? Pick up a deck of the Quark Matter Card both. Instead of kings and queens, the cards feature quarks (up, down, and trons, and their neutrinos; and antiparticles for all.

Hungarian high school students Csaba Török and Judit Csörgő invited their father, Tamás, a physicist at the KFKI Research Institute for Particle Physics and Astrophysics in Budapest. The simplest game is "Anti," in which players quickly identify combinations, bearing in mind a quantum-mechanical property called color of the card. It's an abstract concept, but "even children who cannot read," Tamás says. For adult players, he recommends "Quark Matter," which is piled to represent the quark-gluon plasmas physicists cook up at Brookhaven National Laboratory.



Relativistic Heavy Ion Collider (RHIC), and PHENIX experiments.

cards are available for purchase.

he and his daughter are known for their work on the subject.

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"It's a re around v in your p

2011.01.04.

Quark Matter at RHIC: It's in the Cards

**@brookhavenToday**  
Story Archives

## Quark Matter at RHIC: It's in the Cards

### Students and RHIC physicist develop quark-gluon plasma card game

By Karen McNulty Walsh | January 4, 2011

Happy New Year! Like the sprays of confetti and streamers exploding in Times Square at midnight on December 31, millions of subatomic particles will soon be streaming from heavy ion collisions at RHIC, Brookhaven Lab's Relativistic Heavy Ion Collider.

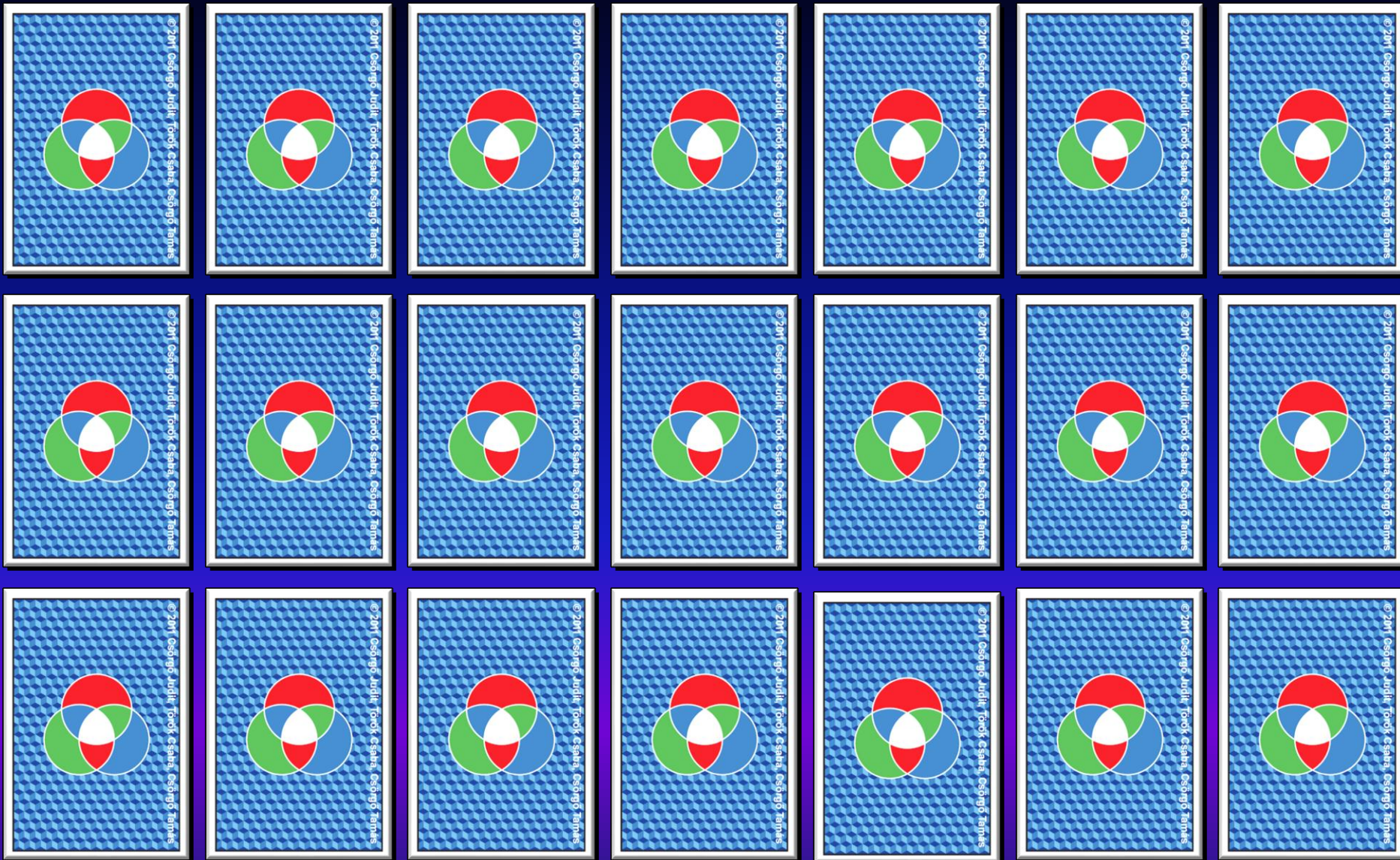
Linking subatomic particles with New Year's Eve celebrations may not be so strange: Two years ago, a group of Hungarian secondary school students rang in the New Year while playing with particles, literally. The group, which included Judit Csörgő, daughter of RHIC/PHENIX collaborator Tamás Csörgő, and her friend Csaba Török, were at a New Year's celebration, playing with the first edition of a set of cards invented by Csaba as an entertaining way to learn about subatomic particles and their interactions. The game, more formally developed and tested by the students with mentoring help from Tamás, won an honorable mention in a 2010 Hungarian competition for junior innovators. It is now available for purchase as an e-book, with cards included, on Lulu, currently with Hungarian directions. An English version is in the works.



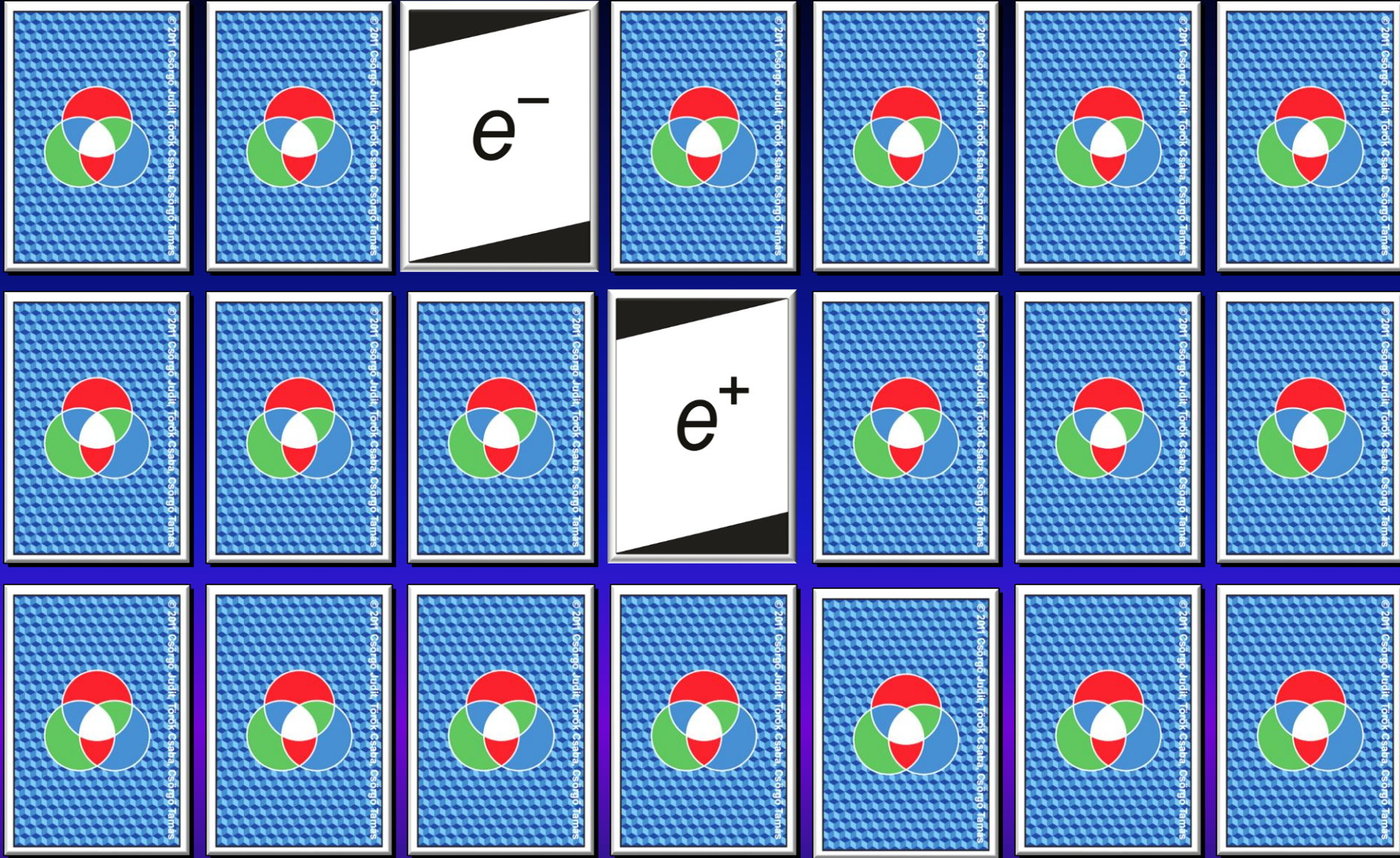
RHIC/PHENIX collaborator Tamás Csörgő, Csaba Török and Judit Csörgő with their card game at the exhibition in the "Palace of Wonders" after the ceremony of the 19th Hungarian National Contest for Junior Innovators and Scientist (Budapest, Hungary, June 10, 2010).

ncemag.org **SCIENCE** VOL 331 14 JANUARY 2011  
Published by AAAS

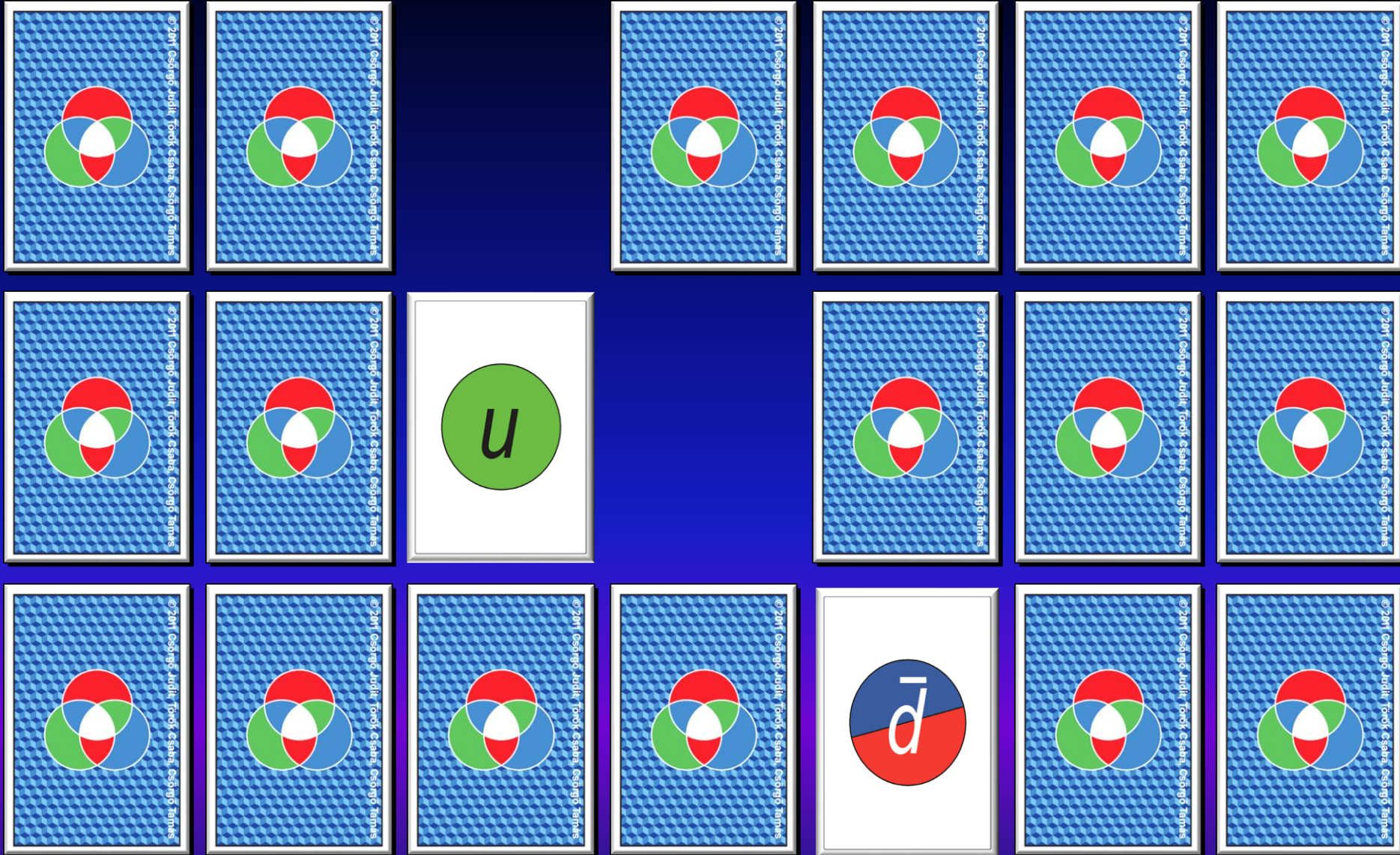
# Quark Matter Card Game – Memory style



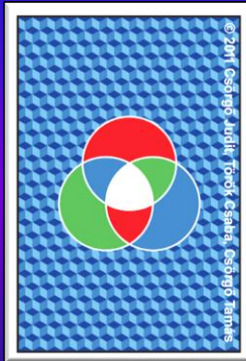
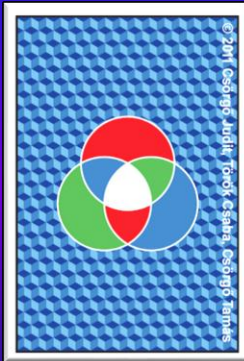
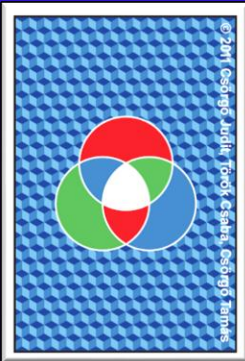
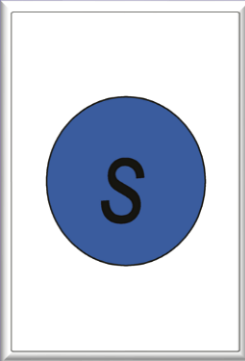
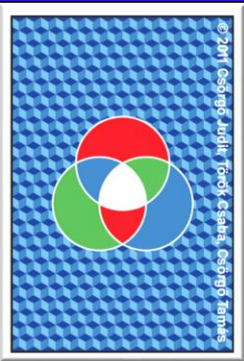
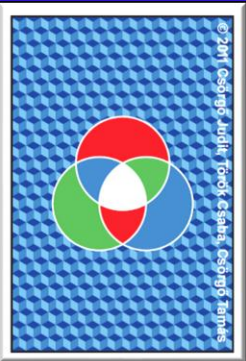
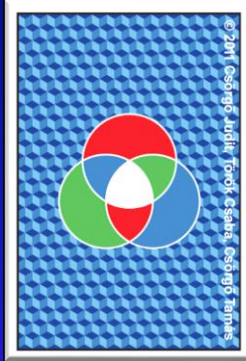
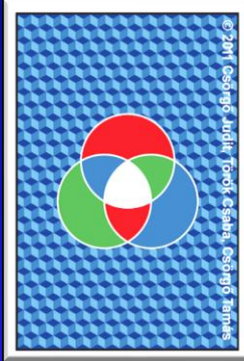
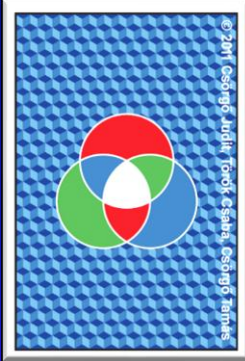
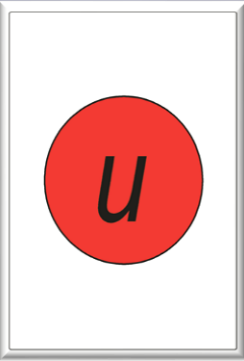
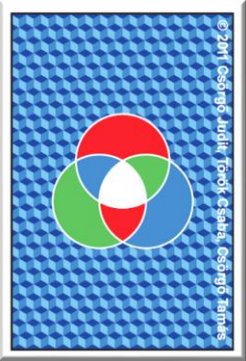
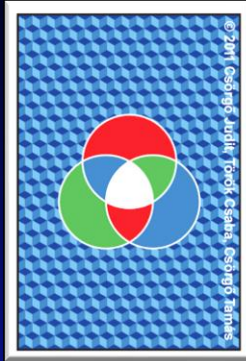
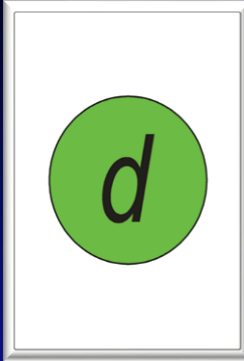
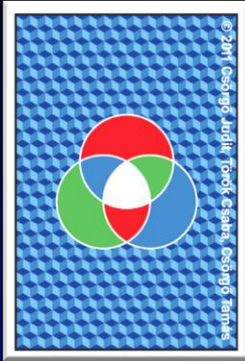
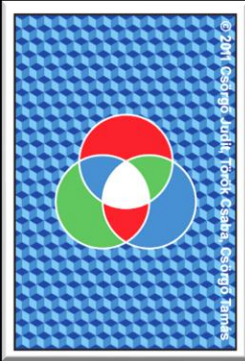
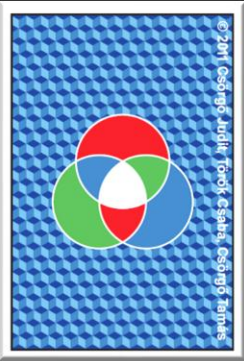
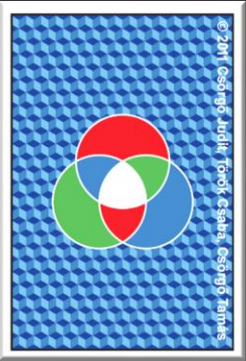
# Quark Matter Memory – valid lepton-pair



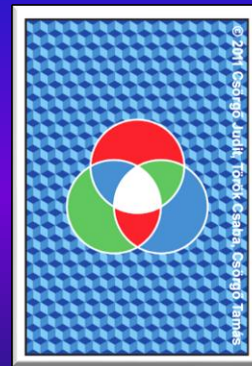
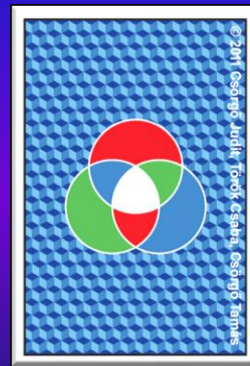
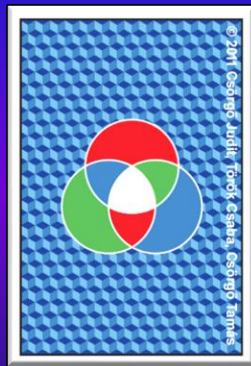
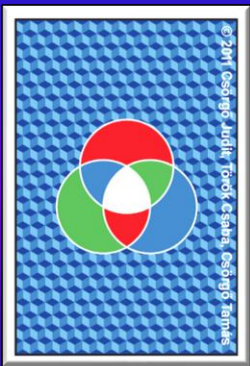
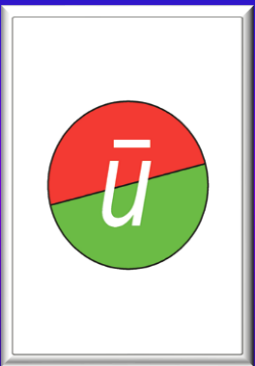
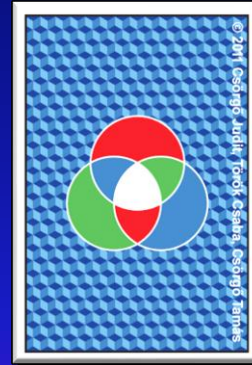
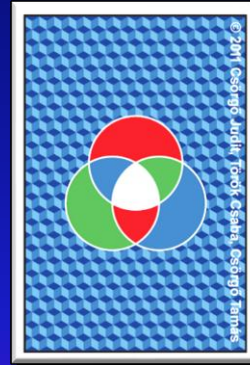
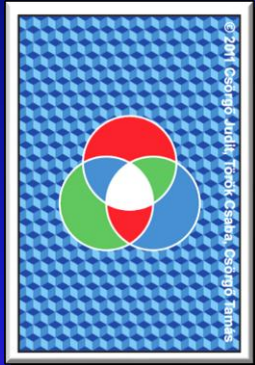
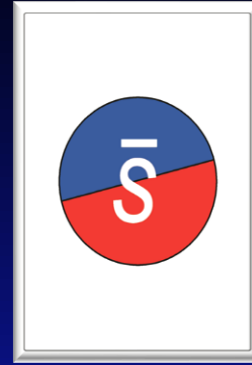
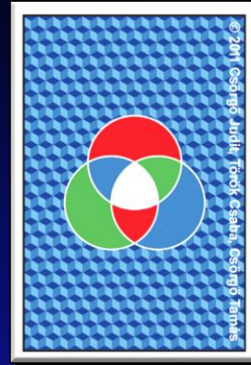
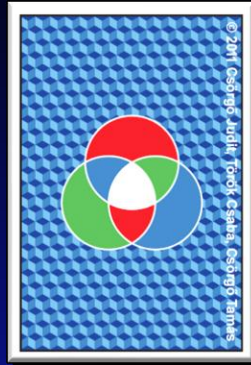
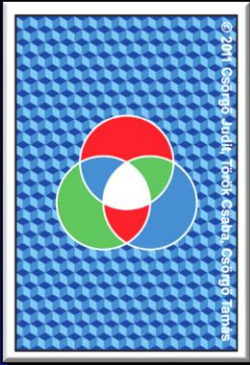
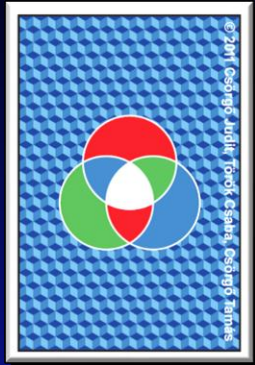
# Quark Matter Memory – valid meson



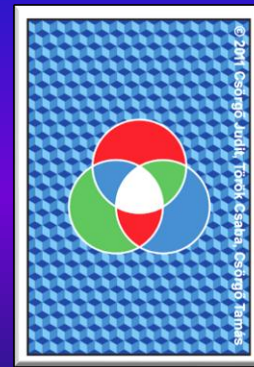
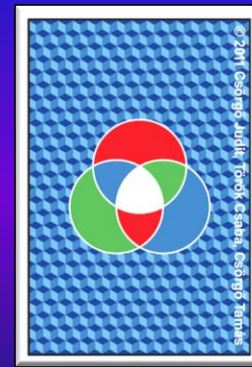
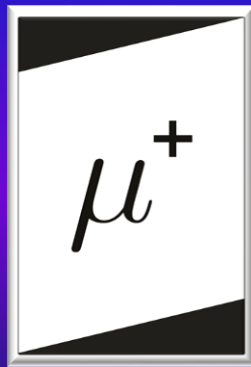
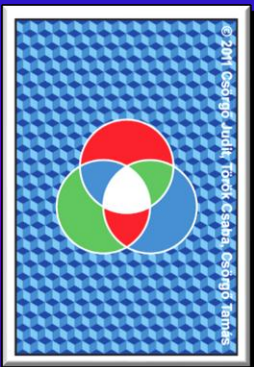
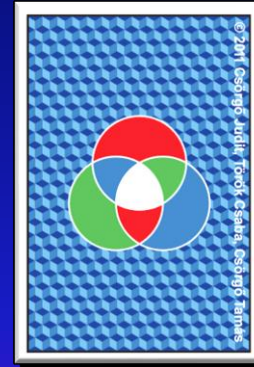
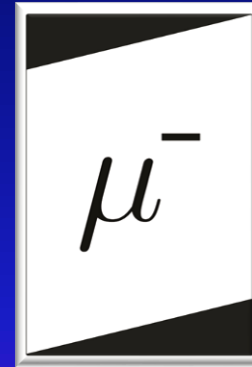
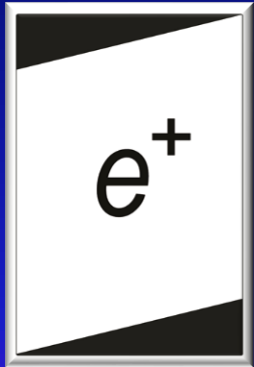
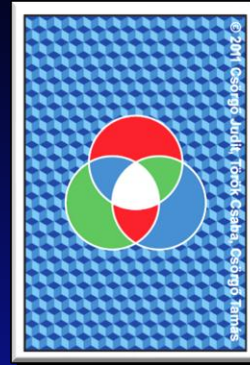
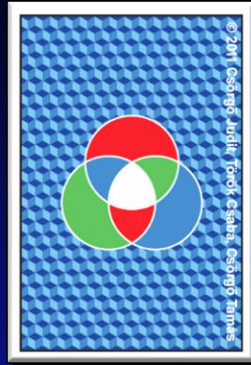
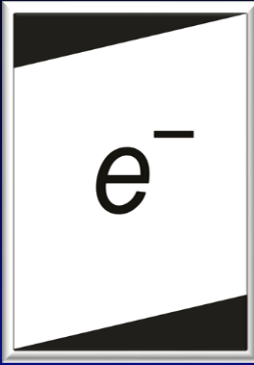
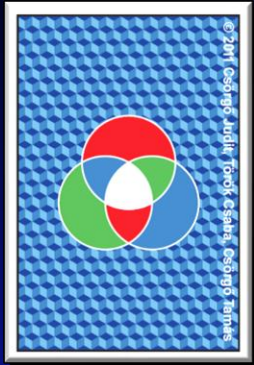
# Quark Matter Memory – a baryon



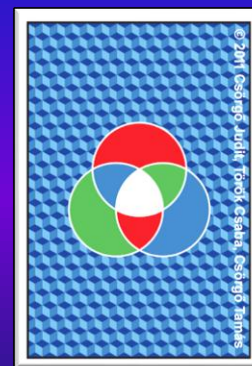
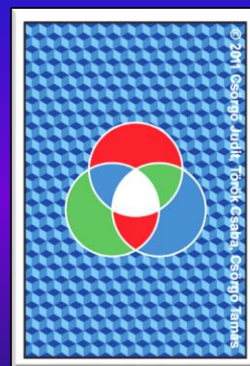
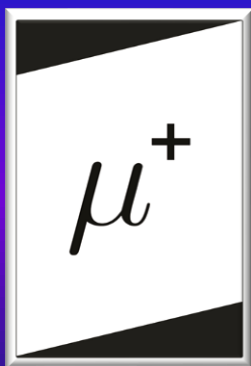
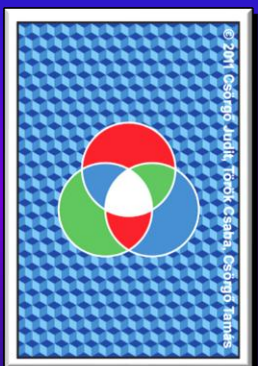
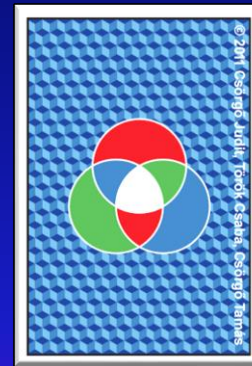
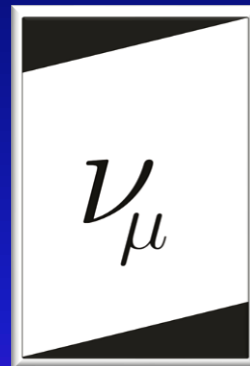
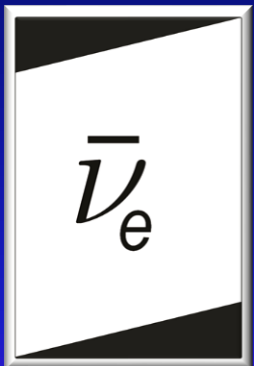
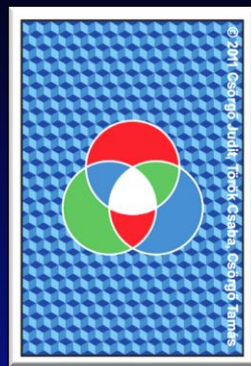
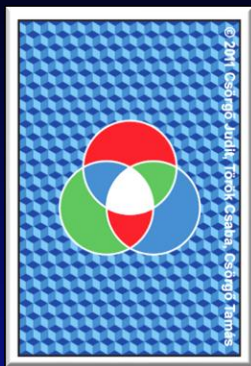
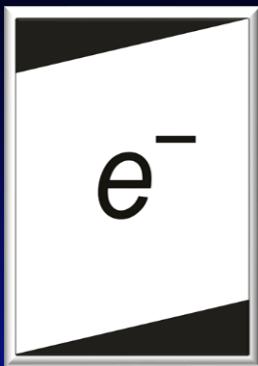
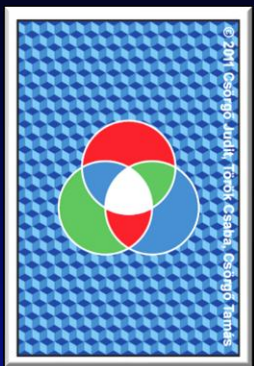
# Quark Matter Memory – an antibaryon



# Higgs-boson search: $H^0 \rightarrow Z^0 Z^0 \rightarrow \ell^+ \ell^- \ell^+ \ell^-$



# Higgs-boson search: $H^0 \rightarrow W^+W^- \rightarrow \ell^+\nu \ell \nu$





# SUMMARY

Meet the Scientist – opening talk

E-book published in Hungarian

Soon an English version:

2nd Hungarian edition

Quark Matter Card Game

Added:

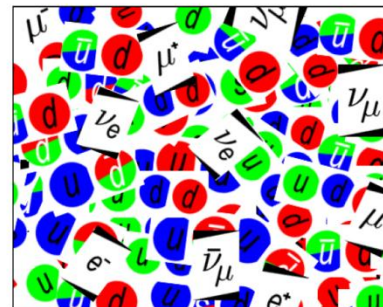
**Memory of Quark Matter**

**Higgs-boson – on your own**

**Thank you for your attention!**

## QUARK MATTER CARD GAME

ELEMENTARY PARTICLES ON YOUR OWN



Judit Csörgő  
Csaba Török  
Tamás Csörgő