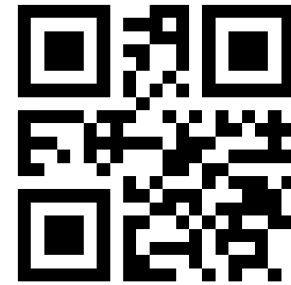


Cosmic-Ray Extremely Distributed Observatory*: novel astrophysical potential and beyond



Piotr Homola[□]

[□]) Institute of Nuclear Physics PAN

^{*}) <http://credo.science>

CGW Workshop'18, Kraków, 24.10.2018

take home physics:
 $N_{\text{ATM}} \geq 1!$

CREDO: simple is (also) beautiful/funny/inspiring!



credo.science → YouTube / CREDO animation:
<https://www.youtube.com/watch?v=6rHnW--PZQk>

Orders of Magnitude



Spacetime Foam

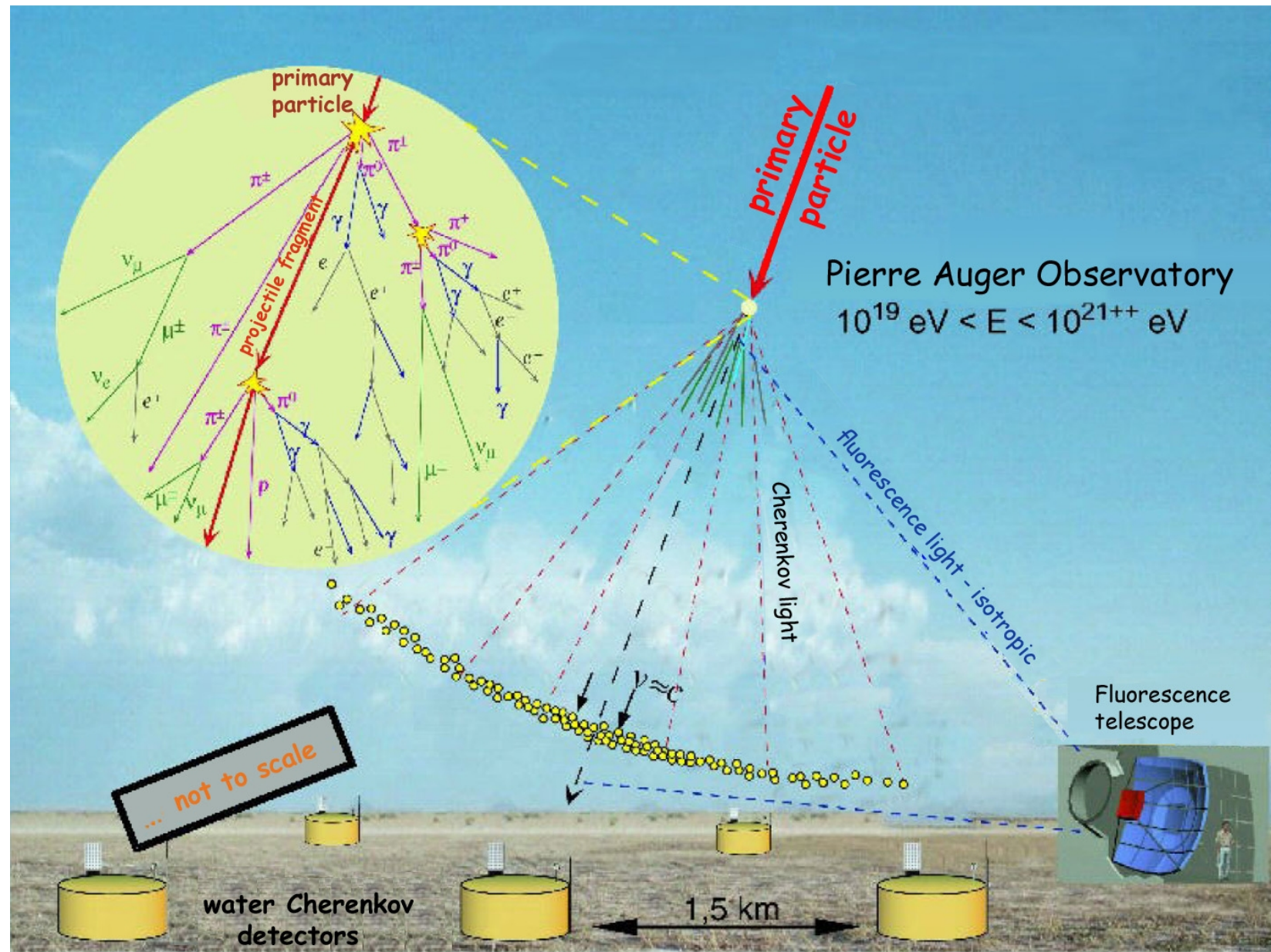
Cosmology,
Dark Matter, ...



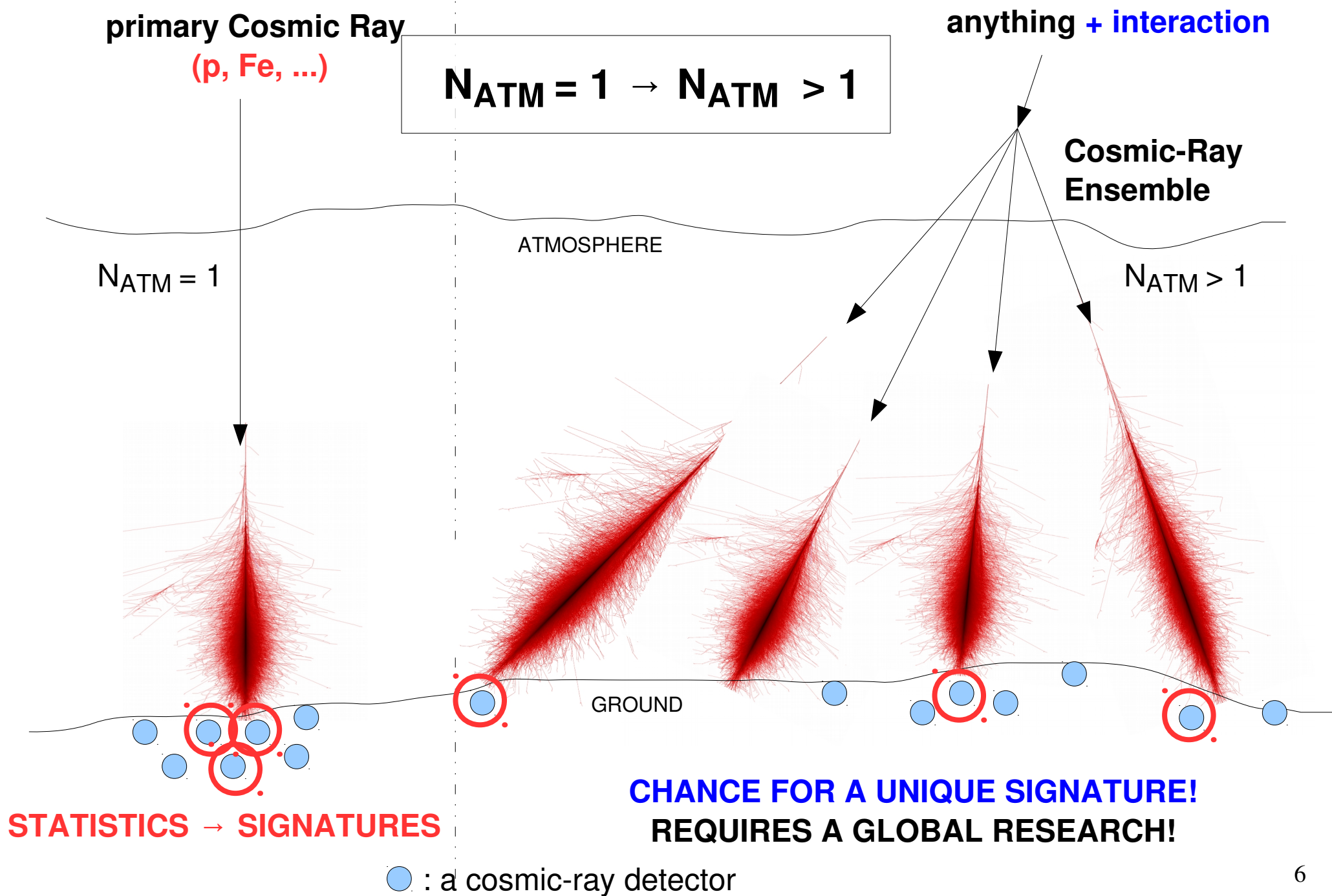
Orders of Magnitude



State-of-the-art detection of cosmic rays: $N_{\text{ATM}} = 1$



Generalized detection of cosmic rays: $N_{\text{ATM}} \geq 1$



$N_{\text{ATM}} > 1$: new subfield of astroparticle physics!

Please **help to name** the object of investigation:

Cosmic Ray Ensembles (CRE)"?

„Cosmic-Ray Cascades (CRC)"?

„Extraatmospheric Showers (ES)"?

„Super-Pre-Showers (SPS)"?

$N_{\text{ATM}} > 1$ motivated by data!

VOLUME 50, NUMBER 26

PHYSICAL REVIEW LETTERS

27 JUNE 1983

Possible Observation of a Burst of Cosmic-Ray Events in the Form of Extensive Air Showers

Gary R. Smith, M. Ogmen, E. Buller, and S. Standil

Physics Department, University of Manitoba, Winnipeg, Manitoba R3T 2N2, Canada

(Received 7 April 1983)

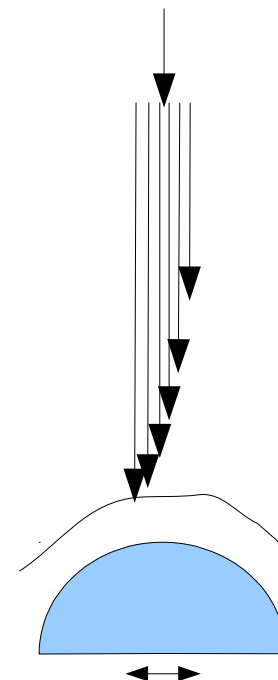
A series or burst of 32 extensive air showers of estimated mean energy 3×10^{15} eV was observed within a 5-min time interval beginning at 9:55 A.M. (CST) on 20 January 1981 in Winnipeg, Canada. This observation was the only one of its kind during an experiment which recorded 150 000 such showers in a period of 18 months between October 1980 and April 1982.

PACS numbers: 94.40.Pa, 94.40.Re, 95.30.-k

Forgotten (!) treasure (?) no. 1

PH: Correlated cosmic rays?

$N_{\text{ATM}} > 1$?



Year = 1981

$N_{\text{obs}} = 32$

$N_{\text{exp}} = 1$

$E = 3 \times 10^{15}$ eV

$\Delta t \sim 5$ min.

$\Delta x \geq \text{small}$

Quantum Gravity with gamma astronomy

The screenshot shows the UC Davis website with a news article titled "Gamma Ray Delay May Be Sign of 'New Physics'". The article discusses the MAGIC telescope's findings on gamma radiation from a distant galaxy, suggesting a 4-minute delay that contradicts Einstein's theory of relativity. It also mentions the possibility of quantum foam. To the right, there is a Facebook post from UC Davis with 117,141 likes, featuring a "WELCOME" banner for the Class of 2022 and a photo of a large radio telescope.

UC DAVIS

Quick Links

ABOUT US ADMISSIONS ACADEMICS RESEARCH CAMPUS LIFE NEWS

Gamma Ray Delay May Be Sign of 'New Physics'

Delayed gamma rays from deep space may provide the first evidence for physics beyond current theories.

The MAGIC (Major Atmospheric Gamma-ray Imaging Cherenkov) telescope found that high-energy photons of gamma radiation from a distant galaxy arrived at Earth four minutes after lower-energy photons, although they were apparently emitted at the same time. If correct, that would contradict Einstein's theory of relativity, which says that all photons (particles of light) must move at the speed of light.

"Everybody's very excited," about this result, said Daniel Ferenc, a physics professor at UC Davis and a member of the MAGIC collaboration. Ferenc cautioned that the results need to be repeated with other gamma-ray sources and that a simpler explanation had not been ruled out. But, "it shows that such measurements are possible," he said.

The researchers propose that the delay could be caused by photons interacting with "quantum foam," a type of structure of space itself. Quantum foam is predicted by quantum gravity theory, an attempt to unite quantum physics and relativity at cosmic scales.

UC Davis 117,141 likes

WELCOME

Like Page Learn More

Be the first of your friends to like this

UC Davis

- 4 min. delay could be the signature of a special space structure: Quantum foam
- predicted by Quantum Gravity

Quantum Gravity Previewer with a smartphone!

On-line experiment: broadcasting live at api.credo.science

Once upon a time, and more precisely on 11/12.03.2018, at user's 106 house...

677087	2018-03-12 13:38:40	SM-G531F
677086	2018-03-12 11:44:42	SM-G531F
677085	2018-03-12 11:43:36	SM-G531F
677084	2018-03-12 11:27:53	SM-G531F
677083	2018-03-12 10:22:27	SM-G531F
677082	2018-03-12 10:16:35	SM-G531F
677081	2018-03-12 05:05:25	SM-G531F
677080	2018-03-12 04:47:41	SM-G531F
677079	2018-03-12 04:00:31	SM-G531F
677078	2018-03-12 03:10:55	SM-G531F
677077	2018-03-11 22:26:31	SM-G531F
677076	2018-03-11 22:22:45	SM-G531F
677075	2018-03-11 19:27:21	SM-G531F
677074	2018-03-11 17:55:47	SM-G531F
677073	2018-03-11 17:52:20	SM-G531F
677072	2018-03-11 17:51:58	SM-G531F
677071	2018-03-11 17:14:45	SM-G531F
677070	2018-03-11 17:10:52	SM-G531F

2018-03-12, 11:44:42

2018-03-12, 11:43:36

1 min 6 s

U106 average rate: 1/100 min

Expected 5min triplet rate: ~ 1/100 days

Observed 5min triplet rate: ~ 1/20 days

triplet rate exceeded 5 times?

More statistics → better significance

Correlations with space weather, geomagnetic changes?

2018-03-11, 22:26:31

2018-03-11, 22:22:45

3 min 46 s

2018-03-11, 17:55:47

2018-03-11, 17:55:20

2018-03-11, 17:51:58

3 min 49 s (a triplet!)

2018-03-11, 17:14:45

2018-03-11, 17:10:52

3 min 53 s

DID YOU KNOW THAT YOU HAVE AN INTERGALACTIC PARTICLE DETECTOR RIGHT IN YOUR POCKET?

Install CREDO Detector app for Android
and hunt for the deeply hidden
treasures of the Universe.

Find CREDO Detector on



or scan QR



CREDO: simple is (also) beautiful/funny/inspiring!



credo.science → YouTube / CREDO Detector tutorial:
<https://www.youtube.com/watch?v=8y07CuTQfOc>

The CREDO Detector App, status 4th October 2018

Some statistics

- 390k+ visible detections (1.4m+ overall)
- 745k+ device pings (sums up to 48 years looking for particles)
- 2k+ users with at least 1 detection
- 4k+ devices
- 1k+ user teams
- 10s of GBs used for storage of data, metrics and backups

Credit: M. Magryś, ACK Cyfronet AGH

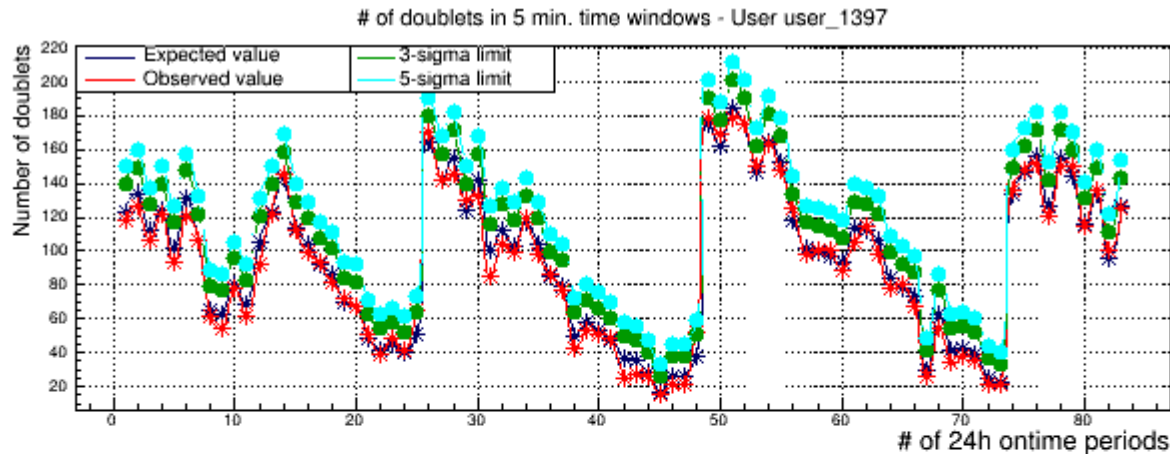
→ First Light in **Quantum Gravity Previewer**,
the first experiment on the CREDO infrastructure!

→ <https://credo.science/quantum-gravity-preview/>

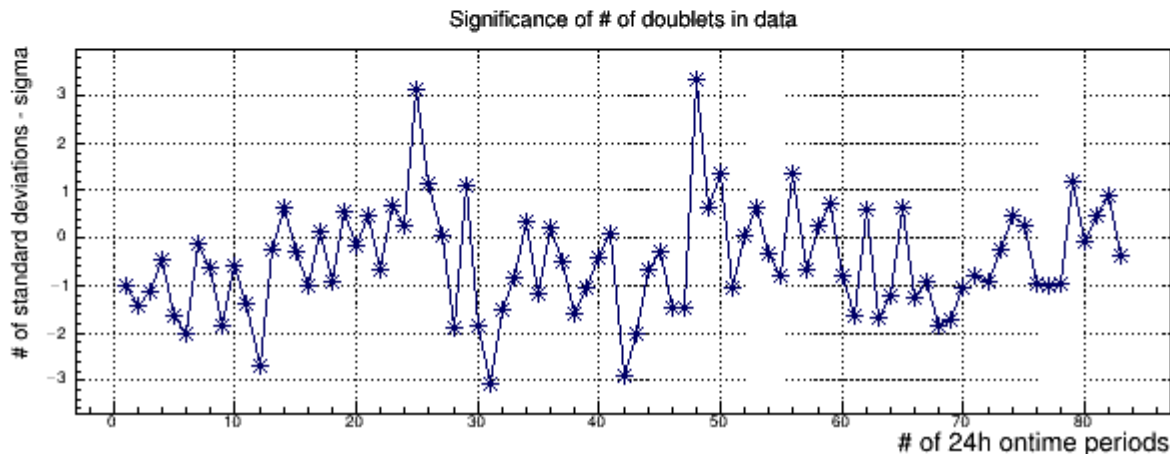
Quantum Gravity Previewer: **online experiment!**

Cumulative number of hit pairs („doublets”) within 5 min, in a single device, ~80 days

by Kevin Almeida Cheminant, for the CREDO Collaboration



expected from random
observed



→ **3σ**
(significance)

The first experiment on CREDO infrastructure!
Running since 17.05.2018! First Light 4.10.2018!

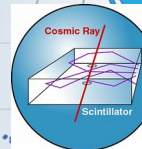
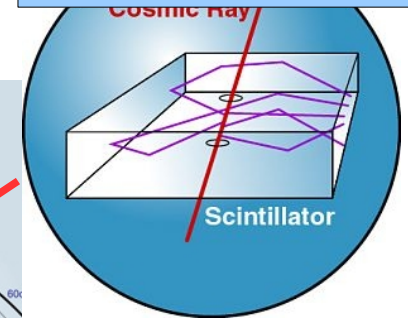
CREDO: the first $N_{\text{ATM}} \geq 1$ observatory

Cosmic-Ray Extremely Distributed Observatory

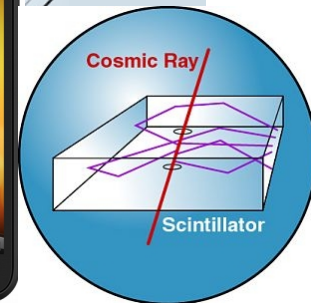


OPEN

Status March 2016:
„an idea”

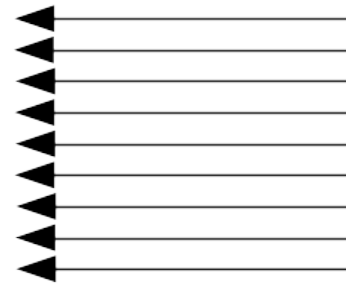


DATABASE/
INTERFACE

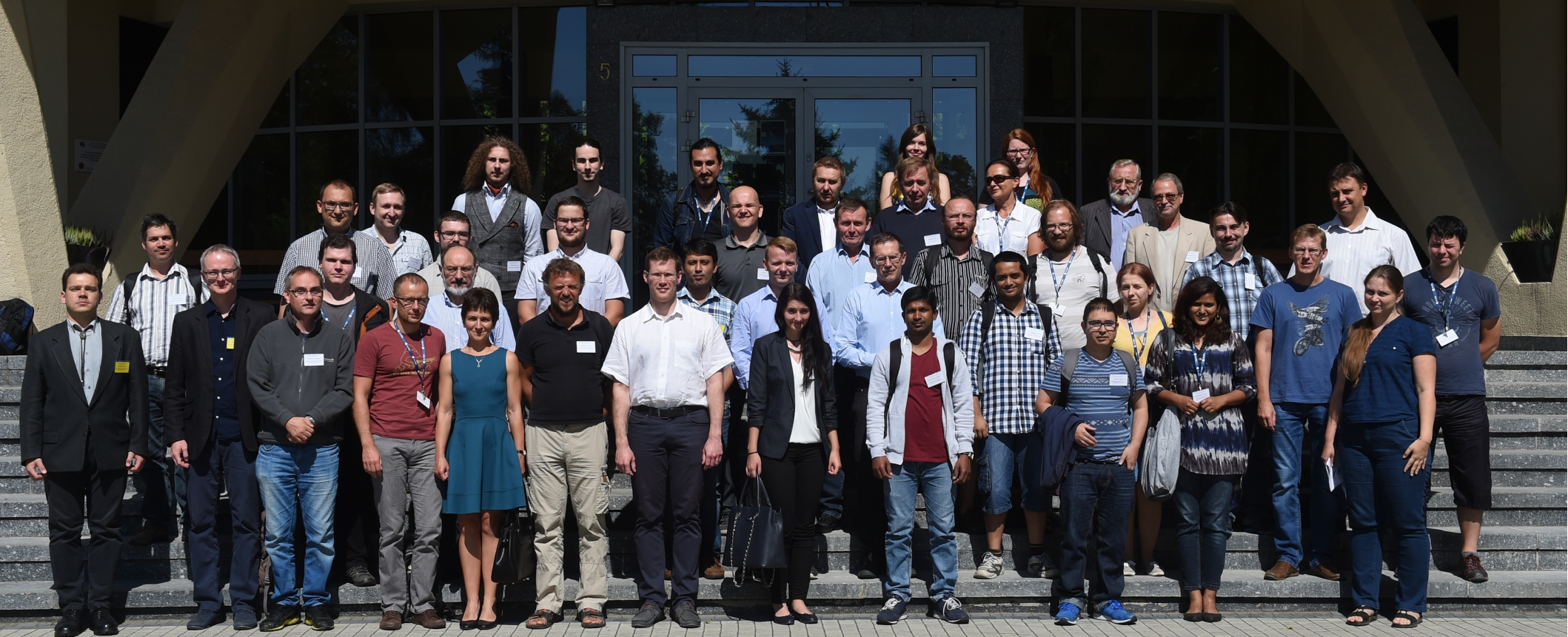


Central database/interface: access to everything for everybody

CREDO



THE QUEST FOR UNEXPECTED



CREDO The 1st Anniversary Symposium
IFJ PAN Kraków, 30th August 2017

fot. Jan Zych

CREDO Week 2018

**Cosmic-Ray Extremely Distributed Observatory:
join a global effort to detect and study
cosmic-ray ensembles.**

Including:

- Discoverology Workshop
- The CREDO School
- Anniversary Symposium
- Collaboration Meeting



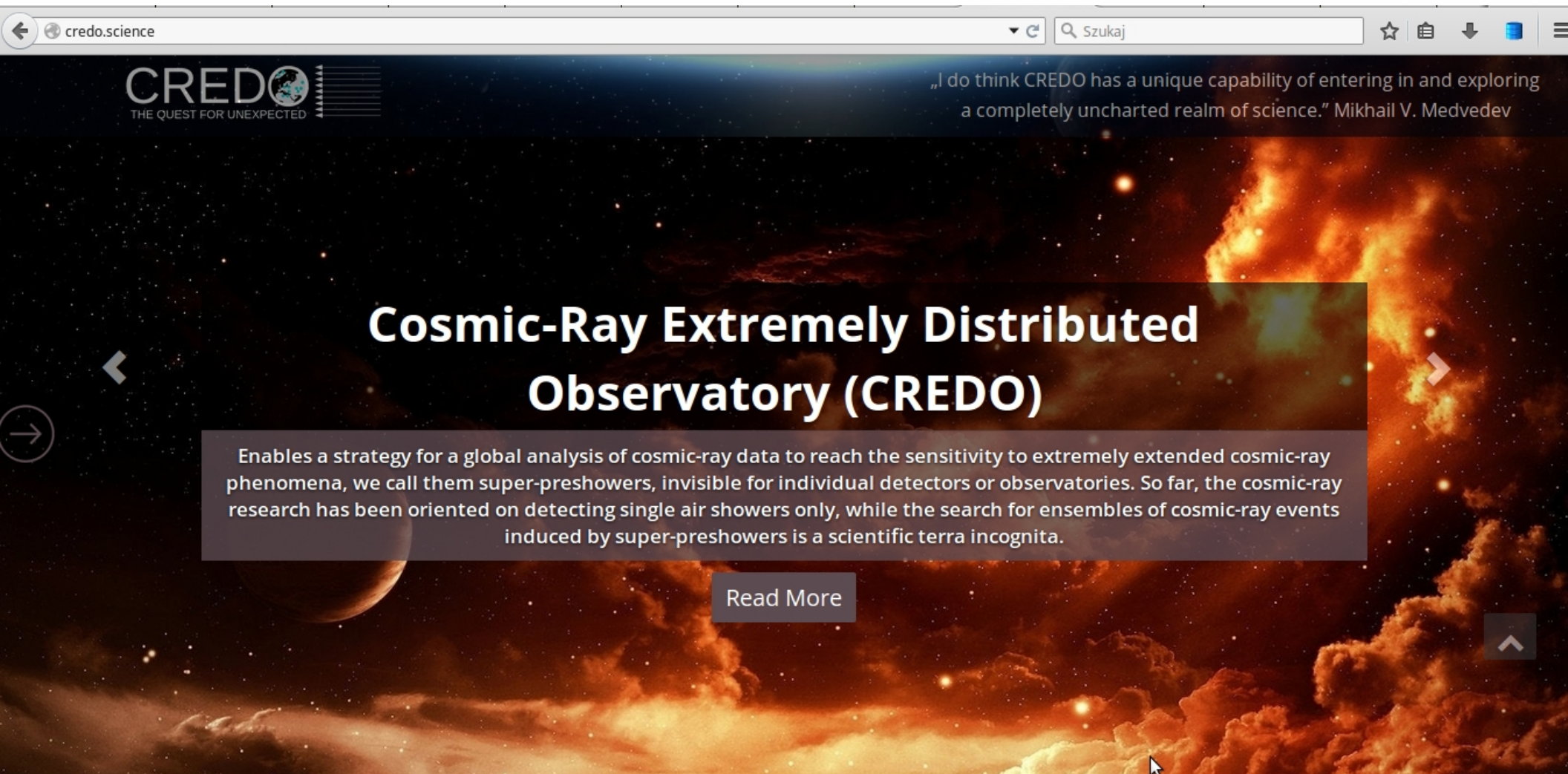
**1-5 October, 2018,
Kraków, Poland**





... (public) **engagement**

Visit credo.science...



... and contribute to CREDO science.



THE QUEST FOR THE UNEXPECTED



/credo.science



Zasięg: 650 osób

Promuj post



Komentarze

Udostępnij



Level 1:

growth/scale generation

<https://play.google.com/store/apps/details?id=science.credo.mobiledetector>

CREDO

THE QUEST FOR THE UNEXPECTED



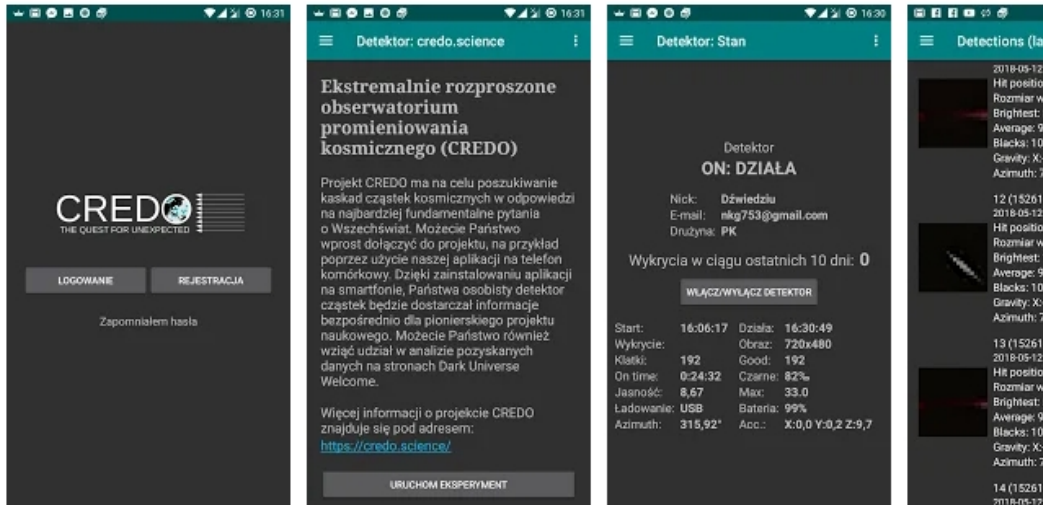
CREDO Detector

IFJ PAN Edukacja

Nadzór rodzicielski

Dodaj do listy życzeń

Zainstaluj



Level 2:
data acquisition

CREDO Detector: examples

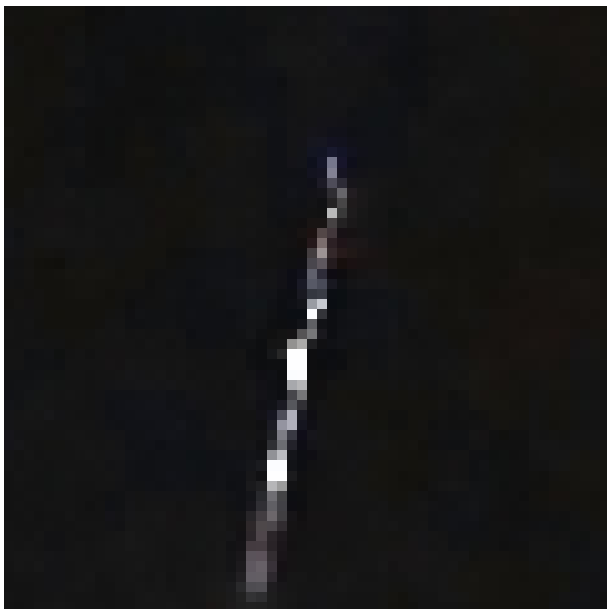
User: „smph-kitkat”, <https://api.credo.science/web/user/smph-kitkat/>

Device: Smasung SM-G357FZ, Android 4.4.4 (KitKat)

Average detection rate: ~10/hr

(flight to Kyiv on 29.05: 60/hr :)

Example images:

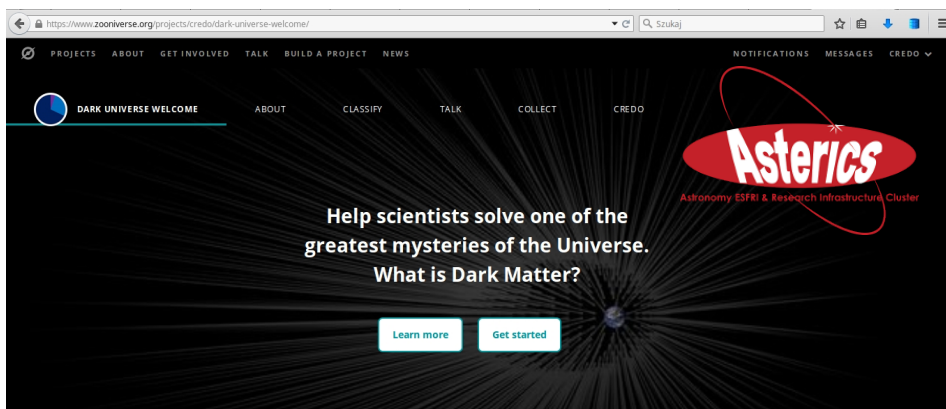




THE QUEST FOR THE UNEXPECTED

Dark Universe Welcome

kategoria
wiekowa:



"Nobody has any idea what Dark Matter or Energy are, so working on this is really exciting! Dark Matter is responsible for the gravitational effects seen in galaxies, while Dark Energy may be the cause of the accelerating expansion of the Universe."

We've got a very big mystery on our hands! Everything we can see in the Universe; you, me, planets, stars and galaxies, only make up 5% of the mass of the Universe. We have very clear evidence that there is a lot more mass, more stuff, out there but we have no idea what it is.

This mysterious stuff is known by scientists as Dark Matter but even the smartest theorists and most advanced technology can't work out what it physically is. We many have a way of solving this mystery by looking for and grouping Dark Messengers - very high energy particle showers which exist because of Dark Matter. However, it's very difficult for us to predict what these groups will look like and how well hidden they are amongst other contaminants. We need your help to identify patterns in the world wide detections of high energy particles shared with the CREDO (Cosmic-Ray Extremely Distributed Observatory) collaboration so we can teach computers to better identify them.



Dark Universe Welcome was developed with the help of the ASTRERICS Horizon2020 project. ASTRERICS is a project supported by the European Commission Framework Programme Horizon 2020 Research and Innovation action under grant agreement n. 653477

Level 3:

data analysis

1st World Championships in Particle Hunting with Smartphones

18-19.05.2018, worldwide



Compete for
science!



Level MAX: fun and emotions

CREDO: simple is (also) beautiful/funny/inspiring!



credo.science → YouTube / CREDO Edutainment:
<https://www.youtube.com/watch?v=TaKB2zhZ8j4>



... potential and beyond

“We need new ideas”

[←](#) [→](#) [×](#) <https://www.livescience.com/63692-standard-model-broken-supersymmetry-new-physics.html>

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Bizarre Particles Keep Flying Out of Antarctica's Ice, and They Might Shatter Modern Physics

By Rafi Letzter, Staff Writer | September 26, 2018 08:16pm ET

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Wolfram's Everything

blog.stephenwolfram.com/2015/12/what-is-spacetime-really/

STEPHEN WOLFRAM | Blog

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What Is Spacetime, Really?

December 2, 2015

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We've Come a Long Way in 30 Years (But You Haven't Seen Anything Yet!)

June 21, 2018



Launching the Wolfram Challenges Site

April 12, 2018



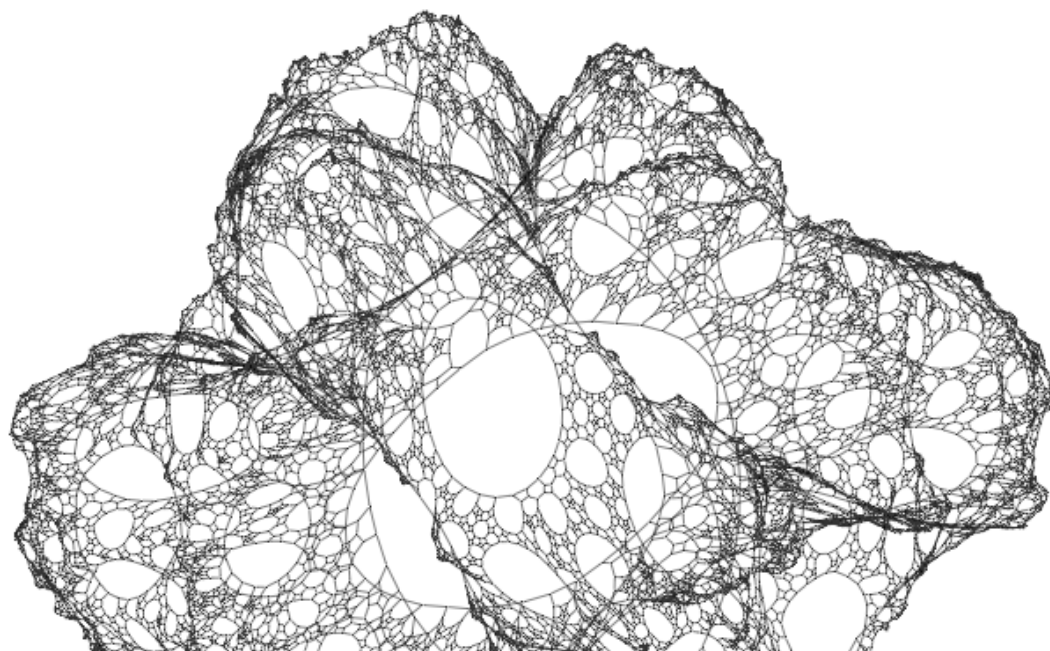
Learning about the Future from 2001: A Space Odyssey, Fifty Years Later

April 3, 2018



Buzzword Convergence: Making Sense of Quantum Neural Blockchain AI

April 1, 2018

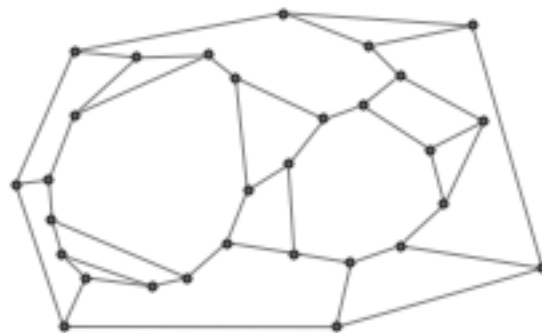


Wolfram: **simple** ultimate theory?

Wolfram's Blog, What is Spacetime, Really?

A Simple Ultimate Theory?

In the abstract it's far from obvious that there should be a simple, ultimate theory of our universe.... what I discovered is that in the computational universe **even extremely simple programs can actually show behavior as complex as anything**. So then the question arises: **could one of these simple programs in the computational universe actually be the program for our physical universe?**

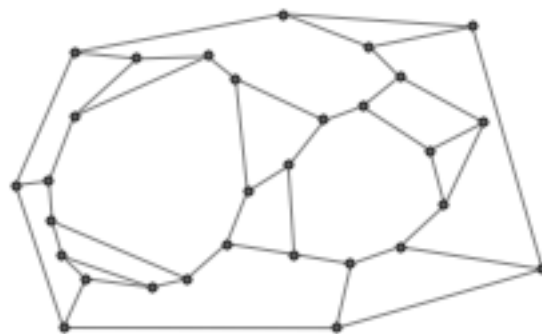


Wolfram: ... “knots in the ether” ...

Wolfram's Blog, What is Spacetime, Really?

Maybe There's Nothing But Space

But, OK, if space is a network, what about all the stuff that's in space? What about all the electrons, and quarks and photons, and so on? In the usual formulation of physics, space is a backdrop, on top of which all the particles, or strings, or whatever, exist. But that gets pretty complicated. And there's a simpler possibility: **maybe in some sense everything in the universe is just “made of space”**.

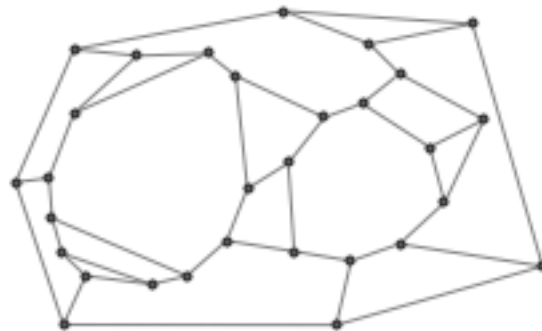


Wolfram: ... “knots in the ether” ...

Wolfram's Blog, What is Spacetime, Really?

Particles, Quantum Mechanics, Etc.

It's wonderful to be able to derive General Relativity. But that's not all of physics. Another very important part is quantum mechanics. It's going to get me too far afield to talk about this in detail here, but presumably particles – like electrons or quarks or Higgs bosons – **must exist as certain special regions in the network**. In qualitative terms, they might not be that different from Kelvin's “knots in the ether”.



Wolfram and discoverology

Wolfram's Blog, What is Spacetime, Really?

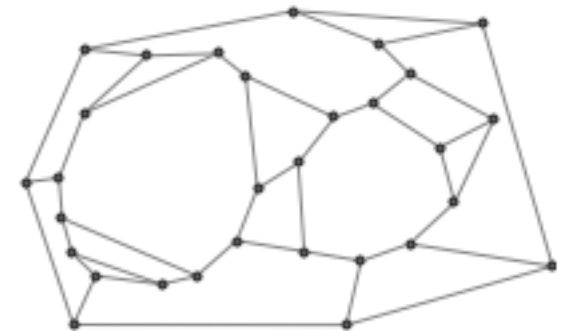
To Do Physics, or Not to Do Physics?

...The first is simply, “You’ve got to do it!” They say that the project is the most exciting and important thing one can imagine, and they can’t see why I’d wait another day before starting on it. The second class of responses is basically, “Why would you do it?” Then they say something like, “Why don’t you solve the problem of artificial intelligence, or molecular construction, ...

There’s also a third class of responses, which I suppose my knowledge of the history of science should make me expect. **It’s typically from physicist friends**, and typically it’s some combination of, **“Don’t waste your time working on that!”** and, **“Please don’t work on that.”**

The fact is that the current approach to fundamental physics – through quantum field theory – is nearly 90 years old. It’s had its share of successes, but it hasn’t brought us the fundamental theory of physics. But for most physicists today, the current approach is almost the definition of physics. So when they think about what I’ve been working on, it seems quite alien – like it isn’t really physics. And some of my friends will come right out and say, “I hope you don’t succeed, because then all that work we’ve done is wasted.

We need new ideas!



Mission

$N_{\text{ATM}} \geq 1 \rightarrow$ scenarios + fishing / education

Strategy

Spread globally & grow giant \rightarrow „1 million scientific community”

Tactics

- tools: variety of detectors / citizen science
- users: young + old
- training: discoverology

Potential

- multidimensional: **beyond astrophysics, beyond science**

\rightarrow evokes **keywords** (big data, machine learning, AI, blockchain, decentralized autonomous organizations, cryptocurrency,...)

CREDO: simple is (also) beautiful/funny/inspiring!



„AGH where fiction becomes science”: **building spacetime tunnels?**

[EN] https://www.youtube.com/watch?v=6GN0Y4MTi_w&feature=youtu.be&t=8m22s

[PL] <https://www.youtube.com/watch?v=OTs45NsKeZU&feature=youtu.be&t=50m35s>