

DATA VS DARK MATTER

OPEN SCIENCE & PARTICLE PHYSICS

Flip Tanedo

2015 Science Ambassador

UCIRVINE

UNIVERSITY OF CALIFORNIA

GORDON AND BETTY
MOORE
FOUNDATION

Science Hack Day: SF 2015

GitHub

Flip Tanedo, Science Ambassador



Theoretical High Energy Physicist
Postdoctoral Scholar at UC Irvine

Dark Matter
Collider Physics
Supersymmetry
Extra Dimensions

What is the theory of dark matter?

What's waiting for us at small sizes?

Why is the Higgs so unbearably light?

What if our "elementary" particles aren't?

*Ask me about
particle physics!*

These Slides: bit.ly/1MKPIyy
particlebites.com
physics.uci.edu/~tanedo/

These guys, too!

Tadej Novak



EXPERIMENTALIST

David Harris



(former ed.) SYMMETRY

Two things on my mind

fundamental forces

Field	Spin	$SU(3)_c$	$SU(2)_L$	$U(1)_Y$
Q	$1/2$	\square	\square	$1/6$
\bar{u}	$1/2$	$\bar{\square}$	\square	$-2/3$
\bar{d}	$1/2$	$\bar{\square}$	\square	$1/3$
L	$1/2$	\square	\square	$-1/2$
\bar{e}	$1/2$	\square	\square	-1
H	0	\square	\square	$1/2$
χ	???	\square	\square	0

matter particles

Higgs

Dark Matter

Mass doesn't make sense!

???

... is "dark"

Little Particles, Big Data

Large Hadron Collider (30 petabytes / year)

Collider = Giant Microscope

What is the organizing principle of particle physics?

Data is mostly **closed** to public (starting to change)



Fermi Telescope (10 gigabytes / year)

What does Dark Matter annihilate into?

(—And other astrophysical questions not in my field)*

Data is **open** to public



LHC: 'Mo Data, 'Mo Problems



CAVEAT: THIS IS NOT A FAIR DESCRIPTION OF CERN!



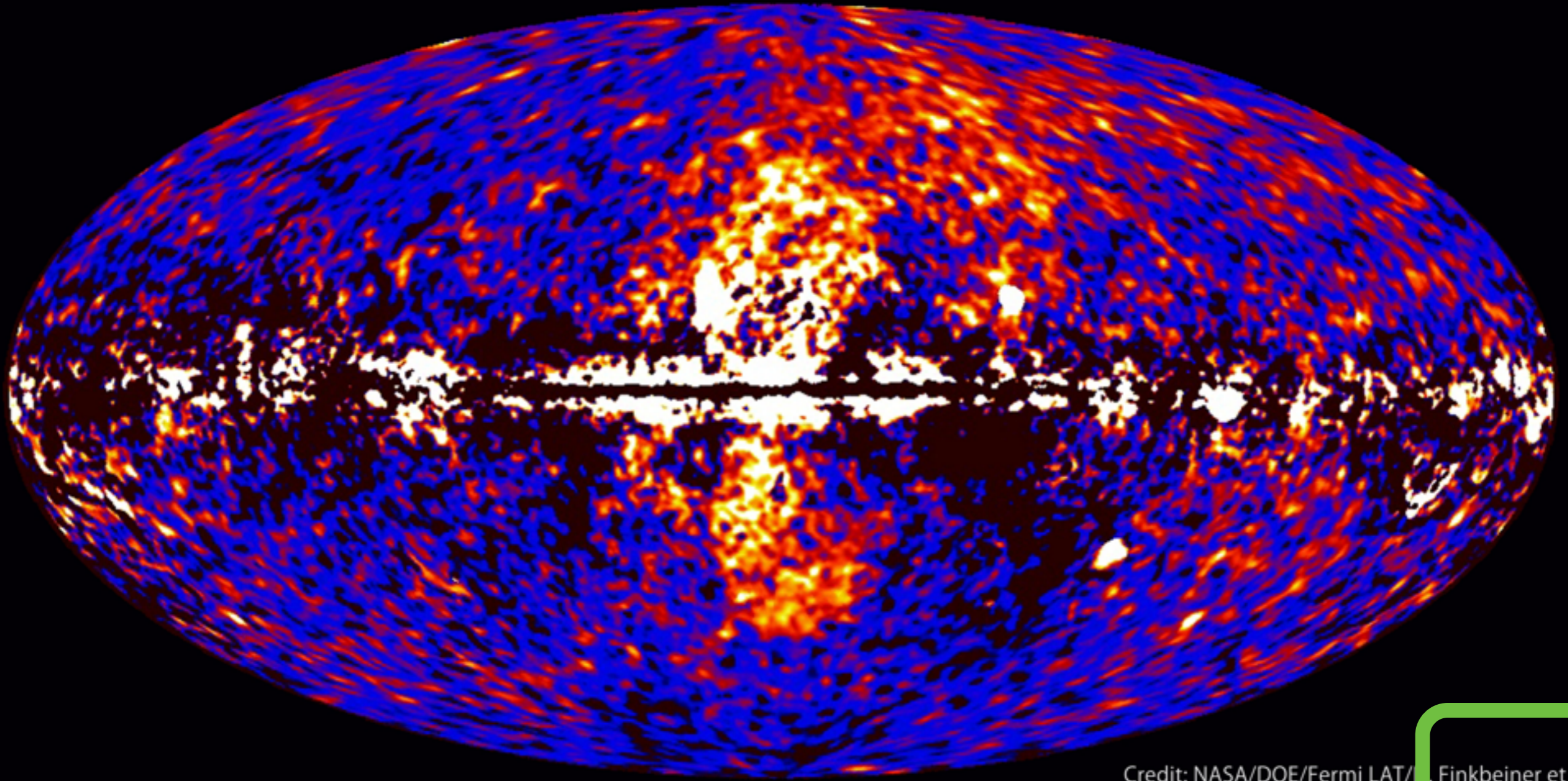
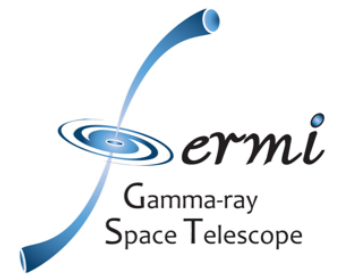
Firehose of data with known and unknown background

Thousands of researchers making sure things are done correctly

Real reason: avoid wasting time babysitting theorists who will "discover" things that aren't there in the data

The Fermi Bubbles

an example from astrophysics



Credit: NASA/DOE/Fermi LAT/ Finkbeiner et al.

Image from NASA Press Release

flip.tanedo @ uci.edu

DATA VS. DARK MATTER

bit.ly/1MKPIyy

Opportunities to Play With Data

Things to play with *after* Science Hack Day



kaggle

2014 HIGGS CHALLENGE
2015 $\tau \rightarrow 3\mu$ CHALLENGE

kaggle.com



opendata
CERN

VIRTUAL MACHINE FOR DATA
ANALYSIS OF ACTUAL DATA

opendata.cern.ch



CRAYFIS

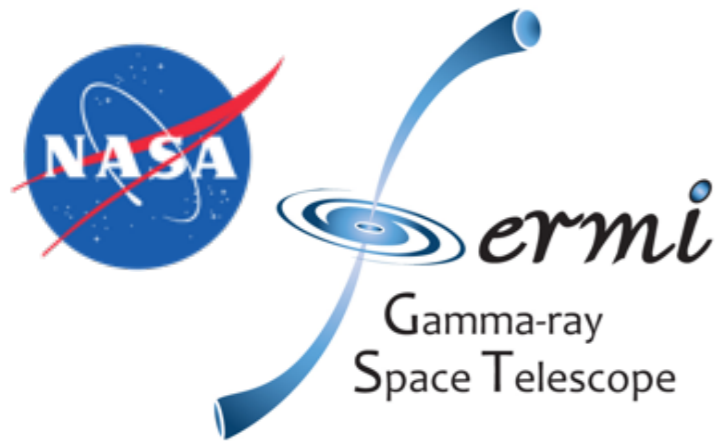
SMART PHONE COSMIC
RAY CITIZEN SCIENCE

crayfis.io

...show us that there's demand for these!

Opportunities to Play With Data

Data sets to play with today!



FERMI DATA AND TOOLS

fermi.gsfc.nasa.gov/ssc/data/



SCIENCE HACK DAY 14: CMS & ICECUBE DATA

git.io/vWEfN

github.com/mattbellis/Science_Hack_Day_SF14

TUTORIALS AND DATA: CMS & CLEO

particle-physics-playground.github.io

MANY THANKS TO
MATT BELLIS



inspirehep.net/info/hep/api

inspirehep.net/hep_records.json.gz

Particle Wind Chime 2.0

www.mattbellis.com/windchime/

www.sos.siena.edu/~mbellis/ppw/

IDEA: **sonify** particle collisions



SCIHACKDAY PRODUCT
BY MATT BELLIS

Energy Direction Particle

can we improve the mapping?

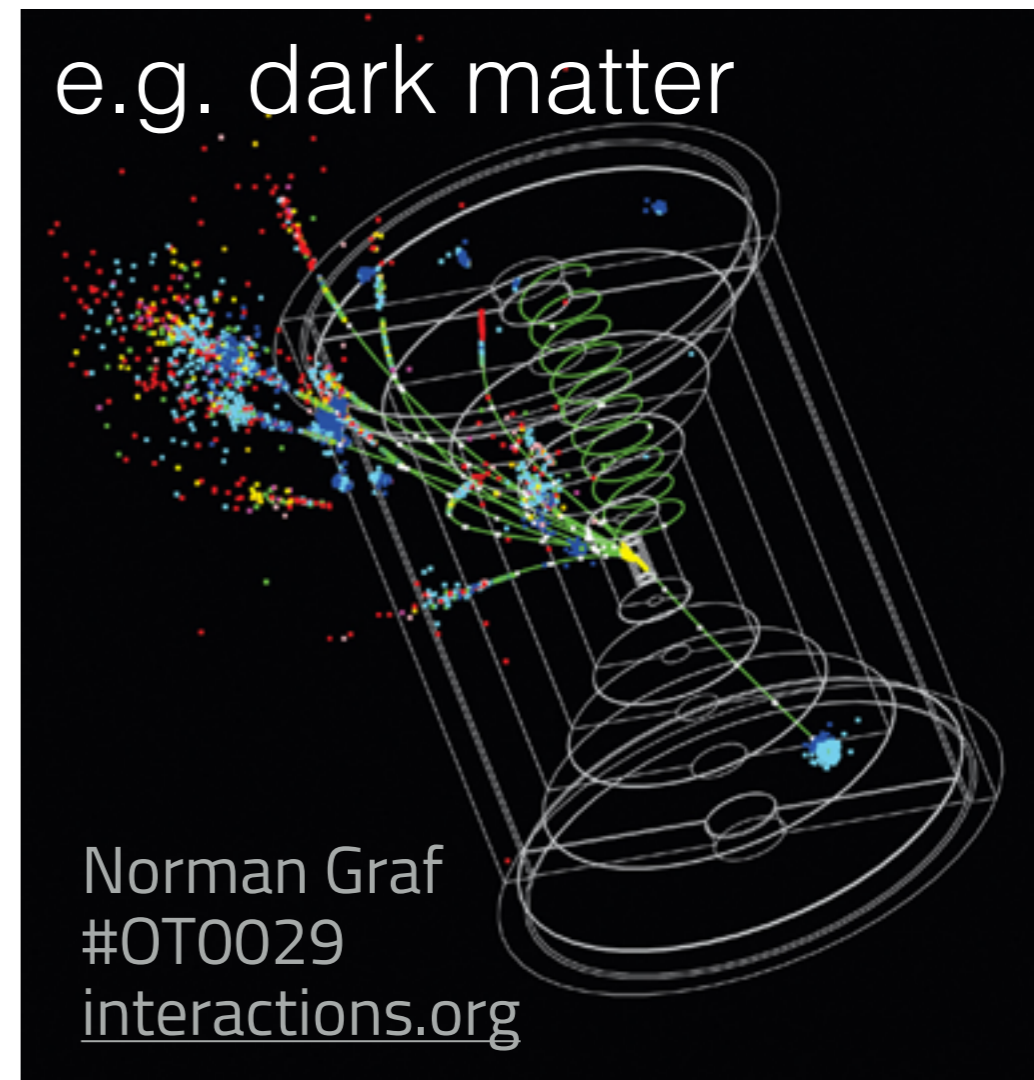
rhythm

volume

frequency

surround

e.g. dark matter



Norman Graf
#OT0029
interactions.org

Particle Wind Chime 2.0

www.mattbellis.com/windchime/

IDEA: **sonify** particle collisions

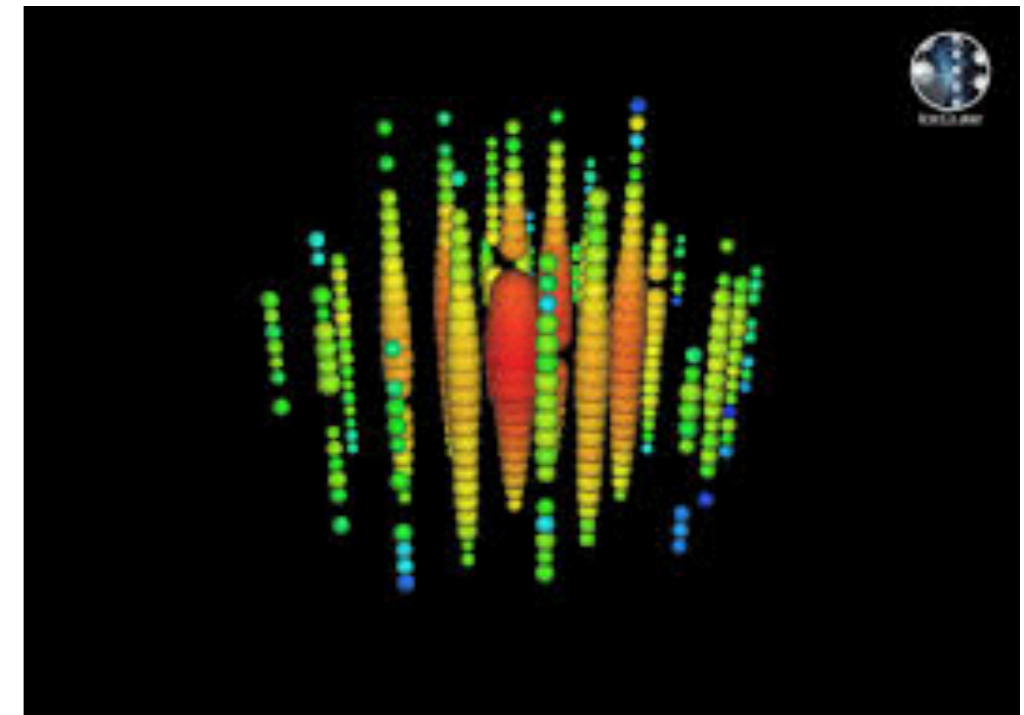


SCIHACKDAY PRODUCT
BY MATT BELLIS

Energy Pattern Timing

can we improve the mapping?

rhythm volume
frequency surround



Invisible Constellations

Fermi Large Area Telescope

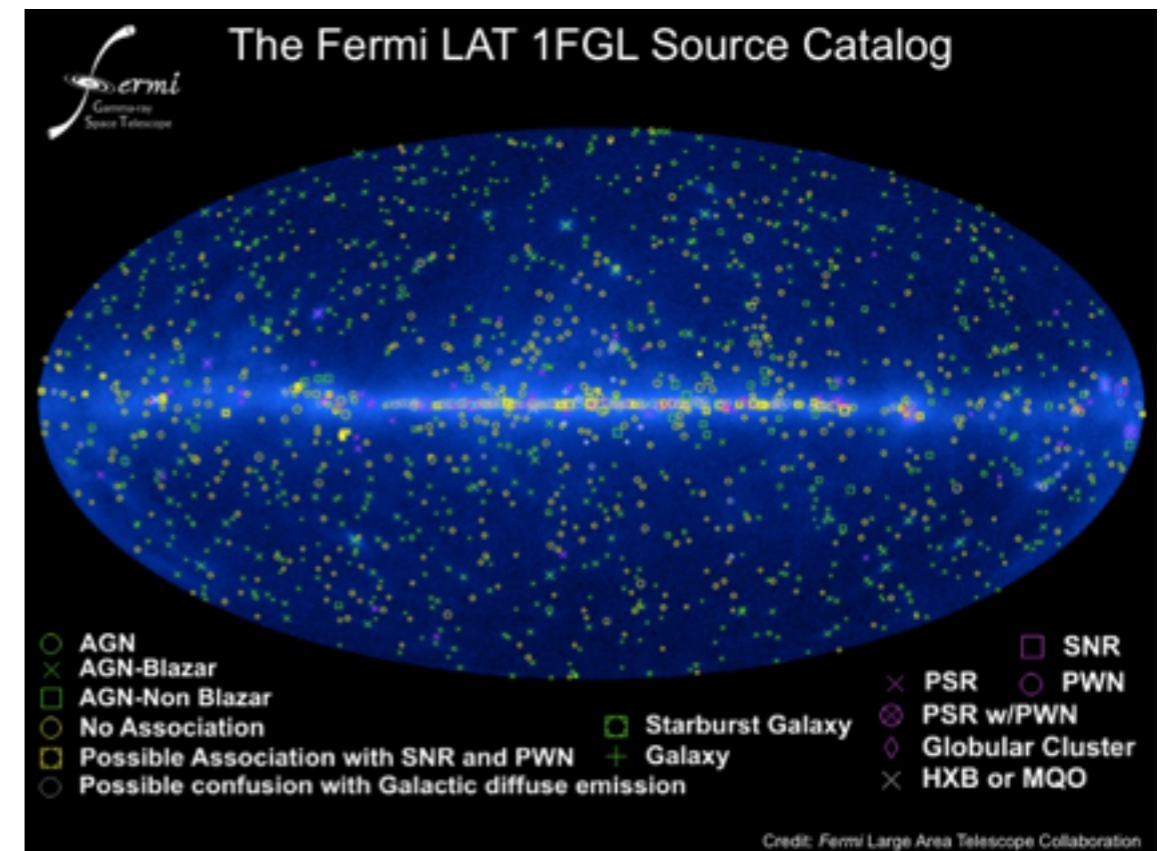
fermi.gsfc.nasa.gov/ssc/data/

3FGL γ -ray Point Source Catalog

- XML data file available
- Position of each source
- Energy spectrum



Alvesgaspar [CC BY-SA 3.0] Wikimedia Commons

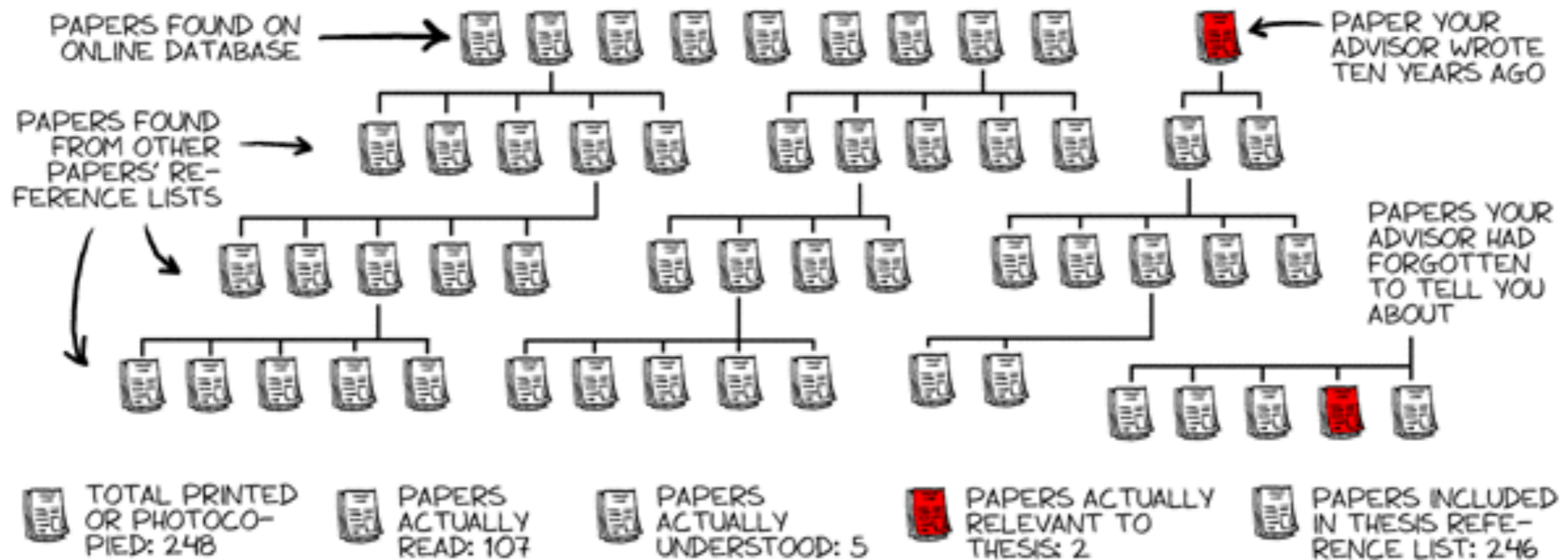


Bibliographic Data

REFERENCES

MAKING SURE NO ONE HAS ALREADY WRITTEN YOUR THESIS

phd.stanford.edu
JORGE CHAM © STANFORD DAILY



Jorge Cham, PhD Comics (2/27/2002)

flip.tanedo@uci.edu

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bit.ly/1MKPIyy

Bibliographic Data



Open access literature database for high energy physics

Metadata for **all published papers** in particle physics

Can we use this to answer questions like

Here's a draft of my paper... who am I forgetting to cite?

I'm reading these papers... where is this field going?

What are the 'big ideas' and how are they connected?

inspirehep.net/info/hep/api ← ~ 1 gig json file

ArXiv vs. SnarXiv

snarXiv.org > hep-th

About

arXiv vs. snarXiv

[1] [arXiv:1510.7487](#) [[ps](#), [pdf](#), [other](#)]

Unparticle Physics With an Adjoint Gauge-field

[K. Maldacena](#), [H. 't Hooft](#)

Comments: 26 pages

Subjects: **High Energy Physics – Phenomenology** (hep-ph); Nuclear Theory (nucl-th); Cosmology and Extragalactic Astrophysics (astro-ph.CO)

We use supergravity with equivariant kahler potential deformed by local operators to bound the spontaneous low-scale formulation of models of pions. This provides an extremely precise test of a Planck hierarchy. While explaining models of ghosts, we predict that currents on AdS_m are multidimensional. Unfortunately, recently, a fair amount of work was done demystifying type IIB. We take an anthropic approach. WIMP production is also demystified. We hope this paper provides a good starting point for bounding NS5 instantons.

arXiv.org > hep-th

Search or Article-Id

([Help](#) | [Advanced search](#))

All papers

Go!

[1] [arXiv:1510.06456](#) [[pdf](#), [ps](#), [other](#)]

Integrability, Einstein spaces and holographic fluids

[P. Marios Petropoulos](#), [Konstantinos Siampos](#)

Comments: v1: 1+30 pages, Latex. arXiv admin note: substantial text overlap with [arXiv:1506.04813](#)

Subjects: **High Energy Physics – Theory** (hep-th); General Relativity and Quantum Cosmology (gr-qc)

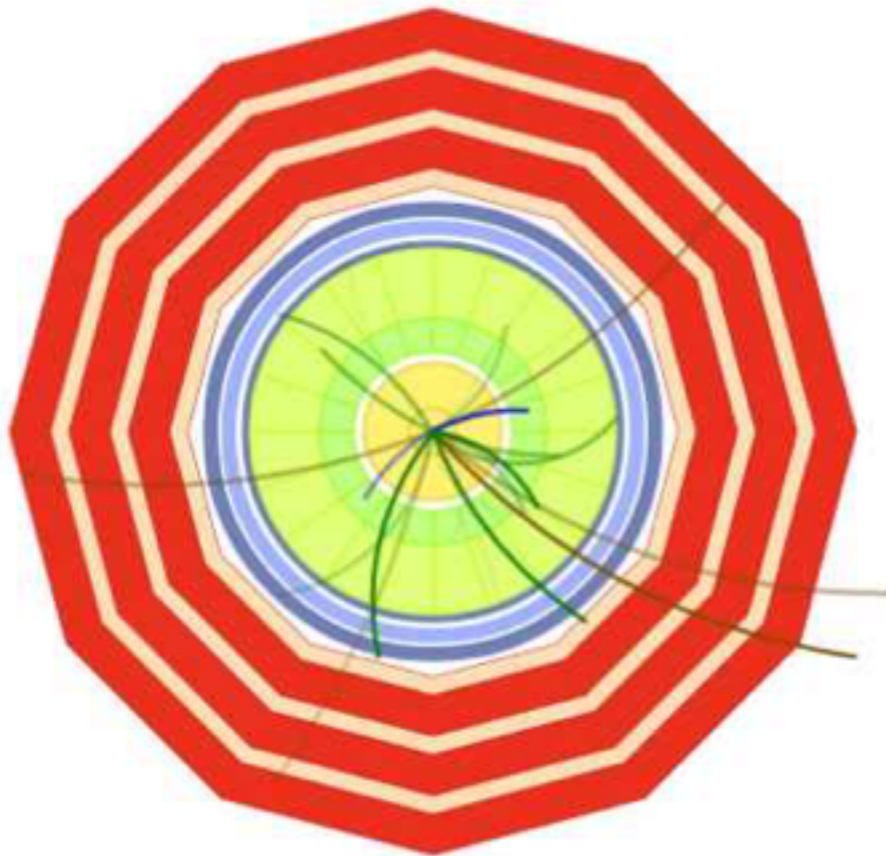
Using holographic-fluid techniques, we discuss some aspects of the integrability properties of Einstein's equations in asymptotically anti-de Sitter spacetimes. We remind how exact four-dimensional Einstein spacetimes, which are algebraically special with respect to Petrov's classification, can be reconstructed from boundary data: this is possible if the boundary metric supports a traceless, symmetric and conserved complex rank-two tensor, which is related to the boundary Cotton and energy-momentum tensors, and if the hydrodynamic congruence is shearless. We illustrate the method when the hydrodynamic congruence has vorticity and the boundary metric has two commuting isometries. This leads to the complete Plebanski-Demianski family. The structure of the boundary consistency conditions depict a $U(1)$ invariance for the boundary data, which is reminiscent of a Geroch-like solution-generating pattern for the bulk.

snarxiv.org

ParticleClicker

... when you need a break

KelTech



Data
142 +2

Reputation
8

Funding
JTN 2.1k +48

HR

Upgrades



PhD Students 2

Cheap and enthusiastic manpower, they can save you a lot of work. They produce 1 data per second.

Hire (JTN 196)

Postdocs

Hire (JTN 2.0k)

Free beer

The work is easier when the worker is happy. Your PhD Students will produce +2 data.

Buy (JTN 1.0k)

Accelerator upgrade

Increases the luminosity (you get 3 times more data with clicks).

Buy (JTN 1.0k)

Detector upgrade

Your amazing detector works with better efficiency (you get +4 data with clicks).

Buy (JTN 500)

Tadej Novak



EXPERIMENTALIST

From 2013 CERN Hackathon

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