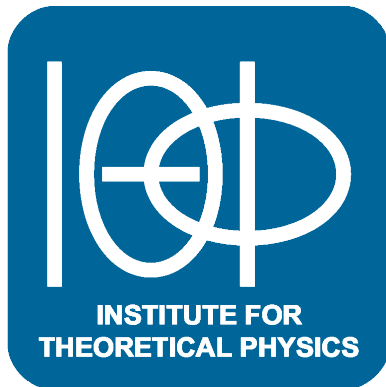


Austrian Roadmap Round Table Meeting May 2024 — ITP, TU Wien Past

INSPIRE: 1871 e-prints with TU Wien affiliation and less than 11 authors

hep-th	hep-ph	gr-qc	hep-lat	nucl-th
833	422	302	231	183



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833	422	302	231	183

Top-8 charts (ITP-TU Wien affiliation at time of paper highlighted)

- 495 *Collective modes of an anisotropic quark gluon plasma.* P. Romatschke, M. Strickland
- 482 *Dilaton gravity in 2d.* D. Grumiller, W. Kummer, D.V. Vassilevich
- 465 *Nonconservation of Total Lepton Number with Scalar Bosons.* W. Konetschny, W. Kummer
- 438 *Cold Quark Matter.* A. Kurkela, P. Romatschke, A. Vuorinen
- 366 *Approx. selfconsist. resummation for thermodynamics of QGP.* J.P. Blaizot, E. Iancu, A. Rebhan
- 358 *Complete classification of reflexive polyhedra in 4d.* M. Kreuzer, H. Skarke
- 330 *Poisson structure induced (topological) field theories.* P. Schaller, T. Strobl
- 293 *Cosmic anti-friction and accelerated expansion.* W. Zimdahl, D.J. Schwarz, et. al.

Present I

Persons at ITP active in research (alphabetical list; at least 5 publications in past decade; above postdoc)

- ▶ Kirill Boguslavski (since 2019)
QGP, real time dynamics in QCD

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QFT, QCD and hadron physics, holographic QCD
- ▶ Harald Skarke (1987-1992, 1995-1997, and since 2012)
string theory, mathematical physics, cosmology

Present II

FWF projects (status Fall 2023)

Boguslavski	P 34455	Nonperturbative properties of evolving gluonic plasmas
Grumiller	P 33789	Generalized SYK/JT correspondences
	P 32581	Quantum energy conditions in two dimensions
	P 30822	Soft Heisenberg hair on horizons
Ipp	P 34764	Simulating the earliest stages of heavy-ion collisions
	P 32446	Upscaling Glasma simulations using machine learning
Rebhan	P 34562	Classical string backgrounds with cosmological constant (w. David Andriot)
	P 33655	Holographic QCD and Hadron Physics
	2014-2023	Doktoratskolleg "Particles & Interactions"

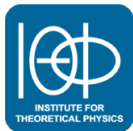
Future I

Professur (§98) “Theoretical High Energy Physics”

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$\int dk \Pi$ Doktoratskolleg Particles and Interactions



HEPHY
Institut für Hochenergiephysik



universität
wien



TECHNISCHE
UNIVERSITÄT
WIEN



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 - ▶ (beyond the) Standard Model
 - ▶ dark matter/energy
 - ▶ gauge/gravity duality
 - ▶ gravitational waves
 - ▶ inflation/cosmology
 - ▶ neutrinos/flavour physics
 - ▶ quantum gravity/string theory
 - ▶ (strongly interacting) quantum field theories

selected FWF grants since 2009:

- ▶ 1 Doktoratskolleg (2014-2023), 2 START prizes
- ▶ 23 individual projects, 6 Lise-Meitner fellows

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 - E138 Computational materials, quantum materials
Bühler-Paschen, Held

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12th VIENNA CENTRAL EUROPEAN SEMINAR ON PARTICLE PHYSICS AND QUANTUM FIELD THEORY
PHYSICS AT LHC - RUN 2
Dec 01-02, 2016

Invited Speakers: Alan Pope (EPFL, Switzerland), Alan Cooper (TU Wien, Austria), Thomas Curatolo (University of Turin, Italy), Jürg Konrad (CERN, Switzerland), Helmut Kopp (TU Wien, Austria), Karl H. Kampert (TU Wien, Austria), Alan Williams (EPFL, Switzerland), Alan Cooper (CERN, Switzerland), Alex Pagan (Université de Savoie, France), Thomas Curatolo (University of Turin, Italy), Christoph Bock (University of Salzburg, Austria), Thomas Huber (TU Wien, Austria), Michael Mühlbauer (TU Wien, Austria), Michael Mühlbauer (TU Wien, Austria), Michael Mühlbauer (TU Wien, Austria).

Public Lecture: Christos Papageorgiou (TU Wien)

Organizers: Andre Hering (University of Vienna), Axel Maier (TU Wien), Michael Mühlbauer (TU Wien), Thomas Curatolo (University of Turin), Jürg Konrad (CERN), Helmut Kopp (TU Wien), Alan Williams (EPFL), Alan Cooper (CERN).



11th VIENNA CENTRAL EUROPEAN SEMINAR ON PARTICLE PHYSICS AND QUANTUM FIELD THEORY
QUANTUM AND GRAVITY
Nov 27 - 28, 2015

Invited Speakers: Martin Ammon (TU Wien), Markus Aspöckler (TU Wien), Helmut Kopp (TU Wien), Jürg Konrad (CERN), Thomas Curatolo (University of Turin), Christoph Bock (University of Salzburg), Thomas Huber (TU Wien), Michael Mühlbauer (TU Wien), Michael Mühlbauer (TU Wien), Michael Mühlbauer (TU Wien).

Organizers: Daniel Gromoll (TU Wien), Helmut Kopp (TU Wien), Thomas Curatolo (University of Turin), Jürg Konrad (CERN), Helmut Kopp (TU Wien).

14th VIENNA CENTRAL EUROPEAN SEMINAR ON PARTICLE PHYSICS AND QUANTUM FIELD THEORY
Global and Local Symmetries
Nov 30 - Dec 01, 2018

Invited Speakers: Martin Ammon (TU Wien), Markus Aspöckler (TU Wien), Helmut Kopp (TU Wien), Jürg Konrad (CERN), Thomas Curatolo (University of Turin), Christoph Bock (University of Salzburg), Thomas Huber (TU Wien), Michael Mühlbauer (TU Wien), Michael Mühlbauer (TU Wien), Michael Mühlbauer (TU Wien).

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Pradler, Schieck; Aspelmeyer, Brukner; Widmann
- ▶ Synergies with other faculties: Mathematics & Geoinformation
Arnold, Baaz, Gittenberger, Izmistiev, Ludwig, Rubey

Future I

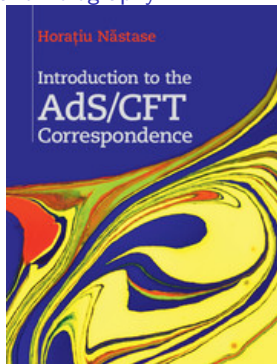
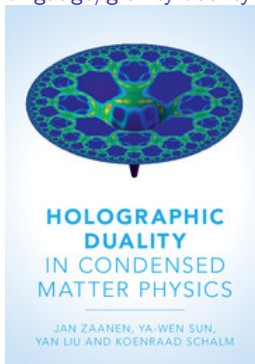
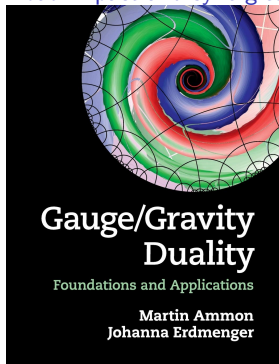
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Arnold, Baaz, Gittenberger, Izmistiev, Ludwig, Rubey

Goal for remainder: narrow down research area/maximize synergies

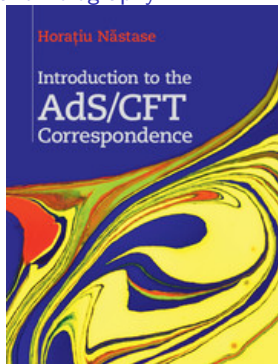
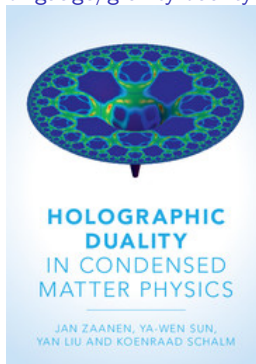
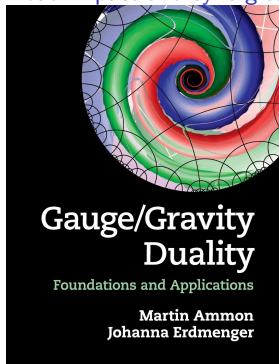
Future II

Broad impact and synergies of gauge/gravity duality and holography



Future II

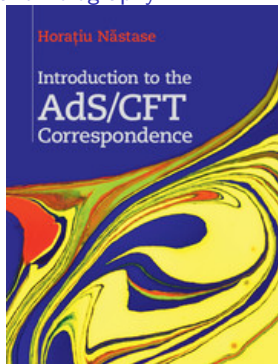
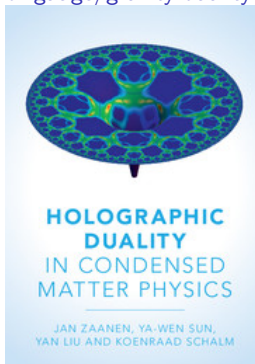
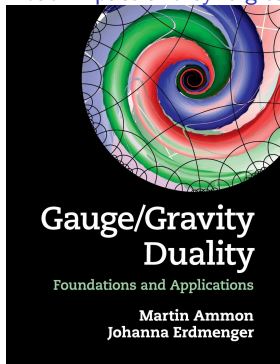
Broad impact and synergies of gauge/gravity duality and holography



- ▶ Strong coupling physics QCD, non-abelian plasmas, neutron stars, cold atoms, strange metals, SYK, holographic superconductors, viscous fluids, ...

Future II

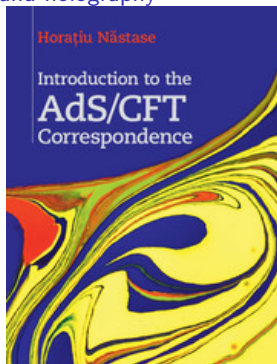
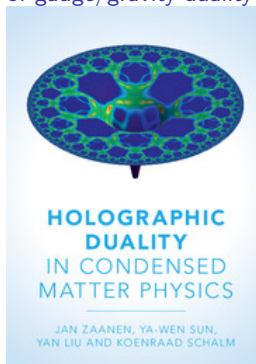
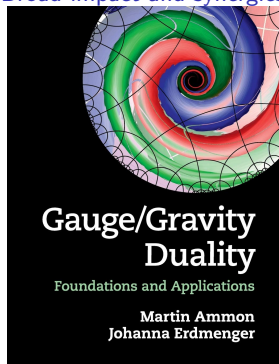
Broad impact and synergies of gauge/gravity duality and holography



- ▶ Strong coupling physics QCD, non-abelian plasmas, neutron stars, cold atoms, strange metals, SYK, ...
- ▶ Scattering amplitudes flat space holography, celestial holography, Carroll holography, gravitational waves, memory effects, Mellin amplitudes, ...

Future II

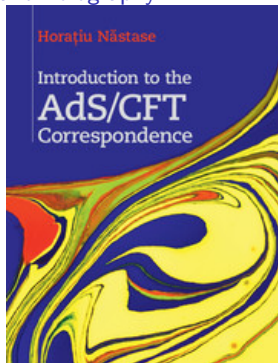
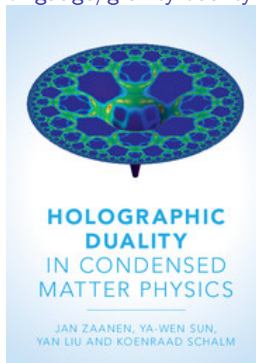
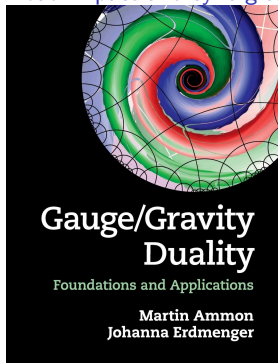
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- ▶ Strong coupling physics QCD, non-abelian plasmas, neutron stars, cold atoms, strange metals, SYK, ...
- ▶ Scattering amplitudes flat space, celestial and Carroll holography, gravity waves, memory effects, ...
- ▶ Quantum information **holographic entanglement entropy, chaos bound, holographic complexity, quantum energy conditions, holographic quantum error correction, quantum extremal surfaces, ER=EPR, ...**

Future II

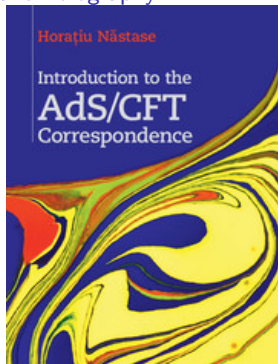
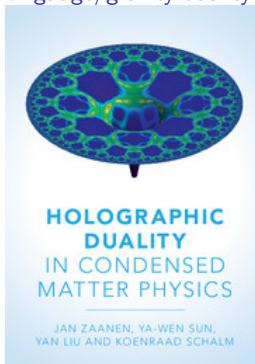
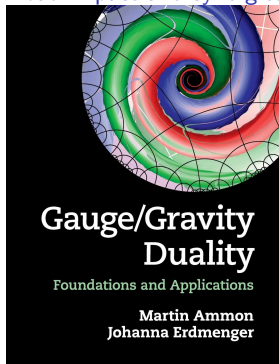
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Broad impact and synergies of gauge/gravity duality and holography



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More than enough research avenues for rest of the century!

Future III

Goal: start search for successor to Prof. Rebhan around September 2024
(application deadline September 8)

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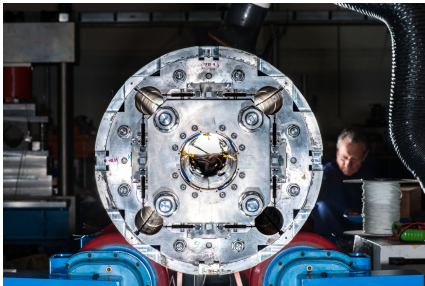
Suggested research focus: gauge/gravity duality & holography

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Pertinent current and future experiments:

- ▶ **High Luminosity LHC (HL-LHC):** major upgrade of LHC that will be installed in 2026-2029, enabling high precision experiments at CERN (HEPHY)



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- ▶ **A Large Ion Collider Experiment (ALICE):** at the LHC and HL-LHC, ongoing with major upcoming upgrades (SMI — new group starting last Fall, David Dobrigkeit-Chinellato; current overlap with our institute: Kirill Boguslavski and Andi Ipp)

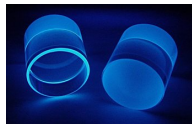


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- ▶ Dark matter searches (currently: **CRESST** with HEPHY participation: Jochen Schieck et al.)



Backup Slide 0: Status of Theoretical High Energy Physics

All data are from the INSPIRE HEP database of over 1.2 million papers

12 papers with over 10k citations (🏆=Breakthrough prize, 🏅=Nobel prize):

1. **18367 J.Maldacena (1997)** 🏆 The Large N limit of superconformal field theories & supergravity
2. 16627 **GEANT4 collab.** (2003) GEANT4—a simulation toolkit
3. 15044 **A.Riess et al** (1998) 🏆 Observational evidence from supernovae for accel. universe & cc
4. 14877 **S.Perlmutter et al** (1998) 🏆 Measurements of Ω & Λ from 42 high redshift supernovae
5. 14060 **ATLAS collab.** (2012) 🏆 Observation of ... Higgs boson with ATLAS detector at the LHC
6. 13895 **S.Weinberg** (1967) 🏅 A Model of Leptons
7. 13659 **CMS collab.** (2012) 🏆 Observation of a New Boson ... with CMS Experiment at the LHC
8. 12637 **T.Sjostrand et al** (2006) PYTHIA 6.4 Physics and Manual
9. **11752 E.Witten (1998)** 🏆 Anti-de Sitter space and holography
10. 11450 **M.Kobayashi, T.Maskawa** (1973) 🏅 CP Violation in ... Theory of Weak Interaction
11. 11441 **PLANCK collab.** (2015) Planck 2015 results. XIII. Cosmological parameters
12. 10233 **S.Hawking** (1975) 🏆 Particle Creation by Black Holes

1. and 9. started gauge/gravity duality and holography

Backup slide I: Recent theory faculty hirings at CERN

Data includes all current members hired during the past decade; **holography highlighted**

- ▶ Samuel Abreu (gluon amplitudes)
- ▶ Chiara Caprini (gravitational waves)
- ▶ Timothy Cohen (dark matter)
- ▶ Valerie Domcke (inflation, gravitational waves)
- ▶ **Alba Grassi (strings, Seiberg-Witten, holographic correlators)**
- ▶ Alexander Huss (QCD aspects of collider physics)
- ▶ Andreas Juttner (flavor physics, lattice QCD)
- ▶ **Shota Komatsu (holographic correlators, integrability in holography)**
- ▶ Joachim Kopp (neutrino physics, dark matter)
- ▶ Matthew McCullough (collider physics, BSM phenomenology)
- ▶ Pier Monni (Higgs production, parton showers)
- ▶ **Kyriakos Papadodimas (holography and emergence of spacetime)**
- ▶ Nicholas Rodd (dark matter)
- ▶ Marko Simonovic (inflation, dark energy, effective field theory)
- ▶ Irene Valenzuela (string pheno, swampland)
- ▶ **Wilke van der Schee (heavy ion collisions, numerical holography)**
- ▶ **Alexander Zhiboedov (celestial holography, higher spin holography)**

Backup slide II: Recent hep-th faculty hirings worldwide, selected places

Data includes all current members hired during the past decade; **holography highlighted**

Places: Cambridge U. (DAMPT); Harvard U. (Center for the Fundamental Laws of Nature); MIT (Center for Theoretical Physics); PI (QFT&Strings); Princeton U. (hep-th); Santa Barbara; ETH Zurich (ITP); UC Davis; Caltech

- ▶ Alejandra Castro (AdS₃ and AdS₂ holography, higher spin holography)
- ▶ Sean Hartnoll (cond-mat applications of holography)
- ▶ Enrico Pajer (CMB physics, inflation, cosmological correlators)
- ▶ Jorge Santos (numerical holography)
- ▶ David Skinner (twistors, celestial holography)
- ▶ Christopher Thomas (lattice QCD)
- ▶ Maria Ubiali (parton distributions)
- ▶ Aaron Wall (holographic entanglement entropy)
- ▶ Daniel Jafferis (string theory, SQFT, quantum gravity, gauge/gravity)
- ▶ Matthew Reece (BSM model building, effective FT)
- ▶ Xi Yin (string theory, black holes, gauge/gravity)
- ▶ Simon Caron-Huot (scattering amplitudes and holography)
- ▶ Sarah Harrison (Lifshitz holography)
- ▶ Katelin Schutz (dark matter)
- ▶ Netta Engelhardt (holographic EE, holographic BH evaporation)
- ▶ Daniel Harlow (holographic quantum error correction)
- ▶ Phiala Shanahan (lattice gauge theory)
- ▶ Mikhail M. Ivanov (cosmology)
- ▶ Silviu Pufu (holographic superconductors, F-theorem, holographic HIC)
- ▶ Asimina Arvanitaki (strings, axions, dark matter)
- ▶ Alex May (entanglement, complexity and holography)
- ▶ Sabrina Pasterski (flat space and celestial holography)
- ▶ Nate Craig (particle physics pheno)
- ▶ Xi Dong (holographic bulk reconstruction, holographic EE)
- ▶ Niklas Beisert (integrability in AdS/CFT)
- ▶ Lavinia Heisenberg (massive gravity, gravitational wave memory)
- ▶ Leonardo Senatore (cosmology)
- ▶ Tudor Dimofte (localization, SQFT, Chern-Simons)
- ▶ Veronika Hubeny (holographic EE, fluid/gravity)
- ▶ Mukund Rangamani (holographic EE, fluid/gravity)
- ▶ Jaroslav Trnka (scattering amplitudes, amplituhedron)
- ▶ David Simmons-Duffin (bootstrap and holography)

Backup slide III: Recent postdoc/research scholar hirings at IAS Princeton

Data includes all current members staying for at least 2 years; **holography highlighted**

- ▶ Chandrasekaran, Venkatesa quantum info in holography, dS holography
- ▶ Eberhardt, Lorenz string holography in AdS_3/CFT_2
- ▶ Hannesdottir, Holmfridur IR aspects of S-matrix
- ▶ Haouzi, Nathan gauge/liouville triality, little string theory
- ▶ Heydeman, Matthew AdS_3/CFT_2 , SYK/JT, AdS_5/CFT_4
- ▶ Itzhaki, Nissan AdS/CFT, holography beyond AdS, black hole interior
- ▶ Khan, Ahsan Z Landau-Ginzburg models
- ▶ Kruthoff, Jorrit finite cutoff holography, holographic superconductor
- ▶ Kudler-Flam, Jonah quantum info and holography
- ▶ Mazac, Dalimil conformal bootstrap and holography
- ▶ Mizera, Sebastian scattering amplitudes, celestial holography
- ▶ Parisi, Matteo amplituhedron
- ▶ Prem, Abhinav fractons
- ▶ Saad, Phil holography and RMT, SYK/JT duality
- ▶ Seifnashri, Sahand CFT_2
- ▶ Shirley, Wilbur fractons
- ▶ Turiaci, Gustavo Schwarzian and AdS_2 holography

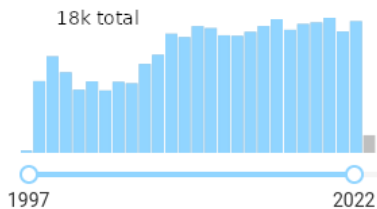
Backup slide IV: 1000+ cited high energy theory papers in past decade
Review articles excluded in list

Again, **holography-related research is highlighted**

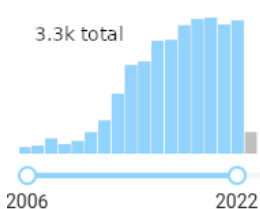
1. 1572 K.Bamba et al. (2012), Dark energy cosmology
2. 1484 J.Maldacena, S.Shenker & D.Stanford (2015), A bound on chaos
3. 1390 A.Almheiri et al. (2012), BHs: Complementarity or Firewalls?
4. 1385 CMB-S4 collab. (2016), CMB-S4 Science Book, First Edition
5. 1312 J.Maldacena & D.Stanford (2016), Remarks on the SYK model
6. 1309 D.Buttazzo et al. (2013), Investigating near-criticality of Higgs
7. 1137 L.Hui et al. (2016), Ultralight scalars as ... dark matter
8. 1074 J.Maldacena & L.Susskind (2013), ER=EPR
9. 1053 S.Shenker & D.Stanford (2013), Black holes & butterfly effect
10. 1031 E.Berti et al. (2013), Testing GR w. ... astrophys. observations

Half of the top-10 papers on gauge/gravity duality & holography

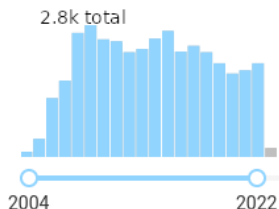
Backup slide V: Citations of some key gauge/gravity duality papers



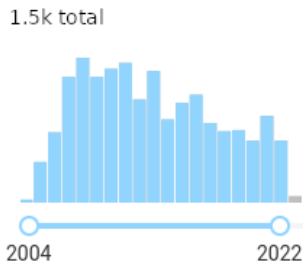
AdS/CFT ('97)



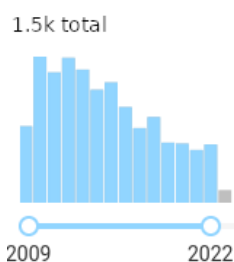
HEE ('06)



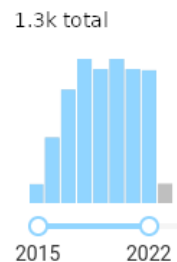
KSS bound ('04)



Sakai-Sugimoto ('04)



H.Supercond. ('09)



SYK/JT ('15)