

Title: Perimeter Researcher Talk - 'Into the woods and through the trees to gravity, amplitudes, and CFTs'

Speakers: Sabrina Pasterski

Collection: The Day of Discovery

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Into the woods...

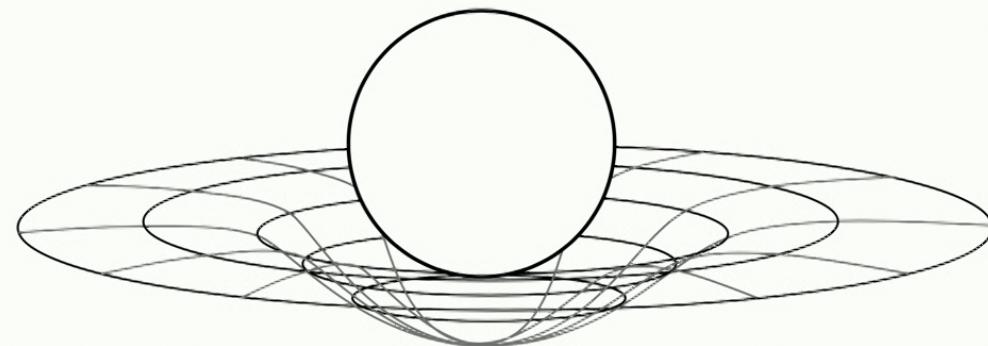
... and through the trees to gravity, amplitudes, and CFTs

Sabrina Pasterski @ Perimeter's Day of Discovery



The standard pitch starts by invoking the big-picture problem...

$$i\hbar \frac{\partial}{\partial t} |\psi\rangle = H|\psi\rangle$$

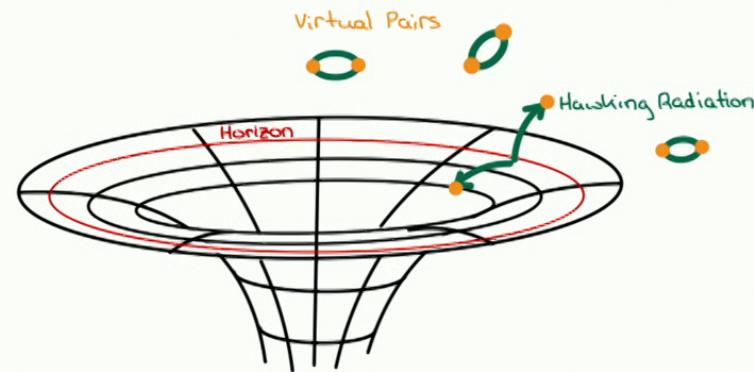


... of combining quantum mechanics and general relativity into a consistent fundamental theory.

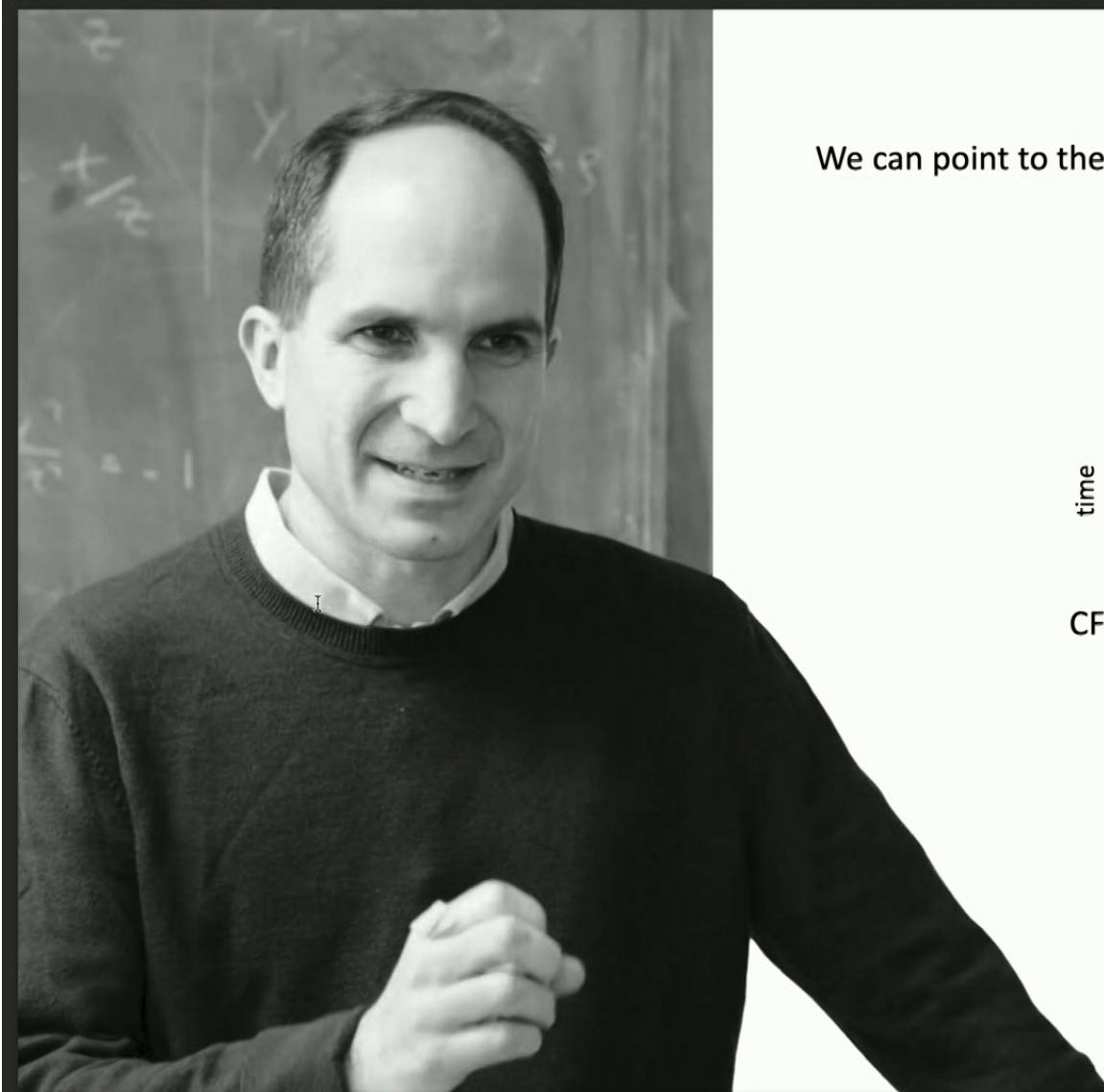
Our understanding of black hole thermodynamics points to the **holographic principle** whereby...

$$S_{BH} = \frac{c^3 Area_{Horizon}}{4G_N \hbar}$$

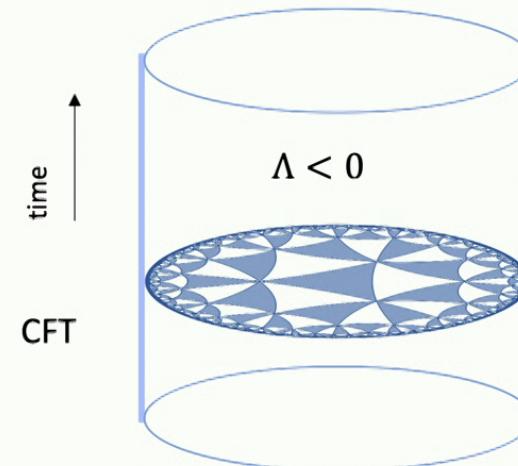
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... a theory of quantum gravity should be encoded in a lower dimensional theory without gravity.

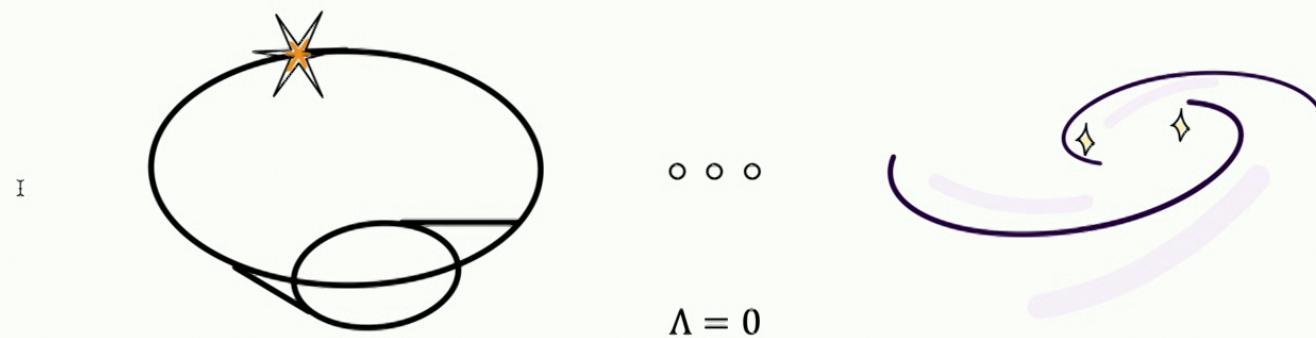


We can point to the successful precedent of AdS/CFT...



... where we have an explicit top down construction from string theory...

... demand that it should generalize to experimentally relevant scenarios...



... well approximated by spacetimes which are asymptotically flat

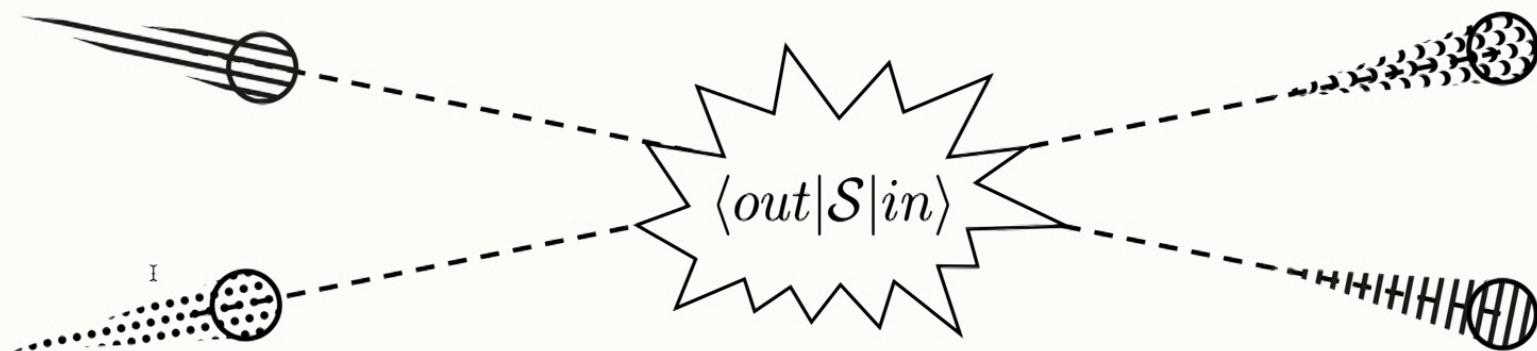
... and try to apply Noether's theorem...

More Symmetries \Rightarrow More Constraints

... to constrain the structure of our hologram
starting from the bottom up.

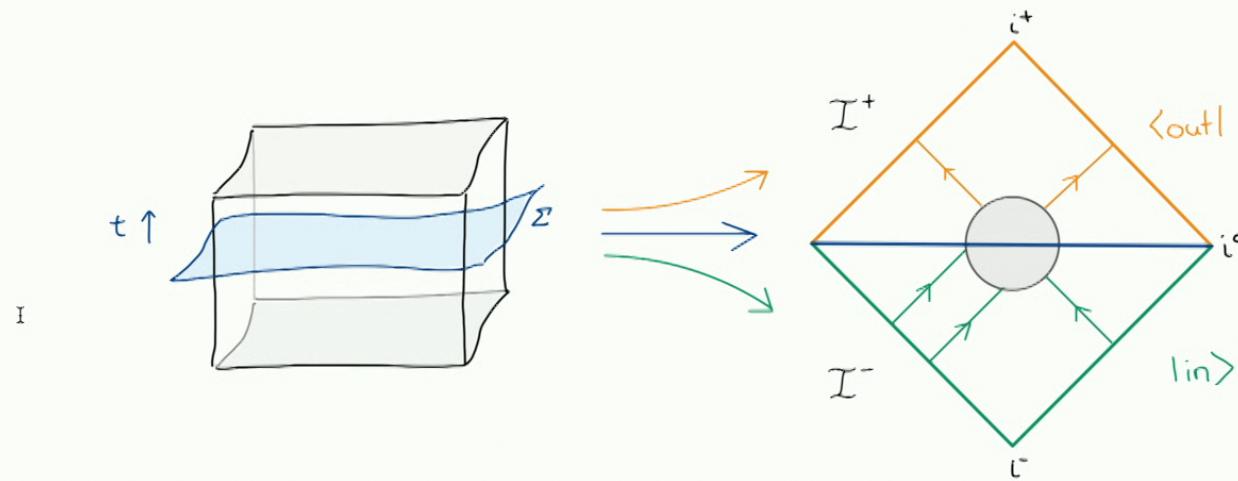


The central object of study is the scattering matrix...



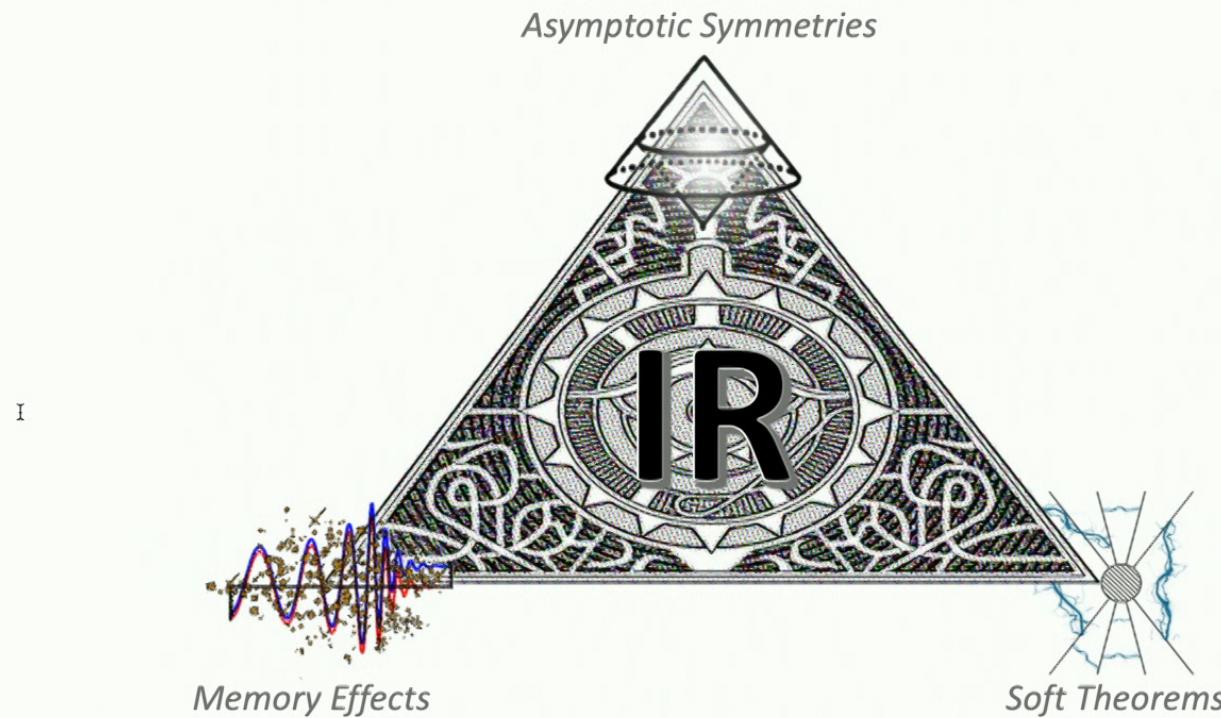
... which we want to study not just in the context of collider experiments but also including gravity.

In practice, we can phrase the scattering problem more holographically...



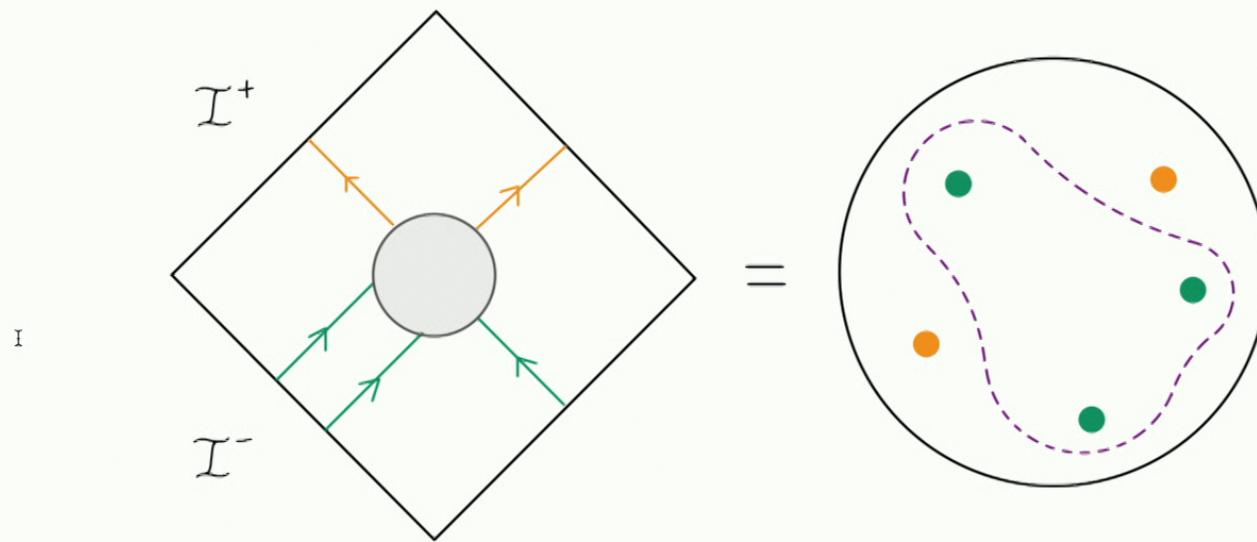
... which lets us merge our understanding of asymptotic symmetries with IR behavior of the S-matrix.

Upon doing so one finds a beautiful set of connections...



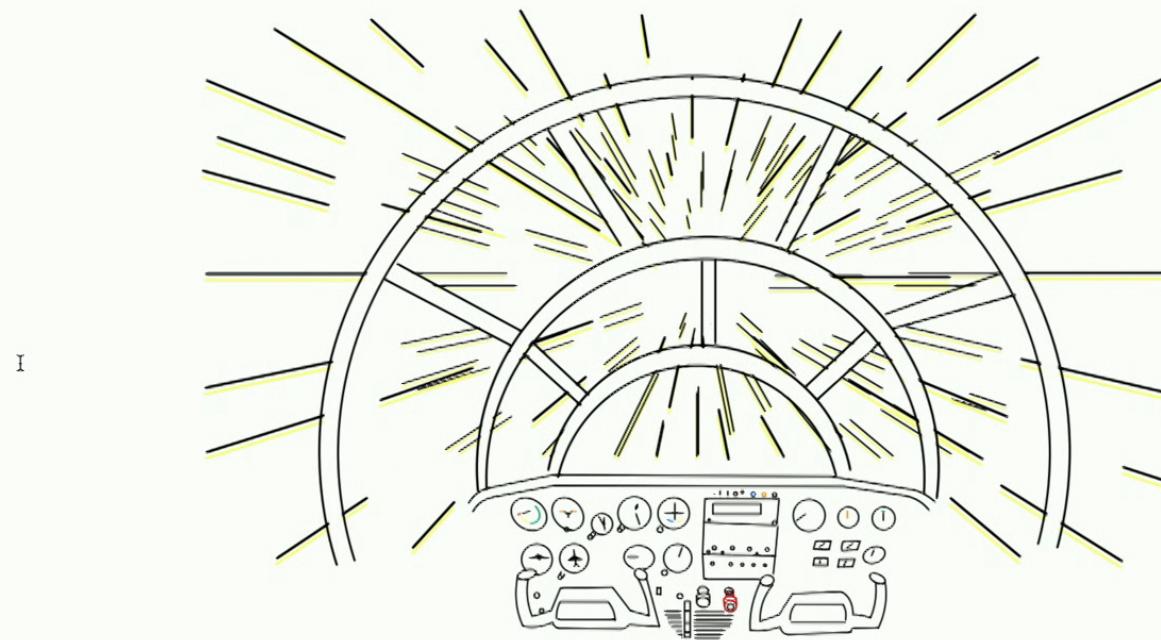
... that generalize to many examples.

Perhaps surprisingly, these symmetries point to a natural dimensional reduction...



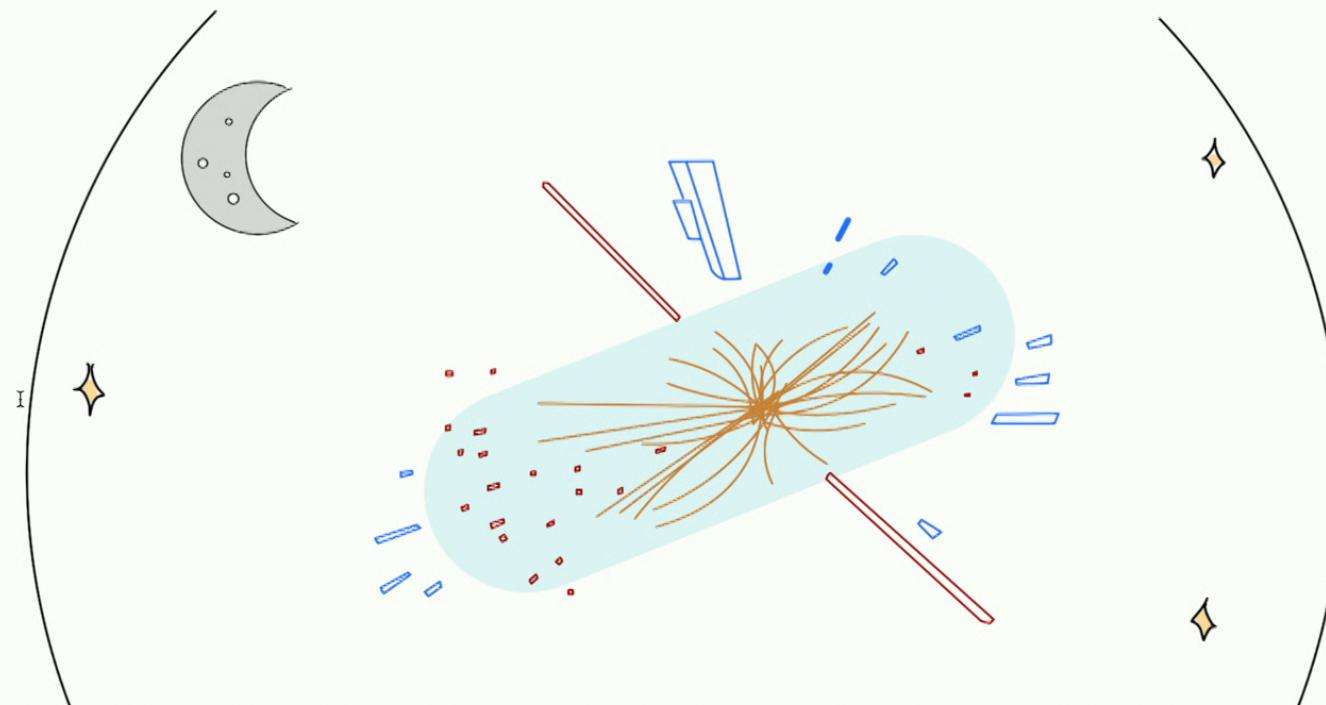
... of the conformal boundary to the celestial sphere.

Now Lorentz transformations of Minkowski space...



... act as global conformal transformations on the celestial sphere.

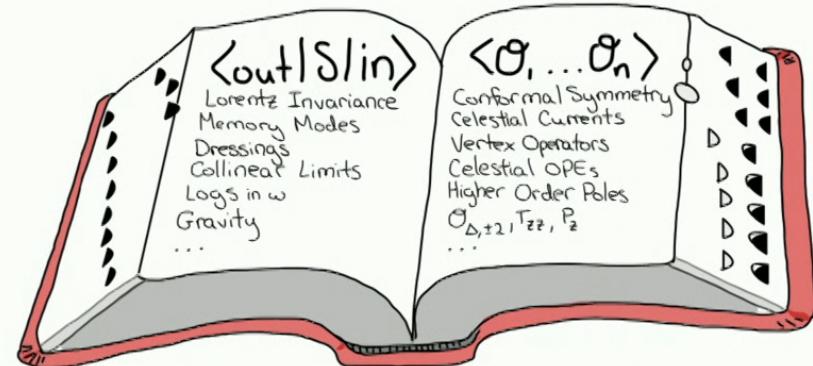
Celestial Holography proposes a duality between scattering in asymptotically flat spacetimes...



... and a CFT living on the celestial sphere.

Some successes from this program include...

- New soft theorems connected to ASGs (thanks Freddy!)
- New observable memory effects to be detected
- Rephrasing of soft dressings used to define an IR finite S-matrix
- Constraints on black hole evaporation
- Analytic features of quantum gravity in the boost-weight plane
- Collinear limits as a celestial OPE
- Towers of symmetries beyond the ASG analysis (thanks Laurent!)
- Connections to twistor theory
- Possible top down constructions from twisted holography (thanks Kevin!)
- ...





Into the woods...

... and through the trees **to gravity, amplitudes, and CFTs**

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Where does this fit in the bigger picture of QF&S research?



Into the woods...

... and through the trees to gravity, amplitudes, and CFTs

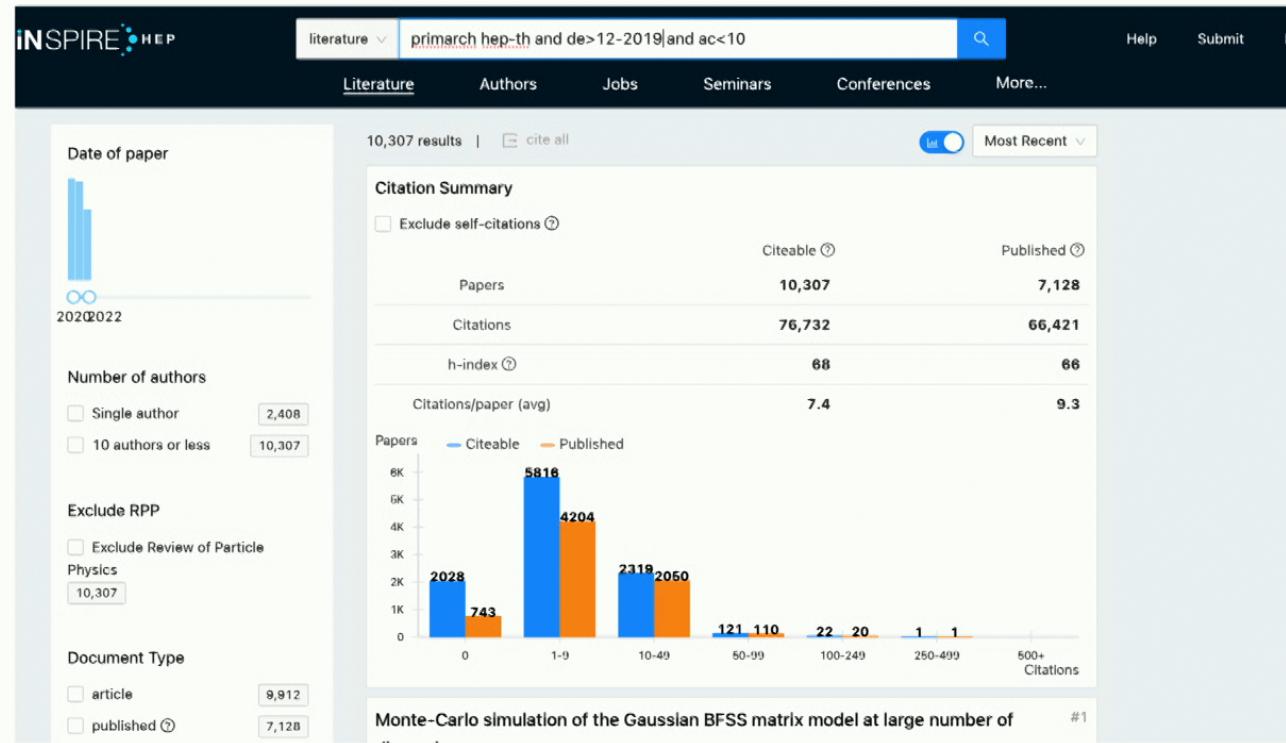
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What is Strings?

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Who ~~What~~ is Strings?

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use INSPIREHEP api... ask for author
identifiers with hep-th primarch paper in
last 3 years with <10 authors ...

9.1k

J.V.Ramallo.1,G.B.De.Luca.1,S.Steinhaus.1,Christoph.F.Uhl.1,A.Helayel.Neto.3,J.Jurkiewicz.1,J.H.Gao.1,H.Malcha.1,F.V.Nomura.1,J.J.Blanco.Pillado.1,Sandor.Nagy.1,P.Chattopadhyay.1,F.Toyoda.1,W.S.De.Paula.1,Tomas.Andrade.1,M.Benincasa.1,A.Andreev.1,M.Alam.2,S.Pasterski.1,S.H.H.Tye.1,Avik.C.1,E.M.C.Abreu.1,K.BitaghSir.Fadafan.1,M.Ghodrati.1,A.V.G.T.Horowitz.1,S.Kaushal.3,S.Y.Alexandrov.1,L.A.Ferreira.1,Daniel.Baumann.1,B.L.Giacchini.1,M.Ashwinkumar.1,S.N.Djukic.1,T.Q.Loc.1,M.R.Setare.1,A.F.Vieira.1,I.Andrade.1,I.J.Lindstrom.1,A.Nicolis.1,M.Usovitsuk.1,V.Karapetyan.1,A.H.F.

... merge with participant lists for major
conferences (strings, string math,
amplitudes, bootstrap, it from qubit ...)

9.5k

use INSPIREHEP api... ask for author
identifiers with hep-th primarch paper in
last 3 years with <10 authors ...

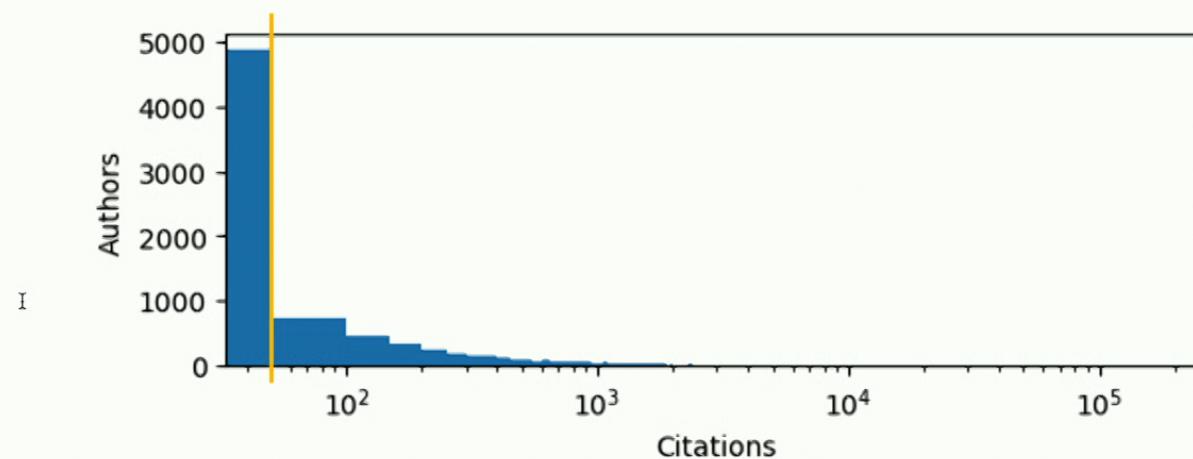
9.1k

J.Ramallo.1,G.B.De.Luca.1,S.Steinhaus.1,Christoph.F.Uhl.1,A.Helayel.Neto.3,J.Jurkiewicz.1,J.H.Gao.1,H.Malcha.1,F.V.Nomura.1,J.J.Blanco.Pillado.1,Sandor.Nagy.1,P.Chattopadhyay.1,F.Toyoda.1,W.S.De.Paula.1,Tomas.Andrade.1,M.Benincasa.1,A.Andreev.1,M.Alam.2,S.Pasterski.1,S.H.H.Tye.1,Avik.C.1,E.M.C.Abreu.1,K.Bitaghsir.Fadafan.1,M.Ghodrati.1,A.V.G.T.Horowitz.1,S.Kaushal.3,S.Y.Alexandrov.1,L.A.Ferreira.1,Daniel.Baumann.1,B.L.Giacchini.1,M.Ashwinkumar.1,S.N.Djukic.1,T.Q.Loc.1,M.R.Setare.1,A.F.Vieira.1,I.Andrade.1,I.Jedetstrom.1,A.Nicolis.1,M.Usovitsuk.1,V.Karataeva.1,A.H.F.

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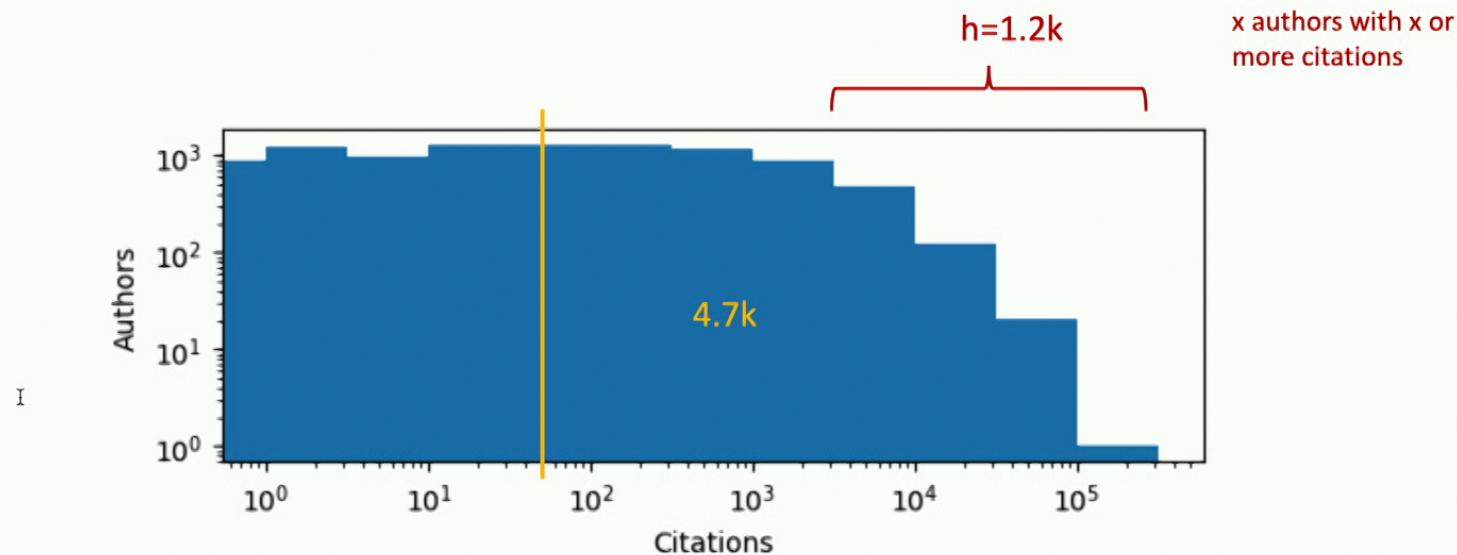
9.5k

Still an overestimate since this includes a lot of people entering the research pipeline....



.... imposing an IR cutoff > 50 hep-th citations removes half

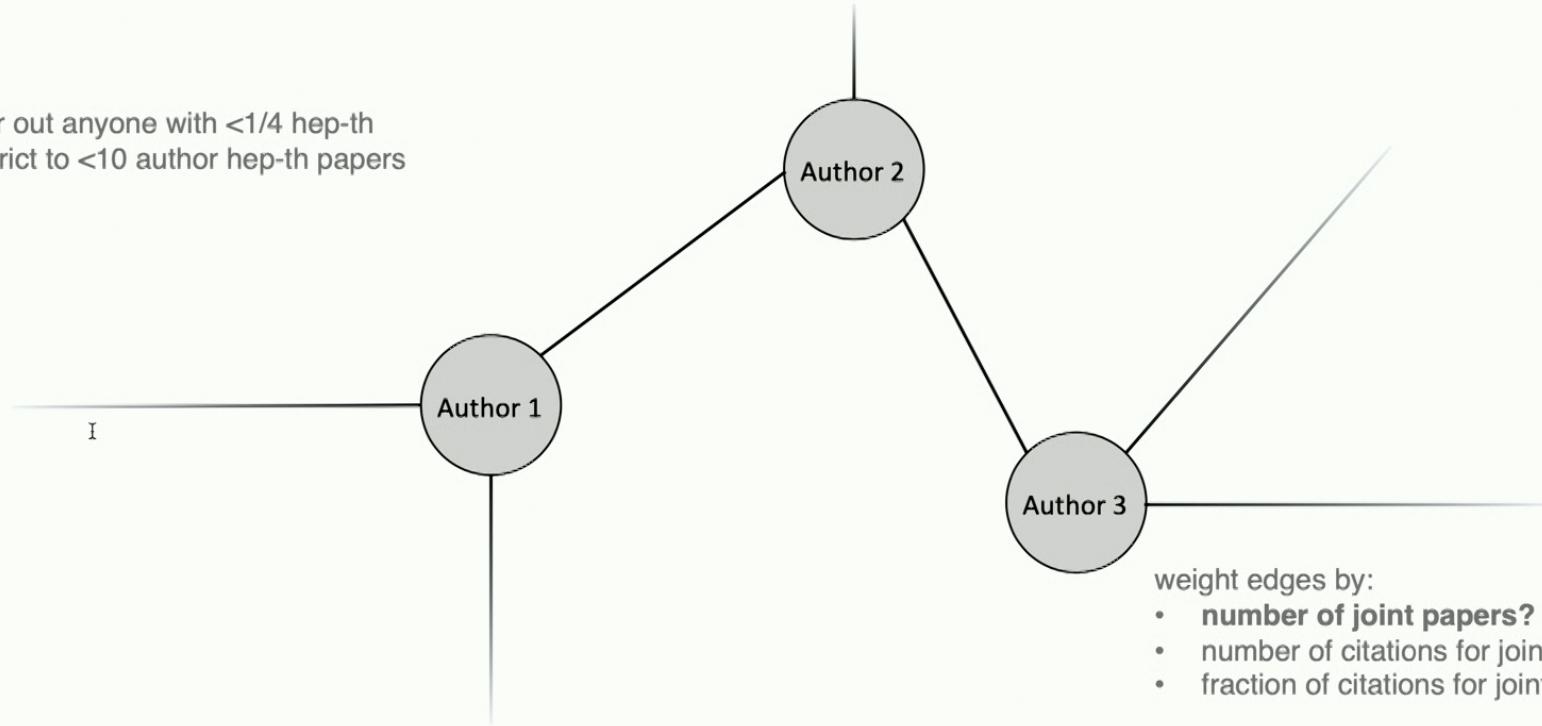
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So let's look at these top 1.2k over the last 10 years...

filter out anyone with <1/4 hep-th
restrict to <10 author hep-th papers



weight edges by:

- **number of joint papers?**
- number of citations for joint papers?
- fraction of citations for joint papers?

.... and see who's worked with who

some hep-th precedents

http://www.casos.cs.cmu.edu/computational_tools/datasets/external/hep-th/index11.php (1995-1999 by M. Newman)

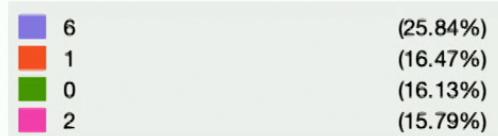
<https://snap.stanford.edu/data/ca-HepTh.html> (1993-2003 by J. Leskovec)

a recent quant-ph study

<https://arxiv.org/pdf/2112.03403.pdf>

So let's look at these top 1.2k over the last 10 years...

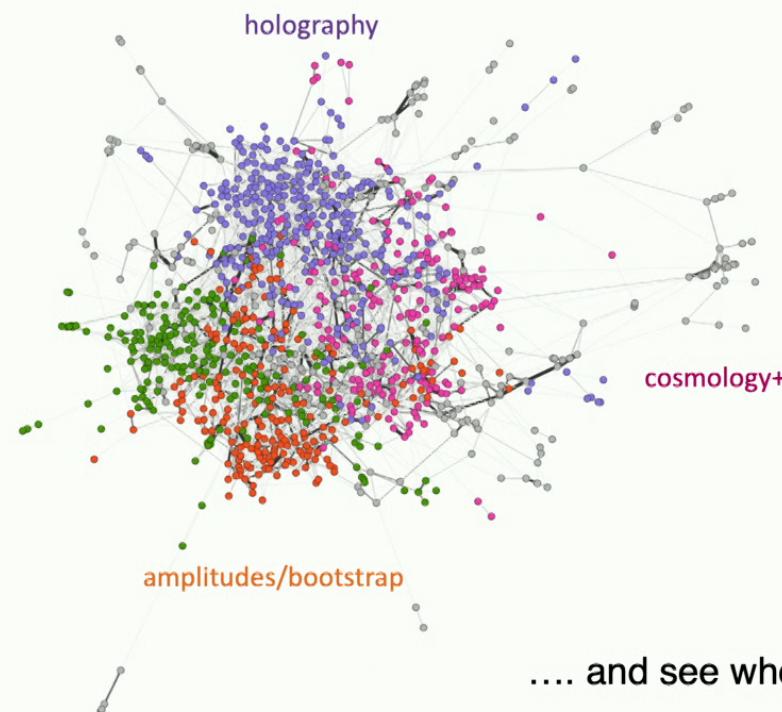
can identify communities using Gephi



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strings

holography



.... and see who's worked with who

So let's look at these top 1.2k over the last 10 years...

can identify communities using Gephi

