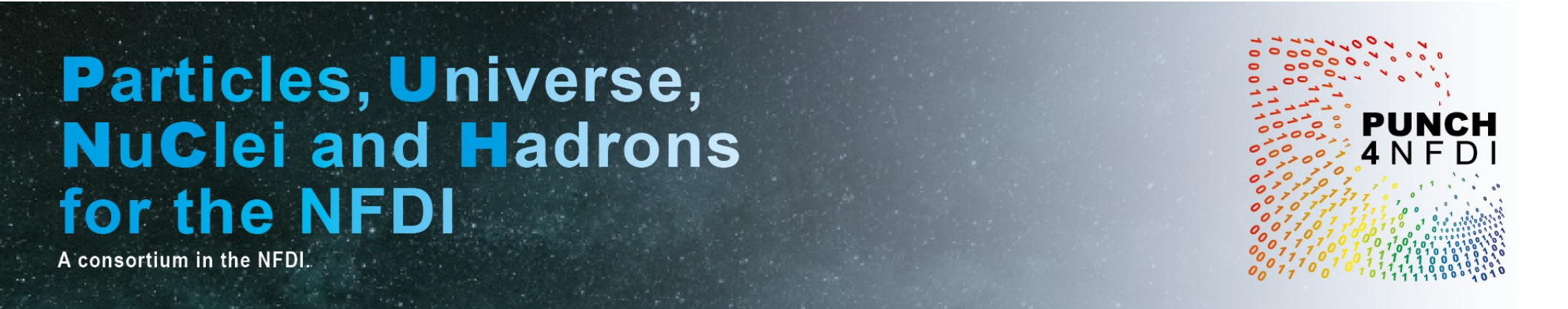
UNIVERSITÄT BIELEFELD

CRC-TR 211

# Data Challenges for Hot Physics

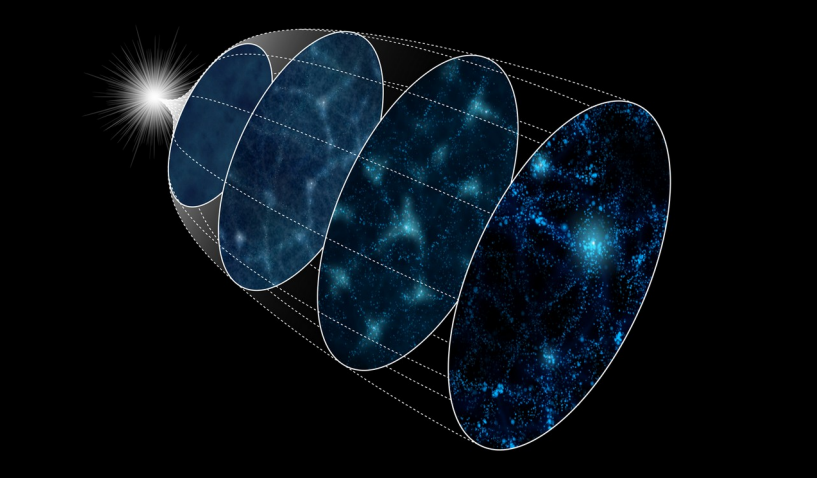
David A. Clarke



Nuclear matter

Very dense

Very hot



Early universe

Credit: The Institute of Statistical Mathematics

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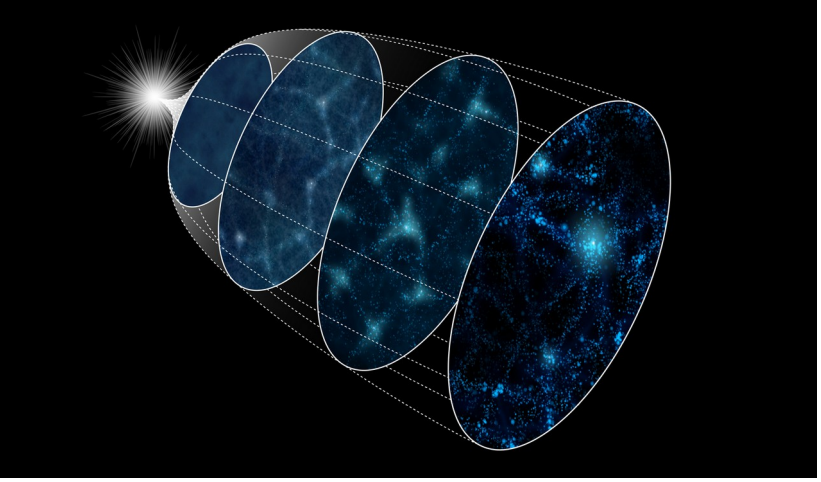

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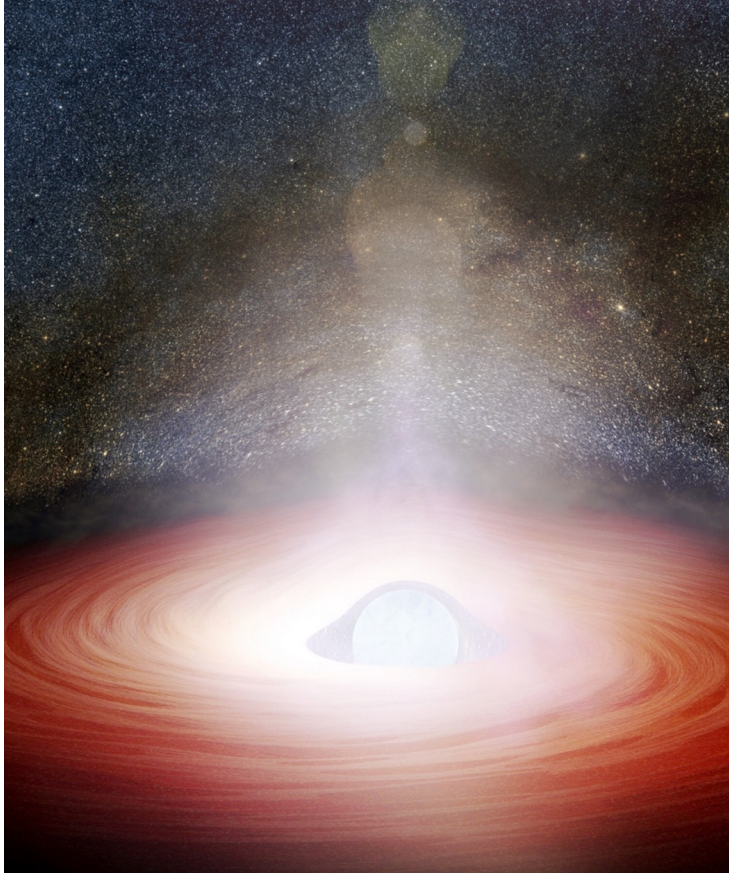
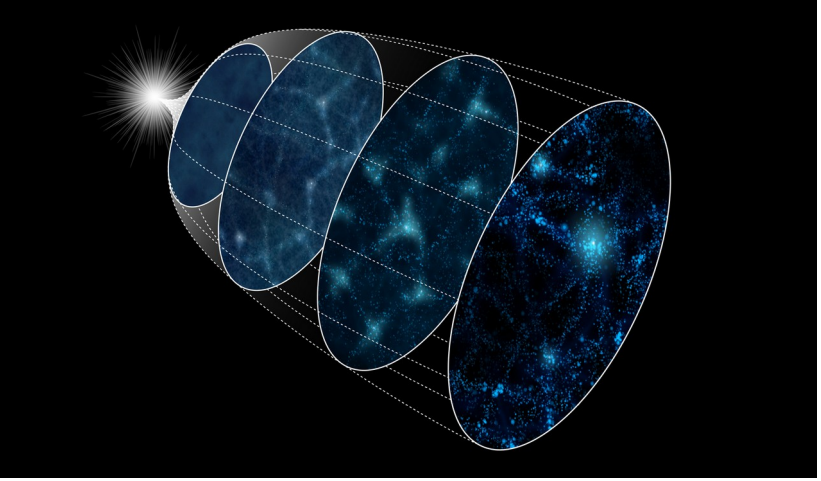


Neutron stars

Credit: Wikipedia



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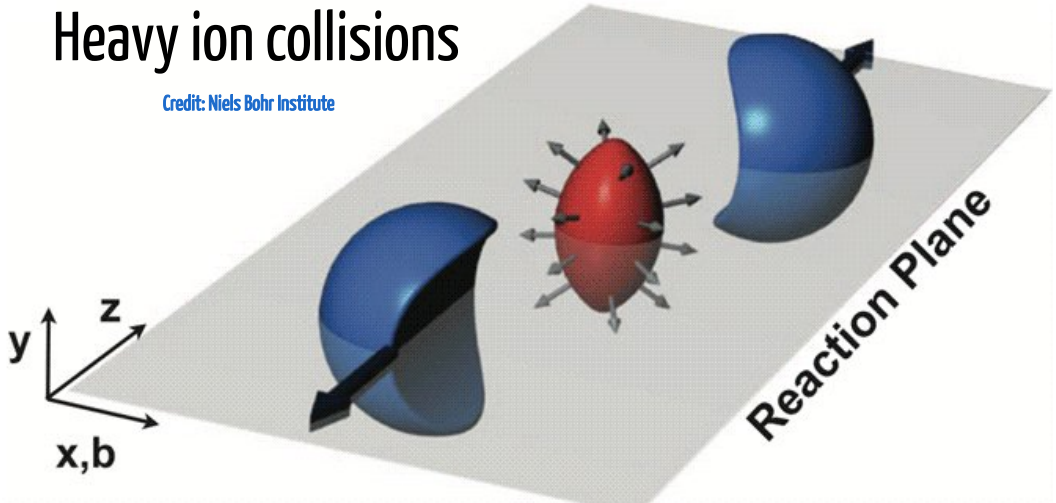
Credit: Niels Bohr Institute

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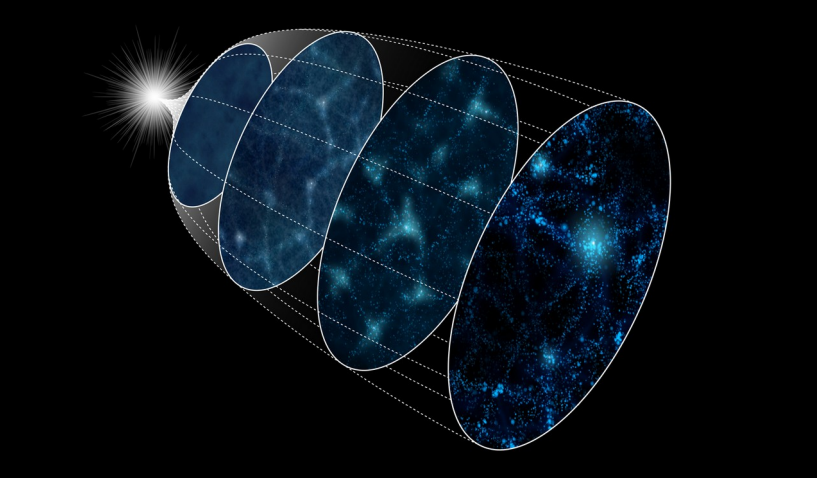

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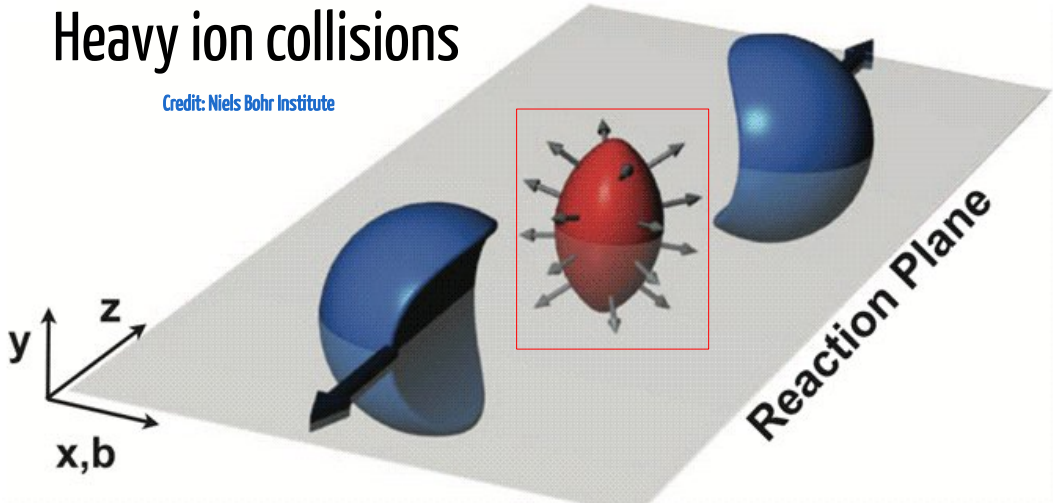
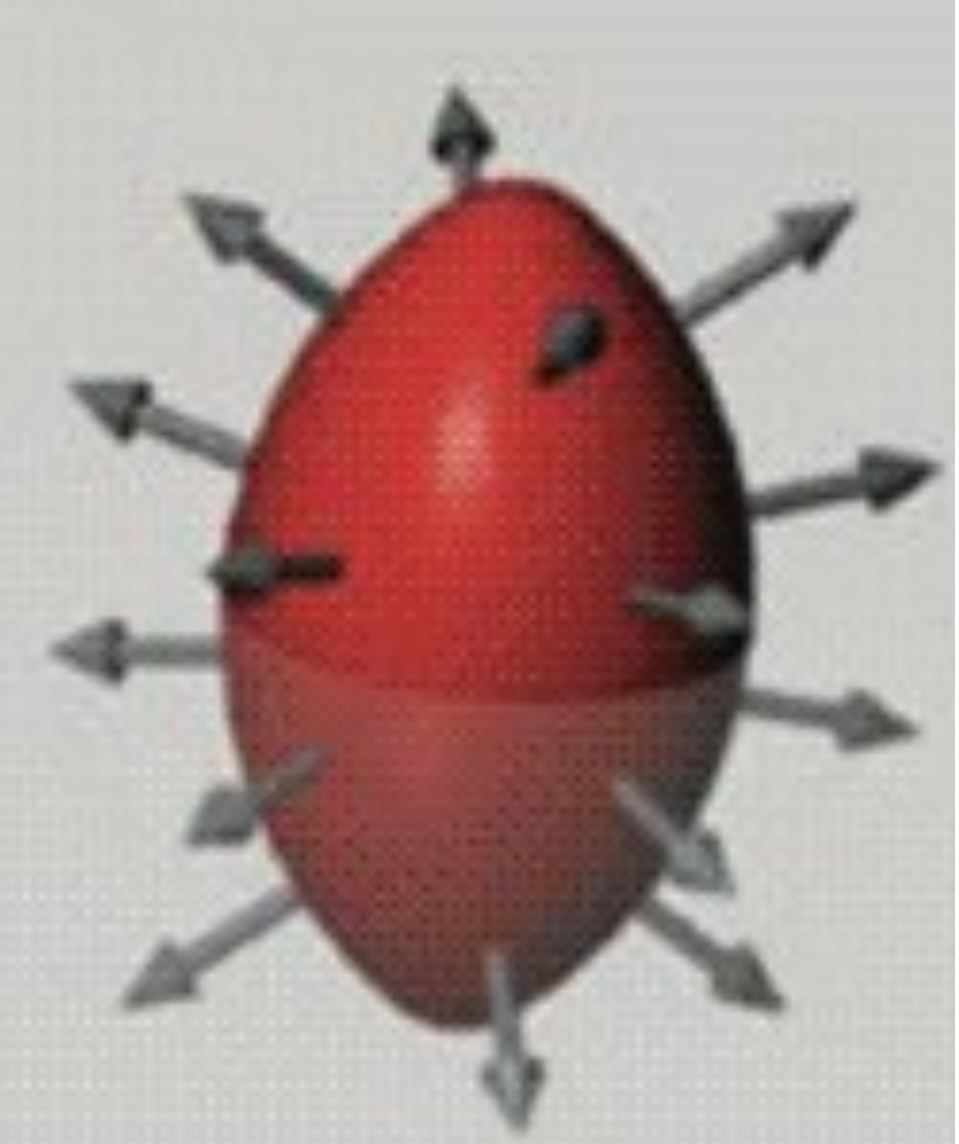
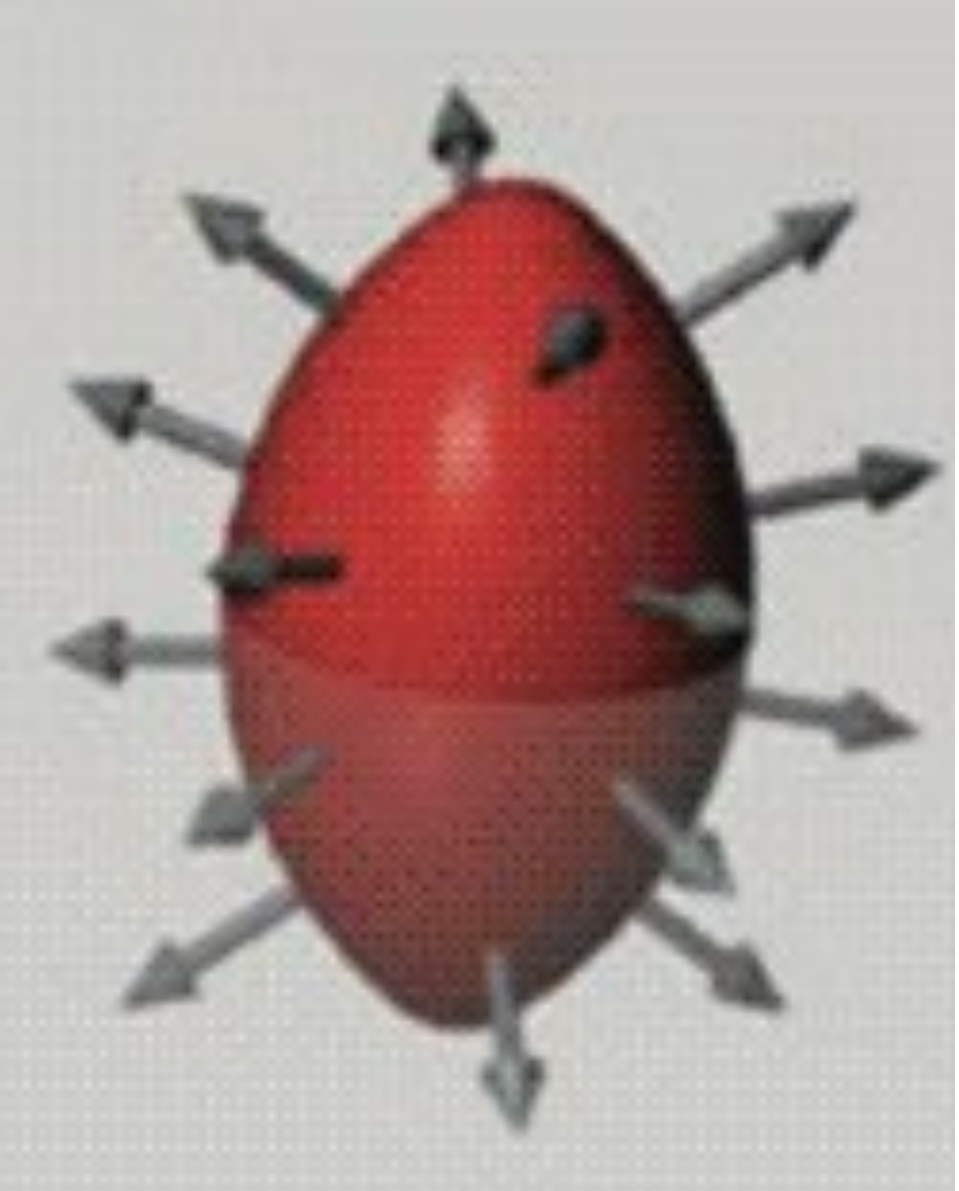
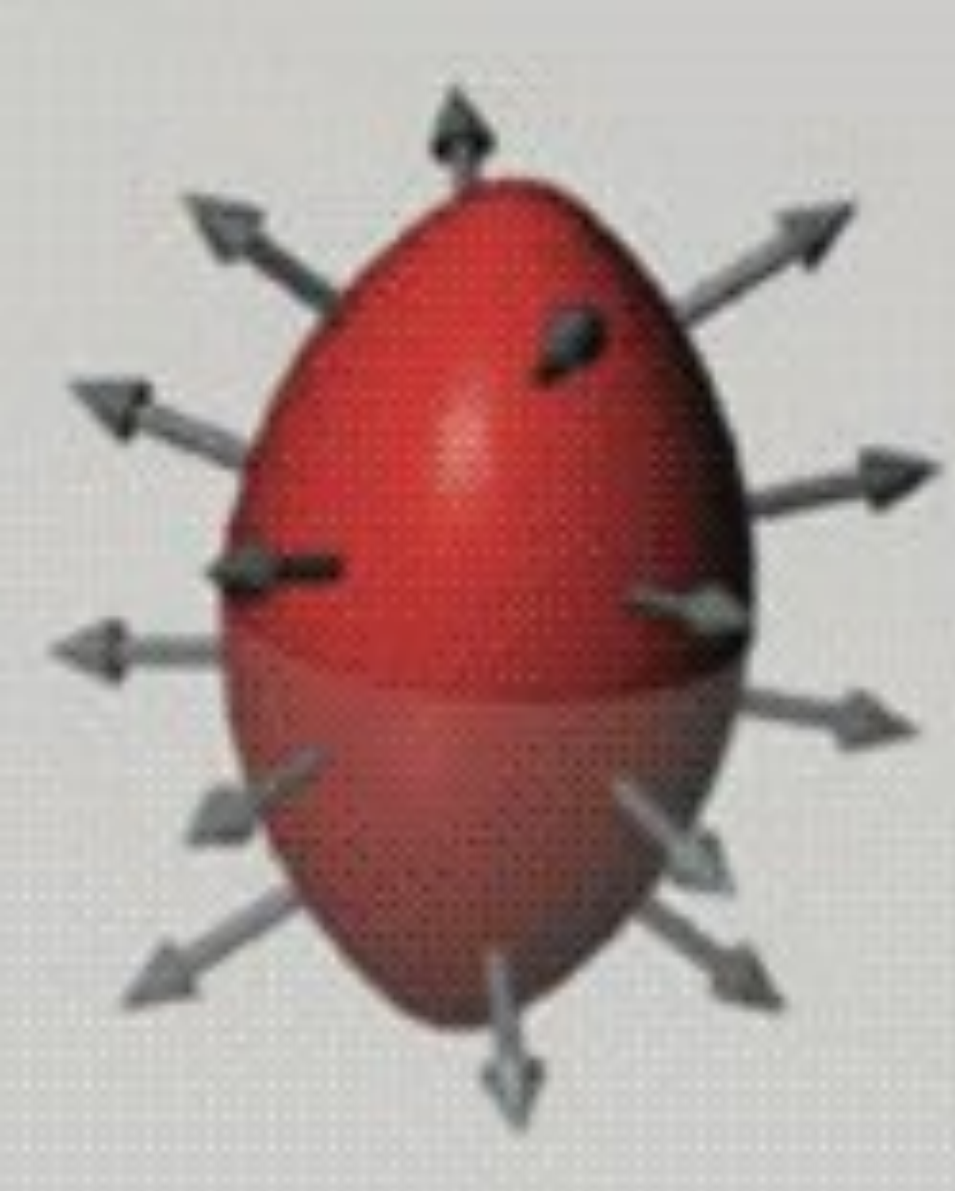
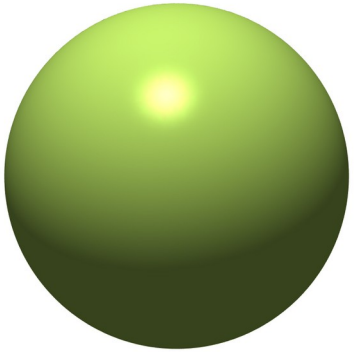
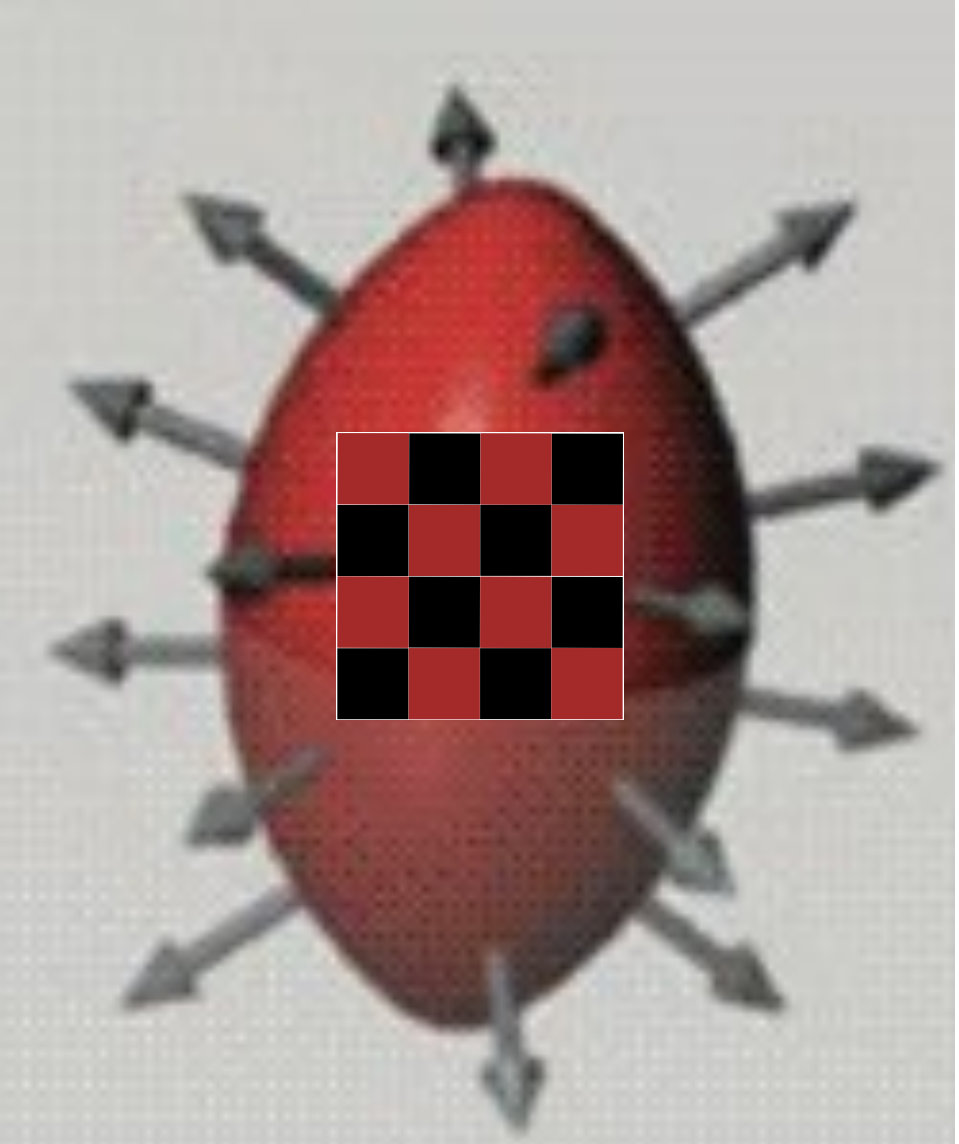


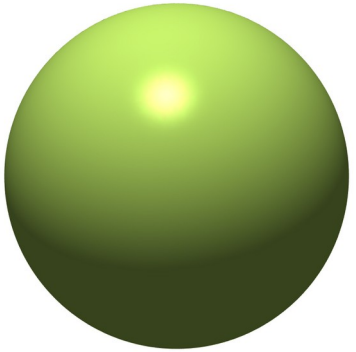




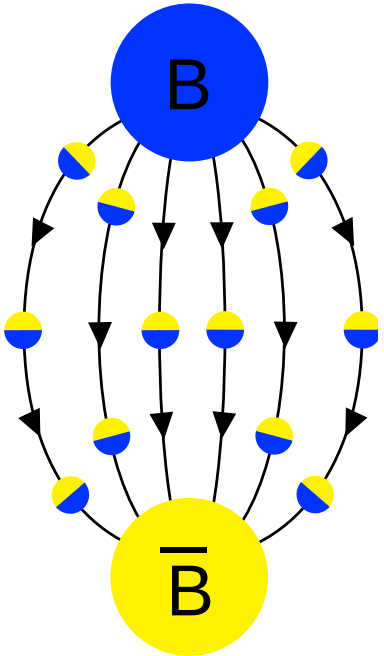






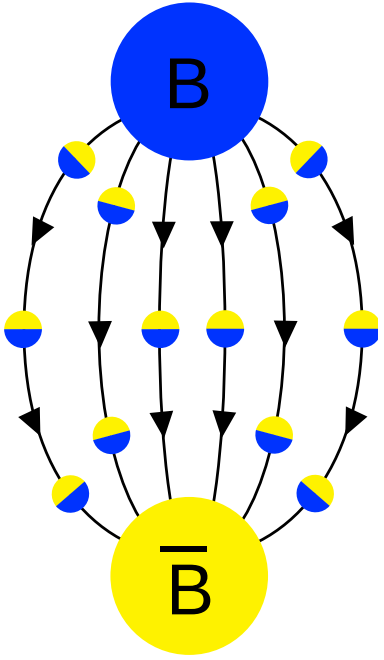


Fields




Elementary particles

Fields

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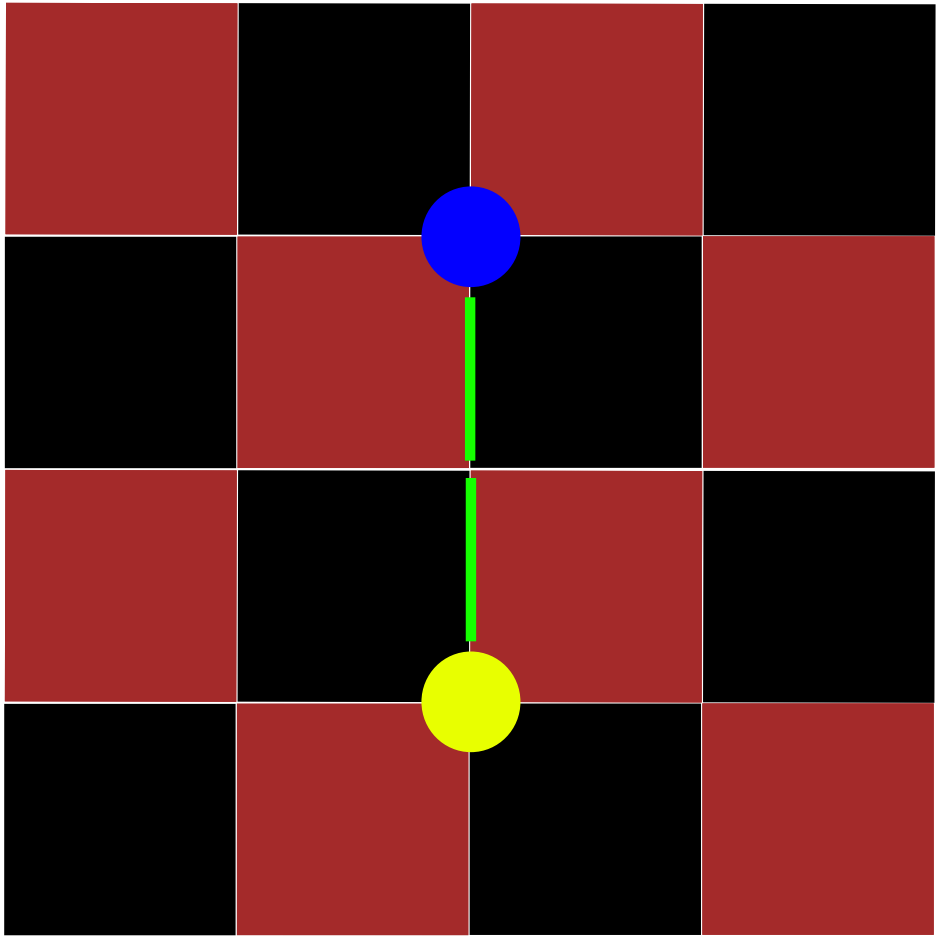

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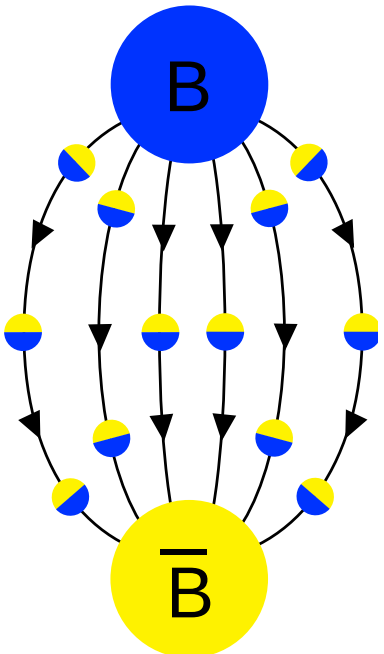


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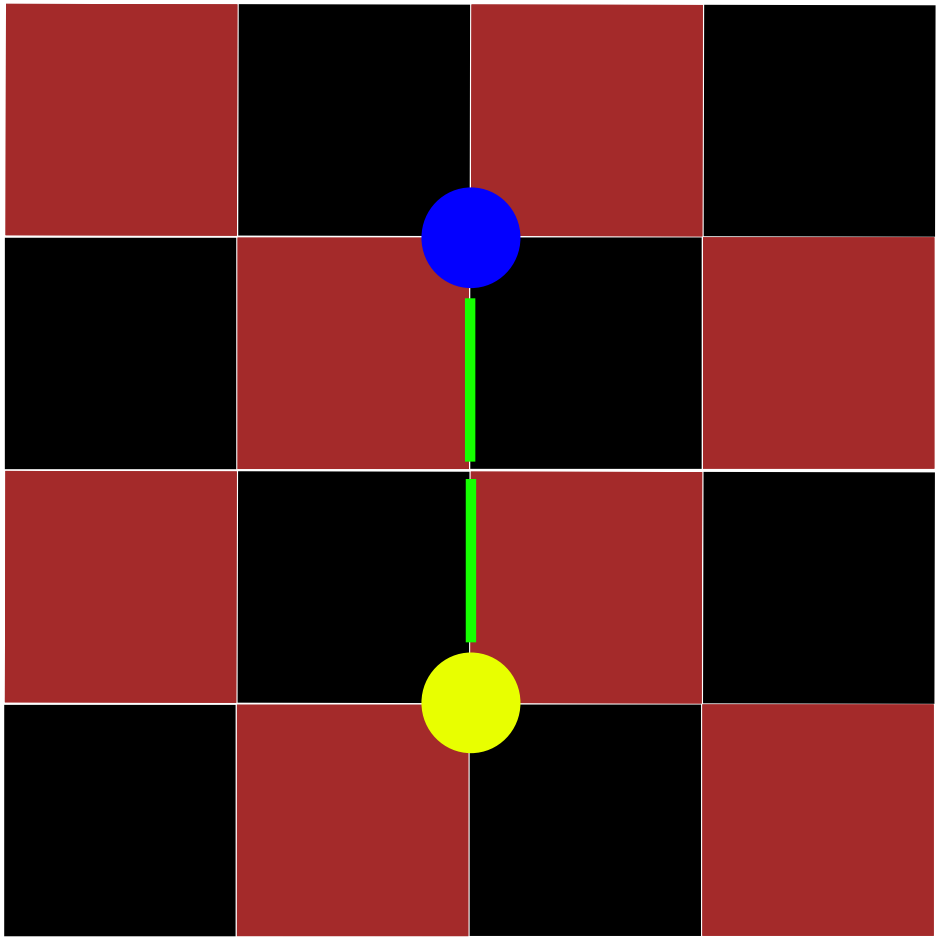
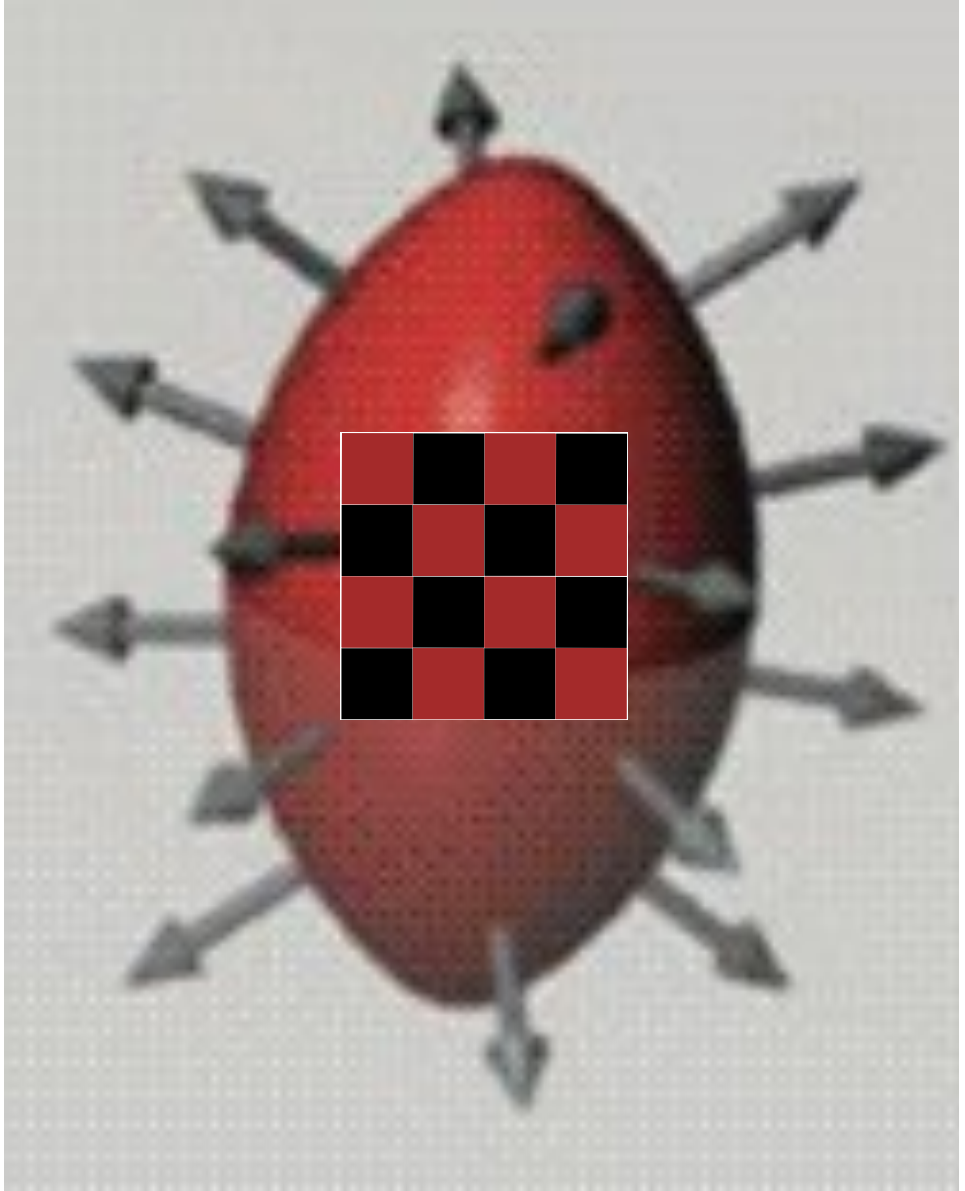
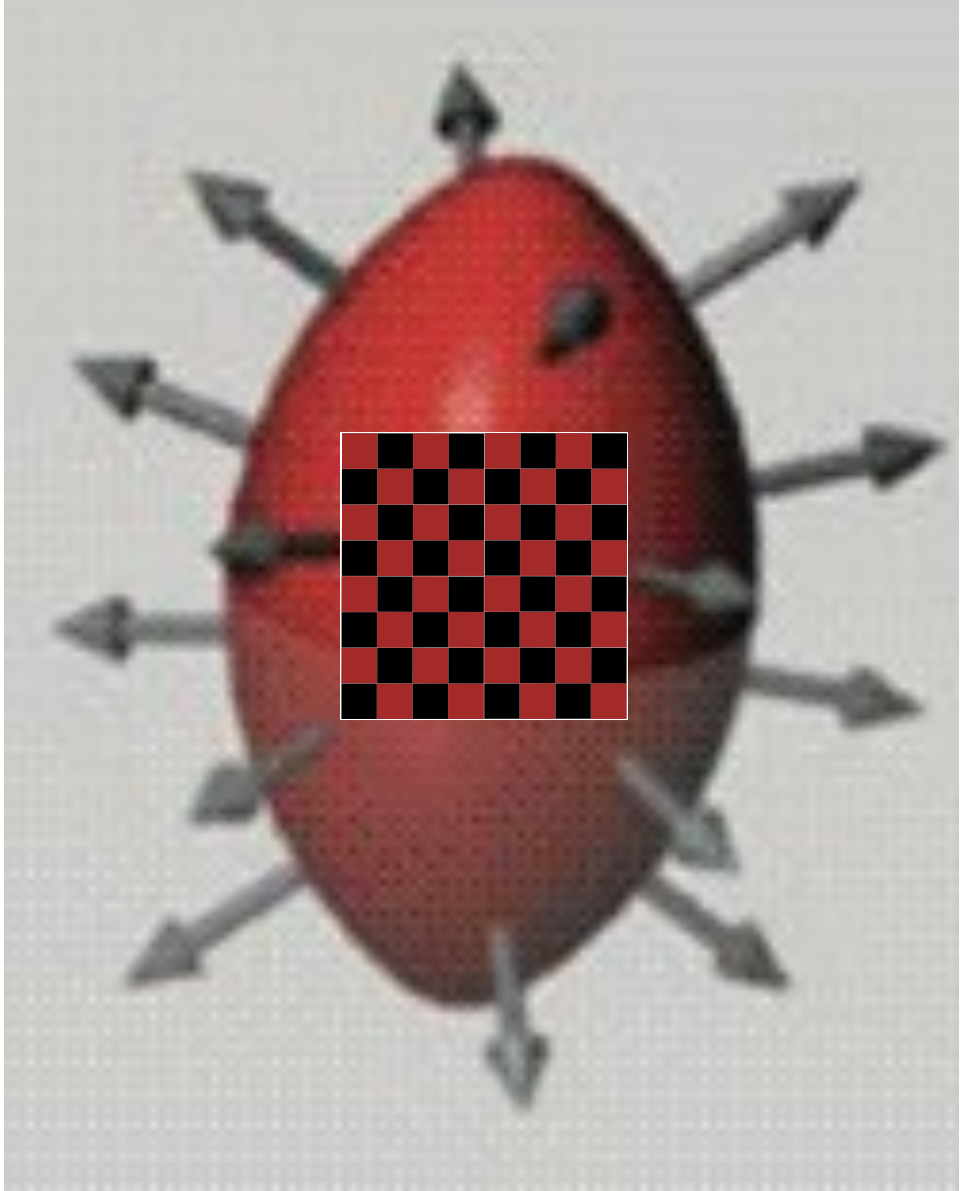
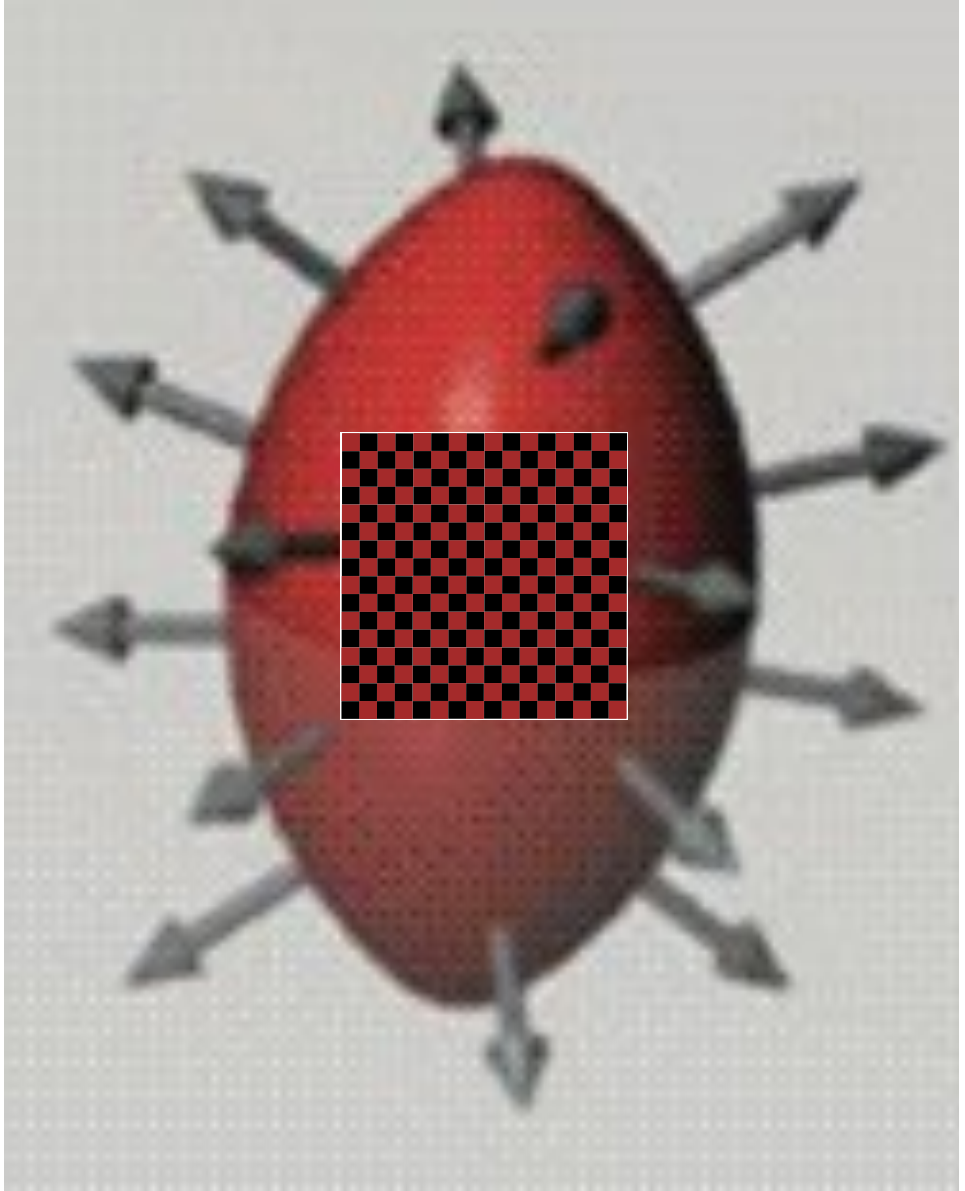
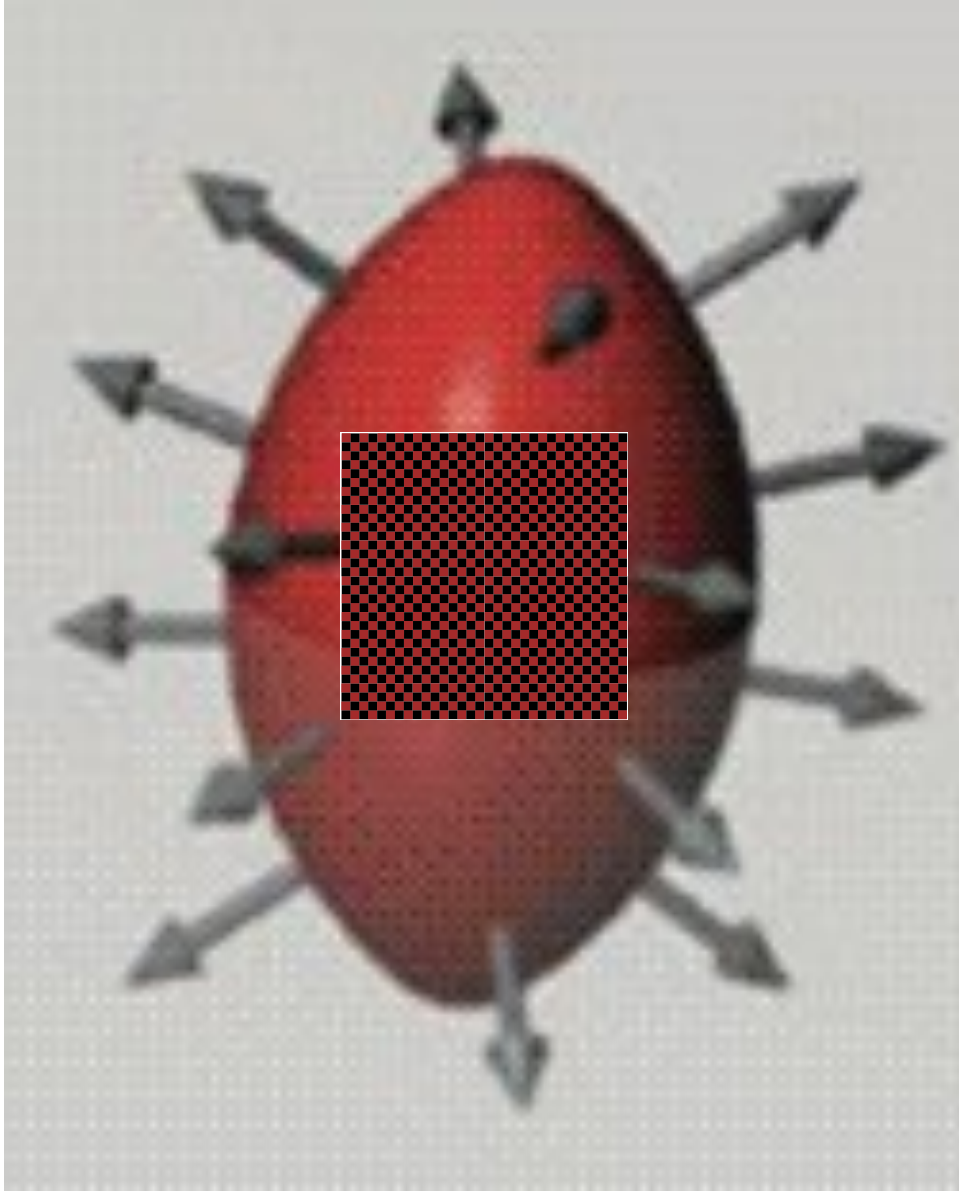


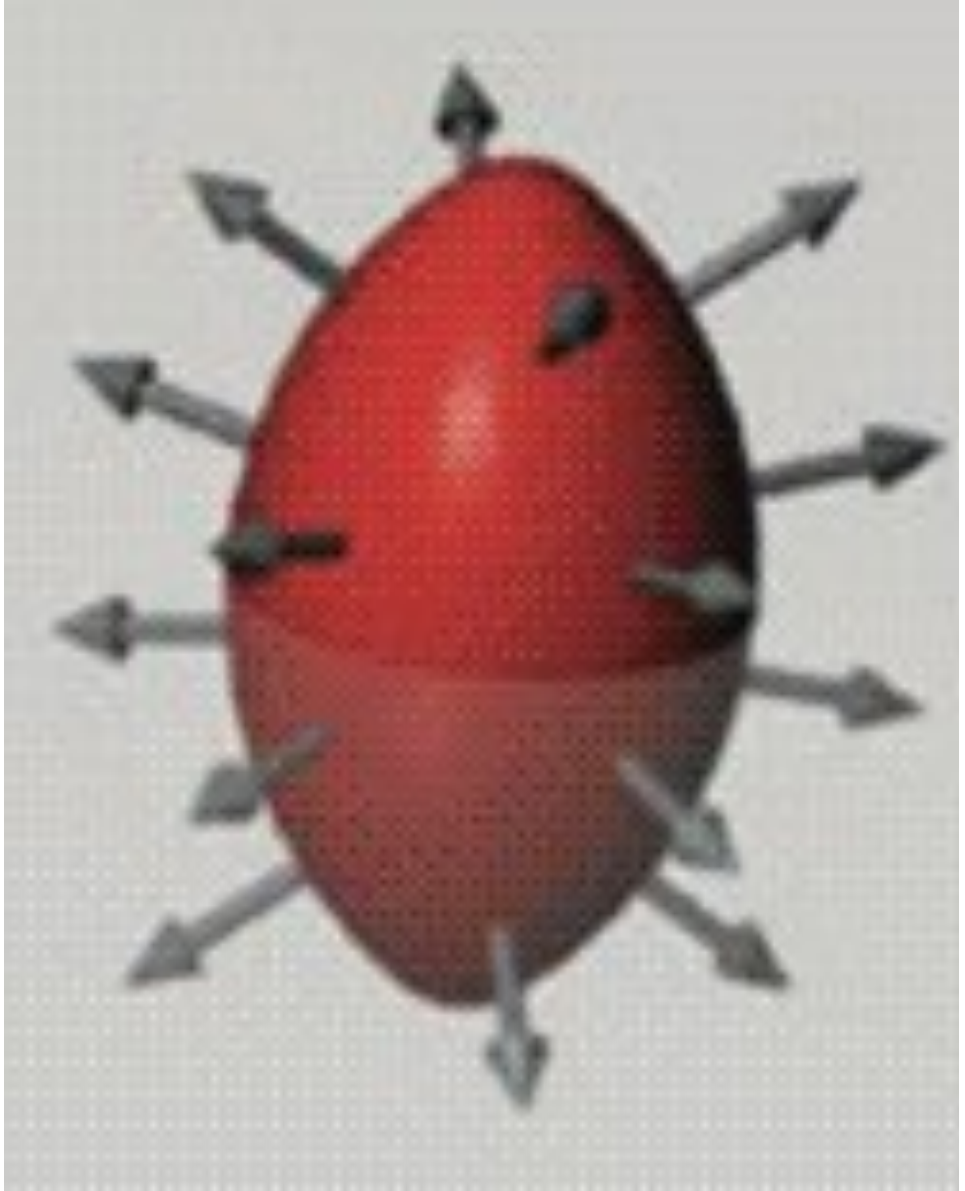
“Lattice”





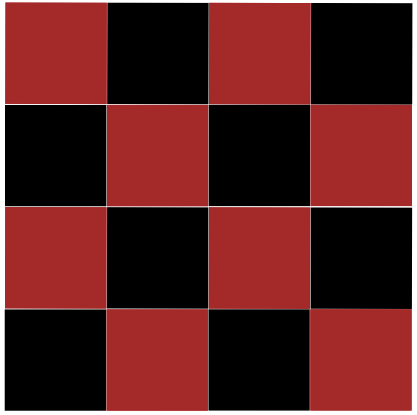


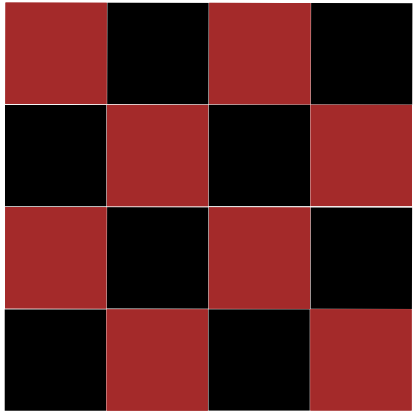




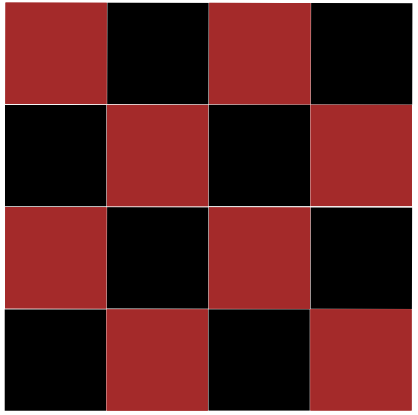
Gives us a way to learn about this system

- Compare to other theory
- Maybe no other option





$E_1$



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## Quantum Mechanics: Fields fundamentally random

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- But we **can** calculate average
- Correspondingly, lattice is **possible** outcome
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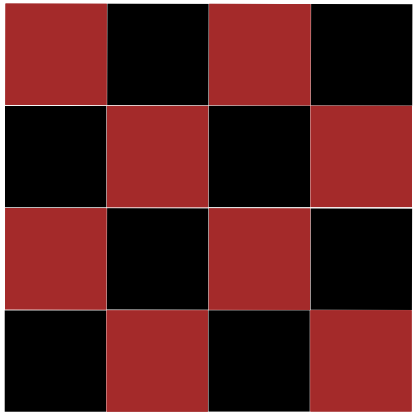
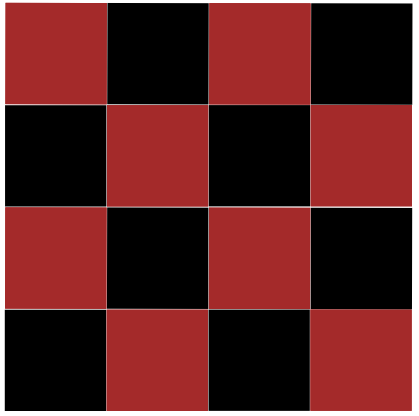
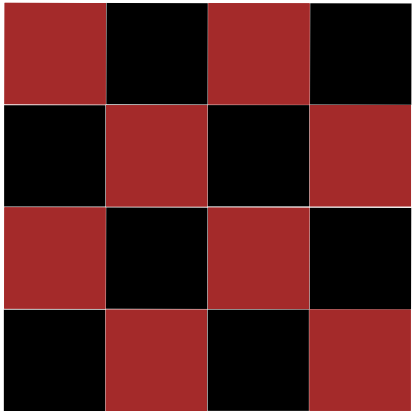
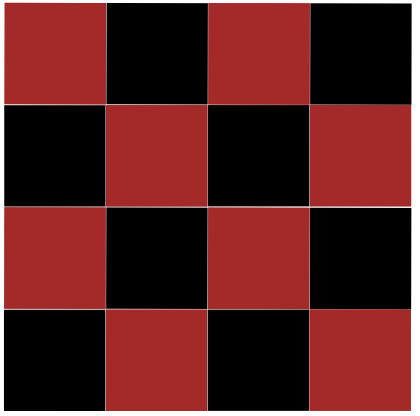


$$\langle E \rangle \approx \frac{1}{N_{lattice}} \left( E_1 + E_2 + E_3 + E_4 + \dots \right)$$







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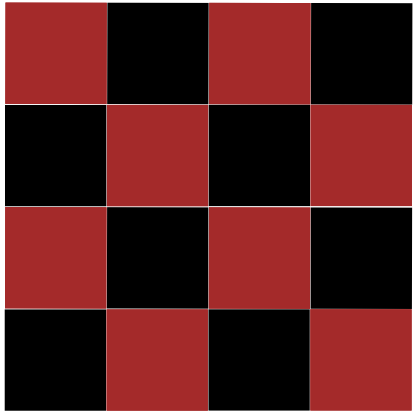

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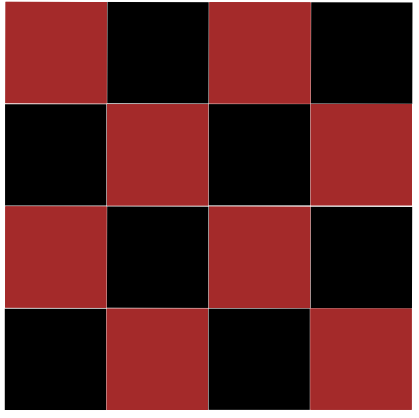
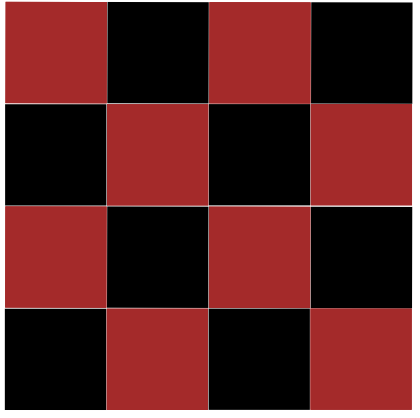
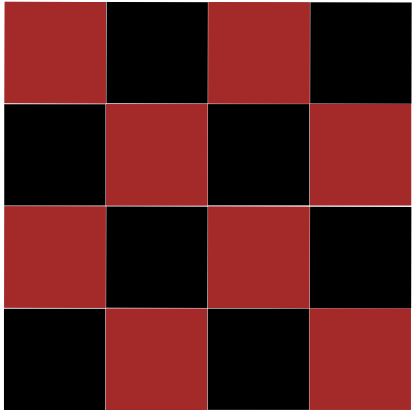




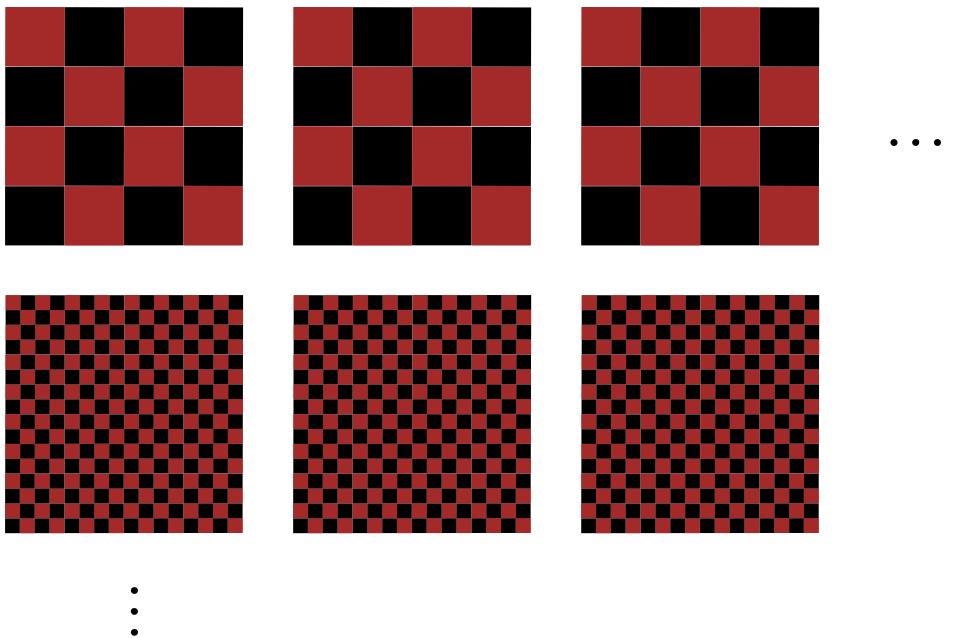


… make $N_{lattice}$

$N_{lattice} \sim 10^6$

Summary: Using lattice field theory to compute $\langle E \rangle$

1) Put hot, dense region on a lattice
2) Quantum Mechanics: Sample snapshots of that region
3) Lattice isn't real: Repeat for finer and finer lattices



Need **a lot** of lattices...

- High storage requirements
- High computational cost

Storage challenges:

Information stored in “links”

Link represents field here

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One lattice ~ **8 GB**

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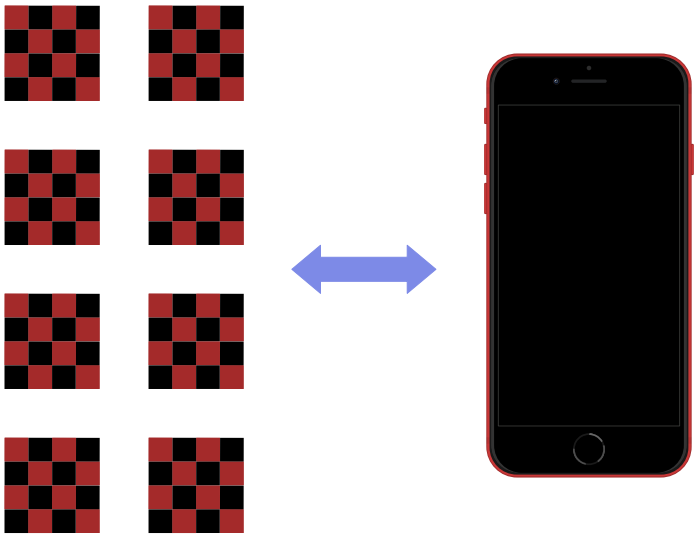

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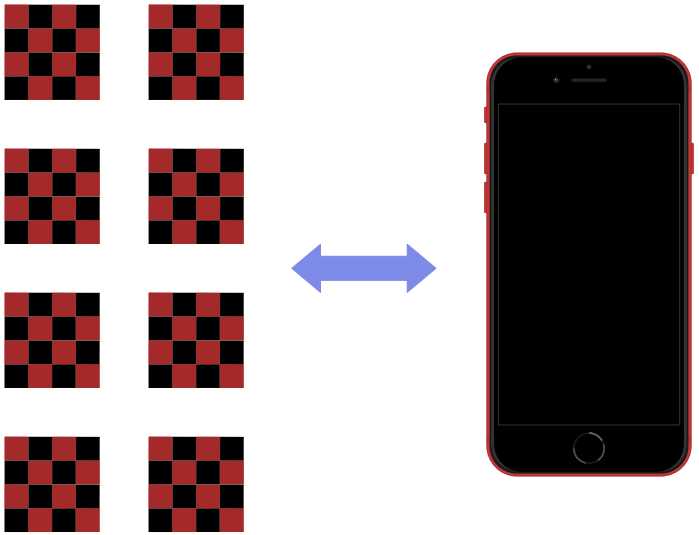

15K x

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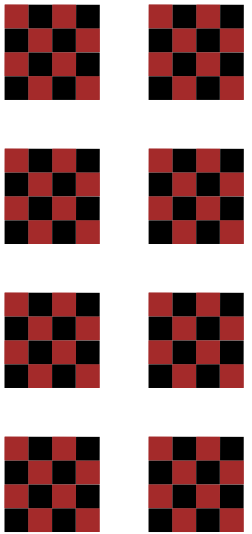

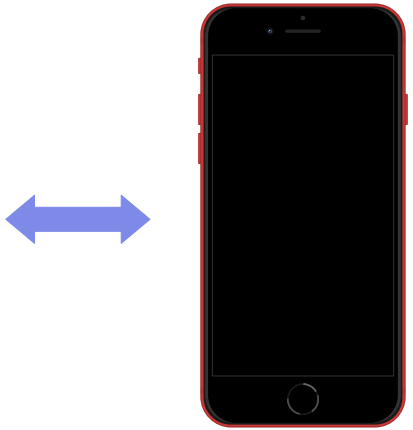

15K x

Research project: 100K x

15 bil x

Production challenges,

- Lattices take a long time to produce
- High cost in time, energy, money

Production challenges, thinking about the future:

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Source: EPM Magazine

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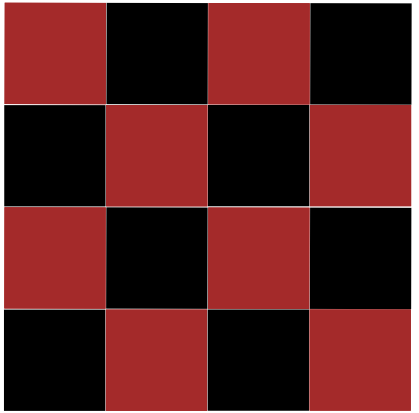
Some ways NFDI will help:

- Sharing optimized code
- Sharing lattices
- Sharing results

# We are working to meet these challenges!



**Particles, Universe, NuClei and Hadrons for the NFDI**

A consortium in the NFDI.

PUNCH 4NFDI