

Physics Acronym Left as an Exercise to the Reader

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1. A 2012 paper by a bunch of authors in the Simons Bootstrap Collaboration exploited crossing symmetry in this system to determine several parameters for it. Alexander Polyakov suggested reducing this model to a system of non-interacting Fermi strings. A 2014 paper by Andrew Lucas formulated a range of NP-complete problems in terms of this system for the purpose of adiabatic quantum optimization. This system's critical exponents can be analytically calculated in every number of (*) dimensions except 3, where determining the ground state is also NP-complete. Frustration produces a spin-glass in the presence of antiferromagnetic ordering in this model. For 10 points, name this model which models a magnetic material as a lattice of interacting spins.

ANSWER: Ising model [accept specific types like 3D Ising model]

2. The issue of searching a spatial region with Grover's algorithm is discussed in a paper by this scientist and Andris Ambainis. A 2018 paper by Raz and Tal on BQP/PH oracle separation relies on the "forrelation" problem proposed by this scientist. An essay by this scientist proposed quantifying morality in an iterated prisoner's dilemma using a modified version of PageRank, and wrote the essay "It's Hard To Think When Someone Hadamards Your Brain". The (*) Complexity Zoo was created by this man during his time at the University of Waterloo, and he collected his MIT lecture notes into the book "Quantum Computing Since Democritus". For 10 points, name this UT Austin professor and quantum computer scientist who runs the blog "Shtetl-Optimized".

ANSWER: Scott Aaronson

3. *Description acceptable.* A 1971 bombing at one of these places damaged \$45000 of equipment, but neither the perpetrator nor their motives were ever identified. They're not hospitals, but the term "culture of no culture" was used to describe one of these places in an ethnography by anthropologist Sharon Traweek. Phillip Anderson and Nico Bloembergen testified before congress to oppose the construction of one of these places, though its budget was never reappropriated for the causes they supported. A collaboration between one of these places and LNGS resulted in an anomalous (*) time-of-flight measurement that was eventually traced to a cable malfunction, and that place of this type is currently undergoing a "high-luminosity" upgrade. For 10 points, identify these research facilities, the largest of which was built near Geneva by CERN.

ANSWER: particle accelerator laboratories [prompt on physics laboratories; prompt on Department of Energy national labs before "anomalous"; accept SLAC and prompt on universities before "construction"]

4. *Description acceptable.* One approach to doing this, which relies on assembling nets of operators from a C-star algebra, was proposed by Haag and Kastler. Another approach to this task can be generalized by an analytic continuation to Euclidian space via the Osterwalder-Schrader theorem. One approach to this task relies on statements about the fact that components of a certain object are operator-valued distributions over Schwarz spaces, and the existence of a Lorentz-invariant vacuum state. Arthur (*) Wightman laid out several propositions with the aim of, for 10 points, what goal of providing a rigorous foundation for a framework which combines quantum mechanics and relativity?

ANSWER: axiomatizing quantum field theory [prompt on axiomatizing quantum mechanics]

5. Modeling this class of substances with Kohn-Sham DFT is often prohibitively expensive, necessitating an orbital-free approach, while treating nuclei semi-classically. The intersection of a line for which $\beta\mu = 1$, and one for which $kT = E_F$ is the center of an elliptical region corresponding to this kind of substance on logarithmic density-temperature plot. The most notable occurrence of this substance is within (*) inertial confinement fusion. For 10 points, name this type of matter for which the kinetic and potential energies of electrons are comparable, which shares characteristics of plasma and condensed matter.

ANSWER: warm, dense matter

6. The Chen-Gackstatter family generalizes one of these objects, and they be grouped into Bonnet families. These things can be parametrized as $x = f - g^2$, $y = f + g^2$, and $z = fg$, where f is analytic and g is meromorphic. A conformal map corresponds to one of these things if at critical points of the Dirichlet energy, and a periodic one of these, for which the sum of the cosines of every coordinate is zero, is named for Schwarz. Another of these (*) surfaces is named for Enneper, and these objects have zero mean curvature. Other examples include the catenoid and helicoid. For 10 points, name these surfaces exemplified by soap films.

ANSWER: minimal surfaces

7. *Description acceptable.* Most software distributed by TechX is for performing this task, as is the XGC codebase. Gyrokinetics allows one to reduce dimensionality from 6 to 5 in this task by exploiting adiabatic invariants, and Birdsall and Langdon authored a classic text on methods for doing this. Sampling a distribution function with phase space macroparticles interacting with a grid is the basis of the (*) PIC method for doing this. Performing it kinetically requires discretizing the Vlasov-Maxwell equations, but it can also be done by numerically solving magnetohydrodynamics equations on a grid. For 10 points, identify this task which a computer is used to numerically model a state of matter found in fusion reactors.

ANSWER: simulating a plasma

8. It's not "quantum", but a theory described by this adjective expresses the action in terms of the 3-form " $dA \wedge A$, plus two-thirds $A \wedge A \wedge A$ ". The Atiyah-Segal axioms concern a class of theories described by this adjective, the most notable of which is named for Chern and Simons. Qubits described by this adjective usually rely on non-abelian anyons. States described by this adjective are characterized by (*) fractional excitations. The degenerate ground states of the fractional quantum Hall effect have this sort of order, which Kosterlitz, Thouless, and Haldane received the 2016 Nobel for characterizing. For 10 points, name this adjective which describes a class of insulators with conductive surfaces due to symmetry-protected states.

ANSWER: topological [accept word forms]

9. Much of the recent research in Mike Zaletel's group has focused on the analysis of symmetry breaking and characterization of ground states in this material. Allan MacDonald's group determined via numerical methods that electron tunneling velocity vanishes at a certain parameter for this system. The 2020 Wolf physics prize concerned this material, which was first observed by (*) Pablo Jarillo-Herrero's group at MIT. This material's most notable property, which occurs via band flattening at an angle of roughly 1.1 degrees. Unconventional superconductivity results from a Moiré superlattice, for 10 points, what material made of two overlaid carbon sheets at an angle?

ANSWER: magic angle twisted bilayer graphene [prompt on partial answer]

10. This conjecture's original formulator used a result on expanding pseudorandom sets in Grassman graphs to prove its weaker "2-2" version. A 2010 paper by Arora, Barak, and Steurer put forth a sub-exponential approximation algorithm for this conjecture's central problem. If this conjecture is true and P is not equal to NP, the best known approximation ratio for max-cut is optimal. Originally proposed by Subhash Khot, this conjecture is often formulated in terms of a promise problem for a two-prover one-round (*) game, and implies bounds on the completeness and soundness of probabilistically checkable proofs for NP problems. For 10 points, name this conjecture, which states that determining the number of satisfiable constraints for a graph coloring is NP-hard.

ANSWER: unique games conjecture [or UGC]

11. Stony Brook University's XSB is a superset of this language with support for memoization and higher-order logic. This language's most widely used implementation is its "SWI" version, which includes a built-in web framework. Expressions in this language's "pure" subset are restricted to Horn clauses, which are expressed using a colon followed by a hyphen. A question mark followed by a hyphen is used to express (*) queries in this language, and its statements are divided into "facts" and "rules". Despite being nothing like Perl, this language uses the ".dot.pl" file extension. For 10 points, name this declarative programming language which is basically a constraint solver.

ANSWER: Prolog

12. *Note to players: this is an exceedingly stupid 3-way mashup involving identical acronyms, not before-and-afters. All 3 parts are academic. You have been warned.* This result, which can be used to determine transport coefficients in an insulator-superfluid transition, predicts that a "Cousin's whistle" can be used to revive a group of Albanians. Because of this result, both type IIB supergravity and N=4 supersymmetric Yang-Mills theory suggest that Don Alfonso won a 100-sequin bet because the title character was not given "soul" by Lucrezia, and thus could not rise to meet Rafael. In one example of this relationship, the line "ah but a man's reach should exceed his grasp" reflects the unfaithfulness of Ferrando and Guglielmo's fiancées, possibly resolving the black hole information paradox. Juan Maldacena theorized, for 15 points, what relationship between a Robert Browning poem about a "faultless painter" and a Mozart opera defined on its boundary? (*)

ANSWER: "Andrea del Sarto" / Così fan tutte correspondence [accept "duality" in place of "correspondence"; prompt on anything involving AdS/CFT]