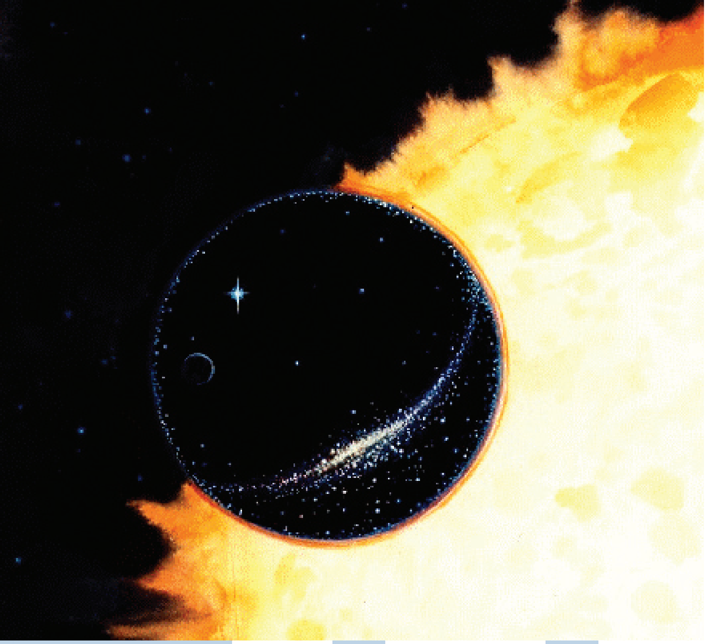

Think

Quantum Leap

The Physics of Field Theory

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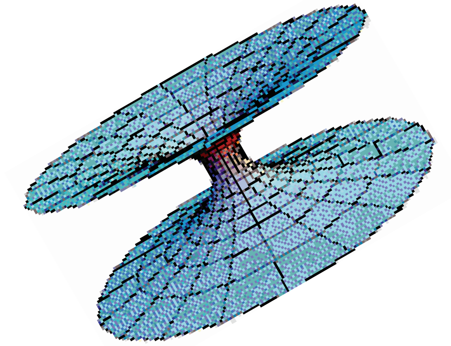
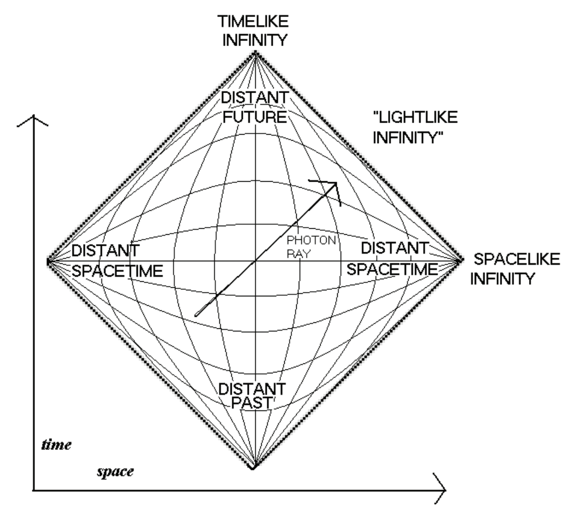
The USU Field Theory Group explores some of the underpinnings of our current theories of space, time, matter, and its interactions. What are the underlying symmetries of all physical laws? What makes a conserved quantity, e.g., energy, conserved? How does matter curve space and time to produce a gravitational field? How does the way we measure the world limit what we can know about the world? What is a quantum field? What is supersymmetry? What happens when you combine quantum theory and general relativity? What happens when two black holes collide? These are the kinds of questions which you can expect to encounter if you work with the Field Theory Group.

Gravitational Physics

The dominant area of activity in the Field Theory Group involves research into gravitational physics from two different perspectives. The first starts from our current best theory of gravity: Einstein's General Theory of Relativity. Research from this perspective involves investigations into the foundations of the theory: the mathematical structure of the Einstein field equations, the theory of conservation laws in general relativity, the Hamiltonian formulation of gravitational dynamics, the theory of spacetimes with symmetries. Applications include the study of inhomogeneous cosmological models, the study of binary black hole spacetimes, and the



study of small-scale causality violations. The second perspective starts from a fundamental symmetry of measurement—conformal transformations. Using this symmetery we construct a new class of geometries containing the space-times of General Relativity. Research on these spaces reveals unexpected relationships between general relativity and gauge theories, as well as insights into Hamiltonian and Lagrangian mechanics. The supersymmetric generalization of these geometries are also a subject of study, and possible relationships with superstring theory are being explored.



Is This for You?

Are you one of those people who like to repeatedly ask "Why? why? why?" Do you find yourself attracted to physics problems which involve elegant mathematics? Are your favorite physics courses mechanics, electrodynamics, quantum mechanics and mathematical physics? Are your favorite mathematics courses topology, analysis, linear algebra and differential equations? Are you the kind of person who enjoys teaching yourself? If so, the Field Theory Group may be right for you.

Interested?

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Quantum Theory of Gravity?

Perhaps the greatest challenge in theoretical physics is to create a quantum theoretic description of the gravitational field. To create such a theory will require advances in quantum field theory and general relativity, and then some. Efforts at USU involve studying the spacetime foundations of quantum field theory, studying the quantum theory of gravitational waves and inhomogeneous cosmologies, and generalizations of general relativity based upon conformal symmetry and conformal supersymmetry.

$$G_{\mu\nu} = 8\pi T_{\mu\nu}$$

Mathematical Physics

The language of physics is mathematics. Many areas of research within the Field Theory Group involve working with and developing mathematical techniques which are of interest in their own right. These include: variational principles and the variational bicomplex for field theories, mathematical foundations of quantum mechanics and quantum field theory, the theory of hyperbolic, elliptic and mixed type partial differential equations, initial value and boundary value problems, and various geometrical methods in physics.

$$S[g] = \int d^4x \sqrt{|g|} R(g)$$

Unified Field Theories

Are the diverse features of the universe just various facets of one underlying structure? Can all matter and its interactions be explained by a single unified field theory? Research at USU approaches this possibility via the notion of conformal supersymmetry.