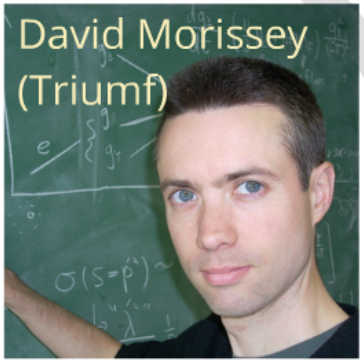
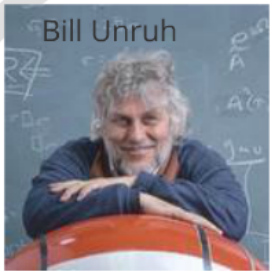
High energy theory

and

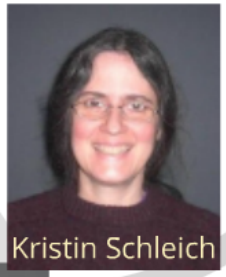
gravity





Particle Phenomenology
Astroparticle
Cosmology

Gravity



String Theory

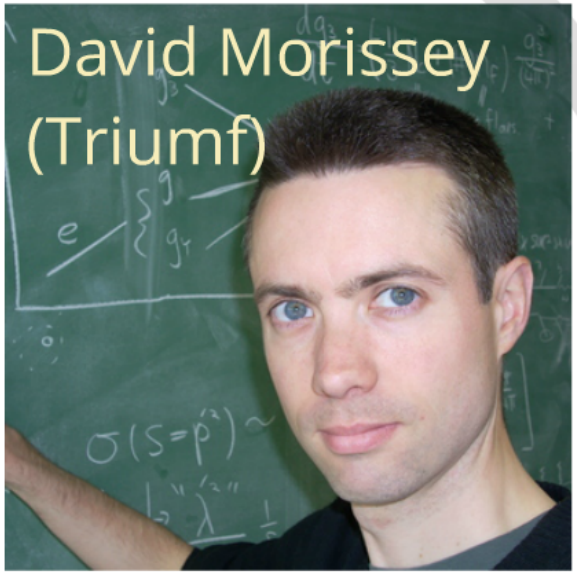
A large and interacting group of faculty, postdocs and graduate students, with lots of opportunities for collaboration.

Weekly events:

String Theory seminar / group meeting
Gravity seminar / group meeting
Astroparticle seminar / group meeting
Also of interest: Quantum Information seminar

Courses:

QED, Quantum Field Theory, Standard Model, String Theory, Group Theory, Topics in GR, Cosmology, Stat. Mech., Quantum I,II



Particle Phenomenology
Astroparticle
Cosmology

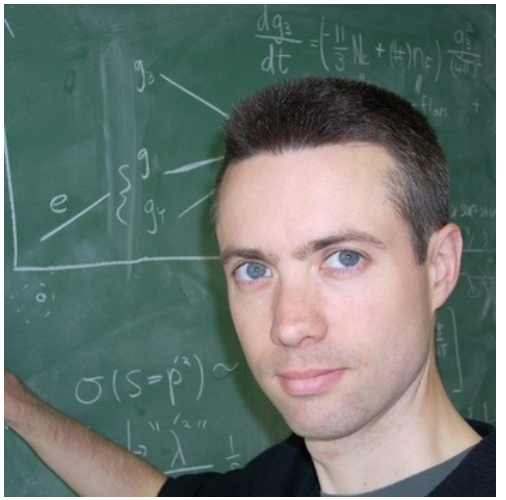
Kris Sigurdson

My theoretical research interests span **cosmology and its connections to fundamental particle physics and string theory**.

What physics do we need to explain **Dark Matter? Dark Energy? Inflation?**

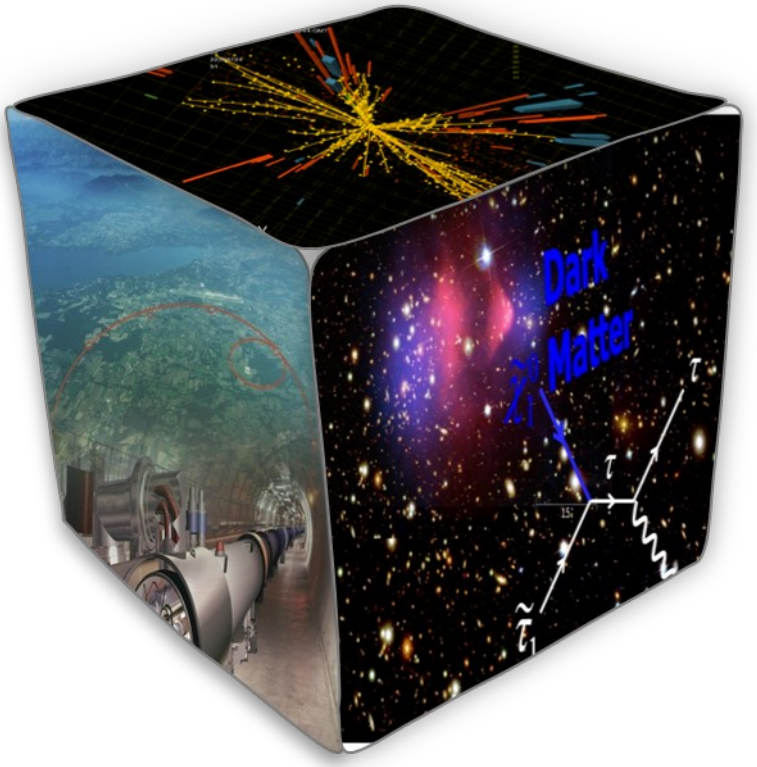
Recent work has focused on the physics of particle dark matter, the effects of dark-sector physics on cosmological perturbations and the subsequent evolution of the Universe, and new cosmological probes of early Universe and the standard cosmological model.

David Morissey



Elementary Particle Physics

- **New particles and interactions** (e.g. supersymmetry, extra dimensions, strong forces)
- Interpretation and explanation of **LHC data**
- Candidates for **dark matter**
- Origin of the **matter-antimatter asymmetry**
- Ways to test this stuff **experimentally**



Eric Zhitnitsky

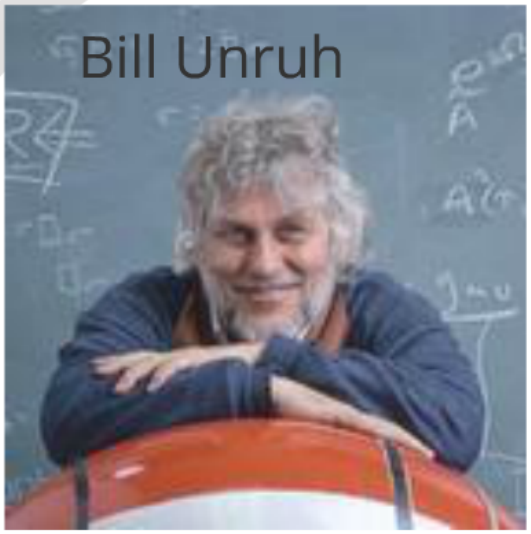
I work on **Quantum Chromodynamics (QCD)** in the unusual environment when **temperature, chemical potential**, the so-called **theta parameter are non-zero**. Such a study is important in the area where the **particle physics / nuclear physics / astrophysics / cosmology** are overlapped.

1. Physics of early Universe at the QCD phase transition (extreme environment): the dark matter problem, baryogenesis, etc.

2. New phenomena at the QCD scale which can be experimentally tested in heavy ion collisions at RHIC, Brookhaven, where such unusual environment can be achieved.

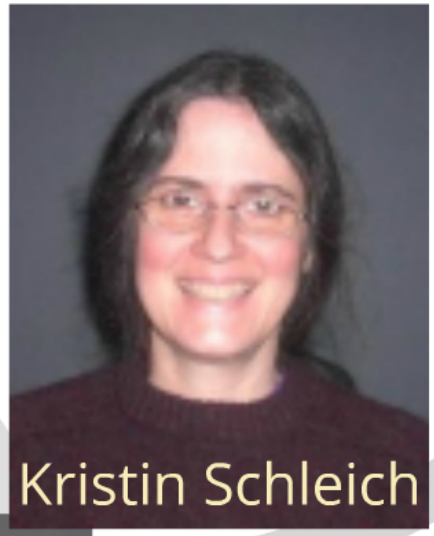
3. Study of the QCD phase transitions as function of temperature, chemical potential, theta parameter. Some of the ideas can be experimentally tested at RHIC.

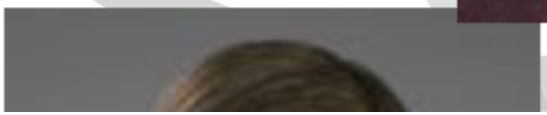
enology



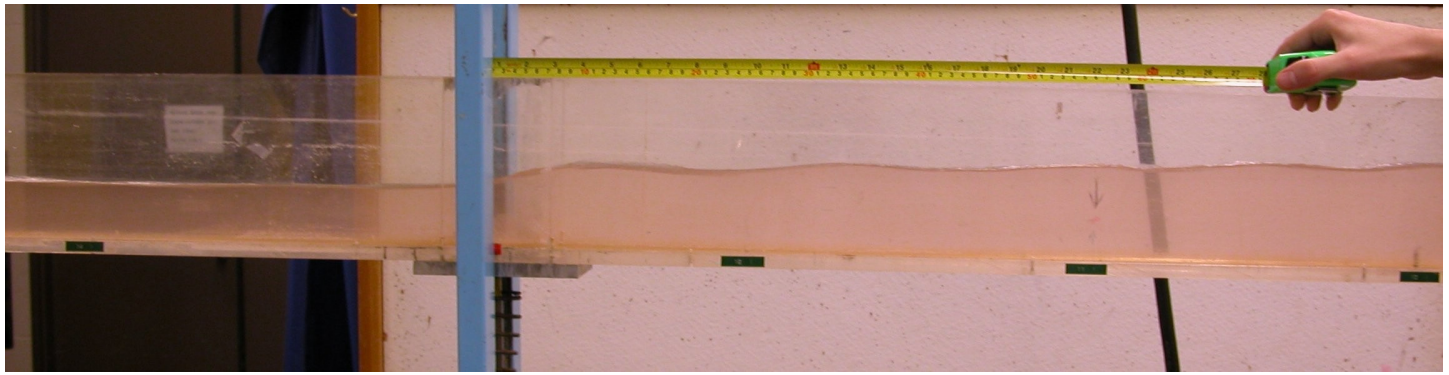
Gravity

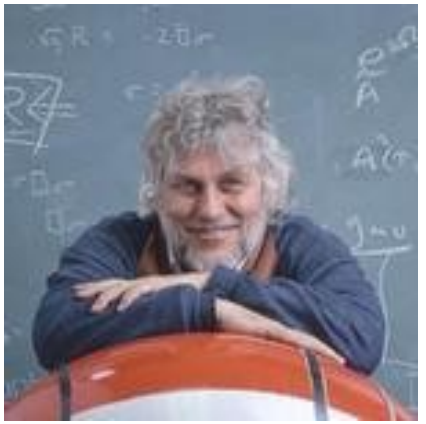
Matt Choptuik





Bill Unruh





• **Dumb Holes**: It turns out that much of the physics around **black holes** can be **modeled in analog systems** (eg sound waves or surface waves in fluids) which can give clues to where the particles in black hole evaporation come from.
[picture of fluid flow above]

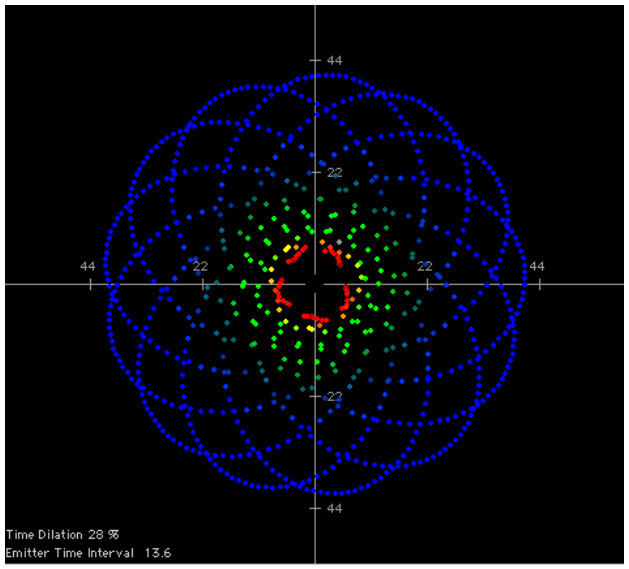
• **Quantum Mechanics and Gravity**: Quantum behavior around black holes, quantum effects in the very early universe.

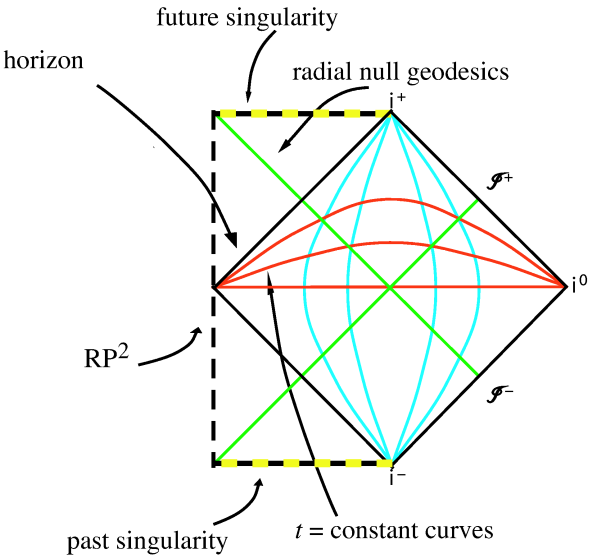
• **Foundations of Quantum Mechanics**: What is the best way of interpreting and understanding quantum theory? What makes quantum computers more powerful than classical?

Kristin Schleich
Don Witt

Classical relativity and quantum gravity, especially the role **topology** plays in the classical and quantum dynamics of our universe.

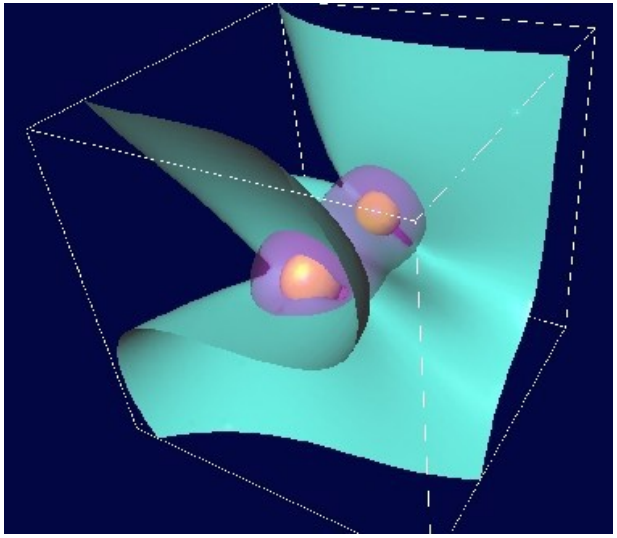
General relativity in **higher dimensions**, with a focus on problems related to **M-theory and string theory**.

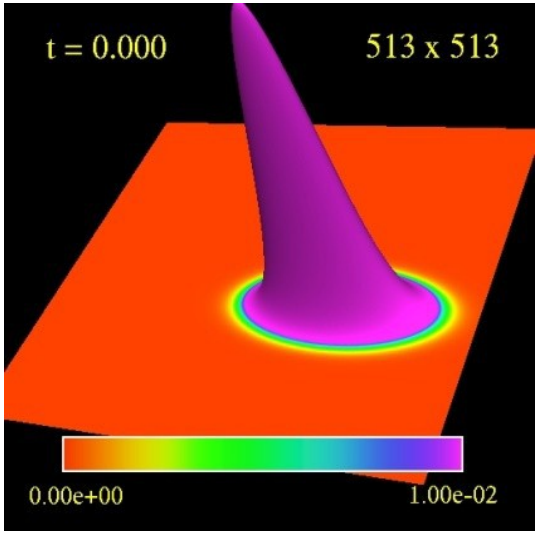


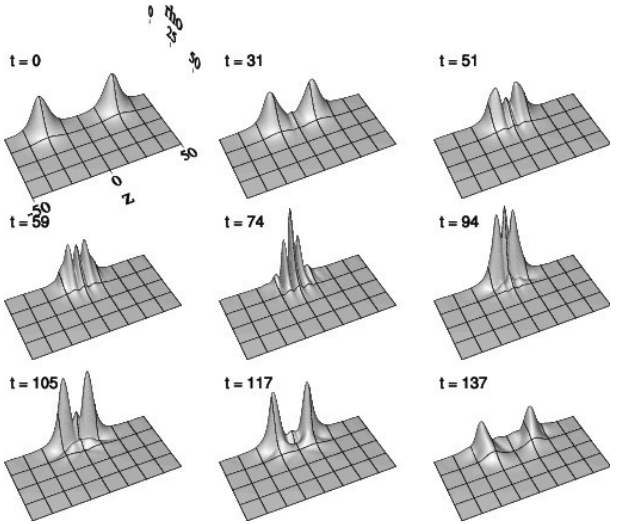


Matt Choptuik

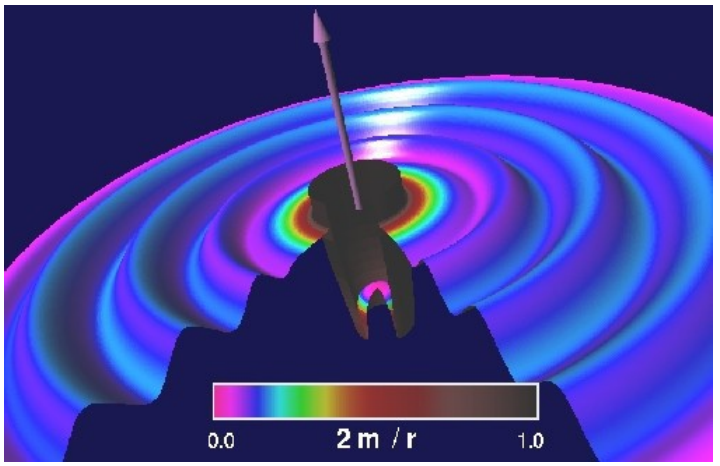
Numerical relativity at UBC:
see **http://laplace.phas.ubc.ca** for more info.



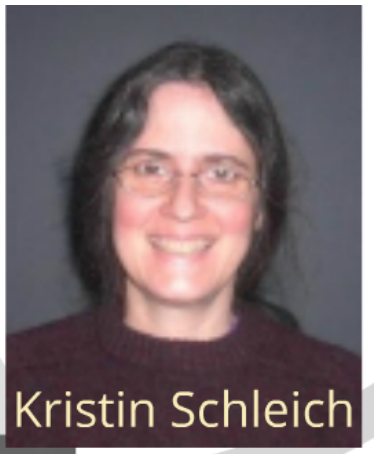




Initial data for **black hole collision;** solution of 2D diffusion equation; head-on **collision** of boson stars; **critical collapse** of a massless scalar field.



Astroparticle Cosmology



String Theory

Mark van Raamsdonk

String theory, quantum field theory, quantum gravity, cosmology.

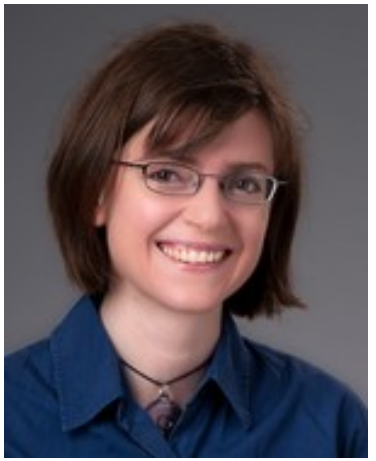
- How are the degrees of freedom **entangled** in a quantum field theory?
- Why are some **quantum field theories dual to gravitational theories** and how does **spacetime emerge** in these examples?
- Can we give a nonperturbative description of **quantum gravity on cosmological spacetimes**?

Gordon Semenoff

I work on **theoretical elementary particle physics, quantum field theory and string theory**:

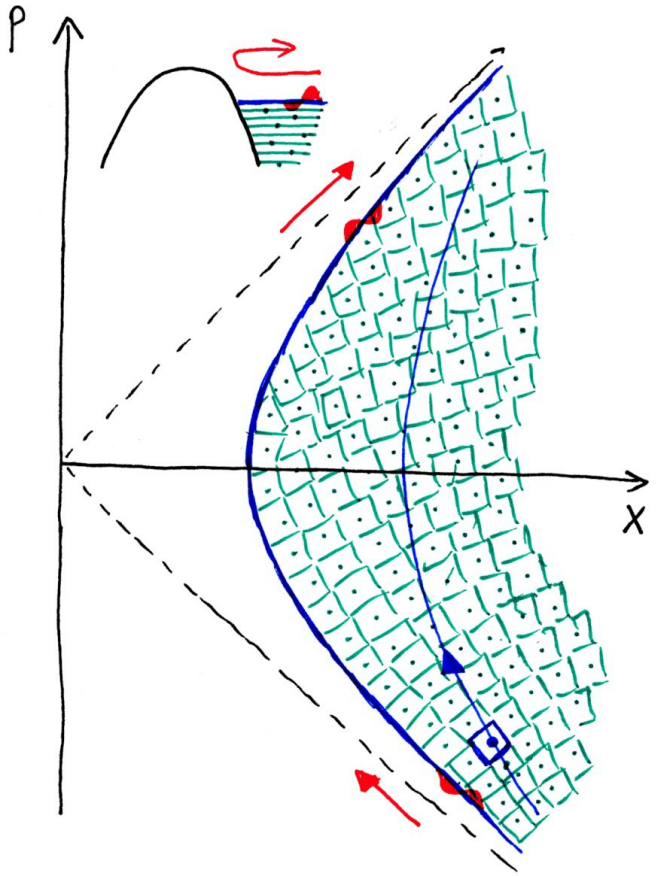
- **duality** between gauge field theories and string theory
- related issues in quantum field theory, particle physics, quantum gravity
- basic properties and solutions of string theory

Joanna Karczmarek



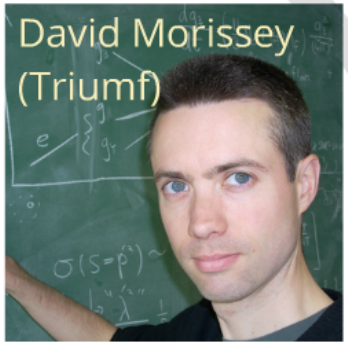
String theory and matrix models:

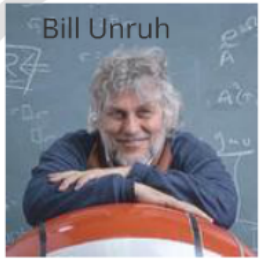
- Where does **space** come from?
- Where does **time and its properties** (e.g. arrow of time) come from?
- Where do **geometry and gravity** come from and what do they mean?



Moshe Rozali

I am mostly interested in understanding **string theory as quantum gravity**. The study of **black holes** in string theory has found novel and surprising ways in which the apparent **contradictions between quantum mechanics and general relativity** are resolved. It also has side-benefits, e.g a better understanding of the physics of the quark-gluon plasma, currently probed by heavy ion collisions at RHIC. Extension of the **holographic methods**, which started their life as ways to understand black hole physics, now seem as a universal **tool to study strongly coupled system,** including in **condensed matter physics**.





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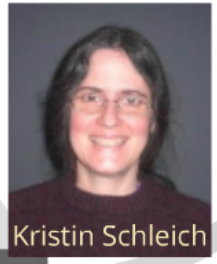

String Theory