Supercomputers are laboratories that can be used for exploring any kind of problem. Supercomputing, or High Performance Computing, lets astronomers perform "experiments" on how stars form that would never be possible in any lab; allows Formula-1 racing teams to judge dozens of new car designs in a fraction of the time and cost it would take to build a prototype model for even one; and allows researchers in the history of music to look for common threads in collections of songs that span centuries and continents.

The computers at SciNet can do in an hour what would take a single PC years to complete, if it were even possible to get the problem to fit on a single computer. This sort of power does more than give researchers the same answer, faster; it allows them to ask questions that could never have been asked before, and to explore problems facing Canada in entirely new ways.

SciNet gives Canadian Science the expertise and resources they need to understand our Universe, to design new drugs, and to build nanomachines. Here is just a small sampling of the work that is SciNet-powered.

Tracing Life's Family Tree

Using supercomputers to find patterns in genes and find in species

Biologists have in the past decade been deluged with high-quality genome data, and the challenge now is to sort through it all and make discoveries through finding patters. A hugely multidisciplinary group including researchers from The Hospital for Sick Children, Departments of Molecular Genetics, Cell and Systems Biology, the Centre for Analysis of Genome Evolution and Function, and the Department of Biochemistry at the University of Toronto have built a web-based tool to help researchers make these discoveries and find connections between seemingly distantly-related species. (Image from Xiong et al. 2011. "PhyloPro: a web-based tool for the generation and visualization of phylogenetic profiles across Eukarya", Bioinformatics, 26:6.)

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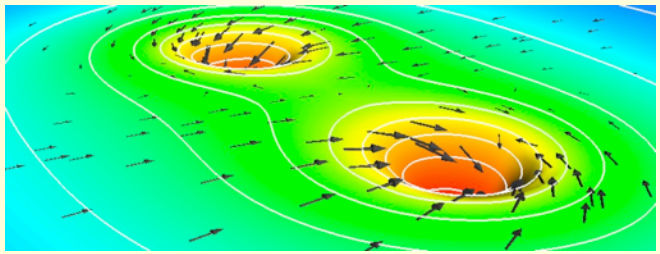
Supercomputers at Work

SciNet offers researchers more than just access to computers. SciNet is also a team of researchers, computer scientists, and educators, who apply their expertise to make sure that researchers from across Canada can make the most of these powerful tools for discovery.

SciNet teaches classes, works with researchers, and with colleagues across Canada and the world developing tools and techniques to prodce the capabilities Canadians need. **SciNet also works with schools and other groups** to explain the power of computing to drive discovery.

SciNet's computers are the biggest in Canada. With 73 TB of RAM, almost 2000 disk drives providing 1,500 TB of storage, and 42 km of cable, and there is no problem too big. The computers are in a highly energy-efficient data centre, saving an amount of energy equal to that used by 500 Toronto-area homes.

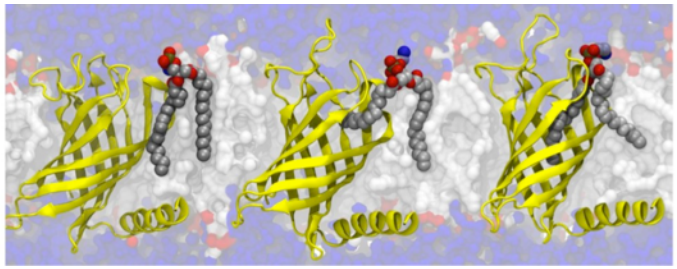
And SciNet is not alone. SciNet is part of Compute Canada, a group of sister organizations crossing Canada providing computing resources and expertise to all Canadian researchers.



Watching Black Holes Dance by the Ripples in Space-Time

Supercomputers solve Einstein's equations to undertand them better

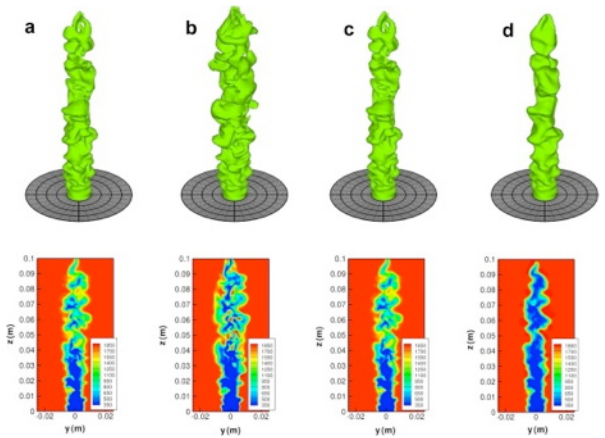
Upcoming experiments aim to measure ripples in space-time caused by orbiting black holes. If Einsten's predictions are correct, then these gravitational waves should permeate the Universe, being sent off whenever these massive objects orbit each other. These ripples are fiendishly difficult to measure, and the only way to identify them is compare them to known signals - but we can't orbit black holes in any laboratory. At the Canadian Institute for Theoretical Astrophysics, a group led by Harald Pfeiffer uses SciNet resources to predict what these experiments may see.



Towards Less Drug-Resistant Diseases

Using supercomputing to understand how drug-resistance develops - and stop it.

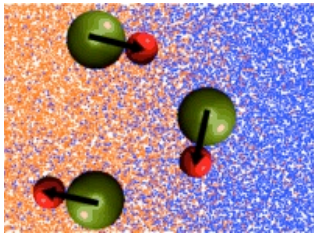
Our immune system destroys bacteria before they reproduce. For some people, however, a weakened immune system is unable to clear the invaders on its own. Researchers at The Hospital for Sick Children, led by Regis Pomés, use Scinet to investigate how antimicrobial agents function in molecular detail, a key step toward rationally designing new antibiotic drugs that work in similar ways.



Burning Better, Cleaner on a Virtual Bunsen Burner

Better living through better combustion

Combustion powers much of modern technology, and reducing emissions and increasing efficiency requires deeply understanding this process. Researchers at the Institute for Aerospace Studies at University of Toronto, led by Clinton Groth, use SciNet to understand flames and their properties. (Image from Hernandez-Prez, Yuen, Groth, Gulder 2011. LES of a laboratory-scale turbulent premixed Bunsen flame using FSD, PCM-FPI and thickened flame models. Proceedings of the Combustion Institute. 33(1):1365-137.)



Nanomotor Catches a Wave, Hangs Ten

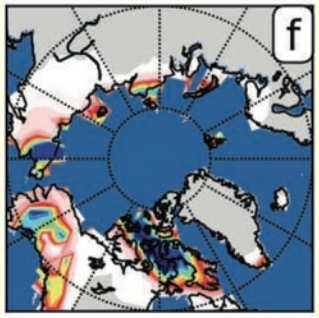
How to design the unseeably small

Scientists at the University of Toronto's Department of Chemistry led by Ray Kapral, working with colleagues at Han Zhou Dianzi University of China, use SciNet resources to design the behaviour of nanomotors - devices that will be the engines for future nanotechnology. (Image from Thakur, Chen, Kapral 2011. *Interaction of a Chemically Propelled Nanomotor with a Chemical Wave.* Angewandte Chemie International Edition.)

Telescope Atop the World Sees History of Universe

Finding Needles in Cosmic Haystacks

One of the highest telescopes in the world in the plains of Chile, the Atacama Cosmology Telescope's structure is the size and weight of a house, and spins back and forth twice a second. This telescope generates Terabytes of data every month - and deep within those piles of data are signals from the dawn of our modern Universe, echos of the Big Bang. Scientists from this international project need SciNet's power to analyze the data and decode our most distant past.



Protecting a Warmer Canada: Predicting how to Adapt to Climate Change

Better living through better combustion

Combustion powers much of modern technology, and reducing emissions and increasing efficiency requires deeply understanding this process. Researchers at the Institute for Aerospace Studies at University of Toronto, led by Clinton Groth, use SciNet to understand flames and their properties. (Image from Vettoretti & Peltier 2011. *The impact of insolation, greenhouse gas forcing and ocean circulation changes on glacial inception.* The Holocene..)